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Cover: *Euphaea pseudodispar* shot at Kalindi River, Thirunelly, Wayanad district, Kerala. © Muneer P.K.



The occurrence of Indochinese Serow *Capricornis sumatraensis* in Virachey National Park, northeastern Cambodia

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Abstract: The Mainland Serow *Capricornis sumatraensis* is an under-studied, enigmatic rupicarin in the family Bovidae that lives in remote parts of the interior of Cambodia's mountain ranges, most of which border neighboring countries. Their population status in Cambodia is unclear but thought to be in decline. Our records stem from steep forested areas and never in open meadows or clearings. Our fairly robust camera trap records, including direct observations, suggest that Virachey National Park in the northeastern corner of the country might be the species' last best chance for survival in the wild in Cambodia.

Keywords: Bovidae, camera-trapping, Indochina, Mainland Serow, poaching, threats.

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Author details: GREGORY MCCANN is an Assistant Professor at Chang Gung University in Taiwan who obtained a PhD focusing on Ecocriticism at Tamkang University in Taiwan. He initiated the Virachey National Park (VNP) wildlife survey in 2014 after completing his doctoral research on traditional animism in the villages in the buffer zone of VNP. He has also organized and led a multi-year wildlife survey in Sumatra, Indonesia, in search of orangutans and tigers. He was responsible for fundraising, organizing the expeditions, and selecting the survey sites in the park. KEITH PAWLOWSKI is an independent researcher who obtained his MS from SUNY Buffalo State College in Great Lakes Ecology. In addition taking part in the survey expeditions, he organized the data collected from the camera traps, and co-wrote the manuscript. THON SOUKHON is the Deputy Director of VNP and has worked for VNP for nearly 20 years, beginning as an ecotourism ranger and then progressing into management positions.

Author contributions: GM and KP collected data in the field and wrote the manuscript; TS permitted the trek, reviewed data, and assisted with all organizational aspects of the expedition.

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INTRODUCTION

Not much is known of the life habits and ecology of the four serow species, which are found from the Indonesian island of Sumatra, across mainland southeastern Asia and the Himalaya, and on the islands of Japan and Taiwan. The status of the Serow in Cambodia has long been poorly understood, and their behavior is not well known (Lovari et al. 2020). In this paper we describe the Mainland Serow *Capricornis sumatraensis* (which some refer to as a sub-species called Indochinese Serow *Capricornis sumatraensis milneedwardsii*) records from Cambodia's Virachey National Park (VNP), in the northeastern corner of the country. This region is mountainous and forested, with peaks reaching up to 1,500 m, and is characteristic of the serow's preferred habitat (Mori et al. 2019; Phan et al. 2020). The only other regions of Cambodia that are confirmed to hold serow are the Cardamom Mountains in the southwestern corner of the country (N. Marx pers. comm. 2021), and Ko Seima Wildlife Sanctuary (Griffin 2019)—all locations with mountains that reach over 1,000 m. It is possible that serow occur in the Dangrek Mountains that serve as the northern boundary between Cambodia and Thailand, but border tensions and intensive illegal logging operations have deterred most researchers from entering the area. The last serow of the Phnom Tnout Wildlife Sanctuary in Preah Vihear province was snared in 2008 (N. Marx pers. comm. 2021), but there are anecdotal reports that some serow persist on the Phnom Tbeng plateau, also in Preah Vihear province in the north of the country. Overall, the serow occurs in the high mountainous segments that in places separate Cambodia from Thailand, Laos, and Vietnam, and their numbers are in decline due to hunting and habitat loss.

Although there has been a debate regarding the classification of the serow species, in particular whether the Mainland and Indochinese Serows are separate species, it is distinct from the Sumatran Serow *Capricornis sumatraensis*, we regard the species found in VNP and throughout Cambodia as well as in Thailand, Laos, and Vietnam, as belonging to *Capricornis sumatraensis* or Mainland Serow, which is consistent with the recent classification by Mori et al. (2019). Other serow species, such as Japanese Serow *Capricornis crispus*, Taiwan Serow *Capricornis swinhoei*, and the Myanmar-China Red Serow *Capricornus rubidus* are clearly different in appearance. It is not within the scope of this paper to attempt a clarification of the classification of the species and sub-species.

We found Mainland Serow at many of our high

elevation camera stations, and a young specimen was observed and photographed by a park ranger in the Yak Yeuk Grasslands area of VNP wandering alone in a rocky and semi-forested section of the meadows in 2018 (S. Leam pers comm. 2021). Interestingly, we never camera-trapped serow at any of our open grassland camera stations, but only in the high mountains in closed forest canopy, many days' walk from the nearest village, so the ranger sighting might be an anomaly. In the Khmer language, the species is called "sat keh" (សត្វកេង), which correlates with Indochinese Serow, and that is also what our guides and porters call them. Recent DNA analysis has determined that outside of Japan and Taiwan, serows belong to the same species *Capricornis sumatraensis* (Mori et al. 2019). Visibly, there is little or nothing to distinguish between serows from Sumatra or mainland southeastern Asia, while the species from Japan and Taiwan are distinctly different. We have camera-trapped serows in Sumatra, Thailand, and Cambodia, and can see no discernible difference between them.

Serows appear to be in decline because of hunting for its horns and meat for Asian pharmacopeia, evident by the photographs which have appeared in the conservation NGO Wildlife Alliance's monthly reports. This paper attempts to help fill that knowledge gap by noting the serow distribution in VNP.

STUDY SITE

VNP is located in northeastern Cambodia along the mountainous international borders with Laos and Vietnam. The park covers an area of 3,325 km². Most of Cambodia is very flat, which is unsuitable terrain for all serow species, as they prefer mountainous habitats (Francis 2019; Phan et al. 2020). Several extensive grasslands dot VNP, and the park is extremely hilly and cut by deep river valleys. Access to its remote points near the border with Laos was, until quite recently, very difficult, but motorbike tracks blazed for selective logging have made access easier, something which may spur additional hunting in previously difficult to reach regions of VNP.

Our three study sites in the park were chosen due to their distance from villages and their apparent high quality forest cover based on satellite imagery. Many of the mountains which form the wild and unmarked border between VNP (Cambodia) and Laos are steep, heavily forested, and reach up to and over 1,000 m, making it prime serow habitat. Our three study areas are known as the Veal Thom Grasslands, Yak Yeuk Grasslands, and T'buen Mountain.

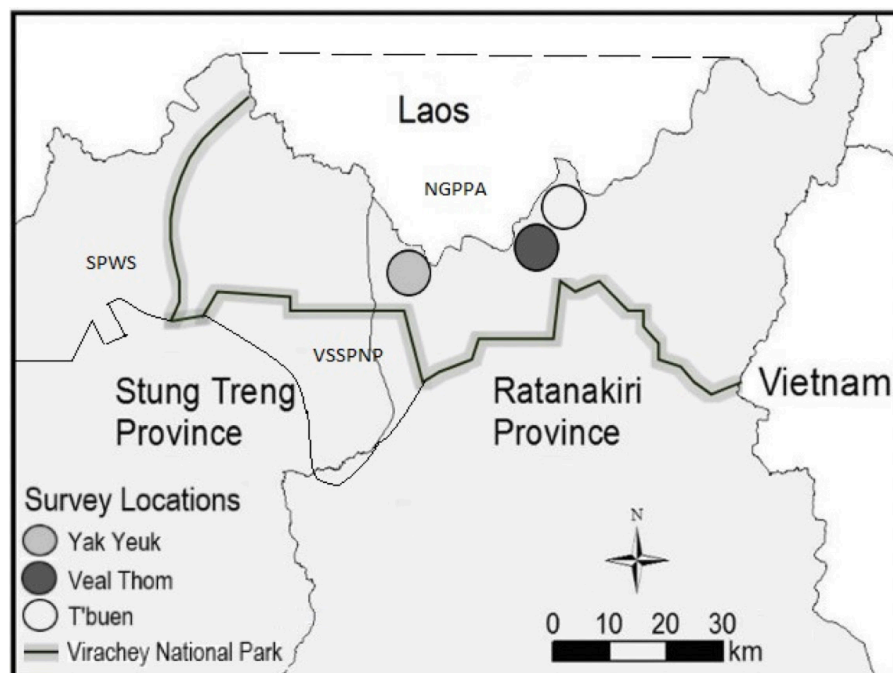


Figure 1. Our three study areas in VNP showing occurrence of serow positions.

MATERIALS AND METHODS

This was a broad wildlife survey, where camera traps were placed in a variety of habitats. Cameras were set along forest paths, ridge lines, game trails, basaltic clearings, streams, and wallows in order to maximize effort and the chances of encountering different species. We also relied heavily on the knowledge of the park rangers and our guides for camera placement. Cameras were often placed in locations where signs of wildlife were observed. Due to our camera deployment methodology, some species may be either over or underrepresented. Site selection, often being on or near game trails, may have influenced our capture rate of serow.

Camera trap stations, with one camera per site, were set approximately 20–100 cm above the ground, depending on slope and vegetation. All camera traps were set to be active for 24 hours each day, and to record time, date, and temperature when triggered. Camera traps from our three study areas were set for a combined total of 299,400 hours or 12,475 camera trap nights. Out of 36 camera traps, 32 were set to photograph mode, recording three pictures for every trigger event, at various time intervals, ranging from 30 seconds to five minutes. Camera traps at wallows or areas that showed signs of foraging were set at longer time intervals to minimize the number of redundant

photographs. Camera traps on game trails were set at shorter intervals to maximize the number of records. The four camera traps set to video recorded for one minute and restart after 1-minute interval if motion was detected; the video would therefore record until the animal had left the area. Encounters were defined as a single or series of photographs separated by more than 30 minutes at the same camera trap location. Coordinates and altitudes were recorded directly from a Garmin GPSMAP altimeter and a base-map of Cambodia that was purchased from Aruna Technologies in Phnom Penh. We used Bushnell HD Trophy Cams, Reconyx Rapidfire, Browning Strikeforce Pro XD, and Covert camera traps. Several camera traps malfunctioned, and five were lost to theft or damaged by poachers. Camera trap data were recorded and organized in MS Excel.

Serows in protected areas adjacent to VNP

Serows have never been detected in the Siem Pang Wildlife Sanctuary due west of VNP (J. Eames pers comm. 2021), likely due to the flatter terrain. Direct observations of serow were made by community patrols in Vuen Sai-Siem Pang National Park, which is adjacent to VNP to the south, but they were not recorded in camera traps (V. Audibert pers comm. 2021), possibly suggesting that VNP is a regional stronghold for the species, along with other habitats which form a kind of semi-circular mountainous international barrier around Cambodia; it

is these mountainous barriers which serve as the habitat and likely final redoubt for the serow in Cambodia. We recorded serow on the ridge line of Phnom Haling-Halang, which serves as a natural boundary between Cambodia and Laos. The name of the Lao area adjacent to VNP to the north is Nam Ghong Provincial Protected Area (NGPPA), so it is plausible that serows are found in this region of Laos because it contains a similar topography to VNP.

RESULTS

We recorded a total of 126 independent encounters, for an encounter rate of 1.01 over a period 12,475 camera trap nights (Table 1).

Serow triggered 24/36 (67%) of our camera trap stations and were present in all three survey areas. Of the three survey areas, the Veal Thom area had the highest number of independent encounters and encounter rate (1.35), where it appeared on 12 of 22 camera traps. Many of the encounters are likely the same individual, feeding or moving past a given camera, as distinguishing characteristics were often difficult to identify.

Sun Bears *Helarctos malayanus* were seen at altitudes ranging 490–1,420 m and appeared at elevations over 1,000 m in 62% of camera-trap occurrences (13 of 21). They were camera-trapped in evergreen, semi-evergreen, mixed deciduous, and mixed-bamboo forest; in forested grassland corridors, along riversides, & mud wallows; and were frequently encountered on well-traveled game trails. They were often captured in our stream-placed cameras. Most individuals encountered appeared to be in good health and none had evidence of snaring. All individuals photographed, except for a mother and juvenile pair, were solitary.

DISCUSSION

Serows were detected at all hours of the day. In several photos they were pictured resting on the ground, while in others they are seen feeding, crossing swift streams, walking on boulders, or running. Similar to our records in Sumatra, serows seemed unperturbed by camera traps and often spent extensive amounts of time feeding in front of them, sometimes triggering several dozen photographs. Our VNP records, however, are encouraging, as serow appear on many of our camera stations, including some with young, and a direct observation (also photographed) a young individual by

Table 1. Serow encounter rates recorded in Virachey National Park. Encounter rate was calculated as independent encounters/100 camera trap nights. Encounter rates at each survey location; Yak Yeuk, Veal Thom and T'buen are represented as YY, VT, Tb, respectively.

Common name	Species	Total encounters	Encounter rate (YY, VT, Tb)	Total encounter rate
Mainland Serow	<i>Capricornis sumatraensis</i>	126	0.45, 1.35, 0.42	1.01

Number of encounters (YY, VT, Tb) of *C. sumatraensis* = 10, 106, 10

Total camera trap nights = 12,475.

Total camera trap nights per area (YY, VT, Tb) = 2,242, 7,865, 2,368



Image 1. Serow with a large mane in the T'buen Mountain area in old growth forest at 1,150 m.



Image 2. Serow with young in forest corridor in Phnom Veal Thom Grasslands.

itself.

Serows are in decline in the Cardamom Mountains in the south-west of the country (N. Marx pers comm. 2021), and due to their habitat requirements—steep, heavily forested mountains—it is difficult to surmise that they are found anywhere else in Cambodia outside of what is likely a very small population in Ko Seima Wildlife Sanctuary in Monduliri province. To the best of our



Image 4. Side view of a Serow, north of the Veal Thom Grasslands in Virachey, NP, Cambodia.

knowledge, no recent records stem from Bokor National Park or from Phnom Kulen National Park—two locations with montane forest which could possibly support serow. Also to the best of our knowledge no recent records stem from the Dangrek Mountain chain on the Cambodian side. This scarcity of knowledge is mainly due to a tense military standoff between Thailand and Cambodia and the illicit trade in Siamese Rosewood in which Khmers illegally cross into Thailand to poach the highly sought-after hardwood, often resulting in violent confrontations between Thai security forces and Cambodian loggers (Stokes 2017). All border areas between Cambodia and Thailand are now off-limits due to the fast spread of Covid-19 in Thailand, so it will be some time before any information can be gathered from the Cambodian side of the Dangrek mountains and other mountainous border areas. Therefore, it is very likely that VNP represents the greatest stronghold for the species in Cambodia.

Elsewhere in the region, limited data from Thailand's National Parks website pinpoints Indochinese Serow occurrence in the Dangrek Mountains right on the Thailand-Cambodian border (www.thainationalparks.com), but just how up-to-date and accurate this information is, is open to question. Across Thailand, serow appear to be widespread and abundant (T. Redford pers. comm. 2021), and we camera trapped them in Khlong Saeng Wildlife Sanctuary in southern Thailand in 2014 during a short pilot survey. Their status in Laos is unclear, though very heavy hunting and particularly snaring pressures are prevalent throughout the country (DeBuys 2015), as is from neighboring Vietnam, which would indicate population declines, possibly very drastic. However, there is a semi-wild rescue center for them at Phong Nha Ké Báng National Park (Tri pers. comm. 2021)



Image 3. A young Serow seen alone in rocky and hilly, semi-forested area of the Yak Yeuk Grasslands in Virachey NP, Cambodia, which had previously been set on fire by local hunters. This photograph was a direct observation by a park ranger and not recorded via camera trap.

which offers some hope for the species in Vietnam; their status in wild throughout the rest of the country is not well known, but likely in steep decline.

The serow's main predators in VNP are dholes *Cuon alpinus*, Clouded Leopards *Neofelis nebulosa*, and humans, with the latter likely representing by far the most serious threat, as Cambodia is in the midst of a snaring epidemic (Gray et al. 2018). A recent study targeted at VNP's wild cats found that Clouded Leopards are still present in VNP (McCann et al. 2020). Dholes were also detected in that survey, but a study on Dhole diet and prey selection noted that serow represented just 6% of Dholes consumed biomass in Cambodia, perhaps due to the serow's preference for steep terrain,

making it more difficult for dholes to hunt them (Kamler et al. 2020).

Overall, the Mainland or Sumatra Serow is an understudied bovine deserving more directed conservation attention, or it could soon go the way of the Saola *Pseudoryx nghetinhensis* of the Annamite Mountains of Laos and Vietnam—becoming extremely rare, and possibly extinct. As such, VNP offers one of its last best hopes for survival in the wild, especially in Indochina (Cambodia, Laos, and Vietnam). It is probably not too late to turn the situation around for serows in Cambodia, but as stated previously they do not garner significant conservation attention. We hope that this publication can help raise an alarm and bring attention and conservation management for the species where it still occurs.

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