Institution: Bournemouth University

Unit of Assessment: 14

Title of case study: Avoiding extinction: conservation initiatives to save a critically endangered giant freshwater fish in India

Period when the underpinning research was undertaken: 2012 – 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Adrian Pinder	Director, Bournemouth University Global Solutions	2013-current
Professor Robert Britton	Professor in Invasion and Fish Ecology	2007-current

Period when the claimed impact occurred: 2017 – 31 December 2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact (indicative maximum 100 words)

Researchers at Bournemouth University (BU) worked with state government departments, academic colleagues, a multi-national utility provider, fishery professionals, educators, non-governmental organisations (NGOs) and local communities in India to prevent an iconic giant freshwater fish from becoming extinct. This work encompassed rescuing the orange-finned mahseer from scientific obscurity and placing it at the forefront of conservation measures across India and southeast Asia by:

- taxonomic identification, enabling its assessment and listing as a critically endangered species.
- influencing breeding and stocking policies of the species in India and beyond.
- designing monitoring programmes to reduce extinction risk and provide transferable lessons in fish conservation.
- raising societal awareness of the fish's cultural, recreational and economic significance.

2. Underpinning research (indicative maximum 500 words)

In 2010 Pinder was fishing in the Western Ghats of southern India and realised that the number and types of mahseer fish being captured did not reflect the historical angling records for the region [R1, R2]. His rapid initiation of a mahseer research programme with Britton led to the identification [R1, R2, R3] and conservation [R2, R4] of a fish now known to be at imminent risk from extinction [R3, R5, R6].

The two mahseers

The hump-backed, orange-finned mahseer (subsequently referred to here as the orange-finned mahseer) is one of the world's largest freshwater fish and is unique ('endemic') to the Cauvery River basin. Of high global angling significance due to its size (>50kg), its spawning migrations have been threatened by dam building since the early 1900s, leading to decreasing fish numbers. This has since been compounded by unsustainable harvesting that created local food security problems as the fish was an important protein source. Nevertheless, the fish generated important income from international sport anglers since the 1980s, attracted to sustainable,

catch-and-release mahseer angling conducted from remote, jungle fishing camps within a Protected Area (PA) [R6].

Concerned about aquatic biodiversity and unsustainable practices from their hydropower schemes in the Western ghats, Tata Power (an Indian-based multi-billion, multinational utility company) instigated the 'Mahseer Conservation Programme' in 1975, involving releasing hatchery-reared mahseer to bolster their populations and mitigate the impacts of the dams [R2]. This appeared successful: by the 2000s, angler catches suggested a large, healthy population of endemic mahseer. However, the opposite was actually true: this yet to be described, large-bodied mahseer was rapidly heading for extinction while the reared mahseer, an alien, smaller species, was rapidly invading the Cauvery River.

Observations and anglers' records

In 2010, Pinder visited a long-established, sustainable catch-and-release mahseer angling camp as a recreational angler. Failing to capture the orange-finned mahseer, he observed that a smaller, blue-finned mahseer was frequently caught, despite never appearing in historical angling records. After negotiating access to analyse angler log books for the years 1998-2012 (the only data available, with none available since 2012 due to a national angling ban in PAs), together with Britton and Dr Rajeev Raghavan from India's Kerala University of Fisheries and Ocean Studies, it was discovered that, overall, mahseer catches by number had increased over time but decreased by weight - indicating strong mahseer recruitment and suggesting population sustainability [R1]. However, they then discovered that, by 2012, virtually all captured mahseer were blue-finned [R2]. Over time, the individual weights of the orange-finned mahseer had also increased substantially. In combination, these results indicated recruitment collapse in the orange-finned mahseer, leaving behind an ageing population of high extinction risk, which had effectively been replaced by the blue-finned mahseer [R2].

Resolving the taxonomy of an endangered species

Despite this ground-breaking revelation, it was clear that the orange-finned mahseer had yet to be afforded a valid scientific name, preventing formal assessment of its extinction risk and its recognition as a conservation priority. Despite immense environmental challenges, working in extremely remote and dangerous areas, as well as the technical and logistical difficulties in taxonomically defining species, Pinder and Britton, along with their Indian collaborators, formally identified the orange-finned mahseer in 2018 as *Tor remadevii* and confirmed it as endemic to the Cauvery Basin [R3]. They demonstrated that the *T. remadevii* population of the Cauvery basin had been reduced by 90% in both their abundance and their distribution range [R2, R5, R6]. It was also apparent that the blue-finned mahseer was the alien *Tor khudree*, which was present only due to the Mahseer Conservation Programme [R6].

Significance and conservation

During this time, Pinder and Britton were advising Tata that they had inadvertently been releasing the alien, highly invasive blue-finned mahseer into the Cauvery River, rather than the endemic orange-finned mahseer [R2]. A lack of monitoring data - common for remote rivers in developing countries - meant this mistake had gone unnoticed until the work of Pinder and Britton [R1, R2], who then managed to persuade Tata to take a corrective conservation course [R6]. As effective species conservation requires the recognition of values beyond local existence, Pinder and Britton also started to generate new knowledge to highlight the cultural and religious significance of the mahseer. They discovered that the species is referred to as 'God's fish', and has been revered for millennia by tribal societies, with pottery paintings depicting them dating back to 3,000 BC [R4]. With conservation and education efforts now commenced [R2, R4], Pinder and Britton have fundamentally altered the fate of the orange-finned mahseer [R6].

3. References to the research (indicative maximum of six references)
R1-6 have all been subject to rigorous peer review.

R1: Pinder, A. C., Raghavan, R. and Britton, J. R. (2015). "Efficacy of angler catch data as a population and conservation monitoring tool for the flagship Mahseer fishes (Tor *spp.*) of Southern India," *Aquatic Conservation: Marine and Freshwater Ecosystems* 25: pp.829–838.

R2: Pinder, A. C., Raghavan, R. and Britton, J. R. (2015). "The legendary hump-backed mahseer *Tor* sp. Of India's River Cauvery: an endemic fish swimming towards extinction?" *Endangered Species Research 28*: pp.11-17. https://doi.org/10.3354/esr00673

R3: Pinder, A. C., Manimekalan, A., Knight, J. D. M., Krishnankutty, P., Britton, J. R., Philip, S., et al. (2018). "Resolving the taxonomic enigma of the iconic game fish, the hump-backed mahseer from the Western Ghats biodiversity hotspot, India," *PLoS ONE 13*: e0199328. https://doi.org/10.1371/journal.pone.0199328

R4: Bower S. D., Danylchuk, A. J., Raghavan, R., Danylchuk, S. C., Pinder, A. C., Alter, A. M. and Cook, S. J. (2017). "Involving recreational fisheries stakeholders in development of research and conservation priorities for mahseer (*Tor* spp.) of India," *Fisheries Research 186*: pp.665–671. https://doi.org/10.1016/j.fishres.2016.05.011

R5: Pinder, A. C., Britton, J. R., Harrison, A. J., Nautiyal, P., Bower, S. D., Cooke, S. J., Lockett, S., Everard, M., Katwate, U., Ranjeet, K., Walton, S., Danylchuk, A. J., Dahanuka, N. and Raghavan, R. (2019). "Mahseer (*Tor* spp.) fishes of the world: status, challenges and opportunities for conservation," *Reviews in Fish Biology and Fisheries 29*: pp.417-452. https://doi.org/10.1007/s11160-019-09566-y

R6: Pinder, A.C., Raghavan, R. and Britton, J.R. (2020). "From scientific obscurity to conservation priority: Research on angler catch rates is the catalyst for saving the hump-backed mahseer *Tor remadevii* from extinction". *Aquatic Conservation: Marine and Freshwater Ecosystems 30*: pp.1809-1815. https://doi.org/10.1002/aqc.3335

4. Details of the impact (indicative maximum 750 words)

Achieving formal recognition and 'Red-Listing' as Critically Endangered

BU's research clarifying the taxonomy of the orange-finned mahseer as *Tor remadevii* was vital in getting it classified as 'Critically Endangered'. As the International Union for Conservation of Nature (IUCN) confirmed, it represented "a critical step in achieving formal global recognition of the species and its subsequent consideration for assessment on the IUCN Red List of Threatened Species" [E1].

The Red List is the most authoritative, comprehensive inventory of the status of biological diversity, but, without a valid scientific name, species cannot be assessed and included. Pinder and Britton's work enabled the orange-finned mahseer to finally be assessed, with its 'Critically Endangered' assessment indicating a higher risk of extinction than the conservation icons giant panda and Bengal tiger, generating a high level of media attention [E2].

The IUCN also acknowledged Pinder and Britton's "novel use of angler catch records", which provided the "vital evidence" needed to support the Red-Listing. "Without the strategic "step-wise" research conducted by [BU], there is a very real possibility that this megafauna could have gone extinct without ever formally being recognised as a species." [E1]

Influencing breeding and stocking policies

International impact

BU's research elevated the orange-finned mahseer from scientific obscurity and potential extinction to international conservation priority. The Declaration of the First International Mahseer Conference 2018 recommended responsible stocking policies across the mahseer genus, found throughout India and southeast Asia. This included the recommended suspension of all hatchery culture and stocking programmes until agreement on the requirements for a

National Fish Stocking Policy were met, and regulations to eliminate the introduction of alien species [E3].

National policymaking impact
The conservation of the orange-finned mahseer was positioned at the forefront of national policymaking with the inclusion of specific guidance in India's Wildlife Action Plan. This instigated a long-term programme of the "removal of the blue-finned mahseer in the Cauvery" and the initiation of "special breeding programmes for threatened fish species such as orange-finned and golden mahseer" [E4].

Commercial practice impact
Tata Power's Mahseer Conservation Programme started in 1975. However, as environmental journalist Bahar Dutt noted, Pinder and Raghavan's "seminal" paper [R2] "proved to be a game changer", by highlighting Tata's unintentionally harmful stocking policies [E5].

Tata thus modified its programme and focused efforts on saving the orange-finned mahseer from extinction, launching a conservation programme in 2018 via an awareness drive with local schoolchildren. "[BU's research] helped deepen our understanding of the ecology of this fish… and… further strengthen our efforts, especially in the conservation aspect of our programme." [E6]

Conservation programme impact
The Forest Department of Madhya Pradesh State (a government body responsible for protecting forest resources, including aquatic environments) asked BU to share with them their "valuable insights" into mahseer conservation [E7]. The department acknowledged that the papers of Pinder, Britton et al. [R1, R2] alerted them to "the danger of stocking the readily available blue-finned mahseer in Madhya Pradesh and [its potential] to impact on the population stability of our indigenous mahseer *Tor tor* (the state fish of MP) and disrupt ecological equilibrium." They were able to "revisit and redefine" their priorities towards effective conservation "of our state fish and associated aquatic resources in [the] forested zone of Narmada and its tributaries." [E7]

Designing conservation programmes
Proving reductions in mahseer extinction risk will take many decades, due to its long lifespan and monitoring difficulties (compounded by the Covid-19 pandemic in 2020). Working with Tata, the Ministry of Environment, Forest and Climate Change, and the World Wide Fund for Nature India (WWF), BU helped develop a robust monitoring programme (initially due for implementation in late 2020, postponed due to Covid-19) that measures population responses and biological traits [E8].

WWF hope the Project Mahseer framework "will play a key role in generating the crucial data on current population status, genetic structuring and ecology of *Tor spp.*" These data will then be used to evaluate the success of conservation projects based on new breeding and restocking programmes in India and beyond, aimed at reducing extinction risk and providing transferable lessons in fish conservation to other Asian countries [E8].

Raising societal awareness of the orange-finned mahseer's significance
Together with Tata Power and the Mahseer Trust, BU launched outreach and education awareness programmes to communicate the cultural, religious, recreational and economic importance of the fish. Frank Anthony Public School in Bangalore described the team's visit in February 2018 as a "wonderful opportunity" for the students to learn about the conservation work being undertaken [E9].

They commented on the "unique and inspirational" educational sessions, which "captured the imagination" of many of the students, and which instilled "a lasting knowledge and fascination" in the River Cauvery, its wildlife and the effects of human interactions. It also helped the school develop its new curriculum area of Environmental Education and "enthused pupils to take action

and help educate others in the importance of healthy rivers and their sustainable management" [E9].

India's national angling body, the All India Game Fishing Association (AIGFA) adopted the orange-finned mahseer as its flagship species during events for World Fish Migration Day, using it to teach 2,160+ children in 14 Indian states about the importance of water and wildlife. "These interactions will no doubt have a lasting impact on the lives of these children and their families' appreciation of the natural world around them", commented AIGFA [E10].
AIGFA also used BU's research to develop best practice guidance to educate anglers about "the conservation benefits of catch-and-release angling and the importance of safe angling practices that… enhance the long-term survival prospects of Indian mahseer" [E10].

5. Sources to corroborate the impact (indicative maximum of 10 references)

E1:
E1a. IUCN. (2020). Letter to Pinder, 20 November.
E1b. Pinder, A., Katwate, U., Dahanukar, N. & Harrison, A. (2018) *Tor remadevii. The IUCN Red List of Threatened Species 2018: e.T56096394A56717605*. Available at: http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T56096394A56717605.en (Accessed 19 November 2020)

E2: Media evidence pack, comprising readership/viewer figures, articles from *Sci News*, NDTV (New Delhi Television Ltd), *The Times of India* and *The Hindu*.

E3: Philipp, D., Wangchuk, K., and Choden, S. (2019) *The First International Mahseer Conference Proceedings,* 2-9 December 2018, Paro, Butan. WWF Bhutan in collaboration with Ministry of Agriculture and Forests, Royal Government of Bhutan and Fisheries Conservation Foundation, USA.

E4: Ministry of Environment, Forests and Climate Change, (2017). *India's National Wildlife Action Plan*. [online] New Delhi: Ministry of Environment, Forests and Climate Change, p.51. Available at: https://wii.gov.in/images/images/documents/national_wildlife_action_plan/NWAP_Report_lo_Res_2017_31.pdf (Accessed 9 February 2021).

E5: Dutt, B., (2019). *Rewilding: India's Experiments in Saving Nature*. [New Delhi]: Oxford University Press India, pp. 90-108.

E6: Tata Power. (2016). Letter, 14 October.

E7: Forest Department of Madhya Pradesh State, India. (2018). Letter to Pinder, 15 January.

E8: World Wide Fund for Nature, India. (2020). Letter to Pinder, 3 August.

E9: Frank Anthony School, Bangalore. (2020). Letter to Mr. Lockett, December.

E10: All India Game Fishing Association. (2020). Letter to Pinder, September.