



# ECOLOGICAL SURVEY OF THE MEKONG RIVER

between Louangphabang and  
Vientiane Cities, Lao PDR, 2011-2012

CRITICAL ECOSYSTEM  
PARTNERSHIP FUND





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This report documents the first detailed biological surveys of a 450 km section of the Mekong from Louangphabang to Vientiane in the Lao PDR.

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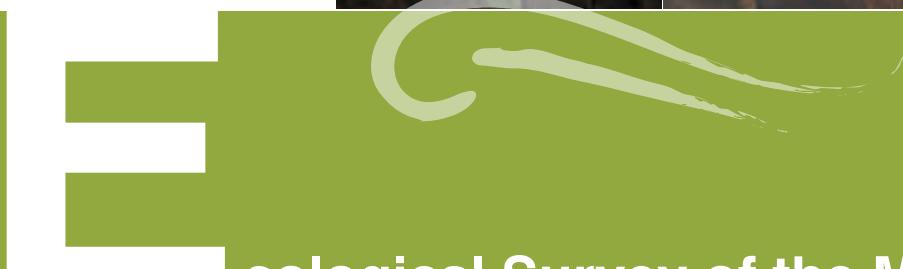
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# **E**cological Survey of the Mekong River between Louangphabang and Vientiane Cities, Lao PDR, 2011-2012



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# Foreword

The Mekong River is one of the major defining natural features of Lao People's Democratic Republic. Entering the country from China just south of its confluence with the Nanla River, the Mekong winds over 1,800 km south forming Lao PDR's border with Myanmar and later Thailand before exiting at Lao PDR's southern tip into Cambodia. Running the length of the country, the vast majority of Lao PDR is located in the Mekong's catchment.

The Mekong in Lao PDR is part of the globally significant Indo-Burma Hotspot for biodiversity, supporting an impressive array of fauna and flora. The richness of the Mekong's biodiversity is not only a matter of national pride but of subsistence. The plants and animals harvested in the Mekong and its surrounding habitats provide an important source of food and income for the people who live along its banks. Yet despite its importance, to the people of Lao PDR and to global biodiversity conservation, the Mekong River in the country has not been thoroughly studied. This is particularly true for the 450-km section of river between the cities of Louangphabang and Vientiane in northern Lao PDR. This section is frequently navigated, with numerous villages lining its banks, but has been minimally surveyed since the early French explorers of the 19th and early 20th centuries.

To lessen this gap in knowledge, a survey led by IUCN Lao PDR in partnership with the Faculty of Science from the National University of Laos was organised. Information was gathered in wet season 2011 and in dry season 2012. Led by specialists, surveys focused on the inventory of plants, large mammals, birds, reptiles, amphibians and aquatic invertebrates. Hundreds of species were recorded and specimens were sent to collections, as permanent contributions to science. These are lodged not only in national institutions, but in international ones such as the University of North Carolina. Several globally or regionally threatened species were identified in the survey area including some species that had never before been recorded in Lao PDR.

The specialists also looked at threats to biodiversity and made suggestions for the sustainable management of the river's biodiversity resources, such as the designation of fish conservation areas, seasonal closure of islands important to ground-nesting birds, steps to reduce the illegal reptile trade, and establishment of ecotourism projects.

With the completion of this report, a large gap in the knowledge on biodiversity in the Mekong has been lessened. The report represents a strong foundation of baseline information that can be looked to in the future to monitor population shifts and ecological changes in the survey area if they occur.

The information contained in this report is testament to the biological treasures Lao PDR contains as well as to their fragility. Additional surveys are now being conducted on livelihoods and management strategies. Hopefully, the expansion of knowledge about Lao PDR's biodiversity resources will contribute to its protection.

For all these reasons it is with great pleasure that the National University of Laos has been involved in this study, through our senior researchers and students. Our institution hopes to continue research in close partnership with development partners and government agencies in this and other stretches of the Mekong River, because many gaps in knowledge still remain.

On behalf of Faculty of Science, National University of Laos, I would like to thank all contributing stakeholders, in particular the IUCN Lao PDR for technical and financial supports.

Dr Somchanh Bounphanmy  
Dean of the faculty of Science  
The National University of Laos

# Message from IUCN

The Mekong River is well known in a general sense - it has a place in the public imagination, is a tourist attraction in its own right and is frequently the subject of intense debate about collaboration between the riparian countries for regional sustainable development. It is all the more remarkable then, that so little is known about the species of fish, crabs, prawns, shellfish, amphibians, reptiles, birds, mammals and plants living in the Mekong, and on which millions of people depend for nutritional security and income.

As recently as 2009 only 76 fish, 5 plants and no molluscs from the Mekong had been properly assessed for their status in an IUCN Red-listing process. Between 2009 and 2012 an IUCN red-listing study involving dozens of scientist from the region and around the world, assessed 2,515 Mekong freshwater species, concluding that almost 17% of fish and molluscs and 34% of crabs are threatened with extinction – and also highlighting the major gaps in our knowledge where more basic surveys and research are needed. One of these areas is the stretch of the Mekong River between Luang Prabang and Vientiane, which surprisingly has never been subject to any systematic or intensive biodiversity surveys until now.

The present surveys were supported by the Critical Ecosystems Partnership Fund (CEPF). The results show the importance of this stretch of the river, but also raise significant concerns about deterioration of habitats and decline in numbers of some species. The information contained in this report is extremely useful for identification of key sites and priority activities for future local conservation action. It also provides a valuable contribution to the information base that is needed for proper consideration of the positive and negative impacts of large-scale development projects on the Mekong River, and without which, decisions on such projects should not normally be taken.

IUCN's "Mekong Water Dialogues", funded by the Ministry of Foreign Affairs of Finland also provided partial funding for the dissemination of this report and will take up some of the information and recommendations from the report for further dialogue with relevant stakeholders.

On behalf of IUCN, I hope the information in this report will be useful to decision-makers at local, national and regional levels, and will also encourage other scientists and researchers to continue to fill other remaining gaps in our knowledge of the biology of one of the world's few remaining great wild rivers.

Dr Robert Mather  
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James Maxwell specifically thanks Vichit Lamxay, for observations on plants in the wet season; Will Duckworth, who sent pictures of the *Crinum* sp. (Amaryllidaceae) flowers he saw in the riverine area; Raphael Glemet, who gave dry material of *Phoenix roebelenii* O'Brien (Palmae) collected along the river in September 2011; Narin Printarakul, my bryological colleague at Chiang Mai University, who identified the five bryophyte specimens I collected, and noted that three of them were new records for the flora of Lao PDR; Casey Alexander, who retyped my original draft on a computer; Keegan Kennedy, who complied the database from my data entry forms; Narin Printarakul, who organised the report and made it ready for submission to IUCN; and Phathana Keopraseurt, who was assigned to the team by the Biology Department, National University of Laos, where he is a graduate student. I am extremely grateful for their help.

The 2011 wet-season bird and large mammal survey was conducted with the help of Assoc. Prof. Bountoup Phasomxay and Don Suvandy, who provided administrative and logistical assistance and patiently translated during the interviews with local people. Sisay Chounnavanh's coordination, translation and camping skills in the 2012 dry-season survey allowed almost every second, day and night, to be spent in important places and in effective observation. The 2004 single-day speedboat-based survey was undertaken personally by JWD, Roland Eve, Dirk Van Gansbergh and Frank Haegeman in large part, because of the then ongoing lack of interest by formal conservation bodies at the dramatic plight of river-channel birds; JWD thanks the others for sharing the (high!) costs and encouraging the use of the records in this report. Andrea Claassen, Nicole Duplaix, Philip Round and Robert Tizard discussed some of the results, and Stuart Ling provided another otter record from the Mekong, albeit not in the survey area itself.

The herpetological team thank Khampong Thanonkeo, Orlavan Xayyavong and Chanda Vongsombath for assistance with the fieldwork.

# Abbreviations and Conventions

CEPF	Critical Ecosystem Partnership Fund
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMU	Chiang Mai University
DAFO	District Agriculture and Forest Office
DoF	Department of Forestry
FAO	Food and Agriculture Organisation
IBA	Important Bird Area
LARReC	Living Aquatic Resource Research Center, in the National Agriculture and Forestry Research Institute, Ministry of Agriculture and Forestry
MRC	Mekong River Commission
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental Organisation
NPA	National Protected Area
NTFPs	Non Timber Forest Products
NUoL	National University of Laos
SUFORD	Sustainable Forest and Rural Development project
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

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# Summary

1. This report documents the first detailed biological surveys of a 450 km section of the Mekong River in the Lao People's Democratic Republic (hereafter 'Lao PDR'; also known as Laos). This section of the river extends from Louangphabang town (in Louangphabang Province) south to Vientiane town (in Vientiane municipality) in northern Laos. Two surveys were undertaken, in September–October 2011 (wet season) and January–April 2012 (dry season) respectively, for flora and vegetation, birds, large mammals, amphibians and reptiles, fish, and aquatic invertebrates.
2. **Flora and vegetation.** This is the first relatively detailed floral inventory for islands within this stretch of the Mekong. Surveys focused on the inventory and collection of vascular plants within the mainstream, selected tributaries, and immediately adjacent land habitats with opportunistic collection of bryophytes (mosses). A plant database, vegetation profiles, and a photographic inventory of flora and habitats were developed.
3. Two plant collections were compiled, one deposited at the National Herbarium of Lao PDR, and the other at the Chiang Mai University (CMU) herbarium, Chiang Mai University, Thailand.
4. In total, 164 vascular plant and five bryophyte species were collected. Twenty-three species had not previously been recorded among the flora of Lao PDR, and 11 are topotypes. A database of 335 species was compiled on habit, habitat, abundance, elevation, life mode, and leafing, flowering and fruiting phenology.
5. The Mekong channel in the survey area comprises three basic vegetation zones: Aquatic, Beach and bedrock, and Strand. Beaches and bedrock are often together; the latter including stunted woody plants often bent by water flow (i.e. rheophytes). Except in small areas, this vegetation has not been significantly changed in recent decades.
6. The adjoining terrestrial area includes seasonal Evergreen, Bamboo and deciduous, secondary growth, and cultivated land. In great contrast to the channel vegetation, most of the original primary Evergreen vegetation has been destroyed. Slash-and-burn agricultural methods as well as the uncontrolled exploitation of forests have resulted in an abundance of abandoned scrub, fragmented habitats, infertile soil and erosion.
7. Some land sites retain some original vegetation or mature regrowth, mainly in sacred areas or on steep limestone slopes. These sites should be further protected with local communities and authorities. Small-scale tourism projects could be developed. Reforestation and changes in agricultural practices would be a key to the preservation and restoration of the Mekong ecological corridor.
8. Further botanical surveys in out-of-channel habitats in this region of Lao PDR should concentrate on places with Evergreen forest or Bamboo and deciduous forest, rather than degraded facies with secondary growth. These are outside the Mekong channel and so were not comprehensively covered by the present survey. It is very likely that many more interesting plants can be found in less degraded vegetation.
9. **Birds and large mammals.** The survey focused on detecting and assessing the status of a suite of target species: species of global or regional conservation concern that might have significant populations in the survey area and/or are potential indicators of ongoing anthropogenic threats.
10. No River Terns *Sterna aurantia* were found and the last Great Thick-knee *Esacus recurvirostris* record

was in 2004, despite the much higher effort in 2011–2012 than during 1990–2004. These species join the many others extirpated from the stretch since records began in the 1890s (a few thick-knees might persist, but even if so, on current trends extirpation from the survey area is likely to occur very soon).

11. Very few populations of regional, let alone global, significance to bird conservation were found to survive: large to fairly large populations of Spot-billed Duck *Anas poecilorhyncha haringtoni*, River Lapwing *Vanellus duvaucelii*, Plain Martin *Riparia paludicola* and Wire-tailed Swallow *Hirundo smithii* are probably the most important. Plain Martin distribution has shrunk considerably since 2000–2004, but information is not precise enough to determine trends in the other species.
12. Of national conservation significance were the second Lao record of Red Avadavat *Amandava amandava* and the first recent records of Savanna Nightjar *Caprimulgus affinis* from North or Central Lao PDR.
13. Various records of faunistic interest included the second Lao record of Black-tailed Godwit *Limosa limosa* and clarification of the status of Southeast Asian-breeding and Palaearctic migrant races of Little Ringed Plover, respectively *Charadrius dubius jerdoni* and *C. d. curonicus*. A provisional record of Pale Martin *Riparia diluta* would be of high faunistic and conservation interest, if correct.
14. No evidence was found of important large mammal populations and given regional trends none was expected (and, thus, survey methods were shaped around bird detection and identification).
15. Small numbers of otters (Lutrinae) seem to persist, but this is based solely on village reports: the one otter seen (stuffed in a village) had reportedly come from a tributary, not the Mekong itself.
16. The unifying threat for the declines to date of many species is overharvest (including of nest contents), affecting particularly species that are large-bodied, ground-nesting and/or colonial.
17. Current proposals for cross-mainstream dams in the survey area would modify the habitat so that all species, including non-hunting-sensitive small birds like Small Pratincole *Glareola lactea*, Little Ringed Plover, resident-race White Wagtail *Motacilla alba alboides* and Jerdon's Bushchat, would also decline.
18. The most important recommendation from this survey is for international recognition; that the pace of declines in these birds is so fast (far faster than for forest birds where, as here, habitat remains extensively unconverted) that interventions in their favour require urgent implementation in the best remaining stretches of habitat in Southeast Asia. For the Mekong, this means north-east Cambodia.
19. In the context of general conservation activities in the area, a low incremental cost action in declining birds' favour could be justified: zoning of areas of seasonally exposed channel bed (in small proportion of the total such habitat, preferably those bounded by water during the dry-season to hinder access by land predators, notably domestic dogs) as no-landing areas by people throughout December–April each dry season.
20. **Amphibians and reptiles.** Sixty-five species of amphibians and reptiles were documented in the channel and in nearby land areas. These included a suite of species characteristic of human-modified habitats (e.g. villages and agricultural lands), a suite of species restricted to closed-canopy forest, and a suite of species threatened by trade.
21. Six globally threatened or Near Threatened species (IUCN 2012) were documented in and adjacent to the surveyed length of Mekong channel: *Amolops cremnobatus* (Near Threatened),

*Rhacophorus kio*, *Manouria impressa*, *Amyda cartilaginea* and *Ophiophagus hannah* (Vulnerable), and *Cuora mouhotii* (Endangered). Seven species of national conservation significance (Stuart 1999) were documented: *Amyda cartilaginea*, *Physignathus cocincinus*, *Varanus bengalensis*, *Python reticulatus* and *Ophiophagus hannah* (Potentially at Risk in Lao PDR) and *Manouria impressa* and *Cuora mouhotii* (At Risk in Lao PDR).

22. Plausible local information was obtained for the historical occurrence of one additional species, Siamese Crocodile *Crocodylus siamensis*.
23. Turtles, large lizards, and snakes are threatened in the study area from over-harvesting for local consumption and commercial trade (the latter as food and/or for traditional medicine). Turtles are the most commercially valuable species. Over-harvesting may be causing the decline of some species, and has probably extirpated *C. siamensis*.
24. Conservation efforts for herpetofauna should focus on monitoring the reptile trade in villages and on monitoring wild populations of species that may be declining, and directed conservation efforts for softshell turtles. Collaborative projects led by the local government and communities will be critical to the success of such conservation efforts, because most threatened species, especially turtles, are traded through local villages in the project area. At least two villages, Ban Pakneun and Ban Houaykhoualouang, are local centres for turtle trade.
25. **Fish.** In total, 116 indigenous species were reported during the survey using local ecological knowledge. The survey found evidence of three CEPF priority species (Mekong Freshwater Stingray *Dasyatis laosensis*, Giant Freshwater Stingray *Himantura polylepis* and Jullien's Golden Barb *Probarbus jullieni*). Local reports of previous presence of a fourth, Mekong Giant Catfish *Pangasianodon gigas*, were collected
26. Spawning sites were identified for one CEPF priority species, *Probarbus jullieni*, and for *Probarbus labeamajor* and *Wallago attu*.
27. The biggest current threat to fish species is overfishing, mostly for sale. A future threat is the development of mainstream hydropower dams.
28. Current proposals for cross-mainstream dams in the survey area would modify the habitat so that all species could decline. Hydropower development could affect the migration of fish, directly by blocking their movements, and indirectly by changing flood pulse (a trigger for migration) and by changing sedimentation patterns in spawning areas. The upcoming Xaignabouli dam could have impacts upstream and downstream on the fish populations, but this was not a focus of this survey.
29. **Aquatic invertebrates.** Over 100 morphotypes of crustaceans, molluscs and insects were documented. The number of species is likely to exceed the number of morphotypes considerably.
30. Aquatic invertebrates are widely distributed in the survey area.
31. The crustacean (crab) genus *Potamon* is in decline in the study area and requires management. *Potamon* is over-caught by local people, for sale more than for local consumption.
32. Conservation efforts for aquatic invertebrates in the study area should focus on reducing collection of crabs. Further survey and precise specimen identification might reveal other priorities.

## ပິດສະຫຼຸບ

1. ປິດລາຍງານສະບັບນີ້ ບັນຫຼາການສໍາຫຼວດທາງຊື່ອະວິທະຍາແບບລະອຽດຄົງທຳອິດ ຢູ່ໃນໄລຍະ 450 ກມ ຂອງແມ່ນັ້ນຂອງ ຢູ່ໃນ ສາຫະລະນະລັດ ປະຊາທິປະໄຕ ປະຊາຊົນ ລາວ (ຕໍ່ໄປເຕັ້ນວ່າ: ສປປ ລາວ; ຫລືທີ່ສູງກັນໃນນາມ ປະເທດ ລາວ). ໄລຍະຂອງແມ່ນັ້ນຂອງທີ່ເລືອກມາດັ່ງກ່າວນີ້ ແມ່ນເລີ່ມແຕ່ເຄີຍອາຫລວງພະບາງ (ຢູ່ໃນແຂວງຫລວງພະບາງ) ຕອນໃຕ້ ໄປຫາ ຕອນເຫັນຂອງ ນະຄອນຫລວງວຽງຈັນ. ການສໍາຫຼວດສອງຄົງ ໄດ້ມີການດຳເນີນ ກ່ຽວກັບພິດພັນ ແລະໄມ້ມີດອກ, ນົກ, ສັດລັງງຸກດ້ວຍນັ້ນນີ້ຂະໜາດໃຫຍ່, ສັດຄົ່ງປົກເຄີ່ງນັ້ນ ແລະ ສັດເລືອການ, ປາ ແລະ ສັດນັ້ນທີ່ມີກະຊຸກສັນຫລັງຕ່າງໆ ໃນໄລຍະເດືອນກັນຍາ ຫາ ຕຸລາ ປີ 2011 (ລະດຸບົນ) ແລະ ໄລຍະເດືອນມັງກອນ ຫາ ພສາ 2012 (ລະດຸບັງ) ຕາມລຳດັບ.
2. ໄນມີດອກ ແລະ ພິດພັນ. ນີ້ແມ່ນ ບັນຊີລາຍຊື່ອັນທຳອິດທີ່ຂ້ອນຂ້າງລະອຽດກ່ຽວກັບໄມ້ມີດອກ ຢູ່ຕາມເກາະດອນຕ່າງໆ ທີ່ຍາວຍຸດຢູ່ຕາມແມ່ນັ້ນຂອງ. ບັນດາການສໍາຫຼວດ ແມ່ນໄດ້ສຸມໃສ່ກ່ຽວກັບຕົ້ນຫາ ແລະ ການເຕັບກຳ ພິດພັນທີ່ມີຫົ່ນ້ຳລັງງ ຢູ່ຕາມລຳແມ່ນັ້ນ, ຢູ່ຕາມສາຂາແມ່ນັ້ນທີ່ຖືກຄັດເລືອກ ແລະ ບ່ອນຢູ່ທຳມະຊາດ ຕາມເຄີດຕິນທີ່ຢູ່ໄກ້ຄູງ ຈາກການເຕັບແນວພັນໄກ ຊະນິດຕ່າງໆ (ໄຄຫິນ). ຖານຂໍ້ມູນກ່ຽວກັບຕົ້ນໄມ້, ບັນດາປະຫວັດຫຍໍ້ຂອງພິດພັນ ແລະ ບັນຊີລາຍຊື່ແບບມີຫຼຸບພາບປະກອບ ຂອງ ພິດພັນ ແລະ ບ່ອນຢູ່ຫາງທຳມະຊາດຕ່າງໆ ໄດ້ຮັກສັງເຊື້ນ.
3. ການເຕັບກຳ ພິດພັນ ໄດ້ລວບລວມໄວ້ຢູ່ສອງແຫ່ງ ຕີ: ແຫ່ງທີ່ຫານີ້ ຢູ່ທີ່ສູນເຕັບຕົກສາຊາກພື້ນແຍ້ງ ຢູ່ມະຫາວິທະຍາ ໄລ ແກ່ງຊາດ ຂອງສປປ ລາວ ແລະ ອີກແກ່ງທີ່ນີ້ ແມ່ນຢູ່ທີ່ສູນ ເຕັບຕົກສາຊາກພື້ນແຍ້ງ ຂອງມະຫາວິທະຍາໄລ ຊຸງໃໝ່ (CMU), ປະເທດໄຫ.
4. ພິດພັນ ທີ່ເຕັບສະລົມໄດ້ຫັ້ງທີ່ມີ ປະກອບມີພິດທີ່ມີຫົ່ນ້ຳລັງງ 164 ຊະນິດ ແລະ ແນວພັນໄກ 5 ຊະນິດ. ສັງເກດເຫັນ ອ່ານີ້ໄມ້ມີດອກ ທີ່ບໍ່ເຕີຍໄດ້ສັບການບັນທຶກມາກ່ອນຕີ່ງ 23 ຊະນິດ ຢູ່ ສປປ ລາວ ແລະ ໃນ 11 ສູບແບບພູມສັນຖານ. ຖານຂໍ້ມູນຂອງ 335 ແນວພັນ ໄດ້ສັບການລວບລວມຂໍ້ມູນກ່ຽວກັບຄວາມຊຸມເຕີຍ, ບ່ອນຢູ່ຫາງທຳມະຊາດ, ຄວາມອຸດົມສົມບູນ, ລະດັບຄວາມສູງ, ສູບແບບຊີ້ວິດ ແລະ ການສຶກສາປະກິດການຂອງການປຶກໃປ, ອອກດອກ ແລະ ອອກຫາມຄາກ.
5. ລຳນັ້ນຂອງ ຢູ່ໃນເຄີດທີ່ດຳເນີນການສໍາຫຼວດ ປະກອບດ້ວຍເຄີດພິດພັນພື້ນຖານ 3 ເຄີດ: ພິດນັ້ນ, ຫາດຊາຍ ແລະ ຫີນ ດານພື້ນນັ້ນ ແລະ ຕະເຟັ້ງ. ປົກກະຕິແລ້ວ, ຊາຍຫາດ ແລະ ຫີນ ດານພື້ນນັ້ນ ແມ່ນໄປນໍ້າວັນ, ສ່ວນໄຕຕໍ່ມາ ແມ່ນປະກອບດ້ວຍ ພິດພັນໄມ້ທີ່ຢູ່ດະຫາຍາຍຕົວ ແມ່ນມັກເນີ້ງກ່ຽວຕາມກະແນນນັ້ນ (ເຊັ່ນ: ກົກໄດ້). ອີກເວັ້ນສ່ວນນ້ອຍໆຂອງບາງເຂດທີ່ ພິດພັນຊະນິດນີ້ ບໍ່ມີການປັບປຸງແປງຫລາຍປານໄດ້ ໃນໄລຍະຫລາຍງ່າຍທີ່ດຳສະວັດທີ່ຜ່ານມານີ້.
6. ເຄີດຕິນທີ່ຢູ່ໄກ້ຄູງປະກອບມີ, ຕົ້ນໄມ້ໃບຂຽງຕະຫລອດປີ, ຕົ້ນໄຕ່ ແລະ ຕົ້ນໄມ້ເສັດຢູ່ນ ໃບຕາມລະດຸການ ທີ່ເຕີບໃຫຍ່ຂະຫຍາຍຕົວ ແລະ ທີ່ດິນປູກເຟັ້ງເຂົ້າງໆ. ກົງກັນຂ້າມກັບແນວພັນພື້ນ ຢູ່ຕາມລຳນັ້ນ, ສ່ວນໃຫຍ່ຂອງປ່າດົງດິບຂຽງຕະຫລອດປີ ພັດໄດ້ຖືກທຳລາຍໄປ. ການຖາງປ່າເຕັດໄຕ່ ແລະ ການບຸກເວິກ ປ່າໄມແບບຊະຊາຍ ໄດ້ທຳລາຍຄວາມອຸດົມສົມບູນຂອງປ່າໄມຕັຍ, ຕັດຮອນ ບ່ອນຢູ່ອາໄສຂອງສັດ, ເສັດໃຫ້ດິນເຊື່ອມຄຸນນະພາບ ແລະ ກໍ່ໃກ້ເກີດດິນເຈື່ອນ.

7. ຢູ່ບ້າງເຈດທີ່ຢູ່ມີພົນຕັ້ງເດີມ ຫລື ມີຕົ້ນໄມ້ໃຫຍ່ ຂະຫຍາຍຕົວຕິນຕັ້ນທີ່, ໂດຍສະເພາະແມ່ນຢູ່ໃນຂົງເຈດປ່າສັກສິດ ທາລີ ເຈດເປັນພູ້ທີ່ບູນທີ່ຄ້ອຍຊັ້ນ. ພຶ້ນທີ່ເຫຼົ່ານີ້ ຄວນທີ່ຈະໄດ້ໂທີກປັກກັກກໍາສາໄວ້ ໂດຍບັນດາຊຸມຊົນ ແລະ ອຳນາດ ການປົກ ອອງທັງໝົດ. ບັນດາໂຄງການທີ່ອງທຸງໆວ່ອຂະໜາດນີ້ອຍ ຄວນທີ່ຈະໄດ້ຮັບການສົ່ງເສີມພັດທະນາ. ການປູກປ່າ ຕິນໃຫຍ່ ແລະ ການປູກປ່າຮູບແບບການຜະລິດກະສິກຳ ເປັນຖຸນີ້ຈະສຳຄັນ ຂອງການປົກປັກກໍາສາ ແລະ ການເຮັດໃຫ້ ລະບົບນີ້ ເວລີທະຍາ ຢ່າງມີຄວາມສຳຄັນ ກັບຕົນສູ່ສະຍາບເດີ.
8. ການສໍາຫຼວດຂັ້ນຕໍ່ໄປ ກ່ຽວກັບພົນຕາມລ່ອງແມ່ນັ້ນ ຢ່າງໃນຂົງເຈດນີ້ຂອງ ສປປ ລາວ ຄວນສຸມໃສ່ບັນດາສະຖານທີ່ງ ມີ ບັນດາໄມ້ຫຼາຍວະຫລອດຢີ ຫຼື ບໍ່ໄມ້ໄຜ ແລະ ບໍ່ໄມ້ປູກປ່າຮູບແບບການ ພູ້ຍໍາກວ່າເຈດເປັນພູ້ຊົມ ທີ່ເປັນປ່າສໍາຫຼວດ. ແນວ່ນຍື່ງນີ້ ແມ່ນນອນຢູ່ນອກເຂດລຳແມ່ນັ້ນຂອງ ແລະ ບໍ່ໄດ້ໂທີກສໍາຫຼວດແບບລະອຽດ ສໍາລັບການສໍາຫຼວດໃນລັ້ງນີ້. ອາດຈະເວົ້າໄດ້ວ່າ ຍັງມີແນວ່ນພົນຕົ້ນທີ່ຫັນ້າສົນໃຈທີ່ກໍາລົງລະບຽບນີ້ ຖື່ນຕົ້ນມີບໍ່ເຈດເປັນທີ່ກໍາພົນພົນ ທີ່ມີຄວາມເຊື່ອບໍ່ຊົມ ຂານອ້ອຍ.
9. **ນິກ ແລະ ສະລັງງລູກດ້ວຍນີ້ມີຂະໜາດໃຫຍ່.** ການສໍາຫຼວດ ໄດ້ສຸມໃສ່ການຕົ້ນຫາ ແລະ ປະເມີນສະຖານະຍາບຂອງ ບັນດາສາຍພົນສັດທີ່ເປັນເປົ້າຫາມາຍ ຕີ: ບັນດາສາຍພົນສັດທີ່ມີຄວາມກັງວົນໃນການອະນຸລັກ ຢ່າງໃນລະດັບໂລກ ຫລື ພາກ ພຶ້ນ ທີ່ອາດມີປະຊາກອນຢູ່ໃນຂົງເຈດທີ່ລຳເປັນການສໍາຫຼວດ ແລະ/ຫລື ເພື່ອເປັນຕົວຊີ້ວັດທ່າຍ່າງຂອງໄຍ້ຄຸກກາມທີ່ເກີດ ຈາກມະນຸດ.
10. ເຖິງແມ່ນົວ່າ ຈະໃຊ້ຄວາມພະຍາຍາມ ໃນການສໍາຫຼວດສິກຳປີ 2011-2012 ສູງກວ່າໃນໄລຍະປີ 1990-2004 ກໍາຕາມ, ແຕ່ການສໍາຫຼວດລັ້ງນີ້ ກໍ່ມີການພົບນິກາທະເລີນອ້ອຍ (*River Terns Sterna aurantia*) ແລະ ການບັນທຶກພົບເຫັນນິກ ຍາງນ້ອຍ (*Great Thick-knee Esacus recurvirostris*) ລັ້ງສຸດທ້າຍ ກໍ່ແມ່ນໃນປີ 2004. ບັນດາສາຍພົນສັດເຫຼົ່ານີ້ ໄດ້ສູນພັນໄປຕີກັບສາຍພັນອື່ນໆ ນັບຕັ້ງແຕ່ມີການບັນທຶກໃນຊູມປີ 1890 (ອາດຈະຍັງມີນິກາຍາງນ້ອຍ ຢ່າງຈຳນວນ ແຕ່ ວ່າ ເຖິງມັນຈະເປັນແບບນັ້ນກໍ່ຕາມ, ໃນປະຈຸບັນພວກມັນກໍ່ຢູ່ໃນທ່າອ່າງ ເປັນສາຍພົນສັດທີ່ຈະໂທີກສູນພົນໄປ ຈາກຂົງເຈດ ທີ່ລຳເປັນການສໍາຫຼວດ ໃນອະນາຄົດອັນໄກ້ນີ້).
11. ປະຊາກອນນິກ ຈຳນວນໜັ້ນອ້ອຍທີ່ສຸດທີ່ມີຄວາມສໍາຄັນ ໃນການອະນຸລັກ ລະດັບຂົງເຈດ ແລະ ລະດັບໂລກ ທີ່ໄດ້ພົບເຫັນ ຍັງມີຊີວິດລອມາໄດ້ເຊັ່ນ: ປະຊາກອນນິກຈຳນວນໜັ້ນຫາລາຍ ແລະ ຫາລາຍສົມຄວນ ແມ່ນ ນິກເປົ້ານີ້ (*Spot-billed Duck Anas poecilorhyncha haringtoni*), ນິກາຍາງຈາຍາວ (*River Lapwing Vanellus duvaucelii*), ນິກແອ່ນແພນມາຕິນ (*Plain Martin Riparia paludicola*) ແລະ ນິກແອ່ນຫາງລວດ (*Wire-tailed Swallow Hirundo smithii*). ການພົບເຫັນນິກແອ່ນແພນມາຕິນ ແມ່ນຫຼຸດຫນວ້ອຍລົງຫລາຍນັບຕັ້ງແຕ່ສິກປີ 2000-2004, ແຕ່ວ່າຍໍ່ມີຂັ້ນນີ້ທີ່ ຊັດເຈນຍູ້ງພື້ນ ທີ່ຈະກຳນົດທ່າຍ່າງຂອງສາຍພົນຊົມນີ້ດີເອີ້ນໄດ້.
12. ຄວາມໝາຍສໍາຄັນ ການອະນຸລັກລະດັບຊາດ ແມ່ນການບັນທຶກລັ້ງທີ່ສອງຂອງ ລາວ ກ່ຽວກັບການພົບເຫັນນິກຈອກປາແງ (*Red Avadavat Amandava amandava*) ແລະ ການຕົ້ນພົບລັ້ງຫຳທຳອິດໃນໄລຍະນີ້ນີ້ ກ່ຽວກັບການພົບເຫັນ ນິກຈອກຫາກົມກາງສິນ (*Savanna Nightjar Caprimulgus affinis*) ຢ່າງເປົ້າຫາເມືອ ຫຼື ພາກກາງຂອງ ສປປ ລາວ.
13. ການບັນທຶກໜັ້ນສົນໃຈຫາລາຍງົງລັ້ງ ເຊິ່ງປະກອບດ້ວຍ: ການບັນທຶກລັ້ງທີ່ສອງຢູ່ລາວ ກ່ຽວກັບການພົບເຫັນ ນິກາຍາງຫາງ ດຳ (*Godwit Limosa limosa*) ແລະ ການອະທິບາຍການຂະຫຍາຍພົນ ຢ່າງເຈດອາຊີຕາເວັນອອກສົ່ງໃຕ້ ແລະການອີບ ພະຍົບເຊື້ມາ ຂອງ ນິກາຍາງນ້ອຍ Little Ringed Plover ແລະ ຍັງມີ ນິກາຍາງຊະນີດ *Charadrius dubius jerdoni* ແລະ ຊະນີດ *C. d. curonicus* ຕາມລຳດັບ. ຫຼັກາກເປັນຈິງ, ການບັນທຶກການຊີ້ວັດວ່າຂອງນິກແອ່ນສິບ້ຕາ ນິຈິດ (*Pale Martin Riparia diluta*) ຈະເປັນສົ່ງທີ່ຫັນ້າສົນໃຈໃນ ການອະນຸລັກ.

14. ບໍ່ມີຫຼັກສາຖານການພົບເຫັນທີ່ສຳຄັນໃດໆ ກ່ຽວກັບບັນດາປະຊາກອນສັດລົງລູກດ້ວຍນິນຂະໜາດໃຫຍ່ ແລະ ກໍ່ບໍ່ມີການຄາດາວັງໄວ້ ກ່ຽວກັບທ່າອ່ງໃນລະດັບພາກພື້ນຂອງສັດດັ່ງກ່າວ (ດັ່ງນັ້ນ, ສູບແບບຂອງການສຳຫຼວດ ຈຶ່ງຕື່ກາກຳນິດໃຫ້ຢູ່ໃນກອບຂອງການຊອກຄົນ ແລະ ຈົດປະເຜດຂອງນິກເຕົ່ານັ້ນ).
15. ຍັງມີນົກການນັ້ນ (*Lutrinae*) ຈຳນວນຫນັ້ນ ຫີ້ຍັງມີຂີວິດຢູ່, ແຕ່ວ່າ ຂຶ້ມູນດັ່ງກ່າວນີ້ ແມ່ນອີງໃສ່ບັນດາບົດລາຍງານຂອງບັນເທົ່ານີ້: ມີການລາຍງານ ກ່ຽວກັບການພົບເຫັນນົກການນັ້ນຕາຫນີ້ (ຕື່ກາຕາແຮ້ງ ຢູ່ໃນບັນແທ່ງໆນັ້ນ) ເຊິ່ງໄດ້ມາຈາກສາຈາແມ່ນັ້ນຂອງ, ບໍ່ແມ່ນໄດ້ມາຈາກແມ່ນັ້ນຂອງ.
16. ໄພຄຸກາມທີ່ເປັນໜຶ່ງງວ່າ ຫີ້ເຮັດໃຫ້ສາຍພັນນິກາຫາຍຸງຊະນິບຫຼຸດໝາຍນ້ອຍລົງ ໃນປະຈຸບັນແມ່ນການລ່າເກີນຂອບເຈດ (ລວມທັງການແສ້ບເອົາສິ່ງທີ່ຢູ່ໃນຮັງນຳ), ເຊິ່ງສິ່ງເຕີນກະບົບໄລຍກົງຕໍ່ຮັບສາຍພັນນິກ ຫີ້ມີຂະໜາດຕ່າງກາຍໃຫຍ່, ສ້າງຮັງຢູ່ຫັນນຳດີນ ແລະ/ຫຼື ລ່າອານາເຈດ.
17. ບັນດາແຍນສະເໜີໃນປະຈຸບັນ ເມື່ອສ້າງເຂື່ອນໄຍ້ພັ້ງຢູ່ຕາມລົ້າແມ່ນັ້ນ ຫີ້ຢູ່ໃນຂົງເຂດຂອງການສຳຫຼວດຄົ້ງນີ້ ຈະໄປປ່ານແບ່ງທີ່ຢູ່ອາໄສ ເຊິ່ງຈະເຮັດໃຫ້ຈຳນວນຂອງນິກາຫຼຸດໝາຍພັນ ລວມທັງນິກາຂະໜາດນ້ອຍຫີ່ບໍ່ຕື່ກາລ່າແຕ່ມີຄວາມອ່ອນໄຫວ່ ເຊັ່ນ: ນິກາຍາງນ້ອຍ (*Small Pratincole Glareola lactea*), ນິກາຍາງນ້ອຍ (*Little Ringed Plover*), ນິການ້ອຍຫາງຍາລວມສືຂາວພັນພື້ນບັນ (*White Wagtail Motacilla alba alboides*) ແລະ ນິກາຈີບເມື່ອງ (*Jerdon's Bushchat*) ຍັງຈະຫຼຸດໝາຍນ້ອຍລົງ.
18. ຂຶ້ແນະນຳທີ່ສຳຄັນທີ່ສຸດ ຈາກການສຳຫຼວດນີ້ ແມ່ນເພື່ອໃຫ້ສາກົນໄດ້ຮັບຮູ່ວ່າ ອັດຕາຄວາມໄວຂອງການຫຼຸດໝາຍນ້ອຍຖອຍລົງຂອງຈຳນວນນິກາເໜີ່ລົ້າ ແມ່ນໄວ້ຫາລາຍ (ດ້ວຍອັດຕາທີ່ໄວ້ກວ່າບັນດາສາຍພັນນິກປ່າ ຫີ້ຢູ່ຕາມເຂດທຳມະຊາດທີ່ຍັງບໍ່ຫັນຕົກບຸກເປົກ) ເຊິ່ງຮູ່ການເຂົ້າໄປຊ່ວຍເຫຼືອໄລຍດ່ວນ ເພື່ອເຮັດໃຫ້ທີ່ຢູ່ອາໄສຂອງນິກ ໃນເຂດອາຊີຕາເວັນອອກສູ່ງໃຕ້ ໃຫ້ຢູ່ໃນສະພາບທີ່ດີທີ່ສຸດ. ສຳລັບເຂດແມ່ນັ້ນຂອງ, ແມ່ນຢູ່ທີ່ຕາເວັນອອກສູ່ງເນື້ອຂອງກຳປູເຈຍ.
19. ກ່ຽວກັບບັນດາກິດຈະກຳຂອງການອະນຸລັກທີ່ໄປ ຢູ່ໃນຂົງເຂດດັ່ງກ່າວນີ້, ການປະຕິບັດງານທີ່ມີຄົກໃຊ້ຈ່າຍຕົ້ນ ໃນການຫຼຸດຜ່ອນພື້ນຕິກຳລ່ານິກາເປັນອາຫານ ຄວນໄດ້ຮັບການຈັດລົງລັກແມ່ນັ້ນ: ກຳນົດຂົງເຂດຊ່ອງຫາງບ່ອນຢູ່ອາໄສຕາມລະດູການ (ໃນອັດຕາສ່ວນຂະໜາດນ້ອຍ ຂອງທີ່ຢູ່ອາໄສທັງໝົດ, ໂດຍສະເພັະ ແມ່ນເຂດອ້ອມແຫລ່ງນັ້ນ ໃນລະດູ ແລ້ງ ເພື່ອບ້ອງກັນບໍ່ໃຫ້ພວກລ່າຫາງພົກພື້ນດິນ ເຊັ່ນ: ຂາມດັບນິນ ເຊົ້າເຕິງໄດ້) ຫີ້ເປັນເຂດທີ່ມີດິນຕິດຈອດກັນນັ້ນ ເພື່ອບໍ່ໃຫ້ຄົນເຂົ້າໄປ ໃນຊ່ວງເດືອນກັນວາ ທາ ເດືອນມັງກອງດູແລ້ງ ແຕ່ລະບີ.
20. ສັດເຄື່ອງບິກເຄື່ອງນັ້ນ ແລະ ສັດເລືອຄານ. ມີການບັນຫຼິກສັດເຄື່ອງບິກເຄື່ອງນັ້ນ ແລະ ສັດເລືອຄານ ໄດ້ເຄື່ອງບິກສືບ ຫ້າຂະນິດທີ່ອາໄສຢູ່ຕາມເຂດລົ້ານັ້ນ ແລະ ເຂັດບໍລິເວັນດິນອ້ອມແຮ້ມັນ. ສັດເໜີ່ລົ້ານີ້ ປະກອບດ້ວຍ: ສາຍພັນສັດ ຫີ້ສາມາດອາໄສຢູ່ຕາມເຂດແດນທີ່ຕົກບຸກເປົກຈາກມະນຸດ (ເຊັ່ນ: ເຂດຫມູ່ບ້ານ ແລະ ເຂດດິນກະສິກຳ), ນອກຈາກນີ້ ຍັງມີສາຍພັນສັດ ຫີ້ຈຳກັດບ່ອນຢູ່ອາໄສ ຕາມເຂດບໍ່ໄມ້ປົກຫຼຸມຕື່ບໍ່ຫານ ແລະ ສາຍພັນທີ່ຕົກບຸກສາມຈາກການຕັ້ງຈາຍ.
21. ມີການບັນຫຼິກກ່ຽວກັບການພົບເຫັນ ສັດສາຍພັນ ຫີ້ຕົກບຸກສາມ ຫລື ໄກສິກຸາສາມ ຫລື ໄກສິກຸາສາມລະດັບໂລກ ອີຣຍິກຊະນິດ (ອີງຕາມ IUCN 2012) ແລະ ຢູ່ໄກກັບເຂດລົ້າແມ່ນັ້ນຂອງທີ່ດຳເນີນການສຳຫຼວດຄື: ກົບ (*Amolops cremnobatus*) (ໄກທີ່ຈະສູນພັນ), ຂູ່ດັບປະປາສີຂູ່ຈົວ *Rhacophorus kio*, ເຕົກະດອງແຮງ *Manouria impressa*, ປາຜັກະດອງດຳ *Amyda cartilaginea* ແລະ ຖູ້ເຕົກ *Ophiophagus hannah* (ມີຄວາມອ່ອນໄຫວ່ຈະສູນພັນ), ແລະ ເຕົກະດອງດຳ *Cuora mouhotii* (ໄກສູນພັນ). ນອກຈາກນີ້ ຍັງມີການບັນຫຼິກ ກ່ຽວກັບການພົບເຫັນສັດສາຍພັນທີ່ສຳຄັນ ຮິກເຈັດຂະນິດ (ອີງຕາມ Stuart 1999) ຄື: ປົກົກະດອງດຳ (*Amyda cartilaginea*), ກະປອນຂູ່ຈົວ (*Physignathus cocincinus*), ແລນອິນເຕຍຂະໜາດໃຫຍ່ (*Varanus bengalensis*), ຖູ້ສິ້ງ (*Python reticulatus*) ແລະ ຖູ້ເຕົກ *Ophiophagus Hannah* (ເຊິ່ງມີຫ່າຍ່ອງທີ່ຈະສູນພັນຈາກສະປປ ລາວ) ແລະ ເຕົກະດອງແຮງ (*Manouria impressa* ແລະ ເຕົກະດອງສິຫາລົ່ງ *(Cuora mouhotii)* (ໄກຈະສູນພັນຈາກ ສປປ ລາວ).

22. มีชื่อปุบช่าวนานที่มีความเย็นໄบ้ได้จากห้องที่นี่ คือวัตถุภานุพิบัต์สัตว์น้ำในประเทศไทย นั่นແມ່ນແຂ້ນໍ້າຈີດ Siamese Crocodile (*Crocodylus siamensis*).
23. ຢູ່ໃນຂົງເຊດຂອງການສຶກສາດັ່ງກ່າວນີ້, ຍັ້ງນີ້ຕີ, ສັດເລືອດານຂະໜາດໃຫຍ່ ແລະ ຖຸ ທີ່ຕົກຢູ່ໃນອັນຕະລາຍ ຈາກການລຳເຕີນຂອບເຈດ ສຳລັບການບໍລິໂພກຂອງຄົນທັງທີ່ນີ້ ແລະ ເພື່ອເປັນສິນຄັກ (ສ່ວນໃຫຍ່ແມ່ນ ໃຊ້ເປັນອາຫານ ແລະ/ຫາລີ ໃຊ້ເປັນຢ່າພື້ນເມືອງ). ຕີ່ນີ້ ແມ່ນສາຍພັນຄັກຈາລີທີ່ມີລາຄາສູງທີ່ສຸດ. ການລຳເຕີນຂອບເຈດ ອາດເປັນສາເຫດທີ່ເຮັດໃຫ້ຈຳນວນແຂ້ນໍ້າຈີດ *C. siamensis* ຫຼຸດລົງ ແລະ ເຖິງຂຶ້ນເຮັດໃຫ້ມັນສູນພັນ.
24. ຄວາມຍະຍາຍາມໃນການອະນຸລັກ ສັດເລືອດານ ແລະ ສັດເຕົ່ງປົກເຕົ່ງນັ້ນ ຄວນເນັ້ນໜັກໃສ່ການຄວບຄຸມການຊື້-ຂາຍ ສັດເລືອດານ ຂອງຫມູ່ບ້ານຕ່າງໆ ແລະ ຄວນສຸມໃສ່ຄຸມຄອງຈຳນວນສາຍພັນຂອງສັດປ່າ ທີ່ອາດຫຼຸດລົງ ແລະ ຕ້ອງໃຊ້ຫຼຸກຄວາມພະຍາຍາມເນື່ອການອະນຸລັກ ເຕີກະດອງອ່ອນ. ບັນດາໄຕງ່າການຮ່ວມມື ທີ່ຈັດຕັ້ງປະຕິບັດໂດຍລັດຖະບານ ແລະ ຊຸມຊົນທັງທີ່ນີ້ ແມ່ນມີຄວາມສຳຄັນຫາລາຍ ເພື່ອເຮັດໃຫ້ການອະນຸລັກດັ່ງກ່າວ ປະສິບຜົນສຳເລັດ ຍັ້ນວ່າບັນດາສາຍພັນສັດທີ່ຕົກຄຸມຮຸນແຮງທີ່ສຸດ, ໂດຍສະເໝາະ ແມ່ນເຕີ່ງ ແມ່ນເກີດຈາກການຊື້-ຂາຍຂອງຄົນທັງທີ່ນີ້ ຢູ່ໃນເຊດໄຕງ່າການເຫັນນັ້ນ. ຢ່າງໜັນອ່ອຍທີ່ສຸດ ມີຢູ່ສອງບ້ານ ທີ່ເປັນສູນກາງງານຊື້-ຂາຍເຕີ່ງ ສີ: ບັນປັດກາເນີນ ແລະ ບັນຫ້ວຍຂ້ອງຫາລວງ.
25. ບາ. ໃນໄລຍະການສຳຫຼວດນີ້, ໄດ້ມີການບັນທຶກລາຍງານມີຈຳນວນສາຍພັນປາທັງໝາຍມີດເຕີງ 116 ຊະນິດ ໂດຍອີງໃສ່ຄວາມຮັດນັນລະບົບນີ້ເດີຂອງທັງທີ່ນີ້. ການສຳຫຼວດຄົ້ນນີ້ ໄດ້ຄົ້ນບົບການບໍລິມາຈີດຂອງ CEPF ຢູ່ສາມຊະນິດ (ປາຟໄລ໌ທີ່ອາໄສຢູ່ຕາມແມ່ນ້ຳຂອງ *Mekong Freshwater Stingray (Dasyatis laosensis)*, ປາຟໄລ໌ວ່າກໍທີ່ອາໄສຢູ່ໃນນີ້ຈີດ *Giant Freshwater Stingray (Himantura polylepis)* ແລະ ປາໄນກໍາຄົນດຳ *Jullien's Golden Barb (Probarbus jullieni)*. ໄດ້ມີການເສັ້ນກຳເອົາຂໍ້ມູນ ຈາກບັນດາບົບການໄລຍະຜ່ານມາຂອງທັງທີ່ນີ້ ທີ່ພົບເຫັນຊະນິດທີ່ສີ ປາບີກໍາຍັກທີ່ອາໄສຢູ່ຕາມແມ່ນ້ຳຂອງ *Mekong Giant Catfish (Pangasianodon gigas)*.
26. ໄດ້ມີການກຳນົດເຊດວາງໄຂ່ ສຳລັບໜຶ່ງຊະນິດສາຍພັນປາ ທີ່ເປັນບູລິມະສິດຂອງ CEPF ສີ: ປາໄນກໍາຄົນດຳ *(Probarbus jullieni)* ແລະ ສຳລັບ ປາໄນສາຍພັນ *(Probarbus labeamajor)* ແລະ ປາແຂ້ຫັນງໍ *(Wallago attu)*.
27. ໄຍຄຸມາຄົມສຳລັບປາທີ່ຮຸນແຮງທີ່ສຸດໃນປະຈຸບັນ ແມ່ນການທຳປາເຕີນຂອບເຈດ, ສ່ວນຫາລາຍແມ່ນ້ຳເອົາໄປຈາຍ. ໄຍຄຸມອີກອັນຫົວໆ ແມ່ນການສ້າງເຂື້ອນໄຍ້ຟ້ານີ້ຕົກຢູ່ຕາມລຳນັ້ນ.
28. ບັນດາແຜນສະເໝີໃນປະຈຸບັນ ເພື່ອສ້າງເຂື້ອນໄຍ້ຟ້າຢູ່ຕາມລຳແມ່ນ້ຳ ທີ່ຢູ່ໃນຂົງເຊດຂອງການສຳຫຼວດຄົ້ນນີ້ ຈະໄປປັບປຸງແປງທີ່ຢູ່ອາໄສ ເຊິ່ງຈະເຮັດໃຫ້ຈຳນວນຂອງປາຫຼາສາຍພັນ ຫຼຸດໜັນອ່ອຍລົງ. ການສ້າງເຂື້ອນໄຍ້ຟ້ານີ້ ຈະສົ່ງຜົນກະທົບຕໍ່ຮັບການຍົກຍັດທີ່ຢູ່ຂອງປາ, ທາງກົງແມ່ນການກົດຂອງການເຄື່ອນຍ້າຍຂອງປາ ແລະ ທາງອ້ອມ ແມ່ນການໄປປັບປຸງແປງຈັງຫວ່າງການໄຫລ້ວ້ອມຂອງນີ້ (ເຊິ່ງເປັນສາເຫດຂອງການຍົກຍັດທີ່ຢູ່) ແລະ ເປັນການປັບປຸງແປງສູບແບຍການຕົກກະກອນ ຢູ່ໃນເຊດວາງໄຂ່ຂອງປາ. ການສ້າງເຂື້ອນໄຍ້ຟ້າໄຊຍະບູລີ ທີ່ກຳລັງດຳເນີນການນີ້ ອາດສົ່ງຜົນກະທົບຕໍ່ຮັບຈຳນວນປາ ທີ່ຢູ່ຕາມລຳນັ້ນດ້ານເທິງ ແລະ ດັບລຸ່ມ ແຕ່ວ່າສິ່ງດັ່ງກ່າວນີ້ ບໍ່ແມ່ນຈຸດສຸມຂອງການສຳຫຼວດຄົ້ນນີ້.
29. ບັນດາສັດນີ້ທີ່ບໍ່ມີກະດູກສັນຫລັງ. ໄດ້ມີການຈົດບັນທຶກ ກ່ຽວກັບສັດໃນເຕືອຍາດສາຍພັນງຽວກັນ (morphotypes) ຂອງສັດຈຳຍວກເລືອກແຈງ, ສັດຈຳຍວກຫາອ່າຍ ແລະ ແມ່ງໄມ້ ຫລາຍກວ່າ 100 ຊະນິດ. ຈຳນວນສາຍພັນດັ່ງກ່າວນີ້ ແມ່ນມີຄວາມເປັນໄປໄດ້ວ່າຈະມີຫລາຍກວ່າ ຈຳນວນຂອງສັດໃນເຕືອຍາດສາຍພັນງຽວກັນທີ່ໄດ້ສຳຫຼວດ.
30. ບັນດາສັດນີ້ທີ່ບໍ່ມີກະດູກສັນຫລັງ ແມ່ນມີຢູ່ຢ່າງຫລວງຫາລາຍ ຢູ່ຕາມເຂດທີ່ດຳເນີນການສຳຫຼວດຄົ້ນນີ້.

31. ສ້າງເຫັນເວັບໄວ້: ຢູ່ຕາມບໍລິເວນທີ່ດຳເນີນການສໍາຫຼວດນັ້ນ, ຈຳນອນສັດຈະຍວກເປົອກແຮງ (ກະບູ), ກະບູນື້ຈິດຕະກູນ Potamon ແມ່ນໜຸ້າທານ້ອຍລົງ ເຊິ່ງຮູກຮ້ອງໃຫ້ມີການຄຸ້ມຄອງ. ກະບູນື້ຈິດຕະກູນ Potamon ແມ່ນຕີກູ່ໃນສະພາບທີ່ກະບູຊີ້ນໜີ້ອ່າງຖື່ນຂອກເຕັບແບບຜົນຂອບເຈດ ເຊິ່ງສ່ວນຫາລາຍແມ່ນ ເຕີ່ໄປເປົາຍ ຫລາຍກວ່າເອົາໄປບໍລິໂພກ.

32. ຄວາມຍະຍາຍຄມໃນການອະນຸລັກ ບັນດາສັດນີ້ທີ່ບໍ່ມີກະດູກສັນຫລັງຢູ່ຕາມບໍລິເວນດຳເນີນການສໍາຫຼວດນີ້ ຄວນສຸມໃສ່ ຫຼຸດຜ່ອນການຊອກເຫັນກະບູ ເພື່ອໄປເປົາຍ ແລະ ບໍລິໂພກ. ນອກຈາກນີ້, ການກຳນົດຕົວຢ່າງຊາກແຫ້ງ ແລະ ການສໍາຫຼວດທີ່ຂັດເຈນ ຍັງຈະເປັນການເປີດເຜີຍໃຫ້ເຫັນບັນດາບໍລິມະສິດອື່ນຖື່ມອີກ.

# 01

## Introduction





## 1. Introduction

### 1.1 The Mekong Basin

**T**he Mekong River runs through six countries from China to Vietnam. It is the 12th longest river in the world, the 21st largest river basin (over 795,000 km<sup>2</sup>), and encompasses a range of physiographic regions, from cold, mountainous headwaters on the Tibetan Plateau to the lowlands of the Mekong Delta where it enters the South China Sea. The Lower Mekong basin covers large tracts of land in Myanmar, Lao PDR, Thailand, Cambodia and Vietnam.

The Mekong is among the major rivers of the world still closest to pristine. Its lower section is currently unimpeded by dams, although construction of the Xaignabouli (Xayaburi) dam has begun. The minimal human impacts on the Mekong's channel and flow, to date, have made it a world-class example of a large river with natural morphological structure and well-preserved wetlands.

The lower Mekong Basin represents one of the most productive inland fisheries in the world and is the main source of protein for the local population. Over 2.5 million tonnes of wild fish are caught annually, worth over USD 2.5 billion: these represent an estimated one-quarter of global freshwater fish catches (Baran *et al.* 2007 and references therein).

Despite its socio-economic importance, in the general context of fast development in Southeast Asia, the Mekong now faces new changes. Increases in the human population, the economy and trade are resulting in greater demands for energy, fisheries and other water-related commodities and services.

In this context, biodiversity information is critical to assess the potential impacts of development on wildlife, including several threatened species, and also to ensure the sustainability of local livelihoods.

### 1.2 Biodiversity surveys in 2011 and 2012

The section between the towns of Vientiane and Louangphabang is one of the least-studied sections of the Mekong mainstream. No detailed bird or other faunal surveys have been conducted in much of this stretch of the river, which is potentially a critical habitat, migration and breeding corridor for numerous species of conservation and economic significance.

In rainy-season (September–October) 2011 and dry-season (January–February; April; May) 2012, the IUCN (International Union for Conservation of Nature and Natural Resources) Lao PDR Office jointly with the Living Aquatic Resources Research Center (LARReC; of the National Agriculture and Forestry Research Institute in the Ministry of Agriculture and Forestry), and the Faculty of Science (FoS) of the National University of Laos (NUoL) initiated the first ecological survey of the Mekong River between the town of Louangphabang and Vientiane city. This was the first step, financed by the Critical Ecosystem Partnership Fund (CEPF), of a five-year Mekong conservation project: "Conserving biodiversity and sustaining livelihoods along the Mekong River in Louangphabang, Xaignabouli and Vientiane provinces, Lao PDR". The team included 19 surveyors.

## **GOAL**

- To obtain baseline biological data and identify priorities for biodiversity conservation and livelihood sustainability in the study area.
- To raise national and provincial awareness about the biodiversity values of the study area, particularly among provincial agencies responsible for natural resource management.

## **OBJECTIVE**

- To document the diversity and richness of flora, birds, large mammals, amphibians, reptiles, fish and aquatic invertebrates along the Mekong, between the towns of Louangphabang and Vientiane.
- To assess the status of endemic, restricted-range and/or threatened taxa, specifically riverine vegetation, selected birds (storks, herons, ducks, cormorants, terns, fish eagles, fish owls, hornbills, resident martins and swallows, wet-grassland birds), large mammals (otters), amphibians, reptiles (especially turtles) and fish (including threatened taxa of non-economic significance).
- To identify threats to biodiversity, especially to threatened taxa.
- To identify biological conservation priorities and consequential management recommendations for the study area.

# 02

## Study Area





## 2. Study Area

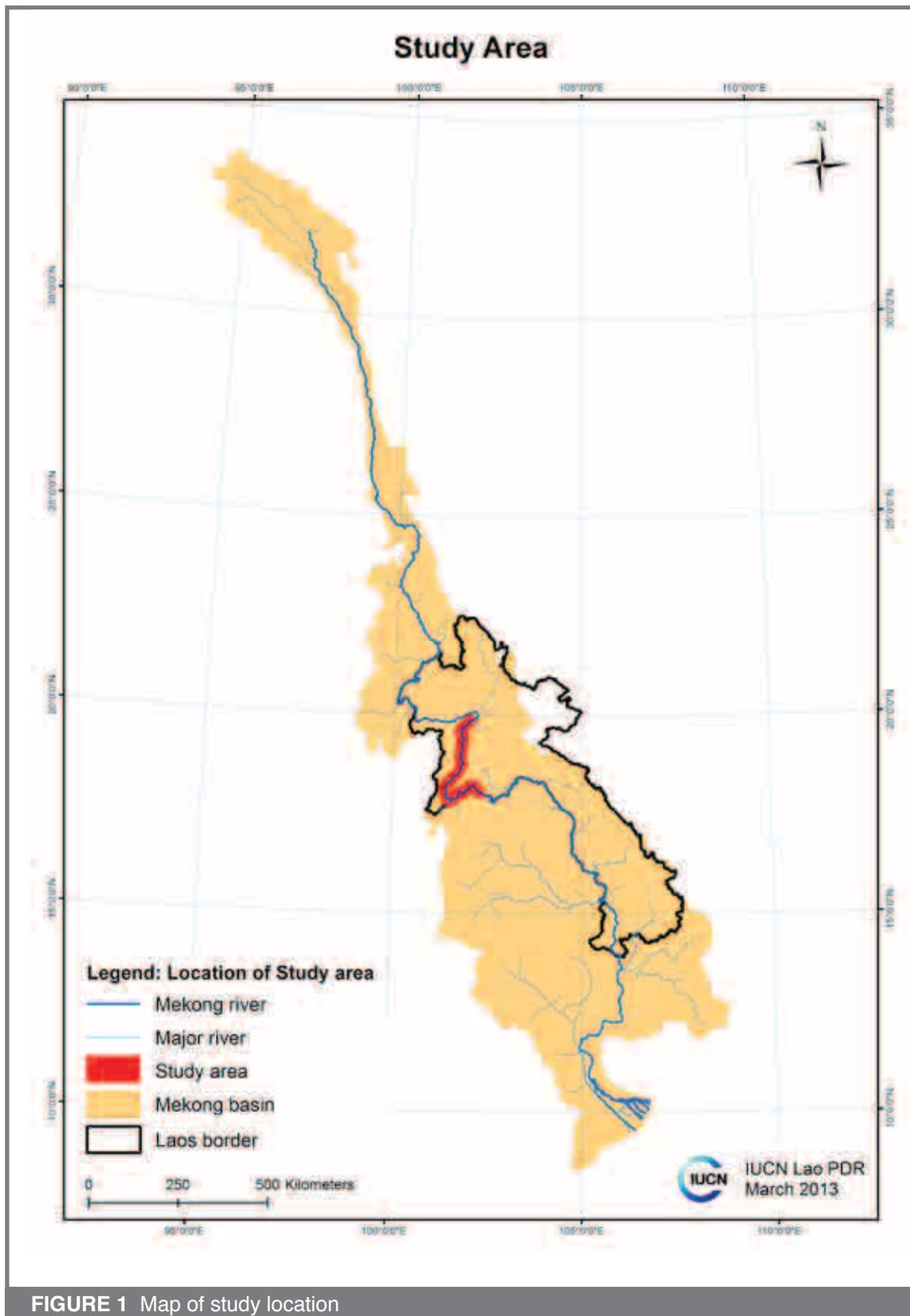
### 2.1 Overview

The study area, in North Lao PDR (*sensu* Thewlis *et al.* 1998), comprises a 450 km section of the Mekong River from the town of Louangphabang (19°52'35"N, 102°07'05"E; in Louangphabang province) south to the national capital Vientiane city (17°57'41"N, 102°36'25"E; in Vientiane Municipality). Here the Mekong's east bank is located in two provinces, Louangphabang (in Louangphabang and Nan districts) and Vientiane (in Kasi, Met, Sanakham and Meun districts) and one municipality, Vientiane (Sangthong, Sikhottabong and Chantabouli districts). The west bank is mostly (300 km; 67%) situated in Xaignabouli province (in Xaignabouli, Kenthao and Paklay districts) and Louangphabang province (Chomphet district) of Lao PDR. The remainder of the west bank (150 km), downstream from the Mekong–Nam Heung confluence, is in Thailand (Loei and Nong Khai provinces). The study area is restricted to the Lao portion of the Mekong.

For most taxonomic groups, the wet-season survey was conducted only from Ban Thadua (a village east of the town of Xaignabouli) to Vientiane town (total survey distance 380 km). It did not include the northern 70 km of the study area (the town of Louangphabang south to Ban Thadua). The dry season survey included the entire length of the Mekong within the study area, from Louangphabang town to Vientiane City. Spelling of site names follows the mid 1980s *Service Geographique d'Etat* 1:100,000 topographic map series for Lao PDR, except with features (e.g. new villages) not on these maps, which were transliterated as heard. With such a large team of diverse backgrounds, complete consistency with the map style was not attained. Sites of historical records are given as in the original source, except where the equivalence to a modern site is evident. Site names are given in full, so Lao prefixes for type of feature are included, such as river (Nam), river-mouth (Pak), stream (Houay), island (Don), rapids (Keng), mountain (Phou), cliff-girt massif (Pha) and village (Ban).

### 2.2 Climate and Hydrology

This part of the Mekong has a pronounced seasonal tropical monsoon cycle, with a dry cool season (November–February), a dry hot season (March–April) and a wet season (May–October). This seasonality strongly influences the annual flood pulse of the river. At the town of Louangphabang, mean annual rainfall ranges from 1,311 to 1,645 mm (MRC 2005) (10 mm in December and 289 mm in August; Anon. 2011) and mean monthly river discharge ranges from 1,060 (March) to 9,920 (August) m<sup>3</sup>/second (MRC 2005). Although extreme, this seasonal variation is relatively constant and additional flooding is rare (MRC 2005). The mean monthly temperatures between the town of Louangphabang and Vientiane city range from 21°C (December) to 29°C (April–June) (MRC 2005). The study area is located within 'Reach 2: Chiang Saen to Vientiane and Nong Khai', one of six hydrologically distinct sections of the Lower Mekong River (MRC 2005). This reach is characterised by mountainous topography and its hydrology is «perhaps the most natural and undisturbed in all the Lower Basin» (MRC 2005: 8). Hydrology in the study area is dominated by upstream inputs in Yunnan province of south-west China, and Reach 2 contributes only 3% of the annual flow discharge of the Mekong (MRC 2005). In contrast, the hydrology of the Mekong starts to change rapidly at the downstream boundary of this reach, due to flow inputs from large tributaries (MRC 2005).



**FIGURE 1** Map of study location

### **2.3 Geology, Soils and Vegetation**

The study area is located mostly within a single physiographic unit of Lao PDR, the ‘Northern Highlands’ (*sensu* Duckworth *et al.* 1999) and comprises mainly low rolling hills on either side of the Mekong, with narrow river valleys and little or no floodplain. The southern portion of the study area is located in another physiographic unit, the ‘Mekong Plain’ (Duckworth *et al.* 1999), and supports large lowland floodplains. River width (distance between banks) is below ½ km in most of the study area, but exceeds ½ km at Vientiane town. Hillsides adjoining the channel support a mosaic of bamboo scrub (canopy height 10–15 m) with small patches of secondary (mostly evergreen) forest, cultivated land and village tree plantations. Very little original riverbank forest remains in the study area, and the present habitats have probably resulted from multiple events of clearance and regrowth over many decades or centuries. Nearly all river valleys are almost wholly cultivated. River elevation drops from 260 m at the upstream limit of survey (the town of Louangphabang) to 165 m in Vientiane city. The highest hills adjacent to the river are mostly in the northern portion of the study area.

Channel habitats comprise the Mekong mainstream with its islands, sandbanks and rock outcrops, particularly around the mouths of permanent tributaries and seasonal streams. Between Ban Thadua and Vientiane town, six tributaries 30–100 m wide enter the Mekong. Many smaller permanent streams also joining the Mekong. Most are shallow and rocky. During the wet season, the Mekong channel largely comprises water from bank to bank. The many parts of the channel bed that are under water in the wet season and exposed in the dry season, presenting large areas of exposed rock outcrops, sandbars and vegetation, support many specialised species that do not occur in dryland habitats. The study area also holds ten permanently exposed islands over 1 km long, but these support small patches of otherwise extensive land habitats (now secondary forest and/or cultivation) and, thus, species of wide distribution.

### **2.4 Human Geography**

Most of the Mekong corridor between the towns of Louangphabang and Vientiane supports low human densities. Topographic maps depict 52 villages along the east bank (density 0.14 villages/km over 380 km) and 30 villages from the town of Louangphabang to the Mekong–Nam Heung confluence (density 0.13 villages/km over 230 km). These maps are over 30 years old, and some additional villages are now present (authors’ pers. obs.). These maps do not depict features of the Thai portion of the river, but for most of the 150 km transboundary section, the west (Thai) bank clearly supports higher human densities and infrastructure than the east (Lao) bank (authors’ pers. obs.). The lowest human densities are in the northern and central reaches of the study area, where long sections of the river support neither roads nor other infrastructure, and permanent settlements are few. Two notable exceptions are the site of the Xaignabouli dam (see below) and the town of Paklay; the latter is the largest settlement along the Mekong between the town of Louangphabang and the Mekong–Nam Heung confluence. The highest human densities and levels of infrastructure development are downstream of the Mekong–Nam Heung confluence, where both banks of the Mekong become progressively more populated and developed. Villages in the survey area will be the subject of further reports.

### **2.5 Biogeography and Conservation Significance**

In wildlife terms, one of the least-studied sections of the entire Mekong mainstream is that from Louangphabang town to a little way upstream of Vientiane city. No detailed surveys of birds or other fauna have been conducted in most of this section (nor, indeed, for most of the Lao Mekong north of Savannakhet province in Central Lao PDR). The little information available before 2011 indicated that the stretch in question might support (or at least have done so in the 1990s) riverine habitats and other biodiversity values significant among those remaining in the Mekong.

Its distinctive assemblage of riverine birds differs from those along the Mekong in southern Lao PDR and Cambodia. The bird communities of these latter areas are better known than in the study area. Part of the study area is globally recognised as an ‘Important Bird Area’ (IBA) because of the numbers of certain species supported by its seasonally inundated channel. The IBA’s northern boundary is somewhat arbitrary, given the absence of recent (post-1930) information on the birds upstream of Paklay.

The study area would probably have supported at least 14 CEPF priority species, including one mammal (Smooth-coated Otter *Lutrogale perspicillata*), four birds (Masked Finfoot *Heliopais personatus*, Greater Adjutant *Leptoptilos dubius*, Lesser Adjutant *Leptoptilos javanicus*, White-shouldered Ibis *Pseudibis davisoni*), three reptiles (Siamese Crocodile *Crocodylus siamensis*, Asiatic Softshell Turtle *Amyda cartilaginea*, Yellow-headed Temple Turtle *Heosemys annandalii*, Asiatic Giant Softshell Turtle *Pelochelys cantori*), and five fish (Mekong Freshwater Stingray *Dasyatis laosensis*, Giant Freshwater Stingray *Himantura polylepis* [formerly Chaophraya Marbled Freshwater Stingray *Himantura oxyrhynchus*], Mekong Giant Catfish *Pangasianodon gigas* and Jullien’s Golden Barb *Probarbus jullieni*). However, given regional patterns, even before the survey it was highly likely that many of these species would be found to have been extirpated.

Breeding populations of regionally or nationally threatened bird species confirmed or assumed in the survey area in the 1990s include River Lapwing *Vanellus duvaucelii*, Wire-tailed Swallow *Hirundo smithii*, Great Thick-knee *Esacus recurvirostris*, Blue-tailed Bee-eater *Merops philippinus*, Plain Martin *Riparia paludicola* and Spot-billed Duck *Anas poecilorhyncha haringtoni*. River Tern *Sterna aurantia*, a regionally threatened bird species, was recorded in the study area until 2000, and is probably the highest-priority bird species that stood a reasonable chance of being found in the study area in 2011–2012.

The study area is part of a critical migration corridor for a large assemblage of migratory fish, which undertake seasonal movements along the mainstream and tributaries between the Great Lake of Tonle Sap (Cambodia) and southern China. Most people in Lao PDR depend upon these fish species for protein. The channel mosaic habitats are particularly important for fish to shelter, forage and spawn.

The river section in the study area contributes to maintenance of the integrity of ecosystem function along the upper Mekong, including regulation of seasonal water flow rates and volumes, silt entrapment, flood protection and other ecological processes. Maintaining the natural characters of such river sections may help to offset the impacts of dams likely to be constructed further upstream.

The study area supports no large protected areas. The south-west portion of one National Protected Area (NPA), Phou Phanang, extends almost to the eastern bank in Vientiane province. This is a low forested hill range. No national parks occur along the Thai bank. The district officers reported that there are no Provincial Protected Areas (PPAs) along the river on the Lao side. According to residents, at least two small sections of the Mekong (one at Ban Khokakha and one at Ban Pakmi) and one island (Don Hon) are locally protected as community forests, and these sites retain some natural land habitats. The extent to which any of these areas included the vital seasonally exposed channel habitats was not established.

## **2.6 Survey Localities and Dates in 2011 and 2012**

Based on topography and general landmarks, the Mekong channel between the towns of Louangphabang and Vientiane can, somewhat arbitrarily, be divided into four sections. The village counts below are from the topographic maps. Additional villages were systematically neither sought nor recorded, and some that were found proved to be rather inconspicuous from the river. The map of the study area is presented in Fig 2, detailed map of all sections surveyed are presented in Fig 2.1 to 2.6.

### Louangphabang (town) to Ban Mouang

In this stretch, the Mekong channel has a mostly relatively narrow exposed dry-season bed; wider stretches are particularly associated with tributary mouths. Most significant to threatened tetrapods is the wide expanse of seasonally exposed bed around the small (below 35 ha) uninhabited island, Don Hon, and the wide area for several contiguous kilometers upstream of this island. Human densities in this river section are low (authors' pers. obs.): topographic maps depict 13 villages on the west bank and 12 on the east bank. Permanently exposed parts of Don Hon support what is probably the least degraded natural bank-top forest anywhere in the study area, a small patch (less than 10 ha) of mature secondary forest along its west bank. The remainder above the level of regular river inundation is degraded scrub. The island is a community protected site of Ban Nongkhai. Residents stated that hunting and logging are prohibited. This section's channel is bordered by low hills with little or no floodplain. These hillsides support degraded bamboo forest/scrub with numerous patches of slash-and-burn agriculture, grading to thick stands of bamboo forest (10–15 m canopy) along the riverbank, which are interspersed with many small village plantations of Teak *Tectona grandis*. Small patches of degraded forest persist on steep upper slopes. In the northern reaches, forest condition is slightly better along the west bank, which retains small patches of secondary dipterocarp forest (canopy height 20 m) near Ban Thadua. South of Ban Khokfak (present local name, Ban Pakpouy), limestone hills occur near the river. A large limestone outcrop, Pha Liap, emerges directly from the channel opposite Ban Muangliap (present local name, Ban Phaliap).

This section supports the site of the proposed Xaignabouli (spelled variously in external documents, often as 'Xayaburi') dam (19°14'55"N, 101°48'51"E), located north of Ban Houaysouy. On 12 September 2011, the following were observed: the construction of a large road (c.10 m wide) above the riverbank, extending several kilometers north and south along the river; a large, newly cleared transmission easement extending west from the site (presumably towards Thailand), together with recently installed electricity pylons (as yet with no overhead transmission lines); new concrete buildings; temporary staff compounds; and numerous heavy vehicles and other machinery. All activities were along the west bank. Staff comprised Thai and Lao workers. Road and easement construction had resulted in extensive clearance and modification of the hillsides immediately above the river, with some slopes cleared of vegetation down to the riverbank.

### South of Ban Mouang to Don Sang

Compared with the upstream section, this river section supports several stretches with a much wider exposed dry-season channel bed, particularly downstream from about Don Kieo (18°20'N, 101°32'E) for large reaches downstream to Don Sang. A small portion of the river channel around Don Vao supports the most diverse wet-season channel habitats in the study area. Here the Mekong comprises a wide, deep western channel and several smaller, shallow eastern channels with rocky rapids. Numerous small rock outcrops and sandbars are vegetated with reeds and scrub. Don Vao itself is a small, uninhabited island with degraded secondary forest. Don Sang, a larger island south of Don Vao, is largely cultivated. In the dry season, the surroundings of Don Vao and Don Sang provide by far the largest tract of exposed channel bed in the survey area upstream of the Lao–Thai border, with a complex matrix of grassland, rock, pools, bushland, sand and seasonal agriculture. The town of Paklay is located in this section, and topographic maps depict 10 villages on the west bank and five on the east bank. There are larger floodplains and river valleys on the banks than those that occur in the section immediately upstream, interspersed with larger limestone hill ranges. Tributary valleys mainly support cultivation or scrub. Steep hill slopes, principally along the east bank, retain numerous small patches of secondary forest somewhat less degraded than are those in the previous river section.

#### South of Don Sang to Mekong–Nam Heung confluence (Lao–Thai border)

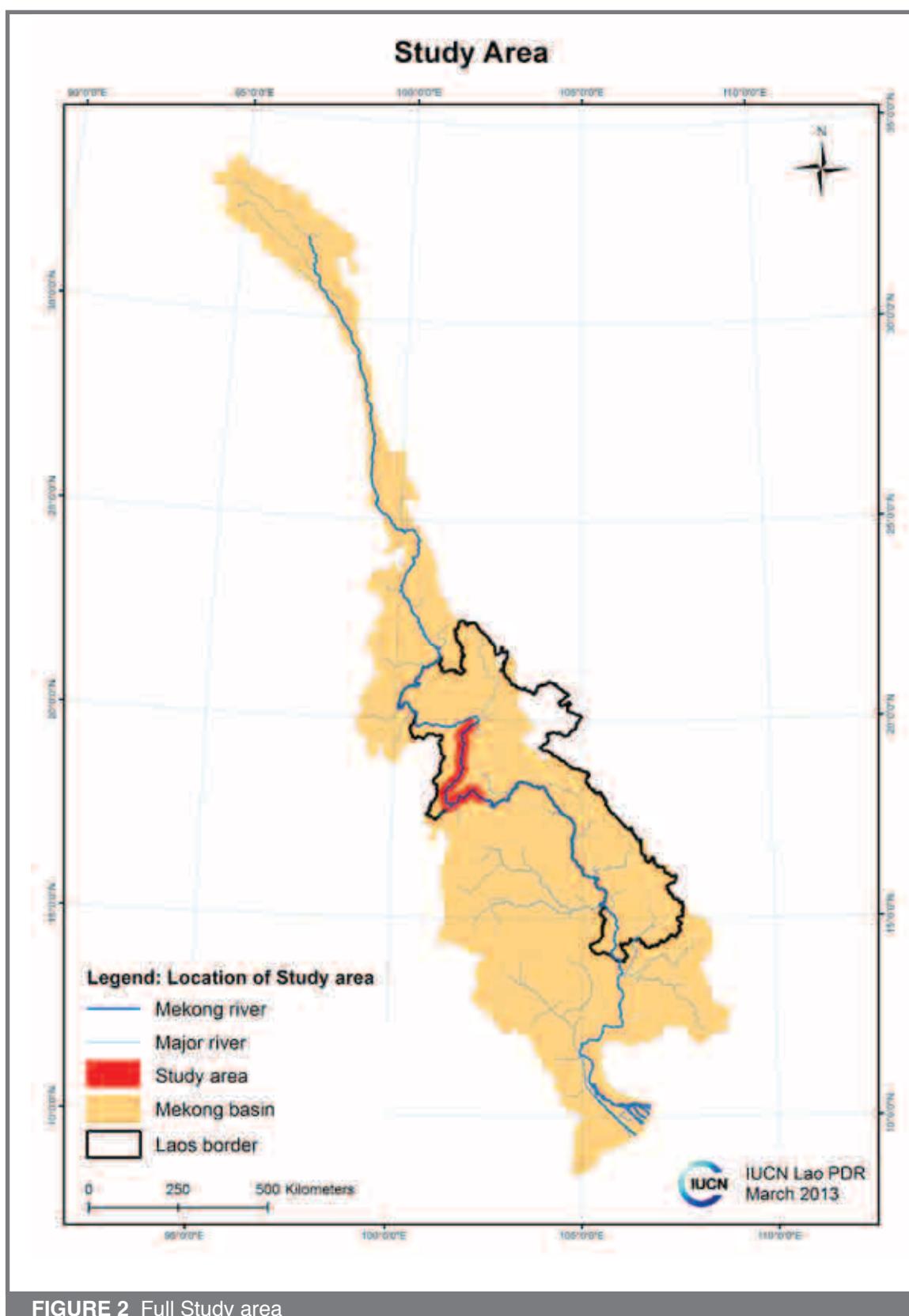
This river section supports a number of extensive sedimentary tracts of bed exposed (as sand, silt and gravels) in the dry season, both mid-stream and as extensions from the banks. Seasonally exposed bedrock and extensive bushland are both much scarcer than in the section immediately upstream. Grasslands and beds of ephemerals are also more localised. Indeed, much of the dry-season channel is simple, with near-vertical banks and little exposed bed. This section supports the lowest human densities in the study area; long stretches may still lack permanent settlements (authors pers. obs.). Topographic maps depict only five villages on the west bank and three on the east. The channel is flanked by low hills with degraded scrub/forest mosaic and little or no floodplain. Riverbanks support bamboo scrub and some degraded secondary forest. The inflow of the Nam Heung marks the border of Lao PDR with Thailand. From this point downstream, the west bank of the Mekong lies in Thailand.

#### South of Mekong–Nam Heung confluence to Vientiane city

From the Mekong–Nam Heung confluence downstream to Vientiane city the river channel is highly diverse. Long reaches have a very wide exposed channel bed in the dry season, often a mixture of bedrock, gravels and sands, and also with the biggest expanses of *Homonoia*-dominated bushland in the entire survey area. Some of the widest tracts are associated with tributary mouths, but there is a long stretch of river off Sanakham, Meun and Sangthong districts with an almost continuous very wide exposed channel bed from both the Lao and Thai banks. In much of this section, the exposed bed is wider on the Thai side than on the Lao. In the downstream part of Sangthong, this seasonally exposed, seasonally inundated habitat fragments and narrows, and downstream from Ban Kengmo most of the dry-season channel to Vientiane city is largely water, although there are some very large, mostly bare, sand-flats. Human densities and levels of infrastructure development are notably higher along both riverbanks south of the Mekong–Nam Heung confluence than above. Settlements and road networks become progressively larger. Topographic maps depict 31 villages along the east bank (Lao PDR); the Thai bank clearly supports higher human densities (authors' pers. obs.).

Topography adjacent to this section comprises a series of progressively larger river valleys and floodplains, interspersed with areas where hill ranges extend to the river and where there is little or no floodplain. Just upstream of Vientiane city, both banks support large floodplains of low elevation. At Ban Pakmi (east bank), a large limestone outcrop, Phou Phaleng, is a community protected site that supports secondary forest descending to the riverbank. Between Phou Phaleng and Ban Ang-Noi (east bank, Lao PDR) small patches of natural forest persist along steeply sloping hillsides. Emerging from the channel are five permanent islands, four of which are more than 1 km long (the largest is Don Konkong). These islands support some secondary forest but are largely cultivated. Upstream of Vientiane city, the island off Ban Mai supports what are probably important seasonally-inundated graminoid beds at its northern end, but otherwise holds extensive draw-down cultivation.

Around Ban Kengmo (east bank, Lao PDR) are several small permanent floodplain pools, apparently the only such pools within the study area. These support scrub and the invasive weed *Mimosa pigra* and are bordered by agriculture. South of Don Konkong, several kilometers of both banks are bordered by hills with mature secondary forest. Here, the east bank (Lao PDR) is just within Phou Phanang NPA, but the west bank (Thailand) is not within any national park.



**FIGURE 2** Full Study area



FIGURE 2.1 Full Study area 1

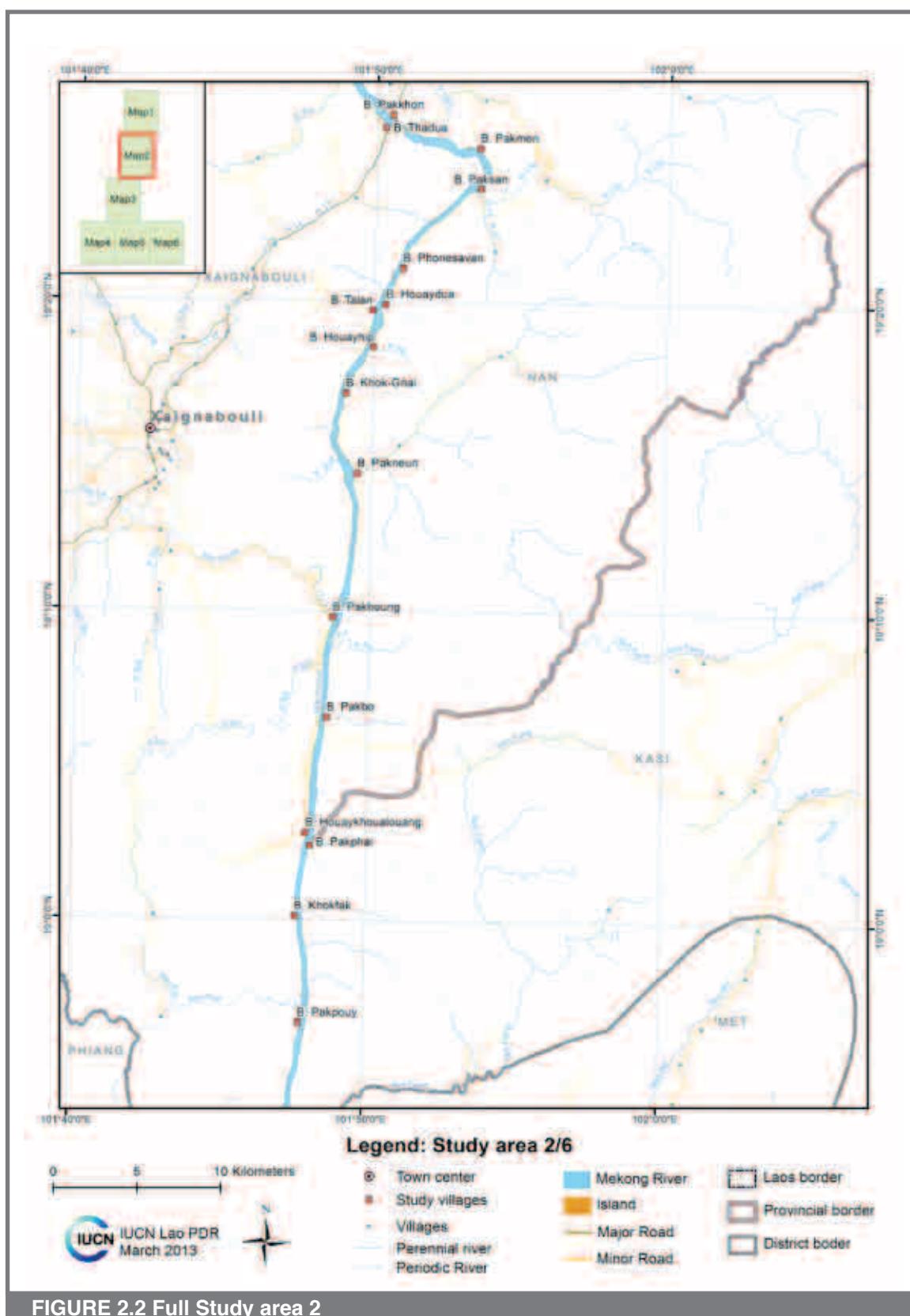


FIGURE 2.2 Full Study area 2

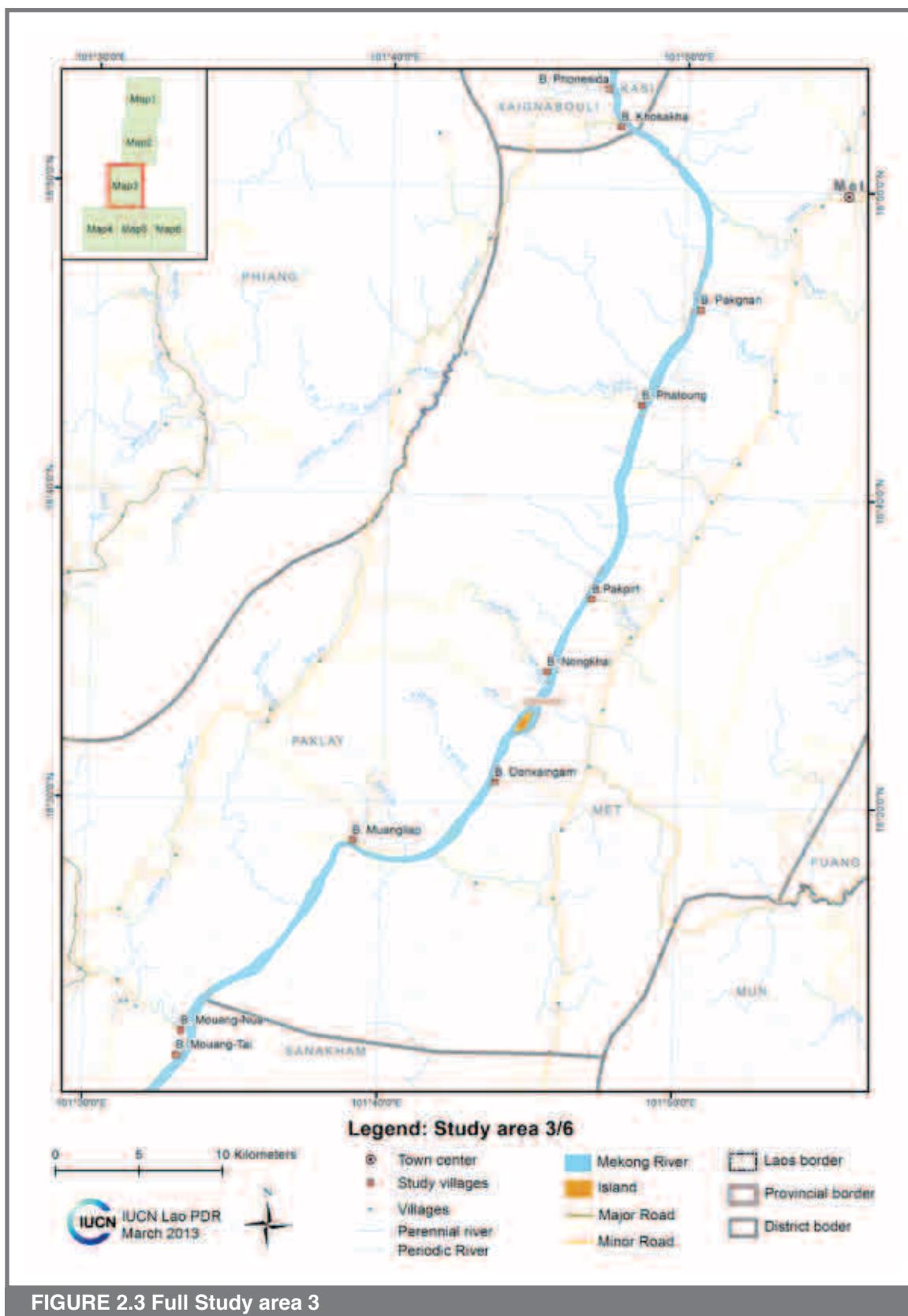
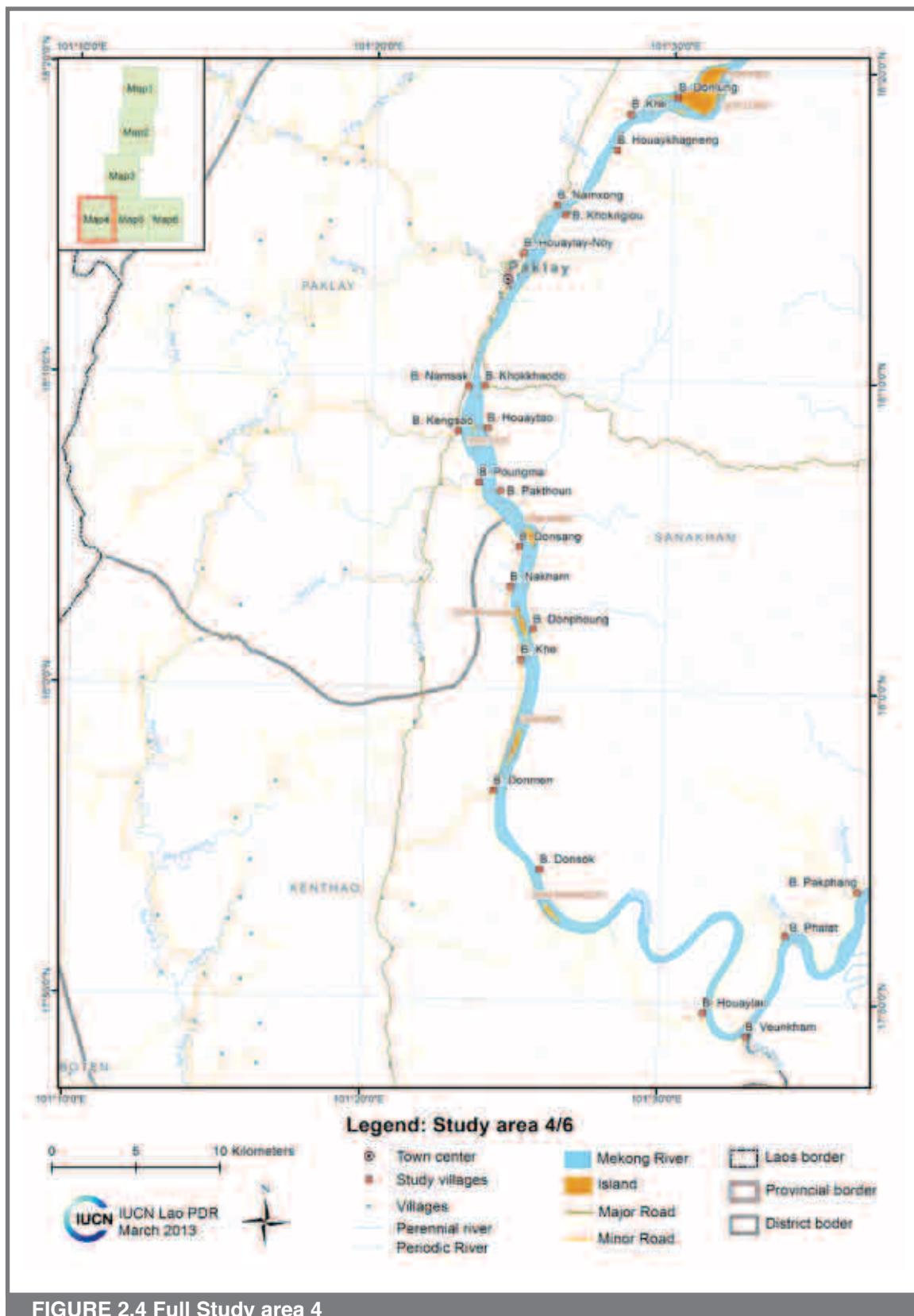
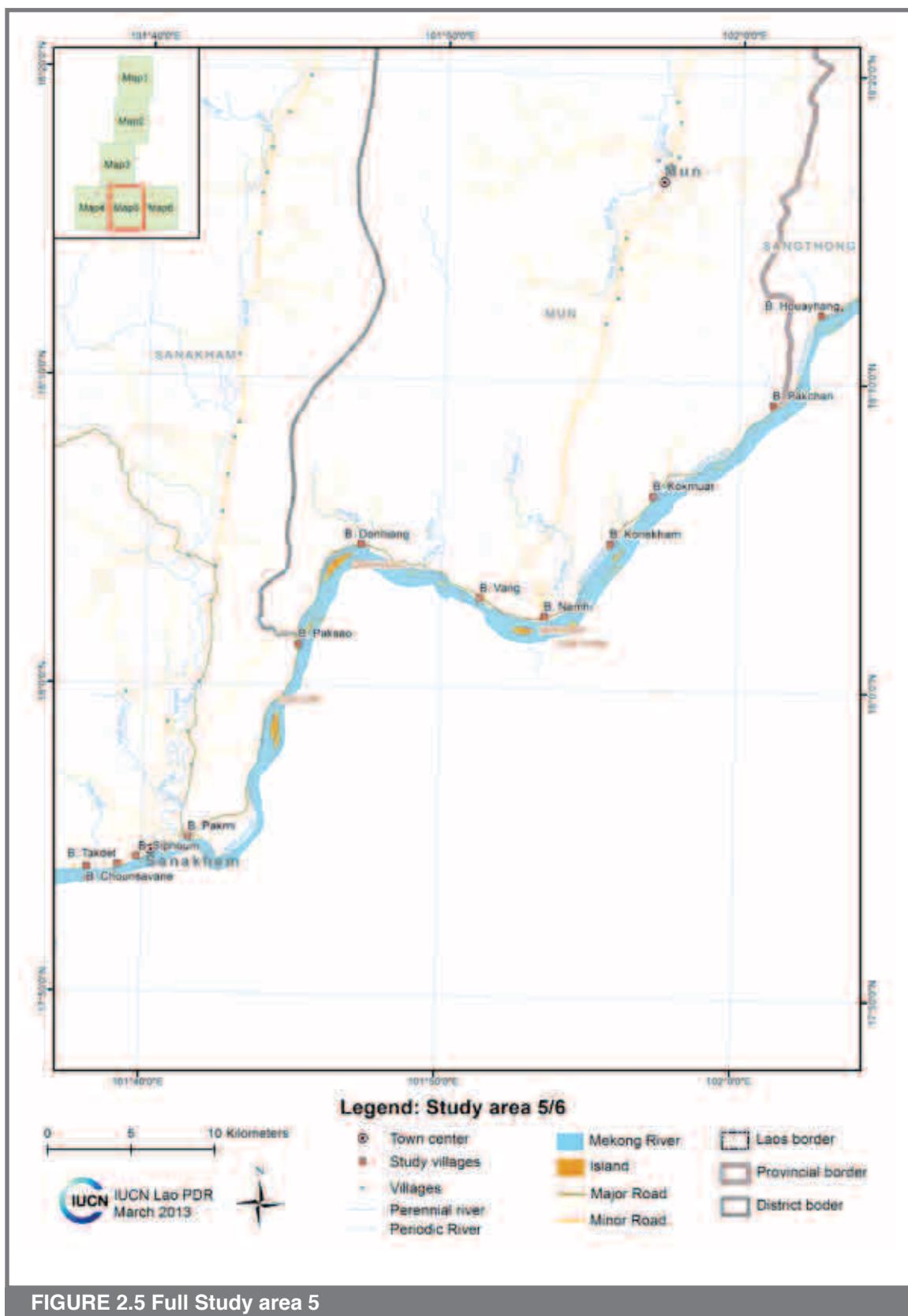


FIGURE 2.3 Full Study area 3





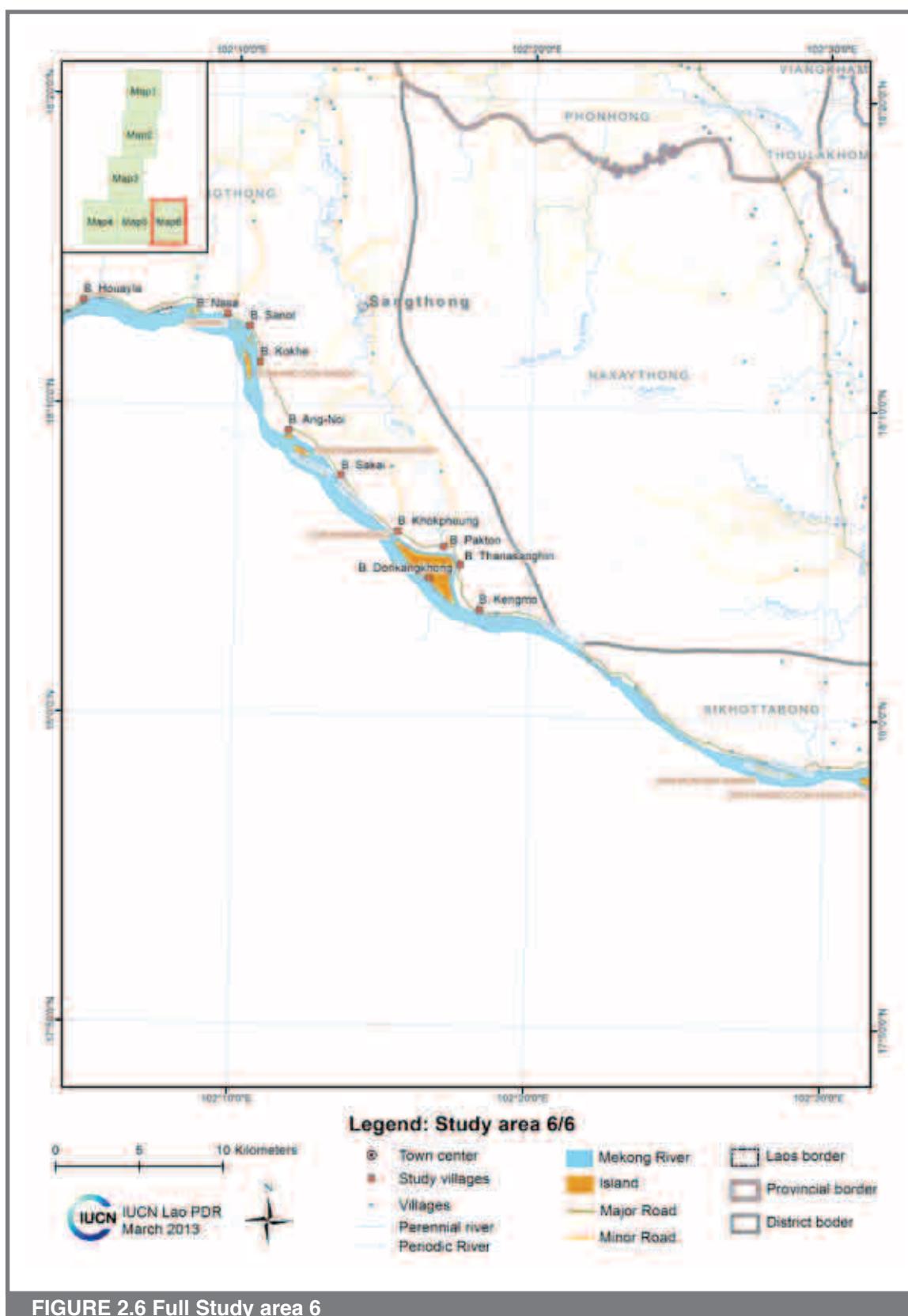


FIGURE 2.6 Full Study area 6

# 03

## Vegetation and Flora





### 3. Vegetation and Flora

#### 3.1 Introduction

Few studies of the Mekong in North Lao PDR have been conducted. The rheophyte vegetation of the Mekong in Ubon Ratchatani province, Thailand, was studied by Puff & Chayamarit (2011). Accounts of the riverine flora of the Mekong are available for the Siphandon (Seephandon) or '4,000 islands' area in southern Lao PDR (Maxwell 2000, 2001) and in Kratie and Steung Treng provinces in north-east Cambodia (Maxwell 2009a, 2009b). This botanical survey was to assess the vegetation and its condition in and adjacent to the Mekong between the towns of Louangphabang and Vientiane. Areas of special botanical interest, especially for conservation, were sought. Conservation and management recommendations are also needed.

#### 3.2 Methodology

##### 3.2.1 Study Sites and Dates

The botanical survey was conducted from 21 April to 9 May 2012. Much collecting occurred outside the river channel, in adjacent dry-land habitats. The locality names were recorded using the Thai style of transcription and some (marked ^) are not readily related to those used by the other survey teams in this study and on the Lao maps.

##### *28 April 2012.*

Opposite Bak Pouy^ sacred forest, Nan district, Louangphabang province; riverine sand and rocks, excellent Strand; 260–300 m altitude, shale bedrock. Ban Na Konken^, Xaignabouli district; huge *Garcinia thorelli* Pierre. (Guttiferae) in remnant Strand.

##### *29 April 2012.*

Ban Na Konken^, sacred forest, Houay Gawn Goy^, Evergreen forest degraded near the mouth of the stream, excellent inside; 300 m, shale bedrock. Houay Gohk Akha^, much destroyed Evergreen forest.

##### *30 April 2012.*

Ban Na Konken^, Houay Bah Hieo^: excellent Evergreen forest, 350 m, shale bedrock. Down river from this village only a few patches of Evergreen forest remain. All hills have been cleared or severely degraded by logging and burning. Much cleared land, exposed soil, and abandoned land with used and infertile soil. At Paklay many big logs were on the beach as a result of Thai–Lao cooperative exploitation.

##### *1 May 2012.*

Don Hon, Paklay district, Xaignabouli province. First island encountered, degraded Evergreen forest with much secondary growth; 300–325 m, shale bedrock; ancient brick ruins indicating a long history of settlement on the island; huge *Tetrameles nudiflora* R. Br. ex Benn. (Datiscaceae, Plate 3.10).

##### *2 May 2012.*

Opposite Ban Muangliap, limestone hill Pha Liap; Met district, Vientiane province; 300 m; excellent Evergreen forest around cliffs on the east side, massive clearing next to this for agriculture; *Melocanna baccifera* (Roxb.) Kurz (Gramineae, Bambusoideae), dominant bamboo along with *Neothorelia laotica* Gagnep. (Capparaceae) were noteworthy finds.

### *3 May 2012.*

Don Sau (Wau)<sup>^</sup>, opposite Keng Sao, Sanakham district, Vientiane province; 240 m, metamorphic sandstone bedrock; margins of the island have been logged and now with much secondary growth; interior with some original Evergreen forest canopy trees and recent logging. Don Sang, Sanakham district, 275 m, metamorphic sandstone bedrock; 80% of forest has been cleared, 1 ha of remnant Evergreen forest remains on south-west side; much land cleared for agriculture with many weeds; huge *Ficus callosa* Willd. (Moraceae).

### *4 May 2012.*

Opposite Ban Khe Houay Bah Pie<sup>^</sup>, Sanakham district, Vientiane province; 300 m, shale bedrock; Beach and Strand zones. Don Men, opposite Ban Donmen, Kenthao district, Vientiane province; 275 m, shale bedrock; sand and coarse gravel substrate.

### *5 May 2012.*

Opposite Ban Donmen, Kenthao district; degraded Bamboo and deciduous, seasonal forest and cleared land; 275–325 m, shale bedrock; *Cephalostachyum pergracile* Munro (Gramineae, Bambusoideae), a very common bamboo. Don Men, south-east side, 90% of forest cleared for agriculture, much secondary growth and weeds; fruit tree orchard, remnant c. ½ ha Evergreen forest; huge *Ficus racemosa* L. and *F. callosa* Willd (both Moraceae).

### *6 May 2012.*

Phou Phaleng limestone hill, Keng Khoutkhou, Ban Pakmi, Sanakham district, Vientiane province; Strand and Bamboo and deciduous, seasonal forest margins which is close to intact; 275 m, limestone bedrock.

### *7 May 2012.*

Don Hin Lek Fai<sup>^</sup>, c. 2 km upriver from Ban Vang; 225 m, shale bedrock; excellent Beach and Rocky zone, forbidden to enter the degraded Bamboo and deciduous, seasonal forest.

### *8 May 2012.*

Don Konkong, Sangthong district, Vientiane Capital municipality; 200 m, shale bedrock; 99% of island deforested for ‘permanent agriculture’, much degraded land and secondary growth; several huge

#### **3.2.2 Survey Methods**

Considering the large size of the study area, the riverine vegetation was extensively surveyed by random stops along the river. Terrestrial vegetation was also studied, but in a more selective manner. The survey was during the hot-dry season, to determine the extent of deciduousness of the terrestrial vegetation. Obvious evergreen habitats were sampled, with less emphasis to degraded or destroyed habitats.

Limestone and shale are common throughout the area while metamorphic sandstone is present on two islands in Vientiane province. Sandstone was only seen in the vicinity of Vientiane on the last day of the trip. All original vegetation on this bedrock had been cleared so it was not studied.

Usually three or four specimens of each species desired for identification or botanical interest were made. One set was donated to the National Herbarium, Lao PDR, on 10 May 2012. The other specimens are at CMU herbarium, Chiang Mai University. Notes on species not collected and habitat notes were made. The vegetation along the survey route was noted on topographic maps for further GIS mapping.

### 3.2.3 Limitations

This can only be a preliminary study because not all riverine vegetation and sites (islands, beaches, limestone) were surveyed throughout the year. Algae were not collected. A complete flora of the study area, including adjacent land habitats, would require frequent and extensive collecting. Further collections, studies on forest dynamics, plant distributions, and observations on chronologies will add more information to the database and enable more detailed vegetation mapping. Management actions such as revegetation would require more precise information of the location of seed sources, planting sites and habitat requirements.

## 3.3 Results

The two main kinds of vegetation along the studied area of the Mekong are riverine (riparian) and terrestrial. The riverine vegetation comprises all vegetation in the river to the highest water level; this is attained in August–September, whereas the terrestrial vegetation is all that is present on land above the flood-level of the river. A database of recorded vascular plants and bryophytes is located in Appendix 3.2. Plates 3.1–3.18 show a variety of habitats within and adjacent to the channel, some of the individual plant species, and some of the human uses of plants in and adjacent to the channel.

### 3.3.1 Riverine vegetation

Along the Mekong, between the towns of Louangphabang and Vientiane, there are only three riparian zones: Aquatic, Beach and bedrock, and Strand. The Beach and bedrock zones, although distinct in Siphandon and Cambodia, are often found together in the present survey area. The relative narrowness and faster flow of this stretch of river means that no *Acacia–Anogeissus* zone is found here although it is present in lower sections of the river. The sandstone bedrock from Vientiane to Siphandon and metamorphic sandstone in Cambodia could also be a factor in differences.

Riverine habitat between the towns of Louangphabang and Vientiane has three kinds of facies: massive gorges with vertical limestone bedrock (especially immediately south of Louangphabang); broken boulders; and sandy beaches. The latter two often merge together. The Strand zone is usually distinct, merging with terrestrial vegetation, but is frequently degraded and mixed with secondary growth. The river level is at its maximum in August–September, an estimated 15 m above its lowest level (Plate 3.1).

#### Aquatic Zone

This zone is made up entirely of herbaceous plants. Plants in this zone are often found in the river during the dry season when water level, turbidity and flow velocity, are all at their lowest. These plants are all either floating or submerged (attached to the bottom) because they are all obligate aquatics. *Potamogeton crispus* L. (Potamogetonaceae) is the only representative of this zone that was found. It was seen in two places in shallow, relatively still water, in dense colonies of 1–2 m<sup>2</sup>. The plant roots in a silt–sand substrate, with stems and leaves submerged to floating, and emergent (2–3 cm) inflorescences.

#### Beach Flora

This zone is made up of sandy beaches and to a lesser extent mud flats found throughout the riverine area, the former extending from just above the low water level to the Strand zone. Exposed bedrock and boulders are frequently found in this habitat.

Almost all plants growing on the sand are annuals, both dicots and monocots. No pteridophytes or bryophytes were found. These annuals are also commonly found as initial colonisers in cultivated areas, especially rice fields, where they are considered weeds. Some of the weeds found in cultivated areas were not

found in riverine sand or mud. These plants are included in the section about cultivated areas. *Hemisorghum mekongense* (A. Camus) Hubb. (Gramineae) is only found on sandy beaches. All these riverine annuals begin to germinate after the substrate becomes exposed as the river level decreases during October–November and by March they have reached maturity. All were in flower or fruit during this survey. The Beach flora was sampled extensively but time was insufficient to determine among these annuals; their relative abundances, preferred niches, and associations with bedrock and other factors involved with their diversity and abundance. The most common representatives of Beach flora are listed in Table 3.1.

**Table 3.3.** Riverine woody rheophytes

**Dicots**

- Rorippa indica* (L.) Hiern, Cruciferae
- Portulaca oleracea* L., Portulacaceae
- Meliolotus suaveolens* Led.; Leguminosae, Papilionoideae
- Ludwigia hyssopifolia* (G. Don) Exell, Onagraceae
- Dentella repens* (L.) J.R. & G. Forst., Rubiaceae
- Anaphalis margaritacea* (L.) Bth., Compositae
- Crassocephalum crepidioides* (Bth.) S. Moore, Compositae
- Grangea maderaspatana* (L.) Poir., Compositae
- Spilanthes paniculata* Wall. ex DC., Compositae
- Xanthium inaequilaterum* DC., Compositae
- Youngia japonica* (L.) DC., Compositae
- Physalis angulata* L., Solanaceae
- Lindernia antipoda* (L.) Alst., Scrophulariaceae
- Lindernia crustacea* (L.) F. Muell., Scrophulariaceae
- Scoparia dulcis* L., Scrophulariaceae
- Verbascum chinense* (L.) Sant., Scrophulariaceae (Plate 3.3)
- Phyla nodiflora* (L.) Greene, Verbenaceae
- Leonotis nepetaefolia* (L.) R. Br., Labiateae
- Chenopodium ambrosioides* L. Chenopodiaceae
- Chenopodium ficifolium* Sm., Chenopodiaceae
- Amaranthus spinosus* L., Amaranthaceae
- Amaranthus viridis* L., Amaranthaceae
- Polygonum plebeium* R. Br., Polygonaceae
- Rumex dentatus* L., Polygonaceae
- Euphorbia thymifolia* L., Euphorbiaceae

**Monocots**

- Cyperaceae
  - Bolboschoenus maritimus* (L.) Palla ssp. *affinis* (Roth) T. Koy.
  - Cyperus difformis* L.
  - Cyperus michelianus* (L.) Link ssp. *pygmaeus* (Rottb.) Asch. & Graebn.
  - Fimbristylis bisumbellata* (Forssk.) Bub.
  - Fimbristylus brunneoides* Kern
- Gramineae
  - Digitaria bicornis* (Lmk.) Roem. & Schult.
  - Digitaria longiflora* (Retz.) Pers.

## Monocots

- Eleusine indica* (L.) Gaertn.  
*Hemisorghum mekongense* (A. Camus) Hubb.  
*Zoysia matrella* (L.) Merr.

*Cyperus elatus* L., *C. leucocephalus* Retz. and *Fimbristylis cymosa* R. Br. (all Cyperaceae) are deciduous herbs found in the riverine area. All are less common than are the annuals listed in Table 3.1. Occasional seedlings of woody species are found on beaches. They do not become established and are rarely more than one year old. *Crateva magna* (Lour.) DC. (Capparaceae), *Muntigia calabura* L. (Tiliaceae, introduced), *Buddleja asiatica* Lour. (Loganiaceae), and *Ricinus communis* L. (Euphorbiaceae, escaped from cultivation and not native) are common examples.

Some of these annuals are edible and were often eaten by the plant team (Table 3.2).

**Table 3.2.** Edible plants found in riverine and terrestrial vegetation (all were collected and eaten at many meals by the plant team).

### Riverine Plants

- Rorippa indica* (L.) Hiern, Cruciferae  
*Centella asiatica* (L.) Urb., Umbelliferae  
*Momordica charantia* L. Cucurbitaceae  
*Crassocephalum crepidioides* (Bth.) S. Moore, Compositae  
*Spilanthes paniculata* Wall. ex DC., Compositae  
*Solanum nigrum* L., Solanaceae  
*Solanum torvum* Sw., Solanaceae  
*Amaranthus spinosus* L., Amaranthaceae  
*Amaranthus viridis* L., Amaranthaceae  
*Homonoia riparia* Lour., Euphorbiaceae  
*Diplazium esculentum* (Retz.) Sw., Athyriaceae

### Terrestrial Plants

- Leucaena leucocephala* (Lmk.) De Wit; Leguminosae, Mimosoideae  
*Saraca declinata* (Jack) Miq.; Leguminosae, Caesalpinoideae  
*Piper sarmentosum* Roxb. ex Hunt., Piperaceae  
*Tacca chantrieri* Andre, Taccaceae

## Rocky Areas

Limestone, shale, and less frequently metamorphic sandstone outcrops in sandy places, are found throughout the survey area. Riverine shrubs, treelets and trees are only found among rocks and are often bent by water flow (Plates 3.2–3.5). *Homonoia riparia* Lour. (Euphorbiaceae) is an exception and has straight stems. These rheophytes are all deciduous, losing their leaves when inundated, and were flowering or fruiting during this survey. Established habitats for these seasonal rheophytes are scattered and often include one or two species together. Most Rocky areas, especially those in narrow parts of the river, lack these unique plants. *Homonoia riparia* is the most common rheophyte and is found in water throughout the year or in seasonally flooded/dry riverine places up to the base of the Strand zone. Table 3.3 lists these woody rheophytes.

**Table 3.3. Riverine woody rheophytes**

<i>Polyalthia modesta</i> (Pierre) Fin. & Gagnep., Annonaceae
<i>Microcos sinuata</i> (Wall. ex Mast.) Burr., Tiliaceae
<i>Flemingia lineata</i> (L.) Roxb. ex Ait. f. var. <i>glutinosa</i> Prain; Leguminosae, Papilionoideae
<i>Eugenia mekongensis</i> Gagnep., Myrtaceae
<i>Xantonnea parviflora</i> (O.K.) Craib var. <i>salicifolia</i> (Pierre ex Pit.) Craib, Rubiaceae
<i>Gmelina elliptica</i> J.E. Sm., Verbenaceae
<i>Antidesma montanum</i> Bl. var. <i>salicinum</i> (Ridl.) P. Hoffm., Euphorbiaceae
<i>Homonoia riparia</i> Lour. Euphorbiaceae (Plate 3.2)
<i>Phyllanthus jullienii</i> Beille, Euphorbiaceae
<i>Salix tetrasperma</i> Roxb., Salicaceae

### Strand

The Strand (Maxwell 2009a, 2009b) is the highest riverine zone. It is the last riverine area to be flooded in the wet season, the first to be exposed when the dry season starts, and borders terrestrial vegetation. All Strand plants are woody and include climbers and trees, most of which are evergreen (Plate 3.6). Common woody climbers include *Acacia caesia* (L.) Willd. var. *subnuda* (Craib) I. Niels. and *A. megaladena* Desv. var. *indo-chinensis* I. Niels. (both Leguminosae, Mimosoideae), *Pterolobium macropterum* Kurz (Leguminosae, Caesalpinioidae), *Derris alborubra* Hemsl. (Leguminosae, Papilionoideae), and *Premna scandens* Roxb. (Verbenaceae). Disturbance of original conditions has allowed some of these plants, usually found in secondary growth, to establish in the Strand zone.

Common Strand trees are *Archidendron laoticum* (Gagnep.) I. Niels, (Leguminosae, Mimosoideae), *Eugenia siamensis* Craib (Myrtaceae), *Cordia cochinchinensis* Gagnep. (Boraginaceae), *Drypetes salicifolia* Gagnep. (Euphorbiaceae), *Ficus kurzii* King, and *F. racemosa* L. (both Moraceae). Destruction of Strand vegetation has allowed much secondary growth to develop in this zone. Excessive removal of terrestrial vegetation where Strand vegetation is absent has resulted in extensive collapsing of embankments (Plate 3.7).

### 3.3.2 Terrestrial vegetation

Forests beside the Mekong in this part of Lao PDR have been heavily disturbed by people. Forms include degraded evergreen, destroyed evergreen, which has been succeeded by deciduous facies, degraded deciduous, bamboo and deciduous facies. Much has been cleared. The loss of soil by erosion is a critical factor and is directly related to the condition of the forest, the most degraded vegetation having the least and poorest soil. Continuous hacking, logging and fire have resulted in most of the forest cover below Ban Pakhoun to be classified as very degraded to destroyed. Over vast areas of abandoned land, intensive agriculture has rendered the soil infertile and insufficient for sustainable crop production. These areas, if neglected, will develop secondary growth and remain that way for many years until the soil redevelops.

Lamxay & Larnorsavanh (2012) mention “dry dipterocarp forest” in their report of botanical surveys in this area, noting it near Ban Talan in Xaignabouli district, Xaignabouli province. No surveys were undertaken here in the dry season, and this type of vegetation was not seen during that survey.

### Primary, Evergreen, Hardwood Forest (Evergreen Forest)

From the town of Louangphabang to Ban Pakleum<sup>^</sup> the terrestrial vegetation is primary and evergreen on limestone hills. This area was not surveyed, given the difficulty of landing and entering the forest. Down river from Ban Pakleum, Evergreen forest has been mostly destroyed. Thadua Falls, Xaignabouli district,

near Mua Nan<sup>^</sup>, was the first Evergreen forest visited. This is a freshwater limestone area (300–375 m) with extensive deposits of tufa (recrystallised limestone, at the falls) and limestone above it. The riverine vegetation below the falls is diverse and mostly undisturbed around the falls. A picnic area has been made above the falls in which the ground flora and understory have been cleared.

Dominant evergreen herbs include *Alocasia macrorhizos* (L.) G. Don and *Aglaonema simplex* (Bl.) Bl. (both Araceae), *Tacca chantrieri* Andre (Taccaceae), and *Alpinia malaccensis* (Burm.f.) Rosc. (Zingiberaceae)—all monocots. *Vesicularia montagnei* (Schimp.) Broth. (Hypnaceae) and *Splachnobryum aquaticum* C. Muell. (Splachnobryaceae), both epilithic mosses, are common on tufa at the falls. *Sauropus thorelli* Beille (Euphorbiaceae), a cauliflorous evergreen shrub, is abundant in this area. Common understory trees are *Streblus ilicifolius* (S. Vidal) Corn. (Moraceae), *Arenga westerhoutii* Griff. (Palmae), and *Mallotus lanceolatus* (Gagnep.) A.S., *Bischofia javanica* Bl. and *Baccaurea ramiflora* Lour. (all Euphorbiaceae). Canopy trees are mostly over 20 m tall with *Duabanga grandiflora* (Roxb. ex DC.) Walp. (Sonneratiaceae; 25 m tall, dbh 188 cm, Plate 3.9), *Tetrameles nudiflora* R. Br. ex Benn. (Datiscaceae), *Toona ciliata* M. Roem. (Meliaceae) and *Spondias lakonensis* Pierre var. *lakonensis* (Anacardiaceae). *Entada rheedei* Spreng. (Leguminosae, Mimosoideae) and *Combretum latifolium* Bl. (Combretaceae) are common, deciduous woody climbers.

Other Evergreen forest areas are few and isolated, and some are being logged. The Nam Pouy and especially the Houay Ak, a tributary, in Xaignabouli district were visited. Because this river is narrow and slower-flowing than the Mekong, *Elaeocarpus hainanensis* Oliv. (Elaeocarpaceae) was only seen here. *Crateva magna* (Lour.) DC. (Capparaceae) was present along with *Osmunda vachellii* Hk. (Osmundaceae) on shale just above the lowest water level. The Houay Ak and several streams bordering remnant Evergreen forest in sacred areas (*i.e.* cemeteries) was also surveyed. These streams flow through shale bedrock and include the most diverse and closest to intact Evergreen forest seen during the project. Houay Gawn Goy<sup>^</sup> and Houay Bah Hieo<sup>^</sup>, both near Ban Na Konken<sup>^</sup>, Xaignabouli district, merit distinction because many plants collected or seen there were not found elsewhere during the survey. The Evergreen forest along these streams represents the condition of the region prior to human settlement, subsequent exploitation and 'development'. Evergreen forest has a closed canopy, dense understory of several levels, and evergreen ground flora. *Tectaria decurrents* (Presl) Copel. (Dryopteridaceae), *Cibotium barometz* (L.) J. Sm. (Dicksoniaceae) and *Angiopteris evecta* (Forst.) Hoffm. (Marattiaceae), all evergreen pteridophytes, are typical indicators of pristine conditions. Noteworthy shrubs, treelets and small trees are *Silvianthus tonkinensis* (Gagnep.) Rids. (Carlemanniaceae); *Urophyllum glabrum* Wall., *Tarenna baviensis* (Drake) Pit. and *Psychotria mekongensis* Pit. (all Rubiaceae), *Cyrtandromea grandiflora* Cl. (Scrophulariaceae) and *Saraca declinata* (Jack) Miq. (Leguminosae, Caesalpinoideae).

*Elatostema aff. subpellata* Gagnep., *E. lineolatum* Wight (both Urticaceae), *Spatholirion ornatum* Ridl. (Commelinaceae), *Begonia lecomtei* Gagnep. (Begoniaceae) and *Ardisia murtonii* Flet. (Myrsinaceae) are some botanically exciting herbs found and collected. More collecting in these undisturbed places is needed to get a better idea of their conservation values.

Pha Liap, a limestone hill in Met district, Vientiane province, is an isolate of Evergreen forest. Vegetation on the north side of the hill was being cleared during our visit, but the base and cliffs are intact. *Ophiopogon marmoratus* Pierre ex Rodr. (Liliaceae) and *Sauropus aff. thyrsiflorus* Welz. (Euphorbiaceae), both evergreen ground herbs, and *Neothorelia laotica* Gagnep. (Capparaceae), an evergreen woody climber, were found only here.

### Degraded Evergreen Forest

Don Hon, an island in Paklay district, Xaignabouli province, was the first island encountered during this survey with some land permanently above water. The place has historical interest through the ruins of an

ancient military fort on the north-west side. The vegetation is basically Evergreen, but has been constantly degraded by logging so that secondary growth has become established. The bedrock is shale.

Canopy trees include several huge individuals of *Tetrameles nudiflora* R. Br. ex Benn. (Datiscaceae). These included the largest and most impressive tree seen during the survey (Plate 3.10). The original flora resembles that at Thadua Falls. Disturbance has created openings now with secondary growth. *Clerodendrum infortunatum* L. (Verbenaceae) is a very common treelet 1–2 m tall in disturbed places. *Harrisonia perforata* (Blanco) Merr. (Simaroubaceae) is a common, thorny deciduous scandent species. Some common secondary growth trees are: *Fernandoa adenophylla* (Wall. ex G. Don) Steen. and *Oroxylum indicum* (L.) Benth. ex Kurz (both Begoniaceae), *Macaranga denticulata* (Bl.) M.A. (Euphorbiaceae), *Holoptelea integrifolia* (Roxb.) Pl. (Ulmaceae) and *Boehmeria nivea* (L.) Gaud. var. *tenacissima* (Roxb.) Miq. (Urticaceae). Secondary growth is discussed in more detail later in this report. Bamboo was not seen on the island.

Downriver from Don Hon there are only a few degraded strips of Evergreen forest, all in sacred forests. Much of the terrestrial vegetation has been cleared for agricultural use, while various species of bamboo become increasingly more frequent in vegetation with more deciduous species.

### Bamboo and Deciduous, Seasonal Forest

Bamboo and deciduous forest is common downstream from Ban Muangliap (Paklay district, Xaignabouli province) and opposite that in Met district, Vientiane province. A hundred years ago, the vegetation was probably basically Evergreen forest but has been degraded by human abuse. Patches of understory with Evergreen forest facies are still present in some places, thus indicating that the original Evergreen canopy has been removed and replaced with Bamboo and deciduous, seasonal forest (Plate 3.11).

Trees in Bamboo and deciduous, seasonal forest are typically shorter than are those in Evergreen forest, the understory is more open, and the ground flora is mostly deciduous. Some common deciduous trees in Bamboo and deciduous, seasonal forest include *Miliusa velutina* (Dun.) Hk. f. & Th. (Annonaceae), *Bombax anceps* Pierre var. *anceps* (Bombacaceae), *Schleichera oleosa* (Lour.) Oken (Sapindaceae), *Pterocarpus macrocarpus* Kurz (Leguminosae, Papilionoideae), *Anogeissus acuminata* (Roxb. ex DC.) Guill. & Perr. (Combretaceae), *Hymenodictyon orixense* (Roxb.) Mabb., *Mitragyna hirsuta* Hav., and *Morinda tomentosa* Hey. ex Roth (all Rubiaceae); and *Wrightia arborea* (Denn.) Mabb. (Apocynaceae). *Bambusa bambos* (L.) Voss. ex Vilm., *Cephalostachyum pergracile* Munro and *Dendrocalamus nudus* Pilg. (all Gramineae, Bambusoideae; bamboos) are found in Bamboo and deciduous, seasonal forest. Severely degraded Bamboo and deciduous, seasonal forest is dominated by dense, often impenetrable, growth of *Bambusa bambos*, a wickedly spiny species. Fire caused by humans, in the hot dry season, plus logging and hacking have all resulted in various degrees of degradation in Bamboo and deciduous, seasonal forest. Phou Phaleng (a limestone hill) near Keng Khoutkhoun in Kenthao district, Vientiane province, has close to intact Bamboo and deciduous forest. It is a good example of this kind of forest.

### Secondary Growth

Secondary growth develops when primary vegetation is removed, especially where it is cleared (Plate 3.12). Herbaceous invaders, *i.e.* weeds, often the same as noted in the riverine vegetation, are abundant. *Conyza sumatrensis* (Retz.) Walk. and *Eupatorium odoratum* L. (both Compositae), *Euphorbia hirta* L. (Euphorbiaceae), and *Dactyloctenium aegyptium* (L.) P. Beauv. (Gramineae) are examples, and were only found in terrestrial locations. *Amorphophallus paeonifolius* (Denn.) Nicol. (Araceae) and *Musa* sp. (Musaceae) are common herbs in recently cleared land. *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. ex Hubb. & Vaugh., *Thysanolaena latifolia* (Roxb. ex Horn.) Honda, *Saccharum arundinaceum* Retz., and *S. spontaneum* L. (all Gramineae) are good examples of invaders in cleared, often burned, land – the latter two often growing in upper riverine areas.

Woody species are also diverse and abundant in overgrown and abandoned cultivated land. Treelets and shrubs are represented with *Capparis micracantha* DC. ssp. *micracantha* (Capparaceae), *Casearia flexuosa* Craib (Flacourtiaceae), *Salacia verrucosa* Wight (Celastraceae), *Melicope viticina* (Wall. ex Kurz) T. Hart. (Rutaceae), *Ardisia obtusa* Mez var. *obtusa* (Myrsinaceae), and *Croton kongensis* Gagnep. (Euphorbiaceae). *Anomianthus dulcis* (Dun.) Sincl. and *Uvaria rufa* Bl. (both Annonaceae), *Tinospora sinensis* (Lour.) Merr., *Calycoperis floribunda* (Roxb.) Lmk. (Combretaceae), and *Congea tomentosa* Roxb. var. *tomentosa* (Verbenaceae) are typical woody climbers, all of which are deciduous.

*Microcos tomentosa* Sm. (Tiliaceae), *Anthocephalus chinensis* (Lmk.) A. Rich. ex Walp. (Rubiaceae); *Mallotus barbatus* M. A., *M. paniculatus* (Lmk.) M.A. var. *paniculatus*, and *M. philippensis* (Lmk.) M.A. (all Euphorbiaceae); *Broussonetia papyrifera* (L.) Vent. and *Ficus hispida* L. f. (both Moraceae) are common secondary growth trees.

Don Sau (Wau)<sup>^</sup> and Don Sang (Sanakham district, Vientiane province), Don Men (Kenthao district, Xaignabouli province) and Don Konkong (Sangthong district, Vientiane Capital) are mostly cleared for farming and are excellent places to see terrestrial weeds and secondary growth (Plates 3.12–3.13).

### Cultivated Areas

All agricultural land was fallow during the survey. Many places were already cleared and burned. Others were being cut and prepared for June planting with *Oryza sativa* L. (rice) and *Zea mays* L. (corn), both Gramineae. subsistence and cash crops, respectively (Plates 3.14–3.16). Ninety percent of Don Men has been cleared for agricultural use which includes a fruit orchard. *Litchi chinensis* Sonn. ssp. *chinensis* (Sapindaceae; litchi); *Citrus maxima* (Burm.) Merr. (pomelo) and *C. x sinensis* (L.) Osb. (orange), both Rutaceae; *Manilkara achras* (Mill.) Fosb. (Sapotaceae; chicle/chico), *Mangifera indica* L. (Anacardiaceae; mango), *Carica papaya* L. (Caricaceae; papaya) and *Ceiba pentandra* (L.) Gaertn. (Bombacaceae; kapok), which are all introduced species, were successfully growing there. *Tectona grandis* L. f. (Verbenaceae; teak) plantations are common above the Strand zone. Secondary growth is found in these places where the trees are up to 12 m tall and with a dbh of 25 cm, which are about 20 years old. *Samanea saman* (Jacq.) Merr. (Leguminosae, Mimosoideae), *Tamarindus indica* L. (Leguminosae, Caesalpinioidae) and *Cocos nucifera* L. (Palmae; coconut), all introduced trees, are common in villages.

### 3.3.3 New Records

The survey found 23 plant taxa not previously recorded for Lao PDR. These comprise:

#### Dicots

- *Argemone mexicana* L., Papaveraceae; native to tropical America (also noted by Lamxay & Larnorsavanh 2012)
- *Begonia lecomtei* Gagnep., Begoniaceae
- *Mycetia squamulopilosa* Pierre ex Pit., Rubiaceae
- *Urophyllum glabrum* Wall., Rubiaceae
- *Ardisia murtonii* Flet., Myrsinaceae
- *Telosma pallida* (Roxb.) Craib, Asclepiadaceae
- *Cyrtandromoea grandiflora* Cl., Scrophulariaceae
- *Lindernia elata* (Bth.) Wett., Scrophulariaceae
- *Dicliptera roxburghiana* Nees, Acanthaceae
- *Eranthemum nervosum* R. Br. ex Roem. & Schult., Acanthaceae
- *Leonurus sibiricus* L., Labiateae
- *Euphorbia thymifolia* L., Euphorbiaceae

- *Mallotus brevipetiolatus* Gage, Euphorbiaceae
- *Mallotus pierrei* (Gagnep.) A.S., Euphorbiaceae
- *Ficus kurzii* King, Moraceae
- *Elatostema integrifolium* (D. Don) Wedd. var. *integrifolium*, Urticaceae

#### Monocots

- *Cyperus difformis* L.
- *Cyperus elatus* L.
- *Spatholirion ornatum* Ridl., Commelinaceae

#### Pteridophyte

- *Osmunda vachellii* Hk., Osmundaceae

#### Bryophytes

- *Neckeropsis boniana* (Besch.) Touw & Ochyra, Neckeriaceae
- *Splachnobryum aquaticum* C. Muell., Splachnobryaceae
- *Vesicularia montagnei* (Schimp.) Broth., Hypnaceae

### 3.3.4 Topotypes

Specimens from the same area as type specimens, i.e. the type locality, are topotypes. These are particularly valuable reference specimens. The survey collected 11 topotypes (Table 3.4).

**Table 3.4. Topotypes collected during this survey, with the type locality noted for each.**

1. *Neothorelia laotica* Gagnep., Capparaceae; Paklay
2. *Garcinia thorelii* Pierre. Guttiferae; Paklay
3. *Clausena harmandiana* (Pierre) Pierre ex Guill., Rutaceae; Louangphabang
4. *Phyllotrichum mekongense* Lec., Sapindaceae; Louangphabang–Paklay
5. *Psychotria mekongensis* Pit., Rutaceae; Louangphabang
6. *Croton kongensis* Gagnep., Euphorbiaceae; Paklay
7. *Drypetes salicifolia* Gagnep., Euphorbiaceae; Paklay
8. *Sauropus thorelii* Gagnep., Euphorbiaceae; Paklay
9. *Tupistra muricata* (Gagnep.) N. Tanaka, Liliaceae; Paklay
10. *Phoenix roebelenii* O'Brian, Palmae; Paklay
11. *Hemisorghum mekongense* (A. Camus) Hubb., Gramineae; Paklay

### 3.4 Local use

The local communities visited during the preliminary survey in the wet season were very knowledgeable about plant use. Surveys with local participation were undertaken in 10 villages during the wet season with more than 20 interviewed informants. About 34% of plants surveyed were not used by local people, 31% were used for medicinal purposes, 24% were eaten, and 3.29% have fibre and ornamental uses. Plants used for construction, trade, for poisonous properties and as exudates each represented less than 3% of the plants collected by local people. Local people's views of local name, distribution, habitat, conservation status, threat level, introduced species, and species of disturbed areas were recorded during these discussions.

In terms of economic value, it is commonly accepted that the limited transport, electricity, roads and communications are a major reason for the limited development from Ban Thadua to Paklay. Access to markets and social services is quite limited. Trade opportunities are limited by the small size of local markets and the limited access to bigger markets.

### **3.4.1 Threats**

The main threats identified to plants in this survey are:

- 1.) The development of a new road along the Mekong - from Ban Talan to Ban Houaysouy, Xaignabouli district, Xaignabouli province - will lead to clearance of this remaining riparian forest.
- 2.) The agricultural lands: hill and flat-land rice, maize plantations cover areas adjacent to the river. Forest clearance was extensive within most areas adjacent to the river, leading to significant erosion and habitat loss.
- 3.) The chemical pesticide and herbicide use to increase agricultural production can contaminate water and result in serious environmental degradation and biodiversity loss.

### **3.5 Discussion**

In total, 164 pteridophytes and angiosperms, plus five bryophytes, were collected. Included here are 23 new records for the Lao flora with the possibility of a few more; pending confirmations of their identities. Eleven topotypes are confirmed. A preliminary database of 335 species etc. has been prepared (Appendix 3.2), which can be amended by future botanical work.

From this initial botanical survey a general perspective of the vegetation of the Mekong River from the town of Louangphabang to Vientiane city can be made.

There are two basic kinds of vegetation in and around the survey area: riverine and terrestrial.

Riverine vegetation is submerged by the river during the rainy season and has three zones: Aquatic, Beaches and bedrock, and Strand. The riverine vegetation has not been significantly altered except in very short stretches. It seems to be similar throughout the survey area, especially with annual herbs, and most likely also with the seasonal rheophytes which are found only in some Rocky areas.

Terrestrial vegetation seen during this project includes seasonal Evergreen, Bamboo and deciduous, Secondary growth, and Cultivated land. Limestone predominates in the Louangphabang area where the river is narrow and passes rapidly through vertical bedrock. Shale is present after Ban Thadua. The riverine flora on these two bedrocks is similar, but the terrestrial vegetation differs and needs to be studied further. In the past 20 years, most of the original terrestrial vegetation directly adjacent to the channel has been destroyed (Plates 3.17–3.18). The vegetation is basically Evergreen and has deciduous facies in disturbed places. The Nam Pouy has both bedrocks and has evergreen terrestrial vegetation. Houay Ak and vicinity is being logged and should be protected from further destruction.

Don Hon, the upstream-most permanent island in the survey area, has degraded Evergreen forest which is rapidly disappearing through hacking and logging by local people. Much secondary growth has

become established because of this. Down river from Don Hon the terrestrial vegetation has been severely degraded to destroyed. Patches of Evergreen forest, isolated, encroached, and mostly 2-3 ha in area, persist in several sacred forests. These places are of extreme botanical and conservation importance since they are final refuge for many plants which have been extirpated from other locations along the river.

From the town of Paklay to Vientiane city, the terrestrial vegetation is deciduous with bamboo being very common. This must be because of lower rainfall than in the area upriver, plus more severe and recurrent abuse of the vegetation with slash-and-burn agriculture. Many places have been cleared for agriculture. Aridity and soil erosion are consequences of this, and will become more severe and extensive in the future.

Islands and stream sites have been identified in the management section that are still in excellent condition and should be priority conservation locations (recommendations are outlined in depth in Sect. 10.1.1). In addition to a Mekong-focused project, it would be in the interest of the environmental health of the region for existing Evergreen forest and Bamboo and deciduous, seasonal forest to be preserved. This policy should include a shift away from slash-and-burn agriculture towards systems which minimise soil erosion, aridity and soil infertility. A policy that is acceptable by both national and local officials will need to be agreed upon for any such preservation to occur.

# 04

## Birds and Large Mammals



J. W. DUCKWORTH & R. J. TIMMINS



## 4. Birds and Large Mammals

### 4.1 Introduction

**A**s in most of the world, birds and large mammals are the two faunal groups in Lao PDR with the best-known national conservation status. Thus, compared with other groups, their survey often allows a clearer context of a survey area's importance for the group in question. (But it does not follow that the importance for birds or large mammals indicates that of other groups.) The level of knowledge is well indicated by the relative rarity of the discovery of bird or large mammal species new to science in the last 20 years (even though this has been higher in Lao PDR and surrounding countries than in most other parts of the world; CEPF 2012). By contrast, discoveries of new species are routine among reptiles, amphibians, fish and invertebrates, and not unusual with bats and small non-volant mammals.

In Lao PDR and the rest of the Mekong catchment, the birds of large rivers are among the region's most threatened communities. Many of the several dozen species using river channels, including a dozen or so that are closely associated with them, are at real short-term risk of national and regional extinction. Proportionate to the number of species, and probably now in absolute numbers, they are at higher risk than are the birds of any sort of Lao forest (e.g. Thewlis *et al.* 1998, Goes *et al.* 2010, CEPF 2012). If floodplain wetlands are to be considered part of the river system, then the concentration of mainland Southeast Asia's regionally threatened bird species that are associated with rivers becomes even higher. Yet river birds are also among the most under-protected bird communities in the region: large rivers are important for daily use in travel, fisheries, water abstraction and various other uses, forestalling their declaration as conventional strict protected areas (Thewlis *et al.* 1998). Southeast Asia has so far shown little of the experimentation that will be required to produce working models where high levels of human use of large rivers continue without severe detriment to their birds. Only one stretch of the Lao Mekong is within a National Protected Area (NPA) - that in Phou Xiang Thong NPA - and at present, it apparently receives no active management. The situation is broadly similar for the wide tributaries such as the Nam Ou, Nam Ngum, Nam Kading, Xe Bangfai and Xe Kong, in terms of effective protected area management. Some river channel birds are in rapid decline (e.g. the loss of River Lapwing from the Nam Ou between the surveys of the mid 1990s and mid 2000s; Fuchs *et al.* 2007). Thus, although some of tropical Asia's fastest declining bird species have been recorded along the Mekong between the towns of Louangphabang and Vientiane (see below), nothing could defensibly be inferred about the current status of riverine birds there. Their poor regional conservation status gives survey of river birds a high priority.

The situation with river-associated large mammals in Lao PDR and the other Mekong countries is somewhat similar, although there are many fewer species. Most or all are extirpated from large stretches of navigable rivers, or very nearly so. Fortunately, there is no evidence that any large mammal species in Lao PDR other than Irrawaddy Dolphin *Orcaella brevirostris* is tied to rivers, still less large navigable ones; all also use standing wetlands, and most are known to use streams too small to be navigable at least in other countries.

The present survey therefore concentrated on birds, recording large mammals only as they were encountered. In sum, the chances of finding any large mammal in the stretch of river that was of high national, let alone regional, importance were low, but this was a distinct possibility with birds.

The survey area is profiled in this report's general introduction. In general, the Mekong's birds were only patchily collected in the main era of biological exploration (1890–1950), with one distinctive endemic species remaining unnamed to science until 2001 (Mekong Wagtail *Motacilla samveasnae* Duckworth *et al.*, 2001), and some typical high-density channel inhabitants remaining undiscovered there until the 1990s, e.g. Jerdon's Bushchat (Duckworth 1997). Even if in some cases specimens had been collected historically, their context was not remarked upon at the time (e.g. resident race of White Wagtail; Bangs & Van Tyne 1931). For any given stretch of the Mekong, the collection and observation record before 1990 is highly incomplete.

#### 4.1.1 Conventions

Bird taxonomy and nomenclature follows Inskip *et al.* (1996), except for explicit departures. Species records which are provisional (i.e. should be treated as unconfirmed) are denoted [ ].

'Large mammals' are considered those families where all or most species are identifiable on field views, following Dorst & Danelot (1970).

Scientific names of birds are given in the text only for those not in Table 4.3 or in Appendix A4.1.

The 'river channel' includes all the areas typically underwater at the season of highest river water levels, and rugged projections of rock. It thus excludes land (other than bare rock) between the banks that is high enough to project from the water except during flash-floods. Extensive observations at various places in the Mekong show that these areas support bird species typical of the adjacent plains, but not species dependent upon the channel per se. This is to be expected entirely, given that the habitats such permanent islands support are those of the adjacent plain.

The 'survey area' is the Mekong channel from Louangphabang to Vientiane. Animals outside the river channel were also recorded when practicable, and are discussed here, given the general paucity of wildlife information from this part of Lao PDR.

### 4.2 History of bird and large mammal survey along the Lao Mekong, and the regional context

#### 4.2.1 Previous observations in the survey area

Of all stretches of the lower Mekong (i.e. that downstream of China) thought to be, or at least recently to have been, significant for bird conservation, the Vientiane city–Louangphabang town section (= 'the survey area') has received the least survey in the last 25 years. On the basis of piecemeal information, much of the survey area has been recognised as significant for global and regional bird conservation: on the Lao side, Important Bird Area (IBA) LA006 runs along the channel from somewhere around the town of Paklay to Ban Thanaleng, Vientiane (Ounekham & Inthapatha 2003), while on the Thai side IBA TH022 ('Mekong channel near Pakchom') covers 160 km (Pimathi *et al.* 2004) apparently equivalent to that part of LA006 that lies on the international Thai–Lao border.

Map 7 in Ounekham & Inthapatha (2003) indicates an upstream limit of LA006 at "Ban Mai-Pakthoun" some 14 km downstream of the town of Paklay; if this is the same as mapped "Ban Pakthoun" ( $18^{\circ}06'30''N$ ,  $101^{\circ}25'E$ ), then the IBA would omit (by starting just downstream of) some of the best habitat: Don Vao, which lies upstream of Ban Pakthoun (extending to Ban Khokhaodo). However, the text uses records upstream to the town of Paklay to support the IBA designation, and indeed states that the upstream-most 80 km of the IBA had not, at that time, been surveyed at all [implicitly, in recent decades]; these 80 km, therefore, would be upstream from the town of Paklay. Depending on where its upstream limit is taken, the IBA is about

300 km long. The Lao IBA was designated on the basis of two congregatory species, River Lapwing and Small Pratincole, the Thai IBA on the congregatory Small Pratincole. Both also made reference to the presence of the (purportedly) biome-restricted Jerdon's Bushchat (of the 'Indo-Genetic Plains') but this can only be a subsidiary feature as the species is widespread in the degraded tracts of Lao PDR's northern highlands, although these have (correctly) not thereby become IBAs.

Duckworth *et al.* (2002) found in the Mekong three more-or-less distinct types of channel morphology relevant to bird distribution. Whatever their bird communities before the major human alteration of the last two centuries, only one of these three now retains high importance to much-declined species: stretches with extensive mosaics of exposed bedrock, sand, dry-season water-channels and pools, and bushland. The others are (i) stretches with little channel bed exposed in the dry season, and (ii) stretches with only extensive sand and mud, with or (more usually) without bushland. Nowadays these lack importance to much-declined species, presumably because they are so accessible to people and dogs that it is difficult for ground-nesting birds to breed successfully, other than the common species (Small Pratincole and smaller). Nothing seen on the present survey contradicted these conclusions, and these deductions are thus used extensively in this report for prediction of relative bird importance of various stretches of the Mekong.

The large mammals of the Lao Mekong channel have never been collected or otherwise surveyed in any depth; but as there are no grounds to think the habitat is or was important for more than a few species of large mammals (see below), they are not considered in the following discussion.

Historically, several collecting expeditions visited at least part of the survey area. The Prince Henri d'Orléans (1894), arriving from the north, spent 3 – (at least) 11 April in Louangphabang and at least 21–22 April 1892 in Paklay, and presumably used the Mekong to move from one to the other. He did not bring back many bird specimens, and none of channel species, but he procured one of the few North Lao records of Golden-fronted Leafbird, in Louangphabang on 3 April, and a Thick-billed Green Pigeon *Treron curvirostra* and a Red-breasted Parakeet around Paklay on 22 April.

The French Count de Barthélémy visited the survey area in 1897. His bird records are in Oustalet (1898), but no explicit itinerary is given. Based on specimen dates, he arrived in Louangphabang (from Xiangkhouang) in late March 1897 and apparently spent April on and near the Mekong, collecting in Vientiane in April and, mostly (based on numbers of specimens) May; it seems that he then went on to Savannakhet via the Mekong, and then left Lao overland for Annam. The specimens and sight records in Oustalet (1898) are by far the best profile, albeit laconic, of the survey area's birds in the past. Assuming that all April records come from the survey area or adjacent dry-land habitats, then as well as many common species, most notably in today's context he: took a White-shouldered Ibis *Pseudibis davisoni* (Black Ibis *P. papillosa davisoni* in Inskip *et al.* 1996) in the upper Lao Mekong in April; observed Great Thick-knee in flocks along the upper Mekong banks and collected a specimen from the Mekong (but in May, so perhaps downstream of the survey area); found River Tern *Sterna aurantia* the length of the Mekong from Louangphabang to Savannakhet; collected an Indian Skimmer *Rynchops albicollis* along the Mekong in April (and thus around or upstream of Vientiane) and noted how the species was rarer there than along the lower Mekong, for example in Champasak; noted flocks of Great Cormorants *Phalacrocorax carbo* roosting on river rocks and collected one along the Mekong in April; apparently encountered Little Cormorant *P. niger* occasionally (but this is not explicit); collected a Darter *Anhinga melanogaster* in April along the Mekong; killed a fish eagle *Ichthyophaga* (given as Grey-headed *I. ichthyaetus*, but see comments on species identifications in Thewlis *et al.* [1998]) along the Mekong near Vientiane; noted, by implication, that Black Kite (race *M. m. lineatus*) was common; and considered Green Imperial Pigeon *Ducula aenea* very common from Louangphabang downstream. Other records of lesser significance are that he: found Little Egret common; found River Lapwing everywhere, explicitly including North Lao PDR (although as with Great Thick-knee the only specimen may have come from downstream

of the survey area); collected Small Pratincole along the Mekong, considering it well distributed along the rapid stretches of the survey area; collected a Cotton Pygmy-goose on the Mekong in late April; collected Red-breasted Parakeet; killed an Osprey *Pandion haliaetus* in April and considered it common; collected a Stork-billed Kingfisher in Vientiane in May, having observed it between the towns of Louangphabang and Vientiane (although whether on the Mekong is unclear); observed Crested Kingfisher *Megaceryle lugubris* (although whether or not on the Mekong is not stated); recorded Golden-fronted Leafbird in Louangphabang; found Crested Bunting *Melophus lathami* around Louangphabang and a little more rarely to the south; and killed several Thick-billed Green Pigeons around Vientiane.

The deduction from month of the location of de Barthélemy's Mekong skimmer specimen, placing the species's historical occurrence firmly within North Lao PDR, has been overlooked by all previous compilations of Lao bird records (e.g. Thewlis *et al.* 1998, Duckworth *et al.* 1999, BirdLife International 2001, Robson 2008). Both d'Orléans and de Barthélemy's bird specimens are apparently at the Muséum National d'Histoire Naturelle, Paris, France (MNHN). If either d'Orléans or de Barthélemy collected mammals, these may not have been published explicitly; they would very probably also be at MNHN.

In early 1920, a zoological collecting expedition organised by the Siam Society collected extensively along the Lao Mekong and its hinterland from some way north of the town of Paklay to level with Mukdahan, Thailand. The team therefore covered much of the present survey stretch: within 12–29 Jan (dates derived from specimen dates), they arrived at the town of Paklay (overland from the west) and went upstream as far as 'Pak Mat' [= Ban Pakmet], "the mouth of a small tributary on the east side, some ten miles south of lat. 19°" (Robinson & Kloss 1931: 320), then went downstream passing Chiang Khan, in this period collecting at 'Hoi Kun Yuang' on 12 Jan, 'Ban Muang' [evidently the 'Ban Mouang' mapped at 18°21'N, 101°33'E, nor that recorded by the 2011 survey's fish team at 18°53'N, 101°47'E] on 12–13 Jan, 'Muang Liep' [Ban Muangliap] on 14–16 Jan, 'Ban Pak Toong'/'Ban Pak Tung' [plausibly = Ban Phatoung] and 'Nong Kai' [evidently = Ban Nongkhai] on 18 Jan, 'Pak Mat' [Ban Pakmet] on 19–22 Jan, Paklay on 27 Jan, 'Ban Pak Men' on 28 Jan and 'Hoi King' on 29 Jan. No specimens were reported on for 30–31 Jan, but during 1–3 Feb the team went downstream from Chiang Khan to Vientiane, collecting at 'Khet Don Heing'/'Khet Don Hieng' on 1 Feb, 'Sa Ngao' on 2 Feb and 'Ban Muang' on 3 Feb. (Names given here as spelt in the original are within inverted commas. It has not been confirmed whether those that sound similar to modern place names, e.g. Pak Si, are in fact the same places; note that they collected at two different villages called Ban Muang by this expedition, within the survey area.) Sir W. J. F. Williamson and E. G. Herbert took responsibility for the birds (Robinson & Kloss 1931). Two of the era's most capable and diligent mammalogists resident in South-east Asia, H. C. Robinson and C. B. Kloss, supplied the expedition with one of their mammal collectors, J. Bangassar (although his handwriting is too poor for this spelling to be certain; Fooden 1987). The novelties were described piecemeal (e.g. Baker 1920, Thomas 1921, Robinson & Kloss 1922) but the sheer volume of material appears to have overwhelmed any comprehensive publication of the trip's birds or mammals. The birds are covered incompletely in Robinson & Kloss (1931), and most or all of the remainder lie, catalogued but largely unpublished explicitly, in the Natural History Museum, Tring, UK (NHM). Various of the mammal specimens are detailed in sources such as Weitzel *et al.* (1988); many, perhaps most, of the mammal specimens are housed at the Raffles Museum for Biodiversity Research, Singapore, although some went to NHM. A field journal giving copious detail about route and events (Day 1920) is held at the Department of Zoology, National University of Singapore. Perusal of the journal and of specimen tags might establish further significant records from the survey area. Even the incomplete listings in Robinson & Kloss (1931) allow some sense of the survey area's then bird life. As well as many common species, they collected several species of outstanding significance in today's context: single Black-bellied Terns *Sterna acuticauda* at Ban Muangliap on 14 Jan, Ban Pak Toong on 18 Jan and Hoi King on 29 Jan; single River Terns at Ban Pakmet on 20 Jan, Paklay on 27 Jan and Hoi King on 29 Jan; three Great Thick-knees at Ban Muang on 12 Jan and one at Ban Muangliap on 15 Jan; single White-shouldered Ibises at Hoi Kun Yuang on 12 Jan, Ban Muangliap on

13 Jan and Ban Pakmet on 22 Jan; a Darter at Sa Ngao on 2 Feb; and Savannah Nightjars at Nong Kai on 18 Jan (one of each sex) and Ban Pak Men on 28 Jan (one). Species collected that are still widespread in the survey area included: River Lapwings at Hoi Kun Yuang and Ban Muang on 12 Jan (singles), Nong Kai (three) and Ban Pak Tung (one) on 18 Jan; a Grey-headed Lapwing at Ban Muangliap on 16 Jan; a Small Pratincole at Nong Kai on 18 Jan; a Spotted Dove on 18 Jan; and single Large-billed Crows at Khet Don Hieng on 1 Feb and Ban Muang on 3 Feb. Other riches might well be discovered by systematic examination of the collection: many of today's much declined species were then considered too common to be noteworthy. The next relevant expedition was that of the anthropologist F. R. Wulsin, in 1924. Delacour & Jabouille (1927) pointed out that his collection of 114 bird forms from Lao PDR and Tonkin (northern Vietnam), held in the United States National Museum of Natural History, Smithsonian Institution, Washington D.C., USA (NMNH) had not been written up, and although some bird specimens were mentioned by Riley (1938), nearly a century later there still remains no account of this collection! The mammals have, however, been listed comprehensively, by Osgood (1932). The itinerary and individual specimen localities are not well documented (Weitzel & Vu Ngoc Thanh 1992).

A few years later, the Kelley–Roosevelts' Expedition, which had collected extensively in Phongsali and the Nam Ou, travelled down the Mekong from Pak-Ou through the entire present survey stretch during 18–25 June 1929 (when the river was still low; Coolidge & Roosevelt 1933), and on to Savannakhet. The journey to Vientiane went as fast as possible because R. W. Hendee, leaving the main party early, had just died in Vientiane. Thus, they collected few specimens while on this leg of their expedition, and only frustratingly few field observations were published (Bangs & Van Tyne 1931, except where stated). The main party noted three now-rare large waterbirds - Darter, Painted Stork *Mycteria leucocephala* and White-shouldered Ibis - first on 20 June, about halfway from the town of Louangphabang to the town of Paklay, thereafter seeing single Darters at intervals which were too wary for collection, many Painted Storks (until Vientiane on 25 Jun), and frequent White-shouldered Ibises, usually in small flocks. Specimens of these three species comprised: a Darter near the town of Paklay about 31 May (by Hendee); single Painted Storks 30 miles upstream of the town of Paklay (21 Jun) and at Ban Donmen (23 Jun); and single White-shouldered Ibises about 40 and about 20 miles upstream of the town of Paklay (20 and 21 Jun). A River Tern was collected at Pak Si on 18 Jun, but terns were not seen in numbers until 22 Jun (around the town of Paklay); frustratingly, it is not made explicit whether they remained common all the way to Vientiane. This was the only species of tern identified on the Mekong (all the way to Savannakhet). This contrasts with the mid-dry-season records of Black-bellied Tern in Robinson & Kloss (1931; above), suggesting that by late June these birds had already dispersed elsewhere (as Small Pratincoles are now known to do). At Ban Donmen on 22 Jun, a Great Eared Nightjar and two Grey Nightjars *Caprimulgus indicus* were collected. A Wire-tailed Swallow was collected on 19 Jun downstream of Pak Si, and singles of each sex of White Wagtail *M. a. alboides* were collected half way between the town of Louangphabang and the town of Paklay on 20 Jun. Three common small land-birds were also collected: Common Iora, Common Tailorbird and White-bellied Yuhina. Surprisingly, the breeding-season presence of Grey Nightjar and White Wagtail was overlooked in subsequent secondary sources on Lao bird status, leading to 1990s finds of their breeding-season presence in Lao being placed in a misleading context (e.g. Duckworth *et al.* 1998a, 1999). The narrative account of Coolidge & Roosevelt (1933) mentions, for the survey area, only one bird not in Bangs & Van Tyne (1931): pelicans *Pelecanus* (presumably Spot-billed Pelican *P. philippensis*) are said to have been collected. Perhaps these were lost; confusion with another part of the expedition seems unlikely as no pelicans are listed for anywhere in Bangs & Van Tyne (1931). Coolidge & Roosevelt (1933: 203) also mention seeing "a few small deer" (presumably muntjacs *Muntiacus*).

Delacour and colleagues mounted various collecting expeditions to the then French Indochina, summarised in Hennache & Dickinson (2000). They paid strangely little attention to the Mekong; their 7th expedition, over winter 1938–1939, explored the river from the town of Louangphabang upstream to Ban Namkeung-kao, some way upstream of Ban Houayxai (Delacour & Greenway 1940a), but they never entered the present

survey stretch. They recorded a number of species in the channel not noted by the earlier collecting expeditions into the survey area, and since most of these are also known from south of the survey area, they have been assumed in the discussion below to have been occurring within the survey area in the first half of the 20th century.

Very little credible bird or large mammal information was collected from this stretch of the Mekong in the next few decades. In the 1960s, a Jean Deuve published, sometimes with his brother M. Deuve, a series of papers in a local journal, the *Bulletin de la Société Royale d'Histoire Naturelle du Laos* (apparently edited by himself and friends), on the mammals of Lao PDR. This culminated in the book *Les mammifères du Laos* (Deuve 1972). These sources gave many purported locality records. However, even cursory inspection of them reveals masses of peculiar statements, including incompatibilities between papers and book, and many obvious errors. These documents require interpretation with great care, and a strong argument can be made for ignoring them entirely (e.g. Timmins & Duckworth 1999). However, a few records are given with primary detail and seem acceptable (e.g. Timmins *et al.* 2013). While these include at least one from close to the Mekong in the present survey stretch (*Semnopithecus phayrei*), there is no information relevant to channel mammals.

The modern era of conservation-oriented surveys in Lao began in 1988 with the Lao-Swedish Forestry Programme's (LSFP) Forest Resources Conservation Project (FRCP). One boat-based survey of birds in the project stretch took place, for the c.50 km from Ban Mouang (18°21'30"N, 101°33'E) to Ban Phatoung (18°43'N, 101°48'E) and back on 29 March 1991 (Table 4.1) (Salter 1991). The Mekong in the upstream part of Muang Sangthong was covered on several days at different seasons from 1996 to 2000: 14 Feb, 13 Mar, 22 Jun and 16 Jul 1996, 31 May 1997, 31 Dec 1998 and 26 Sep 1999 (Duckworth 1996, 1997, Duckworth *et al.* 1999, 2002) and, so far unpublished, on 15 Feb 2004 and 16 Mar 2008 (JWD); observations from these visits are included in the species accounts below, but time was insufficient to add them comprehensively to Appendix A4.1.

Table 4.1. Birds counted between Ban Mouang and Ban Phatoung, 29 March 1991.

Species	Count
Lesser Whistling-duck	5
Dollarbird	1
Common Kingfisher	1
House Swift	300
Common Sandpiper	4
Little Ringed Plover	3
River Lapwing	7
Grey-headed Lapwing	2
Small Pratincole	6
River Tern	2
Chinese Pond Heron	12
Little Heron	1
Large-billed Crow	4
Barn Swallow	1
White Wagtail	10

Scientific names in Appendix A4.1.

After Salter (1991).

There are few recent credible bird or large mammal surveys along the Mekong upstream from Sangthong to Louangphabang. A 7–8 January 2000 trip on a commercial barge from the town of Paklay to Vientiane city found a few Spot-billed Ducks, two Great Thick-knee duos, 42 River Lapwings, 17 Grey-headed Lapwings, dozens of Small Pratincoles, a large gull *Larus* aff. *L. argentatus*, a River Tern, an egret, a few Grey Herons, a duo of Large-billed Crows, dozens of Jerdon's Bushchats, 34 Plain Martins, 40 Wire-tailed Swallows, and many common or non-channel dependent species (Duckworth *et al.* 2002). The pace at which it was undertaken (two days for the entire stretch) means that all counts except probably the tern and gull are likely to be major underestimates of the birds actually present, including Great Thick-knee. A day-trip on a speedboat from Vientiane to near Ban Donmen (at 17°56'35"N, 101°24'24"E) and back on 2 October 2004, at almost the highest water level the Mekong reaches, using a boatman happy to check all above-water channel habitat, was specifically conducted to look for rare river-channel species; the observations, previously unpublished, are included below (JWD and others).

Other incidental observations by JWD in the survey area included here comprise: from the newly made-up road along the Mekong from Sangthong to the town of Sanakham on 15 Feb 2004 and 10 Apr 2010; between Vientiane and Ban Ang (18°01'N, 102°24'E) on 26 Sep 2004; between the town of Paklay and Ban Houaylay-Noy on 23–24 Mar 2010 (on foot), in the town of Paklay on 30 Mar 2010 and Ban Namxong (18°16'N, 101°24'E) on 31 Mar 2010. Some observations in the Mekong channel from the Thai side were included in Duckworth *et al.* (2002), but time was insufficient to trace the others that doubtless exist.

#### 4.2.2 Previous observations from elsewhere in the Lao and Cambodian Mekong

The stretch of the Mekong from the town of Louangphabang upstream to Ban Xiangkok in Louangnamtha province has the greatest degree of similarity in habitat and human use to the survey area. Lao-based Mekong bird and large mammal surveys to date have covered this stretch a little better than the survey area (Duckworth *et al.* 2002), although there are also many observations from the Thai side, particularly around Chiang Saen. These are dispersed in many sources, such as the 'Recent reports' in the *Bird Conservation Society of Thailand Bulletin*, and time was insufficient to collate them here. Historical records from the Thai side are included in Deignan (1945). These greatly expand, reasonably inferring as to what was living in the Upper Lao Mekong at that time. Some reports from this area by an NGO project in the 2000s are full of mistaken identifications and the bird and mammal 'records' therein must not be used.

Downstream of the survey area, the Mekong from the upstream urban limit of Vientiane downstream to Ban Xiangkhouan (downstream of Ban Thadua), too has been the best covered part of the Lao Mekong, mainly through recreational observations when surveyors spent time in Vientiane (e.g. Thewlis *et al.* 1996, Duckworth *et al.* 1998a, 2002, Evans & Timmins 1998, Duckworth & Tizard 2003; many unpublished observations of JWD and D. Van Gansberghe during 2003–2010). It is structurally quite simple, with no exposed bedrock or boulders, and limited bushland, although there are extensive sandbars.

Further downstream, the Mekong downstream of Ban Xiangkhouan to Phou Xiang Thong NPA has received very little survey, notably (1) a boat journey by Salter (1990) from Vientiane to Savannakhet on 1–2 June 1990, which noted many lapwings and whistling-ducks, and seven unidentified terns (and many swallows and swifts); (ii) extensive observations along the Savannakhet province Mekong during spring 1997 (Evans 2001); (iii) land-based observations from Thailand at several points in spring 2000 (Duckworth *et al.* 2002); (iv) boat-based survey with many stops between Pakxan downstream to about the Bolikhamsai–Khammouan border over 11–13 February 2005 (Timmins & Robichaud 2005); and (v) the unpublished observations of JWD and C. Wood around Pakxan in 2001–2005. Despite the patchiness of coverage and low effort in much of this stretch, it is unlikely that areas significant to globally or regionally threatened birds lie undetected, because human habitation densities and use along most of this stretch of river are high, and the channel morphology is in general relatively simple in those areas not well covered.

Almost all the Mekong from Phou Xiang Thong NPA downstream to the Lao–Cambodia border was surveyed at least once in the 1990s–2000s, mostly in the earlier decade (Duckworth *et al.* 1994, 1999, Thewlis *et al.* 1996, 1998, Cunningham 1998, 2001, Evans *et al.* 2000, Duckworth 2008a). Towards the international border lies a long stretch of river with many habitat similarities to the survey area; having rocky stretches, braided channels, and a complex mosaic of exposed dry-season channel habitats. Extensive survey work has been carried out in the Cambodian Mekong, along two major sections of the river in the north of the country that share similarities in river morphology with the survey area, documented most completely in Timmins (2006, 2008a, 2008b).

Compared with those in the countries' other habitats, large-river bird communities in Cambodia and Lao PDR are now fairly well understood, reflecting the surveys cited above and also observations on other river systems (e.g. Le *et al.* 1997, Timmins & Men 1998, Duckworth *et al.* 1998a, 1998b, Evans & Timmins 1998, Thewlis *et al.* 1998, Evans 2001, Buckton & Safford 2004, Claassen 2004, Claassen & Ou 2006, Fuchs *et al.* 2007, Dersu 2008, Timmins 2006, 2008a, 2008b, BirdLife International 2012); this body of literature greatly aids assessing regional status of riverine birds and in setting observations from the present survey into context.

## 4.3 Methods

### 4.3.1 Definition of survey area

The maximum area for consideration was the river corridor of the Mekong between the towns of Louangphabang and Vientiane. The special features of this corridor are those that are very poorly represented in the Lao NPA system (and by protected areas at provincial and district levels): the channel habitats permanently or predictably seasonally underwater, and rugged rocky terrain projecting from them. Areas of the river corridor outside the channel were excluded from the survey area because the chances of finding anything of high conservation management significance were low. Had there been reason to believe floodplain wetlands of importance to bird or large mammal conservation existed; these would have been surveyed, because the species of these wetlands depend upon flow regimes in the channel, and these habitats are highly threatened across the country. However, in the survey area the Mekong runs mostly through rugged terrain, and areas with flanking plains are already heavily settled. All standing wetlands are believed to be small, based on RJT's examination of satellite images. These latter are confidently predicted to be almost insignificant for birds and large mammals, compared with the many on the adjacent Nam Ngum plain (see Duckworth in press). The habitats flanking the channel are dryland forest and various degraded derivatives, in many areas largely converted for agriculture. The forests are already well represented in the NPA system and the river corridor focus brings nothing additional to the national bird and large mammal conservation prospects of these habitats. Indeed, given their highly degraded and fragmented condition along the Mekong, such habitats there would prove extremely challenging, and thus inefficient, places to undertake conservation of hunting-sensitive wildlife. Although for a few channel species, tall forest, or at least occasional tall trees, close to the channel edge might be important (White-winged Duck, Stork-billed Kingfisher, fish owls and fish eagles), given their regional status, it was confidently assumed that all but the fish owls and perhaps the kingfisher would be extirpated from this part of the Mekong. Thus, the survey area is defined as the Mekong channel between the town of Louangphabang and Vientiane city.

### 4.3.2 Itinerary

The 2011 wet-season survey was rapid, it involved travelling upstream through the entire length of the survey area in six days. The dry-season survey lasted three weeks and omitted only two short sections, from Ban Houaylay-Noy ( $18^{\circ}14'N$ ,  $101^{\circ}25'E$ ) to the town of Paklay (c.3.5 km), which had been covered on foot on

31 Mar 2010 (JWD), and from the island off Ban Mai to Vientiane (*c.*14 km); time ran out on the last day, and the island has been visited several times from Vientiane anyway. Reflecting these other recent observations, these omissions will have had no serious effect on the conclusions drawn. By contrast, the inability to land on the Thai side in areas where the Mekong forms the international border surely did. Along much of the international border, the Thai side of the channel holds superior, often far superior, bird habitat.

The dry-season survey was undertaken as a single journey from the town of Louangphabang to Ban Mai. The downstream direction was selected because going upstream would have required the engine to work harder and thus make more noise (as was found in stretches with multiple channels, of which some were ascended and some descended). Using the surveyor's previous knowledge (between the towns of Paklay and Vientiane, January 2000), insight from the wet-season survey and topographic maps, a rough pace-setting schedule was set with two days to spare, to prevent the team from arriving in Vientiane far too early or far too late. The pace was set to be proportionate to channel area, rather than channel length; thus linear progress was slow in areas with a wide channel and fast in areas with a narrow one.

The itineraries of the wet and dry season surveys are shown in Table 4.2.

**Table 4.2. Survey itinerary.**

**(a) Wet-season, September–October 2011.**

Dates	Survey period / survey stretch	Survey type	Stretch #*
<b>Wet-season, September–October</b>			
<i>Lao–Thai stretch</i>			
27 Sep	Vientiane to Ban Vang	Fast-boat	12–15
28 Sep	Ban Vang to Thai–Xaignabouli border	Fast-boat	15–13
<i>Thai border to town of Paklay</i>			12
28 & 29 Sep			11
Thai–Xaignabouli border to Paklay			Fast-boat, slow-boat
<i>Town of Paklay to Ban Thadua</i>			11
29 & 30 Sep	Paklay to Don Hon	Fast-boat, slow-boat	-
30 Sep	Don Hon to ‘Camp 2’	Fast-boat	-
30 Sep – 2 Oct	‘Camp 2’ to Xaignabouli Dam	Fast-boat, slow-boat	-
2 Oct	Xaignabouli Dam to Ban Thadua	Fast-boat	-
<i>Ban Thadua to town of Louangphabang</i>			-
2 Oct	Ban Thadua to Louangphabang	Fast-boat	-

\*as assigned in Duckworth *et al.* (2002).

**(d) Dry-season, January–February 2012.**

Date	Surveyed stretch	Other notes	Stretch #*
25 Jan	Louangphabang – near Ban Muangkhay, at 19°47'46"N, 101°58'54"E	Start 14h15	-
26 Jan	Ban Muangkhay – downstream of Ban Hatkeo, at 19°36'55"N, 101°48'14"E		-
27 Jan	19°36'55"N, 101°48'14"E – near Ban Pakmon, at 19°24'48"N, 101°52'52"E		-

Date	Surveyed stretch	Other notes	Stretch #*
28 Jan	19°24'48"N, 101°52'52"E – near Ban Pakhoun, at 19°10'24"N, 101°49'13"E		-
29 Jan	19°10'24"N, 101°49'13"E – Pak Pouy, at 18°57'00"N, 101°48'04"E		-
30 Jan	Pak Pouy – near Ban Pakmet, at 18°49'11"N, 101°50'45"E		-
31 Jan	18°49'11"N, 101°50'45"E – 4 km downstream of Ban Phatoung, at 18°40'51"N, 101°48'00"E		-
1 Feb	18°40'51"N, 101°48'00"E – Don Hon, at 18°32'18"N, 101°44'26"E		-
2 Feb	Don Hon – Don Kueung, at 18°26'45"N, 101°37'31"E		-
3 Feb	Don Kueung – Pakphoun, at 18°23'N, 101°33'E	Overnight at 18°24'20"N, 101°35'32"E	-
4 Feb	Pakphoun – a little upstream of Ban Khe, at 18°18'48"N, 101°29'39"E		-
5 Feb	18°18'48"N, 101°29'39"E – Don Vao at c.o. 18°09'N, 101°24'E	Ban Houaylay-Noy (18°14'N, 101°25'E) – Paklay not covered**	part in 11
6 Feb	Don Vao, c.o. 18°09'N, 101°24'E – 18°07'N, 101°24'E		11
7 Feb	18°07'N, 101°24'E – unnamed island at 18°00'07"N, 101°25'40"E, 2 km downstream of Don Phoung		11
8 Feb	18°00'07"N, 101°25'40"E – Ban Phalat, at 17°51'03"N, 101°35'30"E	Poor overnight position for survey	11, 12
9 Feb	Ban Phalat – Keng Khoutkhou, 17°55'30"N, 101°43'E	Overnight: Ban Pakmi, 1½ km upstream of Keng Khoutkhou, dire overnight position for survey	12
10 Feb	Keng Khoutkhou – ½ km upstream of Ban Vang, at 18°03'N, 101°50'E		12
11 Feb	18°03'N, 101°50'E – near Ban Kokmuat, at 18°05'51"N, 101°57'12"E		13
12 Feb	Near Ban Kokmuat – near Ban Houayla, 18°13'N, 102°05'E		13, 14
13 Feb	Near Ban Houayla – near Ban Kokhe, at 18°10'58"N, 101°10'38"E	Dire overnight position for survey	14, 15
14 Feb	18°10'58"N, 101°10'38"E – Ban Mai island, 17°58'N, 102°28'E	Ban Mai at 13h45; then to Khao Lleo fast, no serious survey.	15

\*as assigned in Duckworth *et al.* (2002).

\*\* covered intensively by foot, 31 Mar 2010.

Table 4.3. Target bird species surveyed in the survey area.\*

Group / species	Survey goal / activities	Survey effectiveness – wet	Survey effectiveness - dry
Quails <i>Coturnix</i> and buttonquails <i>Turnix</i>	Walk dry and drying areas of channel bed, particularly areas dominated by grass and herbs.	Seasonally inappropriate	Moderate

Group / species	Survey goal / activities	Survey effectiveness – wet	Survey effectiveness - dry
Ducks and geese (Anatidae)	Survey channel with particular attention to backwaters and large sand-flats; also wet bushland.	Good where a small boat was used; poor otherwise	Good
Stork-billed, Collared <i>Todiramphus chloris</i> , Crested <i>Megaceryle lugubris</i> and Pied <i>Ceryle rudis</i> Kingfishers	Survey channel, including backwaters; long periods without engine noise to allow detection by calls.	As ducks and geese	Good
Blue-throated <i>Merops viridis</i> and Blue-tailed Bee-eaters	Survey air-space and plausible perches within/beside channel; long periods without engine noise to allow detection by calls; check sand-cliffs for breeding colonies.	As ducks and geese	Good, but: too early in year to assess breeding?
Fish owls	Dawn and dusk attention by eye and ear in areas with large trees at channel edge; camp in suitable habitat to listen for calls at dawn, dusk and through the night.	Low: too few nights in good habitat	Moderate
Indian <i>Caprimulgus asiaticus</i> and Savanna Nightjars	Camp in promising habitat (extensive dry, sparsely-vegetated, channel bed; listen dawn and dusk, and through the night, for song.	Seasonally inappropriate	Excellent
Wood Snipe <i>Gallinago nemoricola</i>	Walk damp areas with thick vegetation.	Seasonally inappropriate	Low? (species poorly understood)
Grey-headed Lapwing and Long-billed Plover	Check from boat areas of appropriate sediment; walk to promising looking areas out of view of the boat.	Moderate	Good–excellent
Breeding or potentially breeding thick-knees, plovers, lapwings and pratincoles	Survey channel by day, walking representative areas with limited visibility from boat; assess proportion of birds thereby detected not visible from boat (dry); use small boats to cover stretches with exposed channel (wet); camp in suitable habitat (wide and long areas of exposed bed, with or without vegetation) to listen for thick-knee calls at dawn, dusk and through the night.	As ducks and geese	Excellent,
Breeding or potentially breeding terns <i>Sterna</i>	Survey channel by day, walking representative areas with limited visibility from boat (dry); use small boats to cover stretches with exposed channel (wet).	Good	Excellent
Black and Brahminy Kites <i>Haliastur indus</i> , fish eagles <i>Haliaeetus</i> / <i>Ichthyophaga</i> and Aquila eagles	Attention to overflying birds, particularly in the late morning on days with weather suitable for soaring. Attention to plausible channel-side perches (tall, isolated trees). Some focus on areas with perceived lower human activity and more complex seasonally-exposed channel bed.	Good	Excellent
Long-tailed Shrike	Walk areas of bushland, scanning far ahead for perched birds.	Moderate where a small boat was used	Moderate

Group / species	Survey goal / activities	Survey effectiveness – wet	Survey effectiveness - dry
Jerdon's Bushchat	Count from boat in areas where exposed channel is narrow. Count on foot in areas of wide exposed channel, making good use of tall rocks to scan and count high-perching males at considerable distance; estimate totals in areas of high density (dry season); use of small boats to enter complex areas and count (wet season),	As ducks and geese	Excellent
Asian Pied Starling <i>Sturnus contra</i>	Seek and check flocks of starlings and mynas (themselves a lesser survey focus), particularly around pools and domestic bovids.	Low	Moderate
Resident martins and swallows (Hirundinidae)	Daytime survey of channel; focus at suitable periods in morning and afternoon when hirundine flocks low, to optimise searching for scarce species in flocks of commoner ones; some search of banks for breeding colonies of digging species.	Moderate where a small boat was used	Moderate
White Wagtail (resident)	Daytime survey of channel; check where practicable pre-roost flocks and roost-flights of wagtails for this taxon.	As ducks and geese	Excellent
Weavers, Black-headed Munia <i>Lonchura malacca</i> and Red Avadavat	Check tall graminoid patches by day for feeding birds; look for roost-flights round dawn and dusk	Low	Moderate (but seasonally inappropriate to find breeders)
Other grassland birds	Check tall graminoid patches by day for feeding birds.	Low	Low

\*Surveys were undertaken throughout the survey area unless stated otherwise. Proportionately more time was spent in areas with perceived lower human activity and more complex seasonally-exposed channel bed, than in obviously heavily used (especially, heavily settled) areas with little seasonally-exposed channel bed.

The aerial searches for raptors, large waterbirds, Large-billed Crow and hirundines also gave good opportunities to assess the status of various large dryland birds that fly through the open sky frequently: hornbills (Bucerotidae), parakeets *Psittacula*, most pigeons (Columbidae) and Hill Myna *Gracula religiosa*. Although these are mostly of at least some level of elevated conservation concern, they are not strongly channel-dependent and so were not survey foci themselves.

Various other species that would once have occurred in the area and would be very high conservation priority, if present, were assessed as so unlikely to occur that no special effort was made for them, e.g. Masked Finfoot *Heliopais personata* and Indian Skimmer *Rynchops albicollis*.

Scientific names are given only for species not in Appendix A4.1.

#### 4.3.3 Target species

To use survey time efficiently to assess conservation priorities and needs of birds within the survey area, a suite of target species were selected as primary foci (Table 4.3). These were those species for which the survey area populations might be found to be of national conservation significance, and which might have some management needs. They were selected from those possessing various attributes:

- (i) categorised in *The IUCN Red List of Threatened Species* as globally threatened (Vulnerable, Endangered or Critically Endangered), globally Near Threatened or globally Data Deficient (IUCN 2012);
- (ii) considered At Risk in Lao PDR, Potentially At Risk in Lao PDR, Conditionally At Risk in Lao PDR or Little Known in Lao PDR (Duckworth *et al.* 1999);
- (iii) species identified in Lao PDR after 1999 as greatly decreased or at least surprisingly rare. Most of these are non-forest species, their omission from the 1999 list reflects the heavy 1990s survey focus on forest areas. Some species were profiled in Duckworth *et al.* (2002) or Fuchs *et al.* (2007); most (and all that are relevant to the survey area) are discussed in-depth in Duckworth (in press).
- (iv) tied almost absolutely, at least in this region of Lao PDR, to the Mekong channel.

The main survey objective was to assess all target species' status and conservation needs within the survey area. Other species were sought to the extent that it did not interfere with the search and documentation of target species. All individuals of most species in the channel were noted, but for a selection of common species mostly those so vocal they were background noise or common both in the channel and widely in Lao PDR, and only presence per day was noted.

All surveys put much effort into seeking flying waterbirds and raptors, many of which were over adjacent dryland areas (including wet-season islands), or perched in riverside trees. Other than these, birds outside the channel were recorded only patchily, mostly when in flight over the channel or by vocalisations audible at long range. In Sep–Oct 2011, a few short excursions were made to dryland habitat, including the degraded forest on Don Hon, and a small karst area close to Don Hon. These generated no observations of particular conservation significance, corroborating the general impression from the boat of the heavy over-hunting of birds and large mammals in dry-land habitats. Thus, the dry-season survey spent time outside the channel only in a short mid-day foray up a small stream meeting the Mekong (at 19°00'15"N, 101°47'46"E) on the east bank opposite Ban Khokfak on 29 Jan 2012. Comprehensive recording of birds and large mammals outside the channel would have entailed a different survey strategy and, moreover, one that would probably have provided little information of significance for wildlife conservation management.

#### **4.3.4 Field methods**

All bird surveys in wet-season 2011 were conducted by RJT and all in dry-season 2012 (and on 2 Oct 2004) by JWD. All records from other sources are explicitly noted as such. Birds were counted within survey stretches defined by the upstream and downstream end coordinates. The boundaries reflected (i) a change of method (e.g. from foot to boat), (ii) a stark change in habitat-type, or (iii) an arbitrary point when a stretch seemed to be becoming long. Particularly significant observations were marked on 1: 100,000 maps or recorded specifically with a GPS receiver.

#### **Boat-based observations**

In dry-season 2012, about half the survey time was spent aboard the boat, usually running the engine slowly. Rarely, the boat was allowed to drift in the current, thereby increasing detections of wildlife by ear. Nothing suggested that the motor was often flushing wildlife that would otherwise have been seen, and this would be implausible, given the typical distance from the shore, the many other boats, and the propensity of shy species to use sections of the channel bed not accessible to any boats. Where the exposed channel bed was broad, stops were made every few hundred yards to ascend tall rocks, where present, and scan for 5–10 minutes. In general, except on overcast days, observations were suspended during about

12h00–14h30. A small boat was twice taken for a few hours to go into the shallower areas not accessible to the larger survey boat. Neither case resulted in observation superior to what was expectable by going on foot, so no more small boats were taken.

In wet-season 2011, two broad categories of surveys - ‘fast-boat’ and ‘slow-boat’ - were employed. ‘Fast-boat’ surveys followed a relatively straight upstream course, following open-water sections of the channel and avoiding areas of turbulence and emergent channel features. Fast-boat surveys focused on those target species easily visible. The speed of the boat hindered observation of distant birds. ‘Slow-boat’ surveys investigated areas of complex channel morphology, especially exploring areas with emergent channel features, and maximising potential for finding target species by often ‘zig-zagging’ through such areas. Boat speed was controlled to maximise detection and recording of target species, stopping or using very slow speeds (sometimes only paddling) where presence of target species necessitated detailed observation. Slow-boat surveys were used on four mornings and for shorter periods on four late afternoons along four stretches of the river totalling only 56 km; none of these was downstream of the Thai–Xaignabouli border. In general, full systematic recording only took place for the first few hours of the morning and during slow-boat surveying in the evening. The speed of the wet-season survey meant that recording of non-target species had to be particularly erratic.

On 2 October 2004 a speedboat was used to move rapidly through areas predicted to hold little of conservation interest (stretches with bank-to-bank open water), to circumnavigate and, where practical, traverse areas of exposed rocks, aggregations of flotsam, grassy islets, the margins of permanent islands and the few areas of sand and gravel exposed. In 2004 the river remained almost full on this date, and using the boat in this style allowed highly efficient coverage.

### **Daytime walks**

In the dry season, where the exposed channel was particularly wide or complex, or contained habitats not amenable to survey from the boat (e.g. tall graminoid beds), the surveyor went on foot with the twin aims of flushing birds unlikely to be seen from the boat (e.g. quails, seedeaters) and reaching spots invisible from the boat (pools, backwaters etc.). In general, the focus was on reaching as much shallow water and damp substrate as possible. Some walks were ‘circular’, but others were one-way, with the boat picking up the surveyor at the end. In the wet season, a few larger sedimentary features in the channel were walked over, but such features, which are maintained by annual immersion, are very scarce at this time. Thus, observations added little to detections from ‘slow-boats’ (the reverse of the dry season, when channels navigable by small boat were too few and too heavily disturbed to add materially to foot-based observations).

### **Overnight stops**

In the dry season, paramount importance was attached to the location of each overnight stop, given the number of target species best found by dawn or dusk calling and singing, and the number for which abundance was best assessed by counting roost flights. Where possible, an area within extensive exposed channel bed, out of the sound of other people and rushing water, was selected; on three nights (8, 9 and 13 Feb) substandard areas were used, all close to villages and with little exposed channel bed. Where possible, the team arrived 1–1½ hours before dark, and the surveyor walked through the habitat and selected a good dusk watching-spot; sometimes the team arrived later if the boatman recommended a particular spot somewhat further on than was ideal for scheduling. The following morning, foot-based observations might continue if the exposed channel bed was extensive enough that a different area could be covered, or the team left the site once dawn song was past. In the wet season, only three overnight stops were made in wildlife habitat: far too few to profile the crepuscular species of the survey area, at least some of which in any case are not very vocal at that season. Dusk watches for bird movement (e.g. egrets, wagtails) were made at all five overnight stops in that season.

### **Sign searches**

As the dry-season survey progressed and no thick-knees were seen or even heard, despite a superb selection of overnight stop localities early on, more time was spent looking for possible thick-knee footprints, either in the heat of the day or at overnight stops. There was no attempt during either survey to search for signs of otters or other large mammals.

### **Wildlife habitat characterisation**

General characteristics of wildlife habitats were noted, especially the extent of degradation of channel and bank-side vegetation (i.e. structure, frequency of certain characteristic plant species, substrate types) in relation to observations of use of such areas by the channel bird community. More basic categorisation of dry-land habitat was occasionally made. This was intentionally little noted, because nothing suggested the presence of any out-of-channel habitats of significance to birds or large mammals of elevated conservation concern and threatened by human activity so far.

### **Observations of human use**

Incidental observations of human use were made whenever applicable during the survey, but were not recorded systematically.

### **Interviews with local people**

On the wet-season survey, interviews focused on only two animals, otters and Phayre's Leaf Monkey. Each interviewee was asked about one or both of these species groups. Interviews focused on obtaining first-hand information on these species, especially the last time any of them were recorded and the circumstances. First-hand reports were vetted by asking interviewees for descriptions of the animals and natural history characteristics. On the dry-season survey, few interviews were undertaken, and these were mostly responsive to observations, e.g. finding out about local gibbon status when heard, and local use of *Phoenix*. Although more extensive interviewing had been planned, during the study all resources were directed towards optimal use of direct survey time. The surveyor never knew what was around the next corner, and the needs of ensuring smooth reconnection after daytime walks proved demanding.

#### **4.3.5 Limitations**

No survey runs perfectly and almost all could do with more time. A week longer for the dry-season survey would have allowed near-total coverage of the target species in Lao territory. But this time would have been unlikely to change the order-of-magnitude perceptions of any target species's status. While it might well have allowed one or two more chance records akin to the Red Avadavat record at 11h00 on the last day, this merely changes the status from 'not recorded, at best rare in the survey area' to 'found very rarely, may not be regular in the survey area', a difference rarely germane to management decisions. In general the survey ran exceptionally smoothly, due to the high commitment and flexibility of the boatman and his wife, the pre-existing knowledge of the counterpart about survey methodology and habitats, and the provision of a separate boat to each taxonomic specialist team operating at that time. Several factors did somewhat inhibit the survey:

1. Thick fog on some mornings forestalled effective recording. Boating was then impossible (dangerous, and little would have been seen), while foot-based observations resulted in the sounds of many birds flying away before they were identifiable. Fog is inevitable in cold-season surveying; such surveys should schedule an extra one day in ten to allow for this factor.

2. The inability to land on the Thai side meant that the extensive prime habitat there in some reaches could not be surveyed. This would probably be best solved by a Thailand-based team surveying the Thai side.
3. The lack of permission to land, for security reasons, in some of the Lao side where the Mekong forms the international border was, despite grim forewarnings, a small handicap. Only one prime area was not surveyed because of this. Fortunately, pre-survey statements that in the Lao–Thai border stretch the hours between sunset and sunrise would have to be spent in towns turned out to be groundless; this would have been a colossal handicap to commenting on the status of various species, notably thick-knees.

In the wet-season of 2011, time constraints meant that most of the channel could only be surveyed superficially from a fast-moving boat. This was problematic because the speedboat used for most of the journey rarely travelled much slower than maximum speed (a combination of the owner's reluctance and mechanical constraints), and the owner refused to go even moderately close to areas with emergent rocks, vegetation or sedimentary features, or other shallows. This effectively precluded survey of short sections that looked, on habitat grounds, promising for the target species: *many* interesting areas of exposed channel features, *often with visible (but unidentifiable) birds*, were not investigated. This constraint was partly alleviated by hiring small boats and drivers with good local knowledge of the river to survey short representative sections. However, there was no use of small boats in the Lao–Thai section, making results from this section far less complete, and thus not readily comparable with those from the section upstream of this, or with this section as surveyed on 2 Oct 2004 (where the speedboat was used highly successfully to travel quickly through stretches with unbroken bank–bank water surface, and to explore in detail areas potentially holding target birds). Additionally rain, especially heavy rain, resulted in some stretches being relatively poorly surveyed; once again this affected the Lao–Thai section more significantly than the section upriver of this, especially on 27 Sep downstream of Ban Vang. No nights were spent camped in areas with wide seasonally exposed channel bed.

Presumably, although this has not been demonstrated, the factors driving the declines in Mekong channel birds operate during the breeding season. Along with the much greater extent of seasonally exposed channel habitat to survey at this time, this was why the dry-season survey lasted three times as long as the wet-season survey. Taken in combination, the surveys' timing was suboptimal for assessing the breeding numbers and success. The wet-season survey occurred too late to determine breeding success of species such as River Lapwing (i.e. adults and juveniles could not be told apart), or to associate with confidence the localities of birds to their nesting areas. The dry-season survey occurred too early to be confident that Blue-tailed Bee-eater, and possibly other species, had returned in full numbers.

#### **4.4 Results**

Most bird surveys in Lao PDR have covered a huge two-dimensional unit like a 1500 km<sup>2</sup> protected area, within which several discrete sites have been selected for survey, and most are not visited at all. Results have typically been presented for each survey site within the unit, assigning each species an abundance code (e.g. Thewlis *et al.* 1996). This Mekong survey was essentially a one-way continuous line, and this style of presentation is not so useful: where to make the breaks into 'sites'? Moreover, where focus was on counting a few species and the remainder were recorded only when feasible, it seems preferable to present the records as made without contrived amalgamation into 'survey sites'. Most species are considered only in summary form, in Appendix A4.1. Species accounts are restricted to those species of special management significance in the channel; for those widely recorded, Appendix A4.2 gives a stretch-by-stretch breakdown of counts.

#### 4.4.1 Birds

##### **Spot-billed Duck *Anas poecilorhyncha***

The 2004 wet-season survey recorded 61–93 birds: a flock of 16 at Ban Ang-Noi; a flock of ten at 18°13'12"N, 102°04'46"E; a flock of 25 near Ban Pakchanh; a flock of six near 18°02'08"N, 101°45'44"E; two duos a little upstream of this; and groups of 18 and four near Ban Sakai (these latter may have involved earlier-seen birds). Also, three at the island off Ban Mai on 26 Sep 2004; at Paksang two on 15 Feb 2004 and one on 16 Mar 2008 (JWD); around Don Chau there, at least two on 27 Nov 2005 (RJT); and three sightings of 1–2 on 20 Sep 2011, at 17°55'08"N, 101°43'50"E, 18°02'09"N, 101°45'57"E and 18°03'49"N, 101°47'46"E, and a group of four at 17°58'34"N, 102°28'06"E on 23 Sep 2011 (M. R. Bezuijen *in litt.* 2012). These birds were not identified to race. During Sep–Oct 2011, a minimum of 23 birds was detected throughout the survey area, at least most and possibly all of which were the race *A. p. haringtoni*, which breeds in Southeast Asia. The majority of birds (18+) were in the stretch from 18°11'54.86"N, 102°10'32.09"E to the town of Paklay; only one group (of three) was seen upstream of Ban Muangliap. The largest group was of five, with most sightings being of duos and trios. Birds were almost always associated with areas of complex channel mosaic, and usually close to or within vegetation emergent from the water.

The dry-season 2012 survey found 120 birds with a distribution fairly similar to the wet-seasons of 2004 and 2011: 15 in total around Don Hon and the few miles upstream of it, five in total downstream of Ban Muangliap, but 31 in total around Paklay (both upstream and downstream) and 59 in total between the town of Sanakham and Ban Kengmo. Group size and habitat use was similar to the wet season, although several groups of 4–6 were seen, and a loose flock of 16 was found on 14 Feb on a muddy backwater to a large sand-flat. Of these 120, 32 (about a quarter) could not be identified to race, but all others were *A. p. haringtoni*.

The numbers recorded in wet-season 2011 are, comparing the same stretch, about a quarter of those found in 2004, but the wet-season 2011 numbers are surely a considerable underestimate, especially in the Lao–Thai stretch, and in other more localised stretches for example between the Xaignabouli dam and Ban Thadua, because of route taken by the speedboat. Considering the habitat coverage and locations of the birds, the dry-season count is considered likely to be fairly complete for the Lao–Lao stretch, but a major underestimate (perhaps by a half to a third?) for the Lao–Thai stretch, given that the Thai exposed channel was not entered. The differing survey techniques between the three surveys preclude effective assessment of population trend or the extent of seasonal dispersal.

##### **Stork-billed Kingfisher *Pelargopsis capensis***

One on 27 Sep 2012 at 18°02'16.58"N, 101°52'42.29"E, at the edge of a forested island.

This is a conspicuous species visually and vocally, and must now be extremely rare in the survey area. Although still common in the early–mid 1990s in Lao PDR, it is declining fast, being noticeably much reduced in some areas surveyed since then (e.g. Dersu 2008). A relatively large number use the Nam Ngum 1 reservoir, but otherwise it is now very rare in North Lao PDR (Duckworth *in press*). No 1990s–2000s survey recorded large numbers on the Mekong, and the extent to which the North Lao Mekong was previously used is unclear, because in historical references (e.g. Oustalet 1898, Delacour & Greenway 1940b) it is not explicit whether specimens were from the Mekong or the adjacent plains. It is not clear what is driving the decline, and therefore conservation actions cannot be suggested.

### **Blue-tailed Bee-eater *Merops philippinus***

Three groups, of one, two and five, on 11 Feb 2012 around 18°01'53"N, 101°52'21"E, in a large expanse of pool-studded sandy channel bed supporting much, and diverse, grassy, herbaceous and bushy vegetation. Also, one at Paksang on 16 Mar 2008 and one probably of this species (*M. viridis* was not ruled out) seen from a car from the Mekong-side road over exposed channel mosaic in Muang Meun on 10 Apr 2010 (JWD).

This bee-eater is a seasonal migrant breeder in the Mekong channel of North Lao PDR. Its arrival and departure timings are poorly known, but based on past observations it seems that the wet-season survey was conducted after the birds had left and the dry-season survey was too early for the main return: none were found at Paksang on 16 Jul 1996 (Duckworth 1996), 26 Sep 1999 (Duckworth *et al.* 2002), or 2 Oct 2004 (after breeding) or 14 Feb 1996 (Duckworth 1996) or 15 Feb 2004 (JWD) (before breeding); and none were found in the upper Lao Mekong in Dec 1999–Jan 2000 where it was (provisionally) identified upstream of Ban Houayxai in April 2000 (Duckworth *et al.* 2002), and confirmed there on 29 Mar 2012 by an active small colony (sightings of 1, 2 and 3+ birds; RJT); Dickinson (1966) documented a breeding colony at nestling stage in May, in the Ban Houayxai area. At Paksang the species was fairly easily found on all three visits between mid March and late June, with much less effort than expended on the 2011–2012 surveys: two on 13 Mar and one on 22 Jun 1996, and one on 16 Mar 2008 (JWD). Moreover, one probably of this species was seen in Muang Meun on 10 Apr 2010 (JWD); three had been seen from the Thai side around there in late Apr 2000 (Duckworth *et al.* 2002).

Given the only small numbers found in the main occurrence period (March–July) in the North Lao Mekong in the 1990s–2000s, this population may be on the verge of local extinction. Fortunately, the species remains abundant lower down the Mekong, in Cambodia as well as in various other Southeast Asian countries (e.g. Goes 1999, Round 2008, Timmins 2006, 2008a [online appendix]).

### **Brown Fish Owl *Ketupa zeylonensis***

One seen (not identifiably to species; only as a large owl) and heard at the downstream end of Don Hon at dusk and dawn of 1–2 Feb 2012. One heard from Pha Liap (opposite Ban Muangliap) at dusk on 2 Feb 2012. What was plausibly the same bird was heard on Don Hon by M. R. Bezuijen (*in litt.* 2012) on 16 Sep 2011 in the early evening. The song was noted (in Feb) as a very resonant and deep *ooo'ooo*, probably deeper than Great Bittern *Botaurus stellaris*, the two notes sounding identical to each other and with no break between them, and the couplet about 1 second long. This corresponds with the description in Robson (2008) except that despite trying, no third note could be heard. This may merely have reflected distance, on both nights; P. D. Round (verbally 2012) who knows the species well in Thailand, confirmed that he typically hears only a two-note unit, and his impersonation sounded just like the calls heard.

This is a rather little-known bird in Lao PDR, with few modern records, in part reflecting the difficulties of seeing large owls well enough to identify them by plumage, and much uncertainty over identifications by voice, but also in part a genuine rarity (Duckworth *et al.* 1999). Previously, Delacour & Greenway (1940b) had called this species common in the Mekong upstream of the town of Louangphabang. Its modern status has not been assessed there, the surveys of Duckworth *et al.* [2002] being at unsuitable times of day. It is evidently not common now in the stretch downstream of that town: the dry-season survey period is likely to be a season of high calling intensity, and the camp-sites were selected for their (relative) remoteness. Its decline in Lao PDR presumably reflects persecution. There is no evidence it is of more than national conservation concern. While there is no doubt that the song heard is consistent with Brown Fish Owl in Thailand, doubts persist over whether any other species might make confusingly similar sounds. Brown Fish Owl itself may be more than one species, its populations in different parts of its range apparently make different sounds, and some previous descriptions of sounds said to be this species may have been incorrectly identified (van den Berg *et al.* 2010).]

### **Savanna Nightjar *Caprimulgus affinis***

Two songsters near the upstream end of the Don Vao complex on the night of 5–6 Feb 2012 sang extensively around dusk and dawn and for several periods during the night. Two near Don Vao's southern end on the night of 6–7 Feb were heard only for 10 minutes in the evening, and thus could conceivably have been the same birds; but this would require them to have huge or liquid territories. Two songsters near Ban Kokmuat at 18°05'51"N, 101°57'12"E on the night of 11–12 Feb, and two songsters near Ban Houayla at 18°13'N, 102°05'E on the night of 12–13 Feb were all in areas of wide exposed fairly level channel bed with much sediment and vegetation.

These are the first recent records from North Lao PDR despite considerable efforts to find it at some known historical sites (Duckworth in press, where North Lao PDR records in Duckworth *et al.* [1998a], from two sites, were retracted). It still remains at least fairly common in South Lao PDR, and is abundant and tolerant of major habitat change further south (occurring in towns such as Phnom Penh and Jakarta), so these birds are of no global or even regional concern. Its decline in North Lao PDR has presumably been caused by human-associated predation in some form; another possibility, for a ground-nesting bird of grassland, might be repeated burning of the grassland during the nesting season, which is presumably the late dry season.

### **Great Thick-knee *Esacus recurvirostris***

There were no certain records of thick-knees during the 2011–2012 surveys, although in January–February, several sets of tracks were found that may have been left by thick-knees. The most plausible were at 18°04'27"N, 101°47'02"E, where two trails, both apparently rather old (but certainly made after the sand had entirely dried out) walked for about 200 yards across featureless dry sand, making no diversion towards any of the few bushes there (Plate 4.1). Coucal trails by contrast, while also sometimes walking long distances over apparently dry sand, usually went close to and within bushes. Another plausible thick-knee set was found at 18°05'51"N, 101°57'12"E, in similar dry sand far from water, but with more bushes. These two sites were among the most promising looking for thick-knees in that human activity at the time was relatively low, the area of exposed channel bed was both long and broad, and human access to everywhere in the exposed habitat was not so easy given the various streams. Photographs of the former were shown to A. C. Claassen, who knows the tracks of river channel birds well from Cambodia, and commented (*in litt.* 2012) that “that photograph certainly does look like thick-knee tracks”.

The failure to see or hear any thick-knees indicates massive declines in, if not extirpation from, the survey area. By contrast, almost every previous visit or survey to this stretch has found Great Thick-knee, with much lower levels of suitable survey effort. Although none was found by the original bird survey in Paksang (Duckworth 1996), the whole habitat and bird community was new to the surveyor. But singles were seen there on day-trips of 31 May 1997 and 31 Dec 1998, with two on 26 Sep 1999; during the single previous boat journey through the Don Vao complex, two duos were seen, despite the speed (quite fast) and time of day (mid-morning); and brief land-based observation from the Thai side at Pakchom on 21–22 April found one (Duckworth *et al.* 1999, 2002). Finally, the speedboat survey between Vientiane and Ban Donmen on 2 Oct 2004 (thus, covering Paksang but not the town of Paklay) found one bird. Relative to contact rates of this species on the better-understood rivers of North-east Cambodia, it is reasonable to conclude that a large population remained in the survey area in the 1990s. The total survey effort in 2011–2012 considering both duration and quality (many overnight camps in prime habitat, efficient observations round dawn and dusk) was probably in the order of 10x as intensive as all that in 1996–2000, yet failed to see or hear the species.

Of the waders known to breed in the Lao Mekong channel, Great Thick-knee is the by far the most vulnerable to human factors. Its extirpation from the survey area, already or imminently, fits in perfect sequence with

the loss of terns previously but the survival of many River Lapwings, Little Ringed Plovers and Small Pratincoles. If the prints observed were those of thick-knees at all, it is as or more likely that they were left by Eurasian Thick-knee *Burhinus oedicnemus*. This is of mysterious status in Lao PDR and Thailand (Duckworth 2009a), but is evidently surviving far better in at least the latter country than does Great Thick-knee. In Thailand it is not associated with river channels; but, neither is Savanna Nightjar there (Round 2008, P. D. Round verbally 2012). Since the nightjar clearly now is strongly associated with wide channels in North Lao PDR (see species account), the thick-knee could possibly now be similarly tied in this region.

#### **Long-billed Plover *Charadrius placidus***

Four on 28 Jan 2012 at 19°14'03"N, 101°49'17"E, at the edge of a large sandbar with much human and bovid use, atop a cliff 25 feet above the water's surface, in ledges formed by shattering of the near-vertical soft rock layers. One on 8 Feb at 17°50'46"N, 101°33'40"E, at the water's edge of a narrow fine mud–silt bank. One on 14 Feb at 18°04'26"N, 102°17'24"E, on a low bedrock bar at the downstream exit of a channel braid. All were loafing when found.

All were noticeably confiding and, in contrast to the resident breeding waders, inconspicuous and silent except when flushed. Significantly more could have been present than were detected, but the species can have been no more than scarce. Habitat use by these birds (and others seen in Lao PDR in the 1990s–2000s) gives no suggestion of why the species is scarce. But, because all these, and most previous birds, were loafing rather than feeding, it is impossible to speculate on whether the species's scarcity in Lao PDR may reflect association with some scarce habitat feature. There are few previous Lao records, perhaps only: a single from Ban Namkeung-Kao, Bokeo (Delacour & Greenway 1940b); one, perhaps two, records of small flocks on Mekong sand-flats off Savannakhet town (David-Beaulieu 1949–1950); a duo on the Nam Kading just downstream of the (then, future) Theun–Hinboun dam-site in Dec 1994–Jan 1995 and a single on the island off Ban Mai (in the present survey area) on 21 Dec 1996 (Thewlis *et al.* 1998); in early 2005, two duos on the Nam Mouan between Ban Kokton and the mouth of the Nam Hong, a single along the Nam Kading between the proposed Nam Theun 1 dam site and Ban Phonkham, two just upstream of Ban Phonkham and one just downstream of Ban Phonsy on 14 Feb 2005 (these and the earlier single might have involved only two birds), and at Ban Pakpoung (18°20'30"N, 103°42'E; just downstream of Pakxan), two on 30 Jan and four, together, on 12 Feb (Timmins & Robichaud 2005; JWD); and a visitor's report of on the surprisingly early date of 5 Aug 2005 on a Mekong sandbank 2 km downstream of Muang Paktha (presumably Ban Paktha, 20°06'N, 101°35'E), Oudomxai province (J. Engels in Robson 2005). These are very few records through which to assess national conservation status. The species was listed as globally Near Threatened by Collar *et al.* (1994) but since Birdlife International (2000), its *Red List* status has been Least Concern. It seems likely that it is genuinely scarce, perhaps solely through being at the edge of its range, in Lao PDR, occurring mainly in the North. It depends upon wide rivers (at least in Lao PDR).

#### **Little Ringed Plover *Charadrius dubius***

The 2 Oct 2004 survey recorded 17 birds: four with six unidentified small waders at the island off Ban Mai; a duo and a single near Ban Ang-Noi; two duos and a group of six near Ban Sakai. One at Don Vao on 18 Sep 2011 (M. R. Bezuijen *in litt.* 2012). The 2011 wet-season survey recorded six near Ban Khokkhaodo on 29 Sep [and one near Camp 2 on 2 Oct]. In neither year were these identified to race.

The dry-season 2012 survey found 278 groups of the resident race *C. d. jerdoni*, including several with three and a few with four birds, but nearly all with only one or two birds seen. Most, and all those watched more than a few seconds, showed obvious territorial or breeding behaviour. They were distributed as: none between the town of Louangphabang and Ban Muangkhay; 36 between Ban Muangkhay and 19°24'17"N, 101°52'52"E;

none from there to 19°11'03"N, 101°49'18"E; 14 from there to 18°57'00"N, 101°48'04"E; none from there to 18°53'18"N, 101°47'28"E; 12 from there to 18°43'30"N, 101°48'58"E; none from there to 18°40'51"N, 101°48'00"E; 60 from there (just upstream of Don Hon) to Ban Houaylay-Noy; 35 from the town of Paklay to the Thai border; 47 from the border to Ban Vang; none from there to 18°04'44"N, 101°56'05"E; nine from there to Don Chan; 17 from Don Chan to the upstream end of Don Nou (Paksang); and 48 on Don Nou and downstream to just upstream of the island off Ban Mai. The uncounted extensive suitable habitat from the island off Ban Mai to Vientiane will have held many: the species is a common breeder in the channel even in central Vientiane. In addition, five territories were found between Ban Houaylay-Noy and the town of Paklay on 23–24 Mar 2010, a short stretch not counted in 2012. The stretches with no or few records were those where sand or other unconsolidated sediment occurred only as narrow marginal strips, or as small patches amid an overwhelmingly rocky landscape. A moribund bird was picked up by hand, some way upstream of 17°52'28"N, 101°32'34"E on 8 Feb; no cause of death was apparent. Two newly hatched chicks were seen on 12 Feb just downstream of Don Chan.

Also, at Paksang two displaying on 15 Feb and 16 Mar 2008 (JWD) and around Don Chau there, four duos and two singles, none identified to form, on 27 Nov 2005 (RJT).

The dry-season 2012 survey also found a few of the Palaeartic migrant *C. d. curonicus*: two adults and one first-winter on Don Phoung at 18°01'55"N, 101°25'20"E on 7 Feb; one some way upstream of 17°52'28"N, 101°32'34"E on 8 Feb; and one at 17°53'46"N, 101°36'41"E on 9 Feb. All were at the water's edge of huge fine-sediment sandbars. Also, in the stretch between Ban Houaylay-Noy and the town of Paklay on 24 Mar 2010, not counted in 2012, a single and a duo were found on 24 Mar 2010 (habitat not noted).

No birds were left unidentified to race on the 2012 survey – all the birds seen in flight, when morphological identification is much more difficult, were showing territorial or sexual behaviour and thus were identified as *C. d. jerdoni*.

Robson's (2008) implication that these two races are difficult to separate in the field could not be further from the truth; in the early months of the year, they are so startlingly different to an observer looking carefully at *Charadrius* plovers as to seem different species. Firstly (again *contra* Robson 2008), *C. d. jerdoni* lacks a scruffy non-breeding plumage; adults look neat all year. By contrast, most *C. d. curonicus* in winter (and even into March) still look somewhat dull. They also differ structurally (*C. d. jerdoni* is smaller and chunkier than the more rangy-looking *C. d. curonicus*) and vocally (the call of *C. d. curonicus* is slightly softer and 'wilder' than that of *C. d. jerdoni*). On this survey, all *C. d. curonicus* were picked up at great distance by their bright yellow legs, in contrast to the fawn or pinkish-fawn legs of *C. d. jerdoni* (examination of photographs on the internet shows that this is not a reliable distinction at all times of year all over the species's range; *C. d. curonicus* often shows fawn-coloured legs). Finally, these extensive observations corroborated the expected situation that *C. d. curonicus* does not typically show territorial or sexual behaviour in winter.

This is the first quantification of status of Little Ringed Plover over a large area of Lao PDR. Previous conclusions that it is not at risk in the country (e.g. Duckworth *et al.* 1999) have been based on little more than its evident common breeding status around urban Vientiane, the many widespread records during the 1990s not having been identified to subspecies. Including observations in Dersu (2008) and Duckworth (2008a, *in press*), *C. d. curonicus* is a common spring (and presumably autumn, but this remains to be confirmed) passage migrant, but seems to be localised over winter in Lao PDR. The concentration of birds around the town of Paklay in 2010 probably reflects more that this was visited in late March, peak migration season, rather than any inherent superiority of the habitat over that surveyed in 2012, before migration had probably started. Previous winter records of *C. d. curonicus* in Lao PDR all come from standing wetlands: in Muang Pathoumphon, Champasak Province, where relatively common (Duckworth 2008a), on the Nam

Ngum plain (Duckworth in press), and, apparently, the Nakai plateau (Dersu 2008). It thus seems a good deal more common in winter in Lao PDR at standing wetlands (perhaps particularly at short-turf marsh pasture) than in river channels. It is unlikely to have any conservation needs in the country.

The resident form *C. d. jerdoni* is clearly abundant wherever suitable habitat occurs in the survey area. Its attachment to large expanses of little-vegetated sediment may mean it is rather local on all but the largest tributaries such as the Nam Ou (Fuchs *et al.* 2007) and the Nam Kading except its lowest reach (Duckworth *et al.* 1998a); it did not breed on the network of rivers on the Nakai plateau (Dersu 2008). This gives the Mekong mainstream considerable importance at the national level. However, it is a common breeder at reservoirs in the Nam Ngum catchment, although apparently not at natural standing wetlands in Lao PDR (Duckworth in press). It is plausible it has not been reduced by any significant amount through human activity. Round-the-year observations in Vientiane found that it apparently almost disappears from the area, both the Mekong channel and plains wetlands, during the high-water season; where it goes is unknown. Extensive footprint searches indicate it is not simply becoming elusive during this period.

#### River Lapwing *Vanellus duvaucelii*

The 2 Oct 2004 survey recorded 116–144 birds: a group of 17, and another of seven probably different, near Ban Ang-Noi; groups of 3, 4, 2, 2 and 1 near 18°13'12"N, 102°04'46"E; seven duos, two singles, a trio and a group of seven upstream of Ban Pakchanh; two duos just upstream of Ban Namhe; a flock of 17, a duo and a trio downstream of Chiang Khan; a duo and a single a little upstream of the Thai–Xaignabouli border; and a flock of 28 and two duos around 17°52'33"N, 101°26'34"E. A flock of 21 near Ban Sakai on return was probably additional. Also, four at Paksang on 15 Feb 2004 and three there on 16 Mar 2008; around Don Chau there, three duos and a single on 27 Nov 2005 (RJT); one flying upstream at the Narrows (18°01'29"N, 102°22'31"E) on 26 Sep 2004; one around Ban Namxong on 31 Mar 2010; and two pairs just upstream of Paksang (18°52'57"N, 102°06'39"E) on 10 Apr 2010 (JWD).

During the wet-season 2011 survey, small groups, mostly duos, were found throughout the survey area with a minimum total of at least 230 birds. The largest group found was of 50+ birds, all within 100 m of each other, at dusk in the channel mosaic below Ban Khokhaodo. Many birds were associated with small areas of exposed sedimentary formations and rocks in the channel, or in stretches where such channel bed features were rare, on sparsely vegetated patches of riverbank.

The 2012 dry-season survey found an estimated 207 territories, i.e. sites where 1–3 birds were found. In addition 21 birds in flocks were counted, one flock of five and four of four. They were distributed as: none between the town of Louangphabang and 19°41'22"N, 101°52'37"E; 47 'territories' between there and 18°57'00"N, 101°48'04"E; 59 'territories' and a foursome from there to 18°43'30"N, 101°48'58"E; 49 'territories', three foursomes and a group of five from there to Ban Houaylay-Noy (including seven 'territories' in the wide exposed bed just upstream of that village); 15 'territories' from the town of Paklay to the Thai border; 13 'territories' from the border to Ban Vang; six 'territories' from there to Don Chan; 10 'territories' from Don Chan to the upstream end of Don Nou; and eight 'territories' on Don Nou and downstream to just upstream of the island off Ban Mai. In strong contrast to Little Ringed Plover, there were no long stretches lacking records, doubtless a reflection of the lapwing's use of stretches of stream with narrower exposed channel bed, and areas primarily of rocks. Concerning stretches not counted in 2012, none was found in the heavily-used stretch between Ban Houaylay-Noy and the town of Paklay on 23–24 Mar 2010, and there are unlikely to be any territories on the island off Ban Mai or from there downstream to Vientiane city. However, this cannot be ruled out: a single bird was found in intense alarm (and thus presumably was the mate of an unseen incubating bird) on a small (about 500 m<sup>2</sup>) rock-flat islet in a stretch of channel almost devoid of exposed bed at 17°59'43"N, 102°24'49"E, only 5 km upstream of Ban Mai. A number of other sightings of clearly territorial/defensive birds in what JWD would have assumed to be unsuitable habitat

(fairly narrow marginal shores of mud and boulders, sometimes with buffalos and boats in the same field of view), underlined how commensal this species can be in at least this part of the Mekong mainstream. However, the absence of breeders from otherwise ideal habitat around the two largest towns, Louangphabang and Paklay, joins with the well-established breeding absence from Vientiane city in showing that the breeders are much less tolerant of human activity than are Small Pratincole and Little Ringed Plover.

The dry-season count has to be used cautiously to speculate on the actual population present, for several reasons. First, many birds were incubating (two active nests were found without any effort made) and all singles were assumed to indicate territories, as supported by the obvious territorial calling of many; but this was not seen with all, and if there are birds unable to secure territories that live singly, this will inflate the count. Second, all duos were taken as pairs, although some were doubtless cases of trios where an incubating bird was overlooked; arbitrarily, 10% of territories are taken here to include trios. Third, prolonged observation at several high-density spots showed that a common predator response is for adjacent pairs/trios to join together and mob the predator; after the predator has left, it takes some time (15 minutes or more) for the group to disaggregate, the birds remaining together amicably during this time. This has been taken as the explanation of groups of seven and six, both recorded early in the survey, before this facet of behaviour was understood, and taken here as constituting three territories each. Fourth, while stable trios during breeding are well known, confirmed by repeat observations of individual territories in earlier years (during observations for Duckworth *et al.* 1998b), the interpretation of the groups of 4–5 is less clear; they did not appear to be temporary aggregations of pairs. They are taken here as non-breeders. These combined assumptions give 456 birds in the survey area at time of survey that belong to units (pairs, trios or non-breeder flocks) of which at least one bird was seen.

But the true total population may be more than this, because the foregoing assumptions do not account for units in the survey area at time of survey of which no birds were seen. In fact, the true population may well be hugely more than 456. In many cases, when a stretch was both walked and boated, only one in four or one in five, or less, of the units found on foot were found by boat. There is no objective way to estimate the number overlooked in stretches not walked: the stretches walked tended to be in the widest exposed areas and for much of the river travelled, few birds would be overlooked because suitable habitat was so much narrower. Equally, in some of the widest stretches of exposed channel, birds were certainly overlooked even when walking. Finally, there was no opportunity to walk on the Thai side, and in the last few days on the Lao side, nothing like the full area of habitat was walked; there simply was not time. Subjectively, it seemed that from the town of Louangphabang to the widening of the channel above the town of Paklay, nearly all territories were found. In this stretch, 148 territories were counted, plus all the five groups of 4–5 birds. The few areas where birds were felt to be missed would probably add no more than an extra 20% to the estimated total. Downstream from the widening of the channel above the town of Paklay, a doubling or even tripling of the total number of territories found (59) is likely. For comparison, a much faster survey with no opportunity to stop let alone walk through the habitat in Jan 2000 noted only 20 territories between the town of Paklay and the island off Ban Mai (Duckworth *et al.* 2002). This is only a third the number found in 2012; the difference is most unlikely to reflect a real population increase, but the enhanced survey effectiveness from walking. But the 2000 survey gave better coverage of Thailand (which was poor in all the stretches walked) so the real difference on the Lao side may be closer to four times as many birds being found in 2011 as in 2000; but simply on basis of proportion of habitat actually walked that should have been walked, there is no way that the 2011 count is even approaching the real figure for this stretch. These coarse assumptions suggest a total of about 325 territories in the survey area, including the unsurveyed Thai channel. This may be a considerable underestimate.

The numbers recorded in the 2011 wet-season survey are much less than those found in 2004 (only 19 birds in the stretch where 116–144 had been recorded), but this is very likely to be due predominantly, perhaps entirely, to differences in survey methods (use of speedboat to circle and ‘hover’ at most patches

of exposed channel bed in 2004, allowing precise counting of all waders, versus the driver's refusal to slow down for, let alone approach, such features in 2011). The 2012 dry-season found about 42 territories in this stretch, thus about 90–100 birds for territories detected, depending on the number of trios. This may further support that the wet-season 2011 numbers recorded were a considerable underestimate of numbers present at that time. However, the comparability of wet season to dry season numbers is unknown. Birds move around in the wet season, as shown by frequent wet-season records in the channel of Vientiane city and downstream to Xiangkhouan, a stretch where birds certainly do not breed (JWD and D. Van Gansbergh). The net effect this movement would have on numbers in the survey area in the wet season relative to the breeding population is unclear. The similarity between numbers in this stretch on 2 Oct 2004 and in Jan–Feb 2012 (116–144 vs 90–100) is probably coincidental and should not suggest similar numbers in wet and dry seasons and, thus, stability between the two years and that 80% or so of the birds in dry-season 2012 were seen; the latter suggestion is particularly implausible (see above). The observations of flocks of 28–50 indicate how movement in or out of a stretch by a few flocks, if they are of such size, could have major effects on perceptions on relative importance and total population based on wet-season counts.

In sum, making sense of the numbers of these three surveys is difficult, but it is clear that the survey area remains very important for River Lapwing (Plate 4.2) nationally and probably regionally.

#### **Grey-headed Lapwing *Vanellus cinereus***

The 2 Oct 2004 survey recorded 16 birds: a group of four and a single around 18°13'12"N, 102°04'46"E; a trio downstream of Chiang Khan; and a group of eight upstream of the Thai–Xaignabouli border. Four at a small sandbank at 18°23'38"N, 101°34'22"E on 17 Sep 2011 (M. R. Bezuijen *in litt.* 2012). In the wet-season 2011 survey, aggregations of up to 32 birds were found throughout the survey area, with a minimum total of 90 birds detected. In the dry-season 2012 survey, only 52 birds were found, localised to areas of wide exposed channel with surface water and extensive non-bushy vegetation cover: a group of at least six near Ban Muangkhay on 25 Jan; a foursome downstream of Pak Phoun on 4 Feb; a total of 28 between 18°18'48"N, 101°29'39"E and 18°16'22"N, 101°27'12"E; in total seven in the Don Vao complex; six in ones and duos between the Thai–Xaignabouli border and 18°04'27"N, 101°47'02"E; and one at Ban Kengmo. Also, three at the island off Ban Mai on 26 Sep 2004 and six opposite the town of Paklay on 30 Mar 2010 (JWD).

Many Sep–Oct records may have been of birds on migration (this bird is a winter visitor to South-east Asia). As the species is not tied to the river channel, channel-only counts probably underestimate the numbers in an area. The dry-season 2012 count supports the suggestion of Duckworth *et al.* (2002) that the Upper Lao Mekong channel supports a nationally important total of wintering birds, although considering numbers at this and other important areas in the context of habitat extent (see also numbers in Duckworth *in press*), densities may well be low in the survey area.

#### **Small Pratincole *Glareola lactea***

None was recorded during either wet-season survey, on 2 Oct 2004 or in Sep–Oct 2011. The dry-season survey found: at least 15 near Ban Muangkhay; 95 around Don Hon and in the exposed mosaic upstream of it; five from Ban Muangliap downstream to 18°24'20"N, 101°35'32"E, possibly all commuting birds; four upstream of Ban Houaylay-Noy; a total of 239 in many sites between the town of Paklay and the Xaignabouli–Thai border; a total of 489 between that border and Ban Vang; 146 between Ban Vang and Don Chan; 54 between Don Chan and Don Nou; and 331 between Don Nou and the island off Ban Mai, with 20 on the island itself. Some of these counts may have been underestimates, but to a much lower extent than the counts in Duckworth *et al.* (2002): the comparative figures for the stretch between the town of Paklay and the island off Ban Mai are 218 in 2000 and 1279 in 2012, effectively proving the suspicion in

Duckworth *et al.* (2002) that the counts from a non-stop boat were “major underestimates”. Of the stretches not counted in dry-season 2012, 17 were found between the town of Paklay and Ban Houaylay-Noy on 23–24 Mar 2012 (JWD), and large numbers may be present between the island off Ban Mai and Vientiane town (the species is common in the channel by the town; e.g. Thewlis *et al.* 1998). The 2012 count is certainly not a complete count, but it may not be a huge underestimate. The species’s aerial nature and the survey’s frequent night stops (much feeding is crepuscular) may have given a closer to complete count in wide-exposed-bed stretches than with territorial ground-feeders such as River Lapwing.

Also, at Paksang one on 15 Feb 2004 and seven on 16 Mar 2008; seven around Ban Namxong on 31 Mar 2010; and one just upstream of Paksang (at 18°52'57"N, 102°06'39"E) on 10 Apr 2010 (JWD).

This species, even more than Little Ringed Plover *C. d. jerdoni*, is tied to very wide rivers (and this is well shown by its near absence between the town of Louangphabang and Don Hon, where much of the channel is narrow and there are only short stretches with wide exposed bed); the Mekong thus supports an outstanding proportion of the Lao population. By comparison with figures in Duckworth *et al.* (2002), the survey area seems of great importance; but it may well be the best counted long stretch of the Mekong in the country. Even this being so, simple comparison based on channel morphology the length of the Lao Mekong suggests the survey area should support a high proportion of Lao breeders, and it is sure to be of national importance. Breeding birds tolerate high levels of human activity. The chief conservation uncertainty is the location of the Lao population in the wet season; this remains completely unknown, despite extensive searches in almost every conceivable habitat in Lao. As well as the Mekong mainstream between Vientiane city and the town of Louangphabang, the Vientiane plain with its many standing wetlands, the large Nam Ngum 1 and Nakai reservoirs, the Xiangkhouang plateau wetlands and parts of Siphandon have all been searched (David-Beaulieu 1944, Cunningham 1998, Duckworth in press, JWD, RJT). It seems as if they must all leave Lao PDR, as seems to be the case for at least much of Cambodia (e.g. Timmins 2008a).

### **Little Egret *Egretta garzetta***

In total, eight on 2 Oct 2004. Counts totalling 75 over 27–30 Sep 2011, with another 20 in total probably this species (and most of the 1064 unidentified egrets [Appendix A4.1] were either this species or Cattle Egret). In dry-season (mid-winter) 2012, nine in total between Ban Muangkhay and Ban Hatkeo on 25–26 Jan, then none until 31 Jan near Ban Pakmet. Thereafter generally distributed (237 counted, maximum flock size 30) until end of survey at the island off Ban Mai on 14 Feb. Always common in Lao PDR at migration seasons (including Sep–Oct), this species was rare over winter in the 1990s (Duckworth *et al.* 1998a) but has recently shown a phenomenal increase in several parts of the country, evidently reflecting major drops in gun-use in agricultural areas (Duckworth in press). The 2012 counts for the survey area compared with those for Sangthong in 1996 (Duckworth 1996 – none) and the Paklay–Vientiane Mekong Duckworth *et al.* (2002 – a total of one possibly this species, against 215 in the same stretch in 2012) dramatically illustrate this change. Birds fed in most sorts of wet channel habitats, with numbers probably highest in backwaters amid large open sandbars and other areas of good visibility. Time has been insufficient to compile and present all the incidental records from the survey area.

### **Cattle Egret *Bubulcus ibis***

In total, two on 2 Oct 2004. Counts totalling at least 338 over 28 Sep–2 Oct 2011, with a count of 160 near Ban Khokfak on 1 Oct; most of the 1064 unidentified egrets (Appendix A4.1) were either this species or Little Egret. In dry-season (mid-winter) 2012, highly localised but common at least locally: one late afternoon on 28 Jan near Ban Pakhoun; 110 in roost-flight (not all confirmed as this species) evening of 7 Feb 2 km

downstream of Don Phoung; three near 17°53'46"N, 101°36'41"E on 9 Feb by day, with buffalos; one flew over (ex-roost?) downstream of the town of Sanakham on 10 Feb; 540 (not all confirmed as this species) mostly coming from the Sangthong direction to roost on the trees of a large permanent island near Ban Houyla in the evening of 13 Feb; and four downstream of Don Konkong by day on 14 Feb.

Most observations were of flying birds going to and from roosts, the few observations in the channel itself involving birds associated with domestic stock. As with Little Egret, Cattle Egret has shown a remarkable increase of overwintering birds in the last 20 years (Duckworth in press). By comparison, a month's survey in Sangthong (whence probably came most of the several hundred birds counted on 13 Feb 2012) in Feb–Mar 1996, spending a lot of time in villages and agricultural areas with many livestock, did not record the species at all (Duckworth 1996); nor did the survey of the Paklay–Vientiane Mekong in Jan 2000 (Duckworth *et al.* 2002). The patchiness of records on the current survey (notably the rarity around the town of Paklay) suggests there is considerable scope for continued increase. Time has been insufficient to compile and present all the incidental records from the survey area.

#### **Large-billed Crow *Corvus macrorhynchos***

None was seen on 2 Oct 2004. A duo at Ban Houaysouy (19°14'25"N, 101°49'06"E) on 13 Sep 2011 and 13 at Don Hon on 16–17 Sep (M. R. Bezuijen *in litt.* 2012). In the wet-season 2011 survey, at least 19 birds were recorded, all above the Lao–Thai stretch. All but 3–5 recorded were within the Ban Muangliap–Ban Thadua stretch, with nine around Don Hon. In the 2012 dry-season survey, birds were almost ubiquitous between 19°11'03"N, 101°49'18"E and 18°16'22"N, 101°27'12"E; in addition, three singles and two duos were seen between 18°07'56"N, 101°23'21"E and 17°51'52"N, 101°29'30"E, the species was heard a little upstream of 17°53'46"N, 101°36'41"E, two were seen upstream of 18°10'58"N, 101°10'38"E and one landed on a huge sand-flat upstream of Ban Kengmo. Estimating numbers in the main area is hampered by the bird's mobility. Many dozens are present, with the following large counts: 32 downstream to roost from Ban Houaykhekhet (18°49'58"N, 101°50'26"E), evening of 30 Jan; 17 upstream ex-roost at 18°40'51"N, 101°48'00"E after dawn on 1 Feb; a pre-roost gathering of 16 at Don Hon on the afternoon of 2 Feb (possibly with some overlap in birds with former); and a daytime flock of 21 near the mouth of the Nam Phoun. Also, 98 birds were seen in ones, duos and small groups by day.

Historically, this species was abundant in North Lao PDR, but these numbers are the highest recorded in modern times in the North; only two other parts of the North - Phongsali province and the Nam Ngum reservoir and lower plain - have yielded counts exceeding a dozen (e.g. David-Beaulieu 1944, Duckworth *et al.* 2002, Fuchs *et al.* 2007, Duckworth in press). Duckworth *et al.* (2002) concluded that crows were almost extirpated from the Upper Lao Mekong, a conclusion which may well be sound for the areas they visited (Ban Xiangkok – Louangphabang town and Paklay town – Vientiane city): nearly all the crows on the present survey were in the stretch not covered in 2000. Louangphabang town – Paklay town. This is surely a real distribution pattern: the dry-season boatman said, as the survey was beginning, that he sees crows regularly only between Ban Thadua and the town of Paklay; and the observations during the survey corroborated this. Like the ground-nesting species, crows seem associated with areas of relatively complex channel with relatively low human population densities.

Reasons for the strong national decline have been speculated on in some detail (Duckworth *et al.* 2002, Fuchs *et al.* 2007). The threat of direct hunting (of adults, chick and eggs) has generally been discounted, but without convincing rationale. It is commonly stated that local people do not specifically hunt crows; this is easily verified by the fact that crows are still extant in North Lao PDR, in areas where hornbills, large pigeons, large raptors and other such birds are largely extirpated. This crow, away from towns and farmland, is ecologically localised in Indochina and, therefore at the landscape scale is at best a low-density

species. Moreover it is not a forest species, but is tied to the very open habitats favoured by people. It would have been eradicated before the forest species like hornbills and big pigeons were it favoured quarry, as has happened for a number of species with similar ecological characteristics, amongst them Green Peafowl *Pavo muticus* and White-shouldered Ibis. But, a more meaningful question to ask of a local person than “do you [habitually, by implication] hunt crows?” is “do you know of anyone who has in their lifetime ever killed a crow or taken or destroyed eggs and chicks, or suspects that such has occurred?”. RJT and JWD have never witnessed such an event, but have seen such with other commonly ‘non-hunted’ species (e.g. Long-billed Vulture *Gyps tenuirostris*, various egret species, cormorants; Timmins 2006, Timmins & Sechrest in press); and in Bokeo province in March 2012, JWD observed at least one crow with wing-feather damage from a gun-blast. Shooting a crow is clearly a rare occurrence, but rare occurrences can have significant impacts, when statistics allow. The human population density of North Lao PDR is small by global standards, but compared with crow densities it is enormous. Low levels of crow-hunting per person might easily have resulted in the current crow density but still be consistent with a general belief that ‘people do not hunt crows’. Other reasons are possible, and in fact a combination of factors is probably likely, including poisoning by consumption of contaminated fish, either as a by-product of the technique of ‘poison fishing’ (BirdLife International 2012, Timmins & Sechrest in press) or deliberately (Fuchs *et al.* 2007). The huge loss of crows from urban and agricultural habitats of North Lao PDR probably occurred too long ago (see Duckworth & Tizard 2003) for today’s generation to have meaningful insight on why it happened.

#### **Jerdon's Bushchat *Saxicola jerdoni***

On 2 Oct 2004, 11 were seen: a male near Ban Ang-Noi; two males near 18°13'12"N, 102°04'46"E; a pair and a male near Ban Pakchanh; a male at 18°02'08"N, 101°45'44"E; two single males just downstream of Chiang Khan; a male at 17°52'33"N, 101°26'34"E; and a male by Ban Sakai. All were in tall grass; no *Homonoia* had yet appeared above the water level. Four at Don Vao on 18 Sep 2011, in similar habitat (M. R. Bezuijen *in litt.* 2012). In wet-season 2011, small numbers, mostly males, were seen in exposed tall grass and *Mimosa pigra* patches in the channel below the town of Paklay; as in 2004, *Homonoia* was largely or entirely submerged. A morning spent in the channel mosaic below Ban Khokkhaodo detected at least 37 birds, at least 26 of them males and only definitely one female. This gives some indication of the numbers present at that time and not detected from a boat.

In the dry-season 2012 survey, many hundreds, probably into the low thousands, were found (in some areas the species was far too common to allow meaningful counting without detracting from the ability to seek high-priority species). Mostly only small numbers (below a dozen) were seen, in defined spots where the exposed channel bed was wide, between Ban Muangkhay and 18°53'18"N, 101°47'28"E, with none at all on 28 Jan, but many at Ban Houaykheo. From 18°57'00"N, 101°48'04"E to 17°51'47"N, 101°32'28"E (29 Jan – 8 Feb) suitable habitat was widespread and the bird equivalently so. In much of this stretch, there were fewer than 4–5 birds visible or audible from one spot, but around the town of Paklay (from 18°18'48"N, 101°29'39"E to the downstream end of the Don Vao complex) the species was startlingly abundant, with 15 or more males visible from a typical spot with good all-round visibility. Numbers were high even in areas close to the town with heavily degraded bushland (in places mostly bare rocks) and even on the big Don Vao complex, with few rocks and bushes growing mainly from sand, although elsewhere in Lao PDR these habitats are not much used (Duckworth *et al.* 2002). Downstream of here, none was seen, and habitat was not suitable, almost to the town of Sanakham. From the town of Sanakham to Don Nou, many (with several areas where they were so common as to be uncountable, particularly on the Thai side) were again present. No optimal habitat (*Homonoia*-dominated bushland on rocks) was found downstream of the rocky bushland-dominated exposed channel bed at Ban Ang-Noi, nor could any birds be found in other sorts of woody channel vegetation. Prolonged song was heard, and prominent-perching males seen, throughout the survey. Few birds were seen in grass, in contrast to the wet-season, even in areas with large grass-stands close to good habitat.

Also, at Paksang about 30 on 15 Feb 2004 and several on 16 Mar 2008; around Don Chau there, at least six on 27 Nov 2005 (RJT); eight males and one female in highly degraded bushland in the town of Paklay and upstream to Ban Houaylay-Noy on 24 Mar 2010; uncountable numbers, including fresh juveniles, around Ban Namxong on 31 Mar 2010; three males just upstream of Paksang (18°52'57"N, 102°06'39"E) on 10 Apr 2010 (JWD).

The total population in the survey area must be huge, and may be a significant part of the Lao population. However, the bird is also widespread in montane secondary scrub in the northern highlands where it has potentially a very wide distribution. There is no evidence in this habitat for the very high density populations in favoured parts of the Mekong channel (Duckworth in press). Why it eschews the various other sorts of bushy landscape in Lao PDR, e.g. lowland secondary scrub, is unclear.

Duckworth (1997) wondered where the Mekong channel birds went in the wet-season, when the *Homonoia*-dominated bushland is under water. It may be that some go to channel grass-stands (Plate 4.3), which still project extensively from the water at the highest levels, but the 2011 wet-season count around Don Vao of only 37 birds, in an area well explored by small boat, when many hundreds are there in the dry season, shows that major movement (in terms of numbers of birds involved) is occurring. While many could have been overlooked in wet-season 2011 because of the route taken by the speedboat, the low numbers found by much better survey conditions on 2 Oct 2004 suggest this movement is not simply within the same general area of the channel. Moreover, both 2004 and 2011 observations took place right at the end of the wet season, so the bushchats seen had perhaps not spent all wet-season in the channel, but were early returning birds from somewhere else.

The furthest downstream record along the Mekong ever, and perhaps the most southerly in the world, is from Ban Thanasanghin (Duckworth *et al.* 2002), only 12 km downstream of Ban Ang-Noi. Only small patches of *Homonoia* were found here (although not all areas were checked) and the downstream limit of breeding may be around Ban Ang-Noi. The only conceivable threat to the survey area's population is habitat loss through major alteration of water-flow characters which removes the seasonally inundated bushland.

#### **Black-collared Starling *Sturnus nigricollis***

On 2 Oct 2004, 12 were seen: duos at the island off Ban Mai, at 18°13'12"N, 102°04'46"E, and downstream of Ban Sakai, and a group of six near Ban Thonpeung. During the wet-season 2011 survey only four groups were seen, of 1, 4+, 6 and 3+, widely spaced. The dry-season 2012 survey found a localised distribution: 12 groups of 1–4 birds between 18°53'18"N, 101°47'28"E and Ban Muangliap, and 16 groups of 1–16 between the town of Sanakham and Ban Kengmo. Additionally, a big large sturnid roost in trees of a large permanent island near Ban Houyla in the evening of 13 Feb sounded as if it contained many of this species. While the species may not have been absent from the intervening areas, it was certainly very rare. In the dry-season survey, many were feeding within the channel, mostly in areas of short turf among domestic bovids, but many were in bank-top trees. Because the species feeds also in open bank-top habitats the counts in both seasons are surely large underestimates of the total present in the river corridor.

As with egrets, large non-forest sturnids have shown a phenomenal increase in the survey area since the mid 1990s (Duckworth in press). By comparison, two months' survey in Sangthong in 1996, spending a lot of time in villages and agricultural areas with many livestock, did not record the species at all (Duckworth 1996); nor did the survey of the Paklay–Vientiane Mekong in Jan 2000 (Duckworth *et al.* 2002). As with egrets, the explanation with sturnids is doubtless the great reduction in projectile hunting in agricultural areas (Duckworth in press). By comparison with numbers along wide rivers in southern Indochina, the numbers seen were small and if current trends continue, the species can probably become much more common.

Time has been insufficient to compile and present all the incidental records from the survey area, but two were recorded at Paksang on 15 Feb 2004 (JWD) and there are many other records since.

#### **Common Myna *Acridotheres tristis***

One on 2 Oct 2004, upstream of Ban Mai. None in Sep–Oct 2011. In the dry-season survey there were few observations given the habitat covered: one singing in the town of Louangphabang on 25 Jan 2012, four (and [5]) at Ban Thadua on 27 Jan; 3–5 in roost flight over Don Vao on 5 and 6 Feb; two on a tall mid-channel rock downstream of Ban Houayla on 12 Feb and later that day seven flying from Lao PDR to Thailand to roost. Additionally, a big large sturnid roost in trees of a large permanent island near Ban Houyla in the evening of 13 Feb may well have contained dozens or hundreds of this species. Because the species feed mainly in open bank-top habitats, the counts in both seasons are surely large underestimates of the total present in the river corridor.

As with Black-collared Starling and wintering egrets, this myna has shown a very rapid population growth, from widely extirpated, in North Lao PDR over the last 15–20 years, evidently in response to much decreased projectile hunting in residential and agricultural areas. By comparison, two months' survey in Sangthong in 1996, spending a lot of time in villages and agricultural areas with many livestock, did not record the species at all (Duckworth 1996); nor did the boat-based survey of the Paklay–Vientiane Mekong in Jan 2000, although one (only) was seen in the town of Paklay on 7 Jan (Duckworth *et al.* 2002). This is less of a channel-feeding species than are White-vented Myna and Black-collared Starling. Time has been insufficient to compile and present all the incidental records from the survey area.

#### **White-vented Myna *Acridotheres cinereus***

None on 2 Oct 2004. During the entire wet-season 2011 survey there were only two records of *Acridotheres* mynas, both on 27 Sep: one of at least three, felt to be this species, and a duo, unidentified. In dry-season 2012 there were no records above the town of Paklay, but 22 were seen on Don Vao on 5 and 6 Feb, and nine groups of 1–18 birds were seen between Ban Vang and Ban Kengmo. Additionally, a big large sturnid roost in trees of a large permanent island near Ban Houayla on the evening of 13 Feb may well have contained dozens or hundreds of this species. Because the species feeds also in open bank-top habitats, the counts in both seasons are surely large underestimates of the total present in the river corridor.

As with Common Myna and Black-collared Starling, this myna is in the midst of a massive and rapid reoccupation of large parts of North Lao PDR when it was almost eradicated by the early 1990s (Duckworth *in press*). By comparison, two months' survey in Sangthong in 1996, spending a lot of time in villages and agricultural areas with many livestock, did not record the species at all (Duckworth 1996); nor did the boat-based survey of the Mekong between the town of Paklay and Vientiane city in Jan 2000. Time has been insufficient to compile and present all the incidental records from the survey area, but three were recorded at Paksang on 15 Feb 2004 (JWD) and there are many other records, including some of large flocks, since.

#### **Pale Martin *Riparia diluta***

Two or more birds were observed on 30 Sep 2011 with a few Barn Swallows and Wire-tailed Swallows at the upstream tip of Don Hon. This species has not certainly been recorded from Lao PDR. Identification is cautious because local variation in the Plain Martin populations is not well documented. However these birds differed from Plain Martins seen a few days earlier, and from Cambodian Plain Martins, with which RJT is more familiar. These birds were most like the South Asian resident race *R. d. indica*, with a diffuse

indistinct breast band, pale but not particularly contrasting rump, and very shallowly forked tail. They differed from *R. paludicola* only in having a paler throat with a more distinct two-tone face, and a rump less prominently pale. Identification could only be determined with collection of specimens.]

### Plain Martin *Riparia paludicola*

On 2 Oct 2004, 43 were seen: one at Ban Ang-Noi; two at Paksang; eight at 18°13'12"N, 102°04'46"E; two near Ban Pakchanh; three upstream of 18°02'10"N, 101°59'53"E; and 27 downstream of Chiang Khan. In the wet-season 2011 survey, several large aggregations were seen in the Lao–Thai stretch between Vientiane and the town of Sanakham, including one of probably over 200 birds. Only a single bird was detected further upstream, and none were found above the town of Paklay (but see account for Pale Martin). In the dry-season 2012 survey, birds were again highly localised in distribution: two at 19°00'15"N, 101°47'46"E and four at 18°58'36"N, 101°47'46"E on 29 Jan; 30 widely spread (almost every survey sector) from 18°53'18"N, 101°47'28"E downstream to Don Hon (but not around the island itself) during 30 Jan – 1 Feb; and 302 widely spread (almost every survey sector) from the town of Sanakham to the downstream end of exposed rocky channel around Ban Kengmo during 10–14 Feb. Unlike in the wet season, and consistent with previous seasonal findings, most records were of single figures, with a few flocks of up to 15, two of 20, and one each of 30 and 60 birds.

Also, up to six at Paksang on 15 Feb 2004 and 16 Mar 2008, and five just upstream of Paksang (18°52'57"N, 102°06'39"E) on 10 Apr 2010 (JWD); and around Don Chau there, at least two on 27 Nov 2005 (RJT).

At 18°08'55.33"N, 102°11'54.89"E, birds were actively prospecting nest sites in the eroded edge of a small island in wet season 2011. Sexual chasing was apparent almost everywhere. Plain Martins were seen during the dry season; no attempt was made to look for nests given the near impossibility of suppressing their location from the boatman, and the threat this might cause (see below). Birds watched briefly appeared essentially similar to the Cambodian breeding population with which RJT is more familiar; having a relatively dark chin, throat and uppermost breast and a relatively prominent (but not sharply demarcated) pale rump and very little fork to the tail. JWD noted no difference from previous observations in Lao PDR in birds in any stretch; nothing suggested the presence of Pale Martin anywhere.

This consistently localised distribution (wet-season 2004 and 2011, and dry-season 2012) contrasts with the dry-season survey of 2000 (which covered only Paklay–Vientiane), which found 11 of the 34 birds counted between the town of Paklay and the Thai–Xaignabouli border, an area where none were found in 2011–2012. Without question, Plain Martin is much reduced in Lao PDR from numbers before 1950 (Duckworth *et al.* 1999, 2002). This retraction in recorded distribution since 2000 is likely to indicate a genuine difference given the much higher survey effort in 2012 than in 2000. Even if some birds persist in the stretch between the town of Paklay and the Thai border, this strongly suggests declines in Lao PDR are continuing during the 2000s, corroborating findings (albeit inconclusive) from the Nam Ou (Fuchs *et al.* 2007). The larger numbers recorded in 2011–2012 than in 2000 plausibly simply reflect the great differences in survey intensity and certainly should not be taken to suggest an increase.

There is no obvious habitat-related reason why the species (Plate 4.4) should decline and, implausible though it sounds for such a small bird, human nest-robbing (the species breeds in colonies in self-dug burrows in sand cliffs) is probably the main threat.

There is no evidence of any breeding birds remaining in Lao PDR downstream of Vientiane (Thewlis *et al.* 1998, Duckworth *et al.* 1999, 2002, Timmins & Robichaud 2005), although the Siphandon area has probably not been covered well enough to be sure that a few small colonies do not remain. However, the occasional

modern records in far South Lao PDR are plausibly dispersing birds from Cambodia. The colony around Ban Xayfong, near the southern tip of the Casier-sud downstream of Vientiane city, mentioned in Duckworth *et al.* (2002) was confirmed to persist up to at least 2010 (JWD own observations) and may be the current downstream limit of Lao distribution. The survey area probably holds a fair proportion of the Lao population. Large numbers were found between Ban Xiangkok and the town of Louangphabang in 1999–2000 (many more than were found in the survey area during that survey), but their current status is unknown. They may not persist in such numbers.

#### **Wire-tailed Swallow *Hirundo smithii***

On 2 Oct 2004, 58 birds were found: three at Paksang, six at 18°13'12"N, 102°04'46"E, duos near Ban Pakchanh and upstream of 18°02'10"N, 101°59'53"E, and five near Chiang Khan on the upstream leg, and a concentration of 40 in a few km as well as odd small numbers on return. In the wet-season 2011 survey, only a few were seen, scattered throughout the survey area downstream of Ban Thadua, with a minimum total of 15 birds recorded; yet on the herpetofauna survey 20 were seen between Ban Thadua and Ban Talan on 11–12 Sep 2011 (M. R. Bezuijen *in litt.* 2012). In the dry-season 2012 survey, 209 birds were counted. Although less localised than Plain Martin, they were by no means uniformly distributed: none between the town of Louangphabang and 19°41'22"N, 101°52'37"E; 23 duos, seven singles, two trios and a group of eight between there and 19°14'03"N, 101°49'17"E; none within 19°14'03"N, 101°49'17"E – 18°58'36"N, 101°47'46"E; five duos and four singles from 18°58'36"N, 101°47'46"E to 18°47'34"N, 101°50'44"E; none from there to 18°26'45"N, 101°37'31"E except for three duos and a single around Don Hon and adjacent exposed channel; two duos and two singles from 18°26'45"N, 101°37'31"E to 18°24'20"N, 101°35'32"E; then none from there to Keng Khoutkhou (just downstream of the town of Sanakham), except a duo and a single at 18°18'48"N, 101°29'39"E, and a single at the upstream extent of wide exposed channel bed downstream of the town of Paklay. From Keng Khoutkhou to 18°10'58"N, 101°10'38"E the species was ubiquitous, with 47 duos, 10 singles and a group of four counted. The downstream-most records were of two round Ban Ang-Noi and one at the Narrows (18°01'29"N, 102°22'31"E).

Also: three at Paksang on 15 Feb 2004 and at least six there on 16 Mar 2008, including one flying over the plain 50 m from the channel (JWD); around Don Chau there, a total of six on 27 Nov 2005 (RJT); two singles on 15 Feb 2004 between Paksang and Ban Kokmuat, one feeding over channel mosaic, the other over a freshly felled bamboo-dominated fallow, about 500 yards from the channel; one over the Mekong-side road at the edge of exposed channel mosaic in Muang Meun on 10 Apr 2010 (JWD); and two just upstream of Paksang (18°52'57"N, 102°06'39"E) on 10 Apr 2010.

The difference in numbers between wet and dry seasons 2011–2012 is probably of no biological significance: most wet-season birds present were probably missed, because the speedboat-driver actively avoided, by a wide margin, areas of rocky channel whenever possible. Moreover, the chance element of recording the species is well shown by the return journey of 2 Oct 2004: most of the birds seen on return were not seen on the outward journey. This may be either because the species goes high to feed under certain conditions, or because it loaf in inconspicuous perches. Less likely is that birds leave the channel: other than the two out-of-channel sightings detailed above, JWD has only once in Lao PDR seen the species outside the channel (near Pakxan, also within a few hundred yards of the channel).

In the dry-season, no birds were seen any significant distance from rocky cliffs and crags in the channel, on which they nest (and several nests were found, without specific effort). The distribution was thus quite similar to that of Jerdon's Bushchat, with the exception of two stretches: the stretch round the town of Paklay, where the swallow was rare, because tall rocks were rare, but the bushchat was common; and the long stretch centred on Ban Thadua where cliffs and crags were common, as was the swallow, but the exposed bed was mostly too narrow to hold bushchats.

In both wet and dry seasons 2011–2012, group sizes seen were small: never more than three recorded together in the wet season, and eight in the dry. Evidently, even by late Sep in 2011, the large post-breeding flocks that form (e.g. the 40 on 2 Oct 2004, and in the Ban Nasa–Paksang area, 163, 327 and 200–500 on 14 and 15 Jul 1996 and 26 Sep 1999, respectively; Thewlis *et al.* 1998, Duckworth *et al.* 2002) had already broken up. Birds may therefore already have returned to their dry-season breeding habitat. Most observations in the wet season were obviously associated with rocky sections of channel; the species evidently maintains this tight habitat association through the year with, for example, no records yet in the (rockless) Vientiane city Mekong.

The survey area supports a fair proportion of the Lao population. Unlike Plain Martin, it is not common north of the town of Louangphabang (Duckworth *et al.* 2002, Fuchs *et al.* 2007), but it remains widespread and common in the southern half of the country wherever wide rivers have suitably rocky stretches (Thewlis *et al.* 1998, Duckworth *et al.* 2002, Timmins & Robichaud 2005). It might seem that for a small, non-colonial breeder, the only predictable threat to this species in Lao PDR would be damming of large rivers, which could drastically reduce breeding habitat proportionate to the decrease in seasonal change in water levels. However, nests are easy to find, and RJT's suspicion from Cambodia is that human robbery of their contents may be suppressing numbers there, particularly where channel outcrops are small and simple and thus nests are easily found. Consistent with this, the gaps in the distribution of the survey area within areas of rocky channel tend to be in stretches with narrow and simple rocky outcrops. However, there is no way of telling that this is not a habitat-driven distribution pattern, without evidence of former occupation of such areas.

#### **White Wagtail *Motacilla alba alboides* [resident breeding race]**

The resident race of White Wagtail *M. a. alboides* is very distinct from the other commonly occurring races in Lao PDR (*M. a. leucopsis* and *M. a. ocularis*), and indeed from any that might conceivably occur other than as extreme vagrants, in all plumages except juvenile, which is worn only briefly (Alström & Mild 2003, Fuchs *et al.* 2007). Despite this, White Wagtails were rarely recorded by subspecies in the 1990s, and the Lao status of *M. a. alboides* remains poorly known.

On 2 Oct 2004, most White Wagtails were not identified to form, because of the survey's focus on regionally threatened species, but duos of this race were noted at 18°02'08"N, 101°45'44"E and just upstream of Ban Pakchanh; dozens of *M. a. leucopsis* were identified. In Sep–Oct 2011, the race was only detected from Don Hon and upstream, with none upstream of Ban Thadua; the minimum total count was of 51 birds. In dry-season 2012, none were seen from the town of Louangphabang downstream until 19°42'57"N, 101°53'12"E; they were then almost ubiquitous (although sparse in much of 18°55'20"N, 101°47'46"E–18°49'11"N, 101°50'45"E) until a little upstream of Ban Mouang (itself at 18°21'30"N, 101°33'E), with one a little further downstream at 18°18'48"N, 101°29'39"E. The only records downstream of here were of a single and a duo at Keng Khoutkhou near the town of Sanakham, and of two single songsters and two pairs within a few kilometers (both up- and downstream) of Don Chan.

During the breeding season (when many birds in prolonged song and in sexual display were seen), birds were tied to stretches with extensive tall rock cliffs; low boulders amid unconsolidated sediment were not sufficient. In the upstream part of the survey area (upstream of the town of Paklay) its distribution was fairly similar to Wire-tailed Swallow, although there were several stretches where the wagtail was common but the swallow scarce or even absent; both were almost absent between the town of Paklay and the town of Sanakham; but in the extensive rocky-dominated lengths between the town of Sanakham and Ban Ang-noi, the wagtail was extremely rare and the swallow common. This is the southern limit of the wagtail's world breeding distribution, and here it was only in the areas of the tallest rock-cliffs. Feeding birds ranged freely into sand, silt and gravel flats and overlapped widely with *M. a. leucopsis*.

This subspecies is almost sedentary (at least in Lao PDR), but does disperse to some extent in winter, e.g. one record in the Vientiane city Mekong channel (Fuchs *et al.* 2007). Its breeding distribution in the Lao Mekong upstream of the town of Louangphabang is not clear (Duckworth *et al.* 2002) but it is presumably as common as in the survey area where there are tall rock cliffs. Moreover, it breeds also on small forest streams (similar to those used by Brown Dipper *Cinclus pallasii* and Plumbeous Water Redstart *Rhyacornis fuliginosus*) in Phongsali province – including extensively in areas lacking rocky cliffs, the rock occurring merely as water-level bars and boulders (Fuchs *et al.* 2007). Such streams are widespread in the northern highlands and the Mekong probably therefore forms a much less significant part of its Lao population than for the breeding hirundines. As with the other rocky-area breeding passerines, the only obvious threat to it is habitat loss through changed water levels.

#### **Baya Weaver *Ploceus philippinus***

No birds were recorded, but a group of four or more old nests probably of this species was seen in trees amongst tall grass at the edge of a channel sandbank (Don Sang; 18°04'28"N, 102°25'34"E) on 29 Sep 2011.

Baya Weaver is scarce and local in Lao PDR, but the other two weavers known from the country, Streaked Weaver *P. manyar* and Asian Golden Weaver *P. hypoxanthus*, are both considerably less common and are even more threatened nationally (Thewlis *et al.* 1998, Duckworth 2009a, in press). All are difficult to survey in September–February, and in general, can be very elusive when not nesting.

#### **Red Avadavat *Amandava amandava***

A flock of at least nine on a seasonally-exposed small sandy islet with much tall ‘marram’ grass, in the minor channel braid between the Lao ‘mainland’ and the large Mekong island (with land permanently above water) Don Konkong (between Ban Thanasanghin and Ban Kengmo) at 18°04'26"N, 102°17'24"E.

This is the second Lao record, the only previous one being from rice paddies at about 18°02'N 102°35'E in west peri-urban Vientiane in on 1 Oct 2005 (P. Bourdin in Duckworth 2009a). Nothing about the small islet or the adjacent habitat obviously suggested why the avadavats were there and not on the many other seasonally-exposed sandy areas of channel with much tall ‘marram’ grass. The birds were confiding, in that they had a very close flush distance, but shy in that once flushed they disappeared deep into the grass and were lost to sight for ¼ hour until someone walked into the grass patch from behind to flush them out. Others could thus easily have been overlooked. Without a better understanding of the causes behind this species’s undoubtedly rarity in Lao PDR, it is difficult to propose meaningful conservation measures; a first step would be to determine if it occurs regularly in the Don Konkong area, which is only c.30 km in a direct line from the 2005 Lao record. Large flocks have been found recently in previously poorly-surveyed parts of north-east Thailand, over the Mekong from the Vientiane plain, and indeed a minimum of 170 at Nong Samrong on 7 March 2007 was the highest count for any site in Thailand (P. Bawden in Robson 2007).

#### **Notes on selected bird species not found during 2011–2012**

In the 1990s–2010s there have been many multi-week bird surveys of large Lao areas where the habitat fundamentally remains little converted, most involving at least one of the present surveyors. More than any other such area, the present survey area has lost a phenomenal number of species through human factors, overwhelmingly overhunting (including collection of nest contents). Some species seem already to have been in decline by the early 20th century (Little Cormorant and Indian Skimmer), and the paucity of historical information means that it will never be certain exactly what would remain in the survey area had it not been hunted out.

No species was found for which the habitat is suitable, but that was expected to be extirpated as only resilient species were left. The historical expeditions demonstrated the survey-area presence of some hunting-sensitive species (marked \*) or showed their occurrence both up- and downstream of the survey area (marked ^), while others are inferred likely to have been present based on regional status. For some, even all of them, occasional individuals may still visit or even remain, but it is reasonable to conclude, based on the last 20 years of survey in the Mekong basin, that they are basically now absent from the survey area. These comprise White-winged Duck *Cairina scutulata*, ^Pied Kingfisher *Ceryle rudis*, Crested Kingfisher, Masked Finfoot *Heliopais personata*, Great Thick-knee (last seen in October 2004), \*Indian Skimmer, \*River Tern (last seen in January 2000), Mekong-breeding Little Tern *Sterna albifrons*, \*Black-bellied Tern, Brahminy Kite *Haliastur indus*, Lesser Fish Eagle *Ichthyophaga humilis*, \*?Grey-headed Fish Eagle, three species of vulture *Gyps* and *Sarcogyps calvus*, \*Little Cormorant, \*White-shouldered Ibis, ^Spot-billed Pelican, \*Painted Stork (these two latter species might start to occur again, following reversals of declines at the Tonle Sap colonies in Cambodia; Sun & Mahood 2011), Black Stork *Ciconia nigra*, ^Woolly-necked Stork *Ciconia episcopus*, ^Black-necked Stork *Ephippiorhynchus asiaticus* and one or two species of adjutant *Leptoptilos*.

Various other species known from the stretch, or immediately upstream or downstream, have probably never been common, at least in the 20th century, and the lack of records on the present survey does not imply that they no longer occur, or are becoming rarer in the survey area. These species comprise three Palaearctic wintering geese *Anser*, Ruddy Shelduck *Tadorna ferruginea*, Common Shelduck *Tadorna tadorna*, Mandarin Duck *Aix galericulata*, various Palaearctic migrant dabbling ducks *Anas* and diving ducks *Aythya*, Pallas's Gull *Larus ichthyaetus* and other large gulls, and wintering Purple Heron *Ardea purpurea* (there is little suitable habitat for overwintering; birds doubtless occur, probably quite commonly, on passage).

Several species are less easy to categorise: they were certainly or plausibly formerly regular perhaps common in the survey area; still survive, sometimes in good numbers, elsewhere on or near the Lao Mekong; and may or may not still use the survey area: quails *Coturnix* and buttonquails *Turnix* (the dry-season survey was probably too early for these to be in the channel), Cotton Pygmy-goose (found in Oct 2004), Garganey *Anas querquedula*, Eurasian Thick-knee, Red-wattled Lapwing *Vanellus indicus* (found in Oct 2004), Darter (likely to be becoming more common as a dispersing non-breeder, with the reversal of decline at the Tonle Sap colonies in Cambodia; Sun & Mahood 2011) and Great Cormorant (likely to be becoming more common as a winter visitor, because numbers in northern Thailand are increasing; P. D. Round verbally 2012).

Finally, among the channel species not found and where this would be of conservation concern had they formerly occurred there, are those with a regional distribution too poorly known to be sure whether they ever were in the survey area: Comb Duck *Sarkidiornis melanotos*, Spotted Wood Owl *Strix seloputo*, Blyth's Kingfisher *Alcedo hercules* and Blue-eared Kingfisher *A. meninting* (these kingfishers may never have occurred regularly on such a wide river), breeding Blue-throated Bee-eater *Merops viridis* (its former Indochinese breeding distribution remains entirely unclear), Indian Nightjar *Caprimulgus asiaticus* (one of the least-known of Lao birds), Sarus Crane *Grus antigone*, Wood Snipe *Gallinago nemoricola*, locally-breeding Black Kite *Milvus migrans govinda*, White-bellied Sea Eagle *Haliaeetus leucogaster*, two species of wintering Palaearctic migrant *Aquila* eagles, breeding egrets, Black-headed Ibis *Threskiornis melanocephalus*, Asian Openbill *Anastomus oscitans*, Black-billed Magpie *Pica pica*, Asian Pied Starling *Sturnus contra*, Vinous-breasted Starling *Sturnus burmannicus*, White-eyed River Martin *Pseudochelidon sirintarae*, Striated Grassbird *Megalurus palustris* and Black-headed Munia *Lonchura malacca*.

#### 4.4.2 Mammals

##### **Macaque *Macaca***

Fleeting glimpses of macaques on Don Hon during the wet-season survey probably involved animals released there, apparently by local people for making merit. These pose an extra threat to ground-nesting birds there.

A captive Assamese Macaque *M. assamensis* was photographed in Ban Pakneun in 2011 by M. R. Bezuijen (*in litt.* 2012); given its habitat use in Lao PDR of hill and mountain areas (Timmins & Duckworth 2013), it is most unlikely this animal came from the survey area. A captive young Pig-tailed Macaque *M. nemestrina* was photographed in Ban Donsok (= Ban Veungkin) in 2011 by R. Glemet (*in litt.* 2012); this is also unlikely to have been taken in the survey area, because it is a forest species (e.g. SUFORD in press), but it might survive close to the river's bank.

### **Phayre's Leaf Monkey *Semnopithecus phayrei***

This species, Globally Threatened—Endangered on the *Red List*, does not use the channel and is irrelevant to the current project; however, nearby dry-land populations may be of some conservation significance. The number of people and the degree of deforestation along most of the survey area suggests it is very unlikely that animals persist adjacent to the Mekong but it is perhaps possible that a group might survive in one of the 'spirit' forests. Interviews suggest that small numbers may remain relatively close to the river in localised areas especially the stretch from the town of Paklay to Ban Thadua, and perhaps on large karst massifs (Table 4.4). This monkey is apparently still surprisingly widespread in its Lao range (Timmins *et al.* 2013).

**Table 4.4.** Interview results for khang [= Phayre's Leaf Monkey *Semnopithecus phayrei*] and Nak (nam) [= otter (Lutrinae)].

Date and location	Khang	Nak (nam)	Interviewee(s)
28 Sep, 17°51'04"N, 101°31'59"E	>10 years, and long way from river	Never seen	Old man
28 Sep, 17°51'49"N, 101°32'45"E	Saw a hunted animal in a different village last year	Never seen animal, sees footprints frequently every dry season, otters steal fish	Young man
28 Sep, 17°52'57"N, 101°32'25"E	Vague reports of presence further upriver (c.2 km from Mekong)	Most never seen. One had seen signs for the first time in Oct/Nov 2010, but in a different river stretch in the Lao–Thai border section (Ban Kokniew – Thai village).	7 younger men
28 Sep, 17°51'34"N, 101°30'19"E	Never seen; reportedly still some on west bank in remnant forest back from the river	Never seen; reportedly in Houay Khing /K. Mai	Middle-aged man
28 Sep, 17°51'34"N, 101°29'31"E	Old man heard calls last year close to farm; also heard that someone in village hunted one last year.	One saw hunted animal 5–6 years ago in Ban Kanyeng (close to Paklay). Otherwise never seen. Old man saw hunted animals in his youth and signs	Middle-aged & Old man
28 Sep, 17°52'11"N, 101°27'49"E	Never seen	Never seen	Young man (Houay Khing is 3–4 km downstream on east)
29 Sep, 18°24'27"N, 101°36'03"E	A youngster hunted last month, live on karst relatively close to village. White on chin.	Not seen for >10 years, occasional before then, but talked about Ban Phatoung where someone had otter remains in last 2–3 years.	Old man

Date and location	Khang	Nak (nam)	Interviewee(s)
30 Sep, 18°40'15"N, 101°48'02"E	One saw animals c.3 months ago c. 3–4 hrs from river, another 2–3 months ago in a different area, but similar distance from river, the third hasn't ever seen them. Pale 'white' around eyes.	Not seen otters in area, but talked about Ban Phatoung where someone has otter remains.	Three middle-aged men
30 Sep, 18°40'59"N, 101°47'54"E, Ban Phatoung field houses	Less than 3 hrs from village, one man saw 3 weeks ago, the other c. 1 year ago.	One saw an otter 8 – 9 years ago in Nam Tung, never seen animals in Mekong, but do see footprints each year a few times in the dry-season in Mekong.	Two middle-aged men
30 Sep, 18°42'57"N, 101°48'38"E, Ban Phatoung	--	Stuffed otter caught by fish hook (first said)/ fish trap (later in conversation) in Nam Tung this year ( <i>Duan</i> 3–4, Lao calendar).	Woman and man
30 Sep, Ban Phatoung	--	When young, otters not so hard to see in Mekong; he hunted an otter c.20 years ago. About 7 years ago boat traders asked for 'otters', but for about the last 3 years they haven't been back asking.	Old man
1 Oct, Ban Houaykhekheth	Last saw 5–6 years ago on Phou Phetloy. Face 'grey'; when asked if any white, said around mouth.	Not seen otters or signs in Mekong. At Pak Nyan, 3 years ago saw otter swimming and chased it. Person in village shot an otter in Houay Nyan 7–8 years ago (which he saw); skin was sold.	Man
1 Oct, 18°59'08"N, 101°48'23"E	3–4 hrs from Mekong, saw c.1 month ago	Never seen otters or signs along Mekong, but sees signs 'often' along Houay Inn (downstream on east bank), c.1 hr from Mekong.	Man (and Old man)
1 Oct, 19°08'25"N, 101°48'28"E	Never personally seen in forest, but people from the village hunt every year, he saw one hunted animal last year.	In last dry-season saw footprints and fish remains 'many' times. 20–30 years ago otters very common, and saw actual animals not just signs. Three years ago a man in the village caught an otter in a 'trap' in Nam Houn, far from Mekong.	Older man

Date and location	Khang	Nak (nam)	Interviewee(s)
2 Oct, 19°35'19"N, 101°47'45"E	--	More than 10 years since seeing otters in tributaries or the Mekong. Talked of hunting otters with baited explosives prior to this.	Man and old man
2 Oct, site as last	Never seen	Never seen otters or their signs (except perhaps fish remains 7–8 years ago).	Younger man and several women.

All reports of *khang* less than five years old were supported by descriptions of a tail longer than 50 cm and reference to a colour in the grey spectral range, however relatively few interviewees mentioned paleness on the face and none accurately described the face pattern. But this lack of accuracy in recalling what, to a biologist, would seem prominent details of the species in question, is in RJT's experience typical of local people's descriptions, even when interviewees are clearly familiar with the animal(s) in question.

#### Unidentified crested gibbon *Nomascus*

A distant group was heard east of the Mekong, at a bearing of about 150°, from 18°57'07"N, 101°48'04"E (near the mouth of the Nam Pouy) at 06h20–06h30 on 30 Jan 2012. Some village people in an agricultural shelter on the east bank were questioned after the bout of calling: they reported that only one group remained (the area of discussion was not clear, but was more than a typical village area), in a small patch of forest (probably less than 100 ha, possibly much less) within a landscape of extensive shifting cultivation. The taxonomy of crested gibbons remains uncertain, but because the animals are only c.55 km from the type locality of *N. leucogenys* (Ban Muangkhi, 18°27'N, 101°46'E; Fooden 1987), they may well be that species (Globally Threatened—Critically Endangered on the *Red List*). This species does not use the channel and is irrelevant to the current project; however, it is of some conservation significance. Lao PDR holds by far the majority of remaining *N. leucogenys* in the world, but even in this country it is severely threatened (Duckworth 2008b). Given the fragmented habitat and evident heavy hunting in the area, this would be a challenging place to conserve a very small number of gibbons. But, vocal characters are important in gibbon taxonomy and this may be among the closest sites to the type locality of *N. leucogenys* where recordings could still be made.

#### Otters (Lutrinae)

No field evidence found during either survey, but there was no specific search effort. A stuffed animal was photographed in Ban Phatoung in Sep–Oct 2011 (Plate 4.5), reportedly caught in 2011 in the Nam Tung (Table 4.4). The owner refused to allow a sample to be taken for analysis to provide a clear species identification. It was for sale, and was still there in Jan–Feb 2012. However, the owner was then away, and had locked the cabin, so, while the otter was visible through a chink, it was again impossible to collect a sample.

Interviews were equivocal as to the survival of otters in the survey area. They have clearly been hunted out from most of it, but a few wary animals might persist, visit or have recolonised. If so, these animals may largely go undetected because of current unfamiliarity many residents have with otter signs, especially the younger generation who never experienced otters when they were much more common than at present (Table 4.4).

Up to four species may have been present in this stretch of the Mekong, ranging in global *Red List* status from Near Threatened to Endangered. The ecological niches of all four are too poorly known in Southeast Asia to allow prediction of species-specific former status in the survey area. All four species are heavily persecuted regionally with widespread extirpation of all species especially from lowlands where most waterways and waterbodies are navigable to some extent (e.g. Poole 2003, Dersu 2008, Timmins & Sechrest in press).

The stuffed animal's identity is unclear but after extensive discussion with N. Duplaix (*in litt.* 2012) and examination of photographs, it seems most likely to have been a Smooth-coated Otter *Lutrogale perspicillata*: no long guard hairs, shown by both species of *Lutra*, seem to be present, and various features rule out Asian Small-clawed Otter *Aonyx cinereus*. Although the paws and rhinarium do not at first sight look like *Lutrogale*, they may have deformed during drying. Remains of locally caught otters are presently only rarely seen in Lao PDR, although Stuart Ling (*in litt.* 2010) photographed a fresh otter skin (either *Lutra* or *Lutrogale*) in Ban Poungpa, Muang Meung, Bokeo province in 2010; it had been shot by a hunter from the local Lahu, apparently in the Nam (River) Kha.

### **Small Asian Mongoose *Herpestes javanicus***

One among extensive *Homonoia*-dominated bushland on sand at 18°24'20"N, 101°35'32"E on 3 Feb 2012. Although not frequently found on typical wildlife surveys in Lao PDR, this reflects the species's effective absence from evergreen forest, where surveys are concentrated, and it survives widely even in areas heavily settled; it is of no conservation significance (Duckworth *et al.* 2010b).

### **Unidentified tree squirrels *Callosciurus***

These squirrels were found on 30 Jan (three heard at two sites) and 2 Feb 2012 (one seen in the karst forest of Pha Liap). The animal seen showed no obvious differences from *C. f. williamsoni*, and this is the upstream point along the length of land east of the Mekong that provided the animals used to describe that taxon. However, on field views a similar-looking animal, *C. erythraeus* 'Lak-52', which is known only from an observation of animals in trade at Ban Lak-52, Vientiane, cannot be excluded (Timmins & Duckworth 2008). The taxonomy and thus identification of *Callosciurus* is unresolved in this part of Lao PDR, both sides of the Mekong (Duckworth *in press*, SUFORD *in press*), but it is unlikely that any of the taxa make significant use of the channel, and so they are outside the scope of the project.

### **Unidentified striped squirrels *Tamiops***

These squirrels were heard on 27 (east and west) and 28 (east and west) Jan, and 4 Feb 2012, in degraded secondary forest outside the channel. Based on known distributions (Timmins & Duckworth 2008, SUFORD *in press*) those west of the Mekong are probably *T. mcclellandii* and those east *T. maritimus*. Neither is of any conservation concern, nor likely to use the channel to any significant degree.

### **Ryukyu Mouse *Mus caroli***

One was caught and released on Don Vao (18°07'11.56"N, 101°23'55.09"E; 210 m) on 18 September 2011 at 10h45 by M. R. Bezuijen and R. Glemet. The mouse was under a small log (Plate 4.6). It was measured with dial calipers and a 50 g Pesola spring balance: inner ear (notch to upper tip of ear): 10.2 mm; tail length: 63.8 mm; head-body length: 64.5 mm; head length: 23.0 mm; length of right hind foot: 10.7 mm; weight: 10 g. It was an adult male (large testes), with upper incisors orange-yellow with shallow 'V', and lower incisors pale yellow. As of 1999, this species had not been recorded in north Lao PDR, with Francis (1999) treasuring records only from the Centre and South of the country. However, there have been many rodent surveys of agricultural areas since then.

### **Siamese Hare *Lepus peguensis***

No signs of hares were found in 2011–2012, and given the effort put into searching for thick-knee tracks, this means they cannot have been common, and may well be rare, if still present. By contrast signs (footprints and faeces) were found easily in the Mekong channel at Sangthong in 1996 (Duckworth 1996) and were found there again on 27 Nov 2005 (RJT), in a visit too brief to assess status beyond 'present'.

The hare is not dependent on wide river channel habitats at the national level, but makes (or made) extensive dry-season use of them. Although listed as Not At Risk in Lao PDR by Duckworth *et al.* (1999), this categorisation may no longer be accurate. This hare does not use closed forest, so there are no large areas of prime habitat for it with low human densities. Worse, it seems to occur only in level terrain below about 600 m in Lao PDR. It is avidly hunted. There is little recent information on its Lao status. The Nakai plateau held a large population pre-inundation (Dersu 2008), but most of the suitable habitat has now been lost. The Nam Ngum plain retains fairly extensive, but much fragmented, suitable habitat and hares are now reportedly extremely rare there (Duckworth in press). Current status in the lowland deciduous dipterocarp forests of the South and Centre (where readily recorded in the 1990s; e.g. Duckworth *et al.* 1994) has not been assessed.

During each wet season, the hares that were in the channel in the dry season presumably moved onto the adjacent plain, mostly very narrow. This is where the human activity is concentrated, and the very low numbers of dry-land quarry birds recorded (see above) show the hunting pressure here. Thus, it is plausible hares have been extirpated from the survey area, or nearly so.

## 4.5 Discussion

### 4.5.1 Overview of the bird community in the survey area

Bird communities found in the survey area were much as expected for the habitats present and levels of human activity. This section briefly describes some observations about the relationship between bird communities and habitats in the Mekong channel, and supplements more detailed discussions in other sources (e.g. Duckworth *et al.* 1998b, 2002, Timmins 2006). The waters were receding during the wet-season survey; birds were potentially returning to the approximate stretches of the river in which they would attempt to breed (if indeed they had left at all).

The highest concentration of significant species was, not unexpectedly, associated with areas of complex morphology of the seasonally exposed channel. This is most likely to be because of at least three reasons. First, such areas generally have emergent rocks and are partly swift water, and are thus difficult to navigate. This provides birds in such areas some protection from people, and in the case of species such as ducks actual vegetative cover in which to stay hidden. Additionally such areas generally offer more (per unit length of river) resting and feeding opportunities than do other less complex sections of the river. Third, these sections in the dry-season offer more breeding habitat, per unit length of river.

The entire survey area has frequent use by people and regular boat traffic. The reach from the town of Paklay upstream to Ban Thadua has the lowest density of settled people, and this seems to be reflected in the distributions of some birds, especially Large-billed Crow. The distributions of smaller species (e.g. resident race of White Wagtail, Jerdon's Bushchat, Little Ringed Plover, Small Pratincole) are likely to relate more to habitat factors than to harvesting. Determining the relative distributions of some species such as River Lapwing and Spot-billed Duck was hindered by the uneven survey coverage in both wet and dry seasons. Unfortunately, it is these species for which understanding is most important. However, Savannah Nightjar may be a fair indicator of presently important areas for a suite of larger ground-nesting birds: the records conspicuously came from areas with very wide and long exposed channel bed comprising a mix of rocks, bushland, sand, grass, standing water and streams/braids. That River Lapwing did not everywhere show high densities in these areas no doubt in part reflects the difficulties of surveying this species in two-dimensional landscapes, particularly those difficult to cross (which are, in turn, those most likely to hold larger numbers). But numbers of the waders and some other birds that feed at and near the water's edge may strongly relate to the length of land-water interface per unit length of river, whereas this is less likely to be the case with the nightjar.

The dryland bird community adjacent to the project area has been severely hunted. Four weeks of almost non-stop observation during daylight hours gave no records of any hornbill, even Oriental Pied Hornbill *Anthracoceros albirostris*, any imperial pigeon *Ducula* or any cuckoo dove *Macropygia*, and very few of green pigeons or resident large raptors. All these species are well recorded flying over river during river-bird surveys, when present. In this context, the presence of Red-breasted Parakeet in several areas, with flocks of up to 14 birds, and the relatively healthy numbers of Hill and Golden-crested Mynas was somewhat surprising. Although galliforms are often said to be hunting-sensitive, this is not so of forest species in Indochina, which are atypically resilient for their size (Brickle *et al.* 2008, Duckworth 2009b); this was further corroborated by records of the three loud-calling species to be expected at these altitudes, Scaly-breasted Partridge, Red Junglefowl and Grey Peacock Pheasant. The regularity with which Koels were heard was remarkable for North Lao PDR, and probably reflected proximity to Thailand: during dry-season 2012, only three were heard in 14 days in the Lao–Lao stretch, compared with records at seven sites (some with more than one) on the six days in the Lao–Thai stretch.

#### 4.5.2 Overview of the large mammal community in the survey area

Although the methods used were not shaped around large mammals, the substrate in much of the survey area was excellent for tracks. There are few large wild mammals left in the channel. Small carnivore prints, felt sometimes to be small cats (lacking any claw impression) were found a few times. No ungulate prints that were not likely to be those of domestic stock were found. No monkey prints were found. This grim community-level assessment was corroborated by the dry-season boatman's account. When he started plying this stretch, several decades ago, it was not uncommon in the more remote parts to see wild pigs *Sus*, muntjacs *Muntiacus*, Sambar *Cervus unicolor* and macaques (presumably Rhesus Macaque *M. mulatta*) out in the channel; but he said he had not seen any wild large mammal other than mongooses for many years. It is quite plausible that small numbers of these other mammals survive, but not in numbers significant for their conservation at the national level. In any case these, even the macaque as well as the gibbon and squirrels detected and leaf monkeys reported, are primarily visitors to the channel from the dryland habitats, rather than residents of the project area. They all have more than ample habitat protected in the NPA system where, incidentally, their conservation (in large blocks of habitat with few settlements and limited vehicle/boat access) is a far more practicable proposition.

Potentially more important are the several strongly riverine species, most notably otters. Only a dedicated sign search could clarify their present status, and in the time available this was inappropriate: the risk of finding no signs, based on the wet-season interviews, was high. Yet, even if this occurred, it would not show that otters were locally extirpated. Sensibly, if project activities are undertaken in this area, otters would be built in as part of them, because even if absent they could recolonise anyway. Another species of high global conservation interest might occur, Fishing Cat *Prionailurus viverrinus*. Other than a chance finding of a hunted skin or skull, this is extremely difficult to find and identify, without dedicated camera-trap surveys, and it is not even clear if it occurs in Lao PDR at all (e.g. Duckworth *et al.* 2010a). It does survive in areas of heavy human use (e.g. Cutter & Cutter 2009) and therefore it cannot be known for sure that it does not occur in the survey area.

In sum, while it would be interesting to know more about the large mammals of this stretch of the river channel, it is implausible that any species other than otters and perhaps Fishing Cat would be found that occur in nationally significant numbers and uses the channel and thus would be a sensible project focus. Different conclusions might be drawn about bats and small non-volant mammals.

#### 4.5.3 Threats to birds and large mammals

All parts of the study area have regular human use and presence. The section from the town of Paklay to Ban Thadua appears to have the lowest levels of use and the lowest density of settlement. In the wet-season,

farming activities divert many people's attention from natural resource exploitation, and high water levels restrict many river channel activities. Therefore, few people are found in the area during this time. During the dry season, however, the channel held many temporary camps of people, mostly gold-panners and -diggers. There was so much activity that finding an overnight site convenient to moor the boat and camp that was not already occupied was sometimes challenging. Most of these seasonal residents have dogs, and often chickens. Domestic ungulates (buffalos, cattle, hogs and goats) were widespread even in rugged rocky stretches, probably mostly owned by adjacent villagers rather than itinerants. Even if these people and their animals did not actively kill wildlife, their ubiquity, numbers and activity would render much of the survey area unsuitable for shy wildlife. Investigations in Cambodia have clarified the high levels of nest robbery by people of ground-nesting channel birds (e.g. Claassen 2004, Sok *et al.* 2012). Dogs were often seen roaming in small packs across the seasonally exposed bed, sniffing for food, presumably a fair proportion of which would be nest contents. Hunters with guns were only seen in the channel in the stretches with the broadest exposed bed, and there only rarely. Shots were also not commonly heard.

Most of the longer sandbars (those exceeding 800 m or so) had commercial sediment extraction operations in progress, using cranes and lorries. These operations are much less damaging than the ubiquitous villager/itinerant pressures, because they are restricted to a few sites. It is uneconomic to work small areas or to mine areas with extensive exposed bedrock; both are common along the river. Moreover, the attributes of sites worked (large, flat and readily accessible) mean that while they were probably supporting huge numbers of some now very rare species a century ago (see, e.g., the comments on locations of various large waterbirds in Delacour & Greenway 1940b; such scenes are still visible locally in Southeast Asia, e.g. the Hukaung valley in Myanmar), they have probably long lost their sensitive species.

The role of human activity in vegetation change in the channel is unclear. Bushes are widely cut for firewood, but it seems unlikely that this has resulted in major contraction of the distribution of channel bushland, given that such habitat remains extensive even near large towns such as Vientiane city and the town of Paklay. Several kilometers of bushland had been recently cleared from the east channel around Paklay (Plate 4.7), reportedly to allow easier large-scale extraction of stones. While looking dramatically destructive, the area destroyed represents an insignificant proportion of the total area of such habitat. Even where not cleared, bushland near large towns (the west channel around Paklay is a good example) is often visibly degraded; with sparser, shorter bushes and reduced canopy coverage. Nonetheless, it is unclear if this is directly harmful to any species: densities of Jerdon's Bushchat are as high around Paklay as have been recorded anywhere in the world, even though much of the west channel and all the east channel is approaching a moonscape. Harvested species would be more likely to suffer, given that nests would be found more easily; but at current levels the proportion of seriously degraded bushland is too low to seem likely to have a material effect on numbers even of these birds.

There is no evidence to suggest, in this part of the Mekong, declines in small bird species that do not make nests readily found by people. Species that have declined (some now extirpated) are mostly large (lapwing size or above) and thus choice targets as adults, young, or eggs for hunters and dogs. A few are colonial breeders in holes in sand cliffs (bee-eaters and martins), and the declining kingfishers are solitary breeders in similar sites. While it might seem implausible that human predation may drive declines in small hole-nesters, Cunningham (1998) documented the persistence with which locals further down the Mekong (in the Siphandon area) robbed these birds' nests. Somewhat surprisingly, some of the ground-nesting birds, which would be expected to be susceptible to nest-robbing atleast by dogs and children, remain abundant: Little Ringed Plover, Small Pratincole and Paddyfield Pipit. These are all small species, suggesting their nests are less easily found. Not all small ground-nesting species are doing so well: Little Tern, while scarcely bigger, is now almost extinct in the Mekong, but fortunately coastal populations survive in this region (Timmins 2008a). There is no evidence for declines for two of the smaller channel-associated species that nest neither on the ground nor in holes in sand cliffs; Jerdon's Bushchat and White Wagtail. The situation with Wire-tailed Swallow is less clear (see species account).

Totally new for this stretch of the Mekong, and indeed for the river downstream of China, is the change that a mainstream dam would bring. Active construction on the Xaignabouli dam is well underway. This will seriously reduce the seasonal amplitude in water levels upstream of the dam. These are responsible for maintaining the special habitat of the channel. Without lengthy annual submergence, the higher areas will turn to banktop habitat, as can be seen already on those islands projecting above the wet-season typical water level. These habitats support no special channel species. The lowest areas will become permanently submerged. Duration of exposure will shrink for somewhat higher areas, to be too short for vegetation and sediment conditions to remain as at present. The seasonally exposed zone will shrink in height and, thus, area. This is likely to reduce the populations of all channel-nesting species, including those small birds currently retaining large populations. The magnitude of reduction is difficult to predict, but is liable to be at least proportionate to the area of habitat lost. It may be more if the invertebrate food supplies of these birds drop further, through changed water speed, temperature, oxygen levels or other factors. For harvested birds, the increased ease of human access to those areas of suitable habitat that do persist is likely to mean that declines will be larger than simple loss of habitat. Effects may be particularly severe on Small Pratincole and Jerdon's Bushchat, which are rare in stretches where exposed channel or bushland, respectively are less than 100 yards wide atleast on one bank. If the dams also decrease seasonal amplitude in water level downstream, as is quite plausible and for a long way, then these species will be affected down- as well as upstream.

There is little to say about threats to large mammals in the survey area, other than that they have effectively operated almost to completion. There is no need to invoke anything other than persecution to explain the near-total loss of otters and, apparently, of use of the channel by species based in the adjacent dryland habitats.

#### **4.5.4 Overall conservation significance of the survey area for birds and large mammals**

In an international context, the overall significance of the Mekong between the towns of Vientiane and Louangphabang for bird and large mammal conservation is now low. It has diminished greatly during recent decades. The many hunting-sensitive species that were in this area only 50, in some cases 20, years ago that would have been of most conservation significance had they survived have been extirpated or nearly so. Non-hunting-sensitive species that are of conservation interest because their limited habitat use renders them vulnerable to changes in water flow are still present in good numbers.

At most 3–4 species detected are present in numbers of high regional (Southeast Asian) conservation significance: Spot-billed Duck, River Lapwing, Plain Martin and, if it occurs, Pale Martin. The duck and lapwing are somewhat hunting-sensitive, especially on tributaries where there are few areas of channel bed large enough to offer parts not repeatedly visited (even incidentally) by people. Plain Martins, in demonstrable decline in Lao PDR and the region (Thewlis *et al.* 1998, Robson 2008) are assumed also to be hunting-sensitive. As breeders in Lao PDR and adjacent countries, the duck occurs in large standing wetlands, or large landscapes of many small wetlands (Duckworth *in press*) while the others are tied to wide rivers. The Mekong mainstream thus holds special significance for these species.

Somewhat similarly, Savanna Nightjar may now be restricted in North and Central Lao PDR to wide river channels, presumably through anthropogenic mortality in some form. It is now present only on the widest stretches of exposed channel, with a total population being small in comparison with the large, non-threatened, regional population. Populations of a few non-hunting-sensitive breeding species are probably regionally significant; most notably Little Ringed Plover, Small Pratincole and Wire-tailed Swallow. In Lao PDR and adjacent countries, these three species are almost tied as breeders to wide rivers. Jerdon's Bushchat has a large population in the survey area, but also occurs in large numbers in the extensive degraded (scrub-dominated) northern highlands of Lao PDR (Duckworth 1997, *in press*). The resident breeding

subspecies of White Wagtail is tied to watercourses but also uses small streams in at least parts of Lao PDR (Fuchs *et al.* 2007). Both the bushchat and wagtail are about the southern limit of their world range in the survey area. The national conservation significance of a few species found cannot yet be assessed, but may be quite high: Blue-tailed Bee-eater (inappropriately timed survey), [Pale Martin (identification uncertainties)] and Red Avadavat (too few records for meaningful interpretation).

This remaining significance to bird conservation, greatly reduced in recent years as it is, largely stems from those stretches where the river channel has complex wet-season channel bed exposed in the dry-season, particularly with the widest stretches, and where human settlement density and use is lowest. The most important areas are likely to be:

A. From 17°59'38"N, 101°44'46"E downstream almost to Ban Vang, at 18°02'46"N, 101°51'11"E. This seems to have many fewer people than do stretches B and C, but the prime habitat is less extensive than either.

B. Downstream of Ban Vang, from 18°02'28"N, 101°54'36"E downstream to 18°10'44"N, 102°02'20"E. This is probably the best block: a massive area of seasonally exposed channel, with few dry-land topped islands to attract people out, and a well vegetated seasonally-inundated zone.

C. From the end of Stretch B down to 18°07'48"N, 102°12'58"E is similar to Stretch B, but with more people along the river and seasonally exposed habitat not quite so good or extensive (but still better than in the first stretch)

All of these are in the stretch where the Mekong forms the Lao–Thai border, and the contribution of the seasonally exposed bed on the Thai side is a vital part of their importance. In the stretch wholly within Lao PDR, the Don Vao complex downstream of the town of Paklay (D) has the most potential. However, it is much smaller than any of Stretches A–C, and is much more heavily used by villagers than these stretches. Perhaps the international security aspect in the border stretch reduces human activity; but Don Vao also has a much lower proportion than any of Stretches A–C where rocks hinder human access. Other than these four areas, it would be unhelpful to isolate spots of purported importance: the importance of the rest comes from having mile after mile of habitat. Much of the stretch wholly within Lao PDR has a rather narrow channel and cannot support in total large numbers of any species, even given the occasional widening out. This Lao–Lao stretch, however, holds the majority of breeding White Wagtails, which are not well represented in any of Stretches A–D.

The four stretches A–D, and the several parts of the Lao–Thai border stretch where extensive sandbars are exposed in the dry season but with otherwise simple channel, would formerly have held large numbers of several species now extremely rare in Southeast Asia but known historically from the survey area, e.g. breeding terns and foraging large waterbirds. In principle, with appropriate management, these species could rebuild their numbers: the phenomenal growth in resident large sturnids *Acridotheres* and *Sturnus nigricollis* and in wintering egrets in lower-lying North Lao PDR in the last 10–20 years, following great reduction in projectile hunting in residential and agricultural areas (Duckworth *in press*), shows what is possible for bird populations when threats are eased. Time, however, is running out for the populations of many species that could provide natural re-colonists of the survey area. The rugged parts of the within-Lao stretch have probably not lost so much, lacking the wide expanses of seasonally exposed channel bed and thus large populations of the ground-nesters and other large birds.

Adjacent to the survey area, the status of many species, especially quarry species, and the degree of habitat conversion on bank-tops and inland, speak eloquently of the intensity and ubiquity of human use of wildlife.

Only the hardiest of species now persist there. Small remnants of forest, most if not all ‘spirit forests’ remaining largely because of local taboos, may maintain residual populations of some species associated with riparian forest, such as fish owls, but these are too small to support regionally significant populations. Except from the most local of perspectives, this loss of dryland habitats and their wildlife is inconsequential to bird and large mammal conservation, because similar habitats remain extensive in the NPA system and, moreover, better suited to conservation management. By contrast, the channel habitats are among the best in the country for wide-river species, and that the surviving bird community is so devastated is disastrous for these species’ national conservation status.

Compared with the Mekong in northern Cambodia and southern Lao (Siphandon area), the survey area has little conservation significance for birds and large mammals. All the large and medium-sized hunting-sensitive species survive there in far better numbers (Timmins 2006, 2008a). A few small species in the survey area are absent from or rare in the Cambodian Mekong and major tributaries: Plain Martin, Wire-tailed Swallow, Jerdon’s Bushchat, the breeding subspecies of White Wagtail and, potentially, Pale Martin. Excepting the martins possibly but implausibly, this difference reflects natural geographic range rather than any human-induced contraction. The wagtail and bushchat are not tied to large rivers. Thus, the 2–3 breeding hirundine species are the only birds dependent upon large rivers with significantly greater populations in the survey area than in northern Cambodia.

Comparison with other Lao stretches of the Mekong and major tributaries is hampered by the pace at which river-channel birds are declining: the loss of River Lapwing from the Nam Ou (Fuchs *et al.* 2007) and of Black-bellied Tern from the Cambodian Xe San (and, thus, the Mekong catchment; Goes *et al.* 2010) have both occurred since most other Lao river stretches were last surveyed. Back then, Great Thick-knee and River Tern were readily seen within the survey area. There is no reason not to assume that declines similar to those in the survey area have not also proceeded in the remainder of the Lao Mekong and in the major tributaries. The survey area may thus contain some of the most significant reaches for birds in the Lao Mekong north of Siphandon.

No survey is comprehensive and this one undoubtedly overlooked some features significant to bird and large mammal conservation. ‘Known unknowns’ include the precise status of otters, Blue-tailed Bee-eater, Pale Martin and Red Avadavat in the survey area. However, these gaps apply to every survey. Without question, the survey area has lost most of its bird and large mammal species vulnerable to human predation, and with the impending Xaignabouli dam it stands to lose large proportions of even those species not so vulnerable.

05

## Amphibians and Reptiles



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## 5. Amphibians and Reptiles

### 5.1 Introduction

**A**mphibians and reptiles are the least known vertebrates in Lao PDR, and numerous records of species previously unrecorded in the country (e.g. Stuart 2005, Stuart & Heatwole 2008, Stuart *et al.* 2011b) and discoveries of species new to science (e.g. Rowley *et al.* 2010, Schneider *et al.* 2011, Stuart *et al.* 2012) continue to be made. The amphibians and reptiles of the ‘Upper Mekong’ of northern Lao PDR are particularly under-studied, and knowledge of that fauna is based primarily on the findings of two early expeditions.

Henri Mouhot (1826–1861), French explorer and naturalist, made natural history collections in the area of present-day Thailand, Cambodia and Lao PDR from 1858 to 1861 under the sponsorship of the Royal Geographical and Zoological Societies of London (Stuart *et al.* 2006b). Although his zoological interests were primarily in malacology and ornithology, Mouhot collected some specimens of amphibians and reptiles during his voyage (Mouhot 1864). On his final expedition, Mouhot left Bangkok on 12 April 1861, travelled overland, and arrived at the Lao town of Paklay (“Paklaie”) on the Mekong River, on 24 June 1861. He then travelled to Ban Thadua overland by elephant because of rapids in the Mekong, and from there completed his journey to the town of Louangphabang by boat up the Mekong (Mouhot 1864). He died of a fever near that town on 10 November 1861. Mouhot’s field notes and letters were published posthumously (Mouhot 1864), and his herpetological collections were sent to the Natural History Museum, London, where they were described by John Edward Gray and Albert Günther (e.g. Gray 1862, Günther 1864). New species of reptiles described from Mouhot’s fatal expedition to the Upper Lao Mekong, and that are still recognised as valid, include Keeled Box Turtle *Cuora mouhotii* (Gray, 1862) and Lao Wolf Snake *Lycodon laoensis* Günther, 1864. The locality of “Laos Mountains” or “Lao Mountains” was associated with Mouhot’s collections from his final expedition, and there has been considerable confusion in the literature about where that locality is. The “Laos” (or “Lao”) “Mountains” were stated by Gray (1862) to be in “Siam” and by Günther (1864) to be in far southern Vietnam (“Cochinchina”). Vogel *et al.* (2004: 20) correctly reported this locality to be the “Louangphrabang Range, western Laos, probably between Pak Lai (Xaigna Bouri province) and Luang Prabang (Louangphrabang province) (on the basis of Mouhot [1864])” (i.e., between the towns of Paklay and Louangphabang).

Malcolm A. Smith (1875–1958), British physician to the King of Thailand (Smith 1947) and a herpetologist, made an expedition to the Upper Lao Mekong around January 1920. His specimens were also deposited at the Natural History Museum, London. He described a single new species from this expedition, Lao Water Skink *Tropidophorus laotus* (Smith, 1923). He did not summarise his collection from this expedition in a single publication, but instead referred to some of his material in a number of publications (e.g. Smith 1922, 1923a, 1923b, 1931). His published Upper Lao Mekong localities included “Pak Lai [= Paklay] ... Muang Liep [= Ban Muangliap], Nong Kai [presumed to = Ban Nongkhai], Pak Maat [= Ban Pakmet], Pak Men [modern name not determined], and Hoi King [modern name not determined]”, all of which were “localities on the Mekong River, to the north and south of, and within 80 kilometers of, Pak Lai” (Smith 1923a: 778).

The lack of basic information on amphibians and reptiles for most lowland regions near rivers in Lao PDR is of particular concern because these regions support the nation’s highest human densities and are targeted for extensive further development; including hydropower, transport infrastructure and agricultural intensification. Such development is largely proceeding in the absence of ecological data that could assist in mitigating the potential impacts of these activities.

This report describes the results of a herpetological survey of the Mekong River in Louangphabang, Xaignabouli and Vientiane provinces, northern Lao PDR, undertaken in the wet season of September 2011 and in the dry season of March–April 2012.

## **5.2 Methods**

### **5.2.1 Survey localities and dates**

The wet season survey was conducted over 11–23 September 2011 during the peak height of annual water levels. Sampling was conducted along riverbanks and was limited to Lao PDR. Habitats along the west bank in Thailand were only observed by boat. Sampling began at Ban Thadua and ended at the city of Vientiane. The dry season survey was conducted over 14 March–2 April 2012 during the lowest annual water levels. Sampling was focused on forested areas, including land extending to about 5 km of the Mekong bank. Habitats along the west bank in Thailand were again only observed by boat. Sampling began at the town of Louangphabang and ended at the city of Vientiane. Sampling localities referred to in the text are listed in Table 5.1.

**Table 5.1.** Survey localities referred to in the text.

Locality	Province	District
Tad Kuangsi	Louangphabang	Louangphabang
Houay Ting	Louangphabang	Nan
Ban Pakneun	Louangphabang	Nan
Ban Pasak	Louangphabang	Nan
Tad Jao	Xaignabouli	Xaignabouli
Houay Deng	Xaignabouli	Xaignabouli
Ban Houaykhoulouang	Xaignabouli	Xaignabouli
Nam Pouy	Xaignabouli	Xaignabouli
Ban Talan	Xaignabouli	Xaignabouli
Ban Houaysouy	Xaignabouli	Xaignabouli
Ban Pakneun	Xaignabouli	Xaignabouli
Ban Khokakha	Xaignabouli	Xaignabouli
Ban Pakhoung	Xaignabouli	Xaignabouli
Ban Khokfak (local name: Ban Pakpouy)	Xaignabouli	Xaignabouli
Ban Donsok (local name: Ban Veungkin)	Xaignabouli	Kenthao
Ban Houayla	Xaignabouli	Kenthao
Ban Muangliap (local name: Ban Phaliap)	Xaignabouli	Paklay
Houay Liap	Xaignabouli	Paklay
Ban Pakmet (1)	Xaignabouli	Paklay
Ban Pakmet (2)	Vientiane province	Met
Tad Jang	Vientiane province	Met
Don Hon	Vientiane province	Met
Ban Sakai	Vientiane Capital	Sangthong
Ban Kengmo	Vientiane Capital	Sangthong

## 5.2.2 Sampling

The study area was surveyed by boat. Searches for amphibians and reptiles were made on foot during the day between 10h00 and 16h30 and at night between 18h30 and 23h30. Searches targeted riverbanks, streams, rock piles, wood debris, leaf litter, forest, rocky outcrops, paddy fields and scrub.

Spotlight surveys by boat were conducted during the wet season along the lower reaches of two forested tributaries entering the Mekong, the Nam Houng (13 September; nine person-hours) and the Nam Pouy (14–15 September, from the Mekong confluence to 5 km upstream; 12 person-hours).

Voucher specimens were caught by hand, preserved in 10% buffered formalin, and later transferred to 70% ethanol. Tissue samples were taken by preserving pieces of liver or muscle in DMSO/EDTA solution before specimens were fixed in formalin. Epidermal skin swabs were taken from amphibians (thighs, venter, feet) to assess the presence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis*; those results will be reported elsewhere. Specimens, tissue samples and skin swabs were deposited at the North Carolina Museum of Natural Sciences, Raleigh, North Carolina, USA, and the Faculty of Science, Department of Biology, National University of Laos, Vientiane, Lao PDR.

Specimen measurements were made with dial calipers to the nearest 0.1 mm (for small lizards and all frogs) or with a cloth tape rule to 0.1 cm (for large lizards and all turtles and snakes). Live weight was measured with a Pesola spring balance to the nearest 0.5 g (50 g balance), 1 g (100 g balance), 5 g (500 g balance) or 10 g (1,000 g balance). Measurements reported are total length (TL), snout–vent length (SVL), maximum straight carapace length (SCL) and plastron length (PL).

Survey coordinates and capture locations were recorded with a handheld Garmin eTrex Vista GPS (datum WGS84) during the wet season survey and a handheld Garmin GPSMAP 60CSx during the dry season survey (datum WGS84). Latitude and longitude readings from the wet season survey were converted to decimal degrees using the Federal Communications Commission online website (<http://transition.fcc.gov/mb/audio/bickel/DDDMMS-decimal.html>).

Global threat status is given for species categorised on *The IUCN Red List of Threatened Species* as Data Deficient, Near Threatened, Vulnerable, Endangered or Critically Endangered (IUCN 2012). National threat status is given for species considered At Risk in Lao PDR or Potentially At Risk in Lao PDR (Stuart 1999).

## 5.2.3 Interviews

Seven male residents between 51 and 82 years old, and who had always lived along the Mekong, were interviewed in seven villages about the historical occurrence of Siamese Crocodile *Crocodylus siamensis*. These villages were Ban Houaysouy (19.24022°N, 101.81829°E), Ban Pakneun (19.24000°N, 101.82406°E), Ban Khokakha (18.86759°N, 101.79800°E), Ban Pakhoun (19.16400°N, 101.81362°E), Ban Khokfak (18.94403°N, 101.79792°E), Ban Donsok (17.90172°N, 101.43253°E) and Ban Kengmo (18.05871°N, 102.30593°E).

Six male residents aged between 40 and 70 from five villages were questioned about the potential occurrence of a threatened turtle species, Asian Giant Softshell *Pelochelys cantorii*, in the study area. These residents were from Ban Houayla (17.82400°N, 101.52762°E), Ban Sakai (18.12644°N, 102.22445°E), Ban Houaykhoulouang (19.04671°N, 101.80024°E), Ban Kengmo and Ban Donsok (two; interviewed separately).

### 5.2.4 Limitations

The large size of the study area and brief survey duration required a rapid approach to sampling, and excluded the use of methods such as pitfall trapping that may have detected additional species. No site was surveyed for longer than three nights.

## 5.3 Results

### 5.3.1 Species recorded

Thirty-one species of amphibians and 34 species of reptiles were documented during the wet and dry season surveys (Table 5.2). Voucher specimens were obtained from all but seven of those species. Three species were documented only by field observations, and four species only by observations of captives in villages and markets (Table 5.2). In addition, plausible local information was given for the historical occurrence of one additional species, *C. siamensis* (see species account). A selection of the species found is illustrated in Plates 5.1–5.2.

Of the documented species, one is listed as globally Near Threatened, four as Vulnerable, and one as Endangered (IUCN 2012). Two are considered to be At Risk in Lao PDR and five to be Potentially at Risk in Lao PDR (Stuart 1999). The crocodile, which historically occurred in the study area, is listed as Critically Endangered (IUCN 2012) and At Risk in Lao PDR (Stuart 1999).

**Table 5.2.** Species of amphibians and reptiles observed during the wet and dry season surveys.

Siamese Crocodile *Crocodylus siamensis* is not listed because no evidence was obtained during the surveys that the species persists in the study area.

Taxon	Season	Evidence	Sampled Habitat
ICHTHYOPHIIDAE			
<i>Ichthyophis kohtaoensis</i>	Both	Voucher	Villages
BUFONIDAE			
<i>Bufo melanostictus</i>	Both	Voucher	Diversity of human-modified habitats
MEGOPHYRIDAE			
<i>Leptobrachium smithi</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Leptolalax minimus</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
MICROHYLIDAE			
<i>Calluella guttulata</i>	Dry	Voucher	Riverbank
<i>Kaloula pulchra</i>	Dry	Voucher	On roads
<i>Microhyla berdmorei</i>	Both	Voucher	Disturbed semi-evergreen forest
<i>Microhyla fissipes</i>	Both	Voucher	Diversity of human-modified habitats
<i>Microhyla heymonsi</i>	Both	Voucher	Disturbed semi-evergreen forest
<i>Microhyla pulchra</i>	Both	Voucher	Diversity of human-modified habitats
<i>Micryletta inornata</i>	Dry	Voucher	Disturbed semi-evergreen forest
DICROGLOSSIDAE			
<i>Fejervarya limnocharis</i>	Both	Voucher	Diversity of human-modified habitats
<i>Hoplobatrachus rugulosus</i>	Wet	Observed	Agricultural field
<i>Limnonectes gyldenstolpei</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Limnonectes taylori</i>	Wet	Voucher	Disturbed semi-evergreen forest
<i>Limnonectes limborgi</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest

Taxon	Season	Evidence	Sampled Habitat
<i>Occidozyga lima</i>	Wet	Voucher	Diversity of human-modified habitats
<i>Occidozyga martensi</i>	Dry	Voucher	Disturbed semi-evergreen forest
RANIDAE			
<i>Amolops cremnobatus</i>	Dry	Voucher	Disturbed semi-evergreen forest
<i>Odorrana chloronota</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Odorrana heatwolei</i>	Dry	Voucher	Little-degraded semi-evergreen forest
<i>Rana cubitalis</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Rana erythraea</i>	Dry	Voucher	Disturbed semi-evergreen forest
<i>Rana macrodactyla</i>	Both	Voucher	Agricultural field
<i>Rana nigrovittata</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
RHACOPHORIDAE			
<i>Kurixalus bisacculus</i>	Dry	Voucher	Disturbed semi-evergreen forest
<i>Kurixalus odontotarsus</i>	Dry	Voucher	Little-degraded semi-evergreen forest
<i>Polypedates leucomystax</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Rhacophorus kio</i>	Dry	Voucher	Little-degraded semi-evergreen forest
<i>Rhacophorus orlovi</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Theloderma asperum</i>	Dry	Voucher	Little-degraded semi-evergreen forest
GEOEMYDIDAE			
<i>Cuora mouhotii</i>	Wet	Observed	Village captives
TESTUDINIDAE			
<i>Manouria impressa</i>	Wet	Observed	Village remains
TRIONYCHIDAE			
<i>Amyda cartilaginea</i>	Wet	Observed	Village captive
GEKKONIDAE			
<i>Cyrtodactylus interdigitalis</i>	Dry	Voucher	Little-degraded semi-evergreen mixed with bamboo forest
<i>Dixonius siamensis</i>	Both	Voucher	Village and road through disturbed forest
<i>Gehyra mutilate</i>	Dry	Voucher	Village
<i>Gekko gecko</i>	Both	Voucher	Villages, disturbed and little-degraded semi-evergreen forest
<i>Hemidactylus frenatus</i>	Both	Voucher	Villages
<i>Hemidactylus platyurus</i>	Both	Voucher	Villages
<i>Ptychozoon lionotum</i>	Dry	Voucher	Little-degraded semi-evergreen forest
AGAMIDAE			
<i>Calotes emma</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Calotes versicolor</i>	Both	Voucher	Riverbank scrub
<i>Physignathus cocincinus</i>	Dry	Voucher	Little-degraded semi-evergreen forest
VARANIDAE			
<i>Varanus nebulosus</i>	Wet	Observed	Village and market captives
SCINCIDAE			
<i>Eutropis longicaudata</i>	Wet	Voucher	Riverbank scrub
<i>Eutropis macularia</i>	Dry	Voucher	Bamboo forest
<i>Eutropis multifasciata</i>	Wet	Voucher	Riverbank scrub
<i>Scincella cf. reevesii</i>	Dry	Voucher	Disturbed semi-evergreen forest

Taxon	Season	Evidence	Sampled Habitat
<i>Sphenomorphus maculatus</i>	Both	Voucher	Riverbank and semi-evergreen forest
<i>Tropidophorus laotus</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
XENOPELTIDAE			
<i>Xenopeltis unicolor</i>	Wet	Voucher	Disturbed semi-evergreen forest
PYTHONIDAE			
<i>Python reticulatus</i>	Dry	Observed	Little-degraded semi-evergreen forest
HOMALOPSIDAE			
<i>Enhydris plumbea</i>	Wet	Voucher	Riverbank and agricultural field
PAREATIDAE			
<i>Pareas carinatus</i>	Dry	Voucher	Little-degraded semi-evergreen forest
<i>Pareas margaritophorus</i>	Dry	Voucher	Disturbed semi-evergreen forest
COLUBRIDAE			
<i>Ahaetulla prasina</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Boiga cyanea</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Lycodon laoensis</i>	Dry	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Oligodon deuvei</i>	Wet	Voucher	Agricultural field
<i>Oligodon fasciolatus</i>	Dry	Voucher	Little-degraded semi-evergreen forest
<i>Xenochrophis flavipunctatus</i>	Wet	Voucher	Road through agricultural field
ELAPIDAE			
<i>Ophiophagus hannah</i>	Dry	Observed	Riverbank scrub
VIPERIDAE			
<i>Cryptelytrops macrops</i>	Both	Voucher	Disturbed and little-degraded semi-evergreen forest
<i>Popeia popeiorum</i>	Dry	Voucher	Little-degraded semi-evergreen forest

### 5.3.2 Accounts of significant species

#### Smith's Eastern Spadefoot Toad *Leptobrachium smithi* Matsui, Nabhitabhata & Panha, 1999

A single adult male from Nam Pouy (18.95561°N, 101.75085°E), a series of metamorphs from Pakneun (19.24016°N, 101.82471°E), Houay Deng (19.52756°N, 101.80831°E and 19.52364°N, 101.81487°E), Nam Pouy (18.95270°N, 101.73901°E), Houay Liap (18.51373°N, 101.65924°E), and Ban Pakmet (18.81210°N, 101.84889°E), and a series of tadpoles from Houay Deng (19.52364°N, 101.81487°E) of this species were taken in and along swift rocky streams in disturbed and little-degraded semi-evergreen forest between 248 and 330 m recorded elevation.

The adult (SVL 57.6 mm) had an orange upper half of the iris and blue sclera in life. The tadpoles are brown with scattered small dark spots on the body and tail, and with a light area bounded by two dark bands over the root of the tail. Both life stages are consistent with the original description of this species (Matsui *et al.* 1999). An 818 basepair fragment of the mitochondrial 16S rRNA gene from a specimen from adjacent Phiang district, Xaignabouli province, Lao PDR (GenBank accession number GQ995541; Brown *et al.* 2009) is nearly identical (uncorrected pairwise distance 0.121%) to that from a paratype of this species from Khao Chong, Trang province, Thailand (GenBank accession number AB530438; Matsui *et al.* 2010a), confirming the identity of this species.

*Leptobrachium smithi* is recorded in Lao PDR only from the northwestern part of the country, and is otherwise known from Phiang district, Xaignabouli province and Sanakham district, Vientiane province (Stuart 2005). It occurs throughout Thailand and into western Myanmar (Matsui *et al.* 2010a).

#### **Small Leaf-litter Toad *Leptolalax minimus* (Taylor, 1962)**

A series was taken at Tad Kuangsi (19.74849°N, 101.99153°E), Houay Ting (19.24506°N, 101.84217°E), Nam Pouy (18.95344°N, 101.74309°E and 18.95440°N, 101.75141°E), Ban Pakmet (18.82588°N, 101.84090°E, 18.81210°N, 101.84889°E and 18.81056°N, 101.84999°E), and Houay Liap (18.51457°N, 101.66069°E). The species was abundant on the banks of swift, cascading, rocky streams in semi-evergreen forest at 238–561 m recorded elevation. Males were calling during the dry season survey.

These conform to the original description (Taylor 1962) and expanded description (Ohler *et al.* 2011) by having a small body size (males SVL 26.6–29.4 mm, mean  $\pm$  SD 28.4  $\pm$  0.9, N = 10; females SVL 36.4–41.3 mm, mean  $\pm$  SD 38.5  $\pm$  1.7, N = 10), rudimentary webbing and no fringes on the toes, dark spots on the flanks, and an immaculate venter.

Ohler *et al.* (2011) reported the species in Lao PDR from Louangphabang, Xaignabouli and Khammouan provinces. That distribution included Ban Pakmet (as “Pak Mat”; p. 63) based on Malcolm Smith’s material in the Natural History Museum, London, but which they erroneously reported to be in Savannakhet province. It otherwise occurs in northern Thailand (Ohler *et al.* 2011).

#### **Lao Sucker Frog *Amolops cremnobatus* Inger & Kottelat, 1998**

A series of 10 specimens was found at a single site at Ban Pakmet (18.82588°N, 101.84090°E). These were on wet rock faces and tree leaves above a chute in a 1–2 m wide steep, swift rocky stream in disturbed semi-evergreen forest at 242 m recorded elevation.

These have a glandular tarsal ridge, visible tympanum, vomerine teeth, wide finger discs, and males with nuptial pads but no gular pouches. Males with nuptial pads (SVL 28.0–31.1 mm, mean  $\pm$  SD 30.1  $\pm$  1.2, N = 5) are slightly smaller than the holotype and paratype males (SVL 32.2–33.9 mm; Inger & Kottelat 1998).

The type locality is in Khammouan province, Lao PDR (Inger & Kottelat 1998) and the species has been reported in Lao PDR west to Kasi district, Vientiane province (Stuart 2005). It also occurs in central Vietnam (Nguyen *et al.* 2009). An examination of morphological and genetic variation among populations of this species is warranted.

*Amolops cremnobatus* is listed as Near Threatened (IUCN 2012).

#### **Heatwole’s Odorous Frog *Odorrana heatwolei* (Stuart & Bain, 2005)**

A single immature female was found at Nam Pouy (18.95561°N, 101.75085°E) on a steep bank 3–4 m above a 1 m wide swift rocky stream in semi-evergreen forest at 267 m recorded elevation.

The specimen has SVL 91.6 mm, developing white ova, and a brown dorsum with distinct, small, dark spots that is characteristic of the species (Stuart & Bain 2005).

This species is known only from the type locality in Phongsali province, Lao PDR (Stuart & Bain 2005). It probably occurs throughout northern Lao PDR, but it is a member of a taxonomically difficult group and is probably often misidentified. Ohler (2007) synonymised the species with *O. tiannanensis* (Yang & Li, 1980) but with insufficient evidence, and that synonymy is not recognised here.

### **Smith's Frog *Rana cubitalis* Smith, 1917**

An adult male and adult female were found at Nam Pouy (18.95477°N, 101.75029°E) and Houay Ting (19.24506°N, 101.84217°E) respectively, on the banks of swift, flat, rocky streams in semi-evergreen forest at 259–289 m recorded elevation.

These have distinct, narrow glandular dorsolateral folds and black tear drop-shaped markings around the tympanum. The male has an enlarged gland on the medial side of the forearm, a humeral gland near the corner of the throat, and lacks gular pouches. They agree with the original description and expanded descriptions by Stuart *et al.* (2006a; as its junior synonym *Rana nigrotympanica*) and Ohler (2007; as *Sylvirana cubitalis*), except that Smith's (1917) statement that the males have gular pouches ("external vocal vesicles") is in error (Stuart *et al.* 2006a, Ohler 2007).

This species has been reported in Lao PDR only from Phongsali province (Stuart *et al.* 2006a, Ohler 2007). It otherwise occurs in northern Thailand (Smith 1917, Ohler 2007).

### **Limborg's Fanged Frog *Limnonectes limborgi* (Sclater, 1892)**

A series was taken at Nam Pouy (18.95440°N, 101.75141°E and 18.95477°N, 101.75029°E), Houay Liap (18.51390°N, 101.66012°E), and Ban Pakmet (18.82588°N, 101.84090°E and 18.81210°N, 101.84889°E) near streams in disturbed and little-degraded semi-evergreen forest at 238–332 m recorded elevation.

These have small body size (the largest male has SVL 35.5 mm), males with enlarged odontoids, and reduced toe webbing reaching the middle subarticular tubercle of fourth toe as a fringe.

This species was long confused with *L. hascheanus* in Indochina, but that species is restricted to southern Thailand and Peninsular Malaysia (Inger & Stuart 2010). *Limnonectes limborgi* occurs from northern Myanmar to southern Vietnam, although it exhibits considerable genetic structure across that range and may contain additional, cryptic species (Inger & Stuart 2010).

### **Taylor's Fanged Frog *Limnonectes taylori* Matsui, Panha, Khonsue & Kuraishi, 2010**

A single adult female was taken at Ban Talan (19.33129°N, 101.83409°E) in a 1 m wide shallow rocky stream through scrub and disturbed semi-evergreen forest.

The specimen contains mature ova. It agrees with the original description (Matsui *et al.* 2010b) by having small body size (SVL 43.1 mm), a distinct, dark temporal stripe, dark markings on the dorsum and throat, and full webbing but with deep excisions between the toes.

This recently described species is a member of the *L. kuhlii* species complex, a taxonomically challenging group. The species was originally described based on material obtained from northern Thailand (Matsui *et al.* 2010b), but a molecular analysis extended the range of this species into western Myanmar and across most of northern Lao PDR (McLeod 2010).

### **Green Flying Frog *Rhacophorus kio* Ohler & Delorme, 2006**

A single male was found at Tad Jao (19.43653°N, 101.82927°E) on a tree branch 4 m above a small stream in semi-evergreen forest at 313 m recorded elevation.

The specimen has SVL 70.1, green dorsum, fully webbed hands and feet, webbing with a black spot and yellow distal border, and a single large black spot near the armpit.

This recently described species was split from the widely distributed *R. reinwardtii*. The type locality of *R. kio* is in Phongsali province, Lao PDR, and it has been reported in Lao PDR also from Bokeo (Ohler & Delorme 2006) and Houaphan, Xaignabouli and Khammouan provinces (Stuart 2005, as *R. reinwardtii*). It otherwise occurs in northern Thailand and northern and central Vietnam (Ohler & Delorme 2006).

*Rhacophorus kio* is listed as Vulnerable (IUCN 2012).

#### **Orlov's Flying Frog *Rhacophorus orlovi* Ziegler & Köhler, 2001**

One male and four females were found at Nam Pouy (18.95477°N, 101.75029°E and 18.95561°N, 101.75085°E), Houay Liap (18.50962°N, 101.65860°E), Ban Pakmet (18.82529°N, 101.83967°E), and Tad Jang (18.40989°N, 101.60354°E) on vegetation above rocky streams in disturbed or little-degraded semi-evergreen forest at 228–324 m recorded elevation.

These agree closely with the original description (Ziegler & Köhler 2001) by having medium body size (male with SVL 36.3 mm; females with SVL 42.0–47.0 mm, mean  $\pm$  SD  $44.7 \pm 2.3$ , N = 4), a sharp canthus rostralis, full hand webbing with a deep excision, no dermal flaps on limbs or around vent, a dark interorbital bar, and brown body coloration.

The species has been reported in Lao PDR from Khammouan province (Stuart 2005). It also occurs in central Vietnam (Nguyen *et al.* 2009) and northeastern Thailand (Chan-ard 2003).

#### **Keeled Box Turtle *Cuora mouhotii* (Gray, 1862)**

A live adult captive male (SCL 171 mm, PL 153 mm, weight 550 g), a live adult captive female (SCL 174 mm, PL 173 mm, weight 650 g), and intact plastron and carapace remains of five individuals were observed in Ban Houaykhoualouang (19.04671°N, 101.80024°E) on 14 September 2011. Residents of Ban Houaykhoualouang reported that the live animals had been caught within the previous few weeks, and the remainder had been caught within the previous few years, in 'nearby' forested limestone mountains. The intact carapace and plastron remains of one individual were observed in Ban Pakneun (19.24000°N, 101.82406°E) on 13 September 2011. The owner stated he had purchased it a few years previously from an upland village 'several hours' walk' east of Ban Pakneun. No individuals were observed in the wild.

These had a high, flat-topped carapace with three distinct keels and a serrated rear margin, a weakly hinged plastron, and a black spot on the outer edge of the plastron scutes. The shell measurements of all eight specimens were SCL 88–178 mm (mean  $\pm$  SD  $149 \pm 3.9$ , N = 8) and PL 80–181 mm (mean  $\pm$  SD  $144 \pm 3.8$ , N = 8).

The species was originally described from the "Laos Mountains" based on material collected by Henri Mouhot during his voyage from Bangkok, Thailand, to Louangphabang. The collection locality thus probably lies within the catchment of the Upper Mekong. The species is associated with limestone karst in central and northern Lao PDR (Stuart & Platt 2004, Teynié & David 2010) and also occurs in northeastern India, Myanmar, northern Thailand, southern China and Vietnam (Zhao & Adler 1993).

*Cuora mouhotii* is listed as Endangered (IUCN 2012) and At Risk in Lao PDR (Stuart 1999) because it is heavily harvested.

### **Impressed Tortoise *Manouria impressa* (Günther, 1882)**

The intact carapace and plastron remains of 10 individuals were observed at Ban Houaykhounaloung (five individuals; 19.04671°N, 101.80024°E), Ban Khokfak (three individuals; 18.94403°N, 101.79792°E), Ban Pakneun (one individual; 19.24000°N, 101.82406°E), and Ban Khokakha (one individual; 18.86759°N, 101.79800°E) during 13–16 September 2011. Residents at Ban Khokfak reported that they had caught the turtles in the previous week, while the owners of the others reported that the turtles had been caught within the previous few years. All stated that they had caught the turtles themselves in forested mountains ‘near the village’, except at Ban Pakneun, where the owner reported that he had purchased it from an upland village ‘several hours’ walk’ to the east. No individuals were observed in the wild.

At Ban Khokakha, residents stated that *M. impressa* is ‘common’ in nearby hill forests. Some of these nearby lands are designated as a community conservation area and retain degraded secondary forest extending to the Mekong. Residents used three local names for this species in the four villages where it was observed: ‘tao [turtle] kho’, ‘tao dua’ and ‘tao kham’.

These had the large, strongly flattened carapaces distinctive of this species. The shell measurements were SCL 201–310 (mean ± SD 269 ± 3.2, N = 9) and PL 249–284 (mean ± SD 264 ± 1.4, N = 5).

The species occurs throughout Lao PDR in forested uplands (Stuart & Platt 2004). It otherwise occurs from Myanmar across southern China and Indochina, southward to Peninsular Malaysia (Zhao & Adler 1993).

*Manouria impressa* is listed as Vulnerable (IUCN 2012) and At Risk in Lao PDR (Stuart 1999), as it is heavily harvested.

### **Asiatic Softshell *Amyda cartilaginea* (Boddaert, 1770)**

A captive juvenile (SCL 182 mm, weight 785 g) was observed in Ban Houaykhounalouang 19.04671°N, 101.80024°E) on 14 September 2011. The owner of this turtle stated it was caught two years previously in the Mekong at the village.

Residents throughout the study area consistently reported the presence of this species in the Mekong. Adults and eggs are collected for local consumption, and turtles are also sold for cash income. Some residents reported that in previous years ‘large’ individuals were caught but that most individuals caught now were ‘small’. The local name for this species is ‘pa fa ong’.

Four residents (one each from Ban Houayla, Ban Sakai, Ban Houaykhounalouang and Ban Kengmo) reported that only one softshell turtle species occurs in the study area; ‘pa fa ong’. In contrast, two residents at Ban Donsok, interviewed separately, stated the occurrence of a second type of softshell. They each related that this second type was larger than ‘pa fa ong’ and differed from it by a ‘dark spot on the nose’ and a ‘pointed head with a thick neck’. They reported that it was always more rare than ‘pa fa ong’, was last caught several years previously, and its meat was less sought by traders than ‘pa fa ong’. It is possible that this interview report at Ban Donsok of a second form referred to *Pelochelys cantorii*, a large softshell turtle species that is listed as Endangered (IUCN 2012) and has been recorded in Lao PDR only from the Mekong in the southern part of the country (Stuart & Platt 2004). Because no physical evidence was available, the report of *P. cantorii* remains highly provisional.

No individuals of any softshell turtles were observed in the wild.

The captive *A. cartilaginea* had a slender snout and a row of prominent bumps along the anterior margin of the carapace.

*Amyda cartilaginea* is known throughout Lao PDR (Stuart & Platt 2004), including a historical record from Paklay (Smith 1931). The species occurs widely in Southeast Asia, from Myanmar to Indonesia (Asian Turtle Trade Working Group 2000). It is listed as Vulnerable (IUCN 2012) and Potentially At Risk in Lao PDR (Stuart 1999) as it is heavily harvested.

### **Webbed Forest Gecko *Cyrtodactylus interdigitalis* Ulber, 1993**

A single female was taken at Houay Liap (18.51373°N, 101.65924°E) on vertical dead bamboo above a 2 m wide swift rocky stream in semi-evergreen mixed with bamboo forest at 330 m recorded elevation.

The specimen (SVL 78.9 mm) has the unusual characteristics for this genus of having a scaly skin connection between all digits except the fourth and fifth toes, and a lateral fringe on the body and tail formed by enlarged scales, with those on the tail larger and more pointed than those on the body.

The species has been reported from central Lao PDR (Stuart 1999) on the basis of specimens from Khammouan province. This new record fills a gap in the range between central Lao PDR and the type locality in central Thailand (Ulber 1993). A re-description of this poorly known species based on the Lao PDR material is warranted.

### **Burmese Flying Gecko *Ptychozoon lionotum* Annandale, 1905**

A male and female were found at Tad Kuangsi (19.74910°N, 101.99168°E) on large tree trunks in semi-evergreen forest at 513 m recorded elevation.

Both individuals have four dark transverse bands in the axilla–groin region, no enlarged midvertebral tubercles, at least 20 denticulate tail lobes in the female (male with regenerated tail), and a predigital notch in the preantebrachial cutaneous expansion of the forelimb, distinguishing them from the similar *P. trinotaterra* from Thailand and Vietnam (Brown 1999).

This species is infrequently sampled, and is known in Lao PDR only from Khammouan province (B. L. Stuart, unpublished data). It also occurs in Myanmar, Thailand and Vietnam (Smith 1935, Nguyen *et al.* 2009).

### **Lao Water Skink *Tropidophorus laotus* Smith, 1923a**

Five specimens were taken at Tad Jao (19.43661°N, 101.82940°E), Ban Pakmet (18.82529°N, 101.83967°E and 18.81210°N, 101.84889°E), and an unnamed stream in Xaignabouli district (19.194958°N, 101.821494°E). All sites were swift, rocky streams in disturbed and little-degraded semi-evergreen forest at 248–320 m recorded elevation.

These have smooth upper head scales, smooth dorsal and lateral scales in the adults, lateral scales directed straight backwards, and a divided frontonasal.

The original description was based on 68 specimens “from Muang Liep, Nong Kai, Pak Maat, Pak Men, and Hoi King, all localities on the Mekong River, to the north and south of, and within 80 kilometres of, Pak Lai” (Smith 1923a). The species is endemic to the Upper Mekong region of northern Lao PDR and Thailand.

### **Water Dragon *Physignathus cocincinus* Cuvier, 1829**

A young adult was taken at Nam Pouy (18.95440°N, 101.75141°E) in vegetation above a swift rocky stream in disturbed semi-evergreen forest at 238 m recorded elevation. Seven individuals (including a large adult male) were observed but not collected during a 45-minute period at night at Tad Jang (18.41003°N, 101.60350°E), in vegetation above a cascading stream in disturbed semi-evergreen forest at 264 m recorded elevation.

This species occurs throughout Lao PDR (Stuart 1999). Smith (1923b) reported a specimen from Paklay ("Pak Lai, French Laos"). It is also known from Myanmar to southern China, southward through Vietnam and Cambodia (Das 2010).

*Physignathus cocincinus* is listed as Potentially At Risk in Lao PDR (Stuart 1999) because the eggs and adults are heavily harvested for food.

### **Bengal Monitor *Varanus bengalensis* (Daudin, 1802)**

A captive adult (TL 1.5 m) was observed in Ban Khokakha on 16 September 2011. The owner reported that he had purchased it from a resident of a nearby village earlier the same morning. Two live individuals (TL <1 m) were seen for sale in Xaignabouli town market on 11 September 2011, but the vendor did not know their capture location.

These had nostrils close to the snout tip and a uniformly brown body with numerous small yellow spots that did not form distinct bands.

The Lao population is referred to the subspecies *V. b. nebulosus*, which is elevated to the full species rank of *V. nebulosus* by some authors.

This record might be near to the northern extent of its distribution within Lao PDR. The species occur at lower elevations throughout central and southern Lao PDR (Stuart 1999). It occurs widely from Iran to Java, Indonesia (Papenfuss *et al.* 2010).

*Varanus bengalensis* is listed as Potentially At Risk in Lao PDR (Stuart 1999) because the species is heavily harvested.

### **Reticulated Python *Python reticulatus* (Schneider, 1801)**

A young adult (TL >3 m) was found at night on 20 March 2012 crawling over tree roots on the bank of a large stream in semi-evergreen forest at the top of Tad Jao (19.43795°N, 101.82925°E) near a Buddha shrine at 326 m recorded elevation.

The species is known throughout Lao PDR (Deuve 1970). It occurs widely from Myanmar to Indonesia and the Philippines (Das 2010).

*Python reticulatus* is listed as Potentially At Risk in Lao PDR (Stuart 1999) because the species is heavily harvested.

### **Lao Wolf Snake *Lycodon laoensis* Günther, 1864**

Four specimens were taken at Houay Deng (19.52756°N, 101.80831°E and 19.52679°N, 101.80943°E), Houay Ting (19.24506°N, 101.84217°E) and Nam Pouy (18.95344°N, 101.74309°E) near rocky streams in disturbed and little-degraded semi-evergreen forest at 265–289 m recorded elevation.

These have smooth scales, a preocular separating the prefrontal and loreal from the eye, loreal not or only slightly in contact with the internasal, divided anal scale, and dark coloration above with bright yellow crossbars that expand laterally, becoming narrower and closer together posteriorly.

The species was originally described from the “Laos Mountains” based on material collected by Henri Mouhot during his voyage from Bangkok, Thailand, to Louangphabang, a locality that probably lies within the catchment of the Upper Mekong. It has also been recorded throughout central and southern Lao PDR (Deuve 1970). It also occurs from Peninsular Malaysia northwards to Yunnan province, China, and eastward to Vietnam (Zhao & Adler 1993).

#### **King Cobra *Ophiophagus hannah* (Cantor, 1836)**

An adult was observed but not captured on the west bank of the Mekong opposite Don Hon (18.54693°N, 101.74697°E) on 16 September 2011 at the top of a shrub 2 m above the riverbank.

The snake (TL >2 m) was observed at 10 m proximity and with binoculars for 10 minutes. It possessed a broad, robust square head with large shields, light iris, and a distinctive hood pattern comprising a series of shallow, inverted v-shaped pale bars behind the head, which merged into horizontal pale bands on the body. The hood pattern was clearly observed as the individual spread its hood several times.

The species is known throughout Lao PDR (Deuve 1970). It occurs widely from India across southern China, southward to Indonesia and the Philippines (Zhao & Adler 1993).

*Ophiophagus hannah* is listed as Vulnerable (IUCN 2012) and Potentially At Risk in Lao PDR (Stuart 1999) because the species is heavily harvested.

#### **Popes’ Bamboo Pitviper *Popeia popeiorum* (Smith, 1937)**

A male and female were found at Tad Kuangsi (19.74910°N, 101.99168°E) near a small rocky stream in semi-evergreen forest at 513 m recorded elevation.

Both individuals have the first supralabial distinct from the nasal, overall green coloration, a bicolor postocular streak (wide and red above, thin and white below) that is reversed in the ventrolateral stripe (red below, white above) in the male, and no postocular streak and a thin white ventrolateral stripe in the female.

The species is known in Lao PDR from Phongsali province (Malhotra & Thorpe 2004, Vogel *et al.* 2004) and the “Lao Mountains” (Vogel *et al.* 2004) based on material collected by Henri Mouhot during his voyage from Bangkok, Thailand, to Louangphabang, Lao PDR; a locality that probably lies within the catchment of the Upper Mekong. The species otherwise also occurs in northeastern India, Myanmar and northern Thailand (Vogel *et al.* 2004).

#### **Siamese Crocodile *Crocodylus siamensis* Schneider, 1801**

No crocodiles were observed during the surveys. Four residents (one each from Ban Houaysouy, Ban Pakneun, Ban Khokakha and Ban Donsok) reported that crocodiles occurred in the Mekong until 30–40 years ago (i.e. until at least the 1960s), but that none had been seen or caught since then. Each resident stated they had seen crocodiles, and two (from Ban Pakneun and Ban Khokakha) stated that ‘many’ crocodiles were previously present. Interviewees reported that crocodiles and/or their eggs were collected opportunistically for local consumption. Only one resident (at Ban Khokakha) reported that crocodiles were caught for commercial trade, stating that crocodiles were caught with snares, and that skins were sold to traders from Vientiane town. This resident also related that in the 1960s–1970s, during the period of civil conflict, military personnel

stationed in the area shot ‘many’ crocodiles. He accurately described crocodile nests as ‘large mounds of grass, leaves and soil’ and that ‘eggs were large and deposited in the middle of the nest’, and reported that he had found nests in thick grassbeds along the riverbank. Another interviewee (Ban Donsok) stated that crocodile eggs were ‘much larger’ than duck or chicken eggs, also noting that when crocodiles had been present, they were not considered dangerous by residents, but sometimes ate domestic dogs in the village.

Three interviewees (one each from Ban Pakhoun, Ban Khokfak, Ban Kengmo) reported they had never seen nor heard of crocodiles.

M. A. Smith collected a partial specimen of *C. siamensis* from the Mekong River at Paklay before 1921 (Bezuijen *et al.* 2013). The current survey provides the first indication that *C. siamensis* historically nested along this section of the Mekong.

*Crocodylus siamensis* is listed as Critically Endangered (IUCN 2012) and At Risk in Lao PDR (Stuart 1999).

#### **5.4 Threats and local use**

Amphibians and reptiles along the studied part of the Mekong face the specific threat of over-harvesting for local consumption and commercial trade, and the generalised threat of destruction of remaining closed-canopy forest.

As elsewhere in Lao PDR (Stuart 1999), turtles, large lizards, and snakes are consumed for food and traditional medicine, or sold to traders who visit villages in the study area. This provides opportunistic cash income to supplement daily agricultural and fishing activities. Several residents reported that frogs, turtles, monitor lizards and large snakes are more difficult to find now than they were several years ago.

Turtles are the most commercially valuable reptiles in the study area. Some residents specifically search for turtles and one resident stated he uses trained dogs to do so. Residents reported that commercial traders from Xaignabouli town visit the study area infrequently to purchase wildlife, and will buy turtles for a range of prices, including 25,000 Kip (USD 3.1) for the plastron of *Manouria impressa* and 85,000 Kip (USD 10.7) per individual for *Amyda cartilaginea*. The most commercially valuable turtle species was reported to be a species called ‘pulu’, which was not observed during surveys. Residents described this as having a ‘large head, hard shell and long tail’ and as occurring in forested mountain streams. There is little doubt this refers to Big-headed Turtle *Platysternon megacephalum* (IUCN Red List ‘Endangered’). These are apparently caught in traps baited with fish along streams and are sold for 200,000 Kip (USD 25.1) per individual. At least two villages along the Mekong appear to be particularly important for turtle trade. Ban Pakneun, along the Mekong, serves as an interim point for the trade of wildlife sourced from remote villages in mountains east of the Mekong and with traders from Xaignabouli town. Residents in Ban Pakneun reported that traders visit these upland villages and purchase wildlife such as turtles, then re-sell them to visiting traders. The second, Ban Houaykhoualouang, supported the largest number of turtle specimens observed during the survey (13 individuals of three species: *C. mouhotii*, *M. impressa* and *A. cartilaginea*).

Humans have significantly altered much of the vegetation along the mainstream Mekong in the study area, especially from slash-and-burn agriculture. As a consequence, many of the hills were denuded of trees, and most of the smaller tributaries flowing into the Mekong were surrounded by a mosaic of scrub, bamboo, or heavily disturbed semi-evergreen forest. Most natural closed-canopy forest along this part of the Mekong has been lost, and most remaining natural forest is degraded, fragmented, and/or restricted to small patches on steep slopes or limestone karst. These changes in habitats have presumably resulted in the loss or decline of species requiring closed-canopy, mature, natural forest, and an increase in species that have adapted to degraded habitats such as agricultural lands. It seems likely that the continuing loss and degradation of remnant forest along this part of the Mekong will result in ongoing population declines of these taxa.

## **5.5 Discussion**

Sixty-five species of amphibians and reptiles were documented during the surveys. These included a suite of species characteristic of human-modified habitats (e.g. villages and agricultural lands), a suite of species restricted to closed-canopy forest, and a suite of species threatened by trade.

Six globally threatened or Near Threatened species (IUCN 2012) were documented during these surveys: two frogs (*Amolops cremnobatus* and *Rhacophorus kio*, Near Threatened), three turtles (*Manouria impressa*, *Amyda cartilaginea* [Vulnerable] and *Cuora mouhotii* [Endangered]) and one snake (*Ophiophagus hannah*, Vulnerable). Interview data confirmed the extirpation of one Critically Endangered species, *Crocodylus siamensis*, in the study area. Seven species that may be threatened at the national level (Stuart 1999) were documented: five species Potentially At Risk in Lao PDR (a turtle *Amyda cartilaginea*; two lizards, *Physignathus cocincinus* and *Varanus bengalensis*; and two snakes, *Python reticulatus* and *Ophiophagus hannah*) and two species At Risk in Lao PDR (two turtles, *Manouria impressa* and *Cuora mouhotii*).

Additional species of amphibians and reptiles are expected to occur in the study area, but were not detected because of insufficient effort (a large survey area and limited time). Many small species of amphibians and reptiles are secretive or live in inaccessible places and are difficult to find. These include canopy-dwelling frogs, leaf litter-dwelling lizards, and small or aquatic snakes. Long-term field sampling, including the use of trapping and subterranean digging methods, is required to detect these species. Larger species may not have been detected due to low population densities caused by heavy hunting pressure, for example, Water Monitor *Varanus salvator* and Burmese Python *Python molurus*. Interview information suggested that *Pelochelys cantorii* and *Platysternon megacephalum*, both globally threatened turtle species, might occur in the study area, but this was not confirmed and their local status remains unknown.

No taxa were found that represent new species to science. However, several species, including *Rana nigrovittata* and *Polypedates leucomystax*, harbour cryptic species within Lao PDR (B. L. Stuart, unpublished data) and are likely eventually to be split into more than one species. The morphological variation observed within *Amolops cremnobatus* suggests that it may also harbour cryptic species. *Leptolalax minimus* contains two genetic lineages that are morphologically homogeneous across its geographic range (Ohler *et al.* 2011). Further study may reveal additional evidence to support recognising the Lao (eastern) population as a distinct species.

Over-harvesting is resulting in the decline of some species, including turtles, monitor lizards and large snakes (e.g. cobras, pythons) and has probably resulted in the extirpation of crocodiles. The Mekong provides a strategic access route for wildlife trade, both for residents along the river who visit remote upland villages to the east and west, and for traders from Xaignabouli town or elsewhere.

Based on the survey findings, the mainstream Mekong channel itself remains important primarily for the softshell turtle *Amyda cartilaginea* and, should it exist in the survey area, *Pelochelys cantorii*. Outside the channel, and indeed unrelated to the proximity to the Mekong, small rocky streams in closed-canopy forest in the nearby upland areas comprise an important habitat for amphibians and reptiles. From a wider conservation perspective, some of these may be priority sites for conservation; these are north of the town of Paklay.

Further study is warranted on *Pelochelys cantorii*, *Platysternon megacephalum*, *Varanus salvator* and *Python molurus*: all are species of conservation significance that are likely to occur in the survey area even though they were not collected on the current survey. These species, as well as all turtles and other large snakes and lizards, should be the focus of a monitoring programme of commercially traded reptile species. A field monitoring programme should also be established in selected villages to measure the status of wild populations of terrestrial turtles that may be declining from commercial trade. Detailed recommendations for reptile and amphibian conservation priorities are in Sect. 9.1.3.

Fish

06



Sinthavong VIRAVONG and Douangkham SINGHANOUVONG



## 6. Fish

### 6.1 Introduction

Despite being only the world's 12th longest river, the Mekong's known fish species richness is second only to that of the Amazon, with an estimated 850 species, including numerous endemic and globally threatened species (Hortle 2009).

The aquatic resources of the Mekong are important not only to global biodiversity but to the livelihoods of rural people throughout Southeast Asia. It is estimated that 2.5 million tonnes of fish are consumed in the lower Mekong basin annually (Baran *et al.* 2007). In Lao PDR, inland fish and other aquatic animals provide nearly half of all animal protein consumed by people, and 70% of rural households fish at least part-time (NBSAP 2012). Food and income from Mekong fish are an important safety net for people of Lao PDR.

Many of the Mekong's fish species are migratory. Three systems (the upper, middle and lower migration systems) and two patterns of migration are identified (Poulsen & Valbo-Jorgensen 2000). Fish species that inhabit the upper Mekong require specific habitats to achieve their gene transference and complete their lifecycle. The deep pools, reefs and rapids in the Mekong provide a diversity of habitats supporting many different species of fish. Knowledge of fish, fisheries and critical habitats appears to be improving in the southern Mekong (in the lower migration system), from Tonle Sap in Cambodia up to just below the Mekong great falls in Siphandon, Lao PDR (Blanc 1959, Nguyen Xuan Tan & Nguyen Van Hao 1991, Roberts & Baird 1995, Baird *et al.* 1999, Chea Vannaren & Sien Kin 2000, Poulsen & Valbo-Jorgensen 2001, Poulsen *et al.* 2004, Kolding *et al.* 2001, Baird & Flaherty 2005, Baran *et al.* 2005). Studies on refuge habitats in the Mekong in southern Lao PDR found about 97 deep pools. Their importance in many fish species' life cycles led to designation of some as fish conservation zones (e.g. Roberts & Baird 1995). Studies of deep-pool depth variation and the effective function of the various depths in the southern Mekong have also been published (Kolding *et al.* 2001, Baird *et al.* 2005).

Fish and fisheries in the upper system also contribute substantially to rural livelihoods, but this area has not yet been surveyed as thoroughly. This report describes a fish survey in the upper reaches of the Lower Mekong Basin, between the towns of Louangphabang and Vientiane, carried out in wet season some and dry season 2012. It adds to the existing information on fish diversity, population assemblage, and threats to fish. The objectives of the survey were:

To improve information on fish diversity through identifying and documenting fish taxa in the survey area: fish occurrence and their abundance, novel findings for this section of the river, and information on threatened fish species.

To improve information on critical spawning, refuge and conservation habitats.

To identify general threats to fish populations, including some fishing behaviours and fishing gears, the fish market, and changes to fish habitats.

Focal species for the survey included those listed as globally threatened on *The IUCN Red List of Threatened Species* (IUCN 2012), CEPF priority species (CEPF 2012), and all restricted range and economically important species. The globally threatened species then comprised *Dasyatis laosensis*, *Himantura polylepis*, *Pangasianodon gigas*, *Probarbus jullieni*, *Catlocarpio siamensis*, *Pangasius sanitwongsei* and *Probarbus labeamajor*, and the CEPF priority species *D. laosensis*, *H. polylepis*, *P. gigas* and *P. jullieni*.

## **6.2 Methods**

### **6.2.1 Survey localities and dates**

The wet-season survey was restricted to the Mekong from Ban Thadua to Vientiane city. Of the 14 fieldwork days during 9–23 September 2011, 11 were spent in villages and two on market survey. This latter focused on big towns such as Xaignabouli and Paklay. The dry-season survey took place between the towns of Louangphabang and Vientiane from 24 February to 14 March 2012. The 20 fieldwork days (Table 6.1) involved market survey on three days in Louangphabang, Xaignabouli and Paklay.

**Table 6.1. Fish survey effort**

<b>Survey location</b>	<b>Wet season</b>	<b>Dry season</b>
Village	13 days	20 days
Local ecological knowledge in villages	13 villages	12 villages
Direct capture from isolated pools of the Mekong	0	24 sites
Direct capture from the Mekong	2 sites	5 sites
Fish captured by fishers from the Mekong	12 sites	18 sites
Fish observation in markets	2 markets	3 markets
Ice-box sampling in villages	6 boxes	8 boxes

### **6.2.2 Fish and fishery surveying**

Surveys used several methods to compile information on the area's fish and fisheries (Table 6.1).

#### **Local Ecological Knowledge**

Interviews were undertaken in all areas where the project was focused, including 13 villages between Ban Thadua and Vientiane city in the wet season, and five in Louangphabang and Xaignabouli provinces in the dry season. Fish species occurrence in the Mekong and their behaviour were discussed in each village. The survey also enquired about the occurrence, status and habitats of focal species like big barbs (*Probarbus juillieni* and *P. labeamajor*), giant catfish (*Pangasianodon gigas*, *Pangasius sanitwongsei*, *Wallago leeri* and *W. attu*) and stingrays. A questionnaire and a fish photographs flipchart guided the interviews, and fish books helped the process. District Agriculture and Forest Office (DAFO) staff coordinated with the local villages during the survey to assist in the interview process. In each village, at least five villagers or fishers were interviewed, supplied by the village chief.

#### **Direct sampling**

During the dry season, direct sampling supplemented interview information towards an inventory of all fish species in the survey area. Wild fish were captured directly from the Mekong by surveyors and fishers in the morning. Surveyors sampled fish randomly in isolated pools that emerged in the dry season using 0.5 mm mesh purse-seine. Sampling, not stratified by habitat or location, aimed to record the maximum number of species possible. Fish were also examined in the ice boxes of traders in the villages. Fish were measured and weighed.

#### **Market observations**

Observation was conducted in the morning and afternoon at markets in the towns of Xaignabouli and Paklay in the wet season, and in the towns of Louangphabang, Xaignabouli and Paklay in the dry season. Fish

sellers were asked the source of the fish as one of main river stem, small streams or other possible water bodies. Threatened, flagship, and introduced species were photographed and data on them were recorded.

### **Observations of fishing gear**

Fishing gear used by villagers was observed during both seasons' surveys, separating the survey area into three sections: (1) town of Louangphabang – Ban Thadua; (2) Ban Thadua – town of Paklay; and (3) town of Paklay – Vientiane city.

#### **6.2.3 Specimen preservation**

All specimens obtained were photographed and preserved in 10% buffered formalin solution and later transferred into 70% ethanol. Specimens were brought to the Living Aquatic Resources Research Center (LARReC) laboratory, Vientiane capital city, for further identification.

#### **6.2.4 Limitations**

The survey lasted only a short period in each season, so might have missed species using this section of river at specific times of year and/or under specific conditions. The survey's brevity could have also affected the types of fishing gear observed. More specialised rigs might be used in different conditions or at other times of year. Purse-seine is an effective method for fish sampling in small streams, isolated pools and the Mekong bank in dry season, but has limited use in the wet season due to the Mekong's strong current. This will have precluded detection of some species present during the wet season but not the dry season. The fish pools or deep pools are critical habitats for many fish species but because of their depth and habitat capabilities for fish, they require special survey using hydroacoustic and other techniques not available to the survey team.

### **6.3 Results**

#### **6.3.1 Species found**

Interviews indicated 116 indigenous fish species from the Mekong between the towns of Louangphabang and Vientiane, comprising:

Perciformes (10 families, 10 genera and 13 species)  
Siluriformes (5 families, 15 genera, 34 species)  
Cypriniformes (4 families, 32 genera, 55 species)  
Rafinesqueidae (1 family, 2 genera, 2 species)  
Osteoglossiformes (1 family, 2 genera, 4 species)  
Anguilliformes (1 family, 1 genus and 1 species)  
Symbranchiformes (2 families, 3 genera, 3 species)  
Beloniformes (2 families, 2 genera, 2 species)  
Pleuronectiformes (1 family, 1 genus, 2 species).

Isolated pools surveyed during dry season showed a clear dominance of Cypriniformes (564 individual specimens found), followed by Perciformes (232), Beloniformes (14), Siluriformes (20), Osteoglossiformes (2) and Synbranchiformes (2).

Thirteen families of fish were directly sampled: Cobitidae (7 specimens), Channidae (6 specimens), Cyprinidae (564 specimens), Chandidae (81 specimens), Gobiidae, Belonidae (12 specimens), Tetraodontidae,

Cichlidae (135 specimens, all from one species), Osphronemidae, Bagridae (1 specimen), Pristolepididae, Mastacembelidae and Balitoridae (26 specimens).

### 6.3.2 Records of focal species

Records of the focal species (defined above) were obtained mainly through interview.

#### Giant Barb *Catlocarpio siamensis*

This species is categorised as Critically Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

Three sites reported occurrence of *Catlocarpio siamensis*. Two, between the town of Louangphabang and Ban Thadua, had reports of recent capture. Villagers in Ban Khoktom (19°32'17.5"N, 101°48'59.8"E) indicated they caught a 50 kg individual 5–6 years ago and that they regularly find juvenile or small individuals. Fishermen in Ban Houaykhoualouang (19°02'55.4"N, 101°48'06.4"E) reported the species as rare in the area and sometimes found in a local pool (Nong Inh). Ban Mouang (18°21'34.8"N, 101°33'18.3"E) reported that the pool Nong Leung was historically a fishing area for *C. siamensis*, but that it is no longer found in the area.

#### Giant Pangasius *Pangasius sanitwongsei*

This species is categorised as Critically Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

In response to the survey, residents of Ban Saluan (19°50'15.1"N, 102°00'34.5"E) and Ban Khokgna (19°39'02.7"N, 101°48'48.7"E) said that this species was historically caught. An interviewee stated that the fish occurred in the area 10–40 years ago but is presently not seen. No sign of its spawning ground was recorded. In Ban Paksi (17°52'07.24"N, 101°31'01.01"E), the species was reported to be quite rare and with small size individuals. Most occurrences were reported near Ban Khokgna. In Ban Khoktom there were records of juvenile individuals, but these were said to be quite rare and not seen every year. In Ban Pakhao (19°32'17.5"N, 101°48'59.8"E), villagers reported some individuals of 4–5 kg but very rarely. This fish is not found every year in the river. At Ban Houaykhoualouang (19°02'55.4"N, 101°48'06.4"E), residents reported that it was caught in the past but had not been seen in the last 2–3 years. In the town of Paklay, fishermen reported that they caught this species around the present-day pier location formerly but no longer: They attributed this disappearance to the pier's heavy use by boats with much disturbance by noise. At Ban Ang-Noi, villagers reported a juvenile caught in 1997.

#### Mekong Giant Catfish *Pangasianodon gigas*

This species is categorised as Critically Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

Interviewees identified Ban Ang-Noi (18°00'56.5"N, 102°23'38.4"E) as a former fishing area for the species, but reported that it disappeared over 50 years ago. The village used to do a spiritual ceremony for the species at the beginning of each migration season before fishing, but have given up this tradition because they cannot find the fish anymore. Ban Houaykhoualouang (19°02'55.4"N, 101°48'06.4"E) was also reported as a former fishing area for the species, but which has not caught any recently.

### **Giant Mekong Stingray *Himantura polylepis***

This species is categorised as Endangered on The IUCN Red List of Threatened Species (IUCN 2012).

Giant Mekong Stingray was reported in at least seven sites. Ban Houayhang reported that it is rare, with individuals now smaller than those appearing 10 years ago. Ban Saluan (Ban Pakluan; 19°50'15.1"N, 102°00'34.5"E) reported it as rare; one was caught in the pool (Khok Phasa) near the village. Approximately one individual is caught every two years, weighing 8–20 kg. Ban Khoktom (19°32'17.5"N, 101°48'59.8"E) reported as a rare species, with most individuals weighing less than 2 kg. At Ban Khokgna (19°39'02.7"N, 101°48'48.7"E) it was reported to be rare, caught in local pools, e.g. Khok Gna, and to weigh 10–20 kg. In Ban Pakhoun (19°09'49.2"N, 101°48'47.0"E) it was reported to be rare, weighing 10–25 kg. Ban Nongkhai (18°24'14.7"N, 101°45'37.9"E) reported that previously it was caught nearly every year in nearby pools, e.g. Khok Keub (18°37'04.9"N, 101°47'03.6"E). Now it is rare, mostly weighing 5–10 kg, rarely up to 40 kg. Ban Muangliap (18°28'23.7"N, 101°39'14.6"E) reported it as rare, weighing 10–20 kg. Ban Mouang (18°21'34.8"N, 101°33'18.3"E) reported that individuals of 4–5 kg are encountered nowadays whereas a few years ago some exceeded 20 kg.

### **Mekong Freshwater Stingray *Dasyatis laosensis***

This species is categorised as Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

Ban Houaykhoulouang (19°02'55.4"N, 101°48'06.4"E) reported *Dasyatis laosensis* as rare in the area, that most seem to live in a pool (Khok Veun) just north of the village, and that fish weighs from 1–2 to 20 kg. Ban Poungma (18°06'38.9"N, 101°23'45.7"E) reported that this fish is rare and weighs 2–3 kg.

### **Unidentified stingrays**

Ban Paksi (17°52'07.24"N, 101°31'01.01"E) reported small stingrays (1½ kg) caught every October by hook. These could be *Himantura polylepis* or *Dasyatis laosensis*. No information on spawning habitat was found.

### **Jullien's Golden Barb *Probarbus jullieni***

This species is categorised as Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

Ban Saluan (Ban Pakluan; 19°50'15.1"N, 102°00'34.5"E) reported Jullien's Golden Barb as rare, being caught in only some years, in February and March. Their spawning area was not known, but juveniles were found during the beginning of the wet season in May by fishermen. A display ground was reported at Ban Khokfak (18°57'00.86"N, 101°47'53.01"E). Rapids were identified as spawning grounds at Ban Houayhinheth (18°49'54.3"N, 101°50'25.4"E), Ban Muang (18°53'14.5"N, 101°47'29.8"E [not on RDPL SGE 1: 100:100 maps; a village of similar name (as 'Ban Mouang') is mapped at 18°21'N, 101°33'E, and is used as a locator elsewhere in this report]), and Ban Houaykhoulouang. Ban Phatoung (18°43'10.8"N, 101°48'51.3"E) reported to catch the species every January at 18°42'28.8"N, 101°48'32.9"E and at Keng Sing (18°44'15.2"N, 101°49'18.5"E), with fish weighing up to 10 kg. Ban Nongkhai (18°34'14.7"N, 101°45'37.9"E reported that in previous times, this species was caught nearly every year in the pools of Khok Kai Dam (18°34'23.1"N, 101°45'43.5"E) and Khok Kai Don (18°32'20.1"N, 101°44'17.2"E), usually in March. Villagers thought the fish move to Khok Khao Mao (18°35'23.2"N, 101°46'06.5"E) and Khok Keub (18°37'04.9"N, 101°47'03.6"E), for unknown purposes. Ban Poungma (18°06'38.9"N, 101°23'45.7"E) and Ban Pakhao (19°35'23.7"N, 101°47'47.6"E) reported that this species was rare, reaching up to 20–30 kg

per fish. Keng Mai ( $17^{\circ}52'17.0''N$ ,  $101^{\circ}29'39.4''E$ ) was reported as a fishing area especially for *P. jullieni*. People from many villages in the area, including the town of Sanakham, fish there each January–February, the spawning season. All female fish caught then bear eggs. The species spawns in rapids (Viravong 1995), so Keng Mai, the closest rapids to the display ground, is presumably a spawning area.

#### **Thick-lipped Barb *Probarbus labeamajor***

This species is categorised as Endangered on *The IUCN Red List of Threatened Species* (IUCN 2012).

Ban Paksi ( $17^{\circ}52'07.24''N$ ,  $101^{\circ}31'01.01''E$ ) reported that only juveniles (below 15 cm long) are now caught, in May at the start of the raining season. No large individuals were reported for more than 20 years. No spawning ground was known by the village. Ban Pakhao and Ban Houaykhoulouang reported *P. labeamajor* as occurring, but only very rarely.

#### **6.3.3 Fish habitats and fishing sites**

Important habitats for fish in the study area include deep pools and rapids. *Probarbus* and *Hypsibarbus* depend on rapids for spawning, and many species migrate through them. In the study area 47 rapids were identified. Display and spawning grounds of *P. jullieni* were reported between Ban Thadua and the town of Paklay (detailed above) and, possibly (also for *P. labeamajor*) at Keng Mai, between the towns of Paklay and Vientiane. Fish such *Hypsibarbus* and *Poropuntius* were reported to share spawning areas with *P. jullieni*. Spawning grounds for the catfish *Wallago attu* were described at Ban Nongkhai ( $18^{\circ}34'15.63''N$ ,  $101^{\circ}45'34.22''E$ ). The Mekong between the towns of Louangphabang and Vientiane holds around 88 pools which provide critical resting and feeding sites for several species of migratory fish (Poulsen *et al.* 2002).

In the dry season, sandbars and sandy shallows, mainly between Paklay and Vientiane, provide nursing grounds for juveniles cyprinids and possibly also for freshwater stingrays.

The Mekong's intermittent floodplain between the towns of Louangphabang and Vientiane is now so intensively used that it seems to hold no habitats significant to river fish.

Combining observations from both dry- and wet-season surveys, local fishing activity was observed at 111 sites: 62 between Ban Thadua and the town of Paklay, 34 between the towns of Paklay and Vientiane, and 15 between the towns of Louangphabang and Ban Thadua. The most important fishing areas were the pools, with 22 between Ban Thadua and the town of Paklay and 13 between the towns of Paklay and Vientiane. Such pools seemed to be important fish refuges during dry season.

A fish conservation area reportedly set up in the Nam Houng by residents of Ban Pakhoun suffers from ineffective management. Villagers want to make a Mekong pool at Ban Houaykhoulouang (between Ban Thadua and the town of Paklay) a fish conservation area, but lack appropriate conduct guidelines.

#### **6.4 Threats and local use**

At least 17 fish species were found for sale in the town markets of Louangphabang and Xaignabouli, of which three were exotic (introduced). Indigenous species found at a high price and in high demand for consumption included: *Hemibagrus wyckioides*, *H. nemurus*, *Micronema apogon*, *Pangasius bocourti*, *Hemisilurus mekongensis*, *Oxyeleotris marmorata*, *Hypsibarbus lagleri*, *Helicophagus leptorhynchus*, *Bagarius yarrelli* and *Probarbus jullieni*. Many of these were reportedly sold across borders, especially the Lao–Thai border, because of the higher prices, notably in Thailand. In villages far from towns, most fish caught, except those eaten locally, were sold to the traders resident in that village. These fish were put in ice boxes to be sent to the city market in the next few days.

Five types of fishing gear were used in the wet season. Four were seen in use between Ban Thadua and the town of Paklay, while one (shrimp trap) was seen only between the towns of Paklay and Vientiane. More fishing gear was recorded between Ban Thadua and the town of Paklay ( $n = 664$ ) than between Paklay and Vientiane city ( $n = 340$ ). The most commonly used type was the Chan trap in both stretches, followed by gill nets, single hooks and hooklines, except between the towns of Paklay and Vientiane where shrimp traps were the third most-used type.

Five types of fishing gear were also used in the dry season, both between the town of Louangphabang and Ban Thadua, and between Ban Thadua and the town of Paklay. Dry-season fishing in some stretches seemed less intensive than in the wet season, based on the amount of fishing equipment used. Gill nets were the most popular fishing gear used in both stretches (65.5% and 79.7% respectively). Big scoop nets were the next most popular fishing gear between Ban Thadua and the town of Paklay (35.9%), followed by Tone trap fisheries (31%).

Over-fishing is potentially the greatest present threat to fish of economic importance in the study area. The human population, and thus fishing pressures for commercial sale and local subsistence, are rapidly increasing. Fisheries seem to have commercialised in the survey area following improvement of roads and thus access to urban markets (towns of Xaignabouli and Vangvieng) and to Thailand. Intensive use of gill nets was observed throughout the study area. Local fisherman reported that some large fish species are now caught only rarely and that today's individuals are smaller than they were even only 5–10 years ago. These trends are consistent with overfishing, such as is accepted to underlie the great decrease of at least one species, Mekong Giant Catfish (IUCN 2012).

In the study area as a whole, habitat loss and degradation may also be a great threat to fish populations. Hydropower development could reduce fish migration, directly by blocking migration, or indirectly by changing the flood pulse (a trigger for migration) and by changing sedimentation patterns in spawning areas. The upcoming Xaignabouli dam could thereby affect upstream and downstream fish populations, but this was not the survey's focus. Floodplains between the towns of Paklay and Vientiane are largely converted to agricultural lands and human settlement, while most Mekong banks are cleared of native vegetation. This has probably reduced the extent and quality of breeding and foraging habitats for fish.

## **6.5 Discussion**

The study identified 116 species in this section of the Mekong, representing 19% of fish species recorded for Lao PDR by Kottelat (2001; but many have been described to science, or found new to Lao PDR in the subsequent years) and 13.5% of all fish species recorded for the Mekong River by Horte (2009). More surveying would find more species (migration probably changes the survey area's fish community composition greatly between seasons), but these low proportions raise concerns of declining fish stocks possibly caused by overfishing. By contrast, Bezuijen *et al.* (2008) identified 223 indigenous fish species in the stretch of the Mekong in northern Cambodia between Kratie and Stung Treng towns, although this survey was more intensive and the true magnitude of difference between the Louangphabang–Vientiane Mekong and the Kratie–Stung Treng Mekong cannot be determined.

Seven species categorised as globally threatened by *The IUCN Red List of Threatened Species* (IUCN 2012), and four recorded as CEPF priority species (CEPF 2012), were reported. A few spawning areas for *Probarbus jullieni* were indicated, some corroborating previous information, but the new ones indicate that the area could be more significant for this species than is generally assumed.

Many important large fish species, including *Himantura polylepis*, *Catlocarpio siamensis* and *Pangasius sanitwongsei* were reported to occur as juveniles, but no indication was found of their spawning in the survey area. Village interviewees indicated that *Pangasianodon gigas* has not been recorded from this section of the Mekong for at least 50 years, suggesting for such a distinctive species, extirpation. Coupled with fewer adults reportedly now encountered of several other large species, this suggests overharvesting and lack of management.

Between the towns of Louangphabang and Paklay, the Mekong holds ‘upper Mekong’ type habitats, where strong rapids alternate with deep pools. Downstream, it progressively becomes more typical of the lower Mekong: large sand bars and rocky areas with few rapids and deep pools. These latter habitats remain important to fish for breeding and foraging, with the pools as critical dry-season habitat.

The floodplain has largely been converted to agriculture and settlement, and it is likely that most species dependent on regular connections with floodplain wetlands have disappeared.

The evidently high fishing pressure is likely to decrease stocks of most species and to have a severe impact on sensitive species. Villagers reported that size for most large species is decreasing, an indication of overfishing. Development of roads tends to facilitate commercialisation of fisheries by increasing access to the urban markets in Xaignabouli, Vientiane, Vangvieng and even Thailand. Without management of fish stock, some species will probably be extirpated from this section of the river. Local human livelihoods would then be strongly impacted.

Hydropower development is also a potential threat on this part of the Mekong. The upcoming Xaignabouli dam could have strong impact on the upper migration system and also impacts on downstream migration and spawning. This survey’s evidence of threatened fish species still present in this part of the river indicates the urgency of a detailed assessment of potential impacts of the dam on fish populations.

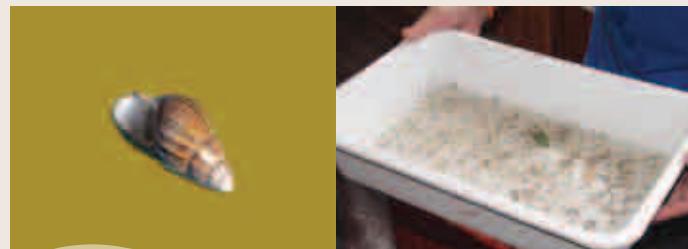
Ban Pakhoud villagers’ attempts to establish a conservation zone for their fisheries resources have been hindered by a lack of strong enforcement. Elsewhere, the lack of information on critical locations (spawning, feeding, refuging) of CEPF-priority and other decreasing species impedes resource management planning. Of the seven focal species discussed above, only for *Probarbus jullieni* is there plausible information on spawning grounds.

In this situation, fish conservation zones should be proposed for areas where spawning is likely to occur. These zones will only be effective if national fishery laws are implemented. This will require strengthening the capacity of national and provincial fisheries staff. Regular monitoring of fish stocks will be needed, supplemented by thorough studies to be completed before any major habitat-changing development, to predict impact. Sect. 9.1.4 gives more detailed management suggestions related to fish.

# 07

## Aquatic Invertebrates





## 7. Aquatic Invertebrates

### 7.1 Introduction

Aquatic invertebrates are a large group with a wide distribution. Some inhabit living and dead vegetation, and many live on or within the substrate of water bodies. They include a wide range of larval or nymphal stages of insects, such as mosquitoes (Culicidae), water beetles (aquatic Coleoptera), water bugs (aquatic Hemiptera), mayflies (Ephemeroptera), stoneflies (Plecoptera), dragonflies (Odonata) and caddisflies (Trichoptera). These insects start their life cycle in the water before becoming water-, surface-, land-dwelling, or aerial adults. Aquatic invertebrates can populate ponds, streams or rivers in great numbers, sometimes thousands per square meter. The presence of an adult near a stream often indicates that its younger stages are in, or close to, that stream. Aquatic invertebrates eat plant material and tiny animals, and are food for larger animal such as fish, bats, birds, reptiles and amphibians. Some animals, such as dragonfly nymphs and water bugs, are important in local people's diets as well. Many aquatic invertebrates indicate water quality and conditions of a stream.

Aquatic invertebrates in the Lower Mekong Basin (the Mekong mainstream and its tributaries) are abundant, rich in species and widely distributed. Biomonitoring studies in the lower Mekong basin, including 17 sites of Lao PDR, in 2004–2007 reported 361 taxa of littoral macroinvertebrates from 77 sampling occasions (MRC 2008). In 2008, a study sampled eight sites in Lao PDR, including three in the North down to Vientiane capital, namely the Mekong at Ban Xiangkok, Louangnamtha province; the Mekong at Ban Doncho, Louangphabang province; and Ban Houayhom, Sikhottabong district, Vientiane capital. In central Lao PDR two sites were considered, the Mekong tributaries of the Xe Bangfai and Xe Banghiang, in Khammouan and Savannakhet provinces respectively; and in southern Lao PDR three sites, Don Gnio in the Mekong at Ban Mouang, Pathoumphon district; the Xe Don at Ban Donhae, Pakxe district; and the lower Xe Kong at Ban Sanamxay, Attapu. These reported a total of 92 taxa of macroinvertebrates (MRC 2010a). Other studies have reported high diversity and distribution of macroinvertebrates in the Nam Mo and Nam Gnon in Vientiane province. One identified 206 taxa (Vannachak 2010). Another reported 162 species, including rock crabs (Gecarcinucidae), in the mountainous streams of Louangphabang province (Malavong & Panthaone 2009). A case study for rapid assessment of aquatic ecosystems by using macroinvertebrates along the Nam Lik and Nam Ngum recorded 40 species (Sophanny & Kingsavan 2005). These previous studies did not cover all sections of the Mekong. There is little information from the Mekong in Louangphabang, Xaignabouli and Vientiane provinces, although some threatened species may be present.

Fresh water supports many species of crustaceans and molluscs. These molluscs fall in two classes, Gastropoda and Pelecypoda (Bivalvia), and include herbivorous grazers, predators and filter-feeders. Many species of Amblemidae, Arcidae, Corbiculidae (Pelecypoda) and Thiaridae and Viviparidae (Gastropoda), are used and marketed as human food. The invasive golden apple snail *Pomacea* is widespread in Lao PDR and damages rice and vegetable crops, and many freshwater snails are intermediate hosts of parasites of human and animals.

The largest freshwater crustacean order, Decapoda, includes shrimps, prawns and crabs. Shrimps (Atyidae) and prawns (Palaemonidae) are common in habitats such as pools, rivers and small streams. Crabs, in three main families (Gecarcinucidae, Potamidae and Parathelphusidae) are also common in both lotic and

lentic water. Most gecarcinucids and potamids live in shelters under rocks and/or holes, and all crabs are predators. The crabs are used as human food. Yeo & Ng (1999) knew of 165 species from 33 genera of freshwater crabs in Indochina, but new species continue to be described, such as three of Potamidae from northern Lao PDR (Yeo & Naiyanetr 1999). Crab diversity, distribution and conservation status is less studied in Lao PDR than in some other countries of Southeast Asia. Out of 122 countries in the world that support freshwater crabs, Lao PDR is one of the 43 with species in need of protection (Cumberlidge *et al.* 2009). Seventeen freshwater crab species from Lao PDR have been assessed by *The IUCN Red List of Threatened Species*, with three classed as Near Threatened, two as Vulnerable and one as Endangered (Cumberlidge *et al.* 2009). Therefore, freshwater crabs require conservation in Lao PDR, as in other regions (Cumberlidge & Daniels 2007, Cumberlidge *et al.* 2009).

This report describes the results from wet- and dry-season surveys of aquatic invertebrates for the project “Conserving biodiversity and sustaining livelihoods along the Mekong River in Louangphabang, Xaignabouli and Vientiane provinces, Lao PDR”. The report (a) documents biological surveys of the study area; (b) considers the conservation significance of the study area for assemblages and edible aquatic invertebrate taxa; (c) considers distribution and status of target species for planning conservation; (d) assists in filling data gaps concerning aquatic invertebrates in the Mekong and its tributaries in Lao PDR; and (e) proposes preliminary conservation measures and a framework for monitoring.

## 7.2 Methods

### 7.2.1 Survey locations and dates

Aquatic invertebrates were surveyed along the Mekong between Xaignabouli and Vientiane provinces over 9–23 September 2011 (total 14 field days), and between Louangphabang and Vientiane provinces from 13 March to 3 April 2012 (20 field days). The field survey was organised by a team of biologists from the Faculty of Science (National University of Laos) and IUCN Lao PDR. Sampling and interviewing locations mentioned in the text are listed in Table 7.1.

**Table 7.1.** Aquatic invertebrate sampling sites mentioned in the text. Elevations were derived from Google Earth (rounded to the nearest 5 m) using

Province	District	Locality	Code	Elev (m)	Da
Xaignabouli	Xaignabouli	Houay Saenhai	001	260	11-Sep-11
Xaignabouli	Xaignabouli	Mekong River	002	262	11-Sep-11
Xaignabouli	Xaignabouli	Houay Souy	003	256	13-Sep-11
Xaignabouli	Xaignabouli	Houay Soy	004	243	13-Sep-11
Xaignabouli	Xaignabouli	Houay Maksan	005	269	15-Sep-11
Xaignabouli	Paklay	Don Hon (w)	006	234	16-Sep-11
Xaignabouli	Paklay	Houay Sao	007	247	17-Sep-11
Xaignabouli	Paklay	Don Sang (w)	008	219	18-Sep-11
Xaignabouli	Kenthao	Houay Phanoy	009	220	18-Sep-11
Vientiane	Sangthong	Houay Dua	010	177	21-Sep-11
Vientiane	Sangthong	Houay Tadkok	011	201	22-Sep-11
Louangphabang	Louangphabang	Mekong River	012	271	14-Mar-12
Louangphabang	Louangphabang	Ban Khokgna*	Ext	352	15-Mar-12
Louangphabang	Louangphabang	Houay Si	013	275	15-Mar-12

<b>Province</b>	<b>District</b>	<b>Locality</b>	<b>Code</b>	<b>Elev (m)</b>	<b>Da</b>
Louangphabang	Chomphet	Nam Hang	014	273	15-Mar-12
Louangphabang	Louangphabang	Mekong pool	015	262	16-Mar-12
Xaignabouli	Xaignabouli	Nam Hao	016	258	16-Mar-12
Xaignabouli	Xaignabouli	Mekong pool	017	250	17-Mar-12
Xaignabouli	Xaignabouli	Houay Deng	018	267	17-Mar-12
Xaignabouli	Xaignabouli	Houay Kay	019	261	18-Mar-12
Louangphabang	Nan	Mekong pool	020	255	18-Mar-12
Louangphabang	Nan	Houay Lan	021	235	19-Mar-12
Xaignabouli	Xaignabouli	Houay Kasouay	022	249	19-Mar-12
Xaignabouli	Xaignabouli	Mekong pool	023	249	20-Mar-12
Louangphabang	Nan	Houay Pikmak	024	254	20-Mar-12
Louangphabang	Nan	Nam Neun	025	252	21-Mar-12
Xaignabouli	Xaignabouli	Nam Houng	026	242	21-Mar-12
Xaignabouli	Xaignabouli	Mekong River	027	232	22-Mar-12
Xaignabouli	Xaignabouli	Houay La	028	243	22-Mar-12
Louangphabang	Nan	Houay Noi	029	267	22-Mar-12
Xaignabouli	Xaignabouli	Mekong River	030	227	23-Mar-12
Louangphabang	Nan	Houay Lakmouen	031	237	23-Mar-12
Xaignabouli	Xaignabouli	Mekong Pool	032	237	24-Mar-12
Xaignabouli	Xaignabouli	Nam Pouy	033	230	24-Mar-12
Vientiane	Met	Nam Fuang	034	226	25-Mar-12
Vientiane	Met	Mekong Pool	035	239	25-Mar-12
Vientiane	Met	Nam Met	036	240	25-Mar-12
Xaignabouli	Xaignabouli	Houay Khoksa Gnai	037	227	25-Mar-12
Xaignabouli	Xaignabouli	Houay Khoksa Noi	038	188	26-Mar-12
Xaignabouli	Xaignabouli	Houay Keng Sing	039	234	26-Mar-12
Vientiane	Met	Nam Pou	040	235	26-Mar-12
Xaignabouli	Paklay	Don Hon (d)	041	219	27-Mar-12
Vientiane	Met	Houay Khi	042	219	27-Mar-12
Xaignabouli	Paklay	Nam Pa	043	231	27-Mar-12
Vientiane	Met	Houay Tadchang	044	227	28-Mar-12
Xaignabouli	Paklay	Nam Phoun	045	219	28-Mar-12
Xaignabouli	Paklay	Houay Ping	046	229	28-Mar-12
Vientiane	Sanakham	Don Sang (d)	047	212	31-Mar-12
Vientiane	Sanakham	Houay Noi	048	205	31-Mar-12
Vientiane	Sanakham	Nam Mi	049	181	01-Apr-12
Vientiane	Meun	Don Koad	050	189	02-Apr-12
Vientiane Cap.	Sangthong	Nam Sang	051	174	03-Apr-12

Note: \*extra location; Houay is stream; Nam is River; Don is Island; (w) indicates wet-season sampling, and (d), dry-season sampling.

### 7.2.2 Sampling

Sample sites were chosen where deposits along the river facilitated access for sampling: where small streams enter the Mekong; at islands; and at temporary pools in the main channel. In total, 51 sites were sampled, 11 in the wet season and 40 in the dry season, with one extra dry-season site (Ban Khokgna, Louangphabang

district) (Table 7.1). Various lentic and lotic littoral habitats, including boulders, cobbles, pebbles, gravel, sand, silt, mud, debris and aquatic plants, were sampled. Both sweep and kick sampling methods were employed to collect aquatic invertebrates, using a D-frame net with a 30 × 20 cm opening and a mesh size of 475 µm. The sampling procedures were modified from MRC (2010b) and some are illustrated in Plate 7.1.

Sweep samples were taken only in large river areas and pools, at intervals of about 20 m. The collector stood in the water about ½–1 m from the water's edge and swept the net towards the bank five times, for about 1 m at right angles to the bank and in water less than 1 m deep reaching the depth of the substrate surface. Four sampling plots (four replicates) were placed per site.

Kicking samples were taken off the riverbank, at the edge of islands and small streams in areas of rapid current and shallow water (0.1–1 m deep). The substrate in an area of 30 × 30 cm was kicked or disturbed with fingers, for about 20 seconds. Four kick samples were taken per site.

Sites were sampled between 08h00 and 16h00, with typically one or two samples a day. Both kicking and sweeping were widely employed in the dry season, but wet season sampling mostly used sweeping.

After netting, the net contents were washed to the bottom of the net. The net was then inverted and its contents were emptied into a metal sorting tray. Any material adhering to the net was washed off with clean water. Invertebrates were picked from the tray with forceps and placed in a jar of 90% ethanol. Small samples were kept in 60 ml jars and large samples were kept in 150 ml jars. The sample jars were labelled with the site location code, date and sample replicate number. Information from interviews of villagers and characteristics of the sampling site that could influence the presence or abundance of various taxa of aquatic invertebrates were recorded in a field sheet.

Informal interviews were carried out with randomly chosen participants in twelve villages: Ban Muangkhay, Ban Thadua, Ban Talan, Ban Houaysouy, Ban Pakneun, Ban Pakhong, Ban Khokfak, Ban Muangliap, Ban Poungma, Ban Pakmi, Ban Houayla and Ban Sakai. Women were the key informants, because they are the primary harvesters of aquatic invertebrates for consumption. The objective was to gather information on the aquatic invertebrate taxa that they collect: where, when, how, for what uses, and, for high-priority taxa perceptions of status. Additional information was collected by surveying five local markets, Phousi (in Louangphabang), the town of Xaignabouli, Thadua–Pakkhon and the towns of Paklay and Sanakham, to observe the kinds and prices of aquatic invertebrates for sale.

In the laboratory, the samples were separated for identification. Each organism was identified to the lowest taxonomic level practicable, usually family, with a stereo-microscope. References used for identification included Brandt (1974), Chuensri (1974), Morse *et al.* (1994), Dudgeon (1999), Yeo & Ng (1999), Yeo *et al.* (1999), MRC (2006), Vannachak (2009) and Lok & Orr (2009). None is comprehensive for Lao PDR and thus all identifications given are provisional and require validation by critical comparison of collected specimens,

The following metrics were calculated/recorded for all sites sampled in both wet and dry surveys: morphotype richness (the number of different morphotypes of organisms collected at a site), abundance (the number of individual organisms collected), threats to taxa and local use. The morphotype assemblage per sample is calculated according to the Margalef Index, an estimate of taxon richness independent of sample size.

The index is:

$$D_{\text{Margalef}} = (S - 1) / \ln(N)$$

$N$  = the total number of individuals in all samples

$S$  = the number of morphotype in all samples

All specimens were stored in the museum of the Biology Department, FoS, National University of Laos, for reference.

### 7.2.3 Limitations

During the wet season, the high water levels gave a large study area with most channel habitats submerged. Few sampling sites could be chosen in the main channel. The wet-season survey focused on stream-mouth areas, so does not represent the mainstream. Even in the dry-season survey, most sampling sites were also selected from tributaries because the main channel's bedrocks, steep riverbank and deep water hindered sampling. All small tributaries sampled during the wet season were dry during the dry season, forestalling sampling in the same places in both seasons.

## 7.3 Results

### 7.3.1 Taxon richness and assemblage

In total, 234 morphotypes, assessed as belonging to 19 orders and 105 families, of aquatic invertebrates were collected from 51 survey sites and one additional location. Higher morphotype richness was found for the insect orders of Ephemeroptera, Trichoptera, Hemiptera, Diptera and Odonata, with 41, 37, 30, 28 and 27 morphotypes, respectively (Table 7.2). The most widely recorded orders were Ephemeroptera, Diptera and Trichoptera, each with two taxa in 30–35 sites. Forty-nine other taxa were found in 10–29 sites and 179 taxa were found in 1–9 sites. (Appendix 7.1). No exotic (non-native) taxa were identified in either the wet or the dry season surveys, but given the rudimentary identification materials available, this does not mean that none was present in the samples. A selection of species recorded are in Plates 7.2–7.16.

**Table 7.2.** Measures of the aquatic invertebrate groups collected during both surveys

Group	Order	Abundance	Number of families	Number of morphotypes
Crustacea	Amphipoda	5	1	1
	Isopoda	38	1	1
	Decapoda	784	4	8
Insecta	Coleoptera	473	12	23
	Diptera	1163	14	28
	Ephemeroptera	5922	13	41
	Hemiptera	1129	11	30
	Lepidoptera	55	1	4
	Megaloptera	17	1	1
	Odonata	711	12	27
	Orthoptera	8	1	1
	Plecoptera	641	5	9
	Trichoptera	3502	17	37
Mollusc	Basommatophora	3	1	1
	Bivalvia	135	3	3
	Mesogastropoda	1140	5	16
	Neogastropoda	3	1	1

Group	Order	Abundance	Number of families	Number of morphotypes
Annelida	Oligochaeta	37	1	1
	Polychaeta	3	1	1
<b>Total</b>	<b>19</b>	<b>15769</b>	<b>105</b>	<b>234</b>

More morphotypes were recorded in the dry season than in the wet. There was also a difference in the numbers of morphotypes found at a given site between surveys, e.g. at Don Hon, 30 (dry season) and eight (wet season), and at Don Sang 28 and 6 respectively.

The Margalef Indices in sites on tributaries (small streams and rivers) in the stretch between the towns of Louangphabang and Paklay were higher than in the sites between the towns of Paklay and Vientiane, except at the site of Houay Dua and Nam Sang in Sangthong district (see Table 7.3). Sampling sites on tributaries presented higher Margalef Indices than did sites in the Mekong including temporary pools, islands and main channel. The average Margalef Index of tributary sampling sites was approximately 5.80 morphotypes per sample, with standard deviation (SD) of 1.87, while Mekong-channel sites had approximately 3.59 morphotypes per sample and SD of 1.57. The ten sites with the largest numbers of morphotypes were: Nam Pa, Houay Kasouay, Houay Khoksa Gnai, Houay Deng, Nam Fuang Houay La, Nam Neun, Houay Pikmak and Houay Lakkouen with 42 to 61 respectively, and the sites of Houay Dua and Nam Sang in Sangthong district with 41 each. The fewest morphotypes (below 10) were found at the sites of Don Sang, Mekong River, Don Hon (wet-season) and Mekong Pool (Table 7.3).

The highest invertebrate abundances were found at sites of the Mekong, e.g. opposite the mouth of the Nam Houng (777 individuals) and the Mekong pool downstream of Ban Pakhao (690). Some sites had both high abundance and richness, such as Nam Fuang, Nam Neun, Houay La, Houay Pikmak and Houay Lakkouen (Table 7.3). Such sites looked to be streams with the lowest impacts from human activities. These sites are located on the east side of the Mekong, in Nan and Met districts.

**Table 7.3.** Recorded abundance, density, morphotype richness and Margalef Index of aquatic invertebrates sampled at each site

Locality	Code	Abundance	Density (indiv/m <sup>2</sup> )	Morphotype richness	Average richness /sample (Margalef Index)
Houay Lakkouen	031	404	101	61	10.00
Houay Pikmak	024	422	105.5	56	9.10
Nam Neun	025	411	102.75	48	7.81
Houay La	028	339	84.75	48	8.07
Nam Fuang	034	551	137.75	48	7.45
Houay Deng	018	283	70.75	47	8.15
Houay Khoksa Gnai	037	361	90.25	45	7.47
Houay Kasouay	022	360	90	43	7.14
Nam Pa	043	355	88.75	42	6.98
Houay Dua	010	243	48.6	41	7.28
Nam Sang	051	434	108.5	41	6.59

<b>Locality</b>	<b>Code</b>	<b>Abundance</b>	<b>Density (indiv/m<sup>2</sup>)</b>	<b>Morphotype richness</b>	<b>Average richness /sample (Margalef Index)</b>
Houay Sao	007	189	37.8	39	7.25
Houay Si	013	562	140.5	39	6.00
Houaysouy	003	168	33.6	36	6.83
Houay Kay	029	511	127.75	36	5.61
Nam Houng	026	340	85	34	5.66
Houay Noi	039	263	65.75	34	5.92
Mekong Pool	035	406	101.5	34	5.49
Houay Keng sing	039	109	27.25	34	7.03
Nam Phoun	045	402	100.5	34	5.50
Nam Hang	014	331	82.75	32	5.34
Houay Khoksa Noi	038	214	53.5	32	5.78
Houay Khi	042	392	98	32	5.19
Mekong River	027	777	194.25	31	4.51
Mekong Pool	032	200	50	31	5.66
Nam Pouy	033	196	49	31	5.68
Houay Tadchang	044	405	101.25	31	5.00
Houay Maksan	005	94	18.8	30	6.38
Don Hon	041	269	67.25	30	5.18
Nam Pou	040	222	55.5	29	5.18
Don Sang	047	534	133.5	28	4.30
Mekong River	030	256	64	26	4.51
Houay Tadkok	011	277	55.4	25	4.27
Mekong River	012	127	31.75	24	4.75
Nam Hao	016	181	45.25	24	4.42
Mekong pool	020	295	73.75	24	4.04
Houay Soy	004	115	23	23	4.64
Mekong pool	015	247	61.75	21	3.63
Nam Met	036	166	41.5	21	3.91
Houay Noi	048	352	88	21	3.41
Houay Ping	046	535	133.75	20	3.02
Mekong pool	023	511	127.75	19	2.89
Nam Mi	049	213	53.25	19	3.36
Don Koad	050	230	57.5	19	3.31
Houay Saenhai	001	72	14.4	14	3.04
Houay Lan	021	429	107.25	14	2.14
Houay Phanoy	009	71	14.2	11	2.35
Mekong pool	017	690	172.5	9	1.22
Don Hon (w)	006	49	9.8	8	1.80
Mekong River	002	54	10.8	7	1.50
DonSang (w)	008	133	26.6	6	1.02
Ban Khokgna*	Ext	19	-	2	-

\*extra location: no code number.

### 7.3.2 Records of priority taxa for this survey

Priority taxa for this survey (Table 7.4) were selected based on Cumberlidge *et al.* (2009), which assessed threatened species; current *IUCN Red List* categories; and value for local use (especially for food). Interviews reported three invertebrate groups as important for local livelihoods: crustaceans, large insects and molluscs.

Potamid crabs were recorded in several places in the upstream part of the study area (from Ban Pakhao and the Houay Si, in Chomphet and Louangphabang districts, to Ban Nongkhai, Xaignabouli district). Survey results suggested crabs were scarce at each sampling site. In twelve villages along the Mekong, interviews suggested that the crab population is lower than five years ago, seemingly from over-collection for sale, illegal fishing in small streams, and catchment activities such as slash-and-burn agriculture, road construction, and other development between the towns of Louangphabang and Xaignabouli, that decrease stream water quality and quantity. Between the town of Paklay and Sangthong, potamid crabs were found only at Houay Dua, Sangthong district, in the wet season.

**Table 7.4.** Priority taxa for three groups

Group	Family	Priority taxa	Criteria
Crustaceans	Potamidae	<i>Ranguna cochinchinensis</i>	(1), (2)
		<i>R. luangprabangensis</i>	(1), (2)
	Palaemonidae	<i>Macrobrachium lanchesteri</i>	(2)
		<i>M. dienbienphuense</i>	(2)
Large insect	Libellulidae	<i>Zygonyx iris</i>	(2)
	Gomphidae	<i>Ophiogomphus sinicus</i>	(2)
Molluscs	Thiaridae	<i>Brotia baccata</i>	(2)
		<i>Melanoides tuberculata</i>	(2)
	Viviparidae	<i>Mekongia swainsoni</i>	(2)
	Amblemidae	<i>Scabies phaselus</i>	(2)

Criteria: (1) current *Red List* categories; (2) important for local livelihood.

Priority species of prawns, dragonflies and molluscs were found in several places, in streams, rivers and pools. Most of these groups were more abundant in dry-season than in wet-season samples. The most abundant prawn was identified as *Macrobrachium lanchesteri* (352 individuals; 28 sites), followed by apparent *M. dienbienphuense* (87 individuals; 21 sites). All large dragonfly nymphs (Odonata) are edible (Table 7.5), especially those identified as *Ophiogomphus sinicus* and *Zygonyx iris*, which are big and abundant (141 and 78 individuals at 18 and 11 sites, respectively).

All molluscs in the priority list are popularly consumed. Each species found in this study was found at only a few sites and was scarcer than prawns and dragonfly nymphs. A form identified as *Brotia baccata* (50 individuals) was found more than any other mollusc. Local information reported that *Brotia* and *Melanoides* (Thiaridae) were common in upstream areas at the same place where many crabs remained. The bivalve snail was found at only one site, with 20 individuals. This species lives in deep water and muddy habitats, which may have hindered its recording.

### 7.3.3 Invertebrate habitats

The sampling sites presented very diverse habitats, with multiple substrate types and different environments surrounding them. Main channel substrates are mostly bedrock and/or sand: these are not suitable for many

kinds of invertebrates. Meanwhile, substrates of the temporary pools (occurring only during the dry season in the Mekong body) mostly are muddy and sandy with large algae and other aquatic macro-vegetation. These habitats support many insect larvae (e.g. dragonflies, water bugs, flies), shrimps (mostly, apparently, *Caridina* and *M. lanchesteri*) and bivalves, including during reproduction.

Small streams and small rivers offer the best living conditions for many aquatic fauna. Their substrates are mostly cobbles (pebbles mixed with gravel, sand, silt and debris), with much streamside vegetation. These habitats occur in many streams along the upper part of the study area from Ban Khokgna and Ban Pakhao in Louangphabang and Chomphet districts to Ban Nongkhai, Xaignabouli district. The specimens collected and information from local people both suggest that potamid crabs live mostly in streams and tributaries of the upstream area, such as the Houay Si, including the protected area around the waterfall of Tad Kuangsi), Nam Hang, Nam Hao, Houay Deng, Houay Kay, Houay Lan, Houay Pikmak, Nam Neun, Houay La, Houay Lakmouen, Nam Pouy, Nam Fuang, Nam Met, Nam Pou, Houay Khoksa Gnai and Nam Pa. Crab populations seemed low at sampling sites near the Mekong channel. According to interviews in twelve villages, these crabs are now decreasing, with the closest crabs further away from the villages than previously. Crab decreases are probably driven by over-collection for sale, and activities such as slash-and-burn agriculture and road construction between villages that occurred in a large area surrounding each village.

#### **7.4 Threats and local use**

The greatest threat to aquatic invertebrate fauna, especially the freshwater crabs (Potamiscinae), in the study area was over-collection for commercial trade. Wet-season observations at Xaignabouli town and Ban Thadua markets showed prices for *Ranguna luangprabangensis* of 30,000–35,000 Kip/kg, similar to that of pork or buffalo meat. In Louangphabang town market, the price was 35,000–40,000 kip/kg. *Ranguna cochinchinensis* is commonly caught during early dry season (November–January); its price was 40,000–45,000 kip/kg in September 2011 at Ban Thadua market.

Local people collected 36 morphotypes (in seven orders and, provisionally, 16 families) for their use (Table 7.5).

**Table 7.5.** Edible aquatic invertebrate taxa and their reported main habitats  
(*S* = stream, *P* = pool and *R* = river; most common is listed first)

Order	Family (provisional identification)	Taxon (provisional identification)	Reported main habitats
Megaloptera	Coridalidae	Morphotype 1	S, R
Odonata	Corduliidae	Morphotype 1	P
	Euphaeidae	Morphotype 1	S, R
	Gomphidae	Morphotype 1	S, R
		Morphotype 2	S, R, P
		Morphotype 3	S, R
		Morphotype 4	S, P
		Morphotype 5	S, P
	Libellulidae	Morphotype 1	P, S
		Morphotype 2	P, S
		Morphotype 3	P, S
		Morphotype 4	P, S
		Morphotype 5	P, S
		Morphotype 6	P, S
Hemiptera	Nepidae	Morphotype 1	P

Order	Family (provisional identification)	Taxon (provisional identification)	Reported main habitats
Coleoptera	Dytiscidae	Morphotype 2	P
		Morphotype 3	P
		Morphotype 1	S
	Gyrinidae	Morphotype 2	S, P
		Morphotype 3	P
		Morphotype 1	S, P
Decapoda	Atyidae	Morphotype 2	S, P
		<i>Caridina aff. brachydactyla</i>	P,
		<i>Somaniathelphusa brandti</i>	S, P
	Potamidae	<i>Ranguna cochichinesis</i>	S
		<i>R. luangprabangensis</i>	S
	Palaemonidae	<i>M a c r o b r a c h i u m dienbienphuense</i>	S, R
		<i>M. eriocheirum</i>	S, R
		<i>M. hirsutimanus</i>	S, R
		<i>M. lanchesteri</i>	S, R, P
		<i>Brotia citrina</i>	P
Mesogastropoda	Thiaridae	<i>B. costula</i>	P
		<i>Mekongia swainsoni</i>	P, R
	Viviparidae	<i>Pila pesmei</i>	P, R
		<i>Scabies phaselus</i>	P
Bivalvia	Amblemidae	<i>Corbicular virescens</i>	R, P
	Corbiculidae		

Collection methods for aquatic invertebrates differ between large and small organisms. Crabs are caught mostly by hand, by funnel basket trap, indirect collection, and/or the illegal collection by people using electric fishing methods (this method affects all animals living there, including juvenile and adult crabs). Shrimp, prawns and large aquatic insects are commonly collected with scoop nets, pull nets and lift nets.

Habitat destruction affects crabs and other animals. Shifting cultivation is extensive in hills both sides of the Mekong. Many permanent streams sampled in the wet season were dry during the dry season, e.g. Houay Saenhai, Houay Maksan, Houay Sao, Houay Phanoy, Houay Tadkok and Houay Dua. Upstream slash-and-burn can have strong effects on these small streams' hydrology. Road construction at Ban Talan to Ban Souy and Houay Soy (the Xaignabouli dam site area) destroyed one sampling site. The collection of gold and sand by heavy engines, as at Ban Donmen, also highly degrades habitats. These habitats might be highly affected by the Xaignabouli dam on account of flooding and sedimentation to a large area, including the Nam Neun (at the left side of the dam site), which has rich biodiversity.

Water pollution seems presently to affect sites on only a small scale. However, during the dry season, oils were found released to the water in several areas, e.g. at the ferry port and bridge construction areas at Ban Thadua, the Dam site, at former Ban Souy. Many aquaculture sites (fish cases) from Kenthao to Sangthong districts were reported by villagers to have higher than typical fish mortality rates.

## **7.5 Discussion**

The Mekong and its tributaries in the study area have diverse habitat types, giving aquatic invertebrates high taxonomic richness, abundance, and a wide distribution. Richness varied between sites. Average richness assemblage per total sample of the sites in the tributaries was higher than richness of sites in the Mekong mainstream at 5.80 and 3.59, and with standard deviations of 1.87 and 1.57, respectively.

In total, 217 morphotypes of aquatic invertebrates were recorded from the combined wet and dry season surveys; only 91 taxa morphotypes were found by both surveys. Recorded richness was higher in the dry season, at least in part reflecting the higher diversity of habitats that could then be sampled. The insect orders Ephemeroptera, Trichoptera, Hemiptera, Diptera and Odonata had particularly many morphotypes.

Fewer morphotypes were identified in this study than the number of species reported by MRC (2008), probably in part because MRC's data were cumulative over four years (2004–2007). But the present study identified more morphotypes than the number of species identified in studies such as MRC (2008, 2010a) and Vannachack (2010). Some sites in this study showed both high abundance and richness. The sites of Houay Pikmak and Houay Lakmouen had the highest abundance and highest richness respectively: 422 individuals of 56 morphotypes and 404 of 61, respectively. These sites, on the Mekong's left side, in Nan and Met districts, seemed those with the least impact from human activities.

Two freshwater crab species of the family Potamidae, subfamily Potamiscinae, were found. Potamidae is one of five crab families assessed using current *IUCN Red List* categories and criteria (Cumberlidge *et al.* 2009). Freshwater crabs remain little-studied in Lao PDR. Cumberlidge *et al.* (2009) reported only 17 species of freshwater crabs from Lao PDR: 10 Data Deficient (DD); four Least Concern (LC); two Vulnerable (VU); and one Endangered (EN). Two potamid species found in this survey were considered priority species for management. *Ranguna luangprabangensis* was found more widely and with, apparently a larger population than *R. cochinchinensis*. *Somaniathelphusa brandti* (Parathelphusidae) is a common crab, inhabiting an array of places. Populations of potamids seem lower than five years ago. Over-collection using illegal fishing methods and driven by economic demand for them, and habitat degradation are probably the main causes of these decreases.

Future studies on crabs are necessary to determine their conservation needs and to find the other species that doubtless occur in the survey area. The specific areas of Ban Houysi and Ban Khokgna should be considered for further research, because these villages apparently had the most crabs. Fuller management proposals are given in Chapter 9. The several threats to biodiversity already identified will be investigated during phase two's survey on community uses of natural resources.

# 08 Threats





## 8. Threats

### 8.1 Current threats

#### 8.1.1 Vegetation clearance

**B**ushes in the seasonally exposed channel are widely cut for firewood. Overall, it seems unlikely that this has much reduced the area of channel bushland, given that such habitat remains extensive even beside large towns such as Vientiane and Paklay (Sect. 4.5.3). In general there seem few threats to the vegetation within the channel. By contrast, along the length of the surveyed Mekong, most dryland habitats are degraded or very degraded. The common use of intensive slash-and-burn agriculture creates aridity, soil erosion, and infertile land adjacent to the Mekong channel. Logging also occurs in several places, including spirit forests. This logging has degraded or destroyed most of the terrestrial vegetation along the Mekong in the project area. It seems difficult to control because it is mostly opportunistic and not officially organised. These dryland habitats do not contribute to the special animal conservation significance of the Mekong channel, at least for birds and large mammals, and do not seem a high priority for future project intervention, given the large areas of dryland habitats already within the NPA system and other protective designations. Nonetheless, their heavy conversion has affected the channel. Removal of Strand and dryland bank-top vegetation along the Mekong has resulted in the collapse of many embankments. Moreover, especially in the lower reaches of the survey area, it seems likely that some fish would formerly have migrated during the wet-season into naturally vegetated parts of the flooded plains; this was adjudged unlikely still to happen given the near-total loss of such habitat.

#### 8.1.2 Overhunting, overfishing and wildlife trafficking

Overharvest is one of the greatest threats to herpetofauna and macroinvertebrates in the study area, and has already eradicated most of the hunting-sensitive birds and large mammals of the channel. Distribution patterns and comparison with other recent surveys indicated that declines evidently driven by overharvest are ongoing, and are now affecting even species as small as Plain Martin *Riparia paludicola* (Plate 4.4).

The reptile groups most targeted are turtles, monitor lizards and large snakes. Targeted species of other groups include some frogs and crabs. Several residents reported that some frogs, turtles, monitor lizards, large snakes and some crabs are more difficult to find now than several years ago. Turtles are the most commercially valuable reptiles in the study area. Some residents specifically search for turtles and one resident stated that he uses trained dogs to do so. Residents reported that commercial traders from the town of Xaignabouli visit the study area to purchase wildlife, purchasing turtles for prices ranging from 25,000 Kip (USD 3.1) for the plastron of *Manouria impressa* and 85,000 Kip (USD 10.7) per individual for *Amyda cartilaginea*. The most commercially valuable turtle species from the region (although not from the Mekong channel itself) was not observed, but residents' descriptions fitted *Platysternon megacephalum*. These are apparently sold for 200,000 Kip (USD 25.1) per individual. At least two villages along the Mekong appear to be particularly important for turtle trade - Ban Pakneun and Ban Houaykhoulouang (Sect. 5.4).

The greatest threat to aquatic invertebrate fauna, especially freshwater crabs (Potamiscinae), was over-collection for commercial trade (Chapter 7). The Mekong channel in the study area provides a strategic access route for wildlife trade, both for residents along the channel who visit remote upland villages to the east and west, and for traders from Xaignabouli town or elsewhere.

Many villagers reported declines during the last five years in large fish species, both in numbers caught and sizes of individuals. No report of Mekong Giant Catfish *Pangasianodon gigas* for decades was traced. These findings are highly consistent with overfishing.

### **8.1.3 Road development, gold mining and other economic activities in the main channel and riverine habitats**

Most of the longer sandbars (those exceeding 800 m or so) had commercial sediment removal in progress, and villager/itinerant extraction is almost ubiquitous (Sect. 4.5.3). The extent to which this removal is a direct threat is unclear. At least for vertebrates, it is quite probably overshadowed by its exacerbation of harvest levels. Commercial sediment removal puts many more people in the channel with access to vehicles, roads and urban markets. Oftakes of marketable wildlife are thus likely to be much higher. The total consumption by the many itinerants camped in-channel in the dry season is also likely to drive much higher oftakes for subsistence than was the case only 15–20 years ago, when many fewer people lived like this (JWD, pers. obs. along the channel in Sangthong district). The building and upgrading of roads to and along the channel (notably, upstream of Paksang) allows road access to even more of the channel. Given the easy boat access for decades, this is unlikely to have precipitated a great increase in pressure on high-value species, which would always have been removed when found; but it is likely to have spurred much greater oftakes of species at the mid- and lower levels of market values.

### **8.1.4 Human overfrequmentation and human population increase**

All parts of the study area have regular human use and presence, and this is apparently much increased since the mid 1990s (JWD, pers. obs. along the channel in Sangthong district). The section from the town of Paklay to Ban Thadua appears to have the lowest levels of use and the lowest density of settlement (Sect. 4.5.3). Even this is readily accessible by boat, so large populations of species of high commercial value are unlikely to be found. However, a number of hunting-sensitive species, notably Large-billed Crow, were noticeably more often recorded in this stretch. The effects of overfrequmentation in stimulating additional offtake (Sect. 8.1.2) are compounded by incidental disturbance on ground-nesting birds, which breed during the dry season – the very time when many people move for seasonal residence into the channel. The high dispersion of human presence is particularly problematic, and human activities in the channel could probably be more spatially concentrated without inhibiting their value.

## **8.2 Potential threats**

### **8.2.1 Hydropower development in the study area**

Totally new for this stretch of the Mekong, and indeed for the river downstream of China, is the change that a mainstream dam would bring. Active construction of the Xaignabouli (often spelt 'Xayaburi') dam is well underway. This was not the focus of the present survey (internationally it is conventional for the development's proponents to bear the costs of assessing such developments' likely effects on wildlife) but some speculations on their effects on the various animal groups are given in each chapter. In sum, seasonally exposed, seasonally inundated habitats are critically important for channel species of bird, invertebrate, reptile and probably, at some level, plant; the effects on these groups are likely to be severe if the dam, as seems inevitable, drastically reduces seasonal variation in Mekong water levels over a large area, because this will reduce the area of special habitat. As well as direct habitat loss, the dam also presents a strong threat to the fish in this stretch of river, particularly to those species making long-distance migrations (Sect. 6.4). The negative effects of large dams on river fish species are well documented in the region (Ziv *et al.* 2012).

# 09

## Management





## 9. Management

### 9.1 Priority taxa/location and framework for management interventions

#### 9.1.1 Habitats and plants

The primary threat to the habitats in the Mekong channel comes from changes in Mekong water levels. No evidence was gathered that direct anthropogenic degradation was a threat to these habitats at more than the most local of levels. Continuous degradation of the Strand and adjacent banktop vegetation may be problematic for channel communities, and should be prevented. The dryland habitats adjacent to the channel were not demonstrated to be of any particular conservation value to any of the taxonomic groups surveyed. They therefore do not warrant conservation attention, given the large tracts of forest already given conservation status (e.g. NPAs, but also more local designations) and the distractionary effect that involving them would have on the pressing need to conserve the unique channel habitats and their species. The effects on habitat of the large changes underway in animal communities in the channel are unknown. These involve major declines and extirpations of large mammals, large birds, large reptiles, large fish and even, apparently, large invertebrates. These species' interactions with plants (which define the habitats) are poorly studied but may be profound (e.g. one of the few plausible routes for seeds to go upstream is carriage in guts of animals, notably fish and birds). A precautionary stance is that retaining these special habitats in the future is best served by attention to overharvest of animals.

The plant chapter does not identify any plant species within the channel as highly threatened by any factor other than major change to water flows (e.g. from dams) with, for example, only one of the riparian draw-down annuals not also growing commonly as weeds in banktop cultivation. This would be in stark contrast to the concentration of specialised species of bird, reptile, fish and invertebrate dependent on the channel's habitats. However, at least one plant species does warrant attention: *Phoenix roebelenii*, a distinctive and unusual restricted-range rheophyte palm (Henderson 2009), was found growing at 19°15'38"N, 101°48'34"E (Keng Luang, the site of the Xaignabouli Dam) during the wet season. During the dry-season bird survey it was found only at 19°22'11"N, 101°51'30"E on 28 Jan and 18°57'00"N, 101°48'04"E and 18°49'11"N, 101°50'45"E on 30 Jan 2012, commonly at the last site. Those seen during the wet season were rooted below current water level, and their crowns had been at least briefly fully submerged. All plants seen in the dry season were growing on the highest boulder-dominated areas within the channel. These sorts of spots were frequently used as viewpoints for birds and the paucity of records suggests that the palm is probably genuinely localised. Most plants had been cut, and had regenerated well. The boatman said that he was not familiar with the species, despite 20+ years boating this stretch of the river. Discussion with locals revealed that the palm is cut at the base and dried for use as a ready-made broom; it was said to have no trade value. Conversely, a local boatman in the wet season said that this palm was taken for horticultural purposes, although he could give no detail. Barrow (1994) raised concerns for the species's survival in the wild because of accounts of extensive collection of wild plants apparently for horticulture. Boyer (2011) made extensive surveys along the Mekong upstream of Louangphabang and along the Nam Ou and found the palm highly localised, now apparently extinct in Thailand but with some good populations left in certain upstream parts of the Mekong and along the Nam Ou. He suspected horticultural offtake to be behind this curious distribution, but also concluded that direct collection pressure had now eased off because the trade was growing its own plants. He also cautioned that changes in demand could lead to rapid resumption of collection from the wild and, by implication, the eradication of remaining populations.

### 9.1.2 Birds

This survey underlines the speed with which channel bird species are declining in mainland Southeast Asia. In terms of shaping conservation actions directly for birds and large mammals, this is its most valuable finding: the survey area has lost most of the conservation values it held for these species 15 years ago, and if action is not stepped up significantly in those areas of the Mekong (essentially, northern Cambodia; Timmins 2006, 2008a) and elsewhere in Southeast Asia (notably the Hukaung valley, much of the mainstream Irrawaddy, probably the Chindwin and various others in Myanmar; e.g. van der Ven 2000, 2001, 2002, 2003, Tordoff *et al.* 2008), similar losses are likely to occur there. In all probability, Indian Skimmer and White-eyed River Martin are extinct in Southeast Asia, the latter globally so (BirdLife International 2001); Black-bellied Tern has just been lost from the Mekong (Goes *et al.* 2010) and the only populations left in Myanmar are unlikely to be secure (R. J. Tizard *in litt.* 2012). As this survey makes clear, River Tern and Great Thick-knee are not far behind Black-bellied Tern in their regional declines.

Thus, the most important recommendation for bird and large mammal conservation, from a regional and global perspective, is for immediate effective action for the channel ground-nesters in the relevant parts of Cambodia and Myanmar. In this extremely negative situation, clarity of focus may prevent regional and global extinctions. This will not be achieved by action in the survey area, or indeed now in any part of the Lao Mekong. The habitat currently remains suitable for these birds, which could in principle recolonise. But without swift action in the small proportion of areas in Southeast Asia retaining them, this will not occur, because there will be insufficient source populations. Should these populations be rebuilt in the Mekong elsewhere, recolonisation by some species would be highly likely. As a parallel, successful conservation of Darter breeding colonies in Cambodia has resulted in a great resurgence of Lao records of a species that in the 1990s was barely recorded at all (e.g. Duckworth *in press*).

However, some on-site bird conservation activities might be defensible. Conservation intervention in this stretch is important for reasons such as the retention of values to subsistence local communities and, potentially, the threatened fish species. Under such conservation projects, at little incremental cost, the local conservation status of the ground-nesting birds could perhaps be significantly improved. Currently, fisherman, itinerant gold-panners and other users of the river channel, land and roam during the breeding (dry) season on almost every dried-out section of the channel bed of this stretch of the Mekong. For these birds, the simple ubiquity of their presence is the foundation of the threats. If just one area of seasonally exposed channel bed, or better two or three, could become a no-access zone for people and dogs during December–April annually, this could hugely reduce threats to ground-nesting birds in the stretch at very little cost to human river users. There appears to be no reason why fishermen and others should land on every discrete part of the seasonally exposed channel as opposed to having them use designated sites. Concentrating their presence on some parts of the seasonally exposed channel in any given stretch surely would not hinder their activities significantly. In contrast to direct payments for nest protection (Sok *et al.* 2012), this approach may not have been seriously tried previously in the Mekong for nesting birds, and the practicalities of designing a workable system are therefore unclear. Direct payments for nest protection have had some success in years with external support and a focussed project presence, but failure as soon as either of these factors stops (Sok *et al.* 2012): however, this finding from Cambodia concerns bird species already harvested out of the upper Lao Mekong, and was specifically to prevent deliberate nest-robbing by people. None of the species left in the present survey area is as strongly appealing to nest-robbers, and therefore the needed interventions should not be so demanding. To make a real difference to conservation of the species concerned, a decade or more, rather than simply a few years (as is typical of most conservation projects), of such activity would be needed.

The best spots to become seasonal no-go zones are tracts of land which are submerged in the wet season and exposed, forming islands throughout December–April in a typical year. Preferably (i) they will be separated from the mainland by 100 m or more of water: domestic dogs (suspected to be a major problem for ground-nesting birds) readily swim distances less than this; and (ii) they must be submerged for long enough in the wet-season so as to not develop bank-top (dryland) vegetation (those that do, do not hold the birds of interest on the permanently exposed parts, but these latter are more likely to hold populations of small mammals and reptiles that predate birds' eggs). Spots fitting this description are probably too numerous to single out, and cannot so far be, because the separation through the dry season is not fully known. In general the bigger the seasonally exposed area, the better it will be for decreasing ground-nesting channel birds. Because the success of such schemes depends on local participation, the most important selection criterion is local support: it would be senseless to stack the odds against success by selecting for such a scheme spots important for human use for any of the various reasons people are active in the channel (thereby meaning they will be reluctant to forsake the spots' use), no matter how large or well separated from other land they are.

Another intervention that could usefully be undertaken by general conservation and rural development projects would be to prevent, as far as practicable, the presence of domestic dogs in the channel during November–May. Actions such as a ban on accompanied dogs requires assessment of their palatability to dog owners. The practicalities of restraining unaccompanied dogs (as many as they are) may be challenging.

In the unlikely event of resources being available for bird conservation in Lao PDR but not elsewhere (so the project area would not be, in essence, competing with Cambodia and Myanmar), the large river-channel community, being about the most threatened bird assemblage in the country, is an important national-level priority. Whether the survey area is in the top tier of current national importance is unclear; it has lost, or is about to lose, Great Thick-knee and River Tern, but the thick-knee may have gone from most of the rest of the Lao Mekong too, and the tern certainly has. In general, areas closer to Cambodia are likely to retain the best community, and almost certainly have the highest chances of recolonisation.

Beyond site-based activities, the *IUCN Red List* status of the river channel birds of tropical Asia warrants urgent review. Currently, Great Thick-knee is listed as LC, River Tern as NT, River Lapwing as NT, Indian Skimmer as VU and Black-bellied Tern as EN. This is divorced from their relative conservation status in Southeast Asia: the skimmer is worse off than Black-bellied Tern, and River Tern and the thick-knee are fairly comparable in status, both being much more severely threatened than is River Lapwing. As this survey shows, the lapwing is holding its own on large stretches of very wide rivers with natural flow conditions.

The Important Bird Area status of the survey area depends on congregatory, rather than globally threatened, species. The merits of this approach are well illustrated here, in that one or two mainstream dams would probably eliminate a large proportion of the Lao population of species such as River Lapwing, Small Pratincole, Little Ringed Plover, Spot-billed Duck, Wire-tailed Swallow, Plain Martin, White Wagtail and perhaps even Jerdon's Bushchat (although the huge area of apparently suitable habitat in the degraded northern highlands makes the case for this species weaker). Based on the 2011–2012 survey's observations, the IBA should run from somewhat downstream of the town of Louangphabang (starting at 19°41'22"N, 101°52'37"E) continuously to the island off Ban Mai (Vientiane municipality). And from other survey information (Thewlis *et al.* 1998, Duckworth *et al.* 2002; JWD unpublished), and if Small Pratincole, Little Ringed Plover and, most significantly (as it is evidently in ongoing national and even regional decline) Plain Martin are seen as suitable species for congregatory designation, then continuation of the IBA downstream from Ban Mai through urban Vientiane and to the end of the large sandbar complex around Ban Xiangkhouan (downstream extent, 17°56'N, 102°46'E) would be sensible.

The Lao risk status of some of the target species warrants reassessment. Continuation of listing Small Pratincole as Potentially At Risk in Lao PDR (PARL) is arguably inappropriate, given its widespread large population and lack of plausible threat other than mainstream dams. However, the complete mystery over where the Lao population spends the wet season, with the attendant possibility that the presumably concentrated population faces threats there, suggests a precautionary approach is advisable. Combined with the information in Duckworth (in press), both Lao quail species, Stork-billed Kingfisher, Indian Nightjar, Asian Pied Starling, Black-headed Munia and Red Avadavat are all rare and threatened in Lao PDR and should be listed as At Risk in Lao PDR (ARL), while Savanna Nightjar, Red-wattled Lapwing and Large-billed Crow have all undergone large recent declines in the northern half of the country, with some evidence for reduction in numbers in the southern half, and should be listed as at least PARL. Yellow-legged Buttonquail *Turnix tanki*, Crested Kingfisher and Streaked Weaver *Ploceus manyar* should also be PARL based on their localised distributions and the inherent habitat-level threats they face. The Lao risk statuses have not been revised since Duckworth *et al.* (1999) and given the great volume of information generated since, especially for non-forest species, warrant a comprehensive review. Consideration should be given to produce a national threatened species list applying *IUCN Red List* categories and criteria.

### 9.1.3 Reptiles and amphibians

#### Additional surveys

Undertake additional surveys in the area to seek to confirm the existence of four species of reptiles of conservation significance that are likely to occur in the survey area, but which were not recorded in the current survey except from interviews with local residents: *Pelochelys cantorii*, *Platysternon megacephalum*, *Varanus salvator* and *Python molurus*.

#### Trade-monitoring programme

Undertake a monitoring programme of locally occurring trade-activity in selected commercially valued reptile species. This should include all species of turtle (Trionychidae, Geoemydidae, Testudinidae), python *Python*, cobra *Naja* and *Ophiophagus* and monitor lizard *Varanus*, and Water Dragon *Physignathus cocincinus*. This programme should target four villages: Ban Houaykhoulouang, Ban Pakneun, Ban Khokakha and Ban Donsok. Other villages along the Mekong may be equally involved in reptile harvesting, but the number of project villages should be small enough, at least initially, to avoid spreading resources too thin. The programme should consider the following elements.

- Objective. Provide a surrogate measure of the status of commercially-traded reptile populations and impact of project activities. [Changes in the extent of trade may be detectable within the five-year IUCN project timeframe but changes in reptile populations may not.]
- Target species. All species observed within the target villages of turtle, python, cobra and monitor lizard, and Water Dragon *Physignathus cocincinus*.
- Personnel. One–two residents per village; Lao Biodiversity Association (LBA; as described in IUCN project proposal); one district officer.
- Frequency. Continual recording by residents. Monthly visits by LBA to collect and discuss data.
- Method. Form a Local Management Group (LMA) in each village (as described in IUCN project proposal) made up of selected village residents. The project pays these residents to record data on all target species collected in the village. Each village's LBA is responsible for storing and reporting

- the data.
- Materials. Data form in Lao language (a checklist-format accompanied by colour photographs of each species) and one digital camera for each village.
- 
- Training. Train village residents in the use of data forms and digital camera.

### **Field-monitoring programme**

Develop a field-monitoring programme to measure the status of wild populations of terrestrial turtles that may be declining from commercial trade (Group A). Although aquatic turtles, pythons, cobras and monitor lizards may also be declining, these are not amenable to monitoring because of their aquatic, subterranean or arboreal lifestyles. This component, if undertaken in the same villages as the trade-monitoring programme is relevant to understanding the effects of trade on local Chelonia.

- Objective: Measure trends in the status of wild populations of terrestrial turtles near four villages: Ban Houaykhoualouang, Ban Pakneun, Ban Khokakha, and Ban Donsok.
- Target species: All species of terrestrial turtles.
- Personnel: One-two residents per village; Lao Biodiversity Association (LBA; as described in IUCN project proposal to CEPF); one district officer.
- Frequency: Monthly.
- Method: Conduct timed searches (non-area limited) using trained dogs in fixed monitoring plots. A local resident with dogs would be hired for this. Dogs are much more effective at finding terrestrial turtles than are humans (Stuart & Timmins 2000, Platt et al. 2001, 2003, 2007). There is a risk the resident would return to the site after monitoring to collect turtles; such potential risks need to be evaluated.
- Materials: Data form in Lao language and digital camera.
- Training: Train LBA personnel in data collection, entry, analysis, and reporting.

### **Eliminating the turtle trade**

Slow, then stop, the turtle trade. For softshell turtles (family Trionychidae), conservation efforts should focus on the protection of large nesting females and nests. Elsewhere in Lao PDR, community-led fisheries projects have met with success and are increasingly supported by government agencies, and include the designation of fish conservation zones and self-imposed harvest regulations. This approach could be applied for softshell turtles and in association with fish management activities to be developed by the IUCN project (i.e. to develop fish-and-turtle conservation zones and prohibit capture of nesting females). Lessons learned from a successful nest protection programme by Conservation International in Cambodia for *Pelochelys cantorii* may be relevant to the current project.

For terrestrial turtles, pythons, cobras, monitor lizards and Water Dragon, a combined approach would include: protection of nesting females, such that residents agree to release any gravid females that are caught; village discussions, facilitated by the project, to develop community-led solutions to reduce collection;

training of provincial agencies in relevant national legislation, how to identify large reptile species, and in addressing wildlife trade; and strengthening of national legislation. In this second group of species, the terrestrial turtles are the highest conservation priority: efforts should initially focus on them and to build a community-led conservation programme.

### **Actions outside the Mekong**

Additional to the Mekong-focussed recommendations above, some desirable conservation activities in nearby dry-land areas were identified. Developing or strengthening community-based conservation efforts at key sites for amphibians and reptiles in land habitats may be the most practical approach to managing natural resources in this region, because it seems unlikely that any large, new protected areas will be designated close to the Mekong. Activities may include the facilitation of village meetings to clarify and revive traditional harvest regulations, strengthen the protection of community forests, develop fish/turtle conservation zones, restore natural habitats, and develop or expand ecotourism opportunities. Six high priority sites for conservation were identified: some of these are in villages with resource-use areas overlapping the Mekong, and initiatives to conserve Mekong herpetofauna may need to consider local dryland harvest practices so as to develop realistic packages of management proposals.

- (i) Houay Deng. This site contains standing, disturbed semi-evergreen forest near to the mainstream Mekong, although it is being rapidly encroached by agriculture. The site harbours forest obligates including *Leptobrachium smithi*, *Limnonectes gyldenstolpei*, *Rana nigrovittata* and *Lycodon laoensis*.
- (ii) Tad Jao. This site is within the resource-use area (and walking distance) of Ban Thadua. It consists of a patch of semi-evergreen forest enclosing a waterfall (Tad Jao) with a spectacular view overlooking the Mekong, a Buddhist shrine, and infrastructure consisting of stairs, picnic tables, toilets, and several open buildings, all built by the royal family of Thailand over 10 years ago. The infrastructure is dilapidated and near to collapse owing to a lack of upkeep. Villagers from Ban Thadua reported they do not hunt at Tad Jao owing to the Buddhist shrine. A large wild *Python reticulatus* found during the survey supports this notion. Other significant species recorded there include *Rhacophorus kio* and *Tropidophorus laotus*. The site has high potential for ecotourism. Tourists can exit boats on the riverbank below the falls and could climb stairs (after being repaired or rebuilt) to enjoy the falls, forest and view. A modest entrance fee could be collected by residents of Ban Thadua to support the upkeep of facilities and provide an incentive to residents to continue protecting the forest and wildlife.
- (iii) Houay Ting. This site is within the resource-use area of Ban Pakneun and Ban Pasak (19.24889°N, 101.83666°E). The stream is flanked by standing disturbed semi-evergreen forest mixed with bamboo forest. The site harbours forest obligates including *Leptobrachium smithi*, *Leptolalax minimus*, *Limnonectes gyldenstolpei*, *Odorrana chloronota*, *Rana cubitalis*, *Rana nigrovittata* and *Lycodon laoensis*.
- (iv) The Nam Pouy, between Pak Pouy (its mouth on the Mekong) and the Nam Pouy National Protected Area. Some stands of close to intact semi-evergreen forest and limestone karst forest persist, owing to a paucity of villages along the Nam Pouy. The site harbours forest obligates including *Leptobrachium smithi*, *Leptolalax minimus*, *Limnonectes gyldenstolpei*, *L. limborgi*, *Odorrana chloronota*, *O. heatwolei*, *Rana cubitalis*, *R. nigrovittata*, *Rhacophorus orlovi*, *Physignathus cocincinus* and *Lycodon laoensis*.
- (v) Pak Met. Several small streams flowing into the Mekong at this site support remnant but disturbed semi-evergreen forest. These small streams harbour forest obligates including *Leptobrachium smithi*, *Leptolalax minimus*, *Limnonectes gyldenstolpei*, *L. limborgi*, *Amolops cremnobatus*, *Odorrana chloronota*,

*Rhacophorus orlovi* and *Tropidophorus laotus*.

(vi) Houay Liap. This site is within the resource-use area of Ban Muangliap (18.47754°N, 101.65226°E), but is driving distance (by hand-tractor) from the village. Semi-evergreen forest that is close to intact is present along this stream. The stream harbours forest obligates including *Leptobrachium smithi*, *Leptolalax minimus*, *Rhacophorus orlovi*, *Theloderma asperum* and *Cyrtodactylus interdigitalis*.

#### 9.1.4 Fish

Conservation zones focusing on *Probarbus jullieni* are warranted in this stretch of the Mekong, notably no-fishing zones at each identified spawning ground. These will also benefit other large fish spawning in the same habitat.

A more comprehensive assessment of the commercial fisheries (organisation, number of people involved, income) would benefit the understanding of the fisheries pressure on this section of the Mekong and would facilitate the design and implementation of management measures to alleviate such pressure.

Monitoring will also be a key activity, to confirm and complete preliminary data obtained through this survey. This monitoring could be done in some key locations of the survey (deep pools or rapids) and also in markets to record the catch volume and frequency of selected fish species, including rare, threatened, large species.

All measures will require the strengthening of the capacity of fisheries staff in the provinces and districts, as well as including leadership and representatives from the fishing communities in training workshops and village decision-making. Training should include workshops on identification skills to recognise key species, monitoring and data collection. This collaboration will be necessary for the management of local fisheries and fish habitats.

#### 9.1.5 Invertebrates

The specific areas of Ban Houaysi and Ban Khokgna should be considered for invertebrate conservation measures, because these villages had the least-depleted crab populations. Conservation efforts should first perform further field assessment with specific focus on freshwater crabs in the selected areas, to determine the community resource-use and other social/economic data relevant to designing interventions. Community-based support for crab conservation should be developed through workshops covering the topics necessary for effective results, including: the causes of crabs' declining population; information regarding crab habitats; and definition of protection zones for crabs. The strong legal basis that already exists for crab conservation should be used to prohibit illegal fishing and other collecting methods, and avoid collection in the reproductive season (during wet season).

Monitoring should take place twice a year, during early and late dry season (between November–December and April–May). Early dry season is the optimal season to assess crab collection by people, and late dry season will be the optimal time to determine refuges for crabs when water levels are lowest.

### 9.2 Priority sites for management

The priority interventions in the survey area comprise some that are location-specific, such as fish conservation zones, and some that are not, such as general awareness-raising. The results from the different surveys vary in their level of site specificity, and for those groups which identified them, these locations should be the focus of the project's second phase, to survey local uses of natural resources and start joint work with

communities on conservation and natural resources management.

The plants survey identified no important areas within the channel, reflecting that the main threat to plants is yet to occur (changed water flows through hydropower). Some dryland sites were, however, identified as of local importance, reflecting the large-scale loss of lowland habitats. The bird and large mammal survey identified four general stretches within the survey area which have the best potential for rebuilding bird and otter populations, but because all the highly harvest-sensitive species have been eradicated already, or nearly so, these are not priorities for project implementation. Instead, nest protection activities for the somewhat harvest-sensitive species that remained could be trialled anywhere, and for logistical efficiency this would sensibly be in areas where other project activities occur. Information from the aquatic invertebrates survey was not precise enough to define priority sites, and as with birds measures to bring crab harvest to less damaging levels could sensibly be trialled at any of a large number of sites.

For fish and reptiles, clear priority sites can be proposed. For fish, these are the reported spawning grounds of *Probarbus jullieni*; assuming repeat visits confirm the reports from this survey, these urgently require management to prevent overharvest of the species, and of any other large fish species which spawn there. For reptiles, trade threatens the large species, and sites where the softshell turtle *Amyda cartilaginea* are of outstanding importance. None was confirmed on this survey, but a sensible start can be made by undertaking trade-reduction work in four villages, Ban Houaykhoualouang, Ban Pakneun, Ban Khokakha, and Ban Donsok, and keeping alert (all project personnel) for more precise information on nesting areas.

For plants and habitats and reptiles and amphibians, a number of locations outside the channel and immediately adjacent bank that have some conservation importance for forest species were identified. These warrant conservation measures under a broader regional perspective, but they have no relation to the Mekong and its directly influenced adjacent habitats.

In sum, other than for fish which provide some very clear spatial priorities, site selection for this project should probably be based largely around situational factors such as willingness of the local communities and government to engage. During this process, which will involve much more time in the area and discussion with local people, more specific information concerning species on the edge of extinction from the survey area, such as *Amyda cartilaginea* and Great Thick-knee, may come in. These species warrant immediate intensive nest-protection, and the project should remain flexible to respond when (and if) the need arises.

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# Appendices

## Appendix to Chapter 3: Plant species recorded.

Appendix 3.1. Summary of plant collecting.		
	Families	Species, subspecies, varieties
Angiosperms, Dicots	76	262
Angiosperms, Monocots	14	52
Pteridophytes	11	17
Bryophytes	4	4
Total	95	335

## Appendix 3.2. Preliminary database for the flora of the survey area.

Further botanical work is needed to improve this submission.

Database abbreviations.

Habit:	cr = creeping sc = scandent	h = herb t = tree	l = treelet wc = woody climber	s = shrub v = vine
Aped:	a = annual	pe = perennial evergreen	pd = perennial deciduous	ped = perennial evergreen+deciduous
Life mode:	aqu = aquatic gro = ground rhe = rheophyte	epl = epilithic par = parasite epi = epiphyte	nat = naturalized wee = weed int = introduced/not native	str = strangler cul = cultivated
	0 = Probably extirpated 1 = Down to a few individuals, in danger of extirpation 2 = Rare 3 = Medium abundance 4 = Common, but not dominant 5 = Abundant			
Habitat:	bb/df = bamboo+deciduous forest eg/bb = evergreen with bamboo forest sg = secondary growth da = disturbed areas, roadsides egf = evergreen forest		be = beaches rvf = riverine flood zone rvs = strand cult = cultivated areas	
Substrate:	gv = gravel	rk = bedrock	sa = sand	st = silt/mud
Bedrock:	ls = limestone topo = topotype	ms = sandstone	sh = shale	

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<b>Angiosperms, Dicots</b>															
<i>Anomianthus dulcis</i> (Dun.) Sincl.	Annonaceae	wc	pd	gro	3	da sg		sh	200	375	ap-my		mr-nv	flowers	12-190
<i>Artobotrys harmandii</i> Fin. & Gagnep.	Annonaceae	wc	pe	gro	3	egf		sh	200	350		ap-my	ja-dc	fruits	12-204
<i>Milliusa thorellii</i> Fin. & Gagnep.	Annonaceae	l	pe	gro	2	egf		ls	325	375	ap-my		ja-dc	flowers	12-109
<i>Miliusa velutina</i> (Dun.) Hk. f. & Th.	Annonaceae	t	pd	gro	3	bb/df		ls sh	175	300	ap-my		ap-fb		
<i>Oxymitra fornicata</i> (Roxb.) Hk. f. & Th.	Annonaceae	wc	pe	gro	2	streams in egf		sh	200	300	ap-my		ja-dc	flowers	12-168
<i>Polyalthia modesta</i> (Pierre) Fin. & Gagnep.	Annonaceae	l	pd	gro rhe	3	rvf	sa rk	sh	160	300		ap-my	fb-ag	fruits	12-149
<i>Polyalthia suberosa</i> (Roxb.) Thw.	Annonaceae	l	pe	gro		da sg in egf		sh ms	275	375	ap-my		ja-dc		
<i>Uvaria rufa</i> Bl.	Annonaceae	wc	pd	gro	3	da sg		sh	175	300	ap-my		mr-dc	flowers	12-232
<i>Cissampelos pareira</i> L. var. <i>hirsuta</i> (B.-H. ex DC.) Forman	Menispermaceae	v	a	gro	2	be rvf	sa	sh	275	300	ap-my		fb-ag	flowers	12-119
<i>Tiliacora triandra</i> (Colebr.) Diels	Menispermaceae	wc	pe	gro	3	egf		sh	200	375	ap-my		ja-dc	male flowers	12-171

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Tinospora sinensis</i> (Lour.) Merr.	Menispermaceae	wc	pd	gro	3	da sg		sh ms	275	325			my-ja		
<i>Argemone mexicana</i> L.	Papaveraceae	h	a	gro int nat	3	be rvf	sa	ls sh	250	325	mr-my	ap-jn	fb-jl	flowers fruits	12-88
<i>Rorippa indica</i> (L.) Hiern	Cruciferae	h	a	gro	3	be rvf	sa	ls sh	200	325	ap-my	my	mr-ag	flowers	12-136
<i>Capparis assamica</i> Hk. f. & Th.	Capparaceae	l	pe	gro	2	streams in egf		sh	300	375	ap-my		ja-dc		
<i>Capparis micracantha</i> DC. ssp. <i>micracantha</i>	Capparaceae	l	pe	gro	3	da sg		sh	175	250		my	ja-dc	fruits	12-229
<i>Crateva magna</i> (Lour.) DC.	Capparaceae	t l	pd	gro rhe	3	be rvf	sa rk	sh ms	225	325	ap-my		nv-jn		
<i>Neothorelia laotica</i> Gagnep.	Capparaceae	wc	pe	gro	2	cliffs egf		ls	275	300	ap-my		ja-dc	flowers	12-177 topo
<i>Portulaca oleracea</i> L.	Portulacaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my	my	mr-sp		
<i>Scyphellandra pierrei</i> Boiss.	Violaceae	l	pe	gro	3	egf		ms sh	275	300	ap-my		ja-dc	flowers	12-187
<i>Garcinia thorellii</i> Pierre	Guttiferae	t	pe	gro	2	egf		sh	300	325	ap-my		ja-dc	male flowers	12-154 topo
<i>Casearia flexuosa</i> Craib	Flacourtiaceae	s	pd	gro	3	da sg		sh	175	250	ap-my	my	fb-nv	flowers fruits	12-233
<i>Casearia grewiifolia</i> Vent. var. <i>grewiifolia</i>	Flacourtiaceae	t	pd	gro	2	bb/df da sg		ls	225	275		ap-my	fb-sp	fruits	12-215
<i>Ancistrocladus tectorius</i> (Lour.) Merr.		wc	pe	gro	3	egf		ls sh	200	375			ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Sida rhombifolia</i> L. ssp. <i>rhombifolia</i>	Malvaceae	h	a	gro	2	be rvf	sa	ls sh	160	325			mr-sp		
<i>Bombax anceps</i> Pierre var. <i>anceps</i>	Bombacaceae	t	pd	gro	3	bb/df		ls sh	175	300			jn-dc		
<i>Ceiba pentandra</i> (L.) Gaertn.	Bombacaceae	t	pe	gro cul int	3	cult		sh	160	375		my	ja-dc		
<i>Sterculia pexa</i> Pierre	Sterculiaceae	t	pd	gro	3	da sg		ls	300	375	ja-dc	ap-my	jn-mr		
<i>Grewia acuminata</i> Juss.	Tiliaceae	sc	pd	gro	3	bb/df		ls	275	300	ap-my		mr-oc	flowers	12-208
<i>Microcos sinuata</i> (Wall. ex Mast.) Burr.	Tiliaceae	s	pd	gro rhe	3	be rvf	sa	ls sh	175	325	ap-my	jn-jl	mr-jl	flowers	12-92
<i>Microcos tomentosa</i> Sm.	Tiliaceae	t	pd	gro	3	da sg		ls sh ms	160	375			ap-ja		
<i>Muntingia calabura</i> L.	Tiliaceae	h	a	gro	2	sg rvf	sa	ls sh	160	325			mr-sp		
<i>Elaeocarpus hainanensis</i> Oliv.	Elaeocarpaceae	t	pe	gro rhe	2	streams in egf rvf	rk	ls	275	300	ap-my		ja-dc	flowers	12-124
<i>Citrus maxima</i> (Burm.) Merr.	Rutaceae	t l	pe	gro int cul	3	cult		sh	160	350			ja-dc		
<i>Citrus × sinensis</i> (L.) Osb.	Rutaceae	l	pe	gro int cul	3	cult		sh	160	350			ja-dc		
<i>Clausena harmandiana</i> (Pierre) Pierre ex Guill.	Rutaceae	l	pe	gro	3	egf		ls	350	375	ap-my	my-jn	ja-dc	flowers	12-112 topo

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Glycosmis pentaphylla</i> (Retz.) DC. var. <i>pentaphylla</i>	Rutaceae	I	pe	gro	3	egf		ls sh	200	375	my		ja-dc		
<i>Melicope viticina</i> (Wall. ex Kurz) T. Hart.	Rutaceae	I	pd	gro	3	da sg		sh	175	250	ap-my		fb-oc	flowers	12-224
<i>Micromelum integrerrimum</i> (B. H. ex DC.) Wight & Arn. ex Roem. var. <i>integrerrimum</i>	Rutaceae	I	pd	gro	3	da sg		sh	175	250		ap-my	mr-dc	fruits	12-231
<i>Harrisonia perforata</i> (Blanco) Merr.	Simaroubaceae	sc wc	pd	gro	3	da sg		ls sh ms	200	375			ap-fb		
<i>Irvingia malayana</i> Oliv. ex Benn.	Irvingiaceae	t	pe	gro	2	egf		sh	175	300			ja-dc		
<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Burseraceae	t	ped	gro	2	bb/df egf		ls sh	325	375			ap-fb		
<i>Aglaia silvestris</i> (M. Roem.) Merr.	Meliaceae	t	pe	gro	3	egf		sh	200	375		ap-my	ja-dc	fruits	12-173
<i>Aphanamixis polystachya</i> (Wall.) R. Parker	Meliaceae	t	pe	gro	2	egf da		sh	225	325			ja-dc		
<i>Chukrasia tabilaris</i> A. Juss.	Meliaceae	t	pd	gro	3	egf		ls sh ms	250	375	ap-my		ap-fb		
<i>Cipadessa baccifera</i> (Roth) Miq.	Meliaceae	t l	pd	gro	3	egf da		ls	350	375	ap-my		ap-fb	flowers	12-108

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Sandoricum koetjape</i> (Burm. f.) Merr.	Meliaceae	t	pe	gro	3	egf		sh ms	250	375			ja-dc		
<i>Toona ciliata</i> M. Roem.	Meliaceae	t	pd	gro	3	egf		ls sh	300	375	ap-my		ap-fb		
<i>Iodes cirrhosa</i> Turcz.	Icacinaceae	wc	pe	gro	3	egf da sg		ls sh	275	375	ap-my		ja-dc	male female flowers	12-114 12-222
<i>Salacia verrucosa</i> Wight	Celastraceae	s	pe	gro	3	da sg		sh	175	250		my	ja-dc	fruits	12-227
<i>Ampelocissus martinii</i> Pl.	Vitaceae	v	pd	gro	3	bb/df		ls sh	200	350	my		my-dc		
<i>Cayratia roxburghii</i> (Wight & Arn.) Gagnep.	Vitaceae	wc	pd	gro	2	da sg		ms	275	300		ap-my		fruits	12-189
<i>Tetrastigma ? cauliflorum</i> Merr.	Vitaceae	wc	pe	gro	2			sh	200	300		ap-my	ja-dc	fruits	12-169
<i>Leea indica</i> (Burm. f.) Merr.	Leeaceae	l	pe	gro	3	egf		ls sh	200	375			ja-dc		
<i>Harpullia arborea</i> (Blanco) Radlk.	Sapindaceae	t	pe	gro	3	egf		ls sh	300	375	ap-my		ja-dc	flowers	12-110
<i>Litchi chinensis</i> Sonn. ssp. <i>chinensis</i>	Sapindaceae	t	pe	gro cul int	3	cult		sh	160	350	ap	jn	ja-dc		
<i>Phyllotrichum mekongense</i> Lec.	Sapindaceae	t	ped	gro	3	egf		ls sh	300	375	ap-my		my-ap	flowers	12-105 topo
<i>Schleichera oleosa</i> (Lour.) Oken	Sapindaceae	t	pd	gro	3	bb/df		ls	250	300		jn	ap-fb		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Mangifera indica</i> L.	Anacardiaceae	t	pe	gro cul	3	cult		sh	160	375		my	ja-dc		
<i>Semecarpus albicans</i> Kurz	Anacardiaceae	t	pe	gro	3	egf		sh ms	250	375			ja-dc		
<i>Spondias lakanensis</i> Pierre var. <i>lakanensis</i>	Anacardiaceae	t	pd	gro	3	egf		ls	300	375	ap-my		ap-ja		
<i>Cnestis palala</i> (Lour.) Merr. ssp. <i>palala</i>	Connaraceae	wc	pd	gro	3	da sg		sh	225	375			ap-ja		
<i>Acacia caesia</i> (L.) Willd. var. <i>subnuda</i> (Craib) I. Niels.	Leguminosae, Mimosoideae	wc	pe	gro	3	rvs sg		sh	200	375	ap-my		ja-dc	flowers	12-191
<i>Acacia megaladena</i> Desv. var. <i>megaladena</i>	Leguminosae, Mimosoideae	wc	pd	gro	3	da sg rvs		sh	200	350	ap-my		ja-dc	flowers	12-194
<i>Archidendron laoticum</i> (Gagnep.) I. Niels.	Leguminosae, Mimosoideae	t	pe	gro	3	rvs		sh	200	350	ap-my		ja-dc	flowers	12-192
<i>Entada rheedei</i> Spreng.	Leguminosae, Mimosoideae	wc	pd	gro	3	egf da sg		ls sh	200	375		ap-my	ap-ja		
<i>Leucaena leucocephala</i> (Lmk.) De Wit	Leguminosae, Mimosoideae	t 1	pe	gro int	3	da sg		ls sh ms	160	375			ja-dc		
<i>Mimosa diplostachya</i> C. Wright ex Sauv. var. <i>diplostachya</i>	Leguminosae, Mimosoideae	h	a	gro int nat	2	da be rvf	sa	ls sh	160	325			mr-sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Mimosa pigra</i> L.	Leguminosae, Mimosoideae	l	a	gro int nat	2	be rvf	sa	ls sh	160	325			mr-oc		
<i>Mimosa pudica</i> L.	Leguminosae, Mimosoideae	h	a	gro int nat	2	be rvf	sa	ls sh	160	325			mr-oc		
<i>Samanea saman</i> (Jacq.) Merr.	Leguminosae, Mimosoideae	t	pe	int cul gro	3	da cult		ls sh ms	160	325	ap-my		ja-dc		
<i>Bauhinia bassacensis</i> Pierre ex Gagnep. var. <i>bassacensis</i>	Leguminosae, Caesalpinoideae	wc	pe	gro	3	egf		sh	200	375	ap-my		ja-dc	flowers	12-205
<i>Cassia fistula</i> L.	Leguminosae, Caesalpinoideae	t	pd	gro	3	bb/df		ls sh	175	300	ap-my		ap-ja		
<i>Pterolobium macropterum</i> Kurz	Leguminosae, Caesalpinoideae	wc	pe	gro	3	da sg rvs		sh	200	350	ap-my		ja-dc	flowers	12-175
<i>Saraca declinata</i> (Jack) Miq.	Leguminosae, Caesalpinoideae	t	pe	gro	2	streams in egf		sh	275	300	ap-my		ja-dc	flowers	12-129
<i>Tamarindus indica</i> L.	Leguminosae, Caesalpinoideae	t	pe	gro cul int	3	da cult		ls sh ms	160	375			ja-dc		
<i>Callerya atropurpurea</i> (Wall.) Schot	Leguminosae, Papilionoideae	t	pe	gro	3	egf		sh	250	375			ja-dc		
<i>Crotalaria pallida</i> Ait.	Leguminosae, Papilionoideae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my	my	mr-sp		
<i>Derris alborubra</i> Hemsl.	Leguminosae, Papilionoideae	wc	pe	gro	3	rvs		sh	200	325		my	ja-dc	fruits	12-196
<i>Flemingia lineata</i> (L.) Roxb. ex Ait. f. var. <i>glutinosa</i> Prain	Leguminosae, Papilionoideae	s	pd	gro rhe	3	rocks in rvf	sa rk	ls sh	200	325			fb-sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Melilotus suaveolens</i> Led.	Leguminosae, Papilionoideae	h	a	gro	3	be rvf	sa	ls sh	200	325	ap-my	my-jn	mr- jl	flowers	12-81
<i>Millettia aff. bassacensis</i> Gagnep.	Leguminosae, Papilionoideae	t	pe	gro	3	rocks in egf		ls	275	300	ap-my		ja-dc	flowers	12-182
<i>Millettia aff. extensa</i> (Bth.) Bth. ex Baker	Leguminosae, Papilionoideae	wc	pd	gro	2	rvs		sh	225	250	my		my-dc	flowers	12-218
<i>Mucuna interrupta</i> Gagnep.	Leguminosae, Papilionoideae	v	pe	gro	2	egf rvs		ls	275	300		ap-my	ja-dc	fruits	12-123
<i>Phaseolus vulgaris</i> L.	Leguminosae, Papilionoideae	h	a	gro int	2	be rvf	sa	ls	300	325	ap-my	my-jn	mr-jl	flowers	12-86
<i>Pterocarpus macrocarpus</i> Kurz	Leguminosae, Papilionoideae	t	pd	gro	3	bb/df		ls	250	375			ap-ja		
<i>Anogeissus acuminata</i> (Roxb. ex DC.) Guill. & Perr.	Combretaceae	t	pd	gro	3	bb/df		ls	250	375			ap-ja		
<i>Calycopteris floribunda</i> (Roxb.) Lmk.	Combretaceae	wc	pd	gro	3	da sg		ls sh	175	325	mr	ap	mr-dc		
<i>Combretum latifolium</i> Bl.	Combretaceae	wc	pd	gro	3	da sg in egf		ls sh	200	375			my-fb		
<i>Quisqualis indica</i> L. var. <i>indica</i>	Combretaceae	wc	pd	gro	3	da sg		ls sh ms	200	375	ap-my		my-fb		
<i>Eugenia mekongensis</i> Gagnep.	Myrtaceae	t l	pd	gro rhe	4	rocks in be rvf	sa rk	ls sh	175	325	ap-my	ap-my	fb-jl	flowers fruits	12-116

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Eugenia siamensis</i> Craib	Myrtaceae	t	pe	gro	3	rvs		sh	200	300	ap-my	ap-my	ja-dc	flowers fruits	12-148
<i>Memecylon angustifolium</i> Wight	Melastomaceae	l	pe	gro	2	da sg		sh	175	225	ap-my		ja-dc	flowers	12-225
<i>Ammannia baccifera</i> L.	Lythraceae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-my	my	mr-sp		
<i>Duabanga grandiflora</i> (Roxb. ex DC.) Walp.	Sonneratiaceae	t	pe	gro	3	egf		ls	350	375			ja-dc		
<i>Ludwigia hyssopifolia</i> (G. Don) Exell	Onagraceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my		mr-oc		
<i>Passiflora foetida</i> L.	Passifloraceae	v	a	gro int nat wee	3	da sg		ls sh ms	160	375			ja-nv		
<i>Carica papaya</i> L.	Caricaceae	h	pe	cul gro int	3	cult		sh	160	375	ja-dc	ja-dc	ja-dc		
<i>Coccinia grandis</i> (L.) Voigt	Cucurbitaceae	v	a	gro wee	3	da sg cult		ls sh	160	375			mr-nv		
<i>Gymnopetalum scabrum</i> (Lour.) Wilde & Duy.	Cucurbitaceae	v cr	a	gro	3	be rvf	sa	ls sh ms	160	325			fb-sp		
<i>Momordica charantia</i> L.	Cucurbitaceae	v	a	gro	3	da sg rvf	sa	ls sh	160	325			mr-sp		
<i>Begonia lecomtei</i> Gagnep.	Begoniaceae	h	pe	gro	2	streams in egf		sh	200	300		ap-my	ja-dc	fruits	12-155
<i>Tetrameles nudiflora</i> R. Br. ex Benn.	Datiscaceae	t	pd	gro	3	egf		ls sh ms	200	300		ap-my			

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Glinus lotoides</i> L.	Molluginaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap	my-jn	mr-sp	fruits	12-221
<i>Mollugo pentaphylla</i> L.	Molluginaceae	h	a	gro	3	be rvf		ls sh	160	325	ap-my		fb-sp	flowers	12-214
<i>Cenetella asiatica</i> (L.) Urb.	Umbelliferae	h	a	gro	3	da rvf		sh ms	225	350			ja-dc		
<i>Oenanthe javanica</i> (Bl.) DC.	Umbelliferae	h	a	gro	3	be rvf	sa	ls sh	175	325	mr-my	ap-jn	nv-jl	flowers	12-102
<i>Heteropanax fragrans</i> (Roxb. ex DC.) Seem.	Araliaceae	t	pd	gro	2	da sg		sh ms	225	375			ap-ja		
<i>Silvianthus tonkinensis</i> (Gagnep.) Rids.	Carlemanniaceae	s	pe	gro	2	streams in egf		sh	200	300	ap-my		ja-dc	flowers	12-162
<i>Anthocephalus chinensis</i> (Lmk.) A. Rich. ex Walp.	Rubiaceae	t	pd	gro	3	da sg		ls sh ms	160	375			my-fb		
<i>Benkara sinensis</i> (Lour.) Rids.	Rubiaceae	s sc	pe	gro	3	egf da		ls	325	350	ap-my		ja-dc	flowers	12-113
<i>Dentella repens</i> (L.) J.R. & G. Forst.	Rubiaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	mr-my	ap-jn	mr-jl	flowers	12-77
<i>Haldina cordifolia</i> (Roxb.) Rids.	Rubiaceae	t	pd	gro	3	da in egf		ls	300	375			my-fb		
<i>Hedyotis (Oldenlandia succosa</i> Pierre ex Pit.)	Rubiaceae	h	pd	epl	2	rocks in rvf	rk	ls	325	350	ap-my	my-jn	mr-jl	flowers	12-103
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	Rubiaceae	t	pd	gro	3	bb/df		ls	250	325			ap-my		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Mitragyna hirsuta</i> Hav.		t	pd	gro	3	bb/df			250	375			ap-ja		
<i>Morinda tomentosa</i> Hey. ex Roth	Rubiaceae	t	pd	gro	3	bb/df		ls	250	325			ap-ja		
<i>Mycetia gracilis</i> Craib	Rubiaceae	s	pe	gro	2	streams in egf		sh	200	300		ap-my	ja-dc	flowers	12-140
<i>Mycetia</i>	Rubiaceae	l	pe	gro	2	streams in egf		sh	275	300	ap-my		ja-dc	flowers	12-137
<i>Oxyceros horridus</i> Lour.	Rubiaceae	wc	pe	gro	3	da sg		sh ms					ja-dc		
<i>Pavetta indica</i> L.	Rubiaceae	l	pe	gro	2	egf		ls	275	300	ap-my		ja-dc	flowers	12-125
<i>Psychotria mekongensis</i> Pit.	Rubiaceae	l	pe	gro	2	streams in egf		sh	200	300	ap-my		ja-dc	flowers	12-165 topo
<i>Tarenna baviensis</i> (Drake) Pit.	Rubiaceae	t	pe	gro	2	streams in egf		sh	200	300	ap-my		ja-dc	flowers	12-166
<i>Urophyllum glabrum</i> Wall.	Rubiaceae	l	pe	gro	2	streams in egf		sh	250	300	ap-my		ja-dc	flowers	12-139
<i>Xantonnea parviflora</i> (O.K.) Craib var. <i>salicifolia</i> (Pierre ex Pit.) Craib	Rubiaceae	s	pd	gro rhe	3	rocks in rvf	sa rk	sh	200	250	my	my	mr-sp	flowers immature fruits	12-216
<i>Ageratum conyzoides</i> L.	Compositae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my	my	fb-oc		
<i>Anaphalis margaritacea</i> (L.) Bth.	Compositae	h	a	gro	3	be rvf	sa	ls sh	160	325	mr-my	ap-jn	mr-jl	flowers	12-94
<i>Bidens pilosa</i> L.	Compositae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-my	my	fb-sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Conyza sumatrensis</i> (Retz.) Walk.	Compositae	h	a	gro wee	3	da sg cult		ls sh	160	375	ap-my	my	mr-dc		
<i>Crassocephalum crepidioides</i> (Bth.) S. Moore	Compositae	h	a	gro	3	be rvf	sa		160	325	ap-my	my	mr-sp		
<i>Eclipta prostrata</i> (L.) L.	Compositae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my		mr-sp		
<i>Ethulia conyzoides</i> L.	Compositae	h	a	gro	2	be rvf	sa	sh	300	300	ap-my		mr-jl	flowers	12-117
<i>Eupatorium odoratum</i> L.	Compositae	h	a	gro wee	4	da sg cult		ls sh ms	160	375			ja-dc		
<i>Grangea maderaspatana</i> (L.) Poir.	Compositae	h	a	gro	3	be rvf	sa	ls sh	160	325	mr-my	ap-jn	mr-jl	flowers	12-78
<i>Hemistepta lyrata</i> Bunge	Compositae	h	a	gro	2	be rvf	sa	sh	200	300	ap-my		mr-ag	flowers	12-161
<i>Mikania cordata</i> (Burm. f.) B. L. Rob.	Compositae	v	a	gro	3	be rvf	sa	ls sh ms	160	325			mr-dc		
<i>Senecio oldhamianus</i> (Maxim.) Nord.	Compositae	h	a	gro	2	be rvf	sa	ls	275	300	ap-my		fb-ag	flowers	12-183
<i>Spilanthes paniculata</i> Wall. ex DC.		h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my		mr-sp		
<i>Tagetes patula</i> L.		h	a	gro int nat	2	be rvf	sa	ls	300	325			mr-sp		
<i>Vernonia elaeagnifolia</i> DC.	Compositae	wc	pe	gro	2	bb/df rvs		ls	275	300		ap-my	fb-nv	fruits	12-210

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Xanthium inaequilaterum</i> DC.	Compositae	h	a	gro	3	be rvf	sa	ls sh	200	325	mr-ap	ap-my	mr-jn	fruits	12-80
<i>Youngia japonica</i> (L.) DC.	Compositae	h	a	gro	3	be rvf	sa	ls sh	200	325	mr-my	ap-jn	mr-jl	flowers fruits	12-93
<i>Campanula colorata</i> Wall. ex Roxb.	Campanulaceae	h	pd	epl	2	rocks in rvf	rk	ls	325	350	ap-my	my-jn	mr-jl	flowers	12-104
<i>Wahlenbergia marginata</i> (Thunb.) A. DC.	Campanulaceae	h	a	gro	2	be rvf	sa	ls	300	325	mr-ap	ap-my	fb-jl	flowers	12-95
<i>Lysimachia decurrens</i> J.G. Forst.	Primulaceae	h	a	gro	2	rvf	sa	sh	250	300	ap-my	my	mr-ag	flowers	12-203
<i>Ardisia murtonii</i> Flet.	Myrsinaceae	h	pe	gro	2	streams in egf		sh	200	300	my		ja-dc	flowers	12-167
<i>Ardisia obtusa</i> Mez var. <i>obtusa</i>	Myrsinaceae	s	pe	gro		da sg		sh	175	250		ap-my	ja-dc	fruits	12-230
<i>Manilkara achras</i> (Mill.) Fosb.	Sapotaceae	l	pd	gro int cul	3	cult		sh	160	350			ja-dc		
<i>Chionanthus ramiflorus</i> Roxb.	Oleaceae	t	pe	gro	3	egf		ls sh	250	375	mr		ja-dc		
<i>Jasminum craibinum</i> Kerr	Oleaceae	v	pe	gro	3	rvs			250	325	ap-my		ja-dc	flowers	12-115
<i>Vallaris solanacea</i> (Roth) O.K.	Apocynaceae	wc	pe	gro	3	rocks cliffs in egf		ls sh ms	275	300	ap-my		ja-dc	flowers	12-188
<i>Wrightia arborea</i> (Denn.) Mabb.	Apocynaceae	t	pd	gro	3	bb/df		ls	250	300	ap-my		mr-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Dischidia imbricata</i> (Bl.) Steud.	Asclepiadaceae	h cr	pe	epi	2	streams in egf		sh	250	350			ja-dc		
<i>Dischidia nummularia</i> R. Br.	Asclepiadaceae	h cr	pe	epi	3	egf		sh	250	325			ja-dc		
<i>Drega volubilis</i> (L.f.) Bth ex Hk. f.	Asclepiadaceae	wc	pe	gro	2	rvs		ms	275	300	ap		ja-dc	flowers	12-186
<i>Telosma pallida</i> (Roxb.) Craib	Asclepiadaceae	v	pe	gro	3	da sg		ms	200	325	ap-my		ja-dc	flowers	12-184
<i>Buddleja asiatica</i> Lour.	Loganiaceae	l	a	gro	3	be rvf	sa	ls sh	160	325			mr-sp		
<i>Cordia cochinchinensis</i> Gagnep.	Boraginaceae	t	pe	gro	3	rvs		sh	200	350		ap-my	ja-dc	fruits	12-197
<i>Heliotropium indicum</i> L.	Boraginaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my	my	mr-sp		
<i>Cuscuta japonica</i> Choisy	Convolvulaceae	v	a	epi par	2	be rvf	sa	ls	325	350	ap-my	my-jn		flowers	12-91
<i>Evolvulus nummularis</i> (L.) L.	Convolvulaceae	h cr	a	gro	2	be rvf	sa	ls	300	325			mr-oc		
<i>Operculina turpethum</i> (L.) S. Manso	Convolvulaceae	v	pe	gro wee	3	da sg		ls sh	160	375			ja-dc		
<i>Lycopersicon esculentum</i> Mill.	Solanaceae	h	a	gro int nat	2	be rvf	sa	ls	250	325	ap-my	ap-my	fb-oc		
<i>Physalis angulata</i> L.	Solanaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my	my	mr-sp		
<i>Solanum torvum</i> Swz.	Solanaceae	h	a	gro int nat	3	da be rvf	sa	ls sh ms	160	375	ap	ap-my	fb-sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Solanum verbascifolium</i> L.	Solanaceae	h (l)	a	gro	2	be rvf	sa	ls sh	160	325			mr-sp		
<i>Cyrtandromea grandiflora</i> Cl.	Scrophulariaceae	s	pe	gro	2	streams in egf		sh	275	300	ap-my		ja-dc	flowers	12-158
<i>Lindenbergia muraria</i> (Roxb. ex D. Don) Bruhl	Scrophulariaceae	h	a	epl	3	rocks cliffs	rk	ls	325	350	ap-my	my-jn	mr-jl	flowers	12-101
<i>Lindenbergia philippensis</i> (Cham.) Bth.	Scrophulariaceae	h	a	gro	3	be rvf	sa	ls	200	300	ap-my	ap-my	mr-ag	flowers	12-120
<i>Lindernia antipoda</i> (L.) Alst.	Scrophulariaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-my		fb-ag	flowers	12-151
<i>Lindernia crustacea</i> (L.) F. Muell. var. <i>crustacea</i>	Scrophulariaceae	h	a	gro	3	be rvf	sa		160	325	ap-my	my	mr-ag		
<i>Lindernia crustacea</i> (L.) F. Muell. var. <i>godefroyi</i> (Bon.) Yama.	Scrophulariaceae	h	a	gro	2	be rvf	sa gv	sh	275	300	ap-my	my	mr-ag	flowers fruits	12-202
<i>Lindernia elata</i> (Bth.) Wett.	Scrophulariaceae	h	a	gro	3	be rvf	sa gv	sh	200	325	ap-my	my	mr-sp	flowers fruits	12-200
<i>Scoparia dulcis</i> L.	Scrophulariaceae	h	a	gro nat	3	be rvf	sa	ls sh	160	325	ap-my	my	mr-sp		
<i>Stemodia verticillata</i> (Mill.) Bold.		h	a	gro nat	2	be rvf	sa gv	sh	250	325	ap-my	my	mr-ag	flowers fruits	12-201
<i>Verbascum chinensis</i> (L.) Sant.	Scrophulariaceae	h	a	gro	3	be rvf	sa	ls sh	300	300	ap-my	my-jn	mr-jl	flowers fruits	12-82

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Fernandoa adenophylla</i> (Wall. ex G. Don) Steen.	Bignoniaceae	t	pd	gro	3	da sg		sh ms	250	375			ap-jn		
<i>Millingtonia hortensis</i> L. f.	Bignoniaceae	t	pd	gro	3	bb/df		ls sh	200	350			ap-jn		
<i>Oroxylum indicum</i> (L.) Bth. ex Kurz	Bignoniaceae	t (l)	pd	gro	3	da sg		sh ms	200	300			ap-fb		
<i>Dicliptera roxburghiana</i> Nees	Acanthaceae	h	a	gro	2	da in egf		ls	325	350		ap-my	ja-oc	fruits	12-98
<i>Eranthemum nervosum</i> R. Br. ex Roem. & Schult.	Acanthaceae	h	pd	gro	2	da in egf		ls	325	350	mr-ap	ap-my	ja-dc	flowers fruits	12-99
<i>Phlogacanthus curviflorus</i> (Wall.) Nees var. <i>curviflorus</i>	Acanthaceae	h	pe	gro		streams wet areas in egf		sh	250	350			ja-dc		
<i>Rungia parviflora</i> (Retz.) Nees var. <i>parviflora</i>	Acanthaceae	h	a	gro	2	rocks in rvf	sa rk		250	300		ap-my	mr-ag	fruits	12-206
<i>Thunbergia laurifolia</i> Lindl.	Acanthaceae	wc	pe	gro	3	da sg		ls sh ms	160	375			ja-dc		
<i>Clerodendrum infortunatum</i> L.	Verbenaceae	l	pe	gro	3	da sg		sh ms	160	325		ap-my	ja-dc		
<i>Congea tomentosa</i> Roxb. var. <i>tomentosa</i>	Verbenaceae	wc	pd	gro	3	da sg		ls sh ms	160	375			ap-ja		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Gmelia elliptica</i> J.E. Sm.	Verbenaceae	s	pd	gro rhe	2	rvf	sa rk	sh	200	225	ap-my	my	mr-ag	flowers	12-220
<i>Phyla nodiflora</i> (L.) Greene	Verbenaceae	h	a	gro	3	be rvf	sa	sh	160	325	ap-my		mr-ag	flowers	12-176
<i>Premna scandens</i> Roxb.	Verbenaceae	wc	pe	gro	3	rvs		sh	200	350		my	ja-dc	fruits	12-194
<i>Tectona grandis</i> L. f.	Verbenaceae	t	pd	gro cul int	3	cult		ls sh ms	160	325			ap-ja		
<i>Verbena officinalis</i> L.	Verbenaceae	h	a	gro	2	be rvf	sa	ls sh	160	325	ap-my		mr-sp		
<i>Leonotis nepetaefolia</i> (L.) R. Br.	Labiatae	h	a	gro	3	be rvf	sa	ls	275	325	ap-my	my	mr-ag	flowers	12-134
<i>Leonurus sibiricus</i> L.	Labiatae	h	a	gro	3	be rvf	sa	sh	200	300	ap-my		fb-ag	flowers	12-144
<i>Chenopodium ambrosioides</i> L.	Chenopodiaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	mr-ap	ap-jn	mr-jl	flowers	12-73
<i>Chenopodium ficifolium</i> Sm.	Chenopodiaceae	h	a	gro	3	be rvf	sa	ls sh	200	325	mr-my	ap-jn	mr-jl	flowers	12-79
<i>Alternanthera sessilis</i> (L.) DC. var. <i>sessilis</i>	Amaranthaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-my		fb-sp		
<i>Amaranthus spinosus</i> L.	Amaranthaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my		mr-oc		
<i>Amaranthus viridis</i> L.	Amaranthaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	325	ap-my		mr-oc		
<i>Celosia argentea</i> L.	Amaranthaceae	h	a	gro	3	be rvf	sa	ls sh ms	160	300			fb-sp		
<i>Polygonum odoratum</i> Lour.	Polygonaceae	h	a	gro	2	be rvf	sa	ls sh	200	300	ap-my	ap-my	mr-jl	flowers fruits	12-118

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Polygonum plebeium</i> R. Br.	Polygonaceae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-jn	my-jn	mr-jl	flowers	12-70
<i>Rumex dentatus</i> L.	Polygonaceae	h	a	gro	3	be rvf	sa	ls sh	200	325	ap-my	my-jn	mr-jl	flowers fruits	12-84 12-163
<i>Piper sarmentosum</i> Roxb. ex Hunt.	Piperaceae	h	pe	gro	3	egf		sh	225	350			ja-dc		
<i>Knema tenuinervia</i> Wilde ssp. <i>setosa</i> Wilde	Myristicaceae	t	pe	gro	3	egf		sh	200	375		ap-my	ja-dc	fruits	12-170
<i>Beilschmiedia glomerata</i> Elm.	Lauraceae	t	pe	gro	2	rvs		ls	275	300		ap-my	ja-dc	fruits	12-212
<i>Cinnamomum iners</i> Reinw. ex Bl.	Lauraceae	t	pe	gro	3	egf		sh ms	250	375			ja-dc		
<i>Helixanthera parasitica</i> Lour.	Loranthaceae	s	pe	epi par	2	da sg		sh	175	200	ap-my		ja-dc	flowers	12-234
<i>Acalypha australis</i> L.	Euphorbiaceae	h	a	gro	2	be rvf	sa	sh	200	325	ap-my		mr-ag	flowers	12-164
<i>Antidesma montanum</i> Bl. var. <i>montanum</i>	Euphorbiaceae	t	pe	gro	3	streams in egf		sh	275	300	ap-my		ja-dc	male flowers	12-128
<i>Antidesma montanum</i> Bl. var. <i>salicinum</i> (Ridl.) P. Hoffm.	Euphorbiaceae	t l	ped	gro rhe	3	rocks in rvf rvs	sa rk	ls sh	300	350	ap-my	my-jn	mr-jl	male & female flowers	12-107
<i>Baccaurea ramiflora</i> Lour.	Euphorbiaceae	t	pe	gro	3	egf		ls sh	225	375		my	ja-dc		
<i>Bischofia javanica</i> Bl.	Euphorbiaceae	t	pe	gro	3	egf		ls	250	375			ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Cleidion javanicum</i> Bl.	Euphorbiaceae	t	pe	gro	4	steams in egf		sh	200	325		ap-my	ja-dc	fruits	12-132
<i>Croton kongensis</i> Gagnep.	Euphorbiaceae	l	pd	gro	3	da sg		sh	200	250	ap-my	my	mr-nv	flowers fruits	12-223 topo
<i>Drypetes harmandii</i> Pierre ex Gagnep.	Euphorbiaceae	t	pe	gro	3	egf		sh	200	375		ap-my	ja-dc	fruits	12-172
<i>Drypetes salicifolia</i> Gagnep.	Euphorbiaceae	t	pe	gro	3	egf rvs		sh	200	300		ap-my	ja-dc	fruits	12-147 topo
<i>Epiprinus siletianus</i> (Baill.) Croiz.	Euphorbiaceae	t	pe	gro	3	rocks in egf		ls	275	300	ap-my		ja-dc	female flowers	12-180
<i>Euphorbia hirta</i> L.	Euphorbiaceae	h	a	gro wee	4	da sg cult		ls sh	160	375	ja-dc	ja-dc	ja-dc		
<i>Euphorbia parviflora</i> L.	Euphorbiaceae	h	a	gro	2	be rvf	sa	ls	250	300	ap-my		mr-sp	flowers	12-213
<i>Euphorbia thymifolia</i> L.	Euphorbiaceae	h	a	gro	3	be rvf	sa	sh	160	325	ap-my	my	fb-ag	flowers fruits	12-145
<i>Homonoia riparia</i> Lour.	Euphorbiaceae	s	pd	rhe gro	5	rocks in be rvf	sa gv rk	ls sh ms	160	325	ja-fb	my-jn	mr-jl	fruits	12-87
<i>Jatropha curcas</i> L.	Euphorbiaceae	s	pe	cul gro int	3	da sg		sh	160	350			ja-dc		
<i>Macaranga denticulata</i> (Bl.) M. A.	Euphorbiaceae	t	pd	gro	3	da sg		ls sh ms	160	375			ap-ja		
<i>Macaranga siamensis</i> S.J. Davies	Euphorbiaceae	t	pd	gro	3	da sg		sh ms	200	375			ap-ja		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Mallotus barbatus</i> M.A.	Euphorbiaceae	t	pe	gro	3	da sg		sh ms	250	375	ap-my		ja-dc		
<i>Mallotus brevipetiolatus</i> Gage	Euphorbiaceae	s	pd	gro	3	da sg		sh	175	225		ap-my	mr-dc	fruits	12-228
<i>Mallotus lanceolatus</i> (Gagnep.) A.S.	Euphorbiaceae	t	pe	gro	3	egf		ls	325	375	ap-my		ja-dc	male flowers	12-111
<i>Mallotus paniculatus</i> (Lmk.) M.A. var. <i>paniculatus</i>	Euphorbiaceae	t	pe	gro	3	da sg		ls sh ms	160	375			ja-dc		
<i>Mallotus philippensis</i> (Lmk.) M.A.	Euphorbiaceae	t	pe	gro	3	da sg		ls sh ms	200	375			ja-dc		
<i>Mallotus pierrei</i> (Gagnep.) A.S.	Euphorbiaceae	l	pd	gro	3	bb/df		ls	275	300	ap-my		mr-nv	male flowers	12-209
<i>Microdesmis caseariifolia</i> Pl.	Euphorbiaceae	l	pe	gro	3	da sg		sh	175	225	ap-my		ja-dc	male flowers	12-226
<i>Ostodes paniculata</i> Bl.	Euphorbiaceae	t	pe	gro	3	egf		ls sh ms	225	375			ja-dc		
<i>Phyllanthus amarus</i> Schum. & Thonn.	Euphorbiaceae	h	a	gro	2	be rvf		ls sh ms	160	325	ap-my	my	mr-sp		
<i>Phyllanthus jullienii</i> Beille	Euphorbiaceae	s	pd	gro rhe	3	rocks in rvf	sa rk	sh	200	250	ap-my		fb-sp	male flowers	12-219
<i>Phyllanthus reticulatus</i> Poir.	Euphorbiaceae	s sc	pd	gro	2	rvf	sa rk	ls sh	250	350			mr-nv		
<i>Ricinus communis</i> L.	Euphorbiaceae	h	pe	gro int nat	2	be rvf	sa	ls sh	250	325			mr-sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Sauropolis thorelii</i> Beille	Euphorbiaceae	s	pe	gro	3	egf		ls sh	300	350	ap-my		ja-dc	male flowers	12-96 topo
<i>Sauropolis aff. thyrsiflorus</i> Welz.	Euphorbiaceae	h	pe	gro	3	rocks in egf		ls	275	300	ap-my		ja-dc	flowers	12-179
<i>Suregada multiflora</i> (A. Juss.) Baill.	Euphorbiaceae	t	pe	gro	3	bb/df		ls sh	200	375			ja-dc		
<i>Celtis tetrandra</i> Roxb.	Ulmaceae	t	pd	gro	3	da sg		sh	250	300			ap-ja		
<i>Holoptelea integrifolia</i> (Roxb.) Pl.	Ulmaceae	t	pd	gro	3	da sg		sh ms	225	325		ap	mr-ja		
<i>Broussonetia papyrifera</i> (L.) Vent.	Moraceae	t (l)	pd	gro	3	da sg		ls sh ms	160	375			ap-fb		
<i>Ficus auriculata</i> Lour.	Moraceae	t	pe	gro	2	streams in egf		ls	200	375			ja-dc		
<i>Ficus callosa</i> Willd.	Moraceae	t	pd	gro	3	da sg in egf		sh ms	250	375			ap-fb		
<i>Ficus fistulosa</i> Reinw. ex Bl. var. <i>fistulosa</i>	Moraceae	t (l)	pe	gro	3	da sg		ls sh	200	375			ja-dc		
<i>Ficus heterophylla</i> L. f.	Moraceae	wc sc	pe	gro	3	rvf rvs	sa	ls sh	200	325			ja-dc		
<i>Ficus hispida</i> L. f.	Moraceae	t	pe	gro	3	da sg		ls sh ms	200	375			ja-dc		
<i>Ficus kurzii</i> King	Moraceae	t	pe	gro str	2	bb/df rvs		ls	275	300	ap-my	ap-my	ja-dc	flowers fruits	12-207
<i>Ficus racemosa</i> L.	Moraceae	t	pe	gro	3	rvs		ls sh	175	325	ap-my	ap-my	ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Ficus tinctoria</i> G. Forst. ssp. <i>gibbosa</i> (Bl.) Corn.	Moraceae	wc	pe	gro	2	egf		ls	350	375			ja-dc		
<i>Maclura fruticosa</i> (Roxb.) Corn.	Moraceae	wc	pd	gro	2	da in egf		sh	350	375			ap-ja		
<i>Morus macroura</i> Miq.	Moraceae	t	pd	gro	3	streams in egf da		ls	350	375			ap-ja		
<i>Streblus asper</i> Lour. var. <i>asper</i>	Moraceae	t (l)	pe	gro	3	egf		ls ms	160	375			ja-dc		
<i>Streblus ilicifolius</i> (S. Vidal) Corn.	Moraceae	t	pe	gro	3	egf		ls	300	375		ap-my	ja-dc	fruits	12-106
<i>Boehmeria nivea</i> (L.) Gaud. var. <i>tenacissima</i> (Roxb.) Miq.	Urticaceae	t (l)	pe	gro	3	da sg		ms	275	300		mr-ap	ja-dc	fruits	12-185
<i>Dendrocnide</i> <i>stimulans</i> (L. f.) Chew	Urticaceae	t	pe	gro	3	streams in egf		sh	200	325	ap-my		ja-dc	male female flowers	12-141 12-157
<i>Elatostema</i> <i>integritifolium</i> (D. Don) Wedd. var. <i>integritifolium</i>	Urticaceae	h	pe	gro	3	egf		sh	200	300	ap-my		ja-dc	male flowers	12-153
<i>Elatostema</i> <i>lineolatum</i> Wight	Urticaceae	h	pe	gro epl	3	streams in egf		sh	200	325	ap-my		ja-dc	male flowers	12-142
<i>Elatostema</i> aff. <i>subpeltata</i> Gagnep.	Urticaceae	h	pe	gro epl	3	streams in egf		sh	275	300	ap-my		ja-dc	male flowers	12-130
<i>Poikilospermum</i> <i>suaveolens</i> (Bl.) Merr.	Urticaceae	wc	pe	gro	3	egf		sh	200	325	ap-my		ja-dc	flowers	12-146

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Pterocarya stenoptera</i> C. DC. var. <i>stenoptera</i>	Juglandaceae	t	pd	gro		egf rvs		ls	275	300		ap-my	mr-ag	fruits	12-122
<i>Salix tetrasperma</i> Roxb.	Salicaceae	t	pd	gro rhe	2	streams in rvf	sa rk	ls sh	250	300			nv-jl		
<b>Angiosperms, Monocots</b>															
<i>Potamogeton crispus</i> L.	Potamogetonaceae	h	a	aqu	2	streams in rvf	st	sh	250	300	ap-my	my-jn	mr-jl	flowers	12-83
<i>Spatholirion ornatum</i> Ridl.	Commelinaceae	h	pe	gro	2	streams in egf		sh	200	300	ap-my		ja-dc	flowers	12-156
<i>Musa</i> sp.	Musaceae	h	pe	gro	3	da sg		sh	200	350			ja-dc		
<i>Alpinia malaccensis</i> (Burm. f.) Rosc.	Zingiberaceae	h	pe	gro	3	egf		ls sh	200	350	mr	my-jn	ja-dc	immature fruits	12-97
<i>Ophiopogon marmoratus</i> Pierre ex Rodr.	Liliaceae	h	pe	gro	3	rocks in egf		ls	275	300	ap-my		ja-dc	flowers	12-181
<i>Tupistra muricata</i> (Gagnep.) N. Tanaka	Liliaceae	h	pe	gro	2	streams in egf		sh	200	300	ap-my	ja-dc	fruits	12-152 topo	
<i>Crinum</i> sp.	Amaryllidaceae	h	pd	gro	2	rocks in rvf	rk		225	275	fb-ap	ap-my	nv-jn		
<i>Smilax perfoliata</i> Lour.	Smilaceae	v	pe	gro	3	da sg		sh	225	350			ja-dc		
<i>Aglaonema simplex</i> (Bl.) Bl.	Araceae	h	pe	gro	3	egf		ls sh	350	375	ap-my		ja-dc		
<i>Alocasia macrorhizos</i> (L.) G. Don	Araceae	h	pe	gro	3	streams wet areas in egf		ls ms	350	375		ap-my	ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Amorphophallus paeoniifolius</i> (Denn.) Nicol.	Araceae	h	pd	gro	3	da	sh	225	325	ap-my		my-nv	jn-sp		
<i>Homalomena occulta</i> (Lour.) Schott	Araceae	h	pe	gro	3	streams in egf		sh	250	350			ja-dc		
<i>Pothos scandens</i> L.	Araceae	h	pe	epi cr	3	egf		ls sh	225	375			ja-dc		
<i>Stemona tuberosa</i> Lour. var. <i>tuberosa</i>	Stemonaceae	v	pd	gro	3	bb/df		ls sh	200	350			my-dc		
<i>Dioscorea hispida</i> Denn.	Dioscoreaceae	v	pd	gro	3	bb/df		ls sh	250	350			my-dc		
<i>Arenga westerhoutii</i> Griff.	Palmae	t	pe	gro	3	egf		ls	325	350			ja-dc		
<i>Caryota mitis</i> Lour.	Palmae	s l	pe	gro	2	egf		ls	325	375			ja-dc		
<i>Cocos nucifera</i> L.	Palmae	t	pe	gro int cul		cult		ls ms sh			ja-dc	ja-dc	ja-dc		
<i>Pheonix roebeloni</i> O'Brien	Palmae	s l	pd	gro rhe	2	rocks in rvf	rk	ls sh	250	300		ja	nv-jn		topo
<i>Tacca chantrieri</i> Andre	Taccaceae	h	pe	gro	3	streams in egf		ls sh	275	375	ap-my		ja-dc		
<i>Bolboschoenus maritimus</i> (L.) Palla ssp. <i>affinis</i> (Roth) T. Koy.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	250	325	mr-jn	my-jl	mr-jl	flowers	12-71
<i>Cyperus cyperoides</i> (L.) O.K.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	160	325			mr sp		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Cyperus difformis</i> L.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	200	325	mr-my	ap-jn	mr-jl	flowers fruits	12-76
<i>Cyperus elatus</i> L.	Cyperaceae	h	pd	gro	3	rvf	sa gv	sh	250	300	ap-my	ap-my	fb-ag	flowers fruits	12-198
<i>Cyperus irya</i> L.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	160	325			mr-sp		
<i>Cyperus leucocephalus</i> Retz.	Cyperaceae	h	pd	gro	2	be rvf	sa rk	sh	200	250	my	my	mr-sp	flowers fruits	12-217
<i>Cyperus michelianus</i> (L.) Link ssp. <i>pygmaeus</i> (Rottb.) Asch. & Graebn.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	200	325	mr-my	ap-jn	mr-jl	flowers fruits	12-75
<i>Fimbristylis bisumbellata</i> (Forssk.) Bub.	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	200	325	ap-my	my-jn	mr-jl	flowers fruits	12-85
<i>Fimbristylis brunneoides</i> Kern	Cyperaceae	h	a	gro	3	be rvf	sa	ls sh	225	325	mr-my	ap-jn	mr-jl	flowers fruits	12-74
<i>Fimbristylis cymosa</i> R. Br.	Cyperaceae	h	pd	gro	3	rvf	sa rk	sh	200	325	ap-my	ap-my	fb-ag	flowers fruits	12-150
<i>Fimbristylis spicigera</i> Kern	Cyperaceae	h	a	gro	3	rvf	sa gv	sh	250	300	ap-my	ap-my	fb-ag	flowers fruits	12-199
<i>Cyrtococcum accrescens</i> (Trin.) Stapf	Gramineae	h	pe	gro	3	da sg	ls	sh ms	160	375	ap-my	ap-my	ja-dc		
<i>Dactyloctenium aegyptium</i> (L.) P. Beauv.	Gramineae	h	pe	gro wee	3	da sg cult		ls sh	160	350	ja-dc	ja-dc	ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Digitaria bicornis</i> (L.) Roem. & Schult.	Gramineae	h	a	gro	3	be rvf	sa	ls sh	250	325	ap-my	ap-my	mr-ag	flowers	12-135
<i>Digitaria longiflora</i> (Retz.) Pers.	Gramineae	h	a	gro	3	be rvf	sa	ls sh	200	325	ap-jn	my-jl	mr-jl	flowers	12-89
<i>Eleusine indica</i> (L.) Gaertn.	Gramineae	h	a	gro	3	be rvf	sa	ls sh	160	325	mr-my	my-jn	fb-nv		
<i>Eragrostis ciliata</i> (Roxb.) Nees	Gramineae	h	a or pe	gro	3	be rvf	sa	sh	160	325	ap-my	ap-my	fb-ag	flowers fruits	12-175
<i>Hemisorghum mekongense</i> (A. Camus) Hubb.	Gramineae	h	a	gro	3	rvf	sa	sh	200	250	ap-my	my	mr-sp	flowers fruits	12-222 topo
<i>Imperata cylindrica</i> (L.) P. Beauv. var. <i>major</i> (Nees) C.E. Hubb. ex Hubb. & Vaugh.	Gramineae	h	pe	gro wee	5	da sg cult		ls sh ms	160	375	ap-my		ja-dc		
<i>Leptochloa chinensis</i> (L.) Nees	Gramineae	h	a	gro	3	be rvf	sa	ls	275	300	ap-my	ap-my	mr-jl	flowers	12-133
<i>Oryza sativa</i> L.	Gramineae	h	a	gro cul	4	cult		ls sh ms	160	375			jl-nv		
<i>Phragmites vallatoria</i> (Pluk. ex L.) Veldk.	Gramineae	h	pe	gro wee	3	da sg		ls sh ms	160	325			ja-dc		
<i>Saccharum arundinaceum</i> Retz.	Gramineae	h	pd	gro wee	3	be rvf	sa	ls sh	160	325			ja-dc		

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Saccharum spontaneum</i> L.	Gramineae	h	pd	gro wee	3	be rvf	sa	ls sh	160	325			ja-dc		
<i>Thysanolaena latifolia</i> (Roxb. ex Horn.) Honda	Gramineae	h	pe	gro	3	da sg		ls sh ms	160	325			ja-dc		
<i>Zea mays</i> L.	Gramineae	h	a	gro int	2	be rvf	sa	ls sh ms	160	320			mr-oc		
<i>Zoysia matrella</i> (L.) Merr.	Gramineae	h	a	gro	3	be rvf	sa	ls sh	160	325	ap-jn		fb-jn	flowers	12-72
<i>Bambusa bambos</i> (L.) Voss. ex Vilm.	Gramineae, Bambusoideae	h	pe	gro	5	bb/df		sh ms	200	300			ja-dc		
<i>Cephalostachyum pergracile</i> Munro	Gramineae, Bambusoideae	h	pe	gro	4	bb/df da sg		sh	300	375			ja-dc		
<i>Dendrocalamus nudus</i> Pilg.	Gramineae, Bambusoideae	h	pe	gro	4	bb/df		ls sh	200	350			ja-dc		
<i>Gigantochloa albo-ciliata</i> (Munro) Kurz	Gramineae, Bambusoideae	h	pe	gro	3	egf		sh	225	350			ja-dc		
<i>Melocanna baccifera</i> (Roxb.) Kurz	Gramineae, Bambusoideae	h	pe	gro	3	egf		ls	275	325			ja-dc		
<b>Pteridophytes</b>															
<i>Selaginella helferi</i> Warb.	Selaginellaceae	v	pe	gro	3	da in egf		ls sh	225	375			ja-dc		
<i>Angiopteris evecta</i> (Forst.) Hoffm.	Marattiaceae	h	pe	gro	3	streams in egf		sh	250	350	ap-my		ja-dc		
<i>Osmunda vachellii</i> Hk.	Osmundaceae	h	pd	epl	2	egf rvf	rk	ls	275	300	ap-my		mr-jl	sori	12-121

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Cibotium barometz</i> (L.) J. Sm.	Dicksoniaceae	h	pe	gro	3	streams in egf		sh	250	350	ap-my		ja-dc		
<i>Microlepia pilosa</i> Presl		h	pe	gro	3	streams in egf da		sh	200	300	ap-my		ja-dc	sori	12-159
<i>Adiantum capillus-veneris</i> L.	Parkeriaceae	h	pe	epl	3	cliffs in egf	rk	ls	350	350	ap-my		ja-dc	sori	12-90
<i>Adiantum zollingeri</i> Mett. ex Kuhn	Parkeriaceae	h	pd	epl	2	cliffs egf	rk	ls	275	300	ap-my		ja-dc	sori	12-178
<i>Pteris vittata</i> L.	Pteridaceae	h	pe	gro	3	da streams in egf			200	325	ap-my		ja-dc	sori	12-160
<i>Asplenium apogamus</i> Mur. & Hat.	Aspleniaceae	h	pe	epl	3	egf		sh	275	300	ap-my		ja-dc	sori	12-127
<i>Asplenium nidus</i> L. var. <i>nidus</i>	Aspleniaceae	h	pe	epi	2	egf		sh	250	350			ja-dc		
<i>Pteridys australis</i> Ching	Dryopteridaceae	h	pe	gro	3	egf		sh	200	325	ap-my		ja-dc	sori	12-143
<i>Tectaria decurrens</i> (Presl) Copel.	Dryopteridaceae	h	pe	gro	3	egf		sh	250	300	ap-my		ja-dc	sori	12-131
<i>Tectaria ? devexa</i> (O.K.) Copel.	Dryopteridaceae	h	pe	epl	3	wet areas cliffs in egf	rk tufa	ls	325	350	mr-my		ja-dc	sori	12-100

Botanical Name	Family	Habit	Aped	Life Mode	Abundance	Habitat	Subst	Bedrk	Low elev (m)	Up elev (m)	Flow Mo	Fruit Mo	Leaf Mo	Collected	Number
<i>Thelypteris subelata</i> (Bak.) K. Iw.	Thelypteridaceae	h	pd	gro	3	streams in rvf		ls	275	300	ap-my		mr-ag	sori	12-126
<i>Thelypteris terminans</i> (Hk.) Tag. & K. Iw.	Thelypteridaceae	h	pe	gro	3	egf	da	sh	200	375	ap-my		ja-dc	sori	12-174
<i>Diplazium crassiusculum</i> Ching	Athyriaceae	h	pe	gro	3	streams in egf		sh	200	300	ap-my		ja-dc	sori	12-138
<i>Diplazium esculentum</i> (Retz.) Sw.	Athyriaceae	h	pd	gro		da sg wet areas streams in egf		ls sh ms	200	350			mr-sp		
<b>Bryophytes</b>															
<i>Vesicularia montagnei</i> (Schimp.) Broth.	Hypnaceae	h	pe	epl	3	da sg wet areas streams in egf	rk tufa	ls sh	325	350			ja-dc		B-223 B-225
<i>Neckeropsis boniana</i> (Besch.) Touw & Ochyra	Neckeraceae	h	pe	epl	3	streams in egf	rk	sh	200	300			ja-dc		B-226
<i>Splachnobryum aquaticum</i> C. Muell.	Splachnobryaceae	h	pe	epl	3	wet areas streams in egf	rk tufa	ls	325	350			ja-dc		B-224
<i>Marchantia emarginata</i> Reinw., Bl., Nees	Marchantiaceae	h	a	epl	2	rocks in rvf	rk	sh	175	200	ap-my		mr-oc		B-227

## Appendix to Chapter 4.

**Appendix 4.1.** Bird species recorded in the surveys in 2004, 2011 and 2012, with status annotations.

ENGLISH NAME	SCIENTIFIC NAME	River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Scaly-breasted Partridge	<i>Arborophila charltonii</i>	N	N	N		
Heard in adjacent dryland, 31 Jan 2012.						
Red Junglefowl	<i>Gallus gallus</i>	L	N	N		
Recorded 30 Sep 11 (2x). Small group seen in channel, 29 Jan 2012. Heard in adjacent dryland, 29 & 31 Jan, 2, 3 Feb 2012.						
Grey Peacock Pheasant	<i>Polyplectron bicalcaratum</i>	N	N	N		
Heard in adjacent dryland, 29 Jan 2012.						
Lesser Whistling-duck	<i>Dendrocygna javanica</i>	N	N	N		other
One, Ban Mai island, 2 Oct 2004. No records in 2011-2012. Round Vientiane the river is used mostly in the late dry season and the surveys were not suitably timed to assess the survey area's use.						
Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>	L	N	H		ARL
Three, 2 Oct 2004, near 17°52'35"N, 101°26'34"E. Few recent North Lao PDR records outside the lower Nam Ngum plain; much declined.						
Spot-billed Duck	<i>Anas poecilorhyncha</i>	H	H	H		other
See text.						
Common Teal	<i>Anas crecca</i>	L	N	N		other
A female, Don Vao, 6 Feb 2012. Numbers visiting Lao PDR apparently vary between years (Duckworth in press), and in other winters more might occur.						
Lineated Barbet	<i>Megalaima lineata</i>	N	N	N		
Heard in adjacent dryland on 25-27 Jan, 1-2, 8 & 10-13 Feb 2012. Calls very little in Sept-Oct.						
[Blue-throated Barbet]	<i>Megalaima asiatica</i>	N	N	N		
Possibly heard in adjacent dryland on 3 Feb 2012. Calls very little in Sept-Oct.						
Moustached Barbet	<i>Megalaima incognita</i>	N	N	N		
Heard in adjacent dryland on 25-27 Jan, 1-2, 8 & 10-13 Feb 2012. Calls very little in Sept-Oct.						
Blue-eared Barbet	<i>Megalaima australis</i>	N	N	N		
Heard in adjacent dryland on 30-31 Jan, 2 & 12-13 Feb 2012. Calls very little in Sept-Oct.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Coppersmith Barbet	<i>Megalaima haemacephala</i>	N	N	N		
	Heard in adjacent dryland (singles) on 27 & 28 Jan, & (uncounted) 1-2, 4, 10 & 12-13 Feb 2012. Calls very little in Sept-Oct.					
Red-headed Trogan	<i>Harpactes erythrocephalus</i>	N	N	N		
	Heard in adjacent dryland on 3, 4 & 13 Feb 2012.					
Indian Roller	<i>Coracias benghalensis</i>	L	N	N		
	Two on 2 Oct 2004. Four in total on 29 Sep 2011. Recorded (singly except where stated) on 27 Jan (2x), 31 Jan, 1 Feb (duo), 4, 7 Feb, 8 Feb (two), 9 Feb (trio), 10 Feb (4), 11 Feb (two), 12 & 13 Feb 2012.					
Dollarbird	<i>Eurystomus orientalis</i>	L	N	N		
	Two on 2 Oct 2004. The 2012 survey ended a month before this species returns to North Lao PDR (e.g. Duckworth 1996 [first arrival date 13 March], in press, Fuchs <i>et al.</i> 2007).					
Common Kingfisher	<i>Alcedo atthis</i>	L	N	N		
	Recorded, singly except where stated, 29 Sep (1-2), 30 Sep, 2 Oct 2011, 27, 28 Jan, 3, 9, 11-13 Feb 2012.					
Banded Kingfisher	<i>Lacedo pulchella</i>	N	N	N		
	Heard in adjacent dryland on 30 Jan 2012.					
Stork-billed Kingfisher	<i>Halcyon capensis</i>	?	N	N		other
See text						
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	L	N	N		
	Four in total on 2 Oct 2004. Singles on 29 Sep, 1, 2 Oct 2011, 27 Jan (three), 28, 29 & 31 Jan, 2 Feb, 8 Feb (three). The larger numbers in the Jan-Feb survey reflect movement to the channel as the plain dries.					
Black-capped Kingfisher	<i>Halcyon pileata</i>	L	N	N		
	Five in total on 2 Oct 2004. 1-8 daily on 27 Sep - 2 Oct 2011. Singles on 28, 29 Jan, 1, 3, 8, 10, 11 Feb 2012. Sep-Oct is the peak of autumn migration.					
Green Bee-eater	<i>Merops orientalis</i>	L	N	N		
	14 groups of 1-5 daily during 28 Jan - 3 Feb 2012. Seasonal movements in N Lao PDR poorly understood, and may have produced the apparently localised distribution.					
Blue-tailed Bee-eater	<i>Merops philippinus</i>	E	M?	N		PARL
See text.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	L	N	N		
Eight on 29 Jan 2012. 17 groups of 1-4 daily during 10-13 Feb 2012. Seasonal movements in N Lao PDR poorly understood, and may have produced the apparently localised distribution.						
Bee-eater sp(p).	<i>Merops</i>					
A group of at least 20 on 29 Sep 2011; no other records of any bee-eater in the Sep-Oct survey, or of unidentified bee-eaters on any survey.						
Large Hawk Cuckoo	<i>Hierococcyx sparverioides</i>	N	N	N		
Heard in adjacent dryland on 27 & 29 Jan 2012. Little calling occurs in Sep-Jan.						
Banded Bay Cuckoo	<i>Cacomantis sonneratii</i>	N	N	N		
Heard in adjacent dryland on 11 & 13 Feb 2012. Little calling occurs in Sep-Jan.						
Plaintive Cuckoo	<i>Cacomantis merulinus</i>	L	N	N		
Heard daily from 4 Feb 2012. Little calling occurs in Sep-Jan.						
Violet Cuckoo	<i>Chrysococcyx xanthorhynchus</i>	N	N	N		
One heard singing in adjacent dryland downstream of Pak Houayla on 13 Feb 2012.						
Drongo Cuckoo	<i>Surniculus lugubris</i>	N	N	N		
Heard in adjacent dryland on 13 Feb 2012. Little calling occurs in Sep-Jan.						
Asian Koel	<i>Eudynamys scolopacea</i>	N	X	N		other
Recorded on 28 Sep 2011, 26 Jan, 6, 7, 12 Feb (all singles), 13 Feb (two), 14 Feb 2012 (three). Also on 9-10 & 12 Feb, heard commonly from Thai dryland.						
Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	N	N	N		
Recorded in adjacent dryland on 1 Oct 2011 & 30 Jan 2012.						
Greater Coucal	<i>Centropus sinensis</i>	L	N	N		
Recorded daily 29 Sep - 1 Oct 2011 and daily during the Jan-Feb 2012 survey; common within and outside channel.						
Lesser Coucal		L	N	N		
Singles on 27, 28 (twice), 31 Jan, 3, 6 (twice) Feb 2012; not singing during the survey and perhaps much overlooked.						
Vernal Hanging Parrot	<i>Loriculus vernalis</i>	N	N	N		
Heard in dryland or recorded flying over on 27, 29, 30 Jan, 1, 3, 5 Feb 2012.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Red-breasted Parakeet	<i>Psittacula alexandri</i>	N	X	N		other
	At least one on 2 Oct 2004 (a little downstream of 18°07'36"N, 101°59'40"E) and on 12 (at Pak Houayla) and 13 (downstream of Pak Houayla) Feb 2012. Groups of 14 at the large dryland island upstream of Ban Donmen, at 17°58'N, 101°25'E, and six (at 17°52'28"N, 101°32'34"E) on 8 Feb 2012, and of 12 (a little upstream of Paksang) on 13 Feb 2012. Also 10 c.5 km upstream of Paksang on 10 Apr 2010 (JWD). Much declined in North Lao PDR (e.g. Duckworth in press).					
Swiftlet		L	N	N		
	[A few on 29 Sep 2011.] Totals of six on 28 Jan, 90 on 29 Jan and 40 on 30 Jan 2012.					
Brown-backed Needletail	<i>Hirundapus giganteus</i>	L	N	N		
	One on 7 Feb and four on 13 Feb 2012. Also, unidentified needletails: 150 on 2 Oct 2004, two on 30 Jan and 14 on 11 Feb 2012.					
Asian Palm Swift	<i>Cypsiurus balasiensis</i>	N	N	N		
	[Provisionally recorded on 2 Oct 2004]; present on 25 Jan, 5, 12 and 13 Feb 2012.					
Fork-tailed Swift	<i>Apus pacificus</i>	N	N	N		
	15 provisionally identified on 28 Sep 2011. 150 on 28 Jan, one on 29 Jan 2012. Seasonal movements in N Lao PDR poorly understood, and may have produced the apparently localised distribution.					
Crested Treeswift	<i>Hemiprocne coronata</i>	L	N	N		
	In total, eight on 8 Feb and one on 12 Feb 2012.					
Mountain Scops Owl	<i>Otus spilocephalus</i>	N	N	N		
	Heard from dryland on nights of 28, 29, 30, 31 Jan, 1, 2, 3, 7 Feb; clearly restricted to the better-forested stretches.					
Oriental Scops Owl	<i>Otus sunia</i>	N	N	N		
	Heard from dryland on nights of 27 and 28 Jan 2012.					
Collared Scops Owl	<i>Otus bakkamoena</i>	N	N	N		
	Heard from dryland on nights of 28 and 29 Jan 2012.					
Brown Fish Owl	<i>Ketupa zeylonensis</i>	?	?	M		PARL
See text.						
Collared Owlet	<i>Glaucidium brodiei</i>	N	N	N		
	Heard from dryland on nights of 27 and 28 Jan 2012.					
Asian Barred Owlet	<i>Glaucidium cuculoides</i>	N	N	N		
	At least one on 30 Sep 2012. Heard from dryland daily during 25 Jan - 5 Feb and 8-13 Feb 2012.					

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Brown Hawk Owl	<i>Ninox scutulata</i>	N	N	N		
Heard from dryland on nights of 29 and 30 Jan, 1 and 5 Feb 2012.						
Great Eared Nightjar	<i>Eurostopodus macrotis</i>	L	N	N		
One on 28-29 Jan, four on 29-30 Jan, five on 30-31 Jan, three on 31 Jan - 1 Feb 2012; clearly restricted to the better-forested stretches, but not ubiquitous even in those.						
Large-tailed Nightjar	<i>Caprimulgus macrurus</i>	L	N	N		
Two singles at dawn on 29 Jan, one at dusk on 6 Feb, one at both on 7-8 Feb, one at dawn on 11 Feb (with another on the Thai side) 2012.						
Savanna Nightjar	<i>Caprimulgus affinis</i>	H	H	H		other
See text.						
Spotted Dove	<i>Streptopelia chinensis</i>	L	N	N		other
In total 16 on 2 Oct 2004. Heard on 28 Sep, at least three on 30 Sep and three on 2 Oct 2011; also many records of up to seven unidentified <i>Streptopelia</i> during 28 Sep - 1 Oct 2011. Totals of a dozen or less on 28, 30 & 31 Jan and 4, 6, 10, 11, 12, 13 & 14 Feb, 42 on 29 Jan, but 14 on 2 Feb, 13 on 3 Feb, 18 on 7 Feb, and 40 on 8 Feb 2012.						
Red Collared Dove	<i>Streptopelia tranquebarica</i>	L	N	M		other
[Eight and one on 29 Sep 2011.] This is the peak time for sightings around Vientiane in areas not yet within the breeding range. The lack of sightings in Jan-Feb 2012 indicates it is at best rare as a breeder in the surveyed stretch; in Vientiane birds feed much in the channel.						
Emerald Dove	<i>Chalcophaps indica</i>	N	N	N		
[One provisionally identified on 1 Oct 2011.]						
Peaceful Dove	<i>Geopelia striata</i>	L	N	H		
One heard (unclear if caged or free-flying) on 11 Feb (at 18°01'53"N, 101°52'21"E) and one heard, certainly free-flying, at Paksang on 13 Feb 2012. A recent colonist of Lao PDR, arriving first in Vientiane (Duckworth in press); these are the most upstream records.						
Green pigeon sp(p).	<i>Treron</i>	N	N	N		
Singles on 31 Jan and 1 & 12 Feb 2012.		N19°11'03.87" E101°49'11.52"				

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	L	N	N		
One at 19°11'04"N, 101°49'12"E on 13 Sep 2011 (MRB). Singles on 27 & 29 (twice) Sep 2011, 29 & 31 Jan, 6, 7 (twice) & 8 Feb 2012. Seasonal movements in N Lao PDR poorly understood, and may have produced the apparently localised distribution.						
Pintail/Swinhoe's Snipe	<i>Gallinago stenura/megala</i>	L	N	N		
Singles on 25, 26, 31 (2x) Jan, 3, 12 (2x) and 14 Feb; totals of three on 27 Jan, 15 on 5 Feb, two on 6 Feb, four on 10 Feb and six on 11 Feb 2012.						
Common Snipe	<i>Gallinago gallinago</i>	L	N	N		
Four singles on 5 Feb, one on 7, 10 & 12 Feb, two on 11 Feb, and a duo on 8 Feb 2012.						
Snipe sp(p).						
At least one on 29 Sep 2011; five on 27 Jan, and singles on 29 Jan, 2, 8 & 11 (twice) Feb 2012.						
Black-tailed Godwit	<i>Limosa limosa</i>	L?	N	H	NT	NE
One, southern Don Vao, on 29 Sep 2011, with Grey-headed Lapwings. The second Lao record, after one at Nong Sangai on the lower Nam Ngum plain on 23 December 2009 (Duckworth in press).						
Spotted Redshank	<i>Tringa erythropus</i>	L	N	N		
Three at Ban Mai island on 14 Feb 2012.						
Common Greenshank	<i>Tringa nebularia</i>	L	N	N		
One on 2 Oct 2004. Twelve, mostly singly, during 5-9 Feb; 30, ditto, during 11-14 Feb 2012. Localised recorded distribution probably reflects genuine pattern; strongly associated with areas of wide-open soft sediment.						
Green Sandpiper	<i>Tringa ochropus</i>	L	N	N		
One on 28 Sep 2011. Two duos on 26 Jan, singles on 28 (2x) & 31 Jan, 3, 10 (2x), 11, 12 & 14 Feb; ten singles during 5-8 Feb 2012.						
Common Sandpiper	<i>Actitis hypoleucos</i>	M	N	N		
Daily totals of 38 on 2 Oct 2004, 21 on 27, 47 on 28, 41 on 29, 23 on 30 Sep, 19 on 1 and 34 on 2 Oct 2011. Up to 12, totalling 151, daily except 6 Feb, during 25 Jan - 14 Feb 2012, in ones and twos save one group of five.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Temminck's Stint	<i>Calidris temminckii</i>	E	D	N		
In total seven on 2 Oct 2004. Groups of two, five and one on 9 Feb (at 17°53'46"N, 101°36'41"E), one on 11 Feb (at 18°02'17"N, 101°51'57"E) and a total of 30, widely scattered, on 14 Feb 2012. Highly localised recorded distribution reflects genuine pattern; almost tied in Lao PDR to areas of wide-open soft sediment on very wide rivers; such habitat widespread only on 14 Feb.						
Greater Painted-snipe	<i>Rostratula benghalensis</i>	L	N	N		
In total four in well-watered, well-vegetated (bushes and graminoids) silty channel bed around 18°16'22"N, 101°27'12"E on 5 Feb 2012.						
Great Thick-knee	<i>Esacus recurvirostris</i>	E	H	N		ARL
See text.						
Black-winged Stilt	<i>Himantopus himantopus</i>	L	N	N		
Two singles on 2 Oct 2004, one just upstream of the Thai/Xaignabouli border, the other downstream. Singles at 19°14'25"N, 101°49'06"E on 13 Sep 2011 and 19°02'48"N, 101°48'01"E (MRB). Two on 28 and three on 29 Sep 2011.						
Pacific Golden Plover	<i>Pluvialis fulva</i>	L	N	N		other
Two at Ban Mai island on 2 Oct 2004.						
Grey Plover	<i>Pluvialis squatarola</i>	L	N	M		
One at Ban Mai island on 2 Oct 2004. There are few Lao records (Duckworth in press).						
Long-billed Plover	<i>Charadrius placidus</i>	E	D	M		LKL
See text.						
Little Ringed Plover - migr	<i>Charadrius dubius curonicus</i>	L	N	H		NE
Little Ringed Plover - res	<i>Charadrius dubius jerdoni</i>	H	D	H		NE
See text (both races).						
Kentish Plover	<i>Charadrius alexandrinus</i>	E	D	N		
At least six at Ban Mai island, four off Ban Ang-noi, and one downstream of Chiang Khan on 2 Oct 2004. Singles on 25 & 28 Jan, 3, 7 Feb; three on 1 Feb, five on 2 Feb, 11 on 8 Feb, 30 on 9 Feb, 23 on 11 Feb and 28 on 14 Feb 2012. Localised recorded distribution probably reflects genuine pattern; strongly associated with areas of wide-open soft sediment.						
Lesser / Greater Sand Plover	<i>Charadrius mongolus / leschenaultii</i>	H	N	M		
One at 18°13'12"N, 102°04'46"E on 2 Oct 2004. There are few Lao records of either species, almost solely from the Mekong channel (e.g. Duckworth <i>et al.</i> 1999, 2002).						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
River Lapwing	<i>Vanellus duvaucelii</i>	E	H	N	NT	ARL
See text						
Grey-headed Lapwing	<i>Vanellus cinereus</i>	L	M	N		PARL
See text						
Red-wattled Lapwing	<i>Vanellus indicus</i>	L	N	M		other
Two at 18°02'08"N, 101°45'44"E on 2 Oct 2004; none in 2011-2012. This plains species has declined hugely in North Lao PDR (Duckworth in press) and the extent to which it would use the channel is unclear.						
Small Pratincole	<i>Glareola lactea</i>	E	D	N		PARL
See text.						
Marsh tern	<i>Chlidonias</i> sp(p).	L	N	N		
Two on 27 Sep and groups of eight and three on 28 Sep 2011. Both species recorded in Lao PDR ( <i>C. hybridus</i> and <i>C. leucopterus</i> ) have been found only occasionally, mostly during migration (e.g. Evans 2001, Duckworth in press). Also, 100 unidentified terns (not necessarily this genus) near Ban Pakmi along the Thai bank opposite 17°54'47"N, 101°41'27"E, and "a few hundred" gulls or terns at Don Kuak (18°02'09"N, 101°53'10"E ) on 21 Sep 2011 (M. R. Bezuijen).						
Jerdon's Baza	<i>Aviceda jerdoni</i>	N?	N	M		
Three on 30 Sep 2011 at Don Hon, in the same tree where a group of six was photographed by M. R. Bezuijen and R. Glemet on 17 Sep 2011. Rather poorly known in Lao PDR (SUFORD in press); views insufficient to determine if any of these birds were juveniles.						
Oriental Honey-buzzard	<i>Pernis ptilorhyncus</i>	N	N	N		
In total, four and three probables on 2 Oct 2004, 41 on 28 Sep, eight and four probables on 29 Sep, and two on 1 Oct 2011. All these birds were at migration times. Many fewer in winter: a total of five on 28-30 Jan and one on 4 Feb 2012.						
Black-shouldered Kite	<i>Elanus caeruleus</i>	N	N	N		
Singles on 2 Oct 2004 (by the upstream edge of Vientiane city), 27 & 28 Sep 2011 and 11 Feb 2012.						
Black Kite	<i>Milvus migrans</i>	L	N	M		ARL
A single and a duo on 29 Sep, one on 30 Sep and two on 1 Oct 2011, all probably migrating birds. The lack of winter records of this species, much-declined in Lao PDR (Duckworth in press), indicates a lack of current importance of the survey area for it.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Crested Serpent Eagle	<i>Spilornis cheela</i>	N	N	N		
Singles on 2 Oct 2004, on 26 & 27 Jan, 1, 2, 4, 10 & 11 Feb, and duos on 8 & 13 Feb 2012. Very few records for such a large, vocally and visually conspicuous bird, adding to evidence in Duckworth (in press) that this, among the most resilient of Lao raptors, is much declined in heavily encroached landscapes.						
Harrier sp	<i>Circus</i>	L	N	N		other
One on 5 Feb 2012, quartering over swampy mosaic. The great paucity of records compared with the Mekong channel of the lower Vientiane and Champasak plains doubtless reflects the rarity of plains wetlands in the surveyed stretch.						
Shikra	<i>Accipiter badius</i>	N	N	N		
In total two on 2 Oct 2004, three on 30 Sep 2011, and singles on 28 Jan, 11, 12 & 13 Feb 2012.						
Sparrowhawk sp.	<i>Accipiter</i>	N	N	N		
Singles on 2 Oct 2004, 28 Sep 2011, 28 Jan & 1 Feb 2012.						
Rufous-winged Buzzard	<i>Butastur liventer</i>	N	N	H		
One in display flight and a first-year bird on 26 Jan 2012 over deciduous forest on the west bank at 19°40'43"N, 101°51'58"E. This is among the most northerly Lao record (see SUFORD in press).						
Grey-faced Buzzard	<i>Butastur indicus</i>	N	N	N		
Four singles on 28-30 Jan 2012. The species has been stated to be only a passage migrant in North Lao PDR, but wintering even in the far north was demonstrated by Fuchs <i>et al.</i> (2007).						
Common Buzzard	<i>Buteo buteo</i>	N	N	N		
One on 28 Jan 2012.						
Large raptor						
Daily totals of five on 27 Sep, 21+ on 28 Sep and 81+ on 29 Sep 2011 doubtless involved all, or nearly all, active migrants. Only one in winter: one on 26 Jan 2012. Together with the very few identified large raptors at this period, this indicates an astonishing scarcity of resident and overwintering large raptors throughout the surveyed stretch.						
Common Kestrel	<i>Falco tinnunculus</i>	L	N	N		
Singles on 25, 26 and 28-29 Jan 2012.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Eurasian/Oriental Hobby	<i>Falco subbuteo / severus</i>	N	N	N		
	Singles on 30 [and 31] Jan 2012. One, provisionally identified as Eurasian, but Amur Falcon <i>F. amurensis</i> not ruled out, on 28 Sep 2011. Sep is in the main passage season for Eurasian Hobby, which has never been found in Lao PDR in winter; Oriental Hobby is presumed resident (Duckworth in press).					
Peregrine Falcon	<i>Falco peregrinus</i>	L	?	H		NE
	A male of a resident race on 28 January at 19°14'03"N, 101°49'17"E, and probably a pair, calling from the high crag of Pha Liap, on 2 Feb 2012. The distribution and status of residents in Lao is poorly documented (e.g. Fuchs <i>et al.</i> 2007).					
Little Egret	<i>Egretta garzetta</i>	L	N	M		other
See text.						
Grey Heron	<i>Ardea cinerea</i>	L	N	N		PARL
	Three on 2 Oct 2004. Singles on 31 Jan - 1 Feb (1-2), 2, 3, 5, 6, 7, 8 (3x), 10 (2x), 11 (2x) & 14 (2x) Feb; also a group of six on 14 Feb. These numbers, while much higher than in Jan 2000, are insignificant compared with those beside the lower Vientiane plain.					
Great Egret	<i>Casmerodius albus</i>	L	N	N		other
	A total of at least 14 daily during 28-30 Sep 2011. Unlike Grey Heron and the two small egrets, as yet there is no evidence of wintering in the surveyed stretch.					
Intermediate Egret	<i>Mesophoyx intermedia</i>	L	N	N		other
	A total of at least 11 near-daily during 28 Sep - 1 Oct 2011. Unlike Grey Heron and the two small egrets, as yet there is no evidence of wintering in the surveyed stretch.					
Cattle Egret	<i>Bubulcus ibis</i>	L	N	M		other
See text.						
Egret sp(p).						
	A total of 1064, in addition to identified egrets, during 27 Sep - 2 Oct 2011; this is in the main migration season.					
[Chinese] Pond Heron	<i>Ardeola [bacchus]</i>	L	N	N		
	A total of 48 on 2 Oct 2004. A total of about 750 during 27 Sep - 2 Oct 2011. Up to 30, mostly 6-12, daily during 25 Jan - 14 Feb 2012, when recorded in almost every survey stretch.					

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Little Heron	<i>Butorides striatus</i>	L	N	N		
	Two singles on 1 Oct 2011. Five singles on 29-31 January 2012, the localised recorded distribution doubtless reflecting a real distribution pattern.					
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	L	N	M		PARL
	One on 28 and 12 on 29 Sep 2011. During Jan-Feb 2012, mostly recorded through calls heard after dusk or before dawn, on the nights of [1], 4, 6, 11 and 12 Feb. An immature was flushed by some old ladies from a day-roost in tall channel bushland on 13 Feb 2012.					
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	L	N	M		
	Singles on 20 Sep 2011 (M. R. Bezuijen), [28 Sep 2011] and 6 Feb 2012; winter records are unusual in Lao PDR (Fuchs et al. 2007, Duckworth in press).					
Long-tailed Broadbill	<i>Psarisomus dalhousiae</i>	N	N	N		
	Recorded in dryland on 28 Jan and 1 & 2 Feb 2012.					
Golden-fronted Leafbird	<i>Chloropsis aurifrons</i>	N	N	H		
	Recorded (not counted) in highly degraded streamside forest near the mouth of the Nam Feuang (18°52'58"N, 101°47'42"E) on 1 Oct 2011; there are very few recent (post-1950) records from North Lao PDR (Duckworth & Tizard 2003, SUFORD in press).					
Brown Shrike	<i>Lanius cristatus</i>	N	N	N		
	A total of at least 17 daily during 28-30 Sep 2011; singles on 30 & 31 Jan, 5, 6 (2x), 9, 11, 12 & 13 Feb, and a duo on 7 Feb 2012. Unidentified shrikes heard calling were fairly common in Jan-Feb 2012, perhaps mostly this species. Records both within and outside the channel.					
Long-tailed Shrike	<i>Lanius schach</i>	L	X	M		other
	Singles on 29 Sep 2011 (southern Don Vao) and 28 Jan 2012 (19°11'03"N, 101°49'18"E), the former in heavily-grazed scrub on a permanent islet, the latter in <i>Homonoia</i> -dominated channel bushland. Lowland records of this shrike are now rare in Lao PDR, although it remains common in the northern highlands (Duckworth in press).					

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Racket-tailed Treepie	<i>Crypsirina temia</i>	L	N	N		
A duo on 29 Jan 2012 at 19°03'09"N, 101°48'09"E, within <i>Homonoia</i> -dominated bushland on sand in the channel; a group heard on 31 Jan at 18°40'51"N, 101°48'00"E in unknown habitat. This is a highly localised species in North Lao PDR (e.g. Duckworth et al. 2002, Fuchs et al. 2007, Duckworth in press).						
Large-billed Crow	<i>Corvus macrorhynchos</i>	M	M	N		other
See text.						
Black-winged Cuckooshrike	<i>Coracina melaschistos</i>	N	N	N		
Two on 2 Feb 2012, outside the channel.						
Rosy/Swinhoe's/ Ashy Minivet	<i>Pericrocotus roseus/cantonensis/divaricatus</i>	N	N	N		
Small numbers heard on 4, 6 and 7 Feb 2012; all records from outside the channel.						
Bar-winged Flycatcher-shrike	<i>Hemipus picatus</i>	N	N	N		
Recorded on 4 Feb 2012, outside the channel.						
Pied Fantail	<i>Rhipidura javanica</i>	L	N	H		
At least one on 28 Sep 2011 (at 18°03'28"N, 101°46'09"E); two on 14 Feb 2012 (at 18°10'20"N, 102°10'42"E). This recent colonist of Lao PDR has been slow to spread outside Vientiane city and its surroundings, being so far recorded otherwise only at Pakxan wetlands and, widely, in the lower Nam Ngum plain (Duckworth in press). These are the furthest upstream records along the Lao Mekong.						
Black Drongo	<i>Dicrurus macrocercus</i>	L	N	N		
Up to seven most days in the Sep-Oct 2011 survey. Much more localised in winter: 14 on 5 Feb, 17 on 12 Feb and two on 13 Feb 2012. Recorded both within and outside the channel.						
Ashy Drongo	<i>Dicrurus leucophaeus</i>	N	N	N		
Small numbers on 1 Oct 2011, 28 Jan and 2 Feb 2012. All records from outside the channel.						
Spangled Drongo	<i>Dicrurus hottentottus</i>	N	N	N		
Two on 13 Feb 2012, at a flowering tree outside the channel.						
Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	N	N	N		
Recorded on 30 Sep 2011 and (one) on 2 Feb 2012. Both records from outside the channel.						
Black-naped Monarch	<i>Hypothymis azurea</i>	N	N	N		
Recorded 30 Jan, 1, 2 & 9 Feb 2012. Almost all records from outside the channel.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Common Iora	<i>Aegithina tiphia</i>	N	N	N		
Recorded 26 & 28 Jan, 2 & 11 Feb 2012. All records from outside the channel.						
Blue Rock Thrush	<i>Monticola solitarius</i>	M	N	N		
In total eight on 2 Oct 2004. Two on 2 Oct 2011.						
In total 34 widely spread during 26 Jan - 3 Feb, and eight during 10-12 Feb 2012; the intervening stretch had not many large boulders or cliffs. Almost all records from within the channel.						
Blue Whistling Thrush	<i>Myophonus caeruleus</i>	L	N	N		
Calls of this thrush or of White-crowned Forktail						
<i>Enicurus leschenaulti</i> heard on 28 & 30 Jan, 3 & 4 Feb 2012.						
Eurasian Blackbird	<i>Turdus merula</i>	L	N	N		
Singles on 28 Jan and 5 Feb 2012, within the channel.						
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>	N	N	N		
Singles on 2 Oct 2004, 27 Jan & 2 Feb 2012.						
All records from outside the channel.						
Red-throated Flycatcher	<i>Ficedula parva</i>	L	N	N		
Recorded on 2 Oct 2004, 1 & 2 Oct 2011, and near-daily during 25-31 Jan and 4-9 Feb 2012.						
Common both within and outside the channel.						
Hainan Blue Flycatcher	<i>Cyornis hainanus</i>	N	N	N		
Recorded on 30 Sep 2011: common in dryland habitat of Don Hong.						
Blue flycatcher sp(p).	<i>Cyornis</i>					
Recorded on 30 Sep and 2 Oct 2011, 27-29 Jan, 1 , 2 & 9 Feb 2012. All records from outside the channel.						
Grey-headed Canary Flycatcher	<i>Culicicapa ceylonensis</i>	N	N	N		
Recorded widely during 25 Jan - 5 Feb and 9-10 Feb; almost all records from outside the channel. Birds arrive in the lowlands only in mid October, after the wet-season survey finished.						
Siberian Rubythroat	<i>Luscinia calliope</i>	L	N	N		
Recorded on 28, 29 & 31 Jan and 6-7 Feb 2012 in dense ground-level vegetation in and out of the channel.						
Bluethroat	<i>Luscinia svecica</i>	L	N	N		
Three on 7 Feb and one on 14 Feb 2012 in swampy graminoid beds within the channel.						
Oriental Magpie Robin	<i>Copsychus saularis</i>	L	N	N		
Recorded most days 28 Sep - 2 Oct 2011, 25-26 Jan and 30 Jan - 14 Feb 2012, comonly in the channel bushland, but also outside.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Common Stonechat (mig)	<i>Saxicola torquata</i>	L	N	N		
1-3 on 2 Oct 2004, 29 Sep & 2 Oct 2011, 29 Jan, 5, 6, 7, 8, 11 & 14 Feb 2012. All records from within the channel, in open bushland and agriculture.						
Very rare n dense <i>Homonoia</i> -dominatd bushland.						
Pied Bushchat	<i>Saxicola caprata</i>	L	N	N		
Two on 2 Oct 2004 at 18°13'12"E, 102°04'46"E. Common during 11-13 Feb 2012 (23 territories) but unrecorded elsewhere. All records from within the channel, in areas of open bushland. This is likely to be genunie distribution pattern, not an artefact of recording or a product of seasonal movement; but the underlying reason is unknown.						
Jerdon's Bushchat	<i>Saxicola jerdoni</i>	H	D	N		
See text.						
Chestnut-tailed Starling	<i>Sturnus malabaricus</i>	N	N	N		
Flocks of 100+ and 80+ on 31 Jan, of 40 on 2 Feb, and of 100+ on 13 Feb 2012. All records from outside the channel, mostly at flowering trees.						
White-shouldered Starling	<i>Sturnus sinensis</i>	?	?	N		other
At least two, perhaps ten, on 29 Sep 2011 on a tiny projection (with trees, scrub and grass) from central Don Vao. This species is in need of a comprehensive review of its Lao conservation status; there are startlingly few recent records (Duckworth in press).						
Black-collared Starling	<i>Sturnus nigricollis</i>	L	M	N		other
See text						
Common Myna	<i>Acridotheres tristis</i>	N	N	N		other
See text						
White-vented Myna	<i>Acridotheres cinereus</i>	N	M	N		other
See text						
Golden-crested Myna	<i>Ampeliceps coronatus</i>	N	X	H		PALR
At least 15, mixed in with 50 Hill Mynas at the large dryland island (17°58'N, 101°25'E) upstream of Ban Donmen, on 8 Feb 2012. There are few records from North Lao PDR (Timmings et al. in prep.).						
Hill Myna	<i>Gracula religiosa</i>	N	N	N		
11 on 29 and at least three on 30 Sep, and two on 1 Oct 2011. Eight on 29 Jan, three on 30 Jan, six on 31 Jan, one on 1 Feb, three on 2 Feb, five on 3 Feb, 50 on 8 Feb and one on 13 Feb 2012; all records from outside the channel. These numbers are probably somewhat lower than the habitat could support.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
[Pale Martin]	<i>Riparia diluta</i>	?	?	?		NE
See text.						
Sand/Pale Martin	<i>Riparia riparia/R. diluta</i>	L (Sand)	N (Sand)	N		
Singles on 29 Sep 2011 and 11 Feb 2012, both suspected to be Sand Martins.						
Plain Martin	<i>Riparia paludicola</i>	E	H	N		ARL
See text.						
Dusky Crag Martin	<i>Hirundo concolor</i>	N	N	N		
At least 15 on 29 Sep 2011 and 30 on 2 Feb 2012, all at Pha Liap.						
Barn Swallow	<i>Hirundo rustica</i>	L	N	N		
18 on 2 Oct 2004. Totals of about 220 (and similar number of unidentified hirundines) during 27 Sep - 1 Oct 2011; eight during 25-28 Jan; four on 4 Feb; 18 on 6-7 Feb; and 2022 during 9-14 Feb.						
Wire-tailed Swallow	<i>Hirundo smithii</i>	E	M?	N		PARL
See text						
Red-rumped Swallow	<i>Hirundo daurica</i>	L	N	N		
Birds apparently this species (migrant <i>H. s. mayri</i> not ruled out; see Fuchs <i>et al.</i> 2007) recorded on: 2 Oct 2004 (two), 29 Sep 2011 (1+), and 6 (six), 7 (six) & 14 Feb (80) 2012.						
Striated Swallow	<i>Hirundo striolata</i>	L	N	M		
Eight on 2 Oct 2004. At least three on 29 Sep 2011. Up to 70 on nine days in Jan-Feb 2012, widely spread downstream to Pakphoun on 3 Feb, then only records of four at Keng Khoutkhou on 9 Feb and eight on 11 Feb round the karst at 18°02'17"N, 101°51'57"E. Strongly associated with karsts and other rugged hilly terrain. All records showed characters of <i>H. d. stanfordi</i> .						
Northern/Asian House Martin	<i>Delichon urbica/dasypus</i>	N	N	N		
Three on 27 Jan 2012, over the channel.						
Black-headed Bulbul	<i>Pycnonotus atriceps</i>	N	N	N		
At least five on 1 Oct 2011 and three on 1 Feb 2012. All records from outside the channel.						
Black-crested Bulbul	<i>Pycnonotus melanicterus</i>	N	N	N		
Recorded 2 Oct 2004, 1 Oct 2011 and 29 Jan & 3 Feb 2012. Nearly all records from outside the channel.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	L	N	N		
One on 1 Oct 2004. Recorded (under 20) on 1 & 2 Oct 2011, 27 Jan 2012. Hundreds daily during 28 Jan - 1 Feb, when almost ubiquitous; merely dozens on 2-3 Feb; under a dozen on 8, 10, 13 & 14 Feb. Most records were from outside the channel, but birds ranged freely into channel bushland.						
Sooty-headed Bulbul	<i>Pycnonotus aurigaster</i>	N	N	N		
Recorded on [1 &] 2 Oct 2011, 27, 28 Jan and 11 & 13 Feb 2012. Birds ranged freely into the channel, but were mostly outside.						
Stripe-throated Bulbul	<i>Pycnonotus finlaysoni</i>	N	N	N		
Recorded on 30 Sep 2011, outside the channel.						
Streak-eared Bulbul	<i>Pycnonotus blanfordi</i>	L	N	N		
Recorded almost daily during 6-13 Feb 2012. Most records from within the channel.						
Grey-eyed Bulbul	<i>Iole propinqua</i>	N	N	N		
Heard on [1 Oct 2011], 30, 31 Jan and 4 Feb 2012. All records from outside the channel.						
Zitting Cisticola	<i>Cisticola juncidis</i>	L	N	N		
Two duos on 1 Feb, two songsters on 3 Feb, and singles on 7 & 8 Feb 2012, all in seasonally inundated long grass dry at time of survey.						
Bright-headed Cisticola	<i>Cisticola exilis</i>	L	N	N		
Up to three on 7, 8, 11, 12 and 14 Feb 2012, all in tall graminoids within the channel.						
Grey-breasted Prinia	<i>Prinia hodgsonii</i>	N	N	N		
Recorded on 31 Jan, 3, 7 & 9 Feb 2012, mostly outside the channel.						
Yellow-bellied Prinia	<i>Prinia flaviventris</i>	M	D	N		
Small numbers on 29 Sep 2011, 28, 30 & 31 Jan, 1 & 2 Feb 2012; lots on 29 Jan, 5-14 Feb 2012, from within and sometimes outside the channel. The localised distribution in the upper survey stretches probably reflects the distribution of extensive tall graminoids in channel.						
Plain Prinia	<i>Prinia inornata</i>	L	N	N		
Recorded almost daily 30-31 Jan (rare) and 3-14 Feb (often numerous) 2012.						
Japanese White-eye	<i>Zosterops japonicus</i>	N	N	N		
[Recorded most days during 26 Jan - 14 Feb 2012, occasionally in the channel but mostly in dryland habitats.]						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Japanese [Manchurian] Bush Warbler	<i>Cettia [diphone] canturians</i>	L	N	N		
A songster in channel <i>Homonoia</i> at 18°57'00"N, 101°48'04"E on 30 Jan 2012.						
Lanceolated Warbler	<i>Locustella lanceolata</i>	L	N	N		
Recorded on 7 & 8 Feb 2012 in tall graminoids, as was the genus unidentified to species on 31 Jan; probably much overlooked.						
Black-browed Reed Warbler	<i>Acrocephalus bistrigiceps</i>	L	N	N		
Two on 14 Feb 2012, in tall graminoids in channel at 18°10'20"N, 102°10'42"E. Midwinter records are unusual this far north in Lao PDR.						
Paddyfield / Blunt-winged Warbler	<i>Acrocephalus agricola/ concinens</i>	?	?	H		LKL
At least one, perhaps a Paddyfield Warbler (certainly not Manchurian Reed Warbler <i>A. (a.) tangorum</i> ) on 29 Sep 2011 on a tiny projection (with trees, scrub and grass) from central Don Vao. The only small <i>Acrocephalus</i> commonly recorded in Lao PDR is Black-browed Reed Warbler, and there is only one previous Lao record of Paddyfield Warbler s.s. (e.g. Duckworth et al. 1999).						
Oriental Reed Warbler	<i>Acrocephalus orientalis</i>	L	N	N		
At least three on 29 Sep 2011 in heavily-grazed scrub on a non-seasonally inundated part of southern Don Vao; single songsters on 6 and 7 Feb 2012; midwinter records this far north in Lao PDR are relatively unusual.						
Thick-billed Warbler	<i>Acrocephalus aedon</i>	L	N	N		
Singles on 26 & 28 (2x) Jan, 5, 10 & 13 Feb 2012, both in and out of the channel.						
Common Tailorbird	<i>Orthotomus sutorius</i>	L	N	N		
Scattered records on about half days between 25 Jan and 13 Feb 2012, also 27 Sep 2011 in and out of the channel; probably much underrecorded.						
Dark-necked Tailorbird	<i>Orthotomus atrogularis</i>	N	N	N		
Recorded 30 Sep & 2 Oct 2011, 27 & 29 Jan, 1 & 4 Feb 2012, mostly outside the channel.						
Dusky Warbler	<i>Phylloscopus fuscatus</i>	L	N	N		
One on 2 Oct 2011, after one Dusky or Radde's Warbler <i>P. schwarzi</i> on 27 Sep. Ubiquitous, mostly very common, throughout 25 Jan - 14 Feb 2012; by far the most commonly found passerine in the channel in most areas.						
Yellow-browed Warbler	<i>Phylloscopus inornatus</i>	L	N	N		
Singles on 2 Oct in 2004 and 2011. Found almost daily, often commonly, in and outside the channel, during 25 Jan - 14 Feb 2012.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Greenish Warbler	<i>Phylloscopus trochiloides</i>	N	N	N		
Recorded most days during 26 Jan - 11 Feb 2012, almost always outside the channel.						
Pale-legged Leaf Warbler	<i>Phylloscopus tenellipes</i>	N	N	N		
[One on 4 Feb 2012, outside the channel; the almost indistinguishable Sakhalin Leaf Warbler <i>P. borealoides</i> was not ruled out.]						
Blyth's Leaf Warbler	<i>Phylloscopus reguloides</i>	N	N	N		
One on 29 Jan 2012, outside the channel.						
Grey-crowned Warbler	<i>Seicercus tephrocephalus</i>	N	N	N		NE
One on 4 Feb 2012 in streamside vegetation at 18°18'48"N, 101°29'39"E. Silent single birds of this complex of species (all referred to as <i>S. burkii</i> in Inskip <i>et al.</i> 1996) were found on 29 Jan and 3 Feb 2012, also outside the channel.						
Yellow-bellied Warbler	<i>Abroscopus superciliaris</i>	N	N	N		
Recorded on 29 Jan 2012, outside the channel.						
White-crested Laughingthrush	<i>Garrulax leucolophus</i>	N	N	N		
Recorded on 30 Sep 2011, [28 & 29 Jan and 1 & 2 Feb 2012, outside the channel.						
Buff-breasted Babbler	<i>Pellorneum tickelli</i>	N	N	N		
Recorded on 29 & 30 Jan 2012, outside the channel.						
Puff-throated Babbler	<i>Pellorneum ruficeps</i>	N	N	N		
Recorded almost daily during 26 Jan - 14 Feb 2012, outside the channel.						
Scimitar babbler sp(p).	<i>Pomatorhinus schisticeps</i>	N	N	N		
Recorded daily during 28 Jan - 4 Feb 2012, outside the channel.						
Limestone Wren Babbler	<i>Napothena crispifrons</i>	N	N	M		
Heard at Pha Liap on 2 Feb (four groups) and 18°02'17"N, 101°51'57"E on 11 Feb (one group) 2012. Tied to limestone and recorded in Lao PDR only from the north; few locality records so far (Duckworth in press).						
Rufous-fronted/Rufous-capped/Golden Babbler	<i>Stachyris rufifrons/ruficeps/chrysaea</i>	N	N	N		
Recorded daily 27 Jan - 4 Feb, also 8 & 10 Feb 2012, always outside the channel.						
Grey-throated Babbler	<i>Stachyris nigriceps</i>	N	N	N		
Recorded commonly on 29 & 30 Jan, always outside the channel.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Striped Tit Babbler	<i>Macronous gularis</i>	N	N	N		
Recorded on 30 Sep and 1 Oct 2011, and almost daily 25 Jan - 14 Feb 2012, invariably outside the channel.						
Chestnut-capped Babbler	<i>Timalia pileata</i>	L	N	N		NE
Recorded, usually heard only and probably involving small groups each time, 31 (2x) Jan and 1, 6, 7 (2x), 8 & 10 Feb 12, always in tall graminoids sometimes mixed with scrub, usually in the channel.						
Yellow-eyed Babbler	<i>Chrysomma sinense</i>	L	M	N		NE
One on 31 Jan (in song) at 18°40'51"N, 102°48'00"E, two on 10 Feb at 17°54'45"N, 101°43'21"E, and heard on 11 Feb 2012 at 18°01'53"N, 101°52'21"E, all times in tall graminoids at the channel edge.						
Rufous-throated Fulvetta	<i>Alcippe rufogularis</i>	N	N	N		
Commonly heard from dryland habitats on 28-30 Jan and 8 Feb 2012.						
Brown-cheeked Fulvetta	<i>Alcippe poioicephala</i>	N	N	N		
Heard from dryland habitats on 4 & 8 Feb 2012.						
White-bellied Yuhina	<i>Yuhina zantholeuca</i>	N	N	N		
Recorded on 1 Oct 2011, from dryland habitat.						
Yellow-vented Flowerpecker	<i>Dicaeum chrysorrheum</i>	N	N	N		
At least one on 30 Sep 2011 in dryland habitat (degraded forest on Don Hon).						
Brown-throated Sunbird	<i>Anthreptes malacensis</i>	N	N	H		
A male in a bank-top fruit garden at about 18°26'N, 101°36'E on 3 Feb 2012. This species, formerly localised in Lao PDR (Thewlis et al. 1996), has been rapidly spreading northwards (e.g. Duckworth in press) and has just reached China (Wu et al. 2010).						
Ruby-cheeked Sunbird	<i>Anthreptes singalensis</i>	N	N	N		
Recorded on 29 Jan 2012, from dryland habitat.						
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	L	N	N		
Recorded on 7 Feb 2012, from dryland habitat.						
Little Spiderhunter	<i>Arachnothera longirostra</i>	L	N	N		
Recorded on 27, 28 & 30 Jan and 3, 4 & 12 Feb 2012, mostly from dryland habitat but sometimes visiting flowers in the channel bushland.						
House Sparrow	<i>Passer domesticus</i>	N	N	M		
A female in Louangphabang town on 25 Jan 2012, the only suitable habitat on the survey (Paklay town was not visited). This is a recent colonist of Lao PDR, rapidly spreading (e.g. Duckworth in press).						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Eurasian Tree Sparrow	<i>Passer montanus</i>	L	N	N		
Many in Louangphabang town on 25 Jan 2012, the only suitable habitat on the survey (Paklay town was not visited).						
White Wagtail (subspecies)	<i>Motacilla alba</i> <i>Motacilla alba alboides</i>	H	D	H		NE
See text.						
White Wagtail (subspecies)	<i>Motacilla alba leucopsis</i>	L	N	M		NE
Common on 2 Oct 2004. Up to 30, once 100+, daily during 27 Sep - 2 Oct 2011. Dozens, once 300+, daily, with some in almost every survey stretch, during 25 Jan - 14 Feb 2012. See footnote 1.						
White Wagtail (subspecies)	<i>Motacilla alba 'ocularis'</i>	?	?	M		NE
One apparently of this race ( <i>M. a. lugens</i> could not be ruled out, but see footnote 1) on 7 Feb 2012 on bare wet sand at 18°00'07"N, 101°25'40"E; as in Phongsali province (Fuchs et al. 2007), much less numerous than <i>M. a. alboides</i> and <i>M. a. leucopsis</i> .						
Citrine Wagtail	<i>Motacilla citreola</i>	H	D	N		
One on 25 Jan and two on 11 Feb 2012, all around channel pools.						
Yellow Wagtail	<i>Motacilla flava</i>	L	N	N		
Two on 29 Sep 2011. Up to six, once 12, on 25 & 31 Jan and 1, 2, 5, 7, 8, 10, 11, 12 & 14 Feb 2012, mostly in the channel; with about a fifth of birds Citrine Wagtail could not be excluded from identification.						
Grey Wagtail	<i>Motacilla cinerea</i>	L	N	N		
1-2 on 25, 26 & 27 Jan, and 12 Feb 2012, all in channel habitats.						
Richard's Pipit	<i>Anthus richardi</i>	N	N	N		
One on 25 Jan and two on 6 Feb, all in banktop habitats.						
Paddyfield Pipit	<i>Anthus rufulus</i>	L	N	N		
One on 2 Oct 2004. Found daily, often common, during 25 Jan - 14 Feb 2012, extensively using the channel.						

		River channel association	Conservation significance	Faunistic interest	Global Red List Category	Lao Risk Status
Olive-backed Pipit	<i>Anthus hodgsoni</i>	N	N	N		
Recorded daily on 26-30 Jan, on 1, 4, 5 & 8 Feb 2012, mostly using banktop habitats but sometimes dropping down into the channel.						
Red-throated Pipit	<i>Anthus cervinus</i>	L	N	N		
Up to six on 25 & 26 Jan and 2, 3 & 5 Feb 2012, feeding in the channel.						
Baya Weaver	<i>Ploceus philippinus</i>	L	?	M		PARL
See text.						
Red Avadavat	<i>Amandava amandava</i>	?	?	H		NE
See text.						
White-rumped Munia	<i>Lonchura striata</i>	N	N	N		
At least three on 30 Sep 2011, eight on 28 Jan, 1-2 on 30 & 31 Jan and 2 Feb 2012, mostly in flight between out-of-channel habitats.						
Scaly-breasted Munia	<i>Lonchura punctulata</i>	L	N	N		
Recorded only on 6 (2+) and 11 Feb (one) 2012, in the channel. Also unidentified munias on 29 Sep 2011 (one) and 27 Jan (20) 2012. By contrast this munia is abundant in the channel around Vientiane city.						
Black-faced Bunting	<i>Emberiza spodocephala</i>	H	D	N		
A male on 6 Feb and four on 7 Feb in the large island complex downstream of Paklay, in two different extensive patches of <i>Homonia</i> over sand. Single buntings flying over the channel and calling 'tic' on 3 & 9 Feb 2012 were felt perhaps to be Chestnut Buntings <i>E. rutila</i> .						

## KEY

### River channel association

E = In Lao PDR, effectively tied to wide rivers.

H = High use of wide rivers in Lao PDR, but also found in other habitats locally (e.g. Spot-billed Duck) or in other regions of Laos (e.g. Savanna Nightjar).

M = Species uses large rivers more than other wetland (e.g. Common Sandpiper) or dry-land habitats (e.g. Jerdon's Bushchat), at least in this region of Lao PDR.

L = Species makes regular use of wide-river channels (sometimes only on a seasonal basis), but also uses many other habitats to an equal or greater degree (including at the season of greatest channel use).

N = Species does not make routine use of the channel

? = Species makes or probably makes routine use of wide river channels, but its significance to the species is unknown, either because the species's ecology in Lao PDR is poorly known (e.g. Red Avadavat), or it is suspected that the channel populations has probably been much reduced, but evidence is lacking as to the former extent (e.g. Stork-billed Kingfisher).

**Conservation significance** assesses the national-level conservation priority of the population of the species found or reasonably predicted to occur in the survey area.

- H = High; species for which there is high concern nationally due to ongoing declines, and for which the survey area has a high proportion of the national population, and thus its loss would seriously affect the species's status in Lao PDR.
- M = Medium; species for which there is some concern nationally due to ongoing declines (but not to the same extent as those species above), and for which the survey area has a nationally significant population, but by no means the most significant (e.g. Large-billed Crow), or species for which concern is relatively low, but the survey area has a very significant population (e.g. Wire-tailed Swallow).
- X = Out of channel; species not associated with the channel, but which in the sole context of North Lao PDR have significant populations adjacent to the survey area.
- D = Species strongly associated with large rivers, but only likely to be threatened by a major or series of smaller dams on the mainstream. Severity would probably be strongly correlated with length of river inundated.
- N = No conservation significance in or adjacent to the channel survey area

**Faunistic interest** of the 2004, 2011, 2012 surveys' records

- H = The records were unexpected or the precision of the records greatly increases understanding of Lao status of the taxon.
- M = Lao status is poorly understood and the records assist in clarifying it.
- N = The records contained nothing surprising.

**Global Red List Category** (after IUCN 2012)

Taxa left blank are LC (Least Concern) or NE (Not Evaluated) for subspecies. Only two species are a category other than LC, Black-tailed Godwit and River Lapwing; both are Near Threatened (NT).

**Lao Risk Status** (after Duckworth et al. 1999)

ARL = At Risk in Lao PDR; PARL = Potentially At Risk in Lao PDR; LKL = Little Known in Lao PDR; NE = Not Evaluated; other = considered Not At Risk in Lao PDR but subsequent information suggests this is incorrect (see text). A blank cell = Not At Risk in Lao PDR.

Footnote 1: three birds (two singles on 28 Sep and one on 1 Oct 2011) showed dark eyestripes, indicating either *M. a. lugens* or *M. a. ocularis*; one had black upperparts and another very dark grey, ruling out *M. a. ocularis*, and thus suggesting *M. a. lugens*. However, the best-seen bird had the eyestripe only aft of the eye, whereas *M. a. lugens* has a complete eyestripe. Apparently in Japan *M. a. lugens* and another dark-backed taxon, *M. a. leucopsis*, are hybridising extensively (N. Moores pers. comm.), and this is the most likely explanation for these birds. *M. a. lugens* is unlikely to be of regular occurrence in Lao PDR (it has never been recorded), whereas hybrids would presumably inherit at least to some extent the migratory habit of *M. a. leucopsis*, for which Lao PDR is part of the main wintering range. The other two autumn birds had grey backs and may have been *M. a. ocularis*.

**Appendix 4.2.** Stretch-by-stretch counts of bird species of conservation management significance that were widely recorded along the Mekong channel between the towns of Louangphabang and Vientiane.

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
<b>Wet season 2004</b>											
Vientiane - near Ban Donmen (17°56'35"N, 101°24'24"E)	02-Oct-04		11--15	61-93				17	116-144	16	
<b>Wet season 2011</b>											
Vientiane to 18°11'54.86"N, 102°10'32.09"E	27-Sep-11	Fast boat	15	1+					8(1)	17+(1)	
18°11'54.86"N, 102°10'32.09"E to Ban Vang	27-Sep-11	Fast boat	13, 14	3+(2)					3+(3)		
Ban Vang	28-Sep-11	Fast boat (stationary observation from bank)	12, 13	4+							
Ban Vang to Sanakham (17°53'32.16"N, 101°37'40.28"E)	28-Sep-11	Fast boat	12 part	5+(3)							
Sanakham to Thai-Xaignabouli border (17°51'03.54"N, 101°31'58.98"E)	28-Sep-11	Fast boat	12 part						5+(3)		

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
17°51'33.68"N, 101°29'30.42"E to Paklay	28-Sep-11	Fast boat	11	5(1)					3+(2)		
Ban Khokkhaodo downstream to Don Vao	28-Sep-11	Slow boat	11						51+	1+	
Ban Khokkhaodo: 18°09'48.25"N, 101°23'38.83"E- 18°07'06.50"N, 101°23'58.49"E	29-Sep-11	Slow boat	11	2+				6	20+	32+	
18°07'06.50"N, 101°23'58.49"E- 18°01'44.88"N, 101°25'14.33"E	29-Sep-11	Slow boat	11	3					8	5	
18°01'44.88"N, 101°25'14.33"E to Paklay	29-Sep-11	Fast boat	11						1		
Paklay	29-Sep-11	Stationary observation from bank	11								
Paklay to Pha Liap	29-Sep-11	Fast boat	not covered	2					20(3)	2	
Pha Liap to upstream end of Don Hon	29-Sep-11	Fast boat	not covered						1+	10(2)	
Don Hon	29-Sep-11	Stationary observation from bank	not covered						2	13	

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
Don Hon	30-Sep-11	Slow boat	not covered						3		
Don Hon	30-Sep-11	Stationary observation from bank	not covered								
Upstream end of Don Hon to Camp 2 (18°49'24.37"N, 101°50'32.52"E)	30-Sep-11	Fast boat	not covered						7+(5)		
Camp 2 to 18°50' 49.95"N, 101°49'35.04"E	30-Sep-11	Slow boat	not covered						11		
Camp 2 to Ban Pakpouy (18°56'33.63"N, 101°47'51.16"E)	01-Oct-11	Slow boat	not covered	3					64+ (30;up) 35+ (21;down)		
Nam Feuang (18°52'58.00"N, 101°47'42.25"E)	01-Oct-11	Slow boat	not covered								
Camp 2 to Ban Pakpouy	01-Oct-11	Fast boat	not covered						22+		
Ban Pakpouy to Camp 3 (19°16'44.24"N, 101°48'58.66"E)	01-Oct-11	Fast boat	not covered						8(4)		
Camp 3 - 19°14'50.34"N, 101°48'54.49"E	01-Oct-11	Slow boat	not covered						13+	7+	
Camp 3 down to 19°05'20.74"N, 101°48'24.85"E	02-Oct-11	Slow boat	not covered						22+(10)	1	

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
19°05'20.74"N, 101°48'24.85"E to Camp 3	02-Oct-11	Fast boat	not covered					[1]	6(4)		
Camp 3 to Ban Thadua	02-Oct-11	Fast boat	not covered						19+(7)	1	
Ban Thadua to Louangphabang	02-Oct-11	Fast boat	not covered						15+(8)	3+	
<b>Dry Season 2012</b>											
Louangphabang	25-Jan-12	foot	not covered								
Louangphabang-Ban Muangkhay (19°47'46"N, 101°58'54"E)	25-Jan-12	boat	not covered								
19°47'46"N, 101°58'54"E	25-Jan-12	foot	not covered				2,2,2			6+	as t'mrw
19°47'46"N, 101°58'54"E	26-Jan-12	foot	not covered				as y'day + 2,2,2				15+
19°47'46"N, 101°58'54"E-19°41'22"N, 101°52'37"E	26-Jan-12	boat/foot	not covered								
19°41'22"N, 101°52'37"E-19°36'55"N, 101°48'14"E	26-Jan-12	boat/foot	not covered				2,2,2,1,1,1		2,2,2,2,2,1		
19°36'55"N, 101°48'14"E	26-Jan-12	foot	not covered				1,2		3		

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
19°36'55"N, 101°48'14"E	27-Jan-12	foot	not covered				2,2,2		as y'day		
19°36'55"N, 101°48'14"E- 19°30'00"N, 101°48'08"E	27-Jan-12	boat/foot	not covered				2,3,2,1		2,2,2,2,2,7,2		
19°30'00"N, 101°48'08"E- 19°27'47"N, 101°48'53"E	27-Jan-12	boat/foot	not covered				1,2,2		2,2		
19°27'47"N, 101°48'53"E- 19°24'48"N, 101°52'52"E	27-Jan-12	boat/foot	not covered				1,1		1		
19°24'48"N, 101°52'52"E	27-Jan-12	foot	not covered				2		2		
19°24'48"N, 101°52'52"E- 19°22'11"N, 101°51'30"E	28-Jan-12	boat/foot	not covered						2,2		
19°22'11"N, 101°51'30"E- 19°17'23"N, 101°49'12"E	28-Jan-12	boat/foot	not covered						2,2,2		
19°17'23"N, 101°49'12"E - 19°14'03"N, 101°49'17"E	28-Jan-12	boat/foot	not covered						1		
19°14'03"N, 101°49'17"E -19°11'03"N, 101°49'18"E	28-Jan-12	boat/foot	not covered						2,6		

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
19°11'03"N, 101°49'18"E- 19°10'24"N, 101°49'13"E	28-Jan-12	boat/foot	not covered				2,1,2,2		2		
19°10'24"N, 101°49'13"E	29-Jan-12	foot	not covered				as y'day + 1		as y'day		
19°10'24"N, 101°49'13"E- 19°06'19"N, 101°48'28"E	29-Jan-12	boat/foot	not covered				2		2		
19°06'19"N, 101°48'28"E -19°05'24"N, 101°48'21"E	29-Jan-12	boat/foot	not covered				1		2		
19°05'24"N, 101°48'21"E- 19°00'15"N, 101°47'46"E	29-Jan-12	boat/foot	not covered				2,2,2,1,1		2,2,2		
19°00'15"N, 101°47'46"E	29-Jan-12	foot	not covered						1		
19°00'15"N, 101°47'46"E- 18°58'36"N, 101°48'02"E	29-Jan-12	boat/foot	not covered						1,2,2,2		
18°58'36"N, 101°48'02"E- 18°57'00"N, 101°48'04"E	29-Jan-12	boat/foot	not covered				1		1,1,2,1		

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
18°57'00"N, 101°48'04"E	30-Jan-12	foot	not covered				as y'day + 2		as y'day + 1,2		
18°57'00"N, 101°48'04"E -18°55'20"N, 101°47'46"E	30-Jan-12	foot	not covered							1,2,2,2,2,2,2	
18°55'20"N, 101°47'46"E -18°53'18"N, 101°47'28"E	30-Jan-12	foot	not covered							2,2,2,2,2,2,2	
18°53'18"N, 101°47'28"E -18°49'58"N, 101°50'26"E	30-Jan-12	boat/foot	not covered				1,1			2,2,2,2,2, 1,2,2,2,2,2,1,2	
18°49'58"N, 101°50'26"E -18°49'11"N, 101°50'45"E	30-Jan-12	boat/foot	not covered							1,2,1	
18°49'11"N, 101°50'45"E	31-Jan-12	foot	not covered				1		as y'day + 2,2,3,1,2		
18°49'11"N, 101°50'45"E -18°47'34"N, 101°50'44"E	31-Jan-12	foot	not covered		1			1,1,2,2		2,2,3,2,2,2,1, 1,3,2,2,2,2,2,	

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
18°47'34"N, 101°50'44"E -18°43'30"N, 101°48'58"E	31-Jan-12	boat/foot	not covered	1			2,2,3,1,2		2,2,2,2,2,1,4		
18°43'30"N, 101°48'58"E -18°40'51"N, 101°48'00"E	31-Jan-12	boat/foot	not covered	2					2,1,2,2,1,2,2		7,3,15
18°40'51"N, 101°48'00"E	01-Feb-12	foot	not covered								as y'day
18°40'51"N, 101°48'00"E-Don Hon (18°33'N, 101°45'E)	01-Feb-12	boat	not covered		1,3,2,3		2,2,1,2,2,2,2, 2,2,1,2,2,1		1,4,3,1		70
Don Hon	01-Feb-12	foot	not covered				3,1,1,2,2		2,2,2,2,2		
Don Hon	02-Feb-12	foot	not covered	2				as y'day	as y'day		
Don Hon-Pha Liap (18°28'30"N, 101°38'30"E)	02-Feb-12	boat	not covered				2,2,1,1,1		3,2,2,2,2,2,2		
Pha Liap	02-Feb-12	foot	not covered								
Pha Liap-18°26'45"N, 101°37'31"E	02-Feb-12	boat	not covered		2		1		2,2,2,1,2		1

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
18°26'45"N, 101°37'31"E	03-Feb-12	foot	not covered		1		2,2,2,2		4,2		
18°26'45"N, 101°37'31"E- 18°24'20"N, 101°35'32"E	03-Feb-12	boat/foot	not covered		2		1,1,2,3,2,2		2,4,2,2,2,2,2, 2,2,2,2,2,2,5		1,3
18°24'20"N, 101°35'32"E- Pakphoun (18°22'30"N, 101°33'30"E)	03-Feb-12	boat/foot	not covered				2,3,1		2,1		
18°24'20"N, 101°35'32"E	04-Feb-12	foot	not covered				as y'day		as y'day		
Pakphoun- 18°18'48"N, 101°29'39"E	04-Feb-12	boat/foot	not covered				1,1,1,1,2,2,1		1	4	
18°18'48"N, 101°29'39"E	04-Feb-12	foot	not covered		2		2,2				7
18°18'48"N, 101°29'39"E- 18°16'22"N, 101°27'12"E	05-Feb-12	foot	not covered	2	2,2,3		1,1,3,2,1,1,2,1,1,2		1,2,2,2,2,1,1,	1,1,4,6,1,4	
18°16'22"N, 101°27'12"E- Ban Houaylay- Noy (18°14'N, 101°25'E)	05-Feb-12	boat	not covered				1,1,1,1,				4
Paklay (18°13'N, 101°25'E)-Don Vao at c.o. 18°09'N, 101°24'E	05-Feb-12	boat/foot	11	3			1,2,1,2,2				1,3,2

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
Don Vao, centred on: 18°09'N, 101°24'E	06-Feb-12	boat/foot	11		1		2,1,2,		2		
Don Vao, centred on: 18°07'N, 101°24'E	06-Feb-12	boat/foot	11	6			1			1	8 [2]
Don Vao, centred on: 18°07'N, 101°24'E	07-Feb-12	boat/foot	11	4			1,1,2,2,2,2,		2		1+
18°07'56"N, 101°23'21"E- 18°00'07"N, 101°25'40"E	07-Feb-12	boat/foot	11	2	2	2ad1fw	2,2,2,2,1,2,2		2,1,2	1	3,5,22, 2,60,60
18°00'07"N, 101°25'40"E	08-Feb-12	foot	11	2			as y'day		as y'day		as y'day
18°00'07"N, 101°25'40"E- 17°51'52"N, 101°29'30"E	08-Feb-12	boat	11				1,1,2,1,1,2,1		2,3,2,2,1,2,2,2		70
17°51'52"N, 101°29'30"E- 17°51'47"N, 101°32'28"E	08-Feb-12	foot/boat	11				1,1,4,2,1,		1,2,		30
17°51'47"N, 101°32'28"E- Thai border (17°50'N, 101°32'E)	08-Feb-12	foot/boat	11			1	2				30

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
Thai border- 17°51'03"N, 101°35'30"E	08-Feb-12	foot/boat	12				1		1	1	30
17°51'03"N, 101°35'30"E	08-Feb-12	foot	12						1	1	50
17°51'03"N, 101°35'30"E	09-Feb-12	foot	12				2		2		
17°51'03"N, 101°35'30"E- 17°53'46"N, 101°36'41"E	09-Feb-12	boat	12			1	1,2,2,1,2,2,2,2,1,2,1,2 ,2,2,1,2,2,2		2	2	35,230
Sanakham (17°55'N, 101°40'E)	09-Feb-12	foot/boat	12				1,1,2,2,2,2,2,2,				
Keng Khoutkhou	09-Feb-12	foot/boat	12				2,2				10
Sanakham- 18°04'27"N, 101°47'02"E	10-Feb-12	boat	12	3			1,2,2,2,2,2,1,2,2,1,		1,1,1,2,2	2	20,1,4,6, 1,30,30
18°04'27"N, 101°47'02"E- just upstream of Ban Vang (18°03'N, 101°50'E)	10-Feb-12	foot/boat	12			4	1,1,2,1,1,2,2		1,1,1		2,4,30
18°03'N, 101°50'E	11-Feb-12	foot	13		2				as y'day, 1		6

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
18°03'N, 101°50'E- 18°01'53"N, 101°52'21"E	11-Feb-12	foot/boat	13		3				2		4,60
18°01'53"N, 101°52'21"E- 18°04'44"N, 101°56'05"E	11-Feb-12	foot/boat	13								16,4,4,30
18°04'44"N, 101°56'05"E- 18°05'51"N, 101°57'12"E	11-Feb-12	foot/boat	13		1,4		2,2,2,2,1,1,2		1		1,1,2,2,6
18°05'51"N, 101°57'12"E	12-Feb-12	foot	13				as y'day		1		2
18°05'51"N, 101°57'12"E- Don Chan (18°11'N, 102°03'E)	12-Feb-12	foot/boat	13					1,1	1,2,2		2,4,2,2,4
Don Chan-Ban Houayla (18°13'N, 102°05'E)	12-Feb-12	foot/boat	14		5,2,2		2,2+2d,2,1,4,2		2,1		2,2,3,2
Pak Houayla	12-Feb-12	foot	14		2		1,2		1,1		2,40
Ban Houayla-Don Nou (18°13'N, 102°09'E; Paksang)	13-Feb-12	foot/boat	14	2	1,2,1,		2,1,2,2,1,2,2,2,2	as y'day + 1,1,2,2,1,2,			3

Location	Date	Survey type	Stretch # in Duckworth et al. (2002)	Spot-billed Duck ssp.?	Spot-billed Duck <i>haringtonae</i>	Little Ringed Plover <i>curonicus</i>	Little Ringed Plover <i>jerdoni</i>	Little Ringed Plover ssp.?	River Lapwing	Grey-headed Lapwing	Small Pratincole
Don Nou- 18°10'58"N, 102°10'38"E	13-Feb-12	foot/boat	15		2		1,1,1,2,2,1,1,1,2		1,1,1		7,4,4,8
18°10'58"N, 102°10'38"E	14-Feb-12	foot	15	1							4
18°10'58"N, 102°10'38"E-Ban Kengmo (18°03'30"N, 102°18'E)	14-Feb-12	foot/boat	15		2,1,1,16		1,2,2,2,1,1,2,2,2,2,2 ,2,2,2,2,4,2,2,1,1		1,1,1,2	1	8,15,2,6,2, 2,10,4,20, 10,50,6,20 ,40,20
Ban Kengmo- Ban Mai island (17°58'N, 102°28'E)	14-Feb-12	boat	15				2,1,1,1,1,2,2,2,2,1,2,2 ,2,1,1,2,2		1		30,40,8,20
Ban Mai island	14-Feb-12	boat	15								20
m = males, f = females, u = unsexed individuals, h = vocal records (used only with Jerdon's Bushchat in wet-season 2011).											

**KEY**

Counts are presented in two ways. For 2011, the total number of individuals is followed by the total number of contacts in parentheses, for those species commonly occurring in groups. The number of contacts is not given for wagtails. In the case of Jerdon's Bushchat the number in parentheses is the number of channel 'spots' in which the counts came. When the same stretch of river was covered twice by the same method (once up and once down) two counts are sometimes given; one for the survey upstream, and one for the survey downstream. Note that the many egrets not identified to species are not included in the table, but certainly many were either Cattle or Little Egrets. For 2012, the number of birds at each contact is given, except in cases where a number is followed by 'o/a' (overall) where only the total of individuals is given. For 2012, where counts on one day probably involved the same birds as seen the previous day, a cross reference is given; thus all counts are believed to represent different individuals, although for highly mobile species such as Large-billed Crow, it is difficult to determine the degree of duplication.

**Appendix 7.1.** Aquatic invertebrates: collected taxon list and abundance in the wet season.

Order	Family	TAXON	HSH	MTL	HSU	HSO	HMS	MDH	HSA	MDS	HPN	HDE	HTK
<b>Molluscs</b>													
Basommatophora	Planorbidae	<i>Indoplanorbis</i>	0	0	0	0	0	0	0	1	0	0	0
Mesogastropoda	Viviparidae	<i>Pila</i>	0		0	1	0	0	0	0	0	0	0
Mesogastropoda	Thiaridae		0		0	0	0	0	0	4	0	0	0
Mesogastropoda	Hydrobiidae		0		0	0	0	0	0	0	6	0	0
Mesogastropoda	Stenothyridae		0		13	0	0	0	0	0	0	0	0
Mesogastropoda	Bithyniidae		0		0	0	0	0	0	0	0	0	14
<b>Insects</b>													
Coleoptera	Carabidae	Morphotype 1	3	0	0	0	0	0	0	0	0	0	0
Coleoptera	Dytiscidae	Morphotype 1	0	0	0	0	0	0	0	0	0	0	1
Coleoptera	Dytiscidae	Morphotype 2	0	0	0	0	0	0	1	0	0	1	0
Coleoptera	Dytiscidae	Morphotype 3	0	0	0	0	0	0	0	0	0	3	2
Coleoptera	Elmidae	Morphotype 1	0	0	1	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	Morphotype 2	0	0	0	0	0	0	2	0	0	0	0
Coleoptera	Elmidae	Morphotype 3	0	0	0	0	0	0	3	0	0	0	0
Coleoptera	Elmidae	Morphotype 4	0	0	1	0	0	0	4	0	0	0	0
Coleoptera	Gyrinidae	Morphotype 1	0	0	0	1	1	0	0	0	0	0	0
Coleoptera	Gyrinidae	Morphotype 1	0	0	0	0	11	0	0	0	0	0	0
Coleoptera	Hydrophilidae	Morphotype 1	0	0	0	0	1	0	0	0	0	0	0
Coleoptera	Hydrophilidae	Morphotype 2	0	0	1	0	0	0	0	0	0	0	0
Coleoptera	Hydrophilidae	Morphotype 3	1	0	0	0	0	0	0	0	0	1	0
Coleoptera	Psephenidae	Morphotype 1	0	0	0	0	0	0	1	0	0	0	0
Coleoptera	Scirtidae	Morphotype 1	2	0	0	0	0	0	1	0	0	1	0
Diptera	Athericidae	Morphotype 1	0	0	0	0	0	0	0	0	1	0	0
Diptera	Ceratopogonidae	Morphotype 1	0	0	0	0	0	0	1	0	0	0	0
Diptera	Chironomidae	Morphotype 1	0	0	4	2	2	0	1	0	6	14	10
Diptera	Dixidae	Morphotype 1	0	0	3	0	0	0	0	0	0	0	0

Order	Family	Taxon	HSH	MTL	HSU	HSO	HMS	MDH	HSA	MDS	HPN	HDE	HTK
Diptera	Empididae	Morphotype 1	0	0	0	0	0	0	0	0	1	0	0
Diptera	Sciomyzidae	Morphotype 1	0	0	0	0	1	0	0	0	0	0	0
Diptera	Simuliidae	Morphotype 1	0	0	2	0	0	0	7	0	0	1	0
Diptera	Simuliidae	Morphotype 2	8	1	14	1	0	0	14	0	0	3	39
Diptera	Tabanidae	Morphotype 1	0	0	0	0	0	0	2	0	0	0	0
Diptera	Tipulidae	Morphotype 1	0	0	0	0	1	0	0	0	0	0	0
Diptera	Tipulidae	Morphotype 2	0	0	1	0	0	0	0	0	0	3	0
Diptera	Tipulidae	Morphotype 3	0	0	0	0	1	0	0	0	0	6	0
Ephemeroptera	Baetidae	Morphotype 1	0	0	3	0	0	0	0	0	0	0	8
Ephemeroptera	Baetidae	Morphotype 2	13	0	3	8	3	0	0	0	0	38	4
Ephemeroptera	Baetidae	Morphotype 3	5	27	2	2	2	4	2	0	0	13	14
Ephemeroptera	Baetidae	Morphotype 4	0	0	18	35	1	0	14	0	0	14	10
Ephemeroptera	Caenidae	Morphotype 1	1	0	0	1	10	0	2	0	45	6	16
Ephemeroptera	Ephemerellidae	Morphotype 1	0	0	0	1	0	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	Morphotype 2	0	1	0	0	0	0	0	0	0	1	0
Ephemeroptera	Ephemerellidae	Morphotype 3	0	0	0	2	0	0	0	0	0	0	0
Ephemeroptera	Ephemeridae	Morphotype 1	0	0	0	0	0	0	0	0	0	1	0
Ephemeroptera	Heptageniidae	Morphotype 1	0	0	0	0	0	0	0	0	0	2	1
Ephemeroptera	Heptageniidae	Morphotype 2	14	0	0	0	0	0	0	0	0	3	0
Ephemeroptera	Heptageniidae	Morphotype 3	0	0	1	1	1	0	22	0	0	51	0
Ephemeroptera	Leptophlebiidae	Morphotype 1	0	0	4	0	5	0	3	0	0	16	0
Ephemeroptera	Leptophlebiidae	Morphotype 2	0	0	14	1	0	0	15	0	0	10	0
Ephemeroptera	Leptophlebiidae	Morphotype 3	0	0	0	0	0	0	1	0	0	0	0
Ephemeroptera	Potamanthidae	Morphotype 1	0	0	4	0	0	0	0	0	0	0	0
Ephemeroptera	Potamanthidae	Morphotype 2	0	0	0	0	0	0	2	0	0	0	0
Ephemeroptera	Prosopistomatidae	Morphotype 1	0	2	0	0	0	0	0	0	0	0	0
Ephemeroptera	Teloganodidae	Morphotype 1	0	0	0	0	0	0	0	0	0	4	0
Hemiptera	Gerridae	Morphotype 1	0	0	0	1	0	0	0	0	0	0	0
Hemiptera	Gerridae	Morphotype 2	0	0	0	2	0	0	0	0	0	0	0
Hemiptera	Gerridae	Morphotype 3	1	0	0	1	0	0	0	0	0	2	0
Hemiptera	Gerridae	Morphotype 4	0	0	0	0	4	0	1	0	0	0	2
Hemiptera	Helotrehidae	Morphotype 1	0	0	0	0	0	0	8	0	0	0	0

Order	Family	Taxon	HSH	MTL	HSU	HSO	HMS	MDH	HSA	MDS	HPN	HDE	HTK
Hemiptera	Hydrometridae	Morphotype 1	0	0	0	0	0	0	0	1	0	0	0
Hemiptera	Micronectidae	Morphotype 1	0	0	0	0	0	0	0	0	0	0	3
Hemiptera	Naucoridae	Morphotype 1	0	0	0	0	0	0	0	0	0	1	0
Hemiptera	Naucoridae	Morphotype 2	0	0	5	0	3	0	0	0	0	0	0
Hemiptera	Naucoridae	Morphotype 3	0	0	1	0	0	1	8	0	0	2	2
Hemiptera	Nepidae	Morphotype 1	0	0	0	4	0	0	2	0	0	1	0
Hemiptera	Nepidae	Morphotype 2	0	0	0	0	0	1	0	0	0	0	0
Hemiptera	Notonectidae	Morphotype 1	0	0	0	0	0	0	0	0	0	0	3
Hemiptera	Veliidae	Morphotype 1	0	0	0	0	0	1	0	0	2	0	0
Hemiptera	Veliidae	Morphotype 2	0	0	0	0	0	0	0	0	0	1	22
Megaloptera	Coridalidae	Morphotype 1	0	0	0	0	3	0	1	0	0	0	0
Odonata	Aeshnidae	Gynacantha	0	0	2	0	0	0	0	0	0	0	0
Odonata	Amphipterygidae	Morphotype 1	0	0	0	0	0	0	1	0	0	0	0
Odonata	Calopterygidae	Morphotype 1	0	0	0	0	0	0	0	0	0	2	0
Odonata	Chlorocyphidae	Morphotype 1	0	0	0	0	0	0	0	0	0	1	0
Odonata	Coenagrionidae	Morphotype 1	0	0	0	0	0	0	0	0	2	0	8
Odonata	Corduliidae	Morphotype 1	0	0	0	0	0	0	3	0	0	0	3
Odonata	Cordulegastridae	Morphotype 1	0	0	0	0	1	0	0	0	0	0	0
Odonata	Euphaeidae	Morphotype 1	0	0	1	1	1	0	0	0	0	1	0
Odonata	Gomphidae	Morphotype 1	0	0	0	0	0	0	0	1	0	0	0
Odonata	Gomphidae	Morphotype 2	0	0	0	0	1	0	0	0	0	0	0
Odonata	Gomphidae	Morphotype 3	0	0	4	0	1	0	1	0	0	0	0
Odonata	Gomphidae	Morphotype 4	0	0	0	0	0	0	0	0	0	0	2
Odonata	Lestidae	Morphotype 1	0	0	0	0	0	0	0	0	0	2	0
Odonata	Libellulidae	Morphotype 1	0	0	0	0	0	0	0	0	0	3	0
Odonata	Libellulidae	Morphotype 2	0	0	0	0	0	0	0	0	0	1	45
Odonata	Platycnemidae	Morphotype 1	0	0	0	0	0	0	0	0	0	0	5
Odonata	Protoneuridae	Morphotype 1	0	0	0	0	0	0	0	0	0	2	0
Plecoptera	Nemouridae	Morphotype 1	0	0	9	0	0	0	7	0	0	0	0
Plecoptera	Peltoperidae	Morphotype 1	0	0	2	0	0	0	0	0	0	0	0

Order	Family	Taxon	HSH	MTL	HSU	HSO	HMS	MDH	HSA	MDS	HPN	HDE	HTK
Plecoptera	Peltoperidae	Morphotype 2	0	0	7	0	0	0	1	0	0	0	0
Plecoptera	Peridae	Morphotype 1	0	0	0	0	0	0	3	0	0	0	0
Plecoptera	Peridae	Morphotype 2	0	0	10	1	8	0	11	0	0	0	0
Trichoptera	Brachycentridae	Morphotype 1	0	0	1	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Morphotype 1	0	0	0	0	0	0	0	0	0	1	0
Trichoptera	Leptoceridae	Morphotype 1	0	0	0	0	0	0	0	0	0	2	0
Trichoptera	Leptoceridae	Morphotype 2	0	0	0	0	0	0	0	0	0	2	0
Trichoptera	Leptoceridae	Morphotype 3	0	0	0	0	0	0	0	0	0	0	7
Trichoptera	Helicopsychidae	Morphotype 1	0	0	10	1	2	0	6	0	0	0	0
Trichoptera	Hydropsychidae	Morphotype 1	6	0	0	0	0	0	3	0	0	0	0
Trichoptera	Hydropsychidae	Morphotype 2	0	0	0	0	0	0	16	0	0	3	0
Trichoptera	Hydropsychidae	Morphotype 3	0	0	5	0	15	0	4	0	0	5	0
Trichoptera	Hydropsychidae	Morphotype 4	0	0	0	0	1	0	0	0	0	0	33
Trichoptera	Hydropsychidae	Morphotype 5	4	3	6	0	3	1	3	0	1	13	21
Trichoptera	Philopotamidae	Morphotype 1	1	0	0	0	2	0	0	0	0	0	0
<b>Crustacea</b>													
Decapoda	Gecarcinucidae	Morphotype 1	0	0	3	0	2	0	1	0	0	1	0
Decapoda	Parathelphusidae	Somaniathelphusa	0	0	1	0	0	0	0	0	4	4	0
Decapoda	Atyidae	Caridina	4	0	0	6	1	0	5	4	0	0	0
Decapoda	Palaemonidae	Macrobrachium dienbienphuense	0	0	2	11	3	9	0	0	0	0	0
Decapoda	Palaemonidae	M. lanchesteri	9	17	8	30	3	29	6	115	2	0	0
Decapoda	Palaemonidae	M. hirsutimanus	0	0	1	1	0	0	0	0	0	0	0
Isopoda	Sphaeromatidae	Morphotype 1	0	3	1	0	0	3	0	8	0	1	2

Numbers are the number of specimens collected of the morphotype at the locality.



# Plates



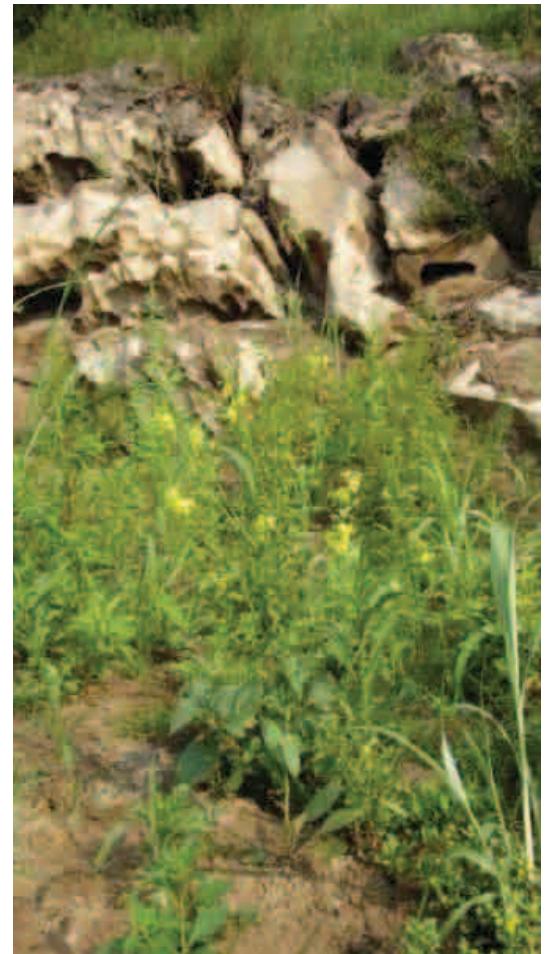
## VEGETATION – RIVERINE ZONES AND TERRESTRIAL FACIES



**Plate 3.1.** Annual riverine herbs, Louangphabang, at 325 m. The flood level (strand), c. 15 m higher, is on the upper left; 21 April 2012, limestone bedrock.



**Plate 3.2.** *Homonoia riparia* Lour. (Euphorbiaceae) is the dominant rheophyte in riverine vegetation and is not bent by river flow. Ban Pakbo, Louangphabang district, 300 m, limestone bedrock, 22 April 2012.



**Plate 3.3.** Riverine beach and rocky (limestone) area at Ban Pakleum, Louangphabang province. *Verbascum chinense* (L.) Sant. (Scrophulariaceae), with yellow corollas, is a common component; 325 m, 21 April 2012.



**Plate 3.4.** *Eugenia mekongensis* Gagnep. (Myrtaceae), in fruit, densely covering shale bedrock at Ban Khokfak, Xaignabouli district; 300 m, 25 April 2012. This is a seasonal rheophytic treelet or tree which has had its stem and branches stunted and bent by river flow.



**Plate 3.5.** Excellent seasonally rheophytic riverine habitat on Don Hin Lek Fai, Vientiane province; 225 m, shale bedrock, 7 May 2012.



**Plate 3.6.** Strand-terrestrial vegetation with sandy riverine flora below. Ban Pakleum area, Louangphabang province, 325 m, 21 April 2012.



**Plate 3.7.** Removal of Strand and terrestrial vegetation along the Mekong River has resulted in the collapse of many embankments. Opposite Ban Donmen,



**Plate 3.8.** Evergreen forest on rugged limestone hills lacks riverine vegetation because of the vertical bedrock, c. 5 m high. Recently exposed sand (foreground) has not been invaded by herbs in contrast to the higher areas (lower right). Ban Pakleum area, 325 m, 21 April 2012. Vientiane province, 275 m, 5 May 2012.



**Plate 3.9.** Massive *Duabanga grandiflora* (Roxb. Ex DC.) Walp. (Sonneratiaceae), 25 m tall and with a dbh of 188 cm; above Thadua Falls, Xaignabouli district, 350 m, limestone bedrock, 24 April 2012.



**Plate 3.10.** The second largest individual of *Tetrameles nudiflora* R. Br. ex Benn. (Datiscaceae) on Don Hon, Paklay district, Xaignabouli province, 1 May 2012, shale bedrock.

**Plate 3.11.** Degraded Bamboo and deciduous, seasonal forest, with many of the deciduous trees with immature foliage. Near Ban Donmen, Vientiane province, 275 m, shale bedrock, 5 May 2012.



**Plate 3.12.** Deforested land on Don Sang, Vientiane province, with many weeds. *Zea mays* L. (Gramineae; corn) will be planted in June 2012; 275 m, metamorphic sandstone bedrock, 3 May 2012.



**Plate 3.13.** Secondary growth on Don Konkong, Vientiane Capital, with a remnant *Irvingia malayana* Oliv. ex Benn. (Irvingiaceae), 17 m tall, dbh 143 cm; shale bedrock, 8 May 2012.

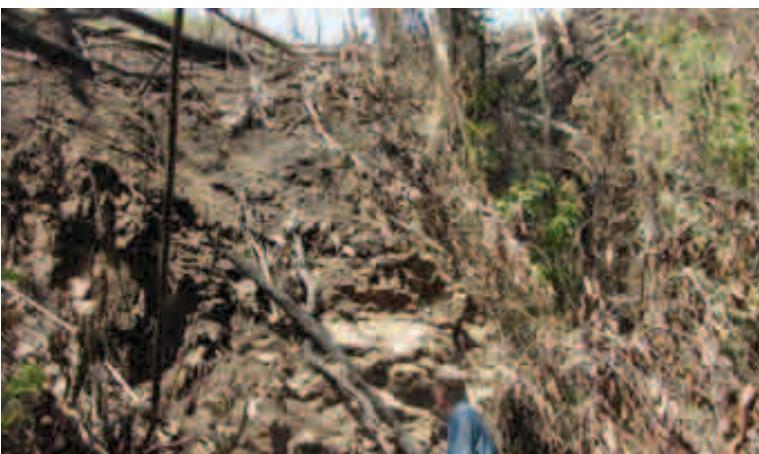


**Plate 3.14.** Cleared evergreen forest on limestone bedrock near Ban Pakleum, Louangphabang province, 21 April 2012.





**Plate 3.15.** Removal of vegetation on steep slopes encourages rapid soil erosion, which in a few years results in abandoned, infertile soil which takes decades to recover. Near Ban Pakbo, Louangphabang province, 235 m, limestone bedrock, 22 April 2012.



**Plate 3.16.** Recently cut and burned area along Houay Gawn Goy (stream) bordering the sacred forest at Ban Na Konken, Xaignabouli district, 375 m, shale bedrock, 29 April 2012.



**Plate 3.17.** Logging has degraded or destroyed most terrestrial vegetation along the Mekong in the project area. Ban Pakbo, Louangphabang district, 325 m, limestone bedrock, 22 April 2012.



**Plate 3.18.** Logs from Pha Tup (a limestone hill) at our Houay Ak camp along the Nam Pouy. These will be floated to the Mekong River when the river level is higher, shale bedrock, 26 April 2012.

## BIRDS AND MAMMALS



**Plate 4.1.** Suspected thick-knee *Esacus* or *Burhinus* tracks, 5 February 2012, at 18°04'27"N, 101°47'02"E. Great Thick-knee *E. recurvirostris* was readily, and regularly, recorded in the survey area up until 2004. But despite far higher intensity of better-sited methods (notably overnight survey in suitable habitat), suspected tracks were the only indication. The species must be very close to extirpation, if it has not already gone. Photograph by J. W. Duckworth.



**Plate 4.2.** River Lapwing *Vanellus duvaucelii* in typical habitat: seasonally-exposed bed of a large river. Archive photograph courtesy of James Eaton.



**Plate 4.3.** Jerdon's Bushchat *Saxicola jerdoni* male. Archive photograph courtesy of James Eaton.



**Plate 4.4.** Plain Martin *Riparia paludicola*. This is perhaps the smallest bird in the survey area where the steep declines evident are suspected to be driven by overharvest. Archive photograph courtesy of James Eaton.



**Plate 4.5.** Otter (Lutrinae; unidentified to species). Ban Paktung, reportedly caught in 2011 in the Nam Tung. Photographs by R. J. Timmins.



**Plate 4.6.** Ryukyu Mouse *Mus caroli*, Don Vao, Mekong channel, 18 September 2011. Photograph by M. R. Bezuijen and R. Glemet.



**Plate 4.7.** Recently destroyed *Homonoia*-dominated bushland just upstream of the town of Paklay, February 2012. The dead branches of some remaining bushes can still be seen. In March 2010 this area had an almost continuous cover of bushes. Such clearance is however only very localized within the survey area. Photograph by S. Chouunnavan.

**REPTILES and AMPHIBIANS**



**Plate 5.1. Amphibians.**

- (A) *Ichthyophis* cf. *kohtaoensis*;
- (B) *Limnonectes kuhlii*;
- (C) *Limnonectes gyldenstolpei* (=*L. pileata*), male;
- (D) *Limnonectes gyldenstolpei* (=*L. pileata*), female, photograph
- (E) *Hylarana nigrovittata*;
- (F) *Hylarana macrodactyla*;
- (G) *Odorranas chloronota*, male; only, no voucher specimen;
- (H) *Polypedates leucomystax*;
- (I) *Microhyla pulchra*;
- (J) *Microhyla berdmorei*;
- (K) *Occidozyga lima*. Photographs by



### Plate 5.2. Reptiles.

- (A) *Cuora mouhotii*;
- (B) *Manouria impressa*;
- (C) *Amyda cartilaginea*;
- (D) *Oligodon deuvei*;
- (E) *Boiga cyanea*;
- (F) *Xenopeltis unicolor*;
- (G) *Cryptelytrops macrops*;
- (H) *Sphenomorphus maculatus*;
- (I) *Tropidophorus laotus*;
- (J) *Dixonius siamensis*;
- (K) *Varanus bengalensis nebulosus*. Photographs by M. R. Bezuijen.

## AQUATIC MACROINVERTEBRATES



**Plate 7.1.** Aquatic invertebrate collecting gear and examples of samples collected.

- (A) Scoop nets;
- (B) scoop nets in use;
- (C) prawn and small fish collected by drift net;
- (D) mixed invertebrates and small vertebrates collected by scoop net.

Photographs by C. Vongsombath.



**Plate 7.2.** Common aquatic invertebrates collected.

- (E) a crab of the Potamidae family;
- (F) crabs for sale in Ban Thadua port;
- (G) dragonfly (Odonata) nymphs;
- (H) a freshwater prawn *Macrobrachium*. Photographs by C. Vongsombath.



**Plate 7.3.** *Ranguna luangprabangensis phuluangensis*



**Plate 7.4.** *R. luangprabangensis phuluangensis*  
(Male ventral view)



**Plate 7.5.** *Ranguna cochinchinensis*



**Plate 7.6.** *R. cochinchinensis* (male ventral view)



**Plate 7.7.** *Somania thelphusa brandti*



**Plate 7.8.** *Macrobrachium dienbienphuense*



Plate 7.9. *Scabies phaselus*

Plate 7.9. *Mekongia swainsoni*

Plate 7.11. *Pila pesmei*



Plate 7.12. *Melanoides tuberculata*

Plate 7.13. *Brotia baccta*

Plate 7.14. *B. citrina*



Plate 7.15. *Zygonyx iris*

Plate 7.16. *Ophiogomphus sinicus*





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