

## Freshwater fish safe zones: a prospective conservation strategy for river ecosystems in India

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The 21st century is a 'time of crisis' for freshwater ecosystems and their resources<sup>1</sup>. A multitude of stressors, including urbanization and associated habitat alteration and loss, alien invasive species, overharvest, pollution and climate change, have resulted in freshwater ecosystems and freshwater fish becoming one of the most threatened ecosystems and taxa on Earth<sup>2-8</sup>. However, the lack of connection between freshwater biodiversity and the general public<sup>9</sup> has resulted in less attention being focused on freshwater-related conservation issues.

The Convention on Biological Diversity's Aichi Strategic Plan for Biodiversity 2011–2020 has set out a series of biodiversity targets where protection and conservation of rivers and their biodiversity is an important priority<sup>10</sup>. The plan recommends that by the year 2020, 'at least 17% of terrestrial and inland water is conserved through effectively and equitably managed, ecologically representative and well-connected systems of Protected Areas (PAs), and other effective area-based conservation measures<sup>10</sup>.' Further, it also recommends that 'all fish are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided<sup>10</sup>.'

India, a megadiversity nation, has over 600 PAs covering about 5% of its total land area<sup>11</sup>. Of this, only a small fraction has been set up to protect freshwater fauna, largely focused on charismatic taxa such as Gharial (*Gavialis gangeticus*) and South Asian River Dolphin (*Platanista gangetica*). Although the freshwater ecosystems of India harbour close to 900 fish species<sup>12</sup> with high levels of endemism and threats<sup>13</sup>, there are no dedicated 'formal' PAs for freshwater fish in the country.

Although some of India's major rivers flow through the boundaries of various terrestrial PAs, little or no attention is given to the health of these rivers and their biodiversity. While seasonal streams are impounded within Project Tiger Reserves during the drier summer months to provide water for the terrestrial species, various tourist roads, tem-

porary bridges and upcoming lodges on river banks within PAs contribute to habitat degradation (N. Gupta, pers. obs.). This has been largely due to the callous attitude of policy makers in India, for whom freshwater ecosystems and fish conservation have been 'out of sight' and 'out of mind'<sup>14</sup>.

The drastic state of Indian rivers and their biodiversity, therefore calls for novel protection and management strategies. In this context, we discuss the idea of setting up of 'freshwater fish safe zones' (FFSZs), defined as 'river reaches important for biodiversity maintenance and connectivity of a river, protected and conserved through legislative measures and local stakeholders' support' bordering the current PA network, to act as a supplementary strategy offering protection to highly threatened river reaches or fish species requiring urgent legislative intervention.

For setting up of FFSZs in India, however, the policy makers need to be convinced regarding their long-term benefits. Similar to marine ecosystems, there are multiple stakeholders associated with a riverine ecosystem<sup>15</sup>. Therefore, before setting up of future FFSZs, there is a need to understand resource use and dependency in the area in order to develop an integrated management plan<sup>16</sup>. This should also take into account the social and economic needs from a river<sup>17</sup>. In this context, there is a greater need for involving local stakeholders in the setting up of FFSZs.

Most PAs were initially set up to protect threatened or charismatic terrestrial species<sup>18</sup>, and the availability of land or local stakeholders' support too played a decisive role<sup>19</sup>. Additionally, as far as protecting rivers and their species within PAs are concerned, the seasonal migratory behaviour of many riverine species which often encompasses multiple habitats over long distances, is a cause of concern<sup>20-22</sup> for the design of FFSZs. We acknowledge that the length of a river and the size of its catchment area can restrict the inclusion of its headwaters as well as its lower reaches within a PA<sup>16</sup>. Protecting river ecosystems also requires a

catchment-scale approach<sup>23,24</sup> due to high permeability of freshwater ecosystems<sup>15</sup>, as threats originating anywhere within its catchment could have profound effects on any of its reaches within FFSZs<sup>3,22</sup>.

Nevertheless, suggestions to protect a river system's upstream catchment and downstream habitats of focal species<sup>15,22-24</sup> should not hinder such an approach<sup>25</sup>, as safeguarding critical fish habitats could have wide-scale benefits in comparison to providing no defence at all<sup>22,26</sup>. The conservation of imperilled river ecosystems does not necessarily always have to involve the macro-scale integrated catchment management, but depending on local circumstances could also focus on the micro-scale restoration of individual habitats<sup>15,22-24</sup>. The protection of carefully selected reaches over an entire river can no doubt have an overall positive effect<sup>27</sup>. Even when FFSZs are unable to enclose an entire catchment basin, they could play a vital role by protecting spawning grounds, nurseries, refuge or migratory routes of various fish species within river reaches inside their boundaries<sup>27</sup>. Furthermore, PAs for marine ecosystems are a widely recognized conservation tool<sup>16,28-30</sup>. In addition, terrestrial ecosystems within PAs could positively benefit from protecting their bordering river ecosystems<sup>15,30</sup> due to the dynamic ecological and biophysical interactions between them<sup>31</sup>.

As a first step, we provide here a list of nine important needs for planning, development and management of FFSZs in India.

(i) Every major river system should have representative FFSZs to protect critically important habitats of native and endemic fish species.

(ii) The exact geographical boundaries of river reaches that need to be managed and conserved should be well defined. River reaches having multiple jurisdiction issues, i.e. rivers shared between different states/union territories and/or river reaches managed by different state ministries, will require utmost inter and intra-governmental cooperation.

(iii) Spatial zonation of FFSZs should be delineated in the form of both 'core

area' and surrounding 'buffer areas' (similar to current terrestrial PA system in India). The buffer areas could be used to satisfy socio-economic use of local stakeholders, e.g. sustenance fishing and catch-and-release angling (spill-over effect from core area). Such an inclusive approach will help target key stakeholders, and assist in gathering their long-term support.

(iv) An integrated management plan for each FFSZ should be prepared in consultation with all relevant stakeholders, and a participatory mode of governance should be practised.

(v) The impacts of the surrounding terrestrial areas to the river reach should be evaluated, as unsustainable land management, including agricultural practices and deforestation can have devastating effect on riverine ecosystems.

(vi) The wider ecological benefits of FFSZs, including the impacts through protection provided to other freshwater-dependent species, e.g. otters, gharials and river dolphins should be assessed through rigorous field studies. Scientific research also needs to address the issue of environmental flows, as any change in the natural flow of a river can have serious consequences for habitat specialist species, many of which are usually endemic and threatened.

(vii) Keystone and flagship species connected with FFSZs need to be identified to help gather local, regional and international support for conservation and generate funds for research.

(viii) The possibility of obtaining legislative support for FFSZs should be worked out in consultation with policy makers and politicians. A detailed report applicable to the general public should also be prepared based on the scientific data obtained and one which satisfactorily argues for the setting up of FFSZs.

(ix) Regular monitoring of the established FFSZs should be carried out, and research needs to be undertaken to understand additional conservation issues.

We understand that FFSZs cannot safeguard river ecosystems from all potential threats on their own and will

require the support of ongoing and future river conservation policies to have a holistic and substantial positive impact on rivers and their rich biodiversity at the landscape or basin-level. A way to deal with this issue would be to develop an approach which would first and foremost bridge the knowledge gap about the distribution and habitat ranges of threatened fish species through scientific research, and provide robust data to convince policy formulators<sup>17</sup>. Such an approach would not only see the amalgamation of expertise and conservation of knowledge from research scientists, but at later stages also focus on generating funds for future research activities<sup>27</sup>.

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