Research Articles

Population Assessment of Crocodiles in Bueng Boraphet, Thailand

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Abstract

This study aimed to estimate the number and distribution of crocodiles in Bueng Boraphet, Nakhon Sawan Province, Thailand. The surveys were conducted between November 2017 and August 2018. The data was obtained from nighttime spotlight and daylight visual surveys using motorboat along two line transects totaling 38 kilometers and covered an area about 7.6 square kilometers of Bueng Boraphet coastal area. Our results revealed that the number of crocodiles was at least 17 individuals with density of 2.24 individuals per square kilometers. The calculated population of crocodiles in the Bueng Boraphet was estimated to be about 17-37 individuals. In this study, most crocodiles were found in the first transect line located in the aquatic sanctuary area where all fishery is strictly prohibited. It shows that human activities directly affect crocodile encounters and these small numbers of crocodiles in Bueng Boraphet remain critically endangered. Therefore, the implementation of protection action is a high-priority project that needs to be done first before further restocking can be undertaken. Bueng Boraphet can be developed into national natural crocodile conservation, while eco-tourism activities can be expanded in such area. Furthermore, population surveys should be carried out continuously to determine population dynamics and develop a crocodile surveillance system. At the same time community engagement should be initiated to support the system to sustainable conservation.

Keywords: Population, Crocodiles, Bueng Boraphet, Thailand

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อประเมินจำนวนและการกระจายของจระเข้ในบึงบอระเพ็ด จังหวัดนครสวรรค์ ประเทศไทย โดยทำการสำรวจระหว่างเดือนพฤศจิกายน พ.ศ. 2560 ถึงเดือนสิงหาคม พ.ศ. 2561 ด้วยวิธีส่องไฟในเวลากลางคืนและสำรวจในเวลากลางวันด้วยเรือยนต์ตามเส้นสำรวจ 2 เส้นทาง ระยะทางรวม 38 กิโลเมตร และครอบคลุมพื้นที่บริเวณชายฝั่งของบึงบอระเพ็ดประมาณ 7.6 ตารางกิโลเมตร ผลการสำรวจพบจระเข้ไม่น้อยกว่า 17 ตัว มีความหนาแน่นของจระเข้ไม่น้อยกว่า 2.24 ตัว/ตารางกิโลเมตร คำนวณจำนวนประชากรจระเข้ในบึงบอระเพ็ดได้ประมาณ 17-37 ตัว ในการศึกษาครั้งนี้พบว่าจระเข้ส่วนมากพบในเส้นสำรวจที่หนึ่งซึ่งอยู่ในเขตพื้นที่รักษาพันธุ์สัตว์น้ำที่ห้ามทำการประมงโดยเด็ดขาด แสดงให้เห็นว่ากิจกรรมของมนุษย์ส่งผลกระทบโดยตรงต่อการพบจระเข้และจำนวนจระเข้ที่เหลืออยู่ไม่มากในบึงบอระเพ็ดนี้ยังมีความเสี่ยงใกล้สูญพันธุ์อย่างยิ่ง ดังนั้นการป้องกันเชิงพื้นที่จึงมีความสำคัญที่ต้องดำเนินการเป็นอันดับแรกจึงจะสามารถฟื้นฟูประชากรจระเข้ต่อไปในอนาคตได้ บึงบอระเพ็ดสามารถพัฒนาสู่การเป็นพื้นที่อนุรักษ์จระเข้ธรรมชาติของประเทศและส่งเสริมกิจกรรมการท่องเที่ยวเชิงนิเวศ นอกจากนี้ควรดำเนินการสำรวจประชากรอย่างต่อเนื่องเพื่อศึกษาพลวัตของประชากรซึ่งจะนำไปสู่การพัฒนาระบบเฝ้าระวังจระเข้ร่วมกับการสร้างการมีส่วนร่วมของชุมชนเพื่อการอนุรักษ์อย่างยั่งยืนต่อไป

คำสำคัญ : ประชากร จระเข้ บึงบอระเพ็ด ประเทศไทย

Introduction

In Thailand, three species of crocodilians are historically abundant throughout the country consisting of the Siamese crocodile (*Crocodylus siamensis*), saltwater crocodile (*Crocodylus porosus*), and false gharial (*Tomistoma schlegelii*). However, the Siamese crocodile is the species normally found in natural freshwater ecosystems such as rivers, swamps, wetlands in lowland central and eastern Thailand, particularly in the Yom, Ping, Chao Phraya, and Pasak River in the past (Smith 1919; Taylor 1969). Recently, their wild population is dramatically depleting due to habitat destruction, illegal fishing, and crocodile poaching (Bezuijen et al., 2012). In addition, many people believe that crocodiles are dangerous animals that can harm humans, pets, and livestock (Aust et al., 2009; Gopi and Pandav 2009). The population of Siamese crocodiles remaining in the wild is scattered in different areas and each area has very small individuals. (Ratanakorn et al., 1994; Platt et al., 2002). Currently, several small remnant populations of wild Siamese crocodiles are found scattered in protected areas including Thung Salaeng Luang National Park, Pang Sida National Park, Kaeng Krachan National Park, Yod Dome Wildlife Sanctuary, Khao Yai National Park, Khao Ang Rue Nai Wildlife Sanctuary, and Bueng Boraphet Non-Hunting Area (Manolis 2017). Hence, there is a great risk of the extinction of Siamese crocodiles in the near future.

In the past, Bueng Boraphet was a natural swamp. Later, a weir was built to store water and become wetlands permanently. Therefore, Bueng Boraphet is the largest man-made freshwater reservoir located in central Thailand surrounded by local communities (Sriwongsitanon et al., 2007). This is an internationally important wetland proposed as the Ramsar site due to its high biodiversity (Office of Environmental Policy Planning 2002). Many rivers carry silts and nutrients flow into the swamp which makes this place suitable for the growth of various aquatic planktons, plants, and is also a proper to be habitat for numerous important wildlife, including aquatic species, birds, and the Siamese crocodile (Office of Environmental Policy Planning 2003; Chaichana and Choowaew 2013). There are records of crocodile sightings from the past to present but the precise status of crocodiles over time in Bueng Boraphet has never been scientifically evaluated. Moreover, people use the area for a variety of purposes, including utilizing natural resources for household consumption or as a source of income, water reservoirs for agriculture activities, and tourist attractions. The beautiful scenery of nature in Bueng Boraphet could be the model and develop sustainable conservation work and promote eco-tourism (Khundiloknattawasa 2019). Therefore, it is necessary to understand populations and habitats to obtain basic information of crocodiles in Bueng Boraphet because no population surveys have been conducted in the area before, and it is necessary for resources management.

The Siamese crocodile is now listed as a critically endangered species by the IUCN and Office of Natural Resources and Environmental Policy and Planning, Thailand. Since 1992, the IUCN/SSC Crocodile Specialist Group has established the Crocodile Action Plan and Siamese crocodile has been listed as the highest priority for action. The basic survey and identification of habitat and population should be done immediately to prevent extinction and to build a basis of specified management and conservation action (Ross 1998). Thailand has well-organized protected areas so implementation of protection of habitat and restocking of the population is the high priority action that should be done (Manolis and Stevenson 2019). However, there is still inadequate policy

and financial support, and a lack of proper studies of population, habitat, and factors affecting the survival which is necessary for habitat management planning in the country. Consequently, the crocodile conservation projects in Thailand are urgently needed. The umbrella project of crocodile conservation in Thailand consists of (1) studying the population of crocodiles in the natural habitat, (2) social studies to initiate a participatory conservation approach, and (3) restoring the population of crocodiles in protective areas. Thus, this study was designed to estimate the number and distribution of crocodiles in Bueng Boraphet which is a fundamental first step towards developing a sustainable management protocol. The data obtained from the surveys was used to assess factors that influence crocodile habitat use which will be used to determine the suitability of the area as a crocodile habitat and develop sustainable management plans for this vulnerable species.

Materials and Methods

Study area

This study was conducted in Bueng Boraphet located in Nakhon Sawan Province, central Thailand. The geographical location is between latitude of 15°40'N and 15°45'N and longitude of 100°10'E and 100°23'E. It is a semi-natural swamp covering an area of 212 square kilometers. The area is divided the area into 2 zones. Zone 1 is an aquatic sanctuary area where all fisheries are strictly prohibited, and zone 2 is an area where people are allowed to do the fishery by using permitted equipment only. Therefore, we designed two transect lines for the crocodile survey according to the mentioned zoning. The first line transect was 20 kilometers in zone 1 and the second line transect was 18 kilometers in zone 2 (Figure 1).

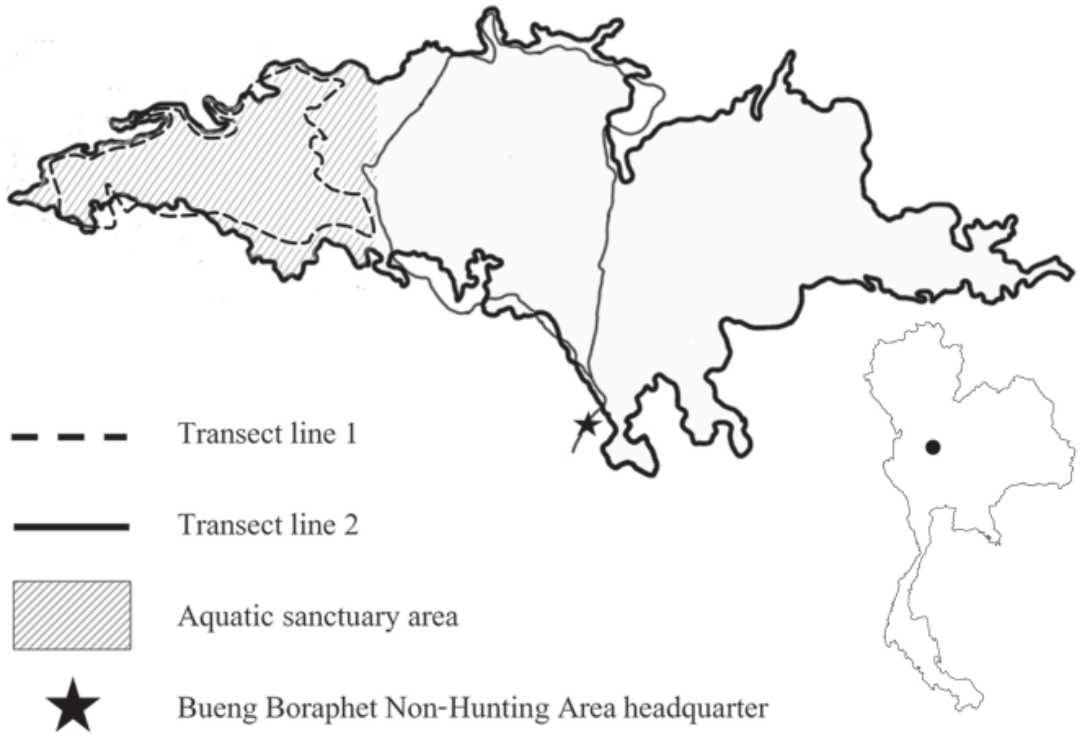

Figure 1. Location of the study area and transect lines for spotlight survey.

Survey Methods

The surveys were done between November 2017 and August 2018. We conducted 36 nocturnal spotlight surveys in the first transect line and 28 in the second transect line. Moreover, we did 33 daytime surveys in the first transect line and 27 in the second transect line.

A motorboat was used to explore the transect lines. On the night, spotlight surveys (Bayliss 1987; Fukuda et al., 2013) were used for collecting data. Crocodiles were counted along the study routes by observing "Eye-shine" because their eyes have tapetum lucidum that will reflect light when exposed to light from our light sources. A hand-held LED spotlight of at least 100W was used as the light source. During the survey, spotters will hold light sources in a horizontal plane at an angle of 180 degrees to the surface of the water, which makes it possible to observe eye-shine well. The average speed of the boat was about 23-26 km/h and this reduced upon each sighting to approach the crocodile as close as possible and estimate its size. A crocodile was recorded as a hatchery if their size was less than 1 meter, a juvenile if their size was between 1 to 1.8 meters, an adult if body length was more than 1.8 meters, unknown when it cannot be identified, and pod if we found a group of hatcheries. The geographic coordinates of each sighting spot were logged using GPS. We recorded time, air and water temperatures and the relative humidity for all surveys. Moreover, we conducted walking surveys on a day mainly in the location where the crocodile had been spotted during previous nocturnal spotlight surveys for observed footprints, tail marks.

Data analyses

The relative abundance was estimated from collected data and the population observed in the area during per transect during the study period was analyzed. The relative abundance was calculated as the number of crocodiles observed per kilometer (Bayliss 1987). The sighting area was calculated by total line transect distance multiplied by the estimated sighting distance from the observer and shore (200 meters). The encounter rate of the total survey was calculated. In addition, the sighting fraction can be calculated from the formula (King et al., 1990).

$$N = \frac{\bar{x}}{p} \pm \frac{[1.96(SD)]^{1/1}}{p}$$

where p is a percentage of the population observed, is the average number of crocodiles spotted, and SD is the standard deviation. Then, crocodile population size with 95 percent cent confidence limits was calculated from the following equation (Messel et al., 1981).

Results

From November 2017 to August 2018, the maximum air temperature was 31.5 Celsius and the minimum was 18.3 Celsius. Whereas, the maximum air temperature was 32.1 Celsius and the minimum was 19.2 Celsius. The water temperature was warmer than the air temperature. The average temperature difference was 1.6 Celsius. There was a 10.8 Celsius difference on a windy day. The maximum the relative humidity was 91.2 and the minimum was 60.5. A total of 45 crocodiles were observed at night time. One crocodile was found in the daytime (Figure 3). In 38 kilometers of survey distance, the encounter rate was 1.211 individuals per kilometer overall range. When comparing the coordinates where the crocodile was found, time, and characteristics of each individual from overall surveys, we estimated observed crocodiles at least 17 individuals in the overall transect lines which 14 crocodiles were spotted in the first transect line and three crocodiles were found in the

second transect line. In addition, two more crocodiles were found outside the study tracks (Figure 2). From all the observed data, they were classified to 4 hatchlings (body length less than 1 meter), 8 juveniles (body length 1 to 1.8 meters), 3 adults (body length over 1.8 meters), and 4 unknowns. Crocodiles are often found near shore. 99.39% of the habitat where crocodiles were found had floating wetland vegetation (e.g., water hyacinth, sedges, reeds, lotus, cattail), and 69.48% of the areas had dense grasses, shrubs, and trees at the coastline.

The relative abundance was 2.24 crocodiles per square kilometer. Furthermore, the calculated the population of crocodiles on the survey line is 7.6 square kilometers were 5.919±4.343 individuals and a density of 0.779±0.571 individuals per square kilometer. Bueng Boraphet covers a total area of 212 square kilometers. The calculated population of crocodiles in the Bueng Boraphet area was estimated to be about 5-37. Thus, it was concluded that the crocodile population in the study area was 17-37 when comparing the calculated population with observed coordinates.

Figure 2. Distribution of crocodiles from spotlight surveys.

Figure 3. Photographs of the crocodiles found during the surveys.

Discussion

According to historical records, crocodiles have been discovered all around Thailand. However, their population is dramatically declined even Thailand has more than forty important lowlands and wetlands. There are a few places where the Siamese crocodiles can survive in their natural environment. Bueng Boraphet is one of the sites where still have reports of crocodiles inhabited since the past to present (Taylor 1969; Smith 1919; Ratanakorn et al., 1994; Platt et al., 2002). Formerly, up to a hundred individuals were most found in Bueng Boraphet. However, there was a recent report found 8 adult Siamese crocodiles during the spotlight survey (Manolis 2017). We found a similar trend from our results which indicated that the population of crocodiles in Bueng Boraphet is 17-37 individuals with at least three adults and three unknowns. However, we could not confirm their population structure because the crocodiles were attentive to changing stimulus. Most crocodiles dove into the water or hid behind floating plants before the observer could estimate body length. In our study, most crocodiles were found in the first transect line located in the aquatic sanctuary area where strict regulations are implemented to protect fish breeding sites. It shows that human activities directly affect crocodile encounters. Fishing regulations in the protected zone can prevent the killing and unintentional catching of crocodiles in fishing nets (van Weerd and van der Ploeg 2003). Crocodiles will have a low incidence of being harmed by fishing gear. Furthermore, this protected zone has higher biological resources such as macrophytes and fish compared with a fishing zone (Chaichana and Choowaew 2013). We mostly

found crocodiles in dense wetland vegetation environment. Similarly, Crocodylus siamensis preferably abundant in still water in the Sre Ambel River where their habitat is dominated by sedges, extensive mats of water hyacinth, floating grasses, and scattered tree cover along the river. The vegetation is important for a hiding place and material for nesting (Platt et al., 2006).

There are some limitations of this study. Although, spotlight surveys are the most common method of crocodile research because crocodiles are difficult to see especially during the daytime but they are easily visible at eye-shine when the light is reflected. The obtained data can provide precise indices of abundance. However, there is visibility bias that can lead to inaccurate observations associated with various factors including animal behavior, degree of wariness, vegetation covering, and weather (Bayliss 1987; Fukuda et al., 2013). Since crocodiles can hardly be seen directly. Therefore, it is necessary to assess the population using obtained data and calculated using the sighting fraction (Messel et al. 1981; King et al., 1990). In Bueng Boraphet, there are many canals with high sinuosity or densely covered with vegetation which can be visibility bias of this study. On rainy days, the reflections from the crocodile's eyes are obscured by reflections from water droplets or dew. Hence, our study started after the rainy season to minimize that error and to avoid an accident that might occur from strong winds during traveling by boat in a large open water area. The water depth of the swamp seasonally changes because it served as a flood control area in the rainy season and water resource in the dry season for local communities to rely on (Haq et al., 2018). There were slight changes in the survey route due to lower water levels affecting areas accessible by boat. Therefore, there are challenges in designing the survey route to cover the entire area. Interestingly, the most common area where crocodiles are found is in a small canal called Khlong Boraphet which has Chao Mae Mon Thong Shrine. This shrine has a myth related to crocodiles that are revered by the local people. Therefore, the belief of the villagers may be another influencing factor that helps the crocodile survive. This requires further social studies to understand the social context of wildlife conservation.

Currently, Bueng Boraphet is the largest freshwater wetland on the Chao Phraya River Basin. Around this area, there are 31 villages, with approximately 5,000 households. Bueng Boraphet provides significant values in various aspects. It has high socio-economic and ecological values. It is used as a water reservoir for domestic and agricultural water supply and flood control. Moreover, it is also an important fishery site for local communities to harvest natural resources for food and income. It is facing threats majority from human activities. Large numbers of aquatic plants, phytoplankton, zooplankton, fish, and birds were reported in the swamp. Even Bueng Boraphet has ecologically important for a wide variety of flora and fauna but dramatic changes in hydrology and landscapes over the past decade have had a great impact on wildlife (Haq et al., 2018). Especially for crocodiles, if an area was established to conserve waterbirds may not be suitable for large reptiles such as crocodiles that need appropriate and careful management of suitable wetland habitat (Webb and Jenkins 1991). The sediment dredging and environmental modification for water storage to solve flooding problems are also significant threats that affect the suitability of crocodile habitat and nesting site in the future. Although fishing is prohibited, illegal fishery still exists. Destructive fishing methods such as electro-fishing and anesthetic chemical substances are still found, even

though the penalties are high. The use of illegal fishing gear will also directly affect the crocodile population (van der Ploeg and van Weerd 2006).

Crocodilians play an important role in the structure and function of the ecosystem. These large-bodied predators are keystone species that contribute to nutrient and energy translocation across ecosystems (Ashton 2010). Therefore, they have the potential to be ecological indicators considering their ecological values (Somaweera et al., 2020). Conservation of crocodiles is the great benefits for ecosystem. This estimate of the population and distribution of crocodiles in Bueng Boraphet is very important that gives the basic information for planning crocodile population management. Our results indicate that these small numbers of crocodiles in Bueng Boraphet remain critically endangered. However, the area with highly strict regulations has a huge impact on helping crocodiles survive in the wild. Therefore, the implementation of protection action is a high-priority project that needs to be done first before further restocking can be undertaken. The crocodile population can recover if their habitats were intact (Fukuda et al., 2011).

Bueng Boraphet can be developed as a national natural crocodile conservation site to conserve the genetic diversity of Siamese crocodiles because it has enough area and ecological integrity. The advantage of being a Ramsar Site will have a positive effect on the conservation of crocodiles in the area. Moreover, the conservation of crocodiles will have a positive effect on the development of eco-tourism site because it can attract wildlife enthusiasts, researchers, and zoologists. Eco-tourism focuses on protecting the resource base and it is also used as a tourism tool that can strengthen conservation with local community participation. They can have additional income from tourism activities (Ryan and Harvey 2000; Rafsanjani and Karami 2011; van der Ploeg et al., 2011). Bueng Boraphet has potential to be a model of sustainable co-habitation of crocodiles and local people. This place has a natural potential and beautiful nature. It is located in the central region. Travelers can visit without having to travel too far. It does not cost too much and no additional equipment is required. The boat ride can accommodate tourists of various ages in a diverse society. This place is already famous for tourist destination. There are a variety of activities suitable for various people who want to learn about nature or the local community lifestyle. At present, tourists visit this scenic place for the purpose of surfing nature because they can take a boat trip to bird watching, see beautiful lotus fields and enjoy traditional food. Therefore, further population surveys should be carried out continuously to determine population dynamics and develop a crocodile surveillance system together with built community engagement for sustainable conservation.

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References

Aust P, Boyle B, Fergusson R, Coulson T. The impact of Nile crocodiles on rural livelihoods in northeast Namibia. South African. J wildl Res. 2009;39:57-69.

Ashton PJ. The demise of the Nile Crocodile (*Crocodylus niloticus*) as a keystone species for aquatic ecosystem conservation in South Africa: The case of the Olifants River. Aquat Conserv Mar Freshw Ecosyst. 2010;20(5):489-93.

Bayliss P. Survey methods and monitoring within crocodile management programmes. In: Webb GJ, Manolis SC, Whitehead PJ, editors. Wildlife Management: Crocodiles and Alligators. Sydney: Surrey Beatty and Sons. 1987. p. 157-75.

Bezuijen M, Simpson B, Behler N, Daltry J, Tempsiripong Y. Crocodylus siamensis. [Internet]. The IUCN Red List of Threatened Species 2012. 2012 [cited 2021 September 27]. Available from: https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T5671A3048087.en.

Chaichana R, Choowaew S. Ecological importance and biological resource conservation of Boraphet marsh, Thailand. Sci Asia. 2013;39(2):105-10.

Fukuda Y, Saalfeld W, Webb G, Manolis C, Risk R. Standardised method of spotlight surveys for crocodiles in the tidal rivers of the Northern Territory, Australia. North Territ Nat. 2013; 24: 14-32.

Fukuda, Y, Webb G, Manolis C, Delaney R, Letnic M, Lindner G, et al. Recovery of saltwater crocodiles following unregulated hunting in tidal rivers of the Northern Territory, Australia. J Wildl Manag. 2011;75:1253-66.

Gopi GV, Pandav B. Humans sharing space with Crocodylus porosus in Bhitarkanika Wildlife Sanctuary: conflicts and options. Curr Sci. 2009;96:459-60.

Haq RU, Eiam-Ampai K, Ngoprasert D, Sasaki N, Shrestha RP. Changing landscapes and declining populations of resident waterbirds: A 12-year study in bung Boraphet Wetland, Thailand. Trop Conserv Sci. 2018;11:1-17.

Khundiloknattawasa, S. Community participation in development of ecotourism Bung boraped, Nakhon Sawan Province. Humanities and Social Sciences Journal of Pibulsongkram Rajabhat University. 2019;14(1):194-211.

King FW, Espinal M, Cerrato LCA. Distribution and status of the crocodilians of Honduras. Proceedings of the 10th Working Meeting of the Crocodile Specialist Group, IUCN-The World Conservation Union, Gland, Switzerland; 1990. p. 313-54.

Platt SG, Lynam AJ, Temsiripong Y, Kampanakngarn M. Occurrence of the Siamese crocodile (Crocodylus siamensis) in Kaeng Krachan National Park, Thailand. Nat Hist Bull Siam Soc. 2002;50:7-14.

Platt SG, Sovannara H, Kheng L, Stuart BL, Walston J. Crocodylus siamensis along the Sre Ambel River, southern Cambodia: habitat, nesting, and conservation. Herpetol Nat Hist. 2006;9(2):183-8.

Manolis, C. "2nd Siamese Crocodile Meeting on Husbandry and Conservation" and "Siamese Crocodile Task Force Meeting" (1-2 June 2017). Crocodile Specialist Group Newsletter. 2017;36(2):5-9.

Manolis C, Stevenson C. Crocodiles. Status Survey and Conservation Action Plan. Darwin: Crocodile Specialist Group; 2019.

Messel H, Vorlicek GC, Wells AG, Green WJ. Surveys of tidal river systems in the Northern Territory of Australia and their crocodile populations. Sydney: Monograph, Pergamon Press; 1981.

Office of Environmental Policy Planning. An inventory of wetlands of international and national importance in Thailand. Bangkok: Ministry of Science, Technology, and Environment. 2002.

Office of Environmental Policy Planning. Biodiversity in Bueng Boraphet. Bangkok: Ministry of Science, Technology, and Environment. 2003.

Rafsanjani AK, Karami M. Eco-tourism necessity to preserve and maintain endangered species: A study of mugger crocodile. J Geogr Reg Plann. 2011;4(14):708-14.

Ratanakorn P, Amget B, Ottley B. Preliminary Surveys of crocodiles in Thailand. Proceedings of the 12th Working Meeting of the Crocodile Specialist Group. Gland, Switzerland: IUCN- The World Conservation Union, Thailand; 1994. p. 35-49.

Ross JP. Crocodiles. Status Survey and Conservation Action Plan. 2nd ed. IUCN/SSC Crocodile Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK; 1998.

Ryan C, Harvey K. Who likes saltwater crocodiles? Analysing socio-demographics of those viewing tourist wildlife attractions based on saltwater crocodiles. J Sustain Tour. 2000; 8(5):426-33.

Somaweera R, Nifong J, Rosenblatt A, Brien ML, Combrink X, Elsey RM, et al. The ecological importance of crocodylians: towards evidence-based justification for their conservation. Biol Rev. 2020;95(4):936-59.

Smith MA. Crocodylus siamensis. J Nat Hist Soc Siam. 1919;3:217-22.

Sriwongsitanon, N, Surakit K, Hawhins PR, Chandrasena N. Decision support tools for water resource management: a case study of Bung Boraphet wetland, Thailand. J Dev Sustainability Agric. 2007;2:17-26.

Taylor EH. The turtles and crocodiles of Thailand and adjacent waters. Univ Kansas Sci Bull. 1969;49(3):87-179.

Van der Ploeg J, Van Weerd M. A paradigm shift in Philippine crocodile conservation. Proceedings of the 18th working meeting of the Crocodile Specialist Group. IUCN-the World Conservation Union, Gland, Switzerland and Cambridge, UK; 2006. p. 164-86.

Van der Ploeg J, Cauillan-Cureg M, van Weerd M, Persoon G. 'Why must we protect crocodiles?' Explaining the value of the Philippine crocodile to rural communities. J Integr Environ Sci. 2011;8:1-12

Van Weerd M, Van der Ploeg J. A new future for the Philippine crocodile Crocodylus mindorensis. Sylvatrop. 2003;13(1&2):31-50.

Webb G, Jenkins R. Management of Crocodilians in Thailand: A Review with Recommendations. Canberra: Australian National Parks and Wildlife Service; 1991.