

WETLAND RESOURCE USE IN XE PIAN NATIONAL PROTECTED AREA, LAO PDR, IN 2005

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ABSTRACT

We recorded natural resource use at nine wetlands in and near Xe Pian National Protected Area, Lao People's Democratic Republic, during two brief visits in April and June 2005 (total 10 days). We observed eight categories of human activities at these wetlands: hunting and wildlife trade, fishing, burning of wetland and forest vegetation, logging, cultivation, livestock grazing, collection of non-timber forest products, and powerline construction. All activities except for powerline construction were recorded in the reserve 5–12 years previously by other authors. We conclude that, despite a relatively intensive history of 'integrated conservation and development' projects in the reserve, most threats to wetland biodiversity remain, and follow-up activities are urgently required to regulate regional development, human population growth and natural resource use in the reserve.

Key words: Laos, Xe Pian, wetland, threats.

INTRODUCTION

Xe Pian National Protected Area (NPA) (total size 2,500 km²: 13° 55' – 14° 47' N, 105° 54' – 106° 29' E; Fig. 1) in Lao People's Democratic Republic (hereafter 'Laos') supports among the largest lowland riverine forests in mainland Southeast Asia and globally important populations of threatened fauna, e.g. gibbon (*Nomascus leucogenys gabriellae*), Giant Ibis (*Pseudibis gigantea*) and Masked Finfoot (*Heliopais personata*) (DUCKWORTH *ET AL.*, 1994, 1995, 1998; THEWLIS *ET AL.*, 1996, 1998; AUSTIN, 1999; STEINMETZ, 2004). The NPA is listed as an 'outstanding representative site' for the Indochinese Tropical Moist Forests Biome (No. AS09), and wetlands in and near the NPA are listed under two 'Important Bird Areas' ('Xe Khampho/Xe Pian LA019' and 'Xe Kong Plains LA020') (OUNEKHAM & INTHAPATHA, 2003). In Laos, Xe Pian NPA is ranked as the second-highest priority for management in the protected area network, after Nakai-Nam Thuen NPA (ROBICHAUD *ET AL.*, 2001). Wetlands in the NPA support high biodiversity values yet are also focal points of human activity. Natural resource use is high: 90 villages comprising 50,000 people are found within five kilometres

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Received 21 June 2006; accepted 6 June 2007.

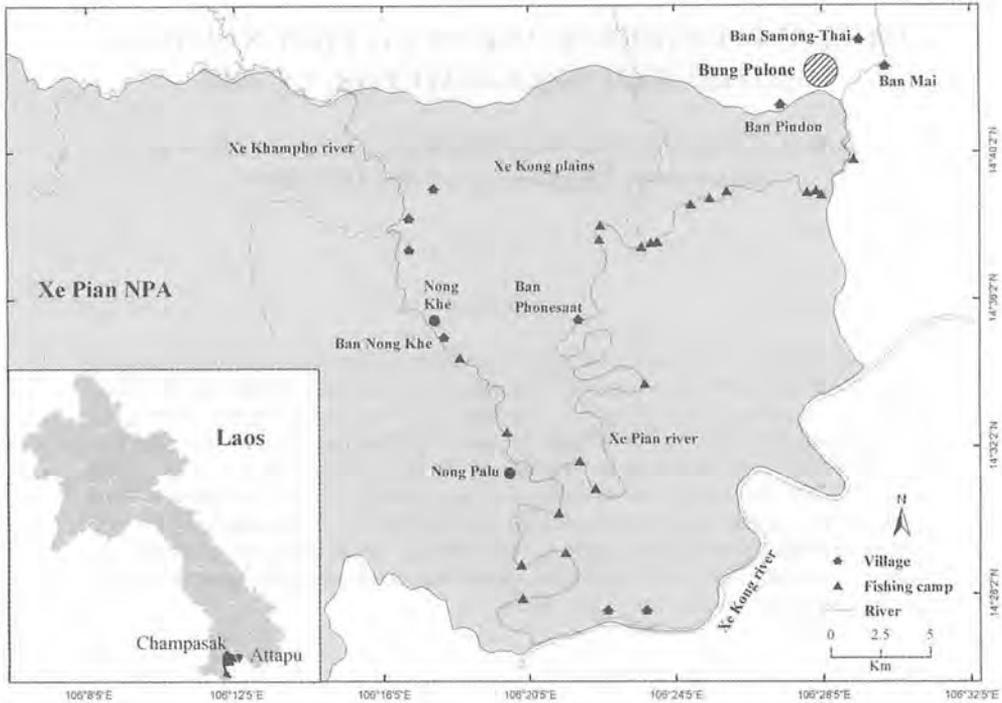


Figure 1. Xe Pian National Protected Area (shaded area in main map and inset) and localities mentioned in the text.

of the NPA, including 14 villages in the NPA, and the NPA has been a major regional source for subsistence and commercial fishing for many years (GOL, 2000). We present incidental observations of wetland use in and near the Xe Pian NPA in 2005, collected during a programme of crocodile surveys (BEZUIJEN *ET AL.*, 2006).

STUDY SITES

Xe Pian NPA is located in two provinces of Laos, Attapu and Champasak (Fig. 1). Our observations were restricted to the 'Xe Kong Plains' region (TIMMINS *ET AL.*, 1993) in the Attapu section of the NPA: a large alluvial plain with a mosaic of dry dipterocarp, semi-evergreen and mixed deciduous forest, drained by the Xe Pian, Xe Khampho and Xe Kong rivers. We visited nine wetlands: two perennial rivers, three permanent lakes and four seasonal lakes (Table 1; Fig. 1). Four wetlands were in the NPA and five were outside the north-east border of the NPA. We did not visit any areas of the NPA in Champasak province.

Observations along the Xe Pian and Xe Khampho rivers were from Ban Mai village to the Xe Pian/Xe Kong confluence (75 km) and Xe Pian/Xe Khampho confluence to Ban Nongkhe village (12 km), respectively. Xe Pian and Xe Khampho are 20–50 m wide, slow-flowing, and fringed by little-degraded forest and bamboo stands. The standing waterbodies we

visited were defined as 'lakes' (> 8 ha), 'ponds' (< 8 ha) or 'marshes' (supporting non-woody aquatic vegetation) following CLARIDGE (1996) (Table 1), but for brevity we refer to all as 'lakes'. Lakes were 0.1–4 km (mean 1.4 km, $n = 7$) from the Xe Pian or Xe Khampho rivers. Six lakes were within forest and one (Nong Khe) was in cultivated land. Two lakes (Bung Pulone, Bung Khe) supported thickly vegetated surfaces of floating and emergent vegetation (sedges, ferns, grasses) with little visible surface water. One lake (Nong Khoung Hape) had no surface vegetation. All other lakes were dry at the time of visit, with sparse grass cover and grazed by livestock. Permanent settlements were located at three of nine wetlands (Xe Pian and Xe Khampho rivers, Nong Khe lake). Wetlands visited in the NPA are within the 'Xe Khampho–Xe Pian–Xe Kong Priority Management Area', a zonation reflecting high biodiversity values (GOL, 2000). We refer to the five lakes outside the NPA as the 'Bung Pulone complex'. This complex is apparently located within a provincial protected area, 'Houaysoy Conservation Forest', although the boundaries of this area are unclear.

We visited four villages with partial community ownership of these wetlands: Ban Phonesaat and Ban Nongkhe, in the NPA, and Ban Mai and Ban Pindon, outside the NPA (Fig. 1). Wetlands were 0.1–8 km from at least one of these villages (mean distance 2.5 km). In 2005 the populations of these villages were 503, 377, 591 and 246 people, respectively (village heads, pers. comm.). Communities were 'Sou' or 'Lao Loum' ethnic groups. Wet season rice cultivation was the principal subsistence activity in all villages, supplemented by fishing, wildlife hunting and collection of non-timber forest products (NTFPs) (pers. obs.). All villages had dry season road access but only Ban Mai had wet season access.

PREVIOUS CONSERVATION ACTIVITIES

Xe Pian NPA was established in 1993 and a detailed management plan was prepared in 2000, under National Decree 164 of the Prime Minister (GOL, 2000). Between 1990 and 2002, biodiversity and socio-economic surveys, livelihood projects and a seven-year 'integrated conservation and development' (ICDP) project, were conducted in the NPA (POULSEN & LUANGLATH, 2005 and references therein). These activities identified NPA management zones and preliminary regulations for natural resource use by local communities. Sustained international funding in the NPA ended in 2000 (POULSEN & LUANGLATH, 2005). Between 2005 and 2007 another ICDP (Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme) conducted surveys of livelihoods, wildlife trade and crocodiles in the Xe Kong Plains region (BEZUIJEN *ET AL.*, 2006; SINGH *ET AL.*, 2006; P-J. Meynell, pers. comm.). In 2005, a small ecotourism project was established by CUSO (a Canadian non-government organisation) at Ban Mai village, which continues to receive visitors (S. Rozak pers. comm.). Published information on the wetlands we visited was largely based on data collected 8–12 years previously (TIMMINS *ET AL.* 1993; DUCKWORTH *ET AL.* 1994, 1995; DAVENPORT, 1997; THEWLIS *ET AL.*, 1996, 1998; THORBJARNARSON *ET AL.*, 2004).

METHODS

We visited the NPA from 2–6 April (dry season) and 31 May – 4 June 2005 (wet season) (total 10 days). Visits to each wetland were brief (1–5 days). At each wetland we recorded

Table 1. Wetlands visited in and near Xe Pian National Protected Area, Laos, in 2005.

Wetland	Coordinates	Wetland category*	Area (ha)	Length (m)	Width (m)	Dry-season depth (m)
<i>Inside the NPA</i>		<i>(31 May – 4 June)</i>				
Xe Pian river	14°30'52"N; 106°20'55"E	Perennial river (4)		75 km [^]	30	0.5–3
Xe Khampho river	14°34'44"N; 106°17'51"E	Perennial river (4)		12 km [^]	20	0.5–3
Nong Palu	14°31'10"N; 106°19'43"E	Seasonal freshwater pond (2)	1.9	223	128	0
Nong Khe	14°34'55"N; 106°17'49"E	Seasonal freshwater pond (2)	0.5	88	69	1
<i>Outside the NPA</i>		<i>(2 – 6 April)</i>				
Bung Pulone	14°42'32"N; 106°27'56"E	Permanent freshwater lake (1)	18.5	952	290	0.3–3
Bung Khe	14°41'49"N; 106°28'18"E	Permanent freshwater pond (1)	4.8	380	100	2
Nong Kham Miem	14°41'16"N; 106°28'25"E	Seasonal freshwater marsh (3)	35.4	793	792	0
Nong Khoung Hape	14°42'20"N; 106°26'01"E	Permanent freshwater pond (3)	0.24	54	44	0.8
Nong Hoi	14°42'03"N; 106°26'25"E	Seasonal freshwater marsh (2)	1.6	135	117	0

*After CLARIDGE (1996). Numbers in parentheses refer to sub-categories: 1 = vegetated water–floating & emergent rooted vegetation; 2 = vegetated water–emergent rooted vegetation; 3 = open water–unvegetated; 4 = perennial river channel. [^]Distance of team observations

human activities and mapped the perimeters of lakes with a Garmin *eTrex Vista* GPS. Lake area was calculated in ArcView GIS 3.2 (©Environmental Systems Research Institute, Inc.) (Table 1).

To compare human disturbance at wetlands, we developed a simple 'disturbance index' by measuring six variables: 'clearance', 'burning' and 'cattle' were the percent landcover within 50 m radius of a wetland which had been cultivated, burnt or grazed, respectively, 'weed invasion' was percent cover of two weeds (*Mimosa pigra*, *Eichhornia* spp.) over the wetland surface + within 50 m radius of a wetland (summed), 'fishing impact' was the number of residences (seasonal or permanent) at a wetland (we assumed larger settlements resulted in more fishing) and 'distance', from wetland to nearest village (we assumed wetlands closer to villages would be more disturbed than remote wetlands). Using *SPSS for Windows* vers. 10.0.1 (©SPSS Inc.), we tested raw data for normality then converted raw values to a value range of 1 to 4, '4' indicating the highest disturbance. A value range of 1–4, rather than 0–3, was used because for three of six variables (burning, livestock, distance), a '0' value would include sites where a disturbance was in fact present. This resulted in all sites having a minimum value of '1' for all variables, even if a disturbance was absent. We compared these results with disturbance scores for 15 other wetlands visited in southern Laos (BEZUIJEN *ET AL.*, 2006).

We supplemented field observations with brief community interviews in the four villages we visited, to obtain information on wetland resource use.

Spelling of site names follows the *Service Geographique d'Etat* (1:200,000) topographic map series for Laos. Site names are given in full, i.e. including the Laos prefix for river ('xe'), pond ('nong'), lake ('bung') or village ('ban'). Conservation status of globally threatened species follows IUCN Red List categories (IUCN, 2006).

OBSERVATIONS

Hunting and wildlife trade.—Over 10 days we recorded the following captive wildlife in four villages: one Water Monitor lizard (*Varanus salvator*), two Elongated Tortoises (*Indotestudo elongata*) ('Endangered'), one Asian Box Turtle (*Cuora amboinensis*) ('Vulnerable'), one Asian Giant Pond Turtle (*Heosemys grandis*) ('Near Threatened') and one Sambar (*Cervus unicolor*). The Water Monitor and one Elongated Tortoise were transported by public bus on 5 June, from Ban Mai village to the town capital. At one lake, Nong Kham Miem, on 6 June at dusk we observed three mistnets erected on the dry lake surface, for duck hunting. Train plumes of recently hunted Green peafowl (*Pavo muticus*) ('Vulnerable') were observed at a border police post (Xe Pian/Xe Kong confluence) and a fishing camp (Xe Pian/Xe Khampho confluence). Hunting dogs and firearms were observed in all villages. Residents stated that hunting is conducted at all wetlands we visited, for subsistence consumption and commercial sale. At Ban Pindon and Ban Mai villages, residents stated that traders 'often' visit to purchase wildlife.

Fishing.—Fishing was observed at all permanent waterbodies, including thickly vegetated lakes with < 0.3 cm dry season depth. We recorded most fishing activity along the Xe Pian river: on 1 June, we recorded 19 fishing camps over 75 km (Ban Mai to Xe Pian/Xe Kong confluence) and 30 motorised canoes over 29.5 km (Ban Mai to Ban Phonesaat). The highest fishing activity was between Ban Mai and Ban Phonesaat villages (Fig. 1). Along the Xe Pian and Xe Khampho rivers, most exposed sandbars supported fishing camps or signs of recent camps. Fishermen were observed to use a wide array of fishing gear (cast-nets, monofilament line nets, traps, hooks). Residents stated that all seasonal lakes are fished between July and January, when water is present. The lakes we visited were each under community ownership of at least one village. Nong Kham Miem, the largest lake in the Bung Pulone complex (Table 1), was dry at the time of visit but is apparently visited by more than five nearby villages and district residents for wet-season fishing. The community which 'owns' this lake (Ban Samong-Thai village) apparently charges non-residents a daily fishing fee of 5,000 Kip (USD 0.50)/cast-net/day and 3,000 Kip (USD 0.30)/bamboo trap/day (residents, pers. comm.).

Burning.—We recorded deliberate burning of forest and aquatic vegetation at eight of nine wetlands. In the Bung Pulone complex, > 70% vegetation within 50 m of five lakes had been burnt in the previous two years. Local guides stated that burning is conducted to assist hunting. The Xe Pian and Xe Khampho rivers retained large sections of unburnt riverine forest during our visits.

Logging.—We recorded timber logging at five of nine wetlands: three sites inside the NPA (Xe Pian and Xe Khampho rivers, Nong Khe lake) and two lakes outside the NPA (Bung Khe, Nong Kham Miem). At the Bung Pulone complex in April, we observed clearance of a 50-m wide swathe of mature mixed dipterocarp/deciduous forest, extending many kilometres, as part of a powerline construction project (below). This activity involved clearance of additional forest for vehicle access and stockpiles of machinery and timber near Ban Pindon village. Cleared timber was being removed by heavy vehicles for commercial sale. In the NPA on 2 June at the Xe Pian/Xe Khampho confluence, we observed recent felling of 30–40 large (20+ m high) dipterocarp trees, over 15 km from the nearest village. It is not known who conducted this logging, although local guides stated it was for subsistence use.

Cultivation.—In the NPA, we observed five sections of cultivated riverbanks (each > 1 ha) along remote regions of the Xe Pian ($n = 4$) and Xe Khampho ($n = 1$), over 10 km from the nearest village. All sites had been cleared and burnt within the previous 12 months and planted with rice or dipterocarp trees (as a cash crop). Small seasonal camps were present at these sites but only one was attended; the ‘owner’ of this site stated he was from Ban Mai village (outside the NPA). Conversion of riverbanks in remote areas of the NPA is being undertaken by communities from within and outside the NPA. Two of seven lakes we visited, both in the NPA, were partly cultivated with rice: Nong Khe (60% of land within a 50-m radius around the lake) and Nong Palu (10%). Both lakes have supported wet-season rice cultivation since the 1960s (residents of Ban Nongkhe village, pers. comm.). Nong Palu is located in relatively intact forest but Nong Khe, next to Ban Nongkhe village, is highly modified by cultivation and grazing. At Ban Nongkhe and Ban Phonesaat villages, cultivated lands extend several hundred metres from the settlements. No cultivation was observed at wetlands in the Bung Pulone complex. No irrigated rice cultivation was observed at any wetlands or villages.

Livestock.—We encountered domestic buffalo at seven of nine wetlands: five wetlands were entirely grazed. Mean herd size encountered was 25 (range 1–43, $n = 5$ wetlands). We observed 25 domestic cows (with a herd of 29 buffalo) at only one lake, Nong Kham Miem. All herds were unaccompanied and had ranged 2–12 km from the nearest village. Seasonal lakes were intensively grazed and retained a sparse cover of grasses. At permanent lakes, wetland vegetation was trampled and damaged. Local guides stated that all wetlands we visited were used as water sources for livestock.

Non-timber forest product (NTFP) collection.—We observed collection of tree resin, bamboo shoots, mushrooms, aquatic invertebrates, plants and frogs by local communities, who stated this was for subsistence use and sale. Dipterocarp tree resin (‘nam man yang’ in Lao language) is burnt as a light source and also used for boat caulks and varnishes: collection involves cutting and burning a large incision in a tree to stimulate resin secretion. In the NPA, at the Xe Pian/Xe Khampho confluence on 2 June we observed fresh resin-cuttings on 15 mature (20+ m high) trees. Containers of tree resin and ‘torches’ (grass bundles dipped in resin) were observed at the four villages we visited and for sale at nearby district markets. At Ban Phonesaat village on 4 June, we saw over 100 kg of wild edible mushrooms (*Astraeus hygrometricus*) (‘het phor’ in Lao language) collected by residents from nearby forests. Residents sold these to the village head for 3,000 Kip (USD 0.30)/kg, who would transport them to the nearest district market (five hours away by motorised boat and vehicle) and sell them for 5,000 Kip (USD 0.50)/kg.

Regional development.—We observed construction of a 50-m wide powerline easement at the Bung Pulone complex, ~500 m north of the NPA border, in April. This easement extends between Attapu and Champasak provinces. Easement construction had resulted in forest clearance and exposure of the south margin of one lake, Bung Khe. No forestry officials were observed to attend this logging during our five-day visit to this wetland complex.

Wetland disturbance scores.—The highest disturbances at most wetlands were from ‘cattle’ (livestock grazing/trampling in wetlands), ‘distance’ (close proximity to villages) and ‘burning’ (of wetland/forest vegetation), which accounted for 58–69% of maximum possible scores (Table 2). Direct impacts we observed from these variables included loss and degradation of wetland and forest vegetation, and soil damage at wetland margins.

Table 2. 'Disturbance' scores at nine wetlands in and near Xe Pian National Protected Area, Laos, 2005 (1 = no/little disturbance, 4 = high disturbance).

Wetland	Clearance	Burning	Fishing	Cattle	Distance	Weed	Total score/site
Nong Khe	4	1	4	4	4	4	21
Xe Khampho river	1	1	4	2	4	1	13
Nong Kham Miem	1	3	1	4	3	1	13
Bung Pulone	1	3	1	4	2	1	12
Nong Hoi	1	3	1	4	2	1	12
Xe Pian river	1	1	4	1	4	1	12
Nong Palu	2	2	1	4	1	1	11
Bung Khe	1	4	1	1	2	1	10
Nong Khoung Hape	1	3	2	1	1	1	9
Total (max. possible score = 36)	13	21	18	25	23	12	
Mean score for 24 wetlands*	2	2	2	2	3	2	
% (= score/36)x100							
[%score for 24 wetlands*]	36 [57]	58 [58]	50 [57]	69 [59]	64 [66]	33 [56]	

*Derived from total disturbance scores for 24 wetlands in southern Laos including the 9 wetlands in this study (data from BEZUIJEN *ET AL.* 2006).

Nong Khe lake was the most degraded wetland we visited (score 21 from a maximum possible score of 36, Table 2) and was located adjacent to Ban Nongkhe village. The most intact wetland was Nong Khoung Hape lake (score 9), where we did not observe cultivation, burning, livestock grazing or weeds, and which was 4.5 km from the nearest village. Other sites were similar in extent of total disturbance (scores 10–13, $n = 7$) although the extent of individual disturbance variables varied slightly between sites (Table 2). 'Weed invasion' and 'clearance' were absent from all except two sites, although another weed *M. pudica* was abundant in Nong Khe lake (it occupied 30% of vegetation cover within a 50-m radius around the lake). Cultivation was only recorded at Nong Khe and Nong Palu lakes, both within the NPA.

DISCUSSION

In 2005 we observed eight categories of human activities at wetlands in and near Xe Pian NPA: hunting and wildlife trade, fishing, burning of wetland and forest vegetation, logging, cultivation, livestock grazing, collection of non-timber forest products, and powerline construction. All activities, except powerline construction, were recorded at the same or nearby wetlands 5–12 years previously and all are listed as threats to the NPA (TIMMINS *ET AL.*, 1993; GOL, 2000).

Hunting occurs throughout the NPA (TIMMINS *ET AL.*, 1993) and apparently occurred in the Xe Kong Plains during the Indochinese Conflict (1961–75) (residents, pers. comm.). In 2005–06, commercial trade in wildlife and fish was documented in the areas we visited (SINGH

Table 3. Fishing activity along Xe Pian river, Laos.

Date	Fishing camps on Xe Pian river (density over 75 km)*	Motorised boats on Xe Pian (density over 29.5 km)**	Source
19-Oct-2000	29 (0.4/km)	31 (1.1/km)	M.K. Poulsen <i>in litt.</i>
1-Jun-2005	19 (0.3/km)	30 (1/km)	Current study
May-2006	19 (0.3/km)	26 (0.9/km)	SINGH <i>ET AL.</i> (2006)

*Ban Mai village-Xe Pian/Xe Kong confluence; **Ban Mai-Ban Phonesaat villages

ET AL., 2006). Ban Mai village is a focal point of wildlife trade due to its proximity to the NPA and a district road (SINGH *ET AL.*, 2006). The decline of large mammals, birds and Siamese Crocodile (*Crocodylus siamensis*) ('Critically Endangered') in the NPA is largely attributed to hunting (TIMMINS *ET AL.* 1993; DUCKWORTH *ET AL.*, 1994, 1995; BEZUIJEN *ET AL.*, 2006).

Fish and other aquatic fauna and flora are the most commonly traded natural resource in and near Xe Pian NPA. Since 2000 the number of fishing camps and motorised boats along the Xe Pian river appears to have remained relatively constant (Table 3), although interpretation of these data is limited due to differences in seasonal timing of counts. Local communities report that fishing activity and numbers of seasonal fishing camps in the NPA has increased since the 1990s (SINGH *ET AL.*, 2006).

Local communities in and near Xe Pian NPA report declines in fish populations and attribute this to over-harvesting (POULSEN & LUANGLATH, 2005; SINGH *ET AL.*, 2006). In 2005, we observed fishing camps on virtually all sandbars along the Xe Pian and Xe Khampho rivers. Fishing may be impacting other fauna such as birds and turtles. Dry-season sandbars along these rivers are zoned as 'Ecologically Sensitive Sites' (GOL, 2000) and are critical nesting habitat for some threatened bird species (THEWLIS *ET AL.* 1996) and potentially, Cantor's Giant Softshell Turtle (*Pelochelys cantorii*) ('Endangered'). Human presence may suppress bird and turtle nesting activity, and fishermen actively search for nests (and other fauna) to supplement their diet or income.

Burning of wetland and forest vegetation, logging, cultivation and livestock grazing had caused direct loss and degradation of wetland vegetation and soil at the sites we visited. At Nong Palu lake, long-term livestock presence may have caused a decline in extent and quality of native vegetation: in March 1993, this wetland was partially grazed/trampled by domestic buffalo, but retained tall reedbeds and shrubs, and a roosting colony of 50 unidentified weavers (THEWLIS *ET AL.* 1996); in 2005, the lake was entirely grazed by buffalo, supported a low (< 0.5 m) cover of grasses and no bird colonies. Human activities have also caused loss of breeding habitat and disturbance to threatened fauna confirmed to occur at the wetlands we visited, e.g. Siamese Crocodile, Lesser Fish Eagle (*Ichthyophaga humilis*) ('Near Threatened') and large waterbirds (DAVENPORT *ET AL.*, 1997; THEWLIS *ET AL.*, 1998; BEZUIJEN, 2006; BEZUIJEN *ET AL.*, 2006). Elsewhere in the NPA, unregulated logging has also damaged wetland habitats (CLARIDGE, 2000).

A range of NTFPs are harvested in the NPA (GOL, 2000; POULSEN & LUANGLATH, 2005), although potential impacts to wetlands are unclear. The extent of dipterocarp resin collection in the NPA is unknown, but studies in Cambodia concluded this practice causes low direct tree mortality (EVANS *ET AL.*, 2003). Within 12 months between 2005 and 2006, the village price

of edible mushrooms (*A. hygrometricus*) in the NPA increased from USD 0.30/kg (current study) to USD 2/kg, due to commercial demand in Laos and Thailand, causing some fish traders to temporarily switch to mushroom trade (SINGH *ET AL.*, 2006). Market prices of this species reach USD 5–6/kg in Thailand (NAFRI *ET AL.*, 2007).

Unregulated regional development is a key threat to biodiversity in and near Xe Pian NPA. Powerline construction observed in 2005 had removed wetland vegetation and created new road access at the south margin of Bung Khe lake. This wetland was one of only two sites in Laos where successful breeding of Siamese Crocodile was confirmed in 2005, and is globally important for this species (BEZUIJEN *ET AL.*, 2006). Planned developments in and near the NPA include commercial peat extraction (previously proposed at Bung Khe lake and planned at other wetlands in and near the NPA), construction of the Xe Nam Noy/Xe Pian dam north-east of the NPA (in 2008) and upgrade of district roads (GOL, 2003; THORBJARNARSON *ET AL.* 2004; COLENCO POWER ENGINEERING, 2007). These activities will almost certainly result in wetland degradation and will further impact threatened wetland fauna.

High regional population growth has almost certainly resulted in increased extraction of wetland resources compared with the 1990s. In 2005, the total population of four villages we visited was 1,717, compared with 1,239 in 1996 (CPAWM, 1996; M. K. Poulsen, unpublished data): increases of 25–77% per village and mean annual growth rates of 3–8%. Population growth at Ban Phonesaat and Ban Nongkhe (in the NPA) was higher from 2000–2005 than from 1996–2000 (respective increases of 5% to 19% in Ban Phonesaat, and 8% to 37% in Ban Nongkhe). At Ban Nongkhe, the population increased from five families in 1962 to 77 families in 2005 (residents, pers. comm.): an increase of 1.7 families/year (we do not know the extent of in-migration versus births in these villages).

Despite these threats, the wetlands we visited in Xe Pian NPA and the Bung Pulone complex were among the most intact of 24 wetlands surveyed in three provinces in southern Laos (BEZUIJEN *ET AL.*, 2006). Nong Palu and Nong Khoung Hape lakes (in the NPA) and Bung Khe lake (Bung Pulone complex) were in the top five least disturbed wetlands (<50% maximum possible disturbance scores). In the nine wetlands in and near Xe Pian NPA, 'clearance' and 'weed invasion' were absent in all except two sites, but at 15 other wetlands surveyed in southern Laos, 'clearance', 'weed invasion' and close proximity to settlements ('distance') accounted for most disturbances to wetlands (BEZUIJEN *ET AL.*, 2006). The reasons for higher intactness of wetlands in and near Xe Pian NPA are unclear, but may include legal protection status (none of the 15 other wetlands were in national protected areas), remote location and low human populations.

The threats to wetland biodiversity we describe in and near Xe Pian NPA are common to many wetlands in southern Laos. Most wetlands in this region are located on the 'Mekong Plain', a narrow strip of flat, fertile land < 200 m elevation which supports the country's most important agricultural lands and highest human populations (density 5,500 people/1,000 ha cultivated land) (DUCKWORTH *ET AL.*, 1999; ICEM, 2003). In this landscape, rivers and lakes are targeted for water-related infrastructure (dams, reservoirs, irrigated agriculture) yet also provide critical dietary resources for local communities (MEUSCH *ET AL.*, 2003; MOLLOT *ET AL.*, 2005), resulting in increasing pressures on remnant wetlands.

Current management activities in the 'Xe Khampho–Xe Pian–Xe Kong Priority Management Area' of Xe Pian NPA include infrequent ranger patrols, gun confiscation, meetings between NPA staff and local communities, and establishment of fish conservation zones near Ban Phonesaat village (POULSEN & LUANGLATH, 2005; K. Luanglath, pers. comm.;

authors' observations). NPA staff reported to us they are hindered by low management budgets and insufficient equipment, e.g. patrol boats and fuel. Despite a relatively intensive history of ICDPs in the NPA, there has been no sustained project presence in the Xe Kong Plains region for at least six years. At the Bung Pulone complex, no management activities have been developed. In contrast, livelihood, ecotourism and biodiversity conservation projects are being implemented or planned in and near the NPA in Champasak province, by a range of provincial government and international agencies. Effective wetland management in the NPA will require new conservation activities in the Xe Kong Plains region in Attapu province.

CONCLUSIONS AND RECOMMENDATIONS

Our brief visits to Xe Pian NPA in 2005 were insufficient to properly assess wetland status, yet they confirm at least three conditions in the Xe Kong Plains region of the NPA: first, that all human threats to wetland biodiversity documented 5–12 years previously persist and some, especially commercial fishing, subsistence agriculture and regional development, have probably increased; second, that wetland resources (wildlife, fish, NTFPs) remain an important component in the diet and income of communities in and near the NPA; third, that management is urgently required in the 'Xe Khampho–Xe Pian–Xe Kong Priority Management Area' of Xe Pian NPA and for a small complex of wetlands outside the NPA with high biodiversity value. Based on our observations, we provide the following recommendations:

- (1) Implement existing NPA regulations (GOL, 2000) for management of infrastructure development, dry-season fishing and sandbar protection, agriculture, logging, population growth, village land zonation and NTFP collection;
- (2) Strengthen community involvement in wetland management in and near the NPA, because these wetlands are focal points of local use;
- (3) Develop community management at the Bung Pulone complex, including designation of 'no-burn' and 'non-residential' zones;
- (4) Conduct new awareness activities about NPA regulations (to follow-up ICDP efforts > 6 years previously) targeting enforcement agencies, local traders and communities;
- (5) Strengthen technical capacity of NPA staff to engage in regional development planning and assess potential impacts to the NPA of proposed developments;
- (6) Assess current logistical needs to strengthen law enforcement in the NPA, e.g. patrolling;
- (7) Consider nomination of Xe Pian NPA as a Ramsar site, which may strengthen international support for future funding;
- (8) Assess current wetland status and management requirements elsewhere in Xe Pian NPA, especially sections of the NPA in Champasak province.

ACKNOWLEDGMENTS

Observations were made during a crocodile survey project funded by the Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme (MWBP) and Wildlife Conservation Society Lao Programme. The MWBP is a joint program of the four nations of the Lower Mekong Basin (Cambodia, Lao PDR, Thailand and Viet Nam), managed by the

United Nations Development Programme (UNDP), IUCN and Mekong River Commission (MRC), and funded by the Global Environment Facility (GEF), UNDP, The Royal Netherlands Government, MRC and Water and Nature Initiative (WANI). We thank W. Y. Brockelman, N. Cox, J. W. Duckworth, A. Johnson, Khamphay Luanglath, P.-J. Meynell, R. Mollot, M. K. Poulsen, and two anonymous reviewers for critical comments on a draft manuscript. M. K. Poulsen provided village population data.

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