

ORIGINAL ARTICLE

Small carnivore records from the U Minh Wetlands, VietnamDaniel WILLCOX^{1*}, Richard BULL², NGUYEN Van Nhuan³, TRAN Quang Phuong⁴
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ISSN 1019-5041**Abstract.**

The U Minh Wetlands in the Mekong Delta have been under-surveyed for small carnivores, despite the known historical presence of several species of national, regional and global priority. Surveys in two sites that form part of this wetland complex, U Minh Ha National Park and the U Minh Ha Fishery and Forestry Enterprises, were conducted in 2007–2008 and 2009–2010 respectively. Hairy-nosed Otter *Lutra sumatrana* and Asian Small-clawed Otter *Aonyx cinereus* were both confirmed in U Minh Ha National Park. However, Large Indian Civet *Viverra zibetha* and Large-spotted Civet *Viverra megaspila* are likely to be locally extinct, or at least at very low population sizes, at these two survey sites. The U Minh Wetlands are far from pristine and their biodiversity is under pressure from a variety of threats. The mammals recorded in these surveys offer some evidence of the robustness of these species and of the potential for their successful conservation; more effective management of the landscape and an immediate suppression of illegal hunting and fishing activities could rapidly improve the conservation status of a number of globally threatened species in the U Minh Wetlands.

Keywords: camera-trapping, peat-swamp, *Melaleuca*, otters, pangolins.

Introduction

The U Minh Wetlands in Vietnam are the last remnants of a *Melaleuca*-dominated peat-swamp forest ecosystem that would have once covered a significant portion of the Mekong Delta (Buckton *et al.* 1999, Triet Tran 2016). Decades of overexploitation for the illegal wildlife trade, rapid agricultural expansion, and the America–Vietnam War (particularly the use of defoliants) have had significant impacts on the area's biodiversity (Safford *et al.* 1998, Buckton *et al.* 1999). This peat-swamp forest ecosystem is now mostly confined to the protected areas of U Minh Ha National Park, U Minh Thuong National Park and the U Minh Ha Fishery and Forestry Enterprises (FFEs).

Rapid biodiversity surveys in the early 2000s confirmed the presence of several globally threatened small carnivore species including Hairy-nosed Otter *Lutra sumatrana*, Fishing Cat *Prionailurus viverrinus* and Large-spotted Civet *Viverra megaspila* (Nguyen Xuan Dang *et al.* 2004). The area's potential conservation significance was given further weight in Robertson (2007), whose exhaustive national review of small carnivore records suggested that the U Minh Wetlands were of definite national, and probable global,

significance to small carnivore conservation, principally because of the relatively large number of confirmed Hairy-nosed Otter records from the landscape. As well as these confirmed records, Hog Badger *Arctonyx collaris*, Yellow-throated Marten *Martes flavigula*, Spotted Linsang *Prionodon pardicolor* and Large Indian Civet *Viverra zibetha* were all predicted to be in this landscape based on confirmed records from similar habitats in mainland South-east Asia (Robertson 2007). Binturong *Arctictis binturong* has been confirmed in peat-swamp forest in Borneo (Semiadi *et al.* 2016); there is a possibility that the species is distributed in this habitat in mainland South-east Asia too (including Vietnam), but that it has so far been overlooked.

Here we report on the results of small carnivore surveys in U Minh Ha National Park and the U Minh Ha FFEs. Conservation recommendations for the landscape follow the discussion.

Materials and methods

Survey areas

U Minh Ha National Park (U Minh Ha NP) and the U Minh Ha Fishery and Forestry Enterprises (U Minh FFEs) are both in Ca Mau province. Between these two sites is U Minh, the main town in the district. Approximately 6 km north of the U Minh Ha FFEs is the buffer zone of Minh Thuong National Park (U Minh Thuong NP), Kien Giang province. This site was not included in the survey, because it had already been well surveyed for mammals (including small carnivore species) in 2000 (Nguyen Xuan Dang *et al.* 2004). These three sites form what is referred to here as the U Minh Wetlands.

The U Minh Wetlands are a mosaic of agricultural land (mainly rice paddy), fruit trees, grasslands dominated by *Phragmites* reeds, or grasslands dominated by *Eleocharis* sedges, open swamp (Figure 1), mixed peat-swamp forest, intensively managed *Melaleuca cajuputi* plantations, and inactive *M. cajuputi* plantations that have been left untended for several decades (defined as “mature semi-natural” forest in Buckton *et al.* 1999). There is no primary *Melaleuca* forest in the area and trees with a diameter-at-breast-height (dbh) of over 30 cm are rarely observed (e.g. U Minh Thuong NP: Tran Triet 2004).

A network of human-made canals has lowered the water levels in many areas, causing the peat soils to dry out during the November to April dry season. Forest fires are consequently a regular occurrence across the U Minh Wetlands, often burning several thousand hectares of forest (Sanders 2002, BirdLife 2004, Tran Triet 2004, Anon. 2016). The peat soil layer is likely to have now become very shallow or entirely absent in most of the U Minh landscape; it was already rare and decreasing in extent due to human-induced fires in the late 1990s (see Safford *et al.* 1998). Climate change is also a longer-term threat; the Mekong Delta is one of the lowest lying parts of Vietnam, and the entire U Minh area is

threatened by sea-level rises and salt water intrusion (Wassmann *et al.* 2004, Kuenzer *et al.* 2013, Erban *et al.* 2014).

The U Minh Wetlands experience a humid tropical monsoon climate with two seasons: a rainy season from May to October and a dry season from November to April.



Figure 1. Open swamp habitat in U Minh Ha National Park, 2007.

U Minh Ha National Park

U Minh Ha National Park (NP) includes the former Vo Doi Nature Reserve, U Minh III and Tran Van Thoi state-owned Fishery and Forest Enterprises (FFE). The National Park is in Ca Mau Province, (9°12' – 9°14'N, 104°55' – 105°00'E) and is around 30 km south of U Minh Thuong NP. The total area of U Minh Ha NP is 144 km², which is split into a 'grid' of approximately 70 squares by a network of human-made canals. The maximum elevation is approximately 2.5 m above sea level (m asl).

Vo Doi gained some level of protection as a Nature Reserve on 9 August 1986 (BirdLife 2004). Prior to this date, the whole area was production forest. The predominant tree species is *Melaleuca cajuputi*, although *Ilex cymosa* and *Alstonia spathulata* are also present and the nature reserve supports areas of open swamp and grasslands (Buckton *et al.* 1999, Birdlife 2004). The national park has been drained by a network of canals but the

former Vo Doi range is kept artificially flooded by a series of artificial dams. The site has some relatively mature *Melaleuca* peat-swamp forest (estimated at the time of the survey to be approximately 30 years old). The now inactive and untended *Melaleuca* forest plantations (the former U Minh III and Tran Van Thoi forestry concessions) are seasonally flooded to a depth of approximately 1.5 m.

U Minh Ha Fishery and Forestry Enterprises

To the North of U Minh Ha NP are the U Minh Ha Fishery and Forestry Enterprises (FFE). This complex is composed of U Minh I, U Minh II, Song Trem and 30/04 FFEs. These four FFEs are collectively referred to and managed as the U Minh Ha FFEs. All of them are active forestry enterprises, mostly for *Melaleuca cajuputi*, though there are also *Acacia* and *Eucalyptus* plantations along the canal bunds. The total size of all four FFEs is approximately 30,000 ha.

U Minh I is adjacent to U Minh Ha National Park and at the time of the survey was only separated from the protected area by a narrow (under 10 m wide) tarmacked road. U Minh II and Song Trem are adjacent to each other but are separated from U Minh I by the main district town, U Minh. Song Trem is approximately 6 km from the buffer zone of U Minh Thuong National Park. 30/04 is the most isolated of the four forestry enterprises and it is separated from the others by rice fields. An extensive network of human-made canals exists in all of the FFEs.

During the surveys, the FFEs used traditional and intensive management of *Melaleuca cajuputi* plantations; it is unknown whether the harvesting practices have since changed. Some of the *Melaleuca* forest patches have been given to local villages, to be managed by village co-operatives (also known as Local People's Forest). Dispersed around these forest patches are rice paddy fields and other types of agriculture. The canal bunds in all of the FFEs have mixed vegetation, often dominated by *Acacia*, *Eucalyptus* or banana plantations, sometimes with dense thickets of reeds and grasses, as well as small fruit trees, which had been planted by local people.

Field survey effort

Three survey methods were used to obtain small carnivore records: diurnal walks, nocturnal spotlighting walks and camera-trapping. Semi-structured interviews of local hunters were conducted in the villages surrounding U Minh Ha NP and the U Minh Ha FFEs to assess threats to small carnivores and hunting methods. The two survey periods ran from September 2007 – April 2008 in U Minh Ha NP and from August 2009 – January 2010 in the U Minh Ha FFEs. Not all of the U Minh Ha FFEs were surveyed; the local management board would not approve any surveys in the 30/04 FFE.

Semi-structured interviews

Semi-structured interviews were conducted from 11–18 September 2007 in U Minh Ha NP and 9–20 November 2007 in the U Minh Ha FFEs. Local hunters living in proximity to the National Park or the FFEs were questioned on their knowledge of otter, civet and cat presence and hunting methods for these small carnivore taxa. Interviewees were identified from their stated reputation among their peers as people with a high understanding of how to hunt carnivore species. The issues discussed in the interviews were highly sensitive because it is illegal to hunt the focal species. Hunters' names are not common knowledge therefore completely random sampling within this demographic unit was not possible. The interviews were in Vietnamese. Questions were memorized but neither written down nor said in any pre-determined order. Twenty interviews were completed in five separate local communities near U Minh Ha NP. Twenty-eight interviews were completed in local communities living near or in the four FFEs.

Nocturnal spotlighting and diurnal walks

Human-made pathways were followed for both diurnal and night walks. In the U Minh Ha FFEs there are few human-made pathways, so the majority of the spotlighting had to be done from the canals in a small four-person boat with an outboard motor. LED head-torches were used to detect the eye shine of mammals by scanning trees and other vegetation along the main trails, in addition to along the trail itself (see Duckworth 1998). A number of globally threatened small carnivore species give a strong eye-shine and are detectable using this method (e.g. Mathai *et al.* 2013: Table 1). When eye-shine was detected, a stronger (approximately two million candle-power) spot-light was used to help confirm the identity of the species. If far from the edge of the pathway or obscured by vegetation, binoculars were used to assist identification. During diurnal walks, canal bunds and pathways were searched on foot for any potential small carnivore field signs that might help to direct survey effort. This included faeces ('scats'), tracks, den sites, and food remains.

A total of 16 nocturnal spotlighting surveys were conducted in U Minh Ha NP during 2007 – 2008. Eight were in the former Vo Doi Nature Reserve and U Minh III because these areas were, based on hunter interviews in nearby communities, thought to contain relatively large numbers of quarry species of mammal. Areas for the remaining eight were randomly selected from U Minh Ha NP. Total spotlighting survey effort was approximately 14 hours. The same 16 walks were also selected for diurnal surveys; approximately 16 hours were spent walking along these human-made pathways looking for possible small carnivore field signs.

A total of 21 nocturnal spotlighting surveys were conducted in the U Minh Ha FFEs in 2010; nine in Song Trem, six in U Minh I and six in U Minh II. Seventeen of these

surveys were conducted from canals using a boat, the remaining four by using human-made pathways that ran along the sides of canals. Habitats covered included 5 to 10-year-old *M. cajuputi* plantations, blocks of *Phragmites* reeds, and canal bunds dominated by *Acacia* or by banana plants. Survey routes avoided any areas where there were recent or ongoing disturbances e.g. clear-felling of *Acacia* trees. Survey effort was approximately 43 hours.

Ten diurnal walks were also conducted: three in Song Trem, four in U Minh I and four in U Minh II. All the *Melaleuca* stands were flooded during the survey so these diurnal walks were restricted to the canal bunds, which were slightly more elevated and therefore drier. Habitats covered were canal bunds dominated by *Acacia*, banana plants or fruit trees of various species, *Phragmites* reed beds and *M. cajuputi* plantations. Survey effort was approximately 36 hours.

Camera-trapping

All camera-traps were attached 20–30 cm from ground level on sturdy trees, taking into account the probable water level fluctuations at each site. This height was chosen because the identification of otter species, one of the main targets for the survey, through camera-trap photographs is particularly challenging. Among the main distinguishing characteristics for otter species are the chin, rhinarium and neck patterning; by placing the camera-traps low to the ground, there was a better chance to photograph these characteristics and therefore to enable confident species identification. Camera-traps were typically stationed on canal bunds as these were one of the few microhabitats that were not inundated with water. Within this microhabitat care was taken to set the camera-traps near to possible animal trails or facing areas where there was relatively easy access to the water's edge. Camera-traps were positioned north or south to prevent image overexposure by the sun. Any vegetation was removed from a 3 m zone in front of the camera-trap to increase the camera sensor's ability to detect any passing wildlife and to reduce the risk of vegetation preventing successful identification. This however would have reduced the possibility of recording skulking small carnivore species such as weasels *Mustela*. All camera-traps were set to be operational for 24 hours. Commercially available artificial lures and natural baits were poured into split rotten logs and left to soak. This prevented the lure from being washed away when it rained. These 'target logs' were then placed in the middle of the camera-trap's field of view, at a distance of approximately 2.5 to 3 m from the camera. Camera-traps were maintained every month to ensure that they were working correctly, changing films, batteries or memory cards (if digital) when necessary.

During September 2007 – April 2008, Cuddeback Deercam film camera-traps were deployed at ten locations in U Minh Ha NP. Distance between each camera-trap station was approximately 2 km. General locations were identified initially during hunter interviews in local villages. The camera-traps were then set in stations where there was evidence of animal trails, faeces and/or foot prints. Hawbaker's Wild Cat Lure No. 2 or Hawbaker's

Otter Lure were used for these ten camera-traps. A total of 896 effective camera-trap nights were achieved.

Thirteen digital camera-traps were used to survey the U Minh Ha FFEs from August–November 2010. This included five Bushnell Trophy Cams and eight Cuddeback Captures. All surveyed FFEs were active to varying levels; extra care had to be taken to ensure that camera-traps were not placed near or in blocks of *M. cajuputi* plantations that were scheduled to be harvested or were in the process of being harvested. This limited the area for camera-trapping and some units had to be placed within 200 m of each other, because undisturbed locations away from local people and workers' camps were scarce. All camera-traps were baited with tinned sardines in tomato sauce and one of the following artificial lures; Hawbaker's Wild Cat Lure No. 2, Hawbaker's Otter Lure or Kishel's Crossbreed Lure. A total of 532 effective camera-trap nights were achieved.

Results

In total, the camera-traps recorded, excluding people and Domestic Dog *Canis familiaris*, 12 species of mammal, including five small carnivores. Local people and Domestic Dogs were frequently recorded on camera-trap: there were a total of 31 notionally independent photographs of local people and seven of Domestic Dog. Notionally independent camera-trap photographs are here defined as photographs of the same species separated by 30 minutes or more. No efforts were made to identify individual animals.

Four species of small carnivore were recorded during spotlighting exercises. Only one species of small carnivore was recorded during diurnal walks: Small Asian Mongoose. There were no signs or print marks detected that could be reliably attributed to small carnivores, other than Domestic Dog tracks. All confirmed small carnivore records from these surveys are in Tables 1 and 2.

Semi-structured Interviews

Responses to questions were often highly variable and some interviewees declined to answer certain questions. Response frequencies are presented as percentages in the format of x% (y/z), where y is the number of interviewees who gave a particular answer and z is the total number of interviewees who responded to that question (see Newton *et al.* 2008).

Otters were reported during the hunter interviews to be commonly hunted in both U Minh Ha NP (68% 13/19) and the U Minh Ha FFEs (100% 27/27) in 2007. A variety of hunting methods was said to be used for otters with snares (48% 22/46), snap-traps (39% 18/46), and domestic hunting dogs (24% 11/46), the most commonly used. Several interviewees confused mongoose species with civets, consequently invalidating the results and any subsequent discussion on the civet-focused interview questions. The majority of

interviewees stated that they did not know whether wild cats occurred in U Minh Ha NP (70% 14/20) or in the U Minh Ha FFEs (79% 22/28).

Table 1. Confirmed small carnivore records in U Minh Ha National Park, September 2007 – April 2008.

Species	Record type	Lat/Long dd mm ss	Habitat type	Record dates
Small Asian Mongoose <i>Herpestes javanicus</i>	CT	9°13'24"N, 104°58'44"E	Banana	3 Oct, 25 Nov, 26 Nov 2007
	CT	9°15'04"N, 104°56'43"E	Eucalyptus	29 Nov, 12 Dec 2007, 16 Feb 2008
	CT	9°15'35"N, 104°57'51"E	Eucalyptus	4 Dec, 6 Dec 2007, 26 Jan 2008
	O	Not recorded	Banana	23 Mar 2008
	O	9°15'40"N, 104°56'34"E	Open scrub	31 Mar 2008
	O	9°15'43"N, 104°55'50"E	Reeds	31 Mar 2008
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	CT	9°15'04"N, 104°56'43"E	Eucalyptus	18 Dec 2007, 3 Jan, 10 Jan 2008
	CT	9°13'26"N, 104°57'09"E	Banana	7 Feb, 11 Feb, 25 Mar 2008
	CT	9°13'24"N, 104°58'44"E	Banana	29 Nov, 30 Nov 2007
	CT	9°13'48"N, 104°57'30"E	Banana	24 Nov 2007, 1 Jan, 8 Jan, 23 Jan, 5 Feb, 12 Feb, 12 Mar 2008
	CT	9°12'39"N, 104°57'32"E	Banana	15 Oct, 19 Oct, 24 Nov, 24 Dec 2007, 7 Jan 2008
	CT	9°15'35"N, 104°57'51"E	Eucalyptus	1 Dec 2007, 3 Jan, 15 Jan, 18 Jan, 20 Mar, 25 Mar 2008
	O	Not recorded	Banana	27 Mar 2008
Small Indian Civet <i>Viverricula indica</i>	CT	9°15'04"N, 104°56'43"E	Eucalyptus	28 Feb 2008
	CT	9°13'24"N, 104°58'44"E	Banana	15 Nov 2007
	CT	9°12'39"N, 104°57'32"E	Banana	23 Dec, 21 Nov 2007
	CT	9°15'33"N, 104°56'43"E	Eucalyptus	Oct 2007
	CT	9°15'35"N, 104°57'51"E	Eucalyptus	23 Nov, 28 Nov 2007, 5 Jan, 20 Jan 2008
Leopard Cat <i>Prionailurus bengalensis</i>	CT	9°15'04"N, 104°56'43"E	Eucalyptus	25 Sep, 26 Sep, 29 Sep, 1 Oct, undated Oct, 14 Nov, 25 Nov, 30 Dec 2007, 29 Jan, 25 Mar, 26 Feb, 19 Mar 2008
	CT	9°13'26"N, 104°57'09"E	Banana	21 Mar 2008
	CT	9°13'25"N, 104°58'06"E	Reeds	7 Apr 2008
	CT	9°12'39"N, 104°57'32"E	Banana	11 Oct, 16 Nov, 30 Nov, 4 Dec 2007
	CT	9°15'33"N, 104°56'43"E	Eucalyptus	25 Sep, 28 Sep, 5 Oct, 8 Oct 2007
	CT	9°15'35"N, 104°57'51"E	Eucalyptus	Oct, 13 Oct, 19 Oct, 28 Oct 2007, 6 Feb 2008
	CT	9°17'13"N, 104°55'10"E	Eucalyptus	16 Oct, 17 Nov, 4 Dec, 17 Dec, 21 Dec 2007
	O	9°16'00"N, 104°57'19"E	Reeds	29 Mar 2008
Hairy-nosed Otter <i>Lutra sumatrana</i>	O	9°17'09"N, 104°57'20"E	Reeds	28 Mar 2008
Asian Small-clawed Otter <i>Aonyx cinereus</i>	CT	9°13'24"N, 104°58'44"E	Banana	16 Nov, 19 Nov 2007, 14 Mar, 29 Mar, 10 Apr, 16 Apr 2008

Record Type: O = Directly observed, CT = Camera-trapped

Habitat type: Acacia = Acacia-dominated canal bund, Banana = Banana-dominated canal bund, Eucalyptus = Eucalyptus-dominated canal bund, Reeds = Phragmites reed beds / All elevations are between 0 and 2.5 m asl.

Table 2. Confirmed small carnivore records in the U Minh Ha FFEs August – December 2010.

Species	Record type	Lat/Long dd mm ss	Habitat type	Record dates
Small Asian Mongoose <i>Herpestes javanicus</i>	CT	9°28'46"N, 104°56'15"E	Acacia	19 Sep, 21 Sep, 3 Nov 2010
	CT	9°20'11"N, 104°55'29"E	Banana	20 Sep, 7 Dec 2010
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	CT	9°29'53"N, 104°57'35"E	<i>Melaleuca</i>	17 Oct, 6 Dec 2010
	CT	9°28'46"N, 104°56'15"E	Acacia	29 Sep, 6 Nov, 18 Oct 2010
	O	9°27'46"N, 104°55'26"E	Banana	13 Sep 2010
Small-toothed Palm Civet <i>Arctogalidia trivirgata</i>	O	9°31'36"N, 104°57'52"E	<i>Melaleuca</i>	4 Sep 2010
Leopard Cat <i>Prionailurus bengalensis</i>	CT	9°20'11"N, 104°55'29"E	Banana	28 Aug, 31 Aug, 1 Sep, 5 Sep, 6 Sep, 10 Sep, 12 Sep, 17 Sep, 29 Sep, 4 Oct, 17 Oct, 26 Oct, 27 Oct 2010
	CT	9°28'46"N, 104°56'15"E	Acacia	4 Sep, 19 Oct 2010
	CT	9°19'14"N, 104°55'47"E	Banana	23 Nov 2010
	O	9°20'13"N, 104°55'49"E	Papaya garden	28 Aug 2010
	O	9°20'50"N, 104°57'08"E	Banana	13 Nov 2010
	O	9°31'45"N, 104°58'00"E	Banana	3 Sep 2010
	O	9°31'51"N, 104°57'30"E	Acacia	19 Nov 2010

Record Type: O = Directly observed, CT = Camera-trapped

Habitat type: Acacia = Acacia-dominated canal bund, Banana = Banana-dominated canal bund, Eucalyptus = Eucalyptus-dominated canal bund, Reeds = Phragmites reed beds / All elevations are between zero and 2.5 m asl.

Species accounts

Common Palm Civet Paradoxurus hermaphroditus

This was one of the most commonly recorded species in the survey and was recorded in U Minh Ha NP and the U Minh Ha FFEs. The species was camera-trapped 31 notionally independent occasions in a variety of habitats: young (five to seven years old) *Melaleuca* plantations and canal bunds with mature *Acacia*, *Eucalyptus* or banana plants. There were two direct sightings of Common Palm Civet. The location of one of these observations was approximately 1.5 km away from an active workers' camp, where the forest management were engaged in clear-felling *Melaleuca* and *Acacia* plantations.

Small-toothed Palm Civet Arctogalidia trivirgata

A Small-toothed Palm Civet was seen on the 4 September 2010 in a Custard-apple fruit tree *Annona reticulata*, on a canal bund next to a block of approximately 5-year-old *Melaleuca* plantation in Song Trem FFE. A full description of the record is in Willcox *et al.* (2012).

Small Indian Civet Viverricula indica

Small Indian Civet was camera-trapped nine times at five different stations, all in U Minh Ha NP. There were no direct sightings of Small Indian Civet and no records from the U Minh Ha FFEs.

Small Asian Mongoose Herpestes javanicus

Small Asian Mongoose was the third most commonly recorded small carnivore. Of the 14 notionally independent camera-trap records, nine were in U Minh Ha NP and five in the U Minh Ha FFEs. The camera-trap records were from five stations, positioned in a variety of habitats: canal bunds supporting mature *Acacia* plantations, *Eucalyptus* plantations or banana plants. All three direct observations were in U Minh Ha NP in March 2008, by day.

Leopard Cat Prionailurus bengalensis

This was the most commonly recorded small carnivore with a total of 52 notionally independent records from ten camera-trap stations: 33 records were from U Minh Ha NP and 19 from the U Minh Ha FFEs. The camera-traps that recorded this species were stationed in *Phragmites* reed stands, and along canal bunds dominated by banana plants, *Eucalyptus* or mature *Acacia* plantations.

In addition to these camera-trap records there were five direct observations of Leopard Cats: four in the U Minh Ha FFEs and one in U Minh Ha NP. One was seen half-way up a 2 m high Papaya tree in a local person's garden in U Minh 1 FFE. The Leopard Cat was observed by torchlight for about 30 seconds before running back down the tree and escaping along the ground. The sighting was approximately 50 m away from a local person's house, where as many as six domestic dogs had been seen during the morning.

Hairy-nosed Otter Lutra sumatrana

A pair of Hairy-nosed Otters was observed in U Minh III, U Minh Ha National Park at 20h30 on 28 March 2008. The location was along an open dirt track approximately 2 m wide and 2 m from a canal bank. On the other side of the track were dense *Phragmites* reeds. The first otter was scared into the reeds upon first sight of the researchers, whilst the second otter was more curious and came within 3 m of the research team; photographs were taken of this animal (Figure 2). On the 31 March 2008, a camera-trap was set within several metres of this sighting but did not record the species; there were no camera-trap records for this species during the surveys.



Figure 2. Hairy-nosed Otter *Lutra sumatrana* observed in U Minh Ha National Park, Vietnam, 28 March 2008.

Asian Small-clawed Otter Aonyx cinereus

Asian Small-clawed Otter was camera-trapped in the Vo Doi part of U Minh Ha National Park on six dates at one camera-trap station, approximately 1 m from the edge of a canal. The maximum group size documented was eight and all except one series of photographs was during daylight hours.

Smooth-coated Otter Lutrogale perspicillata

An otter skin confiscated and given to the research team during the interviews in Song Trem FFE, U Minh district, in November 2007 was identified as a Smooth-coated Otter by S. I. Robertson, RB and DW (Figure 3). This skin is highly unlikely to have had an origin outside of U Minh. During the interviews, there were no suggestions of a trade of otters or their skins into the survey area; all trade in otters were of animals hunted in U Minh, including the national parks, with the skins then sold on. The skin's poor condition is presumably why it had not been sold.



Figure 3. Smooth-coated Otter *Lutrogale perspicillata* skin collected during interviews in Song Trem FFE, U Minh, Vietnam in November 2007.

Other significant mammal records

Sunda Pangolin *Manis javanica* was recorded at three camera-trap stations and there were three records during spotlighting. Two Sunda Pangolins were observed in *Phragmites* reeds next to the road that leads to the central forest guard station in the Vo Doi part of U Minh Ha NP, and one pangolin was observed on the border of Vo Doi and U Minh III. The latter record was observed at 20h30 on 1 April 2008 in a block of *Melaleuca* forest that was regenerating from a forest fire in 2003. It was observed feeding on weaver ants *Oecophylla*. Sambar *Rusa unicolor* was recorded at four camera-trap stations in U Minh Ha NP.

Observed threats to small carnivores

U Minh Ha National Park

Various anthropogenic disturbances and threats were recorded on 14 of the 16 spotlighting transects during the 2007–2008 survey. In total 49 local people were observed within the boundaries of U Minh Ha National Park in the early morning or late at night; none of the people observed were thought to be NP staff or FPD rangers (RB pers. obs.). Spotlighting transects on the border of Vo Doi and U Minh III were regularly disturbed by large lorries carrying shingle along the new road.

Domestic dogs were another source of disturbance within U Minh Ha NP. Every FPD station that the field team visited had at least two resident dogs. These dogs left the stations to roam the forest for several days at a time, before returning to their FPD station. In U Minh III a dawn transect was abandoned after 0.5 km because two domestic dogs were 50m ahead of the research team and so no animals would have been seen on the transect. These dogs belonged to the local FPD rangers. On the 2 April 2008, one set of snare traps were observed in U Minh Ha NP (Figure 4); this was the only record of this hunting method during the survey.



Figure 4. Snare trap observed in U Minh Ha National Park, 2 April 2008.

U Minh Ha Fishery and Forestry Enterprises

Each FFE consists of local people's forest (which is effectively state-owned land, leased to local communities) and strictly protected forest that is controlled and managed as state-owned forestry enterprises. No one should be living, hunting or fishing within the strictly protected forest according to Vietnamese state law; however there were several violations recorded during the 2010 survey.

U Minh I FFE

In U Minh I, local people were living within the strictly protected area. On this land the local people were growing crops, mainly papaya, and had set up numerous fine-mesh (1-2 inches) nylon gillnets in the canals. Nearly all of the houses within this FFE had domestic dogs; in one instance as many as six were seen in one household. Walks along the canal bunds in U Minh 1 produced several observations of illegal hunting, including a single cable-snare trap and four gillnets that had been placed in shallow water and along the ground; these nets had been allegedly set to catch snakes. In the agricultural fields surrounding the strictly protected area there was a mist-net approximately 15 m in length.

SFE rangers in U Minh I were observed hunting, consuming and trading wildlife. The SFE rangers for this FFE had set up gillnets in the blocks of *Melaleuca* plantation near their Forest Guard Station and were harvesting snakes for consumption and for trade. At least 12 green pigeons *Treron* were delivered to the Forest Guard Station and later eaten by the rangers. On the 12 November 2010, whilst doing some spotlighting exercises, a Purple Swamphen *Porphyrio porphyrio* was disturbed, promptly shot with a slingshot by the accompanying SFE Ranger and then taken back to the Forest Guard Station to be eaten.

Song Trem FFE

Song Trem FFE contained the largest number of people living inside the FFE and had the largest number of recorded threats. Eight cable-snare traps were recorded in this area, all in the strictly protected part of the FFE. These were set along two animal runs, both of which contained four snare traps each. Several gillnets recorded during diurnal walks were large with a mesh approximately 2 inches in width and set perpendicular to the canal bund (Figure 5). These nets were allegedly set to catch Sunda Pangolin *Manis javanica*; hunters and their dogs scour the banks at night and drive animals into these nets, collecting what becomes entangled. This was supported by an observation on 3 September 2010 of two hunters using head-torches and at least six dogs along the same bank where one of these gillnets had been recorded. Statements from the local hunters interviewed in 2007 also supported this; this method was allegedly used by the interviewees as a method to hunt pangolins in the area.



Figure 5. Hunting nets in Song Trem FFE, September 2010.

On the 4 September 2010, a Small-toothed Palm Civet was recorded in the strictly protected part of Song Trem FFE. On 6 September 2010, the field team was told by the SFE ranger who had accompanied the team during the spotlighting exercises on 3 and 4 September that the Small-toothed Palm Civet had been killed. Local people had apparently cut down the tree and killed the civet with dogs; this was backed up by the field team's observation of the remaining tree stump. This same SFE Ranger had on 3 September beached the boat and tried to shake a Leopard Cat out of a tree, later claiming that the species can fetch as much as 500,000 VND/Kg (about 25 USD/Kg) in the local markets. Two small houses were also found within in the strictly protected area and were being used for short stays by hunters/fishermen during trips into this part of the FFE.

U Minh II FEE

No local people were seen living inside the strictly protected area of U Minh II. However, this FFE was the most active of the three surveyed and there was a large camp of workers who were engaged in harvesting from *Acacia* and *Melaleuca* plantations. No snare traps were observed but during the day local people were observed collecting lotus *Nelumbo* and/or water-lily *Nymphaea* from a canal inside the strictly protected area. Approximately five fish box-traps were seen inside flooded *Melaleuca* plantations, or in canals close to

these. The SFE rangers destroyed or confiscated all fish traps and nets that they came across inside the strictly protected zone.

Other threats

Small (under 15 m in length) segments of canals in the U Minh Ha FFEs were damned at both ends with deposits of canal bed. The water would then evaporate during the dry season and any fish left were collected and either traded or consumed. Fish is likely to be an important prey for a wide range of animal species in this landscape, and this fishing practice, which is likely to be unsustainable, could be contributing to prey depletion.

The majority of local communities in the U Minh wetlands live alongside the canals: plastics, animal waste, food remains and human excrement were regularly observed being dumped into the canals. Agricultural runoff from the surrounding paddy fields is also likely to be affecting water quality; chemical use is high in Vietnam. It is assumed that water quality in the U Minh wetlands, including the two survey sites, is low, and a probable threat to the landscape's biodiversity, including its small carnivores.

Discussion

This survey confirmed the presence of several globally threatened small carnivore species in U Minh Ha NP. No small carnivore species of conservation concern were recorded in the U Minh Ha FFEs.

The confirmation of Hairy-nosed Otter in U Minh Ha NP is arguably the most significant result from this survey; this is one of the most threatened otter species in the world (Aadrean *et al.* 2015). This species was not recorded for many years in Vietnam until its rediscovery in U Minh Thuong NP in 2000, where it was camera-trapped (Nguyen Xuan Dang *et al.* 2001, 2004). Subsequent otter-focused surveys in U Minh Ha NP in 2002 provided some indications based on local people's reports, observed otter tracks attributed to Hairy-nosed Otter, and found a Hairy-nosed Otter skin, allegedly from an animal hunted in Vo Doi NR (IOSF, undated). No photograph of the skin is in the unpublished report. The U Minh Wetlands are the only landscape in Vietnam where this globally threatened species has been recorded within the last 20 years. Historical records exist for Nha Trang (Robertson 2007).

Asian Small-clawed Otter has previously been recorded in U Minh Thuong NP (Nguyen Xuan Dang, 2004) and this is the first confirmed record for U Minh Ha NP. The species has recently been recorded in other protected areas in Vietnam including Cat Tien National Park, Dong Nai province (Willcox *et al.* 2014: SOM T3). It is though, like the other otter species in the country, threatened with national extinction. The records during this survey were all from the same camera-trap station, and likely to involve only one family group.

The Smooth-coated Otter skin suggests that at least three otter species inhabited the U Minh wetlands, and potentially other sites in the Mekong Delta. There are areas in South-east Asia that are known to support multiple otter species, in Thailand (Kruuk *et al.* 1994) and also in South Asia (Raha & Hussain 2016). Hairy-nosed Otter and Smooth-coated Otter are known to co-exist in the Tonle Sap Great Lake, Cambodia (Willcox *et al.* 2016). Smooth-coated Otter is one of the more readily recorded otter species in Asia, with a significant proportion of records being direct observations during the day (e.g. Chutipong *et al.* 2014 and citations therein). The species's behaviour and ecology lends itself well to camera-trapping as it tends to leave easily-detectable signs, including well-used latrines, by which camera-traps can be set (DW pers. obs.). The lack of any wild records of this species from U Minh Ha NP or the U Minh Ha FFEs suggests that it is very likely now to be locally extinct within these two sites. This fits with the conservation status of Smooth-coated Otter in Vietnam where it is thought to be very close to extinction in the country (Robertson 2007, Duckworth & Le Xuan Canh 1998).

The observation of Small-toothed Palm Civet in the U Minh Ha FFEs is apparently the first record for *Melaleuca*-dominated wetland forest from anywhere in its range. This record and its conservation implications for the species are given further discussion in Willcox *et al.* (2012).

Large Indian Civet *Viverra zibetha* and Large-spotted Civet *V. megaspila* have both been previously recorded in U Minh Thuong NP (Nguyen Xuan Dang *et al.* 2004) but were not recorded in this survey. This is unlikely to reflect differences in survey methods or efforts; similar methods were used, and survey effort was comparable to if not greater than that in Nguyen Xuan Dang *et al.* (2004). The relatively large size of these two civet species (adults of both species can reach around 10 kg), and their vulnerability to ground-level snares and other hunting methods, makes them obvious targets for the illegal wildlife trade. Neither species seems to be particularly sensitive to habitat degradation (e.g. Chutipong *et al.* 2014); therefore, it seems likely that the absence, or at best very low populations, of these two species from this survey is because of recent hunting-driven declines.

Leopard Cat was the most commonly recorded small carnivore species in these surveys, being found regularly by camera-traps and spotlighting. The records give further evidence that this cat species is very adaptable and highly unlikely to be threatened in Vietnam or, presumably, in other parts of its range. Fishing Cat *Prionailurus viverrinus* was recorded several times during surveys in U Minh Thuong NP, both by camera-trap and by direct observation (Nguyen Xuan Dang *et al.* 2004). The reasons for its absence/non-detection in this survey are unclear but they are unlikely to be habitat-based; the areas surveyed are ecologically very similar to U Minh Thuong NP and as a species it is very tolerant to habitat degradation (e.g. Adhya 2014). A fuller discussion of Leopard Cat and Fishing Cat conservation status in Vietnam is given in Willcox *et al.* (2014).

Hunter interviews indicated that illegal incursions into U Minh Ha NP to hunt wildlife are commonplace; this was supported by the relatively large number of observations of local people during fieldwork at both sites. Ground-level snares, snap-traps and domestic hunting dogs were some of the commonly reported methods for hunting small carnivores and this was partly supported by field observations; domestic dogs were frequently seen and camera-trapped. Snares were very rarely encountered relative to surveys in other protected areas in Vietnam, where several thousand can be recorded in a single survey (e.g. Willcox *et al.* 2015; WWF 2015; Harrison *et al.* 2016). It is likely that because a significant proportion of the available dry-land is flooded for at least half a year, snaring is either concentrated in these areas (and that these areas were missed during the survey), and/or that snaring is a seasonal activity that had not yet been started or reached its peak during either the surveys in 2008 or in 2010. Statements from some local hunters supported the latter; there was some suggestion that wildlife hunting was a wet-season activity as the animals had limited dry land during this time.

The hunter interviews provided a good example of the limitations of using this technique for wildlife surveys. The majority (75%) of local hunters interviewed, whilst open and relatively knowledgeable about hunting otter and pangolin species, stated that they did not know if cats occurred in the area. All interviews were in Vietnamese and there are no local or regional differences in the standard Vietnamese word that authors are aware of. The results from the camera-trapping and spotlighting surveys were in contrast to these interview statements; Leopard Cat was one of the more commonly encountered small carnivore species at both sites. This apparent inconsistency is likely to stem from the difficulties of locals and outsiders being sure they are speaking about the same animal species (or group of species), rather than a genuine failure of the interviews to have ever noticed these evidently almost synanthropic Leopard Cats.

Conclusion

The confirmation of Hairy-nosed Otter and Asian Small-clawed Otter in U Minh Ha NP, and the previous records of both species in U Minh Thuong NP, make the U Minh Wetlands one of the most important landscapes for small carnivore conservation in Vietnam. Large Indian Civet and Large-spotted Civet are likely to be extinct, or nearly so, in U Minh Ha NP and the FFEs; however there has been too little survey effort in U Minh Thuong NP to be confident of either species's status there. The U Minh Wetlands are far from pristine and their biodiversity is under pressure from a variety of threats. The mammals recorded offer some evidence of the robustness of these particular species and of the potential for their successful conservation; more effective management of the landscape, including an immediate suppression of illegal hunting and fishing activities, could rapidly improve the conservation status of a number of globally threatened species in the U Minh Wetlands.

Conservation recommendations

1. *Strengthen wildlife protection*

Illegal wildlife hunting is common across the U Minh Wetlands, sometimes with the direct participation of SFE Rangers. SFE or FPD rangers that contribute or facilitate the illegal wildlife trade must be held accountable so that Vietnam's wildlife protection laws are not undermined. Patrolling activities should focus on the removal illegal snares, gillnets and the larger nets set along the banks, apparently for Sunda Pangolin. Domestic Dogs that are seen within the strictly protected areas should be confiscated immediately. Dogs that belong to the SFE/FPD guard stations should be vaccinated against diseases (canine distemper, rabies) and prevented from wandering into the protected areas.

2. *Surveys in U Minh Thuong NP*

U Minh Thuong NP was the last place in Vietnam where Fishing Cat was recorded in the wild. The conservation status of this species in Vietnam is assumed to be poor and it is likely to be extinct from most of its former range in the country. Surveys for this species, as well as otters, need to be urgently implemented in U Minh Thuong NP; surveys since Nguyen Xuan Dang *et al.* (2000) have been too limited in duration to determine the current status of small carnivores (e.g. Tran Van Bang *et al.*, undated; Nguyen Xuan Dang, 2009). Surveys should use methods likely to generate verifiable records (i.e. camera-trapping) and be of a duration that will enable confident assessments of probable conservation status (i.e. minimum of 1000 camera-trap days). Some of the camera-traps should be placed at the same locations given in Nguyen Xuan Dang *et al.* (2004).

3. *Develop and implement an effective long-term management plan*

There are a variety of threats facing the U Minh's biodiversity. Some are direct threats (e.g. illegal hunting and fishing) for which interventions could be, if there is sufficient political will from the local authorities, quickly implemented. Other threats will need longer-term management plans to mitigate them. The landscape has been significantly altered by decades of human-induced modification, particularly through canalisation and the consequent drying out of the peat layer. It is now probably too late wholly to reverse this and completely to restore the habitat; education on the impacts of human-made fires, enforcement against activities likely to cause fires, and better fire suppression activities at a landscape level may help to mitigate the impact of forest fires. No new canals should be built within either National Park; this is the main reason why the peat layer dries and becomes combustible. Attempts to reach a more natural water regime would significantly aid biodiversity conservation in these wetlands.

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