

Philippine Crocodile *Crocodylus mindorensis*

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Common Names: Philippine crocodile (English), buwaya (general Philippines), bukarot (northern Luzon), bangitaw (Mindanao)

Range: Philippines



Figure 1. Distribution of *Crocodylus mindorensis*.

Conservation Overview

CITES: Appendix I

CSG Action Plan:

Availability of survey data: Adequate
Need for wild population recovery: Highest
Potential for sustainable management: Low

2018 IUCN Red List: Critically Endangered (Criteria A2cd. Observed decline in both known localities (82%) and

estimated and inferred population of adults (85-94%) in last 75 years (since 1937); causes understood and potentially reversible, but ongoing (last assessed in May 2012; Van Weerd *et al.* 2016).

Principal threats:

Taxonomic Status

The Philippine crocodile was described in 1935 by Karl Schmidt on the basis of a type specimen and three paratypes from the island of Mindoro (Schmidt 1935, 1938). Schmidt also described the closely related New Guinea freshwater crocodile (*Crocodylus novaeguineae*) in 1928 and later made a comparison of morphological differences between *C. mindorensis*, *C. novaeguineae* and *C. porosus*, maintaining *C. mindorensis* as a separate species (1956). However the Philippine crocodile has long been treated as *C. novaeguineae mindorensis*, a sub-species of the New Guinea crocodile, by other authorities. Hall (1989) provided new evidence of the distinctness of the Philippine crocodile and nowadays *C. mindorensis* is generally treated as a full species endemic to the Philippines.



Figure 2. Juvenile *C. mindorensis* in Dunoy Lake, in Northern Sierra Madre National Park, northern Luzon Photograph: Merlijn van Weerd.

Ecology and Natural History

The Philippine crocodile is a relatively small freshwater crocodile. Although much is still unknown, studies at two captive breeding facilities [Palawan Wildlife Rescue and Conservation Centre (PWRCC), Palawan Island (Ortega

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1998) and Silliman University, Negros Island (Alcala *et al.* 1987)] and in the wild in northern Luzon and the University of Southern Mindanao, central Mindanao, on Ligawasan Marsh, have now yielded much more information on the ecology of this rare species.

The maximum reported length of a museum specimen is 3.02 m (Hall 1989), with the largest wild male caught in Luzon being 2.7 m. Both females and males become reproductively active at about 1.5 m long and bodyweights of about 15 kg in captivity.

Females generally built mound nests of dried leaves, twigs, bamboo leaves and soil during the dry season (eg see Akmad and Pomares 2008), with a mean height of 55 cm, length of 2 m and width of 1.7 m (average of 4 nests in Luzon). Akmad and Pomares (2008) reported nest material to comprise 70% organic material (leaves, branches) and 30% inorganic material (soil, stones, mud), and moisture content of 25%. Observations from the Muleta River (Ligawasan Marsh) revealed that three nests were located on same side of the river from July to October, approximately 100 m apart close to bamboo and similar slope of terrain. After egg-laying, both male and female crocodiles take turns “watching” the nest. The female crocodile make routine visits to their nest late in the afternoon and early in the morning (Akmad and Pomares 2008).

Hole nesting has also been observed in the wild and in captivity. A study in 2008 in northern Luzon monitored 6 nests, of which four were mounds and two were holes. Hole nests were constructed in open areas, mound nests were partly shaded. Nests were constructed on river and pond banks at a distance of 4–21 m from the waters’ edge (Akmad and Pomares 2008). Decoy or practice nests, both holes and mounds, were made in captivity and the wild.

Mating was observed starting in January in the wild (Luzon) and in captivity (Palawan and Negros). Oviposition took place in April and May in the wild (Luzon) and in captivity (Negros), and during February to October in captivity (Palawan). In captivity on Negros and Palawan multiple nesting has been observed in a small number of pairs. The second clutch is laid 4–6 months after the first with similar clutch sizes.

Mean clutch size in the wild in the northern Philippines was 20.1 eggs (10 nests, range 16–27), slightly lower than that reported from the Muleta River, Tambad, Carmen (Ligawasan Marsh tributary); 26.0 eggs (3 nests, range 22–30) (Akmad and Pomares 2008). In captivity on Palawan, average clutch size was 26 eggs (range 18–33), and on Negros it was 15.7 eggs (range 7–25). Incubation time in the wild was 65–78 days and 77–85 days in captivity.

Crocodylus mindorensis exhibits temperature-dependent sex determination, and under artificial incubation mainly females are produced at 30–31°C and mainly males at 33°C. It is possible that females are also produced at temperatures higher than 33°C but there are insufficient data to support this

at this time

Mean nest temperatures in the wild were 29.5°C and 30.1°C for two nests monitored with hourly data loggers in 2008 (N= 827 and 601 data points, respectively). Akmad and Pomares (2008) reported nest temperature measured at 4 points about 30 cm from the middle of the nest to be in the range 28.4 to 30.0°C, relative humidity (measured at 0700 h, 1200 h and 1700 h) to be 70.7 to 90.3% and illumination on the nest to be 30 to 287.5 foot-candles

Egg fertility rates in captivity were 56% and 57% in Palawan and Negros respectively, and hatching rates of fertile eggs were 45% and 51% respectively. In comparison, egg fertility and hatching rates were higher for wild nests (N= 10 nests, 201 eggs) on Luzon, at 75% and 70% respectively. Wild egg hatching success in the Muleta River (Ligawasan Marsh) was 45.5% in one nest examined; hatchlings were average of 27.7 cm long with 53.41 g in weight (Akmad and Pomares 2008).

Egg predation and anthropogenic nest and egg losses are a considerable threat in the wild on Luzon (17% lost to natural predators and 13% to people) and Mindanao (2 of 3 nests were poached by people; Akmad and Pomares 2008).

The Philippine crocodile lives in rivers, creeks, ponds and marshes from sea level up to at least 850 m above sea level in the Cordillera Mountains of Luzon (Manalo 2008). It has been observed in saline waters along the coast of Luzon where it moves between small creeks through the sea (van Weerd, pers. comm.). In several areas, *C. mindorensis* and *C. porosus* appear to occur sympatrically. This is the case in Ligawasan Marsh on Mindanao (Pomares *et al.* 2008) and in the coastal wetlands of Isabela on Luzon.



Figure 3. *Crocodylus mindorensis* in Dunoy Lake, Northern Sierra Madre Natural Park Photograph: Merlijn van Weerd

Crocodylus mindorensis seems to prefer small wetlands where it occurs in relatively low densities (Ross 2008), although historical information on natural Philippine crocodile densities is lacking. In northern Luzon, *C. mindorensis* has been found in shallow natural ponds and marshes, man-made water reservoirs, shallow narrow creeks, littoral creeks and mangrove areas and fast-flowing larger rivers in mountain areas up to 850 m. One particular habitat occupied by *C. mindorensis* in both the Sierra Madre and Cordillera Mountains is fast flowing rivers with rapids and deep pools lined by limestone cliffs with caves that are used as hiding

places by crocodiles. Philippine crocodiles also make burrows in sandy and clay river banks.

Observed prey species include shrimps, dragonflies, small fish and snails in juvenile crocodiles to large fish, wild and domestic pigs, dogs, civet cats, snakes and water birds in large crocodiles. Philippine crocodiles are very aggressive towards each other in captivity. Intra-specific aggressiveness in the wild has been observed among juveniles but not among adults or between size or age classes. Field observations in northern Luzon indicate that juveniles establish individual territories through aggressive interactions in their second year. Pairs of adult crocodiles are sometimes seen basking and swimming together. Home ranges of radio-tagged crocodiles varied from just over 1 km to 6 km of river in northern Luzon. A study there showed that crocodiles use individual sites in larger rivers during the drier season when water levels and currents are low but congregate in shallow ponds and creeks during the wet season when river currents are high.



Figure 4. Adult *C. mindorensis* tracked using radio-telemetry in the San Mariano Municipal Disulap River Philippine Crocodile Sanctuary. Photograph: Merlijn van Weerd.

Conservation and Status

Historical distribution

Philippine crocodile specimens have been collected from the islands of Luzon, Mindoro, Masbate, Samar, Jolo, Negros, Busuanga and Mindanao (Ross 1982; Ross and Alcala 1983), suggesting that *C. mindorensis* historically was widely distributed throughout the archipelago and probably occurred on all larger Philippine islands. The probable exception is the island of Palawan which is biogeographically more similar to Borneo than to the other Philippine islands. A reported nest of a palustrine crocodile on Palawan (Schultze 1914) probably refers to *C. porosus* as it contained 30 eggs that were all considerably larger than the largest known wild *C. mindorensis* eggs. The report of a small introduced *C. mindorensis* population on Palau is known to be in error (Messel and King 1992a).

Survey history

Published information on the distribution of *C. mindorensis*

remains rare although much more information on the current distribution and status have become available since 1998. C.A. Ross conducted surveys in southern and central Philippines (Mindanao, Visayas and Palawan) in 1981 (Ross 1982; Ross and Alcala 1983) and recently published an account on crocodile observations in northern Philippines (Dalupiri Island) in 1990 (Ross 2005). Ross (1982) and Ross and Alcala (1983) have also inventoried museum specimen collection localities, which provide the best source of information on the historical distribution of crocodiles in the Philippines. Aoki (1985) observed *C. mindorensis* on Mindoro during the mid-1980s. Alcala *et al.* (1987) collected information on crocodiles on Negros. Ortega added information gathered during the 1990s, mainly from secondary sources (Ortega *et al.* 1993, 1994; Ortega 1998). Rebong and Sumiller (2002) reported on capture localities of the Philippine crocodile in the wild in 1992 on Mindanao and Busuanga for the captive breeding program of the Crocodile Farm Institute (CFI). Pontillas (2000) conducted targeted surveys in areas with historical and recent accounts of crocodiles on Luzon, Mindoro, Busuanga and Mindanao in 1999 and 2000. Manalo (2008) conducted crocodile surveys in Abra Province on Luzon and south Cotabato on Mindanao (Manalo *et al.* 2013). Since 1999 surveys have been conducted in northeast Luzon (van Weerd 2000, 2002; van Weerd and van der Ploeg 2003; Tarun *et al.* 2004; van Weerd *et al.* 2006). Oliveros *et al.* (2005, 2006) conducted surveys on the Babuyan islands. Pomares *et al.* (2008) conducted surveys in Ligawasan Marsh on Mindanao (see also Van der Ploeg *et al.* 2007).

Current distribution and population size

Dalupiri: Crocodiles were observed in 1990 by Ross (2005) on Dalupiri Island (part of the Babuyan island group north of Luzon). In 2005 an adult female *C. mindorensis* was caught and released in Caucauyan Creek and tracks of two different sized juveniles were found (Oliveros *et al.* 2006). Subsequent surveys failed to find more crocodiles and the adult Philippine crocodile population on Dalupiri probably consists of at most one pair.

Luzon: Cordillera Mountains. In 2002 four captive *C. mindorensis* were found in a mini-zoo in Bangued, Abra Province, Cordillera Mountains, and the source of these animals was identified as Binungan River in the municipality of Tineg, Abra (Manalo 2008). Field surveys recorded tracks of 12 juvenile and 2 sub-adult crocodiles in a limestone stretch of the river with caves at 850 m above sea level. No surveys have been conducted there since 2002. It is likely that a small *C. mindorensis* population continues to survive here. Reports of crocodile sightings elsewhere in the Cordillera, notably from Apayao and Abra Provinces need confirmation.

Cagayan Valley, Sierra Madre Mountains and Pacific Ocean coast. In 1999 Van Weerd (2000) found *C. mindorensis* in Cagayan Valley in the foothills of the Sierra Madre Mountains, municipality of San Mariano, Isabela Province. This wild population has been the target of conservation action by the Mabuwaya Foundation since then (van Weerd and van der Ploeg 2004). Crocodile distribution, population size and

population growth have been monitored annually (van Weerd *et al.* 2006). In 2008, 10 adults, 41 juvenile/sub-adults and 35 hatchlings were counted. Crocodiles dynamically use ponds, lakes, creeks and larger rivers in 3 distinct areas: 1) Dunoy Lake, Dungsog Lake, Narra Lake and Catalangan River (Catalangan River area); 2) Diwakden Creek, Diwakden Lake and Disulap River (Disulap River area); and, 3) Dinang Creek, Diamallig Creek and Ilaguen River (Ilaguen River area). Since 2007, the growing population of crocodiles has started to disperse and occupy new wetland areas in San Mariano. If the observed population recovery continues favorably, the non-hatchling Philippine crocodile population in San Mariano was expected to reach 100 individuals in 2010.

Philippine crocodiles also occur on the eastern side of the Sierra Madre Mountains along the Pacific coast in the Northern Sierra Madre Natural Park, Isabela Province. The Sierra Madre physically separates these crocodiles from San Mariano. A very small population of probably only one pair of adult crocodiles and several juveniles is found in Dibukarot Creek in the municipality of Palanan. *Crocodylus mindorensis* has also been found in several littoral creeks and rivers in the municipalities of Maconacon and Divilacan. An adult was caught and released in Po River in Maconacon in 2005. A small breeding population permanently occupies Divilacan River, where two juveniles were caught and released in 2009. Fifty captive-bred, sub-adult *C. mindorensis* were released in Dicitan Lake, Divilacan, in July 2009, re-establishing a large wild population that is expected to begin reproducing in 2012.

Mindanao North and Eastern Mindanao. No recent *C. mindorensis* observations have been reported from North and Eastern Mindanao. Prior to 1982, Philippine crocodiles were known to occur in Surigao del Norte and in the headwaters of Agusan Marsh in the municipality of Nabunturan, Compostela Valley Province. Ross (1982) reported the killing of three juvenile *C. mindorensis* here in 1979. Although no *C. mindorensis* specimens have been collected from Agusan Marsh itself, Ortega (1998) reports a captive live adult individual on display in the provincial capital (Prosperidad) in 1994. It is not certain whether this individual originated from the marsh. Surveys in 1994, 1998 (Ortega 1998) and 1999 (Pontillas 2000) failed to locate any *C. mindorensis* but did find a small population of *C. porosus* in Agusan Marsh. Specimen have been collected prior to 1982 from the municipality of Tagum, Davao del Norte Province, and the municipality of Malita, Davao del Sur Province (dates and localities unknown; Ross 1982).

In 1992, in northwest Mindanao, the CFI caught a wild sub-adult *C. mindorensis* in Lanao del Sur (locality and municipality unknown), a sub-adult in the municipality of Malabang, Lanao del Sur, an adult in Lanao del Norte (locality and municipality unknown) and a hatchling in the municipality of Bonifacio (Misamis Occidental) (Rebong and Sumiller 2002). Ross (1982) reports a sighting of *C. mindorensis* in Calarian Lake, Zamboanga City, in 1979, and a captive animal said to originate from the vicinity of Pagadian

City in 1981, both Zamboanga Province. No recent crocodile surveys have been conducted in northwestern Mindanao.

Specimens of *C. mindorensis* have been collected from Ligawasan Marsh in the provinces of North Cotabato and Maguindanao before 1981 (Ross 1982). Ross (1982) reports examining a live juvenile from Macasendey Marsh, part of Ligawasan Marsh, in the municipality of Midsayap (North Cotabato) in 1981. In 1992 the CFI caught 4 wild crocodiles in Ligawasan Marsh (Rebong and Sumiller 2002): an adult in the municipality of Carmen (North Cotabato), a juvenile in the municipality of Dinaig (Maguindanao) and two hatchlings in the municipality of Lutayan (Sultan Kudarat). Pomares *et al.* (2008) report sightings of *C. mindorensis* from various localities in the municipalities of Kabacan and Carmen (North Cotabato) in 2007. *Crocodylus mindorensis* is also known from the headwaters of Ligawasan Marsh. The CFI caught a sub-adult and a hatchling *C. mindorensis* in the municipality of Kidapawan (North Cotabato) in 1992. Pontillas (2000) reports a breeding pair from Pulangui River (Bukidnon) in 1999. In October 2007 (Van der Ploeg *et al.* 2007), an adult *C. mindorensis* and a nest were found along Muleta River in the municipality of Carmen (North Cotabato). Pomares *et al.* (2008) report sightings in 2007 of *C. mindorensis* from the municipality of President Roxas (North Cotabato) and from Pulangui River (Bukidnon). Reliable *C. mindorensis* population estimates are not available from Ligawasan Marsh but it has been established beyond doubt in 2007 and 2008 that there is a breeding population with a relatively large distribution in the marsh itself and its tributaries. Two rescue efforts were recorded in 2016 and 2017 at Barangay Cuyapon, Kabacan, North Cotabato for an adult breeder's *C. mindorensis* named "Silangan" (male) and "Kanluran" (female). Both individuals were held in a rescue facility in Carmen, North Cotabato volunteered by the 602nd Brigade, Philippine Army. It was noted that both *C. mindorensis* and *C. porosus* coexist in the Ligawasan Marsh (Cayetano Pomares, pers. comm. 2017). The new distribution and altitudinal record (740-840 m asl) record of *C. mindorensis* at the highland habitat of Barangay Ned, Lake Sebu, southern Mindanao in 2012, suggests that altitude may not be a constraining factor when searching for potential habitat of this species (Manalo *et al.* 2013). This can be considered as one of determining factors for their dispersal across terrestrial landscape. Historically, the Philippine crocodile probably had a wider altitudinal distribution on various Philippine islands, large and small.

Other islands with historical but no recent sightings are Negros, Mindoro, Samar, Masbate, Busuanga, Jolo. Before 1999, *C. mindorensis* occurred in the Pagatban River in Negros Oriental (Ross and Alcala 1983) and in Sta. Catalina and Ilog River in Negros Occidental (Alcala *et al.* 1987). It is believed that the Philippine crocodile is now extinct in the wild on Negros (Ely Alcala, pers. comm. 2007).

The type specimens of *C. mindorensis* were collected from the vicinity of Naujan Lake in Mindoro Oriental. No Philippine crocodiles have been reported from the lake itself, only *C. porosus*. *Crocodylus mindorensis* has been reported from the

Caituran River on Mindoro (Aoki 1985) but recent surveys failed to find it and the species is thought to be extinct on Mindoro Island (Pontillas 2000).

Philippine crocodile specimens have been collected from the islands of Masbate and Samar prior to 1981 (Ross 1982). Both islands have not recently been surveyed for crocodiles.

The Philippine crocodile occurred with certainty on Busuanga Island, part of the Calamian Islands north of Palawan. Philippine crocodiles have been collected from Dimaniang (Schmidt 1956), and the Dipuyai and Busuanga Rivers (Ross and Alcala 1983; Ortega 1998) with the last certain observation in 1993. Pontillas (2000) failed to find surviving *C. mindorensis* on Busuanga and the species is now thought to be extinct there

Historically, specimen have been collected prior to 1981 from the island of Jolo, part of the Sulu archipelago in Sulu Province (Ross 1982). No recent surveys have been conducted.



Figure 5. Sub-adult *C. mindorensis* in the Cadsalan Village Dinang Creek Philippine Crocodile Sanctuary, northern Luzon Photograph: Merlijn van Weerd.

Conservation

The Philippine crocodile is nationally protected by law since 2001 (Republic Act 9147: the Wildlife Act). Killing a Philippine crocodile carries a minimum penalty of six years imprisonment and/or a fine of 100,000 Pesos (approx.

\$US2500). The protection of crocodiles and conservation of their habitat is the responsibility of the Protected Areas and Wildlife Bureau (PAWB) of the Department of Environment and Natural Resources (DENR). A National Philippine Crocodile Recovery Team (PCNRT) was established in 2000 (Banks 2000a) consisting of scientists, Government representatives and representatives of two foreign captive breeding programs in Melbourne Zoo and Gladys Porter Zoo. A National Recovery Strategy was published in 2000 (Banks 2000b) and updated in 2005 (Banks 2005). A national forum on crocodiles in the Philippines was held in February 2007 (Anon 2007; Ross 2008). In 2015, the PCNRT was reconstituted to be known as the National Committee for the Conservation of Crocodiles (NCCC). The national recovery strategy for the *C. mindorensis* was revised and forms part of the Conservation and Management Plan for the Crocodile Species in the Philippines. A 2nd Forum on Crocodiles in the Philippines was held in March 2019 (Manalo and Mercado 2019).

Government maintains the Palawan Wildlife Rescue and Conservation Centre (PWRCC), formerly the Crocodile Farm Institute (CFI), which has been breeding *C. mindorensis* in captivity since 1987. The Mabuwaya Foundation and the PWRCC have reintroduced 50 crocodiles into Dication Lake in Isabela in July 2009 and maintains about 750 Philippine crocodiles in 2009. Captive stocks in the Philippines are also held by Manila Zoo, Ailon Montalban Zoo, Malabon Zoo, Cebu City Zoo, Zoobic Safari, Ocean Park Manila, Davao Crocodile Park, and a number of private crocodile farmers and individual collections. Silliman University has maintained a captive breeding program and Philippine crocodile research program since 1980 (Alcala 1997). Internationally, three captive breeding programs operate under a Memorandum of Agreement with the Philippine Government. These are administered by Melbourne Zoo (Australia), Gladys Porter Zoo (USA) and the Krokodille Zoo (Denmark). A number of facilities in the USA and Europe have Philippine crocodiles on loan under these programs. In addition, illegally exported Philippine crocodiles are maintained by an unknown number of facilities and individuals outside the Philippines.

In-situ conservation of Philippine crocodiles only seriously started in 1999 after the discovery of a remnant *C. mindorensis* population in Isabela Province. Isabela State University and Leiden University of the Netherlands are implementing a Philippine crocodile research and conservation project here and have established the Mabuwaya Foundation. The Mabuwaya Foundation has used a combination of communication, education and public awareness campaigns, community empowerment and local capacity building to implement localized protection strategies in the municipality of San Mariano (van Weerd *et al.* 2004; van Weerd and van der Ploeg 2004; van der Ploeg and van Weerd 2006; van der Ploeg *et al.* 2008). Using the decentralized law system of the Philippines, the municipality of San Mariano has declared the Philippine crocodile their flagship species and has enacted municipal ordinances that protect crocodiles. This has led to the establishment of three Philippine crocodile sanctuaries protecting Dunoy Lake, Disulap River and Dinang Creek. A

local protection group consisting of farmers and fishermen has been trained to manage the sanctuaries (Miranda *et al.* 2004; van der Ploeg and van Weerd 2004). In order to increase hatchling survival rates and assist a recovery of the Philippine crocodile population in San Mariano a head-start program successfully raises and releases juveniles (van Weerd and van der Ploeg 2008). The municipalities of Maconacon, Palanan and Divilacan, Isabela Province, have also declared Philippine crocodile sanctuaries in the Po River, Dibukarot Creek and Dicitian Lake respectively. In July 2009, 50 PWRCC captive-bred crocodiles were reintroduced back to the wild in Dicitian Lake, which is protected as a village crocodile sanctuary but is also situated in the Northern Sierra Madre Natural Park, the largest protected area of the Philippines.

Elsewhere, the Mabuwaya Foundation and Isla Biodiversity Conservation are implementing community-based Philippine crocodile conservation on Dalupiri Island (Oliveros *et al.* 2006). The University of Southern Mindanao (USM) is implementing a Philippine crocodile research and conservation project in Ligawasan Marsh.

In 2009, the first release of Philippine crocodile in Mindanao was took place in a small wetland in Sto. Tomas, Davao del Norte initiated by the JK Mercado and Sons Agricultural Enterprises Inc., an active member of the Crocodylus Porosus Philippines Inc. (CPPI). The CPPI has also initiated the released of 36 semi-wild captive-bred *C. mindorensis* juveniles for conservation introduction in Paghungawan Marsh, Pilar, Surigao del Norte within the Siargao Island Protected Landscapes and Seascapes in 2013 (Manalo *et al.* 2016). A supplemental released of 29 juveniles in Paghungawan Marsh took place in 2017 (Manolis 2017). Both releases have formed a nucleus population in this region. The introduction of ecotourism as community-based sustainable livelihood has enhanced the integration of habitat and species protection among communities.

The future of the Philippine crocodile looks much brighter since the publication of the last status report in 1998. Still it will take years before the (sub) population(s) will recover to viable non-threatened levels. The challenge for the coming years will be to sustain conservation efforts.



Figure 6. Both *C. mindorensis* and *C. porosus* occur

in Ligawasan Marsh, southern Mindanao. Photograph: Cayetono Pomares.

Priority Projects

High priority

1. **Sustain *in-situ* conservation efforts on Dalupiri Island, in Cagayan Valley and the Northern Sierra Madre (Luzon), and in Ligawasan Marsh (Mindanao) and its tributaries.** Philippine crocodiles are protected on Dalupiri Island and in the municipalities of San Mariano, Divilacan and Maconacon in Isabela Province by local communities, local government and protected area authorities with the help of conservation NGOs. The various sub-populations in Isabela are recovering by natural growth and population reinforcement through a hatchling head-start and reintroduction program (San Mariano) and the reintroduction of captive-bred crocodiles (Divilacan). Philippine crocodile population growth here offers new conservation challenges such as an increase of livestock predation. Communication, education and public awareness (CEPA) campaigns have to be sustained and expanded. Local governments, communities and managers of the Northern Sierra Madre Natural Park need sustained technical assistance and training in crocodile and wetland management and conservation. Benefits need to be secured for communities protecting crocodiles in the form of income from eco-tourism, livelihood assistance and possibly crocodile harvesting programs when populations recover further. Conservation efforts in Ligawasan Marsh have started in 2007. The *in-situ* conservation activities here have to be sustained with CEPA campaigns, technical support and training for local communities and governments and the design and implementation of local crocodile protection measures such as sanctuary establishment and nest protection.
2. **Continued and new surveys in areas with confirmed Philippine crocodile presence.** A Philippine crocodile population monitoring system is in place in Cagayan Valley, the Northern Sierra Madre Mountains and on Dalupiri Island, with annual monitoring surveys. Monitoring of the current recovery of the wild crocodile population here needs to be sustained as a basis for adaptive conservation strategies and to update Philippine crocodile status. The Cordillera Mountains of northern Luzon and Ligawasan Marsh and its tributaries on Mindanao have confirmed Philippine crocodile populations but detailed distribution and population size data are not available. More field surveys, using interviews, day counts and spotlight techniques are needed in these two areas as a basis for conservation interventions and to update Philippine crocodile status.
3. **Monitoring of released crocodiles in harmony with the recent iteration of National Crocodile Management Plan.** Captive-bred Philippine crocodiles have been reintroduced in 2009 into semi-wild conditions on protected habitats in Mindanao and into the wild in the Northern

Sierra Madre Natural Park on Luzon. Head-started juvenile crocodiles have been reintroduced annually into the wild in San Mariano on Luzon since 2005. Adaptation, survival, movements and eventually reproduction of reintroduced crocodiles has to be monitored. Other suitable release sites have to be identified, for example on Mindoro and Negros Islands. Monitoring results of the various restocking programs have to be in agreement with the national crocodile management strategy leading to the implementation of a continued restocking program throughout the species' historical range and suitable release sites.

4. **Facilitate the establishment of Protected Areas and/or Critical Habitats.** Suitable habitats in surrounding forests and the wetlands have been gradually converted for agricultural purposes. The very limited remaining habitats have been compromised due to its proximity and potentials to agricultural developments. The probability of human encroachment to habitat also encourages further conflict. Addressing these will increase the area of occupancy, extent of occurrence and/or quality of habitat.

Moderate priority

5. **Surveys of historical Philippine crocodile distribution localities.** Several historical distribution localities that were identified on the basis of locality tags of historical museum specimen have never been thoroughly surveyed for crocodiles, notably the islands of Samar, Jolo and Masbate. Other more recent survey sites on Mindanao, visited by Andy Ross during surveys in 1979-1981 (Ross 1982) or by teams of the CFI in 1992 (Rebong and Sumiller 2002) with confirmed or suspected Philippine crocodile presence also need repetition, notably the Zamboanga Peninsula, head waters of Lanao Lake, head waters of Agusan Marsh and Compostela Valley. Although Philippine crocodiles are assumed to be extinct on Mindoro, Negros and Busuanga, unverified crocodile observations sometimes are reported by local residents or visitors and historical Philippine crocodile sites here need to be surveyed using a combination of interview and field observation techniques.

6. **Increased social understanding and acceptance of crocodiles living in their natural habitats.** Local information and awareness campaigns for the protection of crocodiles were focused mainly in northeastern Luzon and northern eastern Mindanao. The continuing success of the Mabuwaya Foundation Inc. in enhancing awareness of the local communities has developed a sense of ownership of the Philippine crocodile population in the Sierra Madre. *Crocodylus Porosus* Philippines Inc. (CPPI) has explored the community-based sustainable ecotourism in Siargao Island, Mindanao. This strengthens and encourages positive public attitude visitor's appreciation toward crocodiles in the Philippines. The presence of an overall supportive campaign would present a better opportunity to a more collaborative and holistic approach in changing community perception nationwide.

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