



ABSTRACT BOOK

**The 2nd International Mahseer Conference 2020
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PLENARY AND KEYNOTE ADDRESSES

Biodiversity and Research of Thailand's River Fishes

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Current Research on Thailand Mahseer

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Status of Migratory Fishes in Asia

Dr. Zeb Hogan, Professor University of Nevada-Reno and Host of the National Geographic television series "Monster Fish."



Current Status of Mahseer Taxonomy: 200 Years and Still Confused

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Threats and Opportunities for Asian rivers, Fish and People

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Asian rivers holding mahseer fishes are deeply interconnected with surrounding ecosystems, both terrestrial and aquatic, and highly interactive with the atmosphere. Mahseer species and the ecosystems within which they are integrated reflect the vitality of these connected ecosystems as they impinge on water quality, hydrology and habitat. Mahseer therefore indicate far more than just ecological health, also reflecting the capacities of these systems to sustain the needs of dependent human populations.

The United Nations announced a decade of ecosystem regeneration running from 2021 to 2030. This is part of wider global, and some national, recognition of the need to elevate common understanding and policy focus of many purportedly 'sustainable development' activities beyond a wholly inadequate de minimus perception of lightening human pressures on rapidly degrading ecosystems. Rather, this elevated perception needs to recognise, value and embed the stark realities that global ecosystems are in steep decline, and that this inevitably serially reduces their capacities to support the needs of growing human populations from the most basic of needs through to resources essential for economic progress and civil security.

Climate change vectored through temperature and hydrological trends and extremes, land use pressures and other demands from increasing human numbers, progressively more concentrated demands from an urbanising world and threats from alien species are all known problems. The strategic issue is how we address them by working with and finding ways to regenerate, rather than working in opposition to, natural resources and processes that constitute irreplaceable primary capital underpinning human needs.



Holistic Environmental Flow Modeling to Design a Basin-wide Protection Program for Golden Mahseer

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The 100 MW Gulpur Hydropower Project is a run-of-the river project built on the Poonch River, a tributary of the Jhelum River. The river was designated as a national park to protect the Endangered Mahaseer fish (*Tor putitora*) and is also home to the Critically Endangered Kashmir Catfish (*Glyptothorax kashmirensis*). Falling in a Critical Habitat as per IFC and ADB standards and policies and requirements of local regulations, the project needed to demonstrate a net gain in species. DRIFT (Downstream Response to Imposed Flow Transformation), a holistic environmental flow assessment model previously tested on similar rivers in Pakistan was applied to study the basin level impact of various flow and biodiversity management scenarios. Design and management scenarios with varying levels of protection were then developed in consultation with the park managers and conservation groups, and combinations of flow release, peaking, and protection levels were simulated. A non-peaking operation with a substantially reduced low-flow section was agreed upon and the project was redesigned accordingly. The results and subsequent monitoring over a four year period demonstrated that following redesign the gain achieved by better protection of the river far exceeded the loss due to the dam. The analytical and modeling frameworks developed have subsequently been applied in a number of project and basin level environmental flow assessments in the region since.



Current status of Mahseer rec fisheries across the region

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'God's Fish' For Sale - Mahseer as a Commodity

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Mahseer are equally revered as 'god's fish' and prized as the most delicious eating. They are both highly valued home aquarium fish and the focus of a rapidly growing aquaculture-based conservation drive. While many questions remain, even over such basics as correct identity at species level, we must ask: how can mahseer be sustainably useful as a commodity without further endangering precious wild stocks?

ABSTRACTS

Promotion of Mahseer Conservation through Pescatourism and Recreational Catch-and-Release Angling

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There are many effective conservation tools available to resource managers throughout the Mahseer range. Among these, the development of pescatourism and recreational catch-and-release angling programs are some of the least intrusive and most dynamic.

Pescatourism is defined as tourism designed to supplement incomes of fishermen and their communities in areas of declining or threatened fisheries through creative fisheries-based tourist activities including angling. Pescatourism is relatively new to the eco-tourism industry, an industry that generates US\$77 billion annually across the globe and is growing at an annual rate of 10 to 30%.

These programs have the potential to benefit mahseer in many ways, primarily through the financial contributions of anglers and eco-tourists and provide financial incentives to protect and conserve local fish stocks and the surrounding ecosystems that support them. Though exact figures are difficult to define based on limited data especially derived from developing nations, global financial contributions through recreational angling alone are estimated to total somewhere between US\$190 billion annually with the number of recreational anglers totaling between 220 and 700 million.

Local human populations also benefit through incentives to develop infrastructure - hotels, eco-lodges, restaurants, outfitted services and resultant job creation - whereby protection of mahseer which are often targeted through illegal harvesting practices such as poisoning, explosives use and electricity, becomes paramount in regions where poaching or overharvesting previously has held a predominant role. In sum, through pescatourism and catch-and-release angling programs, a live fish becomes worth more than a dead fish.



Golden Mahseer Angling: A tool for Conservation and Sustainable Development

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Sports Fishing of Golden Mahseer is a form of Eco-tourism, in the sub-Himalayan hilly rivers of North East India having 33 percent of India's total fresh water; the home of Golden Mahseer. Angling enhances environmental consciousness among people. It promotes healthy way of living, by associated oneself with nature and provides solution for sustainable development of the area. The catch, photograph, weight and release back to water are the order of the day for anglers today. In India there has been a shift of rural population towards urban areas in search of livelihood; Sports fishing can be an answer to job creation in the remote, hilly and difficult areas; it helps in data creation, creel census, research on fish in breeding and migration. The angling-tourism will provide a platform for area specific livelihood opportunities; this might help in counteracting urban migration and urbanization. The awareness generated through the eco-tourism will impart sense of belongingness to nature, particularly rivers, streams, rural heritage and culture of the area. There is need for capacity development for conservation, curriculum development for wildlife and fisheries people for training on sports fishing. There is a huge need for detail study on Mahseer migration, breeding in the nature, and breeding habitat. A number of international medical authorities reported that "It is healthy for people to go Fishing".



The Movement and Habitat Utilization of *Neolissocheilus soroides* in Tembat River System, Malaysia.

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Development of Tembat Dam, Malaysia in 2014 has resulted in the inundation of the lower part of Tembat river. The river was home to two of Malaysian mahseer species, *Tor tambra* and *Neolissochilus soroides* and most of these species were rescued prior to the lake impoundment. In order to assess the well-being of this species in the newly altered river system, an acoustic telemetry study of the movement and habitat utilisation were conducted. Five individuals of *N. soroides* were surgically tagged with acoustic transmitters. Two methods were used to track the individuals; Passive tracking using acoustic receivers to detect the occupancy and movement activity and active tracking to detect the range of movement by the individuals. The study found that the tagged individuals were moving a linear distance of 1275m to 5127m and are significantly difference, $t(5)=5.1946$, $p=0.006$ with a weak correlation between the total length of individuals and linear distance movement, $r = 0.36$. There were no significant difference between day time and night time movement, $t(118)=0.9$, $p=0.360$. *N. soroides* were found to be actively moving at two peak hours; 0500 to 1000 and 1800 to 2200. The individuals were found to significantly spent their time at the lower part of the river and through PCA analysis the detection of the individuals were associated with four physical attributes; distance to the nearest rapid, water depth, elevation and velocity.



The World Fish Migration Day

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Migratory fish species in rivers are severely threatened. The main causes are man-made obstacles like dams and weirs, which disrupt the natural flow of rivers and prevent fish migration. These fish species need to migrate to reproduce, feed and complete their life cycles. They make up a crucial link in the food chain and play an important ecological role in productive river systems. Furthermore, they provide an important food supply and livelihood for millions of people around the world. In order to bring global attention to these facts the World Fish Migration Day (WFMD) was initiated by a partnership of 6 organizations. WFMD is a one day global celebration and held every second year. It starts in New Zealand and follows the sun around the world, ending in Hawaii. The central message "Connecting fish, rivers and people" is used to connect sites around the world. The last edition in April 2018 hosted 570 local events organised by over 3000 organizations. WFMD help to reach students, teachers, resource

managers, commercial and recreational anglers, as well as those who influence public policies. After 3 editions the global reach is 50-70 million people through (social) media. The fourth edition is planned for May 16, 2020.



Length-Weight Relationship and Relative Condition Factor of *Neolissochilus soroides* (Duncker, 1904) (PISCES, Cyprinidae) in Tembat Reservoir, Terengganu, Peninsular Malaysia: Indication of Environmental Health

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The length-weight relationship (LWR) and relative condition factor of mahseer fish, namely *Neolissochilus soroides* from Tembat Reservoir, Terengganu, Peninsular Malaysia were studied during the inundation and operation phase of Tembat Dam from March 2015 to May 2017. *N. soroides* was selected for population dynamic study due to their conservation status, as well as their high commercial value. Even though it was categorized as Least Concern by the IUCN, however their population was in a great threat together with other mahseer species, *Tor tambra*. A total of 2003 individuals had total length and weight ranges of 17 cm to 58 cm and 70 g to 1985 g, respectively. Linear equation of $\log W = \log a + b \log L$ which transform the value of constants (a) and the coefficient correlation (b) from the length and weight data, were then fitted to the parabolic equation, $W = aL^b$. The overall LWR equation of *N. soroides* ($W = 0.046L^{2.602}$) showed negative allometric form of growth indicated by the growth coefficient ($b < 3$) and the measurement was significant and positively correlated ($R^2 = 0.804$ at $p <$

0.0001). The results indicate that *N. soroides* growth was still in the ideal growth for freshwater fish. The relative condition factor index ($K_n > 1$) suggests that *N. soroides* individuals in Tembat Reservoir have good physical characteristics due to adequate food resources, and suitable habitats for expansion of the fish population. This study contributes to the knowledge base for mahseer fish in Tembat Reservoir and crucial in terms of understanding the ecology of the reservoir for supporting conservation strategies, restoration and management of this species in future.



The Myth Behind Hatcheries and the Need for a National Fish Stocking Policy

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Whenever a population of fish is negatively impacted by human developments (e.g., a dam blocking fish passage, mining destroying a spawning tributary, etc.) one of the universal default mitigation options is the use of hatcheries to produce fish for supplemental stocking. It seems so simple – if there is a shortage of fish, just add more. The conservation goal, however, is to rebuild a self-sustaining population that reproduces naturally. Stocking of hatchery-produced fish to accomplish that goal assumes that hatchery and wild fish are equivalent, but by definition, they are not. In the wild each brood is subjected to a vast array of natural selection pressures, resulting in only a tiny fraction of the individuals surviving...those best adapted to that environment. Hatcheries, however, work very hard to remove all selection pressures to maximize survival. As a result, hatchery-produced fish are very different from wild fish and can, therefore, pose serious genetic, demographic, and ecological risks to the recipient populations into which they are stocked. The literature is replete with examples of how introducing hatchery-produced fish has damaged wild fish populations; it is essentially devoid of successful ones. So, to avoid succumbing to the myth of hatcheries and thereby irrevocably damaging native stocks of Mahseer, every country throughout the region should develop a National Fish Stocking Policy, i.e., a decision tool to determine when, where, and how stocking fish should be permitted or prohibited. We will present a model for such a decision tool that could serve that purpose.



Present Scenario of Mahseer Resources (*Tor* and *Neolissocheilus* Spp.) in Indian Himalaya: Innovative Strategies for its Rehabilitation and Conservation by ICAR-DCFR

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Distribution, abundance and conservation of Masheer (Tor) in Periyar Tiger Reserve, Southern Western Ghats, Kerala, India

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The king of river the mighty Mahseer fish is a one of the endangered species in the world. Mahseer is acclaimed as a world famous, outstanding ecologically, economically important game and food fish of India. Several of the larger species have suffered severe declines, and are now considered threatened due to pollution, habitat loss, and overfishing. As a sport fish, it provides unparalleled recreation to anglers from all over the world, better than salmon. Mahseer, at one time considered to be of single species, is now represented by *T. Chelynoides*, *Tor khudree*, *Tor kulkarnii*, *T. mosal*, *T. mussullah*, *T. neilli*, *T. progenius*, *T. putitora* and *T. tor* distributed all over India. A study was carried out in Periyar Tiger Reserve (PTR) to understand the number of *Tor* species present, their abundance and distribution. River Periyar and Mullaiyar is the major river which originate from Periyar Tiger Reserve and supports a varied aquatic biota especially many endemic and threatened fish species. The major portion of the Reserve forms the catchment of the river Periyar and the rest that of River Pamba. Fishes were collected using cast net, different mesh size gill nets and drag net depends on the depth and water velocity. Fishes were photographed in the field itself. The habitat character was noted to know whether the colour pattern of the fish is influencing by the habitat character. The specimens were tagged and the reference numbers were given for further specimen identification. These three species identification was conformed using Talwar and Jhingran (1991), Jayaram (1999). Water quality parameters, Habitat inventory and habitat quality was assessed to know the habitat preference. A total of 28 species were recorded from nineteen sites during the present study. In this three species of *Tor* were recorded from River Periyar. *Tor malabaricus* was recorded in OorPannikadam, Valukkuparai, Milaparai, Pulikayam, Mullaiyar, *Tor Khudree* was recorded in OorPannikadam, Valukkuparai, Milaparai, Pulikayam, Kochu aruvi, Pondian Thodu vayal, Ummikuppamthodu, Thenkashithodu, Sathukal. *Tor* sp. recorded from PTR may be new to sciences. One *Tor* species present in river Periyar is having unique characters may be a new species. Need immediate attention to save this unique species, which is not present anywhere in the world. Unless otherwise we take necessary action this unique species will became extinct.



River stretch co-management approach for conserving mahseer and aquatic biodiversity resources in Karnali and Rapti Rivers, Nepal

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Water resources and aquatic biodiversity in the Karnali and Rapti river basins of Nepal provide a wide range of goods and services for local communities. Decision makers require thorough knowledge and a database on ecological and ichthyofaunal variability to develop conservation initiatives for sustainable management of aquatic biodiversity. Paani's biodiversity assessment across Karnali and Rapti Rivers revealed the presence of 170 fish species including three migratory species of mahseer (*Tor putitora*, *T. tor*, *T. chelynoides*). Human interventions and environmental stressors are increasingly posing threats to aquatic biodiversity in these river basins. Overfishing and destructive fishing practices, unsustainable infrastructure development, urban pollution, over extraction of river aggregates, and habitat degradation are among the threats posed on mahseer migration ecology. USAID's Paani Program enhanced collaborative aquatic resource management using a co-management approach. River stretch co-management builds on concepts taken from other conservation management practices to designate delineated stretches of river for implementation of targeted, comprehensive, and sustainable community conservation initiatives. This framework provides a foundation for communities to self-determine balanced access and use of certain river stretches to enhance sustainability through managing water resources for multiple uses and users and conservation of aquatic biodiversity including free movement of large migratory fish species. This presentation highlights Paani's contribution to fill knowledge gaps on freshwater biodiversity and mahseer migration in the Karnali and Rapti river basins, and the Paani pioneered river stretch co-management model.



Developing Fish Sampling and Monitoring Protocols for the Hydropower in Nepal

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The Trishuli River in north central Nepal is a fast-flowing river with a steep elevational gradient, making it of high interest for hydropower development. In the upper reaches, six fish species were documented with *Schizothorax richardsonii* (Common Snow Trout) the most common. The Golden Mahseer (*Tor putitora*), *Tor tor*, and other migratory species occur downstream. Information is sparse on fish species, distributions, migratory patterns and population sizes. Fish sampling is challenging due to the fast flow and deep waters. The most common sampling method is cast net. The International Finance

Corporation (IFC) initiated a project to develop robust fish sampling and monitoring protocols for the Trishuli Basin. Five international experts on fish sampling and fish biology were hired to lead this process. The first step was a Fish Sampling and Monitoring Protocol Workshop held in November 2019. Thirty-one participants included international and Nepali fish experts, university aquatic ecologists, environmental consultants, hydropower project environmental staff, and representatives from Nepal government departments. The workshop produced draft protocols for: 1) Sampling fish and other aquatic biodiversity (e.g. macroinvertebrates), 2) Monitoring fish and macroinvertebrates, and 3) Monitoring fish passage through fish ladders to evaluate fish ladders effectiveness. The protocols will be field tested in Spring 2020 and finalized by June 2020. Protocols will be made available to hydropower projects and government agencies in the Trishuli Basin and also adapted for other basins in Nepal, to enhance aquatic baselines for hydropower projects and encourage a higher standard for fish sampling and monitoring throughout Nepal.



Length-weight relationship and abundance of three species of mahaseer (*Tor putitora*, *Tor tor* and *Neolissochilus hexagonolepis*) in the Gandaki River Basin, Nepal

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The biology, migration and spawning periods of mahaseer species are not well understood. In the Gandaki River Basin, one of the three major basins in Nepal, mahaseer occur in many of the rivers and tributaries but have been little studied. Protocols to better sample and monitor mahaseer are being developed for basin, particularly for the Trishuli River. The analysis of fish sizes throughout the year and their growth rates is a method that can contribute to our understanding of mahaseer biology and reproduction. The variation in the length and weight of the fish captured during different periods of the year helps to determine their life cycle and growth rate. Mahaseer were studied in the Seti Gandaki River from July 2017-June 2018 at monthly intervals. A total of 1167 individual fishes were captured belonging to 45 species, which included three species of mahaseer: *Tor putitora* (Golden mahaseer), *Tor tor* (Tor mahaseer) and *Neolissochilus hexagonolepis* (Copper mahaseer). Collection were done using cast net of mesh size 10-15 mm. *Tor putitora*, *Tor tor* and *Neolissochilus hexagonolepis* ranging in length (cm) between 3.1-30.3, 5.3-13.3, 5.3-29 and weight (gm) between 1-188, 3-22, 5.2-29, respectively were captured. Smallest sized fishes were captured during Jan/Feb/March. During Oct/Nov/Dec, fish were comparatively larger. The value of coefficient of correlation shows positive correlation between length and weight. The abundance of *N. hexagonolepis* was highest, followed by *T. putitora* and *T. tor*.



Mahseer of Malaysia : its biology, culture and conservation strategic plans and how population genetics can help manage this population effectively

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Hydropower Development and E-Flows: Policies, Issues and Future Perspectives

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The increasing realization of addressing energy demand through clean energy has encouraged the government of Nepal and the private sector to generate hydroelectricity for domestic uses as well as for export. However, run-of-the-river (RoR) type hydro-projects, which are predominant in Nepal, disrupt habitat connectivity and aquatic ecosystems as the river stretch between the dam and tailrace of powerhouse often remains dry or with reduced flow (Environmental Flows or E-flows). With an increasing number of hydro-projects being developed on its rivers, Nepal has not yet been able to correctly address the issues of maintaining the river ecosystem and ensuring continuous supply of ecological services.

Rivers of Nepal are characterized by high monsoon floods and low winter flows. On the contrary, energy demands are high in winter and low during monsoons. This implies higher market rates for dry season energy. In the absence of strong enforcement mechanisms in place, most often during winters, even the minimum flows as prescribed by the existing policies are diverted for energy generation and thus not released downstream of the dams.

In such context, this paper attempts to elucidate the issue of trade-off between minimum/e-flows and hydropower development in Nepal. The paper further argues that although hydroelectricity is considered a cleaner source of energy as compared to other conventional sources, there is threat of damaging river ecology. The paper explains that while some opportunities for maintaining E-flows in Nepal exist, they still remain limited. With the changing paradigm from energy deficit scenario to energy sufficiency in Nepal, it is the high time to realize the importance of E-flows for sustainable hydropower development.



Genetic Diversity and Population Structure of *Tor douronensis* (CYPRINIDAE) from Sabah, Malaysia using Microsatellite Markers

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Tor douronensis, also locally known as Pelian, is a species of ray-finned fish of the family Cyprinidae in the genus *Tor*. It has an aquaculture potential and of conservational value. It is suspected that the overall population of this species is decreasing due to anthropogenic modification of river morphology, logging, deforestation, agriculture and overfishing. Little is reported about the current genetic diversity and population structure of Pelian. The DNA of 175 samples collected from 18 populations in Sabah was extracted and amplified using 12 microsatellite markers to estimate its genetic diversity and population structure. Microsatellite analysis of Pelian populations show gene diversity ranging from at 0.270 (KTA) to 0.527 (IME) and allelic richness of 2.000 (KTA) to 4.260 (IME). The population shows significant and strong population structuring ($F_{st} = 0.000$ to 0.04892 , $p < 0.05$) with a Mantel test showing evidence of isolation by distance between the population samples. Using Bayesian and UPGMA cluster analyses, two well-defined clusters in Sabah, namely 'eastern' and 'western' clusters that may have been separated by mountain upthrusts throughout the central region of Sabah were determined. In addition, a further subdivision was observed in each of the clusters distributed between river systems. All localities except WCTO and SPO showed very low degrees of admixture. This is the first genetic study to report the genetic diversity and population structure of Pelian in Sabah and the results will be used to develop management and conservation strategies.



Understanding and conserving the Cauvery Mahseer

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The Wildlife Association of South India (WASI) has been engaged in Mahseer conservation since 1972. Our conservation model has four goals, habitat protection, taxonomic and ecological research, management of the endemic and critically endangered Humpback Mahseer and an environment education program to garner conservation support.

WASI's recreational fisheries program has implemented 'Catch and Release' angling as a tool to manage wild Mahseer stocks since the mid 1970's. Through this program we have been able to protect mahseer habitats from unregulated netting and dynamite fishing. Additionally, it has influenced policy on mahseer conservation in the state of Karnataka. Our current eco-morphological assessment has

revealed nine different mahseer morphotypes present in the Cauvery river system. It is still unclear whether these morphotypes belong to multiple species, hybrid groups or to one or two very polymorphic species. The goal of our research program is to tackle this uncertainty through a basin-wide molecular analysis. To manage the declining Humpback Mahseer population we work closely with the Indian Ministry of Environment, Forests and Climate Change to start a recovery program for the Humpback Mahseer and to protect their habitat by designating preferred habitat types as 'Critical Mahseer Areas'. Our new conservation campaign titled 'Namma Tiger of the Cauvery' is determined to shed light on the plight of the species and to promote it as an ambassador for conservation and restoration of the health of the Cauvery river system.



Empowering local communities towards conservation of mahseers in Nayar river valley, Uttarakhand, India

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Nayar River has long been exploited at the hands of poachers and to an extent by locals. Sadly, some communities along the river are dependent on fishing. Starting 2017, our efforts to create awareness, implementation of regulations, patrolling with the fisheries department had some short term, positive effects. However, legislation or deterrence alone can never gain community trust. In past one year, we targeted 'Baagi', 'Vyas-ghat', the villages involved in fishing and 'Chopda', 'Chaitur', 'Matoli' villages, who do not fish but purchase and consume fish. Five youth self-help groups and one exclusive all-women group were formed and allocated 5km river beats to inculcate sense of ownership as 'Guardian of rivers' for checking illegal fishing. Eight critical pools were identified and members were trained for seed collection and given sales support. To promote aquaculture as a mean of food and income, several ponds were constructed. We also worked towards capacity building for recreational fisheries based responsible tourism. Four villagers were channeled to nearby resort for employment and six youths are

under grooming as fishing guides. In four recreational fishing workshops conducted, we invited local entrepreneurs, anglers and seasoned guides as trainers, certifiers and business evangelists. These efforts are generating incentives and realization that 'Live fish is worth more than the dead fish'. Being optimistic, we expect around 25-30% reduction in catch by next season. However, guidelines for sustainable tourism, accountability for monetary gains and a transparent livelihood generation framework yet needs to be developed alongside considering the ecological needs of mahseer.



Environmental DNA (eDNA) as a novel genetic tool for the detection of fish species: Tracing the Golden Mahaseer (*Tor putitora*) in the Trishuli river of Nepal.

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Nepal charts a feasible hydropower bill of approximately 43,000MW and is on a strong narrative to develop its indigenous and renewable hydropower sector to meet growing national and regional power demands. The Trishuli river in Rasuwa (Central Nepal) currently has under construction 12 hydropower projects with more planned or applied permit projects to arrive in the future. Hydropower development can have a cascading series of pressures on river systems and direct or indirect impacts on inhabiting fish populations. In the Trishuli river, there is a significant impact of human activity through overfishing, illegal fishing practices, sand mining among others that have direct threats to existing fish populations. However, measuring these cumulative impacts is difficult without comprehensive baselines and accurate detection methods. Populations of the endangered *Tor putitora* are known to exist in the lower altitude tributaries of the Trishuli but how far or high upstream they travel is still under question. Current fishing practices, all specific in purpose are limited to defined topographies or river conditions and may account for part of the fish captures, if not all, leading to incomplete fish checklists. To address these issues, we conducted a comprehensive non-invasive eDNA (environmental DNA) based fish biodiversity baseline study in the Trisuli River. We collected & analyzed eDNA samples (river water) from 7 E-Flow sites over dry and wet seasons of 2018 in upstream and downstream locations of existing hydropower projects along the main stem of the Trishuli river. Using the Next Generation DNA Sequencing (NGS) platform, we amplified the 12S gene from the mitochondrial DNA to establish a DNA account of fish species, tracing in particular the *Tor putitora* above and below key hydropower projects. This will account for the accurate detection of the species in regions thought previously inaccessible for *T. putitora* habitat and raises significant behavioral and conservation questions for the future of the species. Environmental DNA can act as an important detection tool to offer way for specific fishing

techniques for accurate fish collection and identification in topographically challenging rivers such as the Trishuli. To maintain ecosystem integrity, and sustainable utilization of river resources, we suggest that hydropower projects are designed such that these will have minimal impacts on the maintenance of the freshwater biodiversity.



Research into Action: Developing evidence-based conservation programs for Mahseer

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The first Mahseer Research and Conservation Project in Bhutan was completed in 2019. The results of this research program generated valuable information on the life histories of Golden Mahseer (*Tor putitora*) and Chocolate Mahseer (*Neolissochilus hexagonolepis*), including migration patterns, timing of seasonal movements, and overwintering behavior. It also identified ongoing and future threats to existing population of these two species in Bhutan, including extensive illegal fishing, disruption of migration pathways by hydropower projects, and destruction of key spawning, nursery and overwintering habitats through human-induced activities. This led to a series of specific recommendations for conservation actions. The new biological knowledge generated from the recently completed project is being used to develop strategies address these recommendations in an effort to effectively conserve Mahseer populations. The actions being considered include: developing community-centered recreational fisheries, launching studies to both understand and curb illegal fishing, instituting improvements to the process of permitting and regulating construction projects in an effort to protect Mahseer habitat, and establishing nationwide outreach programs to educate the citizens of Bhutan about Mahseer and the importance of healthy river ecosystems.



Recreational Fishing, Ecotourism and Community Conservation in Northern Thailand

Tatrawee Harikul, Outdoor Thailand,



Does river dam matter in the longitudinal movement of Mahseer and other fish species?

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Free flowing river maintains population of fishes including Mahseer along the longitudinal gradient of a river. However, due to water resource management in a basin to supply drinking water, irrigate agricultural lands and produce hydroelectricity, a large numbers of rivers are being dammed at multiple sections. Construction and regulation of dams obstruct upstream and downstream connectivity of a river which influence longitudinal movement of many fish species including Mahseer affecting population dynamics of the species in the basin. However, study on the longitudinal distribution of Mahseer in the fragmented rivers is lacking in this part of the world. Here, we present how a hydropower dam has posed a threat to the Mahseer population in the Jhimruk river basin. A total of 21 sites in mainstem and tributaries in Jhimruk river basin were selected for the study. An intensive fish sampling using cast nets and gill nets was carried out in post-monsoon and pre-monsoon seasons in 2018 and 2019, respectively. Additionally benthic macroinvertebrates were collected from 10 micro-habitats in 50-100 m in each sampling river reach. Periphyton biomass was also calculated for each site. At this conference, we will present how dam has impacted the Mahseer and other fish species distribution, population status and habitat quality along the longitudinal gradient of the river.



Mahseer of western Nepal - an assessment of morphology, habitat, distribution, and length-weight relations in the Karnali River basin

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Increasing anthropogenic threats have threatened Mahseer habitat and their very existence, listing them as an endangered species. Although research and conservation efforts have been in continuous progression, effective conservation measures are still lacking especially in Nepal, due to limited knowledge of their distribution and ecological interactions. The present study aimed to provide insights into the morphological characteristics, habitat, distribution and length weight relations of the Genus *Tor* in Karnali River basin of Nepal. Altogether 70 sites were studied during pre- (March-April) and post- (October-November) monsoon seasons of 2018 and 2019. The sampled area covers three major ecological regions: the steep hills of the Mahabharat region (upto 2200 MASL), the low-lying Churia Hills and adjacent plain lands of the Silwalik region (upto 1000 MASL), and the Terain Plains (below 1000 MASL). The sampling was done in both smaller (wadable) and larger (non-wadable) streams, at each site, the sampling reach was defined as 40 times the stream width. Cast nets of two mesh sizes and gill nets were used for fish sampling. Similarly, in the Lower Karnali region in the Terain Plains, Seine hauls were also used as it suited the river flow and substrate morphology. All the fishes sampled were identified and counted in the field, and length and weight of each fish species were taken. The % coverage of the substrate types in each sampling reach was noted and various physio-chemical parameters were measured. The detail findings of the research will be presented in the conference.



Potential impacts of non-native fish on the threatened mahseer (*Tor*) species of the Indian Himalayan biodiversity hotspot

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Mahseer (*Tor* spp.) fish species are critical components of locally-adapted freshwater food webs across the Indian Himalayan biodiversity hotspot. However, multiple anthropogenic stressors compounded by climate change have significantly depleted their populations over recent decades. Mahseer species in many regions are now considered locally vulnerable or endangered. Hydropower projects in particular have fragmented populations, impairing genetic exchange, obstructing migratory paths, and changing

the structure and functioning of riverine habitats, especially of formerly fast-flowing rivers. Worryingly, literature survey and group discussions reveal that the increasing spread of non-native fish species further compounds threats to mahseer and overall freshwater ecology. Better understanding of the current distribution, habitat requirement and dispersal of non-native fish is therefore essential to manage the growing threats to mahseer in the Indian Himalayan region.



A Study on Phylogeography of Indochinese Mahseer Species

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The cyprinid fishes of the two genera *Tor* and *Neolissochilus* often referred to as Cá Ngựa xám – horseface in Vietnamese, are an important group of fish in northern Vietnamese mountains. Currently four mahseer species are recognized, of which two species are of genus *Tor* Gray and two species belong to genus *Neolissochilus* Rainboth. However, there is still confusion with regard to taxonomy, uniformity in diagnosis and distribution of this group in Indochina. Fishes of genus *Tor* are in Mekong river with variant colors as red fins, dark midlateral stripe considered as *Tor laterivittatus*, as opposed to *Tor sinensis*, without the lateral black stripe. *Tor tambroides* recorded in Central Vietnam while its original distribution is in West Sumatra. Mitochondrial DNA (mtDNA) sequences have proven effective for elucidating phylogenetic and taxonomic relationships in mahseers (Walton et al., 2017). However, to date there has been only two molecular genetic studies which addresses question relating to genetic relationship among two Vietnamese mahseer species, *T. sinensis* and *T. tambra* (Nguyen et al., 2008, Hoang et al., 2015) suggesting further investigation on the phylogeography within this group. A wider investigation of mahseer taxonomy covering all of Indochina with reference in South China and Thailand, using such an integrated approach to resolve the ambiguous taxonomy and their distribution. In the present study, we used nucleotide sequences of four mitochondrial gene regions, COI, 16 S rRNA, cyt b and ATPase, from two species of *Tor* and two species of *Neolissochilus* to explore their phylogeny, evolution, and biogeography.



River Basin Planning for Mahseer (*Tor spp*) Conservation in Nepal

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Nepal's rivers harbor hundreds of endemic and migratory fish species including Mahseer. Human activities have decimated natural populations to endangered and near threatened levels. Problems stem from a lack of multi-sector planning. Migratory fish are at risk, with potentially harmful long-term consequences for conservation, fisheries and future aquaculture development.

Simultaneously, Nepal is striving to move towards meeting a long-term vision of "Prosperous Nepal; Happy Nepali", with energy development a primary goal, including plans to add 15,000 MW of hydropower capacity in the next ten years. The Water and Energy Commission Secretariat (WECS) is focal entity of Government of Nepal for these efforts. Development of river-dependent sectors such as hydropower, irrigation, and tourism are vital for meeting economic development goals, however, they may yield adverse consequences for rivers and freshwater biodiversity including Mahseer. An in-depth analysis and multi-sector basin plan is required for the development of river basins that meet both conservation and economic development goals.

A pioneer on many conservation fronts, Nepal must strengthen aquatic habitat conservation through integrated river basin planning. With support from USAID and the World Bank, Nepal is drafting a set of planning tools to overlay biodiversity hotspots with strategic development priorities. A Basin Plan, a Hydropower Master Plan, and a Strategic Environmental and Social Assessment will support evidence based decision making for Government of Nepal to prioritize investments while minimizing environmental impacts. Complementing these, a High Conservation Value river assessment will identify critical fish habitat for species like the Mahseer. Consolidated knowledge generated through these independent assessments is inevitable for integrated river basin planning to insure aquatic biodiversity conservation also meeting infrastructure development needs.



The Shoal Partnership for Saving Freshwater Biodiversity

Michael Baltzer, Shoal Foundation

Shoal is a new partnership aimed at engaging a wide range of organisations to accelerate and escalate action to save the most threatened fish and other freshwater species.



RNA-Seqencing revealed differentially expressed reproduction related genes in the brain of matured golden mahseer, *Tor putitora*

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Golden mahseer, *Tor putitora* (Hamilton, 1822) is a potential candidate species for freshwater aquaculture in mid-hills of several South-East Asian countries. However, lack of genetic information related to the physiological process of sex determination, sex differentiation, gonad development and maturation restricts the breeding and seed production of this species in captivity for expansion of aquaculture. Therefore, to understand the molecular mechanism of gonad organogenesis and reproduction in golden mahseer, 20.6 and 21.5 million raw reads were obtained from two cDNA libraries generated from the brain of sexually matured male and female fish, respectively by RNA-Sequencing (RNA-Seq) using Illumina paired-end (PE) platform. From male and female brain 39,047 and 75,736 numbers of unigenes were identified, respectively, of which 26,252 (male) and 33,446 (female) showed homology to existing protein sequences in the database. Clusters of Orthologous Groups (COG), Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genome (KEGG) analysis indicated that many of these genes encoded for proteins related to gonad development, sex differentiation, germ cell development, sex steroids and reproduction. There were 287 numbers of potential sex differentially expressed reproduction related unigenes, of which 153 numbers of genes were up-regulated in the male brain, whereas in female brain 134 numbers of genes were up-regulated. Sixteen sex and reproductive event related unigenes (*cyp19a1a*, *dmrt2*, *gdf9*, *sox9b*, *wt-1a*, *aqp1*, *cxcl2*, *amh*, *fox13*, *dax1*, *kif20*, *tkt*, *sox9a*, *box11b*, *khh16* and *star*) were confirmed by qPCR (quantitative PCR), as male and female golden mahseer predominantly expressed genes.

Keywords: Brain, Differentially expressed genes, Reproduction, Sex, *Tor putitora*, Transcriptome



Taxonomic Revision of Thai Mahseer (*Tor* spp.) by Using of Morphological and Molecular Characteristics.

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Current status on taxonomic study of Mahseer in Thailand was rather confusing, especially in fish genus *Tor*. Since the classical dichotomous key was mainly basing on availability of and size of mental lobe, however, these characters could not fit with a new specimen from new locality such as specimens from the Salween river. Therefore, revision of Mahseer from Thai water by integrating of both morphometric and molecular characteristics might be the potential way to solve this chaotic phenomenon in taxonomic problems of Thai Mahseer.

In order to clarify morphometric problems, 30 specimens of fish genus *Tor* (including *T. sinensis*, *T. tambra*, *T. tambroides* and unknown species from the Salween river) were obtained from Chiang Rai, Mae Hong Son, Nan, Kanchanaburi, Phetchaburi and Yala provinces. All specimens were examined after Kottelat and Freyhof (2007) method. Obtaining data was analyzed for differences among species by one-way ANOVA. The 20 of perfect specimens were selected for molecular analyzing (the Cytochrome Oxidase Subunit I or COI gene) by cutting their flesh at the right side and process after COI protocol, acquiring data was calculated for phylogenetic relationship by using MEGA (version 10.0.5 and 1993-2019). Results from characteristics analysis had revealed that the ratio of HL/SL and length/width of mental lobe could be the best characteristics to distinguished all species of Thai Mahseer. *T. tambroides* had ratio of length/width of mental lobe equivalent to 2 :1 and 31-33 %HL, while *T. sinensis* had ratio of mental lobe 2:1 and 27-29%HL. In *T. tambra* had ratio of mental lobe ratio less than 2 : 1 and 24-26 %HL and the unknown species had mental lobe ratio less than 2:1 and 28-29 %HL. Results from COI had revealed that all species were distinguished species and had closely evolutionary relationship. Therefore, the tentative new dichotomous key for identification of Thai Mahseer were providing in this report.

Since there are rather limiting of time and budget, the specimens form more part of country should be analyzed for more precise on phylogenetic relationship, other gene such as RAG1 and Cyt b should be study in depth.



Application of automatic control recirculating aquaculture system coupled with pure oxygen for a super-intensive culture of *Tor douronensis*

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As conventional pond system utilizes large amounts of water with low capacity for fish production, this study aims to develop a small and compact recirculating aquaculture system (RAS) which supplying pure oxygen instance of conventional aeration in the rearing unit to improve water quality, as well as the growth, survival, and productivity, of the super-intensive fish culture. The RAS designed to reduce COD, ammonia, nitrite, nitrate and TDS from the rearing units was operated and controlled by applying automatic microcontrollers in most unit operations. The value of dissolved oxygen (DO) concentration in the rearing units was controlled nearly 100% oxygen saturation during the whole study period by using an oxygen absorber unit and automatically dissolved oxygen microcontroller. In this study, *Tor douronensis* as a high-value fish in Thailand was chosen to investigate the effects of stocking density and DO concentration on the growth rate, survival rate, and productivity. The rearing units supplying with different sources of dissolved oxygen (i.e., pure oxygen and conventional aerator) were also compared to evaluate an economic valuation. The key factors that affected health and growth of fish (i.e., pH, TDS, temperature, DO, ammonia, nitrite and nitrate) were analyzed and collected periodically during the whole experiment using automatic water quality analyzers and internet of things, respectively. The collected data will be used as a database to develop software and hardware for culturing *Tor douronensis* and other fish by using pure oxygen in the small and compact RAS which controlled by an automatic controller in the future.



Sundaic Mahseers

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An overview of the Mahseers (genus *Tor*) of the Sundaic islands and Peninsular Malaysia is provided, based on field accounts and personal experiences since 1990s. The chaotic taxonomic history of *Tor* is discussed with a brief review of the current situation. Current practises are also touched upon, with suggestions for a more robust and systematic approach.



From scientific obscurity to conservation priority: current status and environmental challenges facing the survival of the World's largest mahseer, *Tor remadevii*

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Despite being the largest of all 16 currently valid species of mahseer, until 2018 the hump-backed mahseer of South India's River Cauvery lacked a valid scientific name, denying it any conservation status. The urgency of addressing these issues was initially highlighted via the analyses of catch-and-release angler log data from a former fishing camp on South India's River Cauvery. Data collected between 1998 and 2012 has demonstrated that the intentional introduction and rapid establishment of a non-indigenous 'blue-finned' mahseer, *Tor khudree*, corresponded with a >90 percent reduction in the numbers of the endemic hump-backed mahseer being caught and released, thus highlighting the high extinction threat to this endemic and iconic megafauna.

Determination of a valid scientific identity for the hump-backed mahseer has required extensive exploration of the River Cauvery basin, examination of museum specimens and detailed morphometric and molecular analyses across the genus *Tor*. Fixing the taxonomic identity as *Tor remadevii* has since seen this iconic megafauna assessed as Critically Endangered on the IUCN Red List of Threatened Species, attracting a concerted international effort to save the last remaining populations from extinction. This paper summarises the background research which led to the Red Listing of this species and the many challenges which are now being addressed to gather the essential ecological data required to inform effective conservation planning and save this icon from extinction.



Balancing the needs for hydropower and migratory fish: new developments in fish passage

Michael Spolum, Natel Energy



The Myanmar Fly Fishing Project: developing community based fly fishing destinations in Myanmar

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The Myanmar Fly Fishing Project is a social enterprise incorporated in Yangon in 2019.

Our goal is to develop Fly Fishing tourism in Myanmar; our Vision is that “The development of fly fishing tourism in Myanmar contributes to the development of local communities through supporting efforts in livelihoods diversification and environmental conservation.”

In order to achieve its Vision, MFFP is pursuing three objectives.

Objective 1: Support Community-led Environmental Conservation

MFFP is working with local communities and various actors to setup fish conservation zones managed in a way that benefits local communities and anglers alike, allowing for the practice of catch-and-release.

MFFP recently initiated work with local communities in Chin State, Tanintharyi Division and Kayin State.

In parallel MFFP will start collecting DNA samples of mahseers across Myanmar in an effort to support scientific knowledge acquisition.

Objective 2: Support the Development of an Economic Ecosystem of SMEs

MFFP works with its partners to identify and support opportunities for the establishment or expansion of SMEs relating to the practice of fly fishing in Myanmar.

MFFP initiated discussions with local communities for fly fishing tourism development in a way that benefits them; MFFP also initiated mentoring a few local Travel & Tours Company for the development of fly fishing tours.

Objective 3: Support the Development of a Fly Fishing Practice in Myanmar

MFFP works to promote fly fishing and catch-and-release among Myanmar citizens in parallel of developing Myanmar as a fly fishing destination for foreign anglers.

MFFP will start fly fishing classes in 2020 aiming at Myanmar citizens.



Poonch River Mahseer National Park –Emerging Challenges and Way Forward

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Poonch is the first river which has been given a protected status in Pakistan. It was notified as Poonch River Mahseer National Park in 2011, as a sanctuary for the Golden Mahseer *Tor putitora* as it provides ideal habitat for this fish. Poonch is a small picturesque river that begins its journey from the southern slopes of the Pir Panjal range in Indian Administered Kashmir and crosses over into Pakistan

Administered Kashmir to conclude its journey, a hundred kilometers downstream in the Mangla reservoir. The national park had been slowly achieving its objectives until the government decided in 2015 to establish a hydropower plant on the river. This presented immense challenges for the Mahseer

as its migratory route was permanently obstructed, and access of the fish downstream of the dam to its breeding areas was blocked. The presentation will show how an inevitable disaster was converted into an opportunity for the river and its future by engaging the government, hydropower developer, financing agencies, the local community, and the researchers to prepare and implement a biodiversity action plan that has resulted in increase in Mahseer population with the dam in place.



Conserving the last giant mahseer from the coastal rivers of Maharashtra, India

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Mahseer, iconic mega-fishes of India's riverine systems are often referred as flagships for freshwater biodiversity conservation. Of the 16 recognised species in the genus *Tor*, the Deccan Mahseer, *Tor khudree* (Cyprinidae: Torinae) growing to sizes of about 31–75 kg in weight, and about ~ 53 inches in length is so far the most heavily exploited slow growing cyprinid of peninsular India, and the Western Ghats Hotspot. Peculiar life history traits of *T. khudree*, including a high longevity and a population doubling time of 4.5–14 years makes them highly vulnerable to overexploitation. *Tor khudree* has been assessed as 'Endangered' on the IUCN Red List owing to the fact that catches have been declining rapidly, throughout its home-range, causing extirpation of several viable local populations. An array of stressors has decimated the fishery of this highly-preferred food fish. Though the natural distribution of *T. khudree* is known to be restricted to the eastward flowing Krishna and Godavari river systems, we carried out surveys to understand their occurrence, population status/trends and threats in the rivers on the western slopes of the Western Ghats in the Konkan region. No population was observed in the Patalganga River, but two additional populations were recorded from independently flowing Savitri and Vaitarana riverine systems. Savitri population appears to be more fragmented, and at high risk of local extinction. In both basins abundance is very low and individuals are of small size (1.9–11.8 inches in SL). We did find two viable populations of large sized (36–43 inches in SL) *T. khudree*, however they appear to be confined to community protected areas. Non availability of large sized fish in both, Savitri and Vaitarana indicates the scale of anthropogenic pressure that this threatened species is subjected to particularly indiscriminate fishing, habitat loss, pollution, alien species and desertification. We provide a site-based status overview of the most threatened mahseer species to inform conservation action and policy, while highlighting the role of community involvement in species protection. For a while, we have retained the identity of this species as *T. khudree*, however this species appears to be a morphological distinct and could be an indigenous species restricted to only west flowing rivers of northern Western Ghats. Despite the fact that the taxonomic identity of this species is yet to be cleared, survival of this population is on edge.



Habitat use by young golden mahseers (*Tor putitora*) in Kosi and Kohlu rivers of Uttarakhand, India

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Aim: Nursery grounds; ecologically critical habitats for recruitment of early life-history stages of fish species. Present study aimed to assess these foraging habitats of young (fingerlings/juveniles) golden mahseers and major threats the fish faces in Kosi and Kohlu river stretch.

Methodology: Stretch of 32km Kosi river and 15km of Kohlu river were strategically divided into three zones; upper, middle and down to locate micro-habitats (nursery grounds) of young golden mahseer; fingerlings (1.5-10cm) & juveniles (10-30cm) for the post-monsoon, post-winter and pre-monsoon season for the year (2018-2019). For each identified zone, 200m river-reach was sampled for different habitat locations and assessment. Micro-habitats of young golden mahseers were further classified into six types as backwater pool, secondary channels, run habitat, associated streams, isolated pools and confluence point. These micro-habitats were mapped using ArcGIS. Use of these micro-habitats by fingerlings and juveniles were analyzed based on four major habitat variables such as depth, flow, substratum and water quality. Major threats were examined and investigated for conservation measures. In addition, to study the movement and migratory patterns of golden mahseer using radio-telemetry techniques; 10 adult individuals were tagged externally and monitored in Kosi and Kohlu streams from (June,2019-October, 2019). But owing to analysis and future plan to tag more individuals, the related results are not discussed here. Only important high-lights will be discussed.

Results: Backwater pools, secondary channels and run habitats were reported to be highly used habitats of fingerlings whereas run habitats were mostly used by juveniles in these rivers in both the seasons. Fingerlings were mostly found at depth between 0.1-0.6 m and velocity ranged between 0-1.0m/s. Reported dominant substratum for fingerling habitats were gravel and sand. Similarly, depth range between 0.3->1.8 m, high flow rate velocity between 0.3->1.5 m/s and habitats having cobbles, bed rock and gravel as dominant substratum were used by juveniles. The results provide crucial information concerning to the classified threats. Over/illegal fishing practices, habitat fragmentation and degradation were found imperiled for golden mahseer population.

Conclusion: Habitats with less flow and optimal depth contribute more for the development of early life-history stages and to the recruitment of adults to the main river channels. Backwater pool, secondary

channels and run habitats are vital as nursing grounds for fingerlings and juveniles and there is strong apprehension about its population decline due to its habitat demolition.



Study of suitable feed for 60-90 days Brook trout (*Neolissochilus stracheyi*).

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Study of suitable feed for nursing of Brook trout (*Neolissochilus stracheyi*) juveniles (60-90 day). Groups of fish were fed in 4 treatments, including protein 40% viz. formula 1; fish meal (commercial nursery feed), formula 2; Fish meal 65%: fine rice bran 30%: spirulina 5%, formula 3; Fish meal 45%: fine rice bran 50%: spirulina 5%, and formula 4; Fish meal 45%: fine rice bran 45%: leucaena leaf 5%: spirulina 5%. The experiments were a completely randomized design (CRD) in 3 replications. Initially the fish were an average length of 2.605 ± 0.261 cm (0.160 ± 0.174 g) in aquarium $0.30 \times 0.60 \times 0.38$ m in size. In total there were 100 fish per aquarium reared for 30 days. At the end of the experiment, a significant increasing of the growth performance in fish formula 3 was better than other treatments as weight gain (0.010 ± 0.001 g/fish), specific growth rate (3.97 ± 0.07 %/day) and feed conversion ratio (1.36 ± 0.15). The study demonstrated that could be use formula 3 for nursing Brook trout *Neolissochilus stracheyi*.



The Optimal Number of Meals for 60-90 days Brook trout (*Neolissochilus stracheyi*)

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The study of effect different rate of feed to growth and survival rate of nursing of Blue Masheer (*Neolissochilus stracheyi*) with 3 treatments and 3 replications of three meals, four meals and five meal, respectively. Initial experimental average weight was 0.456 ± 0.264 grams and average length was 3.390 ± 0.406 centimeters. After 30 days of experiment, it was found that the highest growth was at four meals, the average weight was 0.87 ± 0.20 grams and the average daily length gain was 0.029 ± 0.007 centimeters. The average weight an average length were significant different ($P < 0.05$) and survival rate was 99.75 ± 0.5 percent which none significant different ($P > 0.05$).



Design of Smart Aquaculture System for Mahseer Fish

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Design of smart aquaculture system for Mahseer fish was developed as closed production unit that Thai Mahseer fish has native living area in the northern of Thailand. In order to increase the growth rate of Masheer fish, the aquaculture system should be designed relative to living conditions, which consist of five main parameters as water velocity in range of 0.17-0.77 m/s, 17-30 C of water temperature, 7-8 mg/l of dissolved oxygen, less than 0.01 mg/L of ammonia, and 6.5-7.66 of pH. ESP32 is IoT microcontroller. It is not only control the system but also include warning and monitoring the status of aquaculture system via internet such as Line notify and Blynk application, respectively. To perform the aquaculture conditions, the sensors are installed to control air pumps, water flow, recirculation system, and drain water. The inlet and outlet of water flow in fish tank is designed position and direction using computational fluid dynamics to achieve the designed water velocity. According to experimental results, the temperature, dissolved oxygen, flow rate and pH level can be controlled in the range of Masheer fish living conditions.



Diversity of Fishes in Rangsit Marsh, Pathum Thani Province

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This study presents a result from the survey of species diversity and distribution of fishes in Rangsit Marsh area under the Plant Genetic Conservation Project under the Royal initiative of Her Royal Highness Princess Maha Chakri Sirindhorn. The survey was carried out encompassing the three provinces in central Thailand including Pathum Thani, Saraburi and Ayutthaya. A total of 59 species belonging to 24 families and 8 orders was recorded. The most common and abundant species are *Oreochromis niloticus*, *Trichopodus microlepis*, *Trichopsis trichopterus*, and *Esomus longimanus* respectively. Moreover, *Amblypharyngodon chulabhornae* and *Parachela siamensis* are also recorded in abundant particularly during rainy season. Non-native fishes are also recorded such as *Oreochromis niloticus*, *Clarias gariepinus*, *Hypostomus plecostomus* and *Atractosteus spatula*.



Mahseer (*Tor* spp.) fishes of the world: current taxonomy, distribution and IUCN Red List status

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The mahseer fishes (*Tor* spp.) represent an iconic genus of large-bodied species of the Cyprinidae family. Across the 16 recognised species in the genus, individual fish can attain weights over 50 kg, resulting in some species being considered as premier sport fishes. *Tor* species also generally have high religious and cultural significance throughout South and Southeast Asia.

Despite their economic and cultural importance, the status of *Tor* fishes has been increasingly imperilled through their riverine habitats being impacted by anthropogenic activities, such as hydropower dam

construction and exploitation. Moreover, conservation efforts have been constrained by knowledge on the genus being heavily skewed towards aquaculture, with considerable knowledge gaps on their taxonomy, autecology, distribution and population status.

This poster summarises the outputs of an IUCN Red List classification workshop held at the Indian Institute of Science Education and Research (IISER), Pune on 21st April 2018. Combining a comprehensive literature review of taxonomic status, empirical data on geographic range and population trends, and expert knowledge of habitat, ecology and threats, the IUCN Red List status of all valid *Tor* species were re-assessed; three species are now classified as 'Near Threatened', one 'Vulnerable', three 'Endangered' and one 'Critically Endangered'. However, eight species remain 'Data Deficient'.



Rearing Semah mahseer, *Tor douronensis* (Valenciennes, 1842) brood stock with different densities in water recirculation system

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An experiment on rearing Semah mahseer (*Tor douronensis*, Valenciennes, 1842) brood stock in water recirculation system with 3 levels of density (1, 2 and 4 fish per cubic meter) in the 2x6 m pond. The fish were reared during April 2016 to February 2019. Initial weight and length were 192.1±42.18 g and 25.5±2.86 cm, respectively. Weight and length were measured every 2 months for 14 months. During spawning season from November 2018 until February 2019, maturity rate was checked every 2 weeks. The results showed that 3 levels of density were not significant on growth, survival rate, feed ratio and rate of maturity ($p>0.05$). In addition, the maturity rate of female brood fish, which was reared at the sex ratio of male: female $\geq 2:1$, is higher than the one reared at the sex ratio male: female $\geq 1:1$ ($p<0.05$). Considering the cost of rearing, fish reared in the densities of 4 fish per cubic meter had the lowest cost which the average value was at 1,239.53 THB per kilogram



Optimum Dietary Protein requirement of Semah mahseer, *Tor douronensis* (Valenciennes, 1842) Fingerling

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The optimum dietary protein requirement of Semah mahseer, *Tor douronensis* (Valenciennes, 1842) Fingerling was determined in this study. In this complete randomized designed experiment, formulated diets of 5 levels of dietary protein (25, 30, 35, 40 and 45 percent). Study effects on growth, survival rate, feed conversion ratio, and daily feed intake. Fish reared in the plastic tank has a volume 500 liter. The result showed that the dietary protein had significant effects on growth, fed with the dietary protein level of 40 percent was significantly higher ($p < 0.05$) than that of other dietary protein level. The survival rate, feed conversion ratio, and daily feed intake were not significantly ($p > 0.05$) in all experiment.



Karnali River Corridor Management Framework

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The Karnali river is one of Nepal's greatest environmental assets and a major source of cultural heritage. It is a longest and most pristine river – the main channel of the Karnali has not yet been obstructed by hydropower development, but there is a planning of developing the three hydropower dams in the mainstem of Karnali River. The development of these dams will change the flow of the Karnali river and also face the specific pressure on the environment, ecology, socio – economy, culture, heritage and livelihoods of the communities living in the river basin. This document was prepared in the wake of the Karnali River Scientific Expedition in 2018 and travel the length of the Karnali River from headwaters in China to the confluence with the Ganges River in India with the interdisciplinary team, to examine the different possibilities for conserving the Karnali River. In this document, we present the outline of a Karnali River Corridor Management Framework that can be used to ensure that water resources and

riparian lands are managed to maintain important social and environmental values. We highlight the environmental and sociocultural diversity throughout the river corridor and make several specific policy recommendations about how development and conservation initiatives might be balanced. The Karnai River supports an endangered fish species: Golden Mahseer, Snow Trout and freshwater Dolphin. We recommend to create a "Mahseer Conservancy" from Rakam to 16 Km below the Thuli Gad Confluence and 10Km up the Seti Khola. This conservation area could be a world class research area for Mahseer and support development of a remote (helicopter or boat-in) high-value catch and release fishing business.