

INITIAL SURVEYS OF CROCODILES AND HABITAT
AT
PULAU SELIRONG FOREST RECREATION PARK
AND
OTHER AREAS OF BRUNEI BAY, BRUNEI DARUSSALAM
May and July 2006

TECHNICAL REPORT

prepared for
Forestry Department, Ministry of Industry and Primary Resources,
Brunei Darussalam

Jack Cox
Crocodile Management and Biodiversity Conservation Specialist
2919 Colony Road, Charlotte, NC 28211-2635, USA <jackcoxjr@yahoo.com>

Summary.

Pulau Selirong Forest Recreation Park (PSFRP) is a nearly pristine 2,566 ha island of conserved mangrove communities in Brunei Bay, northeastern Brunei Darussalam (Fig. 1 and 2). Surveys of flora and fauna conducted in 2000 and 2001 documented occurrence of the Indopacific (= Estuarine) Crocodile *Crocodylus porosus* (Charles in Ibrahim 2002; Charles 2002). An initial systematic survey of crocodilians in Pulau Selirong and other areas of Brunei Bay was conducted by the author and Forestry Department personnel 23-29 May and 8-19 July 2006.

No evidence of crocodiles was found at Pulau Selirong, but *C. porosus* was recorded at low levels on night counts in most rivers of Brunei Bay (0.33 crocs/km; 103.5 km surveyed). Hatchlings and yearlings sighted in the Duwau Besar, Temborong and Labu rivers suggest small breeding units persist there. Most crocodiles encountered (58.8%) were wary and did not allow a close enough approach to estimate size. The effect on local populations of historical and allegedly recent hunting for skins is undocumented, but has probably depressed abundance.

The dominant mangrove-nipah forest edge and littoral in the middle and lower reaches of surveyed rivers is largely undisturbed. Outside Pulau Selirong, sustainable harvesting of mangrove poles and timber is permitted inland, and fishing with nets during the day and spears at night is widespread but infrequent.

Good potential exists to rehabilitate the crocodile resource in Brunei Bay through a suggested course of conservation, ecotourism and sustainable utilization.

Two visits were made to rapidly assess crocodile populations and habitat at Pulau Selirong Forest Recreation Park and other areas of Brunei Bay, and to afford technical exchange with Brunei Darussalam Forestry Department officers. These visits followed an initial request via Mr. Masakazu Kashio (Forest Resources Officer, FAO Regional Office for Asia and the Pacific [FAO-RAP]). Approvals were subsequently granted by Mr. Tuan Haji Shahrill Haji Shahbudin, Acting Director, Forestry Department, Ministry of Industry and Primary Resources, Brunei Darussalam), Mr. Mahmud Haji Yussof, Silviculturist, and Senior Forestry Officers Ms. Hj. Jamilah

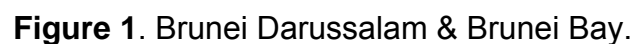


Figure 2. Pulau Selirong and tributaries.

FINAL VERSION

The Indopacific (= Estuarine or Saltwater) Crocodile *Crocodylus porosus* was recorded twice diurnally during field studies to prepare the PSFRP Management Plan (Charles 2002). Two verbal reports of a crocodile resembling the Malayan False Gavia *Tomistoma schlegelii* were also received (Charles 2002), but this species is apparently unrecorded from mangrove habitat anywhere in its known range. The under-recorded herpetofauna of Pulau Selirong comprises 9 of 19 species known from Bornean mangroves (Charles in Ibrahim 2002; Das 2003), including Mangrove-Cat Snake *Boiga dendrophila*, Coronated Flying Dragon *Draco cornutus*, and Worm Gecko *Hemiphyllodactylus* sp.

The visitor and author of this report is a crocodile management specialist with extensive experience in Asia-Pacific, including Sarawak and Kalimantan. Assessments of Pulau Selirong and tidal river systems of Brunei Bay comprised most of the stay in Brunei. After overnighing in Bandar Seri Begawan on 22 May a meeting was held the next morning with Ms. Noorlinda Hj. Ibrahim, Ms. Hj. Jamilah Haji Abdul Jalil and Mr. Haji Ryni Sofian Othman at the Forestry Department to discuss the technical experience of the specialist, distribution and current status of Bornean crocodilians, related conservation issues in Brunei, and general aspects of crocodile resource management. The objectives, logistics and expected outcomes of the visit were reviewed. It was agreed that a report be prepared at Pulau Selirong, which was presented as an Interim Report (Cox 2006) during the author's debriefing at the Forestry Department on 29 May 2006.

Following this submission, the author requested a follow-up visit for mid-July when a period of nocturnal low tides and usually better weather is conducive to crocodile counts. The second visit was approved by Ms. Noralinda Haji Ibrahim and conducted 8-19 July 2006. A broader understanding of crocodile populations and habitat in Brunei Bay was accomplished.

This technical report presents detailed findings of the visits, recommends a course of action to replenish the crocodile resource in Brunei Bay, and outlines a successor crocodile research initiative for Brunei at large.

1. Objectives and methods:

1.1 Assessment of crocodiles in Pulau Selirong Forest Recreation Park area.

The main objective of the first visit was to determine the crocodilians present in the Pulau Selirong area, their current status, and management options that emphasize the conservation needs of presumably relict or defunct populations. Sharing of technical information and experiences among the author, Forestry Department staff and local people was an important related activity.

Daytime reconnaissance of habitat was conducted 23-28 May and most days 11-17 July 2006. Each tributary of Pulau Selirong was reconnoitered by small speedboats equipped with 40 hp or 30 hp motors. Representative 35mm photographs of vegetation, waterways and wildlife were taken for reporting use and for the Forestry Department.

Standard night counts of crocodiles to determine species, abundance and distribution were conducted in each Pulau Selirong tributary except Sungai [=river or tributary] Selirong (Table 1).

Informal, relaxed interviews were carried out with fishermen and local residents met on surveys to better discern patterns of aquatic and land resource use, and interaction of local communities with crocodiles.

Literature on Pulau Selirong emphasizing studies of habitat and crocodilians was reviewed prior to the initial visit. FAO-RAP provided background reports on conservation of mangroves in Southeast Asia and the draft PSFRP Management Plan. The Forestry Department loaned 1:50,000 topographic maps (Ministry of Development, Survey General, 1987) to further discern habitat types, facilitate planning of surveys and assist data analysis. Accommodation and meals at Pulau Selirong, speedboats, fuel and counterpart staff were generously provided by the Forestry Department.

Casual observations of birds and other wildlife were also recorded (Section 5 and Appendix 2).

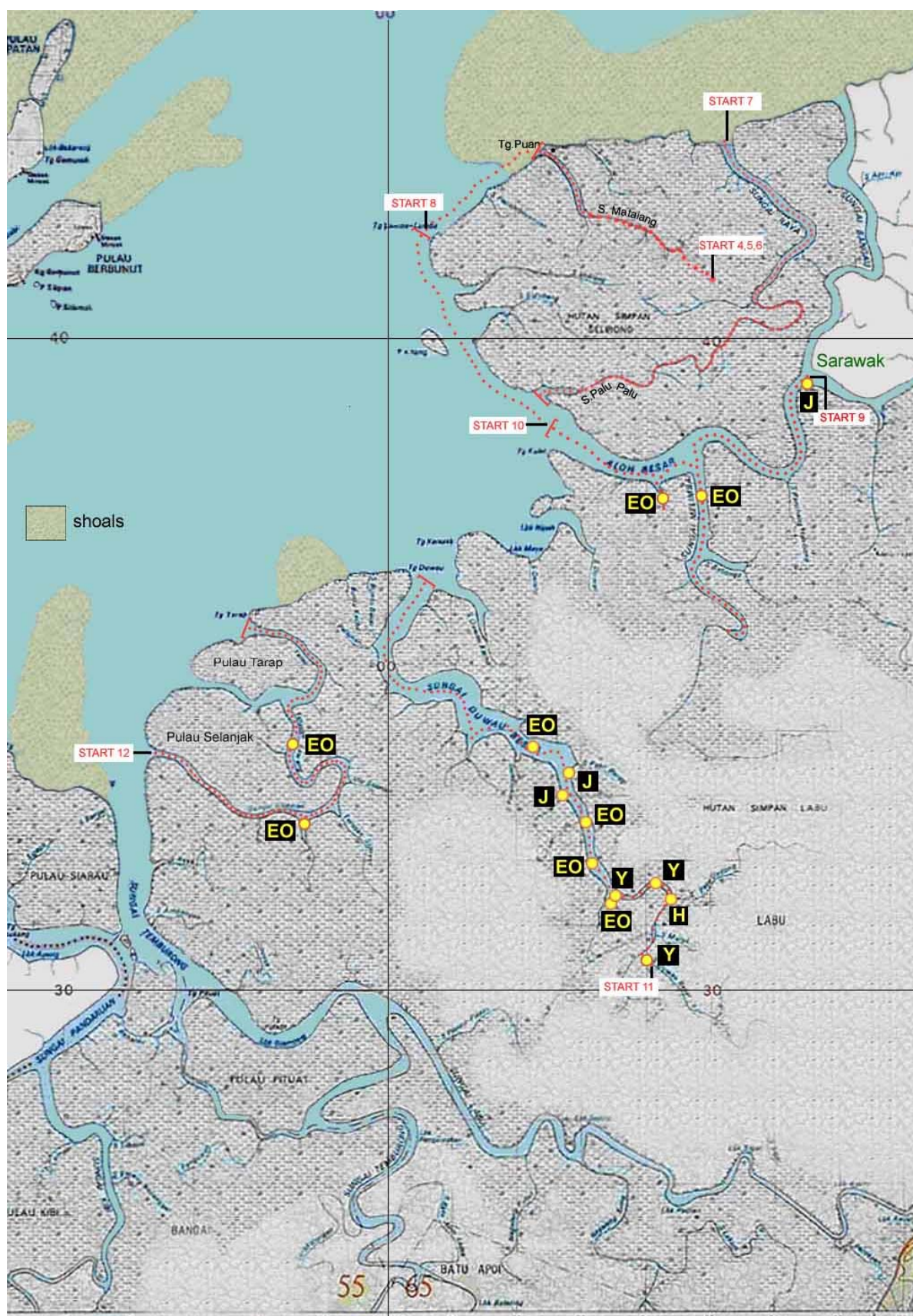


Figure 3. Old growth *Rhizophora articulata*, Pulau Selirong boardwalk.

1.2. Assessment of crocodiles in other areas of Brunei Bay.

Considering that Pulau Selirong is not a stand-alone island of biological diversity or exclusive home range of crocodiles that may occur in Brunei Bay, surveys were expanded to most other tidal rivers of the bay within Brunei Darussalam (Fig. 4). This expansion was deemed even more pertinent when initial information received at PSFRP suggested that rivers and coastal areas south of the island were more likely to harbor crocodiles.

Consensus among PSFRP staff was that a night count at Sungai Temburong under proper conditions would guarantee at least some crocodile sightings; whereas a survey of Pulau Selirong would probably not yield any crocodiles (none have been seen for the past several years). With the permission of Park staff Team Leaders, priority for surveys outside Pulau Selirong in May was given to Sungai Temburong in an effort to identify resident crocodilians in Brunei Bay and gain insight into their population dynamics and ecology. Surveys of the Temborong and additional river systems south of Pulau Selirong were conducted in July.



1.3. Mutual transfer of knowledge and skills.

Meetings with Forestry Department officials in Bandar Seri Begawan included discussions on a range of crocodile management issues in Asia-Pacific countries, and possible strategies for Brunei to conserve and manage its crocodile resource.

Numerous informal consultations were held with Forestry officers at Tanjung (= point) Puan Guard Post on crocodile management, emphasizing impressions of the severely depleted status of crocodiles in the Pulau Selirong area and replenishment options. Several officers advised that local people were generally afraid of crocodiles and any management initiative should carefully consider this view.

2. Results.

Pulau Selirong. Each main tributary on the island was reconnoitered in the daytime to assess habitat condition, in particular the littoral, which is favored as foraging habitat by Indopacific Crocodiles. Except for the PSFRP Guard Post at Tanjung Puan, there are no permanent settlements on the island, but residents of nearby coastal villages in Brunei are allowed to fish with nets, poles and traps. No records of crocodiles resulted from surveys of Pulau Selirong, either incidental sightings during daytime habitat assessments or from six night counts of four tributaries and two sections of coast (Figure 4; Table 1).

Sungai Mataiang. The littoral of this small tidal river is comprised by mixed *Rhizophora* and narrow mudflats at low tide. The waterway is used frequently by local fishermen, and more regularly by Park staff from Tanjung Puan, who patrol and maintain the Park boardwalk via the upper Mataiang jetty.

Three night counts were conducted in the Mataiang, two under suitable conditions (Table 1). Crocodile eyeshine was not detected. Replicates of the 29 March count were largely training exercises for PSFRP staff. On 13 July the *C. porosus* hatchling caught in Sungai Duwau was released in the headwaters of the Mataiang just beyond the boardwalk bridge (central interior of Pulau Selirong).

A noticeably slender-snouted crocodile was said to have been observed by torch at close range in March 2001 while the informant fished opposite the Tanjung Puan Park Headquarters at the Mataiang estuary (Mr. Pengiran Aridin, a Pulau Selirong Team Leader, *verbally*). The crocodile reportedly opened its mouth and momentarily thrashed the surface of water at the littoral. The description suggests Malayan False Gavia *Tomistoma schlegelii*, which is widespread in Kalimantan (Indonesian Borneo) (Ross *et al.* 1998), but known to inhabit only freshwater rivers and peat wetlands (M. Bezuijen, R. Steubing, R. Sommerlad, *in litt.* 23 August 2006).

Sungai Selirong. A long narrow tributary connected with Sungai Raya in eastern Selirong. Daytime assessments at medium-high water on 26 May and 17 July showed intact littoral of tall mixed *Rhizophora-Xylocarpus* forest edge with a prominent component of standing deadwood. The tributary is used occasionally for fishing (Pengiran Affandi, *verbally*). A night count was not conducted.

Sungai Raya/Sungai Palu Palu. Sungai Raya and the upper Palu Palu were assessed on the late afternoon of 28 May. The entire system is edged with a

continuous canopy of mixed mangroves, mainly *Rhizophora*. Naturally occurring standing deadwood is a frequent component. The upper Palu Palu is forested with particularly tall and dense mangrove trees. A night count followed after dark from Sungai Raya estuary to the Palu Palu estuary. Crocodile eyeshine was not detected; no vessels were encountered.

Table 1. Crocodile night counts in the Pulau Selirong area, Brunei. May & July 2006. A=adult, J=older juvenile, Y=yearling, H=hatchling, EO=eyes only; H₂O=water level, M=medium, Hi=high, L=low; We=weather, dr=drizzle; cr=clear, cl=cloudy; Mn=moon, no=no moon; fl=full moon; *=*C. porosus*; **= as calculated from GPS coordinates and 1:50,000 maps; O()=survey under unsuitable conditions excluded from aggregate; []=replicate survey excluded from aggregate; Sg.=sungai; Tj.=tanjung. Italicized location names=daytime habitat survey also conducted. See Appendix 1 for start and end of survey GPS coordinates.

Location	Date	Crocodile Age Class					Distance (km)**	E rate (/km)	Conditions		
		A	J	Y	H	EO			H ₂ O	We	Mn
<i>Sg. Temburong</i>	24 May	0	0	(1)	0	0	(12.6)	(0.08)	M-H	dr	no
<i>Sg. Temburong</i>	27 May	1*	2*	1*	0	6	20.5	0.49	L	cl	no
<i>Sg. Temburong</i>	15 & 17 July	[1*]	[2*]	[2*]	0	[4]	[20.5]	[0.44]	L/M	dr	no
<i>Sg. Mataiang</i>	25 May	0	0	0	0	0	(3.7)	(0.0)	M	cr	no
<i>Sg. Mataiang</i>	26 May	0	0	0	0	0	3.7	0.0	L	dr	no
<i>Sg. Mataiang</i>	13 July	0	0	0	0	0	[0.0]	[0.0]	L-M	cl	no
<i>Sg. Raya/ Sg. Palu Palu</i>	28 May	0	0	0	0	0	9.3	0.0	L-M	cr	no
<i>P. Selirong northwest coast</i>	28 May	0	0	0	0	0	2.2	0.0	M	cr	no
<i>Sg. Bangau/Aloh Besar / Melimbai</i>	11 July	0	1*	0	0	2	9.9	0.30	L	cr	no
<i>Ma. Aloh Besar – Tj. Lumba Lumba</i>	11 July	0	0	0	0	0	3.7	0.0	L-M	cr	no
<i>Sg. Duwau Besar</i>	12 July	0	2*	2*	1*	5	9.6	1.04	L	cr	no/fl
<i>P. Selanjak/ P. Tarap</i>	14 July	0	0	0	0	2	8.4	0.24	L	cr	no
<i>Sg. Batu Apoi</i>	15 July	0	2*	1*	0	4	15.3	0.46	L	cr	no
<i>Sg. Labu</i>	16 July	0	0	0	1	1	20.5	0.10	L	cl/dr	no
TOTALS		1	7	4	2	20	103.5	0.33	crocodiles/km		

Sungai Bangau. Surveyed on a night count of the Bangau, Melimbai and Aloh Besar waterways 11 July 2006. Mangroves bordering the eastern littoral of Sungai Bangau (Lawas District, Sarawak) were clear-felled in the past (Charles in Ibrahim 2002), but have regenerated to a dense even canopy of short trees (Fig. 5), which with adjoining low tide mudflats is suitable general habitat for *C. porosus*.

The only permanent human habitation along the Bangau is a settlement (name unknown) of 11 houses in Sarawak at the confluence with the Ayam Ayam tributary. Inspection of creeks on the Pulau Selirong side of Sungai Bangau showed intact stands of mixed *Rhizophora* with a 'healthy' component of standing deadwood and no sign of cutting or other disturbance.



Figure 5. Bushy *Rhizophora* and mudflat littoral, Sungai Bangau, Sarawak.

Other areas of Brunei Bay.

Sungai Melimbai is a wide tidal tributary located in Labu Reserve Forest south of Pulau Selirong. The main arm of the Melimbai was surveyed in the afternoon of 11 July. An intact littoral of contiguous mangrove and a few fishing nets were noted. From brief views obtained of the forest edge, the mixed *Rhizophora* is not as tall or dense as in most of Pulau Selirong.

The littoral of Aloh Besar on the Pulau Selirong side is intact with no sign of human disturbance. The southern littoral bordering Labu Reserve Forest is similarly well-forested but the *Rhizophora* shorter and somewhat thinner. Cutting for timber and poles is permitted on a sustained-yield basis by the Forestry Department.

A night count on 11 July of the Bangau, Melimbai and Aloh Besar recorded a c. 1.0 m TL *C. porosus* at the start of the survey only 0.5 km from the Sarawak settlement, and two eyes-only crocodiles in Sungai Melimbai, one of which was visibly small and the other in mid-stream apparently large.

Sungai Duwau Besar. This large coastal tributary in Labu Forest Reserve was reconnoitered late in the afternoon of 12 July. A continuous canopy and littoral of mangroves, and wide shallow channels are particularly aesthetic. Little evidence was observed of cutting or other human disturbance in the recent past. Several sections contain large *Rhizophora* and *Xylocarpus*, and standing deadwood is well-distributed along the littoral. No human structures, nets or clearings were noted throughout this system. One small fishing boat was met in the evening. Extensive mudflats were observed at low tide, particularly in the lower reaches.

A night count of Sg. Duwau Besar was also conducted on 12 July. Conditions from the starting point in the upper reaches were optimal, but a rising full moon illuminated the last third of the survey route approaching the confluence at Aloh Besar. Ten crocodiles were spotted, all in the upper half of Duwau Besar. A 48.5 cm total length (TL) *C. porosus* juvenile (Figs. 6 and 11) was caught by hand and four other crocodiles were approached closely enough to identify them as *C. porosus*.

After the survey of Pulau Selanjak and Pulau Tarap on 14 July, an attempt was made to replicate the Duwau Besar night count at low tide and conduct an initial survey of Duwau Kecil, but the Duwau estuary was too shallow to navigate.

Pulau Selanjak and Pulau Tarap.

A reconnaissance was conducted on 14 July. The mangrove vegetation is a physical mosaic of mixed *Rhizophora*. Littoral patches of tall dense trees are intermixed with thinner clumps and occasional openings of tall *Rhizophora* saplings. Excursions up several side creeks found stacks of poles cut from mangrove saplings, the more recent ones in bundles of 40-50, and older ones of about 20. No signs of cutting at or near the littoral were evident. Permits issued by the Forestry Department for extraction of timber and poles in reserved mangrove forest prohibit cutting 50 m from the littoral.



Figure. 6. Forestry officer Abdul Qawi and released *C. porosus* juvenile.

A few thin poles to attach fishing nets were noted in the waterways, but the littoral of the two islands is apparently little disturbed by human activities. A night count on 14 July started at Sungai Selanjak estuary, and traced the Selanjak, Terusan Lawang and Tarap tributaries, included a diversion up the wide unnamed creek in the middle Selanjak, and ended at the Tarap estuary. In the most secluded interior section of the route a c. 2 m TL *C. porosus* was shined in shallow water and mudflats, and a mid-channel eyes-only individual was recorded nearby. Extensive shallow areas (<0.5 m depth) and mudflats at low tide were noted on the night count. No fishing boats, nets or traps were encountered.

Sungai Temburong.

The Temburong river system was considered by Park staff (Mssrs. Afandi, Jamil and Abidin, *verbally*) as the best site for crocodiles in eastern Brunei. The section from Temborong town to the estuary was assessed on the afternoons of 24 and 27 May. Upriver from the tall mangrove fringed estuary the littoral is dominated by Nipah Palm



Figure. 7. Gravel and stone barge, Sungai Temborong.

Nipa fruticans as far as Temborong town. Considerable traffic plies the river: large passenger speedboats traveling back and forth between Bandar Seri Begawan, small fishing boats, and large barges laden with gravel and stone from quarries in the upper Temborong (Fig. 7). The passenger boats do not operate at night.

A partial night count was conducted on 24 May under poor conditions, but a more comprehensive count in satisfactory weather and water level was carried out on 27 May (Table 1), from Temburong town to the estuary. The occurrence of *C. porosus* was confirmed. All 10 crocodiles spotted were wary, not allowing a close enough approach for hand capture. A single adult observed in estuary shallows near the end of the survey displayed aggressive behavior from a distance of 12-15 m. The observed yearling infers that a breeding population persisted as recently as two years ago. The lack of hatchlings is puzzling as captive *C. porosus* in northern Borneo lay eggs mainly from August through November (Johnson Jong Joon Soon, Kuching [Sarawak] crocodile farmer, in Cox and Gombek 1985). Hatchling dispersal from nests should therefore have occurred by the survey dates.

Four of the crocodiles spotted on the 27 May survey were within 1.5 km of Temburong town adjacent to opposite bank streetlights, traffic, houses with lights, and construction noise. Long sections of the dark and undisturbed Sungai Temburong littoral were devoid of crocodiles, suggesting that the local population is (or was until recently) under hunting pressure. An anonymous Temburong resident informed the survey team that foreigners sometimes come to Sungai Temburong with a local *pawang buaya* (crocodile shaman) to hunt crocodiles for skins using hooks, most recently in April 2006 when four crocodiles were allegedly taken.

The informant said the Temborong system was legally hunted many years ago by Haji Bigar, who may still live in Kampong Belais near the Pandaruan River bordering Sarawak east of the Temborong.

On the 24 May Temburong night count, a large eyes-only oval-snouted crocodile was located inadvertently by spotlight just inside the flooded *tanjung* at the confluence of Sungai Temburong and Sungai Labu while traveling upriver to the survey starting point. This crocodile was said to be very large, well known to area residents, and can usually be spotted at night at the confluence (Pengiran Affandi, *verbally*). No eyeshine in this area was recorded during the night count.

A fisherman in Sungai Temburong was interviewed on 24 May 2006 while cast-netting along the middle Temburong littoral. Mr. Amit informed the survey team that a large, species-unknown crocodile bit him on the leg (puncture wound shown to the team) in 2001 while fishing in Sungai Batu Apoi, a tributary of Sungai Temburong. Mr. Amit said he used his hands to force the animal to open its jaws and release him, and added that in 1999 a man was killed by a large crocodile in the Batu Apoi.

The 27 May night count was replicated on 15 July (upper section) and 17 July (lower section) under sub-optimal conditions, but resulted in a very similar number and distribution of crocodiles (Table1). The adult recorded on 15 July refers to a c. 2.5 m TL individual shined at the littoral opposite a small abattoir in Temborong town. The owner (Abdul Qawi's grandfather) said the crocodile has resided there for years and feeds on chicken and buffalo offal discarded from the family-run slaughterhouse. The crocodile was said to occasionally bask at low tide on exposed mud flats at the

opposite shore. Aggressive behavior has not been observed and town residents (mostly children) regularly swim in the area.

The turbidity of the Temborong has allegedly increased as a result of gravel and stone quarries upriver from Temborong town. Prawns are now harder to find compared to before the mining operations began (Ampuan Roza Amalyati Ampuan Hussain, Radio Televisyen Brunei, *verbally*).

Sungai Batu Apoi. This long tributary of the Temborong was considered the remaining stronghold of crocodiles in the river system (Pengiran Affandi, Temborong town elders, *verbally*). Due to time constraints no daytime assessment of habitat was conducted. Temborong town residents said prawn fishing in the less turbid Batu Apoi was the best in the Temborong system, and until recently was known for large aggressive crocodiles (species uncertain).

A 15 July night count from the Temborong confluence to Kampong Selapun tallied seven crocodiles (three positively identified as *C. porosus*) (Table 1). All crocodiles were shined at Kpg. Batu Apoi in the freshwater-saline interface of nipah-dungan *Heritiera globosa* forest, or farther upstream in freshwater where dungan is dominant at the littoral. A 10.8 km section of nipah-edged meanders and mudflats in the lower Batu Apoi appeared suitable for *C. porosus* but no eyeshine was detected.

Sungai Labu. No daytime assessment of habitat was undertaken, but a night count was conducted on 16 July from the bridge at Kampong Labu to the confluence with Sungai Temborong. Dungan forest reportedly dominates the littoral further upstream (Said 2002). Two crocodiles were spotted very near the start of the survey in slightly brackish water. The first, an unidentifiable hatchling, was at a littoral access ramp at the edge of the well-lighted village. The second and last sighting of the survey was an eyes-only < 1 km downstream. No crocodiles were spotted in the remaining 19 km course, passing mainly through nipah-edged littoral and nipah-mixed *Rhizophora* approaching the Temborong confluence.

An informant at Kampong Labu who wished to remain anonymous said two kinds of crocodile inhabited the Labu: *buaya ikan* (fish crocodile) and *buaya tembaga* (copper crocodile). The former is slender-snouted and grows to a large size (>4m TL) but did not attack people. The latter is oval-snouted and dangerous if large. In the immediate vicinity of Kampong Labu the two types overlapped. Nesting of *buaya ikan* was unknown, but the headwaters of small freshwater streams in the Kampong Labu area were assumed to include nesting habitat because groups of hatchlings were noted there 2-3 years ago. Both types of crocodile in the Labu were said to be very shy and best approached in a *sampan* (small wooden boat without a motor). The informant surmised that local crocodile abundance has remained more or less unchanged over the past twenty years.

Three men were met fishing for prawns in the lower Labu. They said they have done this regularly since childhood (≥ 30 years) for personal consumption and have never seen a crocodile. Pronged spears and a spotlight are used to impale prawns at the littoral. The men opined that the local prawn population remained fairly plentiful.

Some night counts in Brunei Bay were constrained by poor conditions: rain and the lack of low tides. In addition, offshore shoals at low tide hindered access to

tributaries intended for survey, particularly the attempt to resurvey Sungai Duwau Besar on 14 July and on 28 May when the Park speed boat could not proceed beyond Sungai Mataiang estuary to reach the Raya/Selirong/Palu Palu tributary system. The team returned to wait for rising, sub-optimal water to start surveying. Pre-placement at the endpoint of a speedboat while water levels are at medium or high stage is required to survey such areas at the desired low water (*tuhur*) stage.

Thirteen of 34 crocodiles (38.2%) recorded on non-replicate surveys in the Brunei Bay area were positively identified as *C. porosus*. The eyes-only component was a substantial 58.8%.

Discussion.

Crocodylians present. The only crocodilian confirmed to inhabit the Brunei Bay region is *C. porosus*. Most (88.2% n=34) sightings in mainly saline tributaries were in upper sections, and included freshwater habitat in Sungai Batu Apoi. The crocodiles were wary, usually not allowing a close approach to ascertain species, or capture by hand. This may be due to disturbance from nocturnal prawn fishing, hunting or other sources. The encounter rate of 0.33 crocodiles/km (Table 1) is similar to that of initial surveys in tidal and semi-tidal river systems of Sarawak (0.54/km; 1,043 km surveyed; Cox and Gombek 1985) and in Sabah (0.49/km; 1,146 km surveyed; Whitaker, 1984) before recovery efforts commenced. As in Brunei, *C. porosus* comprised or was deduced to comprise all sightings.

The Malayan False Gavia *Tomistoma schlegelii* has been photographed in freshwater habitat of Sungai Tutong in Tutong District of western Brunei (Steubing *et al.* 2006). Description of a slender-snouted crocodile consistent with the Malayan False Gavia was related by Noralinda Hj. Ibrahim on 23 May 2006. She observed the individual in the upper Sungai Temburong in Ulu Temburong National Park in February 1996 following a flash flood. *Tomistoma* may inhabit the freshwater sections of the Labu and Batu Apoi. An accurate description of the species was provided by an informant at Kampong Labu. Additional surveys farther upriver in these three systems are desirable.

The Borneo Crocodile *C. raninus* Müller and Schlegel 1844 has been reported from Brunei (Das and Charles 2000, 2002), but the single specimen, a skull from a freshwater lake in Tasek Melimbun Heritage Park, "clearly has the pterygoid suture state of *porosus*" (Charles Ross, *in litt.* 23 August 2006). Ross (1990) resurrected *C. raninus* based on the cranial osteology of two skulls: one collected from the Barito River in Central Kalimantan in 1836, the other labeled "Borneo"; and the scalation pattern of two juveniles preserved in alcohol. The first juvenile was collected between 1836 and 1844 by Diard from the Pontianak area of West Kalimantan and the second by Hornaday in 1878, ostensibly from Sarawak (Ross *et al.* 1998). Surveys of crocodilian distribution in all four Kalimantan provinces in 1995 and 1996 did not locate any *raninus* material (Ross *et al.* 1998). Comparative DNA analysis of a '*raninus* group' (= *C. raninus*, *C. novaeguineae* and *C. mindorensis*) juvenile examined in 1996 at a crocodile farm in Banjar Baru, Southern Kalimantan yielded >95% probability of origin from the north coast population of *C. novaeguineae* (J. Gratten, *in litt.* 2 September 2005).

An apparently disjunct relict population of the Siamese Crocodile *C. siamensis* persists in the Mahakam River system of East Kalimantan, Indonesia (Cox 2004; Kurniati and Widodo 2005). A nest attributed to this species by Kurniati and Widodo (2005) infers at least some reproductive effort in the wild as recently as 2005. Adults purportedly obtained as juveniles from the Barito River system and maintained at a farm in Banjar Baru, South Kalimantan (Ross *et al.* 1998; Cox 2004) suggest that *C. siamensis* may be (or was) more widely distributed in Kalimantan. Radiation from mainland Southeast Asia to Borneo via Sumatra and Java apparently occurred during Pleistocene glacial periods when the region was connected by dry seabeds and major paleoriver systems of the exposed Sunda Shelf (Inger 1966, Ross 1986). These dendritic arteries may have served as pathways for *C. siamensis* to colonize additional palustrine rivers of Borneo.

Pulau Selirong. Although initial surveys of Pulau Selirong do not indicate an extant population of the Indopacific Crocodile, replenishment of the species would enhance local biodiversity, help PSFRP satisfy criteria for listing as a Ramsar Convention site and contribute to ecotourism appeal of the area.

Tourism safety and management. As the largest predator in the mangrove ecological pyramid, the species is assumed to have an important role, even though *in situ* research in countries where *C. porosus* or other crocodilians are distributed has not demonstrated their function as a keystone species (see Gorzula 1987).

Sections of the two kilometer boardwalk traversing central Pulau Selirong are reportedly vulnerable to attack by Indopacific Crocodiles, particularly during spring tide, and require raising and reinforcement of railings (Das 2003). Although the boardwalk is located near several small streams, these are too shallow and obstructed by emergent *Rhizophora* roots (Fig. 8) for large crocodiles to access at most high tides. The existing walkway appears to be sufficiently raised (pers. obs).



Fig. 8. *Rhizophora* roots at high tide, PSFRP boardwalk.

Pulau Selirong provides good general habitat for *C. porosus*, but the ubiquitously dominant mangrove vegetation is unsuitable for nesting. The forest floor is subject to daily inundation and there is a dearth of herbaceous matter required to construct nesting mounds. *Contra* Das (2002), the Indopacific Crocodile is not known to nest in Mud Lobster *Thalassina anomala* mounds, which lack decaying vegetation that mound nests comprise to generate heat for egg incubation.

The reproductive viability of crocodiles at Pulau Selirong is linked to identification and protection of critical nesting habitat and breeding crocodiles in

additional river systems of Brunei Bay. Maintenance of *C. porosus* at Pulau Selirong evidently depends on recruitment of individuals from rather distant nesting areas in the Bruneian region of Brunei Bay. At present these locations can only be surmised from local and topographical information, but likely occur near creeks and perhaps adjoining wetlands in the non-saline upper reaches of river systems that include patches of herbaceous vegetation.

The upper Labu and upper Batu Apoi apparently contain such habitat. Nearer Pulau Selirong, the Ayam Ayam, Melimbai and Duwau Besar may as well. Despite its common names, *C. porosus* in Australia and Papua New Guinea (PNG) typically nests in freshwater wetlands with a substantial herbaceous component (Webb *et al.* 1983, Cox 1985, Webb and Manolis 1989). In the Sepik River of PNG, non-saline habitats such as oxbows and lakes with mats of floating herbaceous vegetation provide optimal foraging and nesting habitat 200-300 km upriver from the estuary (Cox 1985, Cox *et al.* in press).

Development of a strategy to protect breeders and nesting habitat seems essential if *C. porosus* is to be conserved in the region. At present the species is unprotected under Brunei law. Inclusion of *C. porosus* in the Wildlife Protection Act would be an important first step towards recovery of the resource.

Population recovery may also be accomplished by translocation (supplementation) of farmed or ranched animals. Locations in Sarawak and Sabah are the nearest and genetically most appropriate sources. Crocodile farms near Pontianak, West Kalimantan, and Balikpapan and Tarakan, East Kalimantan also rear non-hybridized *C. porosus* from Borneo, but importation of offspring is complicated by CITES obligations and lack of supportive national legislation. Supplementation of any individuals would also need genetic studies to establish conspecific homogeneity with the Brunei Bay population, health screening, post-release monitoring, and other adherence to IUCN Guidelines on Reintroduction.

The recent reproductive success of remnant *C. porosus* in the Duwau, Labu and Temborong river systems appears to present a more cost-effective strategy to repopulate the Brunei Bay area. With active protection of breeders and nesting areas, local translocations (where feasible), and possible enhancement of nesting, the population could gradually increase and disperse, and require fewer external inputs.



Figure 9. *C. acutus* nesting platform, Cispata Bay, Colombia. (Photograph by Giovanni Delgado)

A monitoring and enforcement program would need to be designed but could be implemented with existing Forestry Department capacity and training exercises.

Replenishment of *C. porosus* at Pulau Selirong and other areas of Brunei Bay may be accelerated by constructing raised nesting platforms (Fig. 9). This recently developed technique effectively attracts American Crocodiles *C. acutus* to excavate nests in mangrove habitat in Cispata Bay, Colombia. Within the first year of construction, nests were built on about half (n=35) of the platforms (G. Delgado, Project Manager, *verbally*).

Unlike hole nesting *C. acutus*, *C. porosus* is a mound nester (Fig. 10). A source of coarse herbaceous vegetation is required to provide heat from decomposition to incubate the eggs. Construction of a similar raised but grassy and more secluded platform may possibly attract *C. porosus* to nest in mangrove habitat. Knowledge of *C. porosus* nesting sites in the Brunei Bay wetlands would help determine which plants are best to try on platforms.



Figure 10. Nesting *C. porosus*, at the base of a floating sapling, Kamiemu oxbow, Sepik River, Papua New Guinea. March 1998.

Due to severe population depletion and/or inferior habitat for nesting females at Pulau Selirong, *C. porosus* platforms would probably be more effective in nearby tributary systems such as Sungai Duwau Besar, where survey results infer a small breeding population persists, and current logistic capacity allows for the area to be routinely monitored by PSFRP staff.

The Indopacific crocodile possesses the most valuable skin of all crocodilians. Economic incentives have been used to successfully develop integrated conservation and development programmes in Australia and Papua New Guinea based on recovery and sustainable utilization of wild *C. porosus*. Poultry farms in Brunei could become the nucleus of a commercial effort to replenish *C. porosus* populations. Brunei's established 'green earth' policy of natural resource use, far-sighted view of tropical forest conservation, and pursuit of economic diversification can bolster such an effort and eventually contribute an important example of restorative crocodilian management in Borneo.

Transnational cooperation. Brunei Bay extends northeast to the states of Sarawak and Sabah in Malaysia (Fig. 1). Cooperative management of the bay's wetlands resources can mutually enhance prospects for sustainable use of local

fisheries and wildlife. For Pulau Selirong in particular, there is urgent need to elicit support of the fishing community residing at the confluence of the Ayam Ayam and Bangau tributaries in Sarawak.

Mutual transfer of knowledge and skills. PSFRP officer Abdul Qawi bin Juma'at was trained in the technique of spotlighting for crocodiles and is willing to learn further about night count methodology, crocodile capture techniques and to participate in future surveys. Additional experience is needed in species identification and estimation of size/age classes. Speedboat drivers from Forestry Department teams stationed at Tanjung Puan were familiarized with specialized driving techniques to properly conduct night counts.

4. Recommendations for follow-on work.

The suggested course of action is being followed to propose a collaborative research initiative between the Brunei Forestry Department (Ministry of Development), Florida Museum of Natural History (University of Florida), University of Brunei Darussalam and the Natural History Division (Brunei Museum).

1. Extend protection to *C. porosus* and *Tomistoma schlegeli* under the Wildlife Protection Act (Brunei Darussalam).
2. Develop a Crocodile Management Plan for crocodilians in Brunei that initially emphasizes:
 - a) A country-wide survey to assess current status of resident crocodilians;
 - b) Establishment of a public education program to i) dispel myths about the dangers of crocodiles, ii) promote safe interaction (e. g., prohibit swimming at Temborong town or build a stockade), and iii) highlight the economic and conservation value of crocodile populations;
 - c) Design and conduct of a study to assess the feasibility of ranching and farming *C. porosus* in Brunei;
 - d) Identification of *C. porosus* nesting areas in Duwau Besar, Melimbai, Temborong, Batu Apoi and Labu tributary systems of Brunei Bay;
 - e) Devising a community-participatory strategy to effectively protect breeding crocodiles and nesting habitat in Brunei Bay;
 - f) Construction and monitoring of prototype nesting platforms in Sg. Duwau Besar, and other areas as deemed feasible; and,
 - g) Collecting information from former (or active) hunters such as Haji Bigar on crocodile ecology and the history of crocodile exploitation in Brunei.
3. Integrate future surveys in Brunei Bay (replicates and initial ones in the upper Temborong, upper Labu and Ayam Ayam) with those being proposed for other areas of Brunei (e. g., Sg. Belait, Sg. Tutong, Sg. Damuan, Tasek Melimbun Heritage Park, Sg. Pandaruan), and Sarawak and Sabah.

4. Establish information sharing and technical collaboration with the IUCN-SSC Crocodile Specialist Group (CSG) and other interested organizations.

5. Ornithological and other wildlife observations.

In keeping with Forestry Department policy for visitors to provide records of their wildlife sightings at Pulau Selirong, incidental observations made by the author while assessing habitat or waiting for scheduled crocodile surveys to be conducted are included in this report.

Thirty-six bird species were identified using *A Guide to the Birds of Southeast Asia* (Robson 2000) and *Pocket Guide to the Birds of Borneo* (Francis 1984). The number of species observed in such a short period and semi-casual manner suggests that the revised PSFRP inventory of 57 species remains substantially under-recorded. Appendix 2 provides locality records, comments on the distinctiveness of Pulau Selirong bird communities, and suggestions to enhance appeal and access for visitors. The availability and publication of an updated checklist would facilitate ornithological research in the island and peripheral areas.

Long-tailed Macaque *Macaca fascicularis* was regularly observed around Park headquarters at Tj. Puan. Troops consisting of 8-13 individuals of various age classes usually visited in the morning of each day. Other troops were occasionally noted in the daytime along the Selirong boardwalk, or by boat foraging in littoral mangrove trees of most major tributaries.

A small troop (≥ 3) of Proboscis Monkey *Nasalis larvatus*, including an adult male, was observed at the back of the Park headquarters building along the sandy littoral and mangroves on the mornings of 26 May and 16 July. A larger troop (≥ 8) was noted on 14 and 17 July near the 1450 m to 1850 m section of the boardwalk.

An adult Flying Lemur (Colugo) *Cynocephalus variegatus* was spotted sleeping on 24 May 2006 at 10h20 on a sapling stem in dense mangrove forest along the raised walkway opposite the 1350 m marker. The species was also recorded moving past Tj. Puan Guard Pos on the morning of 14 July.

Plantain Squirrel *Callosciurus notatus* was regularly observed along the PSFRP boardwalk, the periphery of Tj. Puan Guard Post, and in the Bangau, Palu Palu and Selirong tributaries.

A c. 1.7 m Mangrove-Cat Snake *Boiga dendrophila* was spotted at night on 13 July crossing Sg. Mataiang and pausing upright on littoral mudflats.

6. Acknowledgements.

The author is most grateful to Mr. Tuan Haji Shahrill Haji Shahbudin, Acting Director of the Brunei Forestry Department and Mr. Mahmud Haji Yussof for approval and facilitation of the visit. Ms. Noralinda Haji Ibrahim, and Mr. Haji Ryni Sofian Haji Othman provided key liaison with Forestry Department officers based at Pulau Selirong Forest Recreation Park. Haji Ryni is acknowledged and thanked for travel assistance in and around Bandar Seri Begawan, supplemental information and helping to edit the Interim Report.

The author is indebted to Forestry Department officers and staff associated with Pulau Selirong, without whose valuable assistance the visit could not have been conducted. PSFRP Team Leaders Pengiran Noorafandi and Pengiran Abidin contributed greatly to the success of activities by organizing and co-leading surveys. Forestry staff Endey Chin, Jamil, Mambrosek ak. Jenging, Abdul Qawi bin Juma'at and Othman, in addition to Forest Police officers Lai Chu Chen, Kin, Donney, Julai and Zulkarnain, accompanied the author on various excursions. Their camaraderie and helpfulness at every turn is greatly appreciated. Special thanks to the Abdul Qawi family for accommodation and hospitality while in Temborong.

Mr. Masakazu Kashio, FAO Regional Office for Asia-Pacific, is gratefully acknowledged for initiating the visit request and providing background reports and other information (e. g., Kashio *et al.* 2002).

Mark Bezuijen, Steve Gorzula, Noralinda Hj. Ibrahim, F. Wayne King (CSG Honorary Steering Committee Member), Charlie Manolis (CSG Vice-Chairman: Australia and Oceania), Rob Steubing, John Thorbjarnarson (CSG Red List Authority) and Rom Whitaker (CSG Honorary Steering Committee Member) reviewed a draft of this report and provided useful comments for a much improved final version.

Giovanni Andrés Ulloa Delgado (CSG Vice-Chairman: Latin America and the Caribbean) and Prof. Grahame Webb (CSG Chairman) provided information on nesting platforms in Colombia. Mr. Samhan bin Nyawa (Curator of Natural History – Brunei Museum and Manager of Merimbun Heritage Park) briefed the author on conservation needs in Brunei, biodiversity studies and records of crocodiles from western Brunei. Prof. Joseph Charles (Biology Department, University Brunei Darussalam) diverted from his busy schedule to discuss crocodiles in Brunei and further afield, and provided additional information on Pulau Selirong, in particular its birds. Lisdi Rizeki assisted with calculation and checking of survey distances. Amrit Bajracharya helped produce the maps.



Figure 11. Hatchling *Crocodylus porosus* (48.5 cm TL) caught in Sungai Duwau and released in the upper Sungai Mataiang, Pulau Selirong.

Literature Cited.

- Charles, J. (undated). The Colugos. The sleeping beauties of Pulau Selirong (brochure). Forestry Department, Brunei Darussalam.
- Charles, J. 2002. Pulau Selirong – a forest reserve and an ecotourist destination. Pp. 71-74 in Treasures Unknown: Proceedings of the experts consultative meeting on managing Pulau Selirong Forest Recreation Park. Forestry Department, Brunei.
- Cox, J. 1985. Crocodile nesting ecology in Papua New Guinea. Field Document No. 5. PNG Department of Primary Industry-FAO Project PNG/74/029. Port Moresby.
- Cox, J. and F. Gombek, 1985. A preliminary survey of the crocodile resource in Sarawak, East Malaysia. IUCN/WWF project No. MAL 74/85. WWF Malaysia, Kuala Lumpur.
- Cox, J. 2004. Status and conservation of the Siamese Crocodile *Crocodylus siamensis* in Kalimantan (Indonesian Borneo). Pp. 150-154 in Proceedings of the 17th Working Meeting of IUCN-SSC Crocodile Specialist Group. Darwin. IUCN: Gland.
- Cox, J. 2006. A preliminary survey of crocodiles and habitat at Pulau Selirong Forest Recreation Park and vicinity, Brunei Darussalam, 23-29 May 2006. Interim report to Forestry Department Brunei Darussalam.
- Cox, J., B. Gowep, A. Mava, J. Wana, J-M. Genolagani, V. Kula, G. Solmu, R. Sine, D. Wilken and E. Langelet. In press. The saltwater crocodile *Crocodylus porosus* egg harvest program in Papua New Guinea: linking conservation, commerce and community development. Paper for Proceedings of the 18th Working Meeting of the IUCN-SSC Crocodile Specialist Group. Montélimar, France, 19-23 June 2006. IUCN:Gland.
- Das, I. 2003. Report on herpetological observations at Pulau Selirong, Temburong District, Brunei Darussalam. Brunei Forestry Department and Ramsar Center Japan.
- Das, I. and J. Charles. 2000. A record of *Crocodylus raninus* Muller & Schlegel, 1844, from Brunei, North-western Borneo. *Sabah Parks Nature Journal* 3:1-5.
- Das, I. and J. Charles. 2002. New record of a freshwater crocodile from Brunei. *IUCN/SSC Crocodile Specialist Group Newsletter* 21(1):10-14.
- Davison, G. W. H. and C. Y. Fook. 1996. A Photographic Guide to Birds of Borneo. New Holland Publishers: London.
- Francis, C. M., 1984. Pocket Guide to the Birds of Borneo. The Sabah Society: Kota Kinabalu.
- Gorzula, S., 1987. The Management of Crocodilians in Venezuela. Pp. 91-101 in *Wildlife Management: Crocodiles and Alligators*. Eds: G. J. W. Webb, S. C.

- Manolis and P. J. Whitehead. Surrey Beatty & Sons and Conservation Commission of the Northern Territory, Australia .
- Ibrahim, S. Hj. 2002. Proposed Management Plan for Pulau Selirong. Forestry Department Brunei Darussalam.
- Inger, R. F. 1966. The Systematics and Zoogeography of the Amphibia of Borneo. *Fieldiana: Zoology* 52:1-402.
- Kashio, M., W. T. Meng and R. Nakamura. 2002. Treasures Unknown: Proceedings on the experts consultative meeting on managing Pulau Selirong Forest Recreation Park. Forestry Department, Brunei Darussalam.
- Kurnitai, H. and T. Widodo. 2005. Surveys of Siamese crocodile habitat (*Crocodylus siamensis*) in the Mahakam River, East Kalimantan, Indonesia. Indonesian Institute of Sciences (LIPI). Research Center for Biology (Puslitbang). Cibinong, West Java.
- Lambert, F. 1996. Identification of pittas in the '*brachyura*' complex in Asia. *OBC Bulletin* 23: 31-37.
- Robson, C. 2000. A Guide to the Birds of Southeast Asia. Princeton University Press: Princeton.
- Ross, C. A. 1986. Comments on Indopacific crocodile distributions. Pp. 349-354 in Proceedings of the 12th Working Meeting of the IUCN-SSC Crocodile Specialist Group. Pattaya, Thailand. IUCN: Gland.
- Ross, C. A. 1990. *Crocodylus raninus* S. Müller and Schlegel, a valid species of crocodile (Reptilia: Crocodylidae), from Borneo. *Proc. Biol. Soc. Washington* 103: 955-961.
- Ross, C. A., J. H. Cox, H. Kurniati, and S. Frazier. (1998). Preliminary surveys of palustrine crocodiles in Kalimantan. Pp. 46-79 in Proceedings of the 14th Working Meeting of IUCN-SSC Crocodile Specialist Group. Singapore. IUCN: Gland.
- Said, I. M. 2002. Wetlands of Brunei. Pp. 50-65 in Treasures unknown: Proceedings of the experts consultative meeting on managing Pulau Selirong Forest Recreation Park. Forestry Department, Brunei Darussalam.
- Webb, G.J.W., G. C. Sack, R. Buckworth and S. C. Manolis. 1983. An examination of *Crocodylus porosus* nests in two northern Australian freshwater swamps, with an analysis of embryo mortality. *Aust. Wildl. Res.* 10: 571-605.
- Webb, G. J. W. and S. C. Manolis. 1989. Crocodiles of Australia. Reed Books: Sydney.
- Whitaker, R. 1984. Preliminary survey of crocodiles in Sabah, East Malaysia. IUCN/WWF Proj. No. 3127. WWF-Malaysia and Game Branch, Sabah Forestry Department.

Appendix 1. GPS coordinates for crocodile night counts in the Brunei Bay area.

Survey Site	Date	Time	Coordinate	
Sungai Temborong start	24 May '06	19h31	4° 45.005' N	115° 5.212' E
“ end	“	22h10	4° 44.859' N	115° 5.734' E
Sungai Temborong start	27 May '06	19h20	4° 42.479' N	115° 4.390' E
“ end	“	22h01	4° 49.133' N	115° 3.423' E
Sungai Temborong start	15 July '06	19h35	4° 42.479' N	115° 4.390' E
“ end	“	23h15	4° 44.843' N	115° 7.724' E
“ resume	17 July '06	0h40	4° 44.843' N	115° 7.724' E
“ end	“	2h13	4° 49.133' N	115° 3.423' E
Sungai Mataiang start	25 May '06	20h25	4° 54.175' N	115° 6.898' E
“ end	“	21h35	4° 53.272' N	115° 8.084' E
Sungai Mataiang start	26 May '06	20h27	4° 54.175' N	115° 6.898' E
“ end	“	21h44	4° 53.272' N	115° 8.084' E
Sungai Mataiang start	13 July '06	21h09	4° 53.272' N	115° 8.084' E
“ end	“	21h55	4° 54.175' N	115° 6.898' E
Sg. Raya / Sg. Palu Palu start	28 May '06	23h09	4° 54.343' N	115° 8.265' E
“ end	29 May '06	0h24	4° 52.154' N	115° 6.727' E
Pulau Selirong NW coast start	“	1h08	4° 53.492' N	115° 5.799' E
“ end	“	1h42	4° 54.175' N	115° 6.898' E
Bangau/Melimbai/A. Besar start	11 July '06	19h19	4° 52.281' N	115° 8.880' E
farthest pt. up Sg. Melimbai	“	20h18	4° 50.172' N	115° 8.093' E
farthest pt. up small tributary	“	20h53	4° 51.268' N	115° 7.794' E
Bangau/Melimbai/A. Besar end	“	21h47	4° 51.934' N	115° 6.853' E
Ma. Aloh Besar – Tj. Lumba Lumba	“	22h15	4° 51.934' N	115° 6.853' E
“ end	12 July '06	23h00	4° 53.492' N	115° 5.799' E
Sungai Duwau Besar start	“	18h39	4° 47.487' N	115° 7.542' E
“ end	“	22h10	4° 50.686' N	115° 5.797' E
Pulau Selanjak/ P. Tarap start	14 July '06	19h37	4° 49.270' N	115° 3.463' E
“ end	“	20h40	4° 50.243' N	115° 4.341' E
Sungai Batu Apoi start	15 July '06	21h41	4° 44.859' N	115° 5.734' E
“ end	16 July '06	0h10	4° 41.879' N	115° 8.723' E
Sungai Labu start	“	21h48	4° 45.891' N	115° 11.664' E
“ end	17 July '06	0h40	4° 44.843' N	115° 7.724' E

Appendix 2. Birds observed at Pulau Selirong, 23-29 May and 8-19 July 2006.

Birds recorded in Pulau Selirong Forest Recreation Park, Brunei Darussalam, 23-29 May and 9-18 July 2006				
Species	S I T E S			
	Guard Post	Boardwalk	Waterways	Coast
Sunda Pygmy Woodpecker* <i>Dendrocopus moluccensis</i>		■	○ (c. Bangau)	
Common Flameback <i>Dinopium javanense</i>	●	○		
Rufous Woodpecker* <i>Celeus brachyurus</i>		○		
Red-throated Barbet* <i>Megalaima mystacophanos</i>	●	■		
Collared Kingfisher <i>Todiramphus chloris</i>	●	○		
Stork-billed Kingfisher <i>Halcyon capensis</i>			■ (Mataiang)	
Plaintive Cuckoo* <i>Cacomantis merulinus</i>		■		
Little Bronze Cuckoo* <i>Chrysococcyx minutillus</i>		○		
Chestnut-bellied Malkoha <i>Phaenicophaeus sumatranus</i>		○		
Chestnut-breasted Malkoha* <i>Phaenicophaeus curvirostris</i>		●		
Edible-nest Swiftlet* <i>Collocalia fuciphaga</i>	■	○	○ (Selirong)	
Grey-rumped Treeswift* <i>Hemiprocne longipennis</i>	●	○	○ (Selirong)	
Green Imperial Pigeon <i>Ducula aenea</i>			○ (Aloh Besar)	
Pink-necked Green Pigeon* <i>Treron vernans</i>		○		
Common Redshank <i>Tringa totanus</i>			● (Palu Palu)	
Black-naped Tern* <i>Sterna sumatrana</i>				●
White-bellied Sea Eagle <i>Haliaeetus leucogaster</i>	○		(Bangau?)	
Brahminy Kite <i>Haliastur indus</i>			○ (Bangau)	
Little Egret <i>Egretta garzetta</i>			● Palu Palu ○ Bangau	■
Chinese Egret <i>Egretta eulophotes</i>	●			
Pacific Reef Egret* <i>Egretta sacra</i>				●

Species	S I T E S			
	Guard Post	Boardwalk	Waterways	Coast
Little Heron <i>Butorides striatus</i>	●			
Common Iora <i>Aegithina tiphia</i>	■			
Lesser Cuckooshrike* <i>Coracina fimbriata</i>		■	○ (c. Bangau)	
Mangrove Whistler <i>Pachycephalus grisola</i>		○		
Pied Fantail <i>Rhipidura javanica</i>		■		
Mangrove Blue Flycatcher <i>Cyornis rufigaster</i>	●	○	● (Palu Palu)	
Oriental Magpie Robin <i>Copsychus saularis</i>		■		
Velvet-fronted Nuthatch <i>Sitta frontalis</i>	●	●		
Pacific Swallow* <i>Hirundo tahitica</i>	■	■		
Ashy Tailorbird <i>Orthotomus ruficeps</i>	■		● Palu Palu ■ Selirong	
White-chested Babbler* <i>Trichasoma rostratum</i>		■		
Chestnut-rumped Babbler* <i>Stachyris maculata</i>	●	○		
Brown-throated Sunbird* <i>Anthreptes malacensis</i>	●			
Olive-backed Sunbird <i>Nectarina jugularis</i>		■		
Copper-throated Sunbird <i>Nectarina calcostetha</i>	■	■		

Legend:

● May record(s); ○ = July record(s); ■ = May + July record(s).

* (and blue letters): first record for Pulau Selirong.

Each of Pulau Selirong's six known mangrove obligates: Sunda Pygmy Woodpecker, Little Bronze Cuckoo, Chestnut-bellied Malkoha, Mangrove Whistler, Mangrove Blue Flycatcher and Copper-throated Sunbird were recorded.

Of the three woodpecker species recorded, Rufous Woodpecker was previously unknown from mangrove habitat throughout its range. The substantial amount of standing deadwood at Pulau Selirong likely provides suitable habitat for additional Bornean picids.

Most woodpeckers were observed from the boardwalk, usually while they searched stems and branches of large live trees. If the current policy of removing

dead trees adjacent to the boardwalk is revised, this would enhance efforts to display the remarkable biodiversity of Pulau Selirong to visitors, especially birdwatchers and ornithologists. In other areas of the island standing deadwood has its own distinct architecture, including large stems exquisitely decayed by shipworms, insects, and woodpeckers. Access to these areas for most tourists is limited by a scarcity of boats for hire.

Construction of a trail or boardwalk extension from the rest area at the 1450 m mark c. 150 m to the south would bring into view a large clump of standing deadwood in various states of decay.

The Mangrove Pitta *Pitta megarhyncha* is a mangrove specialist distributed widely in mainland Southeast Asia. In the Greater Sundas the species is reported only from Sumatra (Lambert 1996 and Robson 2000), and Borneo (Davison and Fook 1996). A single specimen is known from Brunei, collected in Baram District in 1891 (J. Charles *in litt.* 24 August 2006).

The morphologically very similar Fairy Pitta *P. nympha* winters in Borneo (Robson 2000), but numbers throughout its global range have declined dramatically in recent years (Lambert 1996). Pending confirmation of the Brunei specimen as Mangrove Pitta, Pulau Selirong may provide optimal and critical habitat for this apparently uncommon and similarly declining species.

Sixteen species new to the Pulau Selirong list resulted from the author's opportunistic observations, indicating that the enumeration of the Park's birds is substantially incomplete. Good scope and facilities exist for ornithological research in the Pulau Selirong area.

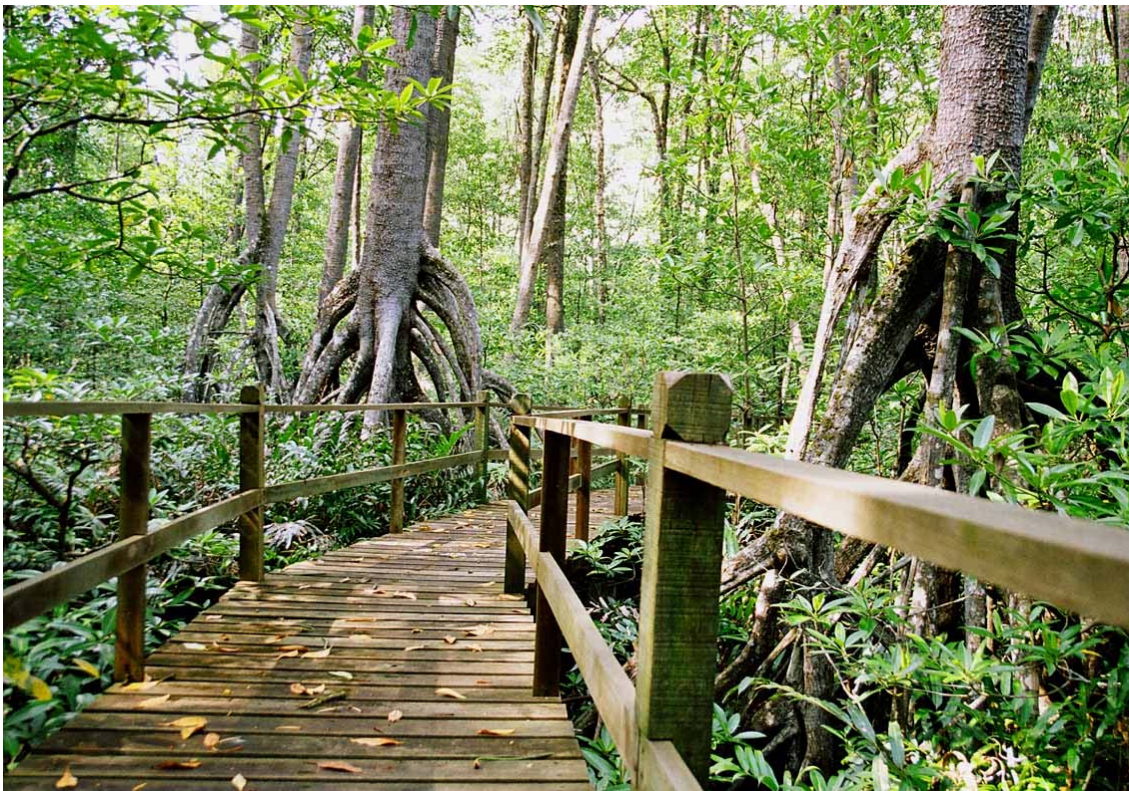


Figure 12. A section of the 1.85 km Pulau Selirong Forest Recreation Park boardwalk.