



# THE DON SAHONG DAM AND THE IRRAWADDY DOLPHIN

A science brief from WWF

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## Key messages

1. The Mekong River population of Irrawaddy dolphin is listed in the IUCN Red List as “Critically Endangered”, the highest form of threat before a population becomes extinct in the wild.

2. The proposed Don Sahong dam would be built <2 km upstream from the third largest group of Irrawaddy dolphins in the Mekong River. This group of 10 individuals represents 14% of the Mekong population.

3. This group is the only population of Irrawaddy dolphins in Lao PDR.

4. The highest potential impacts of the dam relate to (a) reduced abundance and diversity of fish resources – prey species for dolphins; (b) altered conditions in the transboundary Dolphin Pool, a primary dolphin habitat downstream from the dam site; (c) a decline in the dry-season distribution of dolphins in the Mekong River, from 190 km to 126 km (34%).

5. It is likely that impacts to fish populations and habitats in the Dolphin Pool caused by the proposed dam, could not be effectively mitigated.

6. There is a risk that the proposed Don Sahong dam, when added to existing threats, would contribute to the extinction of the Irrawaddy dolphin in Lao PDR.

7. The level of the threat calls for a specific component on dolphin survival in the Environmental Impact Assessment of the Don Sahong dam.

8. No positive impact to dolphins of the proposed dam could be identified at this stage.

## INTRODUCTION

In the Mekong River basin, water-related infrastructure (e.g. dams, reservoirs) is an essential component of regional development and brings important benefits to national economies. A key challenge is to balance hydropower development with management of other freshwater resources, including capture fisheries, wetlands and freshwater flora and fauna. One of the most well-known and endangered freshwater animals in the Mekong River basin is the Irrawaddy dolphin (*Orcaella brevirostris*). This brief examines available information on the potential impact of the proposed Don Sahong hydroelectric dam to the Irrawaddy dolphin. A more detailed impact assessment would be required when further information on the proposed dam is available.

## THE PROPOSED DON SAHONG DAM

In March 2006, the Government of Lao PDR and Mega First Corporation Berhad (MFCB), a Malaysian company, signed a Memorandum of Understanding to conduct a feasibility study for the proposed Don Sahong hydroelectric power project<sup>17</sup>. The dam would potentially be completed by 2010, cost USD300 million and have an installed capacity of about 240 megawatts. According to the MFCB director, “it will be a run-of-river project where we will build a barrage at one of the channels along the river”<sup>11</sup>. The proposed site is the Hoo Sahong channel, between two small islands in the Mekong River mainstream <2 km north of the international border between Lao PDR and Cambodia. Engineering details have not been made public yet, but based on site topography, a previous proposal for a smaller dam at this site<sup>10</sup> and documented “run-of-river” dam designs elsewhere, the project would potentially involve the following.

- Construction of a concrete barrage (dam wall) across the downstream end of the Hoo Sahong channel. This channel is approximately 100 m wide and 5 km long. (The term “run-of-river” includes a range of dam structures, but the current proposal appears to be for a complete wall across the natural channel.)

- This type of “run-of-river” dam is not usually associated with a large reservoir, but relies on natural river flow throughout the year to generate electricity. However, the dam wall may extend above the natural height of channel banks (10+ m), and it is likely that some water retention will occur in the Hoo Sahong channel up to a couple of kilometres upstream of the dam, inundating parts of both adjacent islands. (Reservoir capacity will probably only allow retention of water for several hours, for daily storage and release.)

- Dam operation may cause rapid and significant daily flow fluctuations below the dam, to meet daily peak electricity demands.
- Dam construction may involve blasting (to anchor the dam wall) and stabilizing embankments along the channel banks. Construction may require temporary diversion of water from the channel during installation of the dam wall and embankments.
- Construction of associated infrastructure, including access roads, bridges (from the mainland across intervening islands), a power station, housing / storage sites for construction staff/machinery, and transmission power lines from the dam to the power station and export destinations in Lao PDR, Cambodia or Thailand.

If built, the proposed Don Sahong dam would be the first dam on the Mekong mainstream in the Lower Mekong Basin.

## IRRAWADDY DOLPHIN IN THE MEKONG RIVER

The Irrawaddy dolphin is one of 7 river dolphin species in the world and lives in salt- and freshwater. It has a wide tropical distribution but there are only 3 exclusively riverine populations, in the Mekong River (Lao PDR, Cambodia), Mahakam (Indonesia)

and Ayeyarwady River (Myanmar). These populations are all listed in the IUCN Red List as “Critically Endangered”, the highest form of threat ranking before a population becomes extinct in the wild. The Mekong River supports a population of less than 100 individuals, distributed over 190 km of mainstream<sup>9</sup>. It is the only freshwater dolphin in Lao PDR and Cambodia. The upstream limits of dolphin distribution are the Khone Falls in Lao PDR (722 km up the river), which form a natural barrier to dolphin movement north.

The principle cause of adult mortality is drowning in fishnets, which from 2001-2005 accounted for at least 27% of documented deaths in Cambodia and Lao PDR<sup>7</sup>. Cambodian and Lao governments are working to eradicate this cause of mortality. On the Cambodian side, fishnets have been removed from areas where dolphins are found. Similar activities are being developed on the Lao side. Causes of current juvenile and calf mortality are largely unknown.

In the dry season, most dolphins are confined to deep pools >8-10 m depth<sup>2</sup>, which provide critical shelter from swift river currents and support high prey fish populations. Fish are the principle diet of Irrawaddy dolphins<sup>3,4,8</sup>. Many aspects of the ecology and biology of the Irrawaddy dolphin in the Mekong River are poorly known.

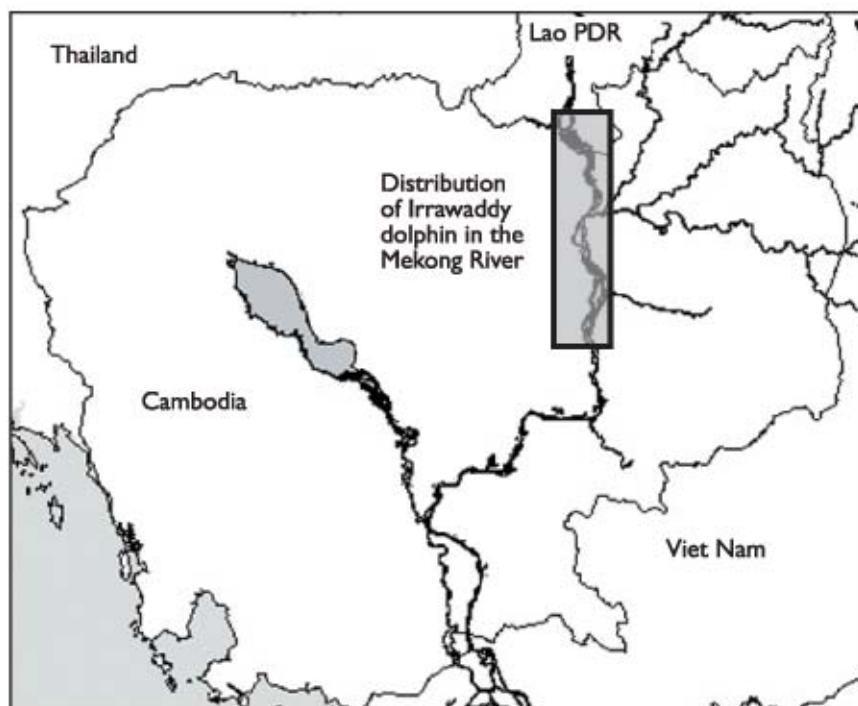


Figure 1. Distribution of Irrawaddy dolphin in the Mekong River

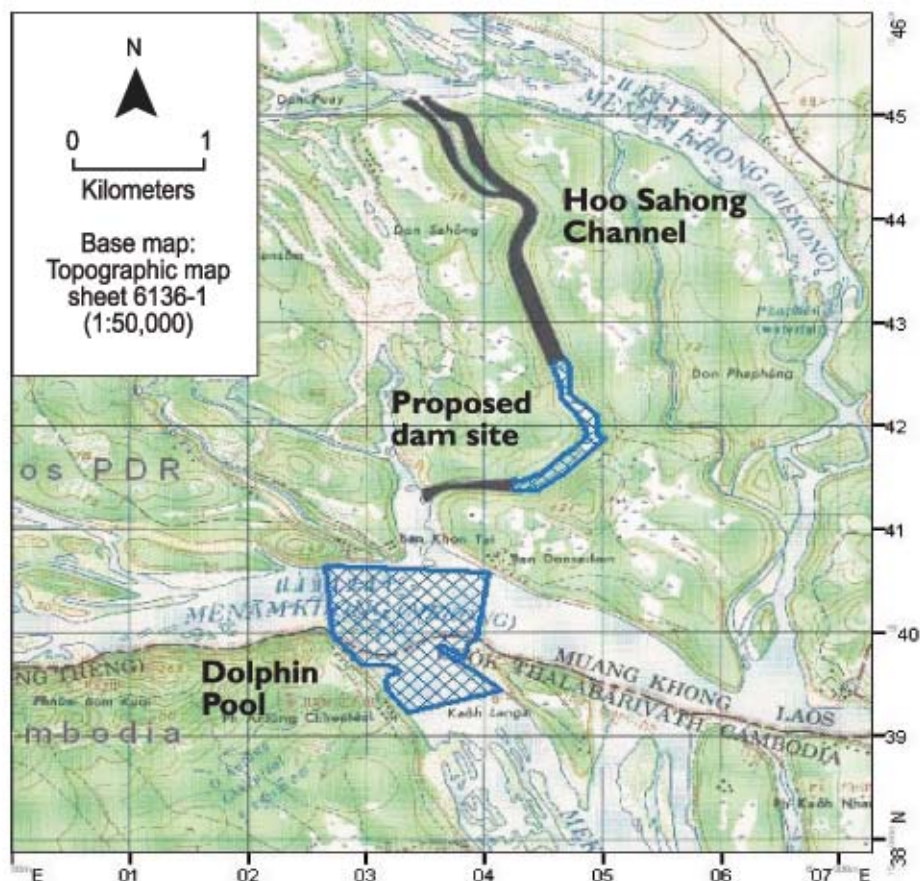


Adult Irrawaddy dolphin (*Orcaella brevirostris*), Mekong River

## THE DOLPHIN POOL

The nearest group of Irrawaddy dolphins to the proposed Don Sahong dam is <2 km downstream, at the “Dolphin Pool”. This pool is a section of the Mekong mainstream located at the international border of Lao PDR and Cambodia, and is called “Veun Gngang” in Laotian and “Anlung Cheuteal” in Khmer. It is approximately 6 km long x 1 km wide (~600 ha) and over 40 m deep.

Figure 2. Dolphin Pool and the proposed dam site.



## Dolphins

Irrawaddy dolphins have been recorded at the Dolphin Pool for over 40 years<sup>3</sup>. The pool currently supports 10 dolphins: 8 adults, 1 juvenile and 1 calf (WWF unpublished data), a decline from 17 individuals in the early 1990s, due principally to drowning in fishnets<sup>3,6</sup>. The pool is critical to conservation of Irrawaddy dolphins in the Mekong River, because: (1) it supports the only permanent dolphin population in Lao PDR; (2) it supports the third largest dolphin group in the Mekong River (two pools in Cambodia support groups of 20 and 16 dolphins respectively, WWF unpublished data); (3) it is the most northerly deep pool in the Mekong River utilized by dolphins in the dry-season (the nearest pool is 64 km south, in Cambodia).

Seasonal dolphin movements are closely linked with fish migration. In the wet season, dolphins disperse from the Dolphin Pool to surrounding channels to catch fish: monitoring data since 2001 indicate that dolphins frequently occur within at least 1 km of the proposed dam site (WWF unpublished data). Current dolphin monitoring efforts would not detect if dolphins utilize the Hoo Sahong channel, because monitoring does not occur further north than the Dolphin Pool. It seems likely that dolphins visit this channel to prey upon fish, as the Hoo Sahong is the main migratory channel for fish passing through the Khone Falls<sup>5,13,14</sup>. In the 1960s, dolphins were observed above this channel in the wet season, and possibly traveled up the Hoo Sahong<sup>3</sup>.

## Dolphin-based tourism

Dolphin-based tourism is the fastest growing source of external revenue for local communities at the Dolphin Pool. Together with the Khone Falls, dolphins are a principle reason many tourists visit the Siphandon region in southern Lao PDR. In 2005, at least 9,000 people were documented visiting the Dolphin Pool, and over 52,539 tourists visited the Siphandon region (250-300 tourists/day in peak season), including 31,891 international tourists and 21,648 domestic tourists<sup>1</sup>. Average duration of visits by international tourists to the Siphandone region was 4.16 days with an average expenditure of USD19.63/day, and for the domestic market, 6.71 days with average expenditure USD39.12/day<sup>1</sup>. Based on these figures, in 2005 the Siphandon region including the Dolphin Pool, received over USD8.2 million tourist revenues.

From January-June 2006, >50,000 people visited the Siphandone region – equivalent to nearly the total number for the entire year of 2005. At least 41 guest-houses with 140 rooms are located within 20 km of the Dolphin Pool. It is predicted that by 2015, up to 105,000 tourists/year will visit the Siphandone region<sup>1</sup>. The Governments of Lao PDR and Cambodia regard tourism as a key income source for poor communities, and have accorded tourism development in this border region a high priority. Tourism development projects are currently planned on both sides of the border.

## Transboundary Wetland Agreement

In July 2006, the Vice-Governors of Champassak (Lao PDR) and Stung Treng (Cambodia) Provinces signed the “Minutes from the Meeting on Transboundary Wetland Management in Champassak and Stung Treng”. This agreement formalized the commitment between Lao PDR and Cambodia to conserve the Irrawaddy dolphin at the Dolphin Pool, and identifies the importance of the Dolphin Pool and other transboundary wetlands for local communities, fisheries, dolphin conservation and dolphin-based tourism. Specific recommendations include protection of dolphins and sustainable management of wild fisheries.

## POTENTIAL IMPACTS OF DON SAHONG DAM

### Potential impacts

Dams are identified as a high potential threat to Irrawaddy dolphins in the Mekong River<sup>7,9</sup>. In general, there are at least four ways that dams result in death, increased stress or reduced breeding in dolphin populations<sup>12,15,16</sup>:

1. Dividing dolphin populations into smaller groups, which are genetically-isolated and more vulnerable to extinction.
2. Loss of microhabitats in the river which are critical for dolphin survival. Dams cause changes in river flow dynamics and sedimentation patterns which alter dolphin habitats, especially counter-current or eddy pools, which are the primary habitat for dolphins and also support prey fish species.
3. Reduced abundance and diversity of prey fish species. Dams may block fish migration routes and degrade habitats for fish breeding and shelter.
4. Short-term disturbance during dam construction (e.g. noise from blasting, increased sediment loads) may disrupt dolphin social, breeding, navigation and foraging behaviour. Increased stress may result in greater susceptibility to disease.

The highest potential impacts of the proposed Don Sahong dam appear to be from factors **2** and **3**. For factor 2, loss of critical dolphin habitats at the Dolphin Pool is a high risk due to the close proximity of the dam site to the pool. Alterations in daily flow patterns and water velocity from the dam may result in a reduction of counter-current areas (required by dolphins as shelter from swift-flowing river sections)

and altered sediment loads in the Dolphin Pool. This may also impact critical habitats of prey fish that utilize the pool (Table 1).

For factor 3, declines in dolphin food supply – fish – may result from dam construction across the Hoo Sahong channel. This channel is the main migration corridor for fish passing through the Khone Falls area and the biological importance of this site is well-documented<sup>5</sup>. Seasonal fish migrations through this channel are a key component in the life cycle of fish populations in southern Lao PDR and northern Cambodia: declines in fish abundance and diversity due to dam construction, would possibly impact the Irrawaddy dolphin through reduced food availability throughout its range in the Mekong River.

Factors 1 and 4 appear to be lower risks for the Don Sahong dam. For factor 1, there are no permanent dolphin groups above the Hoo Sahong channel, and dam construction would not result in the isolation of dolphins from core populations further downstream. Importantly however: (a) it is unknown whether dolphins visit the channel for feeding; (b) isolation of dolphin groups is a high risk when considered with other proposed (but unconfirmed) dams in the Lower Mekong River. The construction of two or more dams in the range of the Irrawaddy dolphin in Lao PDR and Cambodia would isolate dolphin groups, and could cause eventual population extinction.

For factor 4, construction-related impacts may involve short-term noise disturbance and increased stress to dolphins breeding or foraging in the proximity of the dam site (Table 1).



Irrawaddy dolphin, Mekong River.

**Table 1. Potential impacts of the proposed Don Sahong dam to the Irrawaddy dolphin.**

<b>Threat</b>	<b>Potential impacts and mitigation</b>
1. Dolphins isolated above / below dam	<ul style="list-style-type: none"> <li>• <b>Low risk</b> - all permanent populations occur below proposed dam site, but in the wet season, dolphins may visit the Hoo Sahong channel / areas above the channel, for feeding</li> </ul>
2. Loss / alteration of critical habitats	<ul style="list-style-type: none"> <li>• <b>High Risk</b> - loss of critical microhabitats for dolphins and their prey fish (resting, shelter, breeding) in and near Dolphin Pool e.g. daily abnormal peak flow, reduced fish abundance</li> <li>• Nearest deep pool to this site is 64 km south, in Cambodia. If critical habitats in the Dolphin Pool became unsuitable, the total dry-season dolphin range in the Mekong River would decline from 190 km to 126 km: a range decline of 34%</li> <li>• Mitigation probably difficult – requires maintenance of natural hydrological regime</li> </ul>
3. Less food	<ul style="list-style-type: none"> <li>• <b>High risk</b> - dam would block Hoo Sahong channel and may cause declines in fish abundance</li> <li>• Nearby channels (e.g. Hoo Sadam) are less suitable for fish migration. Artificial modification to increase suitability for fish migration would require extensive trials prior to dam construction</li> <li>• Fish declines and changes in seasonal abundance, could impact all dolphin groups in Mekong River</li> <li>• No regional examples of effective measures to mitigate the effect of dams on natural fisheries</li> </ul>
4. Short-term construction impacts	<ul style="list-style-type: none"> <li>• <b>Short-term risk</b> - increased stress to dolphins from blasting, high sediment loads – may disrupt social, foraging, navigation and breeding behaviour</li> <li>• Some mitigation possible - appropriate timing of construction, sediment control</li> </ul>
<b>Cumulative impacts</b>	<ul style="list-style-type: none"> <li>• <b>Overall – High risk of extinction of the Mekong population, when added to existing threats and its critically endangered status.</b></li> </ul>

The assessment of a development project's impacts also requires consideration of "cumulative" impacts: that is, when new potential impacts are added to existing threats. Dolphins in the Mekong River are already critically threatened due to a range of stresses, including close proximity of motorized boats and entanglement in fishnets. Irrawaddy dolphins exhibit strong social behaviour and it is likely the group at the Dolphin Pool is a family group: social, foraging and breeding behaviour of this group may already be modified by existing threats. It is possible that by placing further stress on a weakened population, the proposed dam would result in altered dolphin social behaviour, susceptibility to disease, reduced breeding and eventually death.

### Mitigation

Potential mitigation measures at the proposed dam site cannot be assessed until further details of dam construction and operation are available. In general, the IUCN Cetacean Specialist Group identifies the following potential measures to reduce the effects of water infrastructure development on river dolphins<sup>12</sup>:

- Maintenance of a sufficient natural flow regime that enables: uninterrupted dolphin behaviour and movement between deep pools; access of prey fish species to their seasonal floodplain breeding habitats; natural erosion/deposition cycles to maintain critical deep pool habitat: avoidance of large daily fluctuations in

flow; detailed pre- and post-monitoring of the hydrological regime at the development site to design and adapt site-specific mitigation measures e.g. design of environmental flow releases to mimic natural cycles and/or creation of artificial eddy countercurrents.

- Design of effective fish passes.
- Consideration of the cumulative impacts of multiple developments.

**"Effective mitigation"**. Given the "Critically Endangered" status of Irrawaddy dolphins in the Mekong River and the high priority placed on dolphin conservation by the Governments of Lao PDR and Cambodia, it is reasonable to define "effective mitigation" for any water infrastructure development activity as simply, "no change in the current status of dolphins". In this context, the possibility for effective mitigation of the proposed Don Sahong dam appears low. The close proximity of the proposed dam site to the Dolphin Pool suggests that altered flows, changes in favoured dolphin habitats in this pool, and reduced prey fish supplies, would be difficult to avoid. Fish passes for dams are often ineffective, and no successful fish passes have been designed in the Mekong Basin<sup>5</sup>. Nearby channels appear to be largely unsuitable for fish migration due to presence of waterfalls or low dry-season water levels. It is possible these channels might be artificially modified to enable fish migration, but this could require extensive blasting (possibly at sites close to the Dolphin Pool),

and experimental trials should be proven effective prior to any dam construction. Otherwise the success or failure of this approach would only be known once the dam was completed, when it might be too late to mitigate negative impacts.

It is possible that dolphins may leave the Dolphin Pool if conditions become unsuitable, and travel to pools further south (the nearest dolphin group is 64 km downstream, in Cambodia). It is unknown what impact this would have on the group undertaking the movement, or to resident dolphins. Elsewhere, capture and relocation of river dolphins has been conducted, but this is a high-risk and expensive activity causing stress to dolphins during capture and transport, with unknown impacts for resident dolphins at the arrival location. In both scenarios, the loss of this dolphin group would result in the extinction of the Irrawaddy dolphin in Lao PDR, and loss of dolphin-based tourism revenues for local communities.

## CONCLUSIONS

The absence of dams on the Lower Mekong River until now has almost certainly been a key factor in the persistence of the Irrawaddy dolphin. Elsewhere,

dam construction has been among the principle causes for decline of at least three other river dolphin species<sup>12</sup>. Available data suggest that the proposed Don Sahong dam would cause direct impacts to critical dolphin habitats and prey fish supplies for the third largest dolphin group in the Mekong River. The cumulative impact of the dam, when added to existing threats which have already resulted in the near-extinction of this group, would be difficult to avoid. The loss of this group would cause the extinction of the Irrawaddy dolphin in Lao PDR. The importance of the Hoo Sahong channel for maintaining regional fish populations, suggests the impact of reduced fish prey species could extend to the entire Mekong population of the Irrawaddy dolphin.

Globally, few water development projects have considered river dolphins during construction or management. For the proposed Don Sahong dam, a detailed impact assessment to the Irrawaddy dolphin and other freshwater biodiversity is required. The Governments of Lao PDR and Cambodia have an opportunity to set a global example in river dolphin conservation, by fully considering the impacts of proposed dams on the Irrawaddy dolphin.

<sup>1</sup>Asia Pacific Projects, Inc. (2006). *Greater Mekong Subregion Sustainable Tourism Development Project. Final Draft Report, Vol. 1-2*. Submitted to the Asian Development Bank. Asia Pacific Projects, Inc., Quezon City, Philippines.

<sup>2</sup>Baird, I. G. and Beasley, I.L. (2005). Irrawaddy dolphin *Orcaella brevirostris* in the Cambodian Mekong River: an initial survey. *Oryx* 39(3): 301-310.

<sup>3</sup>Baird, I.G. and Mounsouphom, B. (1994). Irrawaddy dolphins (*Orcaella brevirostris*) in southern Lao PDR and northeastern Cambodia. *Natural History Bulletin of the Siam Society* 42: 159-175.

<sup>4</sup>Baird, I.G. and Mounsouphom, B. (1997). Distribution, mortality, diet and conservation of Irrawaddy dolphins (*Orcaella brevirostris* Gray) in Lao PDR. *Asian Marine Biology* 14: 41-48.

<sup>5</sup>Baran, E. and Ratner, B. (2007). *The Don Sahong Dam and Mekong Fisheries*. WorldFish Centre, Phnom Penh.

<sup>6</sup>Borsani, J.F. (2001). A visual-acoustic survey of the Irrawaddy dolphins (*Orcaella brevirostris*) at Siphandone wetlands. Pp112-116 in: Daconto, G. (ed). *Siphandone Wetlands*. CESVI, Vientiane.

<sup>7</sup>Beasley, I., Somany, P., Gilbert, M., Phohtitay, C., Saksang, Y., Lor Kim San and Sokha, K. (2007). Review of the Status and Conservation of Irrawaddy Dolphins *Orcaella brevirostris* in the Mekong River of Cambodia, Lao PDR and Vietnam. Pp67-82 in: Smith, B.D., Shore, R.G. and Lopez, A. (eds). *Status and Conservation of Freshwater Populations of Irrawaddy Dolphins*. WCS Working Paper No. 31. WCS, Phnom Penh. 115pp.

<sup>8</sup>Lloze, R. (1973). *Contributions a l'etude anatomique, histologique et biologique de l'Orcaella brevirostris (Gray, 1866) (Cetacean-Delphinidae) du Mekong*. Thesis, University of Toulouse, France. (In French).

<sup>9</sup>MAFF (2005). *Cambodian Mekong Dolphin Conservation Strategy*. Ministry of Agriculture, Forestry and Fisheries, Phnom Penh.

<sup>10</sup>Maunsell and Lahmeyer International (2004). *Power system development plan for Lao PDR. Final report, Volume C: Project catalogue*. August 2004. 215 pp.

<sup>11</sup>New Straits Times, 4 May 2007.

<sup>12</sup>Reeves, Randall R., Smith, Brian D., Crespo, Enrique A. and Notarbartolo di Sciarra, Giuseppe (compilers). (2003). *Dolphins, Whales and Porpoises: 2002-2010 Conservation Action Plan for the World's Cetaceans*. IUCN/SSC Cetacean Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. ix + 139pp.

<sup>13</sup>Singhanouvong, D., Soulinavong, C., Vonghachak, K., Saadsy, B. and Warren, T.J. (1996a). *The main dry-season fish migration of the Mekong mainstream at Hat village, Muang Khong District, Hee Village, Muang Mouan District and Hatsalao village, Pakse*. Fisheries Ecology Technical Report No. 3. Ministry of Agriculture and Forestry, Vientiane.

<sup>14</sup>Singhanouvong, D., Soulinavong, C., Vonghachak, K., Saadsy, B. and Warren, T.J. (1996b). *The main wet-season migration through Hoo Som Yai, a steep-gradient channel at the great fault line on the Mekong River, Champassak Province, southern Lao PDR*. Fisheries Ecology Technical Report No. 6. Ministry of Agriculture and Forestry, Vientiane.

<sup>15</sup>Smith, B.D., Haque, A.K.M.A., Hossain, M.S. and Khan, A. (1998). River Dolphins in Bangladesh: Conservation and the Effects of Water Development. *Environmental Management* 22 (3): 323-335.

<sup>16</sup>Smith, B.D. and Reeves, R.R. (eds) (2000). Report of the Workshop on the Effects of Water Development on River Cetaceans. In: R.R. Reeves, B.D. Smith and T. Kasuya (eds.) *Biology and Conservation of Freshwater Cetaceans in Asia*. IUCN Species Survival Commission Occasional Paper.

<sup>17</sup>Vientiane Times, 28 March 2006.



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