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Employing Camera Traps for Studying Habitat Use by Crocodiles in a Mangrove Forest in Sarawak, Borneo

Effective wildlife monitoring for conservation relies on census methods that deliver cost effective and logistically efficient data. Camera trapping has become a common tool in contemporary wildlife science, helping researchers collect images of uncommon or rarely seen and often threatened species as evidence. The development of camera trapping technique has led to significant advancement of the understanding of the diversity of animals and has helped detect secretive species that survive in low densities (e.g., Mohd-Azlan 2003; Mohd-Azlan et al. 2003). However, relatively few studies of crocodilians have employed the technique (Thorbjarnarson et al. 2000; Channa et al. 2010; Charruau and Hénaut 2012; Platt et al. 2014a), and one recent survey reported a lack of success (Platt et al. 2014b), possibly due to lack of technical modification of motion-sensitive infrared cameras (Merchant et al. 2012).

Camera traps are designed purposely to detect wild animals by using a passive infrared sensor (Mohd-Azlan and Engkamat 2006). The camera incorporates a mechanism to trigger a photograph by the movement and differential heat of the main subject in front of the camera and that of its surroundings. Additionally, the use of camera traps can reduce bias in data, such as in wildlife surveys, which can have an adverse effect on the results (Mohd-Azlan 2009). Another advantage of the technique is that it is non-invasive, not involving handling of target species (Ancrenaz et al. 2012; Ariefiandy et al. 2013; Sunarto et al. 2013).

Although primarily aquatic, crocodilians typically require terrestrial substrate, such as mud flats and water-edge environments for activities, including nesting, foraging (for terrestrial animals, such as pigs, primates, and otters), or thermoregulatory purposes. They can move considerable distances both overland (Pooley and Gans 1976) and along waterways (Walsh and Whitehead 1993).

In this study, we analyze crocodile activity and terrestrial habitat use in the vicinity of river banks with the use of camera traps, in order to increase understanding of crocodile behavior. These objectives are relevant given the escalating levels of human-crocodile conflicts in Sarawak (Das 2002). Thus, by setting up camera traps at selected areas where Saltwater Crocodiles are believed to habitually land, more information on their activity patterns can be obtained. The general objectives of the current study were to test whether camera traps can be used to record timing of activities and habitat use of crocodiles.

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Methods

We conducted this study at Pulau Liak in Kuching Wetland National Park (KWNP; Fig. 1), located ca. 8 km SW of Kuching City, the capital of Sarawak State, in East Malaysia (Borneo) where the Saltwater Crocodile (*Crocodylus porosus*) is listed under Part II of the First Schedule of the Sarawak Wild Life Protection Ordinance 1998. KWNP consists of coastal, marine, and freshwater ecosystems, and was gazetted as a National Park in 2002. The 6610-ha area is dominated by saline and deltaic mangrove systems, including marine waterways and tidal creeks, such as connecting rivers of Sungei Sibu-Laut, Batang Salak, and Sungei Santubong. The study area was selected to set camera traps centered around Pulau Liak (1.624°N, 110.25876°E; WGS84), and Sungei Sibu (1.676611°N, 110.23666°E), based on previous frequent sightings of *C. porosus* and the presence of crocodile wallows on river banks. Within the KWNP area, the common mangroves are *Rhizophora apiculata*, *Avicennia alba*, *A. marina*, *Bruguiera cylindrica*, *B. sexangula*, *B. gymnorhiza*, and *Ceriops tagal*.

We deployed three units of commercially made passive infrared Bushnell® Trophy Cam Camo-119445 cameras, with sensor resolution of 5MP, which captured images when triggered by movement and/or differences in temperature in the area immediately in front of the camera sensors. Each of these were established at a subsite within the study area (referred to as CT1, CT2, and CT3). Cameras were set with a delay mechanism of three minutes between photographs to reduce repeat photographs of the same individual crocodile. The study period was June 2013 to April 2014, a period of 11 months.

Time periods were analyzed to determine presence of crocodiles and temporal and spatial aspects of activity. To estimate the number of individuals recorded at the same locality, individuals were identified on the basis of both characteristic marks (such as scar tissue on head and body) and an estimation of body size. The activity pattern in terms of landing and functions of terrestrial habitat was also examined. The levels of activity were determined from the date and time recorded on the photograph.

Results

A total of 55 wildlife photographs of four species were recorded from 207 camera days. This includes a total of 43 images of *C. porosus*, including two of hatchlings that suggest the presence of a nest in the study area during the time of survey (November). Additionally, the cameras captured eight images of the Long-tailed Macaque (*Macaca fascicularis*), three images of Oriental Small-clawed Otter (*Aonyx cinerea*), and a single image of an unidentified species of squirrel (Table 1).