Freshwater Key Biodiversity Areas in the Lower Mekong River Basin Informing species conservation and investment planning in freshwater ecosystems

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Informing species conservation and investment planning
in freshwater ecosystems -
June 2019

Laura Máiz-Tomé
Freshwater Biodiversity Unit
IUCN Global Species Programme

Margaret A.Cargill PHILANTHROPIES

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Acknowledgements

Identifying freshwater Key Biodiversity Areas in the Lower Mekong river basin relies on the willingness of dedicated experts to contribute and pool their collective knowledge. Without their enthusiastic commitment to biodiversity conservation, this work would not be possible. We would therefore like to acknowledge the committed work of the experts who contributed to this project with their data and participated in the KBA workshop held in Bangkok, in September 2018, including: Chhang Phourin, Chheng Phen, Eric Baran, Kosal Mam, Monyrak Meng, Peng Bun Ngor, Ronald W. Jones, Simon Mahood, Sor Ratha, Chen Xiaoyong, Zhang Haomiao, Masahiro Kato, Anoulak Kittikhoun, Bounthob Praxaysombath, Erin Loury, Ilya Vikhrev, Sinsamout Ounboundisane, Victor Cowling, Alexandra Zieritz, Ekaterina Konopleva, Oleg E. Kosterin, Maurice Kottelat, Chavalit Vidthayanon, Chirasak Sutcharit, Maureen Harris, Narumon Sangpradub, Say Lin Ong, Somsak Panha, Teerapong Pomun, Raphael Glemet, Terry Warren, Ting Hui Ng, Merlin Veron, Richard Lansdown, Art Bogan, John Pfeiffer, Vittoria Elliott, Zeb Hogan, Ian Baird, Bui Huu Manh, Dao Trong Tu, Do Manh Cuong, Do Van Tu, Duong Van Ni, Hoang Duc Huy, Jake Brunner, Jeremy Carew-Reid, Nguyen Duc Tu, Nguyen Thai Tri, Nguyen Thi Kim Dung, and Tran Triet.

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Background

The state of freshwater biodiversity in the Lower Mekong River Basin

Freshwater covers less than 1 per cent of Earth's surface, yet is home to an estimated 12 per cent of all known species (Mittermeier *et al*., 2010). Freshwater ecosystems are, however, under increasing levels of threat, with the Freshwater Living Planet Index showing a dramatic 83 per cent decline in selected populations of freshwater species since 1970 (WWF 2018), an estimated 75 per cent of the world's inland waters lost during the 20th century, less than 40 per cent of large rivers remaining free flowing, and approximately one-third of the freshwater species assessed for the IUCN Red List of Threatened Species™ threatened.

The Lower Mekong river basin is internationally recognised for its high freshwater species diversity, which is of critical importance to local livelihoods and national economies in the region (WWF 2016). Thirteen per cent of all freshwater species assessed in 2012 against the IUCN Red List Categories and Criteria within the Indo-Burma region, including the Mekong river basin, are globally threatened (Allen *et al*. 2012). This level of threat continues to increase dramatically due to the large-scale development of hydropower schemes in the basin (Hecht *et al*., 2018). Other major threats include pollution (from agriculture and forestry run-off in particular), biological resource use (direct exploitation and/or habitat loss through deforestation), and competition and predation from introduced invasive alien species (Allen *et al*. 2012).

A major bottleneck to conservation of freshwater ecosystems is a lack of information on where the most important sites of biodiversity are located. This lack of information has hindered the development and implementation of appropriate management actions for freshwater species as well as private sector efforts to direct strategic investment and minimise impacts through the adoption of environmental safeguards.

Conservation of freshwater biodiversity in the Lower Mekong requires a combination of site and catchment scale approaches. In many cases, species are wide-ranging across many different habitats, such that site-based actions alone will not always lead to effective conservation.

In 2012, in response to the situation described, The Critical Ecosystem Partnership Fund (CEPF) funded IUCN to fill the information gaps through a comprehensive Red List assessment of all described freshwater species for selected taxonomic groupings in the Indo-Burma region. This information on species was then used to identify a number of river and lake basins holding potential Key Biodiversity Areas (KBAs) for the protection of threatened and restricted range freshwater species (Allen *et al*. 2012).

In 2018, the IUCN Asia Regional Office, in partnership with the IUCN Freshwater Biodiversity Unit, received additional funds from the Margaret A. Cargill Foundation, –the Building River Dialogue and Governance (BRIDGE) project financed by the Water Diplomacy Programme of the Swiss Agency for Development Cooperation (SDC), and Synchronicity Earth, to complete the work initiated in 2012 to identify and validate freshwater KBAs in the Lower Mekong River basin (Figure 1) using the newly published *Global Standard for the Identification of Key Biodiversity Areas* (IUCN 2016). The KBAs identified will help guide investment decisions on conservation and sustainable management of freshwater biodiversity in the region.

The results reported here will help to focus conservation efforts on those places where site based actions will potentially benefit freshwater biodiversity in the Lower Mekong.

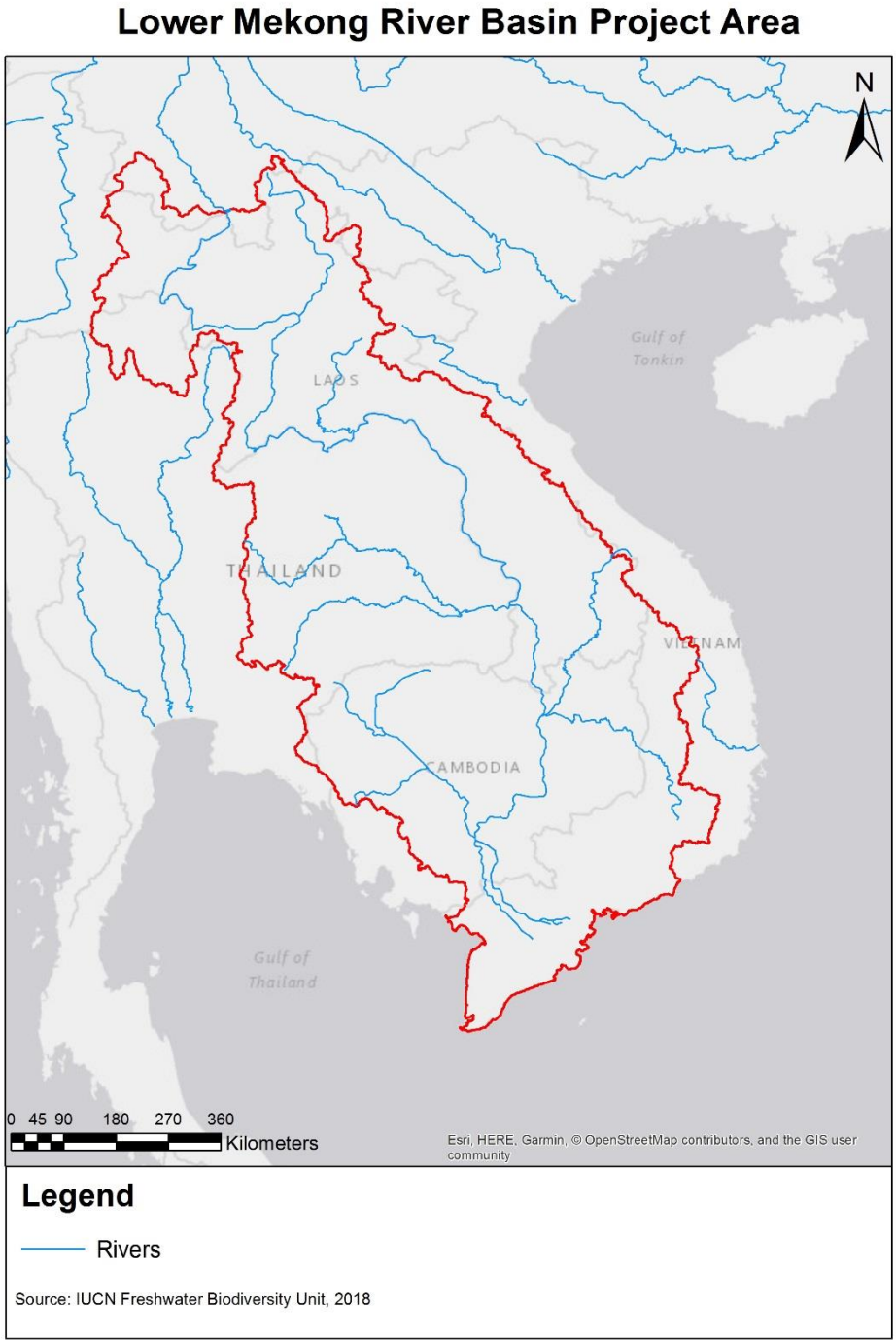


Figure 1. Map of the Lower Mekong region showing the project area.

Project Objectives

1) To guide conservation investment priorities by identifying and validating freshwater KBAs in the Lower Mekong river basin through applying the KBA Global Standard (IUCN 2016);
2) To use the new KBA dataset to inform performance standards and environmental safeguard policies of financial institutions and the private sector to avoid or minimise the impacts of their operations in and around these critical sites for freshwater biodiversity, and;
3) To use the KBA dataset as a scientific basis for potential development and expansion of existing protected area networks in the Lower Mekong river basin to better represent threatened and geographically restricted freshwater species.

A Global Standard for the Identification of Key Biodiversity Areas

Over the last four decades, a range of organisations have invested in compiling information on the location of sites that are significant for biodiversity. Since the late 1970s Birdlife International has maintained criteria for the identification of Important Bird Areas (IBAs) and more than 12,000 sites have been identified worldwide (Dudley *et al*. 2014). Building on this approach other methodologies have been developed, including Important Plant Areas (IPAs); Alliance for Zero Extinction (AZE) sites; Prime Butterfly Areas and Key Biodiversity Areas (KBAs) identified for multiple taxonomic groups in freshwater, terrestrial and marine environments. These approaches generally focus on one group of species or one biome, and use diverse assessment criteria, which has led to some confusion among decision-makers as well as duplication of conservation efforts (IUCN 2014).

As a consequence, during the World Conservation Congress held in Bangkok (Thailand) in 2004, IUCN Members requested IUCN "to convene a worldwide consultative process to agree a methodology to enable countries to identify Key Biodiversity Areas" (IUCN 2004). In response to this Resolution (WCC3.013; https://portals.iucn.org/library/node/44299), the IUCN Species Survival Commission and the IUCN World Commission on Protected Areas established a Joint Task Force on Biodiversity and Protected Areas which, since 2012, mobilised expert input from IUCN Commissions, Members, Secretariat staff, conservation organisations, academics, decision-makers, donors, and the private sector to consolidate globally agreed scientific criteria and harmonise work for identifying KBAs (IUCN 2014). All these efforts culminated in "A Global Standard for the Identification of KBAs", approved by the IUCN Council during its 88th meeting on 11–13 April 2016, that can be robustly applied across taxonomic groups and all elements of biodiversity.

Data generated through the application of the KBA Standard are expected to have multiple uses (Dudley *et al*. 2014). KBAs can support the strategic expansion of protected area networks by governments and civil society working toward the achievement of the Aichi Biodiversity Targets (in particular Targets 11 and 12), as established by the Convention on Biological Diversity (CBD) (Butchart *et al*. 2012); serve to inform the description or identification of sites under international conventions (such as wetlands of international importance designated under the Ramsar Convention, natural World Heritage Sites, and Ecologically and Biologically Significant Areas as described under the CBD); contribute to the development of other effective area-based conservation measures (Jonas *et al*. 2014); inform private sector safeguard policies, environmental standards, and certification schemes; support conservation planning and priority-setting at national and regional levels; and provide local and indigenous communities with opportunities for employment, recognition, economic investment and societal mobilisation (IUCN 2016).

Key Biodiversity Areas are “sites of importance for the global persistence of biodiversity”. However, this does not imply that a specific conservation action, such as protected area designation, is required. Such management decisions should be based on conservation priority-setting exercises, which combine data on biodiversity importance with the available information on site vulnerability and the management actions needed to safeguard the biodiversity for which the site is important. It is often desirable to incorporate other data into priority-setting, such as conservation cost, opportunity for action, importance for conserving evolutionary history and connectivity. KBAs thus do not necessarily equate to conservation priorities but are invaluable for informing systematic conservation planning and priority-setting, recognising that conservation priority actions may also be outside of KBAs (IUCN 2016).

Methodology

KBA Criteria and Thresholds

The global KBA criteria provide quantitative thresholds for identifying sites that contribute significantly to the global persistence of: A) threatened biodiversity; B) geographically restricted biodiversity; C) ecological integrity; D) biological processes and; E) biodiversity through comprehensive quantitative analysis of irreplaceability (IUCN 2016; Annex I).

Sites identified as potential KBAs should ideally be assessed against all criteria. Although not all these criteria are applicable or relevant for the freshwater taxonomic groups considered, meeting any one of the criteria (or sub-criteria) is enough for a site to be considered for qualification as a KBA. Species meeting the KBA criteria and thresholds are defined as KBA *trigger species*.

The Freshwater KBA Delineation process

Stage 1. Desk-based activities in preparation for a stakeholder KBA validation workshop.

The first step in the process was a desktop analysis of data previously collated through IUCN Red List assessments for the following freshwater taxonomic groups: i) fishes; ii) molluscs; iii) odonates (dragonflies and damselflies); iv) decapods (crabs and shrimps) and; v) selected aquatic plants. Given the wide range of trophic levels and ecological roles encompassed within these five taxonomic groups, it is proposed that information on their distributions and conservation status, when combined, will provide a useful indication for the overall status of the associated wetland ecosystems.

KBA delineation is an iterative process that makes use of better and more recent data as they become available (IUCN 2016). The species Red List Assessments are often updated before the KBA analysis to ensure that data are traceable to a reliable source and sufficiently recent to give confidence that the biodiversity elements are still present at the sites. Given the limited timeline of this project however, this update was not possible and the data sets collected included only existing information on species distributions (digital shape files) and their IUCN Red List Categories of extinction risk as published on the IUCN Red List in 2012.

a. Assemble spatial data sets for:

i. Species Red List assessments and distribution maps for freshwater fishes, molluscs, odonates, shrimps, crabs, and aquatic plants, and;
ii. Existing KBAs, Ramsar sites and Protected Areas.

b. Derive proposed site boundaries based on biological data

All river/lake sub-catchments in the Lower Mekong River basin that contain potential KBA trigger species were identified using the species distribution maps assembled in Stage 1a. River/lake sub-catchments were delineated according to the spatial data layer called HydroBASINS (Lehner & Grill 2013).

The resolution used for selecting sub-catchments holding KBA trigger species was HydroBASINS Level 8, which in the Lower Mekong delineates sub-catchments with an average surface area of 272 km^2. In this way, maps were created to show the numbers of potential trigger species per sub-catchment. Lists of these potential trigger species were compiled for each sub-catchment. This process was achieved through a screening of all sub-catchments against the full complement of species maps using

"R" scripts, a free software for statistical computing and data analysis (Venables *et al.* 2017), to identify the trigger species present and the criteria triggered for each sub-catchment.

Stage 2. Stakeholder KBA validation and delineation workshop.

The KBA identification process is a highly inclusive, consultative and bottom-up exercise. A KBA validation and delineation workshop was held in Bangkok, Thailand in September 2018 in collaboration with the relevant stakeholders (species experts and conservation NGOs) from the Lower Mekong river basin (see Annex II).

The aim of the KBA delineation workshop was to gather regional and international experts to confirm that the proposed sub-catchments meet the KBA criteria and to then derive KBA site boundaries that are biologically relevant yet practical for management (IUCN 2016). Workshop participants were first asked to confirm the presence of the KBA trigger species within each sub-catchment identified through Stage 1 (desk analysis); identify any additional freshwater trigger species; and to then delineate KBA boundaries according to the following procedures:

a. Confirmation of KBA trigger species presence within sub-catchments.

The presence of each trigger species within a proposed KBA sub-catchment was confirmed based on museum records from major collections, coarse scale distribution records and regional and international expert knowledge. When species locality records were greater than 50 years old and there was insufficient evidence to confirm presence of the species within a sub-catchment, the species were listed as "potential" KBA trigger species and fieldwork was recommended to confirm their presence at the site before being validated as trigger species. Initial information on the distribution ranges of KBA trigger species within a KBA and in other habitats connected to the KBA was obtained from the IUCN Red List website (www.iucnredlist.org). Additional information for each trigger species, such as its ecological requirements, is also available within the IUCN Red List accounts.

b. Boundary delineation with respect to pre-existing KBAs.

Wherever possible, identification and delineation of KBAs should take into consideration the boundaries of pre-existing terrestrial KBAs, Important Bird Areas (IBAs), Important Plant Areas (IPAs) or Alliance for Zero Extinction (AZE) sites (all of which now fall under the umbrella term "Key Biodiversity Area"), because many have national recognition, active conservation and monitoring initiatives, and/or are linked to international, national, regional legislative and policy processes (IUCN 2016). Adoption of the boundaries of these pre-existing sites therefore aims to: a) minimise the confusion associated with multiple overlapping boundaries and b) maximise the likelihood for conservation management at the site, building on the existing recognition of the pre-existing site and any active management already in place. Thus, where freshwater trigger species were present in sub-catchments overlapping existing sites, the boundary of the existing site was adopted if:

- the trigger species presence within the site met the KBA criteria thresholds; and
- the boundary was ecologically relevant for management of the freshwater trigger species.

c. Boundary delineation with respect to Protected Areas.

Protected Areas (PAs) are established and legally recognised management units with the goal of safeguarding the biodiversity contained within them. Additional recognition of the site as a freshwater KBA, using the existing site boundaries, can bring further attention to their importance and better focus management towards any newly recognised freshwater species of conservation concern. Therefore, when a freshwater trigger species was within a sub-catchment overlapping an existing PA, the protected area boundary was adopted to delineate the KBA if:

- the PA contained enough of the KBA trigger species range to meet the threshold of significance; and
- the boundary was ecologically relevant for the species.

It is important to highlight that terrestrial PAs have shown to be largely ineffective for conserving freshwater habitats and species (Juffe-Bignoli *et al*. 2016; Leadley *et al.* 2014). For example, rivers have often been used to delineate the borders of PAs rather than being the targets of conservation themselves (Abell *et al*. 2007). PAs also often lack targeted actions for management of freshwater biodiversity and often fail in dealing with pressures coming from outside the protected area boundaries. Therefore, information on the presence and management needs of freshwater species within a PA is crucial for assisting management for their long-term survival.

d. Delineation of new freshwater KBAs

Where there was no spatial overlap between the proposed freshwater KBA and any pre-existing KBAs or PAs, site boundaries were based on the location of "Focal Areas" identified for the freshwater KBA trigger species (if the focal area met the KBA criteria and thresholds). Focal Areas are distinct sites (e.g. deep pools, river headwaters, lakes, or springs) of particular importance for the long-term survival of the species (e.g. spawning areas, feeding areas, or sites supporting a significant part of the population of a species) (see Abell *et al.* 2007). Where possible, it is recommended that Focal Areas be delineated using HydroBASINS Level 12 sub-catchments (the smallest spatial units).

The new KBA Global Standard acknowledges that when delineating sites that fall outside existing KBAs and Protected Areas, it is often necessary to incorporate other data on land/water management and catchment boundaries to derive practical site boundaries (IUCN 2016). In the case of freshwater KBAs, using sub-catchments to delineate site boundaries provides clear benefits as they represent well-defined and ecologically meaningful management units; facilitate ease of data storage, search and management (tabular format); account for hydrological connectivity; facilitate input to conservation planning software such as Marxan; and can be flexibly applied at 12 different grain sizes, the smallest being approximately 10 km^2.

e. Complete minimum documentation requirements for each KBA

Finally, workshop participants were asked to complete the minimum documentation requirements for each KBA including: a site description; list of validated trigger species; description of threats and habitat types within the site; conservation actions in place and recommended; and details for potential Site Champions. This information is required to justify confirmation of a site as a KBA, and as guidance for management of the KBA, site-scale monitoring, national conservation planning and priority-setting, and global and regional analyses. Additional information for the larger sub-catchments, within which the KBAs are located, was also presented within the Site Description to inform KBA management of the wider hydrological context.

Stakeholder consultation workshop results

The freshwater KBAs delineated and validated at the stakeholder consultation workshop support 18 important river, lake, karst and wetlands systems, covering 9,0845 km^2, representing approximately 1.3 per cent of the Lower Mekong basin area (Figure 2). These freshwater KBAs support a total of 60 trigger species (see Annex III), including 45 fishes, 9 molluscs, 4 crabs, 1 plant and 1 shrimp, meaning that the presence of these species was confirmed within the sub-catchments of interest, at thresholds that met the KBA Criteria (see Annex I). Out of these, 51 are threatened species (Critically Endangered, Endangered, or Vulnerable) and 21 have a geographically restricted range. At the workshop, the regional and international experts also identified some key areas of ecological importance, including migratory routes and deep pools supporting species spawning grounds and ecological refugia during the dry season.

It is important to highlight that these 18 freshwater KBAs are only a subset of all potential important areas. The evolutionary processes that have led to the biodiversity in this region are related to high species mobility and widespread distribution. Mekong fishes typically migrate from the main river channels to seasonally flooded areas for feeding at the beginning of the rainy season. They then move out of the flooded areas into the main channels at the end of the monsoon and stay in deep pools during the dry season (Swerdrup-Jensen, 2002). As a result many fish species, such as the Critically Endangered Giant Mekong catfish (*Pangasianodon gigas*), are widespread throughout a catchment and do not therefore often occur at identifiable sites at globally significant population levels that meet the KBA thresholds and criteria. Such species may not benefit from site scale conservation and KBA delineation, but from a wider integrated catchment management approach.

Figure 2. Map of the Lower Mekong region showing the locations of all proposed and validated KBAs for freshwater species.

Freshwater KBAs Overview

Existing KBAs/Protected Areas adopted as Freshwater KBAs

Six freshwater KBAs have been delineated, adopting the boundaries of existing Protected Areas or terrestrial KBAs based on the presence of freshwater trigger species. Most of these existing management units have, however, been designed and developed based on the conservation needs (and opportunities) of terrestrial habitats and species and, as such, often fail to include targeted management for the many threatened species living in freshwater ecosystems. For these sites it is therefore most important to ensure site management practices include a focus on these freshwater KBA trigger species not previously recognised as management targets.

The following summaries are largely based on a combination of the information provided at the KBA workshop and within the species Red List assessments, and demonstrate the rationale behind the identification and delineation of freshwater KBAs in the Lower Mekong river basin.

Phu Rua National Park, Thailand. The boundary of the existing Phu Ruea National Park in north-eastern Thailand has been adopted as a freshwater KBA as it includes 30 per cent of the global range of the Endangered freshwater crab *Indochinamon bhumibol,* a species named after the King of Thailand. This species has a highly restricted range and is found predominantly in waterfalls of mountain streams and is threatened by loss and degradation of habitat. The KBA includes channels, waterfalls and torrents, associated with rivers flowing through lowland and some mountain habitats characterised by forest with scattered settlements. This KBA also supports three potential plant KBA trigger species: *Terniopsis heterostaminata, Hydrobryum phurueanum* and *Hydrobryum varium*. These species have not yet been evaluated against the IUCN Red List Categories and Criteria, but expert opinion suggests they are potentially threatened so would qualify as KBA trigger species under Criterion A (Threatened Biodiversity) and Criterion B (Geographically Restricted Biodiversity).

As a general note, available information on wetland-dependent plants as a basis for delineation of KBAs was found to be very limited for the Lower Mekong river basin. There is therefore a need to increase the number of Red List assessments, develop and support initiatives to transfer taxonomic expertise into the region through training and support for PhD programmes and, support documentation of the vegetation of subsidiary wetland-types and determination of species distributions though additional field survey. It is thought likely that such surveys will recognise freshwater taxa new to science many of which will be shown to be rare or conservation dependent.

Mom Ray KBA, Vietnam. Mom Ray National Park is located in the Central Highlands of Vietnam, also known as the Indochina Emerald Triangle, a significantly large proposed trans-frontier conservation area on the border with Laos and Cambodia. The boundary of the existing Mom Ray KBA overlapping the National Park has been adopted as it supports the entire global population of the semi-terrestrial crab *Rathbunamom chumomrayense*. This is a newly described species of the family Potamidae, highly localised and restricted to Chu Mom Ray National Park (Van Tu Do *et al*. 2016). Although it occurs within a protected area, the species is threatened by deforestation and it is very likely that it will qualify as an AZE species once assessed against the IUCN Red List Categories and Criteria. The site also supports two Vulnerable freshwater fish species *Nemacheilus banar* and *Schistura kontumensis*. Better site protection and management, including enhanced law enforcement need to be implemented to stop illegal and unsustainable logging within Mom Ray National Park.

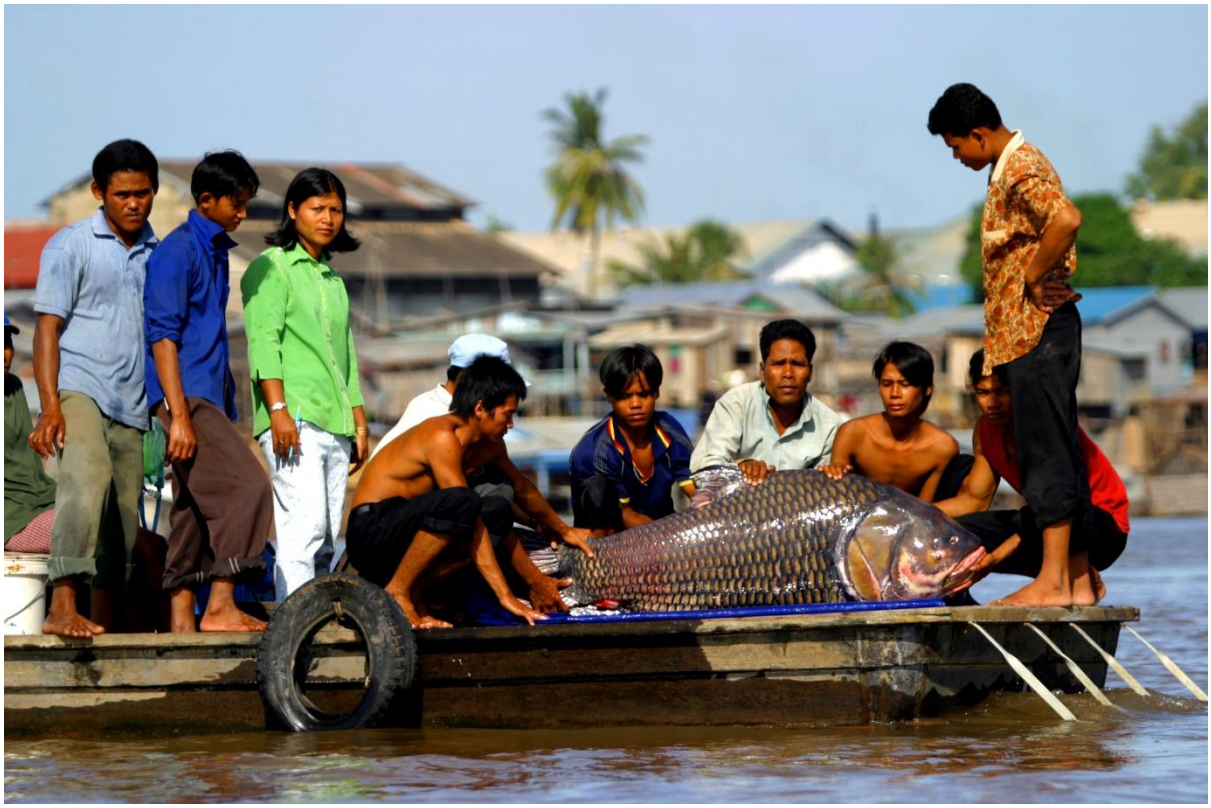
Kien Giang UNESCO Biosphere Reserve, Vietnam. The boundary of the UNESCO Biosphere Reserve Kien Giang in the south (including the existing IBA/National Park/Ramsar Site U Minh Thuong found within the MAB Biosphere Reserve), has been adopted as a freshwater KBA. This site supports at least 29 per cent of the global range for the freshwater shrimp *Caridina uminensis*. The species is considered to be Data Deficient and fieldwork is needed to determine its risk of extinction. Even though the species occurs within a Biosphere Reserve it is likely that future research will find the species classified as threatened as the site represents one of the last remnants of its peat swamp forest habitat in the biogeographic region. Main environmental threats at the site include housing, industrial, and tourist development, timber, livestock and agriculture, invasive species and saline intrusion resulting from a combination of droughts and over-extraction of water resources. The area is currently under a range of conservation measures, including site and resource protection, conservation management, measures to control the impacts of invasive species, education and awareness. However, there is a need for improved fire control, better water management to reduce the risk of increased salinity, and in particular improved collaboration between the various government bodies and local stakeholders.

Prek Toal IBA, Cambodia. The boundary of the existing IBA and Ramsar Site Prek Toal has been adopted for three Critically Endangered freshwater fish trigger species (*Pangasius sanitwongsei*, *Pangasianodon gigas* and *Datnioides pulcher)* and one Vulnerable fish *Tenualosa thibaudeau*. Although these fishes are all wide-ranging, and in most cases long distance migrants, an important part of their ranges falls within the KBA which serves as an important feeding ground during the wet season when fully flooded. The KBA is located at the north-west upstream end of Tonle Sap Lake and it is also completely inside the boundaries of a fishing concession (Fishing Lot No. 2 of Battambang Province) on which the local communities depend for their livelihoods. The site includes some of the most pristine floodplains in the Tonle Sap Biosphere Reserve in Cambodia and could potentially qualify under Criterion C (Ecological Integrity). This unique ecosystem is adapted to withstand seasonal variations in water levels of up to 10 m, and consists of short-tree shrubland and gallery forests dominated by *Barringtonia acutangula* and *Diospyros cambodiana* and a variety of woody lianas. The main threats include overfishing, pollution, agriculture, urban developments and competition and predation from invasive alien species. Recommended conservation actions include strengthening site protection, habitat restoration, invasive species eradication and better coordination among responsible authorities.

Note: Ecological Integrity can also qualify a site as a KBA under Criterion C. We didn't, however, apply this criterion because the guidelines for identifying its use were still under development. Application of Criterion C will, however, in the future represent such sites.

Pangasius sanitwongsei (CR) a trigger species occurring within the Prek Toal KBA. © Zeb Hogan.

Boeung Chhmar Moat Khla, Cambodia. The existing IBA Boeung Chhmar Moat Khla boundary has been adopted for five threatened freshwater fish trigger species: the Critically Endangered *Datnioides pulcher*, *Pangasianodon gigas* and *Pangasius sanitwongsei,* and the Endangered *Probarbus jullieni* and *Probarbus labeamajor.* The IBA comprises the open wetlands and swamp forest of Boeng Chhmar and Associated River System and Floodplain Ramsar Site which has been designated as a fish sanctuary. Boeung Chhmar is a permanent 4,000 ha lake surrounded by flooded swamp forest, linked to Tonle Sap Lake Biosphere Reserve by a maze of channels and streams. The site is a good example of near-natural wetlands that play a substantial hydrological and biological role in the natural functioning of two major rivers, Stoeng Stoung and Stoeng Chikreng. The area supports a large assemblage of plant, fish and waterbird species, many of which are listed as rare and threatened. The Tonle Sap region plays a vital role in Cambodia's economy by supplying fish to the population and several million people depend upon its continued productivity. The population in the Ramsar Site increased by 37 per cent from 1998 to 2003 leading to increased pressure on fish resources and wood collection, with more frequent dry season fires, all of which are affecting the sites ecological character by turning the forest into grasslands and shrublands (Ramsar Secretariat 2012). Efforts to manage these pressures are recommended, including creation of new fish sanctuaries and a more effective implementation of the Ramsar Site management plan. Particular attention is needed to control overexploitation of some of these fish species for the ornamental fish trade.



Catlocarpio siamensis (CR), one of the giant fishes occurring in the Boeung Chhmar Moat Khla, Cambodia © Zeb Hogan

Stung Treng 3S Confluence, Cambodia. This freshwater KBA has been delineated as an area of ecological importance for freshwater fishes which use the site for its dry season as a regufia and as a spawning ground. The KBA site boundary has been delineated at the Cambodia/Laos border taking into consideration the feasibility of management without trans-boundary challenges. There are many deep pools in this site which are key dry season refugia for at least 15 threatened freshwater fish trigger species (see Annex III) and many river bank areas which are important spawning sites. All trigger species were found to be spawning at this site in 2017 surveys (V. Elliott pers. comm, 2018). The site overlaps three pre-existing KBAs: the Sesan River, the Sekong River and the Mekong River from Kratie to Lao PDR. The boundary of the existing KBA Sesan River has been adopted only up to the Lower Sesan 2 Dam since, at this point, hydrological connectivity has been interrupted and the fish are not able to migrate upstream. The existing KBA Sekong River has not been fully adopted as the KBA would become beyond the size for a single manageable unit and also on the basis of available knowledge of locations of spawning sites. However, conservation of the upstream catchment is recommended through separate measures (Meynell, 2014). The existing boundary of Mekong River from Kratie to Lao PDR KBA has also been adopted. Given the complexity of existing sites overlap, further consultation on the final freshwater KBA boundary is needed before validating this site as a confirmed KBA. Forty two dams are proposed in the 3S (Sesane, Sekong & Srepok rivers), and once completed they will exceed the active storage of China's large dam cascade in the Upper Mekong. Given their proximity to the Lower Mekong floodplains the 3S dams could alter the flood-pulse hydrology currently driving the productivity of downstream ecosystems (Arias *et al.*, 2014). The freshwater KBA trigger species are also threatened by overfishing, pollution, agriculture and urban developments and invasive alien species. It is recommended to strengthen site protection and sustainable fisheries management as well as ensure rigorous scientific environmental impact assessments and transparency of any stages of dam development.

Note: The presence of geographically restricted species assemblages can also qualify a site as a KBA under Criterion B3. We didn't, however, apply this criterion because the guidelines for identifying its use were still under development. Application of Criterion B3 will, however, in the future represent such species.

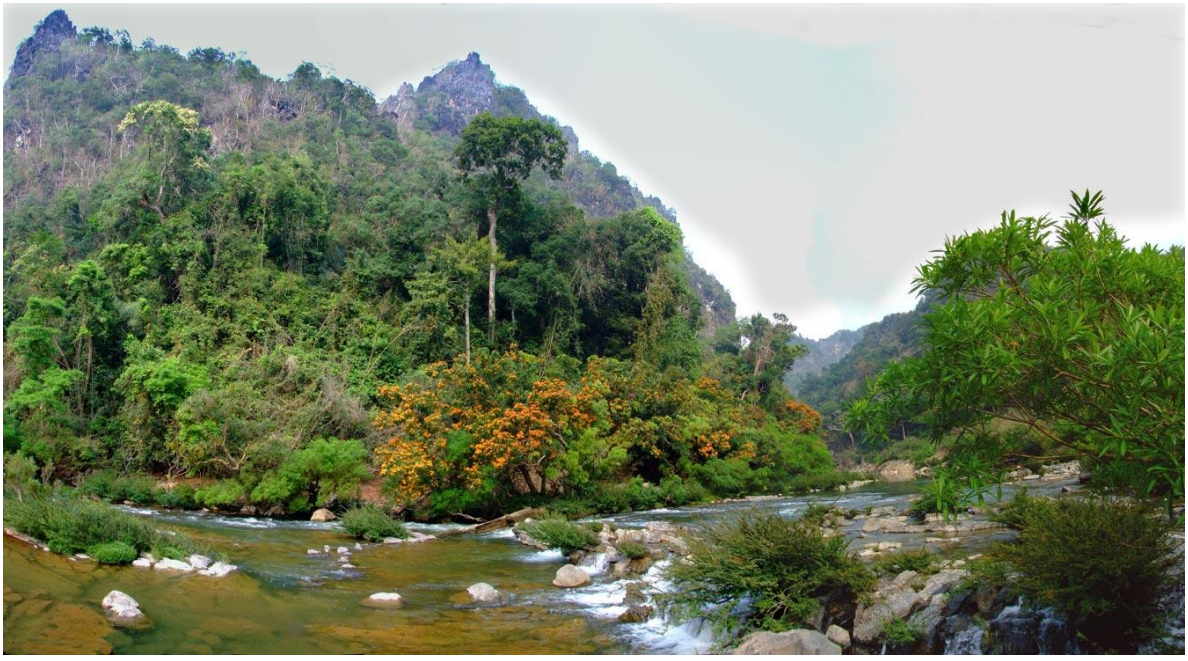
The Dolphin Pool within the Stung Treng 3S Confluence KBA at the Lao Cambodia border ©William Darwall

Fishing near Stung Treng, Cambodia. © William Darwall

Newly delineated KBAs

Twelve new freshwater KBAs were also delineated at the workshop. All these sites remain outside the boundaries of any pre-existing PAs or KBAs, suggesting that significant gaps remain in the coverage of freshwater biodiversity by existing conservation management units. A strategic expansion of national protected areas networks is therefore recommended to better represent freshwater sites such as these critical areas of conservation concern.

Xe Bangfai River Cave System, LAO PDR. Located in a remote corner of Khammouane Province in central Lao this karstic cave system has been in the delineated as a freshwater KBA using HydroBASINS Level 12 sub-catchment boundaries. This site is one of the largest limestone cave systems in the world with large passages some of which are 120 meters tall and 200 meters wide, including a subterranean channel 7 km long. The Xe Bang Fai River originates Annam Trung Sun Mountains on the border between Lao and Vietnam and flows across the Nakhai Plateau towards the Mekong River. This freshwater KBA supports 11 threatened fish trigger species (see Annex III) some of which are endemic and restricted to this cave system like the AZE Endangered species *Terateleotris aspro,* the Vulnerable *Bangana musaei* and the Data Deficient *Schistura punctifasciata* (Kottelat, 2016). Other species present at the site like the Not Evaluated *Devario sp. 'green'* and *Schistura sp. 'Nam Kathang'* need to be formally described and assessed to qualify under Criterion A1e. The main threats are posed by tourism and recreational activities. Species-specific conservation programmes for cave fishes, site protection and tourism management as well as education and raising visitor's awareness of the value and ecological importance of these KBA trigger species are recommended.



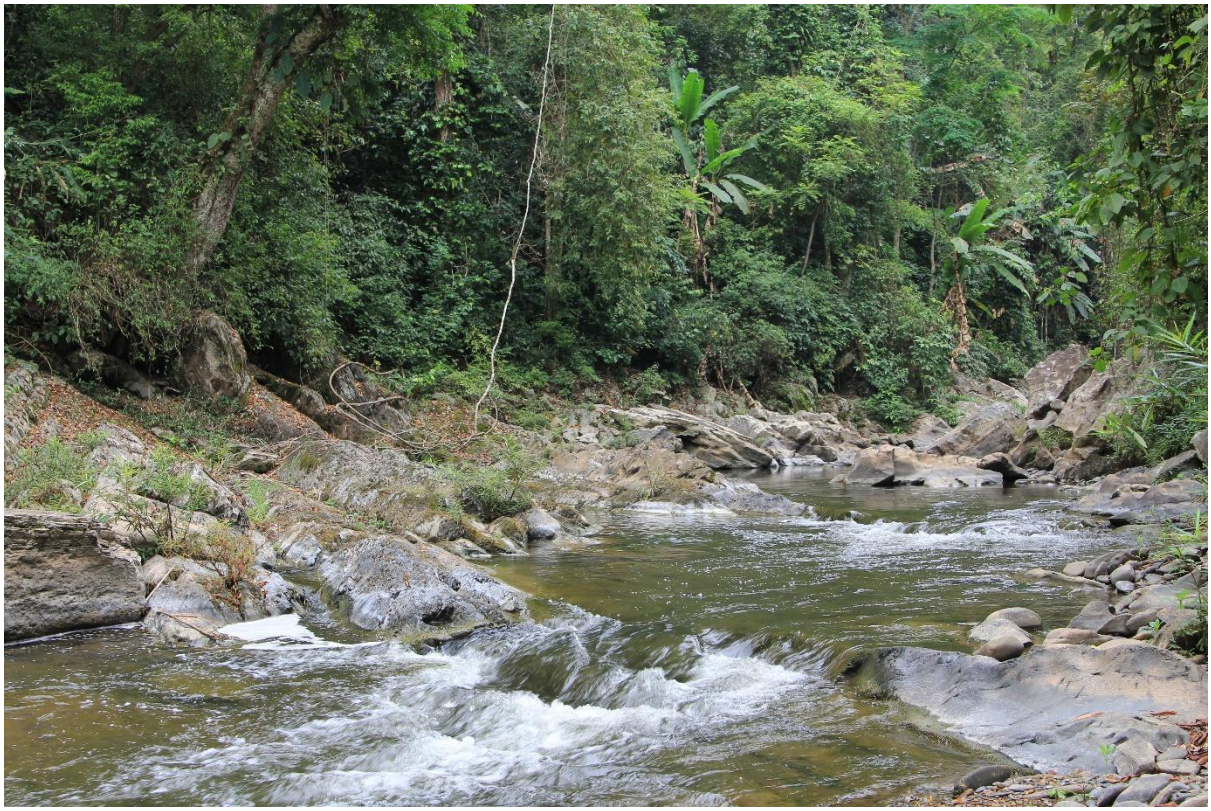
The Xe Ban Fai River, downstream the village of Ban Chalou, Khammouane, Laos Creat © Creative Commons

Nam Ngum Reservoir, LAO PDR. The Nam Ngum Dam is located on the Nam Ngum river, a major tributary of the Mekong and one of the most heavily dammed catchments in Laos. The Nam Ngum River originates in Phou Kout in the north-eastern part of the Tran Ninh Plateau, through which the river flows south-west, and discharges into the Mekong River east of Vientiane. The reservoir and its tributaries have been delineated and validated as a freshwater KBA for two Vulnerable and five restricted range fish species (see Annex III). The dam actively blocks migration by upland fish into the

downstream part of the river, which excludes some of these fish from active spawning sites. Other threats are posed by over-extraction of water resources for agriculture irrigation, pollution and overfishing. Species management, site protection and construction of effective fish passes are recommended.

Fishermen on Nam Ngum reservoir KBA © William Darwall

Nam Ou River Headwaters, LAO PDR. The Nam Ou River is one of the Mekong's largest tributaries, spanning 450 km, flowing south from mountains near the Lao-China border in Northern Laos to meet the Mekong. The Nam Ou river headwaters have been delineated as a freshwater KBA using HydroBasins Level 08. The site supports important spawning grounds for the Endangered fish *Luciocyprinus striolatus*, and more than 10 per cent of the global range of the geographically restricted fish *Acheilognathus deignani*. In the upper catchment the landscape is characterised by mountains, forested valleys and limestone karsts. The lower part of the KBA covers the downstream reach of the Nam Ngay, Nam Pe and Nam Long Rivers to its confluence with the Nam Ou. These rivers are small, with strong currents and rocky bottoms, flowing through evergreen highland tropical monsoon forest. The river banks are dominated by shrubs and bamboos. This area also supports the most vulnerable of the six known populations of the Endangered freshwater mollusc *Margaritifera laosensis*. The population of *M. laosensis* occurring within the KBA is the most intact of those known, but is very vulnerable to over-exploitation, as well as to sedimentation caused by deforestation. There is therefore a need to control logging in the catchment, as well as the harvesting of this species. Fundamental changes to the riparian ecosystems and surrounding communities are underway as development of a seven-dam cascade by China's Sinohydro Corporation, contracted by the Lao government, moves forward. The site is also threatened by soil erosion caused by intensive agriculture. Site protection and management are recommended for the long-term persistence of the freshwater KBA trigger species.



Nam Long River within the Nam Ou Headwaters KBA, Laos. © Julia Kolosova

The Critically Endangered *Margaritifera laosensis,* present within the Nam Ou Headwaters KBA. © Ivan Bolotov.

Nam He Noa, Vietnam – Lao PDR. The Nam He (Vietnam)/Nam Noa (Laos) river flows through limestone forest in the north-west of Vietnam on the border with Laos. This new KBA has been delineated using HydroBASINS Level 12 sub-catchments, and includes more than 0.5 per cent of the global ranges of the Vulnerable freshwater crab *Indochinamon dangi* and the Endangered freshwater mollusc *Pseudodon resupinatus*. This site is also an important site for a range of other mussel species, possibly including *Margaritifera laosensis*. The site is threatened by deforestation and expansion of agriculture due to population growth in the area. Water quality and hydrological connectivity are also threatened by dams and the secondary effects of mining and limestone extraction. Site protection, intergovernmental cooperation and collaborative management strategies are recommended between the Vietnamese and Laotian governments to increase the effectiveness of conservation actions in the catchment.

Indochinamon dangi (VU), is present within the Nam He Noa KBA found in freshwater streams with rocky/sandy substratum in secondary forest near rice fields. © Darren C.J. Yeo.

Vam Nao Confluence, Vietnam. A new freshwater KBA has been delineated using HydroBASINS Level 08 at the Vam Nao Confluence with the Mekong River. This confluence contains important deep pools acting as refuge habitats and spawning grounds for freshwater fishes during the dry season (Vu *et al*., 2009) including the Critically Endangered *Pangasius sanitwongsei* and the Endangered *Probarbus jullieni*. The quality and quantity of these existing deep pools have been affected due to increased silt deposition that resulted from dam constructions and flood mitigation schemes. The KBA trigger species are also threatened by overfishing. Fishing co-management between the local communities, the government and private sector is recommended to achieve long-term sustainable fisheries. These deep pools should be taken into account in environmental impact assessments of water management projects and designated as a fish conservation zones to protect fish stocks and livelihoods in the region.

Dak Poko Headwaters, Vietnam. The Dak Poko headwaters have been delineated as a freshwater KBA buffering the Dak Poko river (with 1 km strip on each side) and its tributary Dak Long in the southwest. This area is an important spawning ground for three fish trigger species, the Critically Endangered *Sewellia breviventralis*, the Endangered *Sewellia patella*, and the Data Deficient *Poropuntius kontumensis*. The upper part of the catchment is forested and the lower part at the confluence with the Dak Long tributary is covered by agricultural land. The site is potentially threatened by the further expansion of agriculture and associated runoff, increased sedimentation and the construction of roads along the river. Management of local fisheries to prevent overexploitation, protection of the river from dam construction and habitat restoration of the river banks to prevent pollution by sedimentation are recommended. Field work is recommended to confirm the presence of the trigger species upstream within the Ngoc Linh Nature Reserve.

Hô Earal, Vietnam. A new freshwater KBA has been delineated in the Đắk Lắk Province in the central highlands of Vietnam. The site includes Lake Earal near the city of Ea Drang and its associated wet woodland. The site supports up to 30 per cent of the global population range of the Critically Endangered Chinese Swamp Cypress (*Glyptostrobus pensilis*) which is threatened by habitat loss due to expansion of intensive agriculture and illegal logging. Chinese Swamp Cypress wood is highly valued for crafts and in China it is reputed to have anti-cancer properties although there is no scientific evidence to support this (Averyanov *et al*., 2009). Urban and industrial developments around the lake and over extraction of water resources are also a significant threat. Urgent site protection and habitat restoration efforts are required to increase the size and viability of the species subpopulations in Vietnam.

Tha Tum Nam Mun, Thailand. The Tha Tum Nam Mun freshwater KBA is located in the middle reaches of the Mun River within the Surin Province in northeast Thailand. The KBA has been delineated using HydroBASINS Level 12m sub-catchments to include part of the middle river channel for two Endangered freshwater molluscs (*Anulotaia forcarti* and *Pachydrobia zilchi*). This KBA also supports 89 per cent of the Endangered freshwater mollusc *Modelnaia siamensis*, potentially qualifying as an AZE species. Within the KBA, the river channel is characterised by hard, sandy mud substrate. The main threats to these molluscs are posed by sand-extraction and construction of hard flood defences. There is a reservoir located east of the KBA which has disrupted the flow of the Mun River and increased sedimentation in this area. There is a need for measures to control exploitation of sand from the river and its margins, as well as a need to obtain up to date information on the conservation status of the populations of these three KBA trigger mollusc species.

Ubon Mun River, Thailand. The Ubon Nam Mun freshwater KBA is located in the lower reaches of the Mun River in the Ubon Ratchathani Province, Northeastern Thailand. This river section is characterised by rocky banks, sandy substrate and sandbanks, and the well-known Saphue rapids in the Phibun Mangsahan District. The KBA supports more than 1 per cent of the global range of four Vulnerable mollusc species (*Hydrorissoia munensis, Jullienia prasongi, Lacunopsis minutarpiettei* and *Lacunopsis munensis*), and it has been delineated using HydroBASINS Level 12 sub-catchments. The main threats to these freshwater KBA trigger species are the construction of hard flood defences along the river, and the Pak Mun Dam, located at the easternmost end of the KBA, which has disrupted the flow of the river and increased sedimentation. The local community is actively engaged in trying to stop the operations of the dam. There is a need to restrict construction of hard flood defences and to instead put an emphasis on restoring floodplains as natural solutions to flood defence.

Kampong Laeng, Cambodia. The Kampong Leang outlet has been delineated as a freshwater KBA for six threatened freshwater fish trigger species: the Critically Endangered *Pangasianodon gigas* and *Catlocarpio siamensis,* the Endangered *Pangasianodon hypophthalmus* and *Probarbus jullieni*, and the Vulnerable *Tenualosa thibaudeaui* and *Cirrhinus microlepis*. The boundary of the site extends from southern Kampong Chnang to the inland delta where the Tonle Sap River meets Tonle Sap Lake. This area supports aggregations of migrating species that constitute more than >1 per cent of the global populations of each of these species. The site is also an important ecological refugia for these species during the dry season. The main threats are from urban development, agricultural encroachment, water pollution caused by sedimentation, urban sewage and agricultural run-off (Song *et al*., 2011). Competition and predation from introduced invasive species, such as the Nile tilapia (*Oreochromis niloticus*), is also a major threat. Site protection, sustainable fisheries co-management and invasive species control and eradication are recommended.

Probarbus jullieni (EN) in a local market. © FISHBIO

Thala Stueng Treng, Cambodia. The Thala Stueng Treng freshwater KBA is located on the west bank of the Mekong River in the Stueng Treng Province, in the Northeast of Cambodia. The KBA has been delineated using HydroBASINS Level 12 sub-catchments to include the main river channel for the Vulnerable freshwater crab *Mekhongthalphusa tetragona*. The Red List assessment for this species needs to be updated to include the species range in Cambodia. The KBA is characterised by open marshland and irrigated agricultural land with remnant forest patches. The river channel includes a range of in-stream habitats such as riffles and sand banks. The downstream reaches and mouth of the river are potentially threatened by urbanisation and changes in land-use such for agriculture. Site protection and management are recommended.

Vinh Cuu, Vietnam. An extension to the existing Vinh Cuu KBA in the south is proposed to include important spawning grounds for five threatened freshwater fish trigger species, the Critically Endangered *Datnioides pulcher,* the Endangered *Fluvitrygon oxyrhyncha*, *Hemitrygon laosensis*, and *Poropuntius deauratus*, and the Vulnerable *Yasuhikotakia nigrolineata*. The site comprises a stretch of the Đồng Nai River flowing through agricultural land from Tri An Dam to the north of Bien Hoa City. Measures to preserve water quality, safeguard river flows, reduce exploitation and protect habitat are recommended.

Site Champions

Forty-six Site Champions have been identified by stakeholders as individuals/organisations best placed to raise awareness of the existence of the KBAs and the issues faced with respect to threats to freshwater biodiversity (Annex IV). It is recommended that these potential Site Champions be engaged in the development and implementation of required actions to safeguard these globally important sites. For three KBAs, namely Nam He-Noa, Nam Ngay and Tha Tum Nam Mun, the experts were unable to identify any potential Site Champions. In these cases, increasing awareness and building capacity of local communities to manage these sites are recommended.

Conclusions and Recommendations

The Lower Mekong river basin supports a high diversity of aquatic species. Many of these species provide direct (e.g. fisheries) and indirect (e.g. water purification) benefits to people, supporting local economies and livelihoods across the basin. Freshwater ecosystems are however undervalued and receive insufficient funding, political attention and protection. Developing interest and funding for freshwater species conservation is crucial for "bending the curve" (Mace *et al*. 2018) to reduce and ultimately reverse current freshwater biodiversity declines. Given the limited resources available for pursuing biodiversity conservation targets efforts should therefore focus on those species and areas most in need, and for which conservation actions are most likely to yield positive outcomes.

The IUCN Red List assessments provide information on those species at greatest risk of extinctions and the KBAs identified here provide a valuable tool to guide conservation action at the sites important for those species. KBAs can be used for the identification of priority sites for donor investment, protection under international conventions and national policies, and in setting and implementing private sector environmental safeguards. A site-based approach on its own will not, however, protect all species and needs to be combined with conservation action at the catchment scale. For example, migratory fish species of the Mekong system may benefit from protection of breeding sites and deep pool refugia in the dry season, but also require catchment scale actions to address more widespread threats such as from land use and barriers to movement throughout the catchment. This combined site and catchment approach is particularly important for freshwater ecosystems where the high levels of connectivity mean that impacts to a site may originate long distances upstream or downstream.

At the basin (catchment) scale, Integrated River Basin Management (IRBM) approaches are recommended to better coordinate conservation, management and development planning of water, land and related resources across sectors, and to maximise the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems.

The focus here on priority sites for conservation action has identified 18 important river, lake and wetland systems which have been mapped and validated as freshwater KBAs in the Lower Mekong River basin. These 18 KBAs combined support 60 freshwater trigger species, meaning that their presence was confirmed to meet the thresholds required to qualify each site as a KBA essential for the global persistence of each species. Approximately 66 per cent of the combined area of these KBAs (5798 Km^2) was found to lie outside the boundaries of any existing protected area. These KBAs therefore represent critical gaps in coverage of freshwater species by protected areas and should be used to improve the representation of freshwater biodiversity within the national protected areas networks. The information presented here represents the start of a process to ensure the long-term protection and management of freshwater biodiversity in KBAs. General recommendations for action include:

- Where freshwater KBAs fall within the boundaries of existing protected areas, with the notable exception of water birds, the freshwater species of concern here are rarely targeted for conservation action with existing management plans. Targeted conservation actions for these neglected freshwater species must therefore be incorporated within the management plans of these protected areas.

- The list of freshwater KBAs and threatened species provided through this assessment should be used to inform Performance Standards and Environmental Safeguard policies of donor institutions and the private sector to help avoid or minimise impacts of their operations in and

around these critical sites for freshwater biodiversity. Efforts should be taken to ensure that this new information for freshwater biodiversity is fully utilised within these processes.

- Capacity must be increased to enable government bodies (national to local) to capitalise upon this new information on freshwater biodiversity through training in the application of biodiversity data sets to species and site based management and enforcement activities.

- Freshwater KBAs need to be integrated within and used across sectorial policies such as energy and agriculture to avoid contradictory regulatory objectives and inconsistent financial initiatives. Without such coordination freshwater species and ecosystems will likely continue to decline.

- Implementation of Environmental Flow methodologies is highly recommended to maintain the quality, quantity and timing of water flows required to sustain freshwater ecosystems within KBAs.

- Private capital investment on freshwater habitat reforestation programmes is recommended for many wetland systems, in particular in the upper catchments such as the Dak Poko and the Nam Ou headwaters, to reduce downstream impacts of sedimentation.

- Increased efforts are required to trace invasive alien species pathways of introduction in the Lower Mekong, prevent future introductions and to manage, or where feasible, eradicate them. Information on the distribution of invasive alien species, their impacts, pathways of invasion and management recommendations can be found in the Global Invasive Species Database (GISD) http://www.iucngisd.org/gisd

- Local empowerment and participatory approaches are key to ensure the legitimacy and the long-term sustainability of any conservation actions. As part to the KBA delineation process 45 potential Site Champions have been identified as individuals and organisations best placed to raise awareness and to help implement the required actions to safeguard these globally important sites for the global persistence of freshwater biodiversity (Annex I). It is recommended that the Site Champions proposed for each KBA are invited to assist in future efforts to promote and/or implement conservation actions at these sites.

- The identification and delineation of KBAs is necessarily a fluid and ongoing process responding to the provision of new information and a constantly changing environment, and thus it is expected that this current freshwater KBA dataset for the Lower Mekong river basin will continue to be refined and updated. Ultimately the process for identification of KBAs should be nationally driven such that all relevant parties can be directly involved, especially to facilitate any recommendations to change boundaries of existing Protected Areas or KBAs. It is therefore recommended that, where not already established, KBA national focal points and national KBA Coordination Groups be established in Vietnam, Cambodia, Laos PDR and Thailand to build upon this foundation for site-based protection of freshwater species. The work presented in this report represents the first steps in taking this process forwards and it provides a baseline data set to inform future KBA designations.

- Species Red List Assessments for the Lower Mekong freshwater species need to be updated to ensure that conservation priorities are sound and based on the most up-to-date scientific knowledge. This includes funding field surveys to resolve the status of Data Deficient species.

Information on the KBAs will be reviewed by the KBA Secretariat and, once confirmed, made publicly available through the World Database on Key Biodiversity Areas (WDKBA) http://www.keybiodiversityareas.org/home managed by Birdlife International on behalf of the KBA Partnership and through the Integrated Biodiversity Assessment Tool (IBAT) https://www.ibatforbusiness.org/ – a tool that is already well known amongst the private sector and donor community.

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Annex I. Summary of the KBA Criteria and Thresholds (IUCN 2016)

A. Threatened Biodiversity	*Biodiversity element at site*	*% global pop. size/extent*	*RU*[1]
A1. Threatened species	(a) CR or EN species	≥0.5%	≥5
	(b) VU species	≥1%	≥10
	(c) CR or EN species Threatened only due to population size reduction in the past or presen	≥0.1%	≥5
	(d) VU species Threatened only due to population size reduction in the past or present	≥0.2%	≥10
	(e) CR or EN species	Entire global population size	
A2: Threatened ecosystem types	(a) CR or EN ecosystem type	≥5%	
	(b) VU ecosystem type	≥10%	
B. Geographically restricted biodiversity	*Biodiversity element at site*	*% global pop. size/extent*	*RU*
B1: Individually geographically restricted species	Any species	≥10%	≥10
B2: Co-occurring geographically restricted species	Restricted-range species: ≥2 species OR 0.02% of total number of species in taxonomic group, whichever is larger	≥1%	
B3: Geographically restricted assemblages	(a) ≥5 ecoregion-restricted species[2] OR 10% of the species restricted to the ecoregion, whichever is larger	≥0.5%	
	(b) ≥5 bioregion-restricted species[2] OR 30% of the bioregion-restricted species known from the country, whichever is larger		
	(c) Part of the globally most important 5% of occupied habitat of each of ≥5 species within a taxonomic group		
B4: Geographically restricted ecosystem types	Any ecosystem type	≥20%	
C. Ecological integrity	*Biodiversity element at site*		
	Wholly intact ecological communities	≤2 sites per ecoregion	
D. Biological processes	*Biodiversity element at site*	*% global pop. size*	
D1: Demographic aggregations	(a) Species aggregation during one or more key stages of its life cycle	≥1%	
	(b) Among the largest 10 aggregations known for the species		
D2: Ecological refugia	Species aggregations during periods of past, current or future environmental stress	≥10%	
D3: Recruitment sources	Propagules, larvae or juveniles maintaining high proportion of global population size	≥10%[3]	
E: Irreplaceability through quantitative analysis	*Biodiversity element at site*	*Irrepl. score*	*RU*
	Site has high irreplaceability measured by quantitative spatial analysis	≥0.90 on 0–1 scale	≥10 (or ≥5 for EN/CR sp)

[1]RU=reproductive units; [2]wtihin a taxonomic group; [3]refers to global population size rather than immature individuals produced.

Annex II. Workshop Participants and Project Contributors

Country		Name	Organisation
Cambodia	Mr	Chhang Phourin	Forestry Administration Ministry of Agriculture, Forestry and Fisheries
Cambodia	Mr	Chheng Phen	Biology Division Fisheries Research and Development Institute
Cambodia	Mr	Eric Baran	WorldFish
Cambodia	Mr	Kosal Mam	WorldFish
Cambodia	Mr	Monyrak Meng	Department of National Parks and Wildlife Sanctuaries, MoE
Cambodia	Dr	Peng Bun Ngor	Department of Planning, Finance and International Cooperation of Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries
Cambodia	Mr	Ronald W. Jones	MNRM (NRI-Manitoba) Ottawa, ON Canada & Phnom Penh, Cambodia.
Cambodia	Mr	Simon Mahood	WCS
Cambodia	Dr	Sor Ratha	Royal University of Phnom Penh
China	Prof	CHEN Xiaoyong	Kunming Institute of Zoology, CAS
China	Dr	ZHANG Haomiao	Kunming Institute of Zoology, CAS

Country		Name	Organisation
Finland	Dr	Matti Hämäläinen	
Japan	Prof	Masahiro Kato	National Museum of Nature and Science, Department of Botany, Japan
Lao PDR	Dr	Anoulak Kittikhoun	Mekong River Commission
Lao PDR	Mr	Bounthob Praxaysombath	National University of Lao
Lao PDR	Mr	Christopher Holmes	WCS
Lao PDR	Ms	Erin Loury	FISHBIO
Lao PDR	Dr	Ilya Vikhrev	Russian Academy of Sciences
Lao PDR	Mr	Sinsamout Ounboundisane	FISHBIO
Lao PDR	Mr	Victor Cowling	WWF Greater Mekong
Malaysia	Mr	Rory Dow	Naturalis Biodiversity Center
Russia	Dr	Ekaterina Konopleva	Russian Academy of Sciences
Russia	Dr	Oleg E. Kosterin	Institute of Cytology and Genetics · Laboratory of Genetics and Evolution of Legume Plants, Russia
Switzerland	Dr	Maurice Kottelat	

Country		Name	Organisation
Thailand		Alessandro Badalotti	IUCN ARO
Thailand	Dr	Chavalit Vidthayanon	Northeastern Research Institute for Petrified Wood and Mineral Resources, Nakhon Rachasima
Thailand	Mr	Chirasak Sutcharit	Chulalongkorn University
Thailand	Mr	Maureen Harris	International Rivers
Thailand	Dr	Narumon Sangpradub	Khon Kaen University
Thailand	Mr	SayLin Ong	IUCN ARO
Thailand	Dr	Scott Perkin	IUCN ARO
Thailand	Dr	Somsak Panha	Chulalongkorn University
Thailand	Mr	Teerapong Pomun	LRA/MCI
Thailand	Mr	Terry Warren	NongKhai Province
Thailand	Ms	Ting Hui Ng	Chulalongkorn University
UK	Mr	Merlin Veron	Synchronicity Earth
UK	Mr	Richard Lansdown	IUCN SSC Freshwater Plant Specialist Grooup

Country		Name	Organisation
USA	Mr	Art Bogan	North Carolina Museum of Natural Sciences
USA	Dr	John Pfeiffer	PhD Candidate Florida Museum of Natural History University of Florida
USA	Dr	Vittoria Elliott	CI Greater Mekong
USA	Mr	Zeb Hogan	Wonders of the Lower Mekong
USA	Mr	Ian Baird	University of Wisconsin–Madison | UW · Department of Geography
Vietnam	Dr	Bui Huu Manh	GAIA
Vietnam	Dr	Dao Trong Tu	CEWAREC
Vietnam	Dr	Do Manh Cuong	Vietnam National Museum of Nature, 18 Hoang Quoc Viet, Vietnam
Vietnam	Dr	Do Van Tu	Vietnam National Museum of Nature, 18 Hoang Quoc Viet, Vietnam
Vietnam	Dr	Duong Van Ni	Mekong Wetland University Network
Vietnam	Prof	Hoang Duc Huy	Faculty of Biology, HCMC University of Science and Technology
Vietnam	Mr	Jake Brunner	IUCN Vietnam

Country		Name	Organisation
Vietnam	Mr	Jeremy Carew-Reid	ICEM
Vietnam	Mr	Nguyen Duc Tu	IUCN Vietnam
Vietnam	Dr	Nguyen Thai Tri	Institute of Tropical Biology
Vietnam	Dr	Nguyen Thi Kim Dung	Vietnam National University
Vietnam	Dr	Tran Triet	International Crane Foundation

Annex III. Freshwater KBA Trigger Species

KBA Name	Group	Trigger Species	Red List Category	A1a	A1b	A1c	A1d	A1e	B1	D1a	D1b	D2	D3
Boeung Chhmar Moat Khla (Confirmed)	Fishes	*Datnioides pulcher*	CR	yes (iv)									
	Fishes	*Pangasianodon gigas*	CR	yes (iv)									
	Fishes	*Probarbus labeamajor*	EN	yes (iv)									
	Fishes	*Pangasius sanitwongsei*	CR			yes (iv)							
	Fishes	*Probarbus jullieni*	EN			yes (iv)							
Dak Poko Headwaters (Confirmed)	Fishes	*Sewellia breviventralis*	CR	yes (iv)						yes			
	Fishes	*Sewellia patella*	EN	yes (iv)						yes			
	Fishes	*Poropuntius kontumensis*	DD							yes			
Kampong Laeng (Confirmed)	Fishes	*Tenualosa thibaudeaui*	VU							yes	yes		
	Fishes	*Pangasianodon gigas*	CR	yes (iv)					yes (iv)	yes	yes		yes
	Fishes	*Pangasianodon hypophthalmus*	EN			yes (iv)							
	Fishes	*Probarbus jullieni*	EN			yes (iv)							
	Fishes	*Catlocarpio siamensis*	CR			yes (iv)							
	Fishes	*Cirrhinus microlepis*	VU				yes (iv)						
Nam Ngum Reservoir (Confirmed)	Fishes	*Rhinogobius albimaculatus*	VU		Yes (iv)				Yes (iv)				
	Fishes	*Osphronemus exodon*	VU				Yes (iv)						
	Fishes	*Schistura personata*	NT						Yes (iv)				
	Fishes	*Schistura coruscans*	DD						Yes (iv)				
	Fishes	*Schistura ephelis*	DD						Yes (iv)				
	Fishes	*Schistura sigillata*	DD						Yes (iv)				

KBA Name	Group	Trigger Species	Red List Category	A1a	A1b	A1c	A1d	A1e	B1	D1a	D1b	D2	D3
	Fishes	*Laocypris hispida*	DD						Yes (iv)				
Nam Ou River Headwaters (Confirmed)	Fishes	*Luciocyprinus striolatus*	EN	Yes (iv)									
	Fishes	*Acheilognathus deignani*	DD						Yes (iv)				
	Molluscs	*Margaritifera laosensis*	EN	Yes (iv)					Yes (iv)				
Prek Toal (Confirmed)	Fishes	*Pangasius sanitwongsei*	CR			Yes (iv)							
	Fishes	*Pangasianodon gigas*	CR			Yes (iv)							
	Fishes	*Datnioides pulcher*	CR	Yes (iv)									
	Fishes	*Tenualosa thibaudeaui*	VU				Yes (iv)						
Vam Nao Confluence (Confirmed)	Fishes	*Probarbus jullieni*	EN			Yes (iv)							
	Fishes	*Fluvitrygon oxyrhyncha*	EN							Yes			
Vinh Cuu (Confirmed)	Fishes	*Hemitrygon laosensis*	EN							Yes			
	Fishes	*Yasuhikotakia nigrolineata*	VU				Yes (iv)			Yes			
	Fishes	*Poropuntius deauratus*	EN	Yes (iv)						Yes			
	Fishes	*Datnioides pulcher*	CR							Yes			
	Fishes	*Schistura spiloptera*	CR	Yes (iv)									
Xe Bangfai River Cave System (Confirmed)	Fishes	*Schistura tenura*	CR	Yes (iv)									
	Fishes	*Luciocyprinus striolatus*	EN			Yes (iv)							
	Fishes	*Schistura bairdi*	EN	Yes (iv)					Yes (iv)				
	Fishes	*Schistura bolavenensis*	EN	Yes (iv)					Yes (iv)				
	Fishes	*Bangana musaei*	VU		Yes (iv)								
	Fishes	*Troglocyclocheilus khammouanensis*	VU		Yes (iv)								
	Fishes	*Schistura kaysonei*	VU		Yes (iv)								
	Fishes	*Schistura susannae*	VU		Yes (iv)								

KBA Name	Group	Trigger Species	Red List Category	A1a	A1b	A1c	A1d	A1e	B1	D1a	D1b	D2	D3
	Fishes	*Schistura tubulinaris*	VU		Yes (iv)								
	Fishes	*Terateleotris aspro*	EN	Yes (iv)				Yes (iv)	Yes (iv)				
	Plants	*Glyptostrobus pensilis*	CR	Yes (iv)					Yes (iv)				
Hô Earal (Confirmed)	Shrimps	*Caridina uminensis*	DD						Yes (iv)				
Kien Giang (Confirmed)	Crabs	*Indochinamon dangi*	VU		Yes (iv)								
Nam He-Noa (Confirmed)	Molluscs	*Pseudodon resupinatus*	EN	Yes (iv)									
	Crabs	*Indochinamon bhumibol*	EN	Yes (iv)					Yes (iv)				
Phu Rua (Confirmed)	Molluscs	*Anulotaia forcarti*	EN	Yes (iv)									
Tha Tum Nam Mun (Confirmed)	Molluscs	*Pachydrobia zilchi*	EN	Yes (iv)									
	Molluscs	*Modellnaia siamensis*	EN	Yes (iv)					Yes (iv)				
	Crabs	*Mekhongthelphusa tetragona*	VU		Yes (iv)				Yes (iv)				
Thala Stung Treng (Confirmed)	Molluscs	*Hydrorissoia munensis*	VU		Yes (iv)								

KBA Name	Group	Trigger Species	Red List Category	A1a	A1b	A1c	A1d	A1e	B1	D1a	D1b	D2	D3
Ubon Mun River (Confirmed)	Molluscs	*Jullienia prasongi*	VU		Yes (iv)				Yes (iv)				
	Molluscs	*Lacunopsis minutarpiettei*	VU		Yes (iv)				Yes (iv)				
	Molluscs	*Lacunopsis munensis*	VU		Yes (iv)				Yes (iv)				
Stung Treng 3SConfluence (Candidate)	Fishes	*Pangasius sanitwongsei*	CR	Yes (iv)						Yes			
	Fishes	*Pangasianodon gigas*	CR	Yes (iv)					Yes (iv)	Yes			
	Fishes	*Aaptosyax grypus*	CR	Yes (iv)						Yes			
	Fishes	*Probarbus jullieni*	EN	Yes (iv)						Yes			
	Fishes	*Urogymnus polylepis*	EN	Yes (iv)						Yes			
	Fishes	*Pangasianodon hypophthalmus*	EN			Yes (iv)				Yes			
	Fishes	*Cirrhinus microlepis*	VU				Yes (iv)			Yes			
	Fishes	*Datnioides undecimradiatus*	VU							Yes			
	Fishes	*Hypsibarbus lagleri*	VU		Yes (iv)					Yes			
	Fishes	*Bangana behri*	VU		Yes (iv)					Yes			
	Fishes	*Osphronemus exodon*	VU							Yes			
	Fishes	*Scaphognathops bandanensis*	VU		Yes (iv)					Yes			
	Fishes	*Tenualosa thibaudeaui*	VU		Yes (iv)					Yes			
	Fishes	*Mystus bocourti*	VU							Yes			
	Fishes	*Labeo pierrei*	VU		Yes (iv)					Yes			

Annex IV. Potential Site Champions

Country	KBA Name	Site Champions
Vietnam	Hô Earal	WWF
Vietnam	Kien Giang	BirdLife International
		Biodiversity Conservation Agency
		National Park Management Board
Vietnam	Mom Ray	Ministry of Agriculture and Rural Development
		Biodiversity Conservation Agency
		National Park Management Board
Vietnam - Lao PDR	Nam He-Noa	Unknown
Lao PDR	Nam Ngay	Unknown
Thailand	Phu Rua	Department of National Parks
Thailand	Tha Tum Nam Mun	Unknown
Cambodia	Thala Stueng Treng	Wildlife Conservation Society of Cambodia
Thailand	Ubon Mun River	Ubon Ratchathani University
		Southeast Asia Rivers Network Thailand
		Samachakonjon (Assembly of the Poor, Thailand)
Cambodia	Boeung Chhmar Moat Khla	Ramsar Administrative Authority (Department of Freshwater Wetland Conservation, Ministry of Environment, Royal Government of Cambodia)
		Fisheries Administration, Royal Government of Cambodia
		IUCN

		Learning Institute
		VSO
		Fisheries Action Coalition Team (FACT)
Vietnam	Dak Poko Headwaters	Research Institute for Aquaculture No.3
		University of Science, Ho Chi Minh City
		Provincial Committee (managing nature reserve)
Cambodia	Kampong Laeng	IUCN
		Conservation International
		Akphivath Neary Khmer Organization (ANKO)
		Association of Buddhists for the Environment (ABE)
		Fisheries Action Coalition Team (FACT)
		Conservation Department of the Fisheries Administration (Royal Government of Cambodia)
Lao PDR	Nam Ngum Reservoir	LARReC (Living Aquatic Resource Research Centre)
		Nam Ngum Fisheries Association
		Department of Livestock and Fisheries
Lao PDR	Nam Ou River Headwaters	Unknown
Cambodia	Stung Treng 3S Confluence	3S Rivers Protection Network (3SPN)
		WWF
		Oxfam
		National Rural Development (NRD)
		Cambodia Rural Development Team (CRDT)
		Fisheries Administration, Royal Government of Cambodia
		World Fish
		Conservation International
		Culture and Environment Preservation Association (CEPA)
		Fisheries Action Coalition Team (FACT)
		Ministry of Environment, Royal Government of Cambodia
		NTFP-EP
		Wildlife Conservation Society - Cambodia

		Forum SYD
Vietnam	Vam Nao Confluence	Research Institute for Aquaculture No.2
		Can Tho University
Vietnam	Vinh Cuu	Vinh Cuu KBA owners
		Dong Nai Cultural and Historical Site Management Authority
		Biosphere Reserve Management Authority
Lao PDR	Xe Bangfai River Cave System	GiZ Lao PDR
		WWF