

**NATIONAL RECOVERY PLAN FOR
THE PHILIPPINE CROCODILE,
Crocodylus mindorensis
2005 – 2008
SECOND EDITION**



Compiled by Chris Banks

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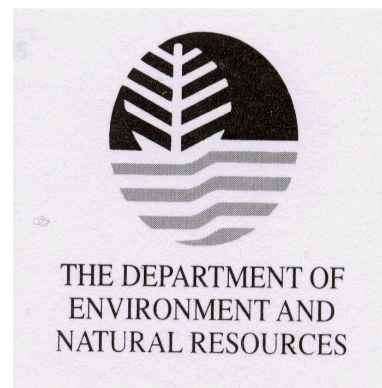
National Recovery Plan for the
Philippine Crocodile, *Crocodylus mindorensis*
Second Edition.

2005 – 2008

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FOREWORD

The Philippine Crocodile is recognised by the Crocodile Specialist Group of the IUCN's Species Survival Commission as among the most threatened species of crocodiles in the world today. The main reasons for this are loss of the crocodile's wetland habitats and negative community feelings towards crocodiles in the Philippines.

The Department of Environment & Natural Resources (DENR) has recognised the threats facing the wildlife and natural environments of the Philippines and is implementing the necessary protocols and processes to address these problems. However, this is a massive task and the support of other agencies and organizations, both within the Philippines and overseas, is warmly welcomed.

In this regard, the DENR acknowledges the extensive discussions, commencing at the July 1997 meeting of the Crocodile Specialist Group (CSG), that led to the development of the first National Recovery Plan for the Philippine Crocodile. These mainly involved experts within the DENR and the Protected Areas & Wildlife Bureau, the Palawan Wildlife Rescue & Conservation Centre, Silliman University in Dumaguete City, Melbourne Zoo in Australia, Gladys Porter Zoo in the USA, Flora & Fauna International, and the CSG itself. This collaboration has continued and, with the additional participation from colleagues working with the Cagayan Valley Program on Environment & Development and the San Mariano Local Government Unit, has allowed the development of this Second Edition of the National Recovery Plan.

The Plan sets out what is known of the Philippine Crocodile's life history and current status in the wild, as well as the efforts implemented to date to assist its recovery. Most importantly, it also outlines a number of conservation objectives and the actions needed to achieve them. Valuable steps forward have been achieved in the past two years, most notably in the Northern Sierra Madre region, and it is vital that these are maintained and expanded over coming years.

A key mechanism in the implementation and review of the Plan and its progress is the Philippine Crocodile Recovery Team, which was created by DENR Special Order 2000-231 on 3 March 2000. As with the Plan itself, the Recovery Team reflects the broad collaboration of Philippine and overseas agencies and individuals, who, through the Team, are charged with working to achieve the conservation of the Philippine Crocodile. This species is a unique component of the Philippines' national heritage and the Philippine Government, through the DENR/PAWB, is committed to its recovery.

Elisea G. Gozun
Secretary, Department of Environment & Natural Resources

EXECUTIVE SUMMARY

Current Species Status and Distribution

The Philippine Crocodile, *Crocodylus mindorensis*, is listed as Critically Endangered by the IUCN (IUCN, 2004). In 1992, the IUCN/SSC Crocodile Specialist Group (CSG) recommended that the species could not be protected in the wild in the short-term and the only hope for the species was captive breeding. The CSG also recommended the development of a “national crocodile management program” as the highest priority for this species (Messel *et al.*, 1992).

The last comprehensive survey, in 1980-81, suggested a total wild population of 500-1,000 individuals. Until 1999, all information indicated that no more than 100 adults remained in the wild in less than 10 sites on three islands in the Philippines. However, recent confirmation of the species and ongoing studies in north-east Luzon may increase that estimate (Van Weerd *et al.*, 2003). With the newly identified populations and recent attempts to conserve the species in the wild in Luzon, a two pronged objective should be pursued, ie. 1. captive breeding and; 2: conserve wild populations where possible.

Habitat Requirements and Threatening Factors

The species occupies freshwater rivers, swamps and lakes. Major threats to its survival are ongoing habitat loss and degradation, and a negative community attitude towards crocodiles in the Philippines leading to ongoing hunting and killing of crocodiles.

Primary Objective

The primary conservation goal is to re-establish and conserve *C. mindorensis* in the wild and ensure its long-term survival throughout its historic range. However, it is recognised that establishment and protection in agreed parts of its historic range may be a realistic outcome over the life of the Plan.

Specific Objectives and Actions

The Recovery Plan has nine objectives, each with a set of relevant actions:

1. Establish protected wild populations of *C. mindorensis*; through:
 - Reassessing distribution and wild status of *C. mindorensis*.
 - Establishing a list of possible release sites in the Philippines and supporting development of conservation/management plans for those areas.
 - Developing a Philippine Crocodile release and restocking program.
 - Developing options for the protection and management of existing and released populations.
 - Monitoring protected wild populations of *C. mindorensis*.
2. Promote and encourage positive community attitudes to, and a good understanding of crocodiles in the Philippines; through:
 - Development and delivery of community awareness programs for crocodiles.
 - Development and delivery of school-based educational programs for crocodiles.
 - Promoting the Philippine Crocodile and its conservation in relevant forums.
3. Co-ordinate the management of captive *C. mindorensis* through:
 - Maintaining a national registry of all captive *C. mindorensis* in the Philippines.
 - Establishing a co-ordinated global captive management program for *C. mindorensis*.

- Improving the operational effectiveness of the PWRCC.
 - Conducting detailed analyses of the PWRCC *C. mindorensis* and records.
 - Developing guidelines for display, holding and transport of *C. mindorensis*.
4. Determine the ecology of *C. mindorensis*; through:
 - Collating and assessing all available ecological data on *C. mindorensis*.
 - Undertaking further ecological studies of *C. mindorensis* as a high priority.
 - Encouraging tertiary institutions and other groups to support and undertake agreed research into *C. mindorensis* ecology.
 5. Clarify the population genetics of *C. mindorensis*; through:
 - Extending and completing the current mtDNA study to determine the extent of differences (if any) between the original populations in each of the main faunal regions in the Philippines.
 6. Integrate *C. mindorensis* conservation with the conservation of freshwater wetlands and other freshwater species in the Philippines; through:
 - Identifying programs targeting conservation of freshwater wetlands in the Philippines.
 - Identifying programs targeting conservation of other threatened freshwater wildlife in the Philippines.
 - Assessing the above programs for relevance to Philippine Crocodiles and integrate materials/programs accordingly.
 7. Build partnerships to support conservation of *C. mindorensis*; through:
 - Promoting and facilitating breeding loan extensions for selected, priority lines/populations, both locally and internationally.
 - Establishment of *C. mindorensis* support groups.
 - Provision of training in crocodile management and surveys.
 8. Establish funding sources to implement conservation actions for *C. mindorensis*; through:
 - Establishing reliable funding sources.
 9. Ensure that all relevant Philippine Government policies support the conservation of *C. mindorensis*; through:
 - Review of all relevant Philippine Government policies to ascertain their support for the conservation of crocodiles, especially *C. mindorensis*.

National Recovery Team

A National Recovery Team was established in 2000 to oversee the implementation of the Philippine Crocodile National Recovery Plan and review its performance annually.

Supporting institutional mechanisms

The Plan will be incorporated in the operating and planning requirements of the Department of Environment & Natural Resources.

INTRODUCTION

The Philippine Crocodile (*Crocodylus mindorensis*) is recognised by the IUCN/SSC Crocodile Specialist Group (CSG) as the most threatened species of crocodile in the world and is listed by the IUCN as Critically Endangered (IUCN, 2004). Previously distributed through many parts of the Philippines, it is now only thought to be found as small remnant populations in northern Luzon and central and eastern Mindanao, with scattered individuals in south-west Negros Island (Pontillas, 2000; van Weerd *et al.*, 2000). Anecdotal reports suggest that no more than 100 adults remain in the wild (Ortega, 1998).

This is a relatively small species, occupying freshwater rivers, lakes and marshes. The species has also recently been found in coastal saline waters (van Weerd *et al.*, 2000). Very little is known of its ecology and information on its reproduction, growth and behaviour is based largely on captive animals.

Following a distribution-wide survey in 1982, which estimated the wild population at 500-1,000 mature individuals (Ross, 1982; Ross & Alcala, 1983), the Philippine Government instituted measures to address the plight of both species of crocodiles in the Philippines. This led to the establishment of a captive breeding program at Silliman University in Dumaguete City, Negros Oriental, and a joint venture with the Japanese Government to create the Crocodile Farming Institute (CFI) at Puerto Princesa City on Palawan, now renamed as the Palawan Wildlife Rescue & Conservation Centre (PWRCC). Breeding has been successful at both locations and the PWRCC maintained almost 1,200 *C. mindorensis* as of 31 March, 2003 (G. Rebong, pers. comm.).

Worldwide interest in contributing to the conservation of the species resulted in agreements with, and transfer of crocodiles to Melbourne Zoo, Australia, and Gladys Porter Zoo in Brownsville, USA. These developments provided the foundation for subsequent provision of funds and other support, successful captive breeding at Gladys Porter, and active promotion of the crocodile and its conservation in both countries.

A key participant in the establishment of the PWRCC was the Crocodile Specialist Group, whose first global Crocodile Action Plan listed *C. mindorensis* as the second most endangered crocodylian in the world and recommended establishment of a “national crocodile management program” as the highest priority for the species (Messel *et al.*, 1992). It was also noted that the best chance for the species’ survival was captive breeding. This recommendation was repeated in the second edition of the Plan, produced in 1998 (Ross, 1998).

At the 1998 meeting of the CSG, in Singapore, agreement was reached on development of a National Recovery Plan for the Philippine Crocodile, with the aim of drawing together the critical issues of habitat protection; community awareness, education and support; captive breeding; and heightened understanding of the species’ biology and ecology.

The first edition of the Plan was published in 2000 and its primary goal was to re-establish the Philippine Crocodile in the wild and ensure its long-term survival throughout its historic range (Banks, 2000). The Philippine Crocodile National Recovery Team was also created in 2000, with one of its main aims being to oversee the implementation of the Plan. The Plan reflects the views of a range of organisations and individuals directly involved with the management and conservation of the species, and focuses their experience and commitment on the common goal of the conservation of a highly threatened crocodile.

2. THE PHILIPPINE CROCODILE

2.1 Description

The Philippine Crocodile, *Crocodylus mindorensis*, or “Buwaya” (Tagalog), is a relatively small freshwater species averaging 1.5 – 2.5m in total length and adult males reportedly reaching 3.5 m (Brazaitis, 1973; Ross, 1998; G. Rebong, pers.comm.). Dorsal colour is dull brown, with darker transverse dorsal bars on the back and tail. The ventral surface is white.

It is distinguished from the closely related *C. novaeguineae* by having the cluster of nuchal scales separated along the midline by soft skin, and the scales on the sides of the body are uniform in size and arranged in uniform longitudinal rows (Brazaitis, *op cit.*). Within the Philippines, the only other crocodylian species, the Estuarine or Saltwater Crocodile (*C. porosus*), has 1-4 small, slightly enlarged (sometimes absent) post-occipital scales (4-6 and enlarged in *C. mindorensis*); and 31-35 transverse rows of ventral scales (25-26 rows in *C. mindorensis*) (Brazaitis, *op cit.*). The Estuarine Crocodile also attains a much greater size, potentially 7m in total length, but adults average 3.5-4.5m (Ross, 1989).

Regionel (1997) has suggested that male and female *C. mindorensis* can be distinguished on the basis of marked differences in the number of contiguous scales in the second precaudal scale row, the number of precaudal rows, double crest caudal scales and rows of dorsal transverse scales.

2.2 Taxonomic Significance

The Philippine Crocodile was first described by Schmidt in 1935 (Type specimen: FMNH 11135), based on three small specimens from Mindoro, plus a comparatively large skull with no collecting data which was subsequently thought to have come from a crocodile caught on the Catuiran River, Mindoro, in the 1890s (Neill, 1971; Schmidt, 1935). Subsequently, Wermouth (1953) and Wermouth & Mertens (1961) placed *C. mindorensis* as a subspecies of *Crocodylus novaeguineae*, a position that was adopted by most authors for over a decade (e.g. Brazaitis, 1973; Guggisberg, 1972). However, in a later work, Wermouth & Mertens (1977) referred to *C. mindorensis* Schmidt again as a separate species and several later authors have followed this taxonomy in detailing the distinctive morphology of the species (Hall, 1989; Ross & Alcala, 1983).

The taxonomic relationships of a number of south-east Asian lacustrine crocodiles have recently been re-examined, confirming *C. mindorensis* as a distinct species (J. Grattan, pers.comm.).

2.3 Conservation Status

The species is listed as Critically Endangered by the IUCN (2004), based on two criteria:

- A.1.c: observed decline in extent of occurrence >80% in three generations.
- C.2.a: less than 250 adults in the wild, populations highly fragmented and declining.

Based on these factors, it is considered to be the most endangered crocodile in the world by the IUCN/SSC Crocodile Specialist Group (CSG) (Ross, 1998). It is legally protected in the Philippines and is included on Appendix I of the Convention on International Trade in Endangered Species (CITES) (CITES, 2003).

2.4 Life History

The life history of *C. mindorensis* is poorly known and current knowledge is mostly based on captive observations from the PWRCC and Silliman University (SU) on Negros Oriental. Limited information is also available from sightings and verbal reports obtained during field surveys.

Courtship and mating commences in January and continues through to May, with observed matings occurring between 0400 and 0700hrs (Alcala *et al.*, 1987). However, pairing of animals from late February to early March has minimised fighting at the PWRCC (Sumiller, 1998). Copulation occurs in the water and is preceded by courtship lasting for about 30 minutes. The male to female ratio is usually 1:1, ratios of 1:2 and 1:3 having been tried unsuccessfully at the PWRCC (Sarsagat & Sibal, 1991).

This species is a mound-nester and nest building has been observed from early February to May at the PWRCC and SU, usually concluding about one week prior to laying – the dry season on Negros and Palawan (Alcala, *op cit.*). Only the female builds the nest, using a mixture of sand, dry grass, rotting leaves and twigs, which she scrapes together with her hind feet, although animals have been known to dig solid ground when making their nest (G. Ortega, pers. comm.). Nesting material at PWRCC has consisted of leaves and stalks of *Phragmites communis*, *Bambusa* spp. and *Oryza sativa*, supplemented with river sand, and nest building takes place mostly at night (Sarsagat & Sibal, 1991). Nests at the SU complex varied from 1.5-2.0m wide and 2.0-2.7m long, and were 0.5m high. The smallest female recorded as breeding at the PWRCC was 155cm total length and 15.2kg (Ortega, 1998). A nest found in July 2000 in the Diwagden area, Disulap River, of San Mariano, was located about 2 m above the water-level on a steep slope of the river behind large boulders. The nest was about 1 x 1m and consisted of a hole dug in sand covered with grass and twigs. The nest site was shaded by overhanging trees and the steep side of the river bank. A clear drag mark trail ran from the river up to the nest. The number of eggs was estimated at 25 based on eggshells found, no un-hatched eggs were found. Eight hatchlings were found in Disulap River, all within 500 m of the nest site. The hatchlings were estimated to be less than 1 month old, suggesting hatching in June, which is at the onset of the rainy season in north-east Luzon (M. van Weerd, pers. comm.).

Egg laying occurs between February and October at the PWRCC, with a peak from April-July (Ortega, 1998). Alcala *et al.* (1987) recorded oviposition from April-August at the SU. Average clutch size at the two sites is 26.7 eggs and the range is 7-25eggs/clutch at SU and 18-33 eggs/clutch at the PWRCC. Eggs are hard-shelled, elliptical, smooth and white, and those from SU averaged 71mm long (67-75mm, n=14), 43mm wide (40-46mm, n=14) and 82g (74-86g, n=14) (Alcala *et al.*, 1987). Egg shells and hatchlings were found in the wild in the Diwagden area, Disulap River, of San Mariano, Isabela Province, in July 2000 and further hatchlings were caught by fishermen in September 2000 and observed during a survey in November 2000 (van Weerd *et al.*, 2000). Hatchlings were further observed in Dinang creek, San Mariano, in January 2001 (Oppenheimer, 2001), in Lake Dunoy, San Mariano, in March 2002 (Tarun & Guerrero, 2002) and again in Dinang Creek in March 2003 (D. Rodriguez, pers. comm.).

Multiple nesting has been recorded at SU and the PWRCC, with the second clutch of eggs being laid 5-6 months after the first (Sumiller, 1998). Although there was no significant differences in clutch sizes, fertility and hatching rates are lower for the second clutches.

Hatching occurs after 81 days (77-85) at 30.6°C (28-33°C) incubation temperature at SU (Alcala *op cit.*). Hatching rates of fertile eggs at the PWRCC ranged from 78.8% at 30°C to 48% at 33°C (Sumiller & Cornel, 1998). Temperature-dependent sex determination studies at CFI indicate that incubation temperatures of 30-31°C and 34°C produces mostly females, while 33°C produces mostly males. A temperature of 32°C produced 65% females and 35% males (Sumiller & Cornel, 1998).

Observations on hatching in a nest at SU showed that the female opened the nest by excavating it with her fore and hind limbs, and carried each hatchling to the water in her mouth (Alcala *et al.*, 1987). Observations on hatching in artificially incubated eggs suggest very little differences from other species of crocodiles. Hatchlings at the PWRCC averaged 270mm total length and 50g (Sibal *et al.*, 1994).

2.5 Habitat

Preferred habitat comprises freshwater marshes, small lake and ponds, and the tributaries of large rivers (Ross, 1982). A study in the San Mariano area of the Northern Sierra Madre showed that the species was utilising three different habitats, ie. a small, shallow lake surrounded by dense vegetation; a narrow, turbid creek surrounded by human activity; and a relatively large, clear river running, in part, between high limestone cliffs (Oppenheimer, 2001; Oudejans, 2002). At the coastal area of the Northern Sierra Madre, Philippine Crocodiles have also been found in saline environments in river estuaries and in a large man-made reservoir (van Weerd *et al.*, 2000; Oppenheimer, 2001) These crocodiles are known to excavate and use burrows up to 0.3m below the water surface (Ross, 1989), and its continual movements are suggested to keep the aquatic environment in balance through inhibiting encroachment of aquatic plants (Ross & Datuin, 1981).

2.6 Distribution

2.6.1 Historical Distribution

The species was once widely distributed throughout the Philippines, on the islands of north-eastern and central Luzon, Samar, Masbate, eastern Mindoro, southern Negros, Busuanga, Jolo and southern Mindanao (Fig. 1) (Ross, 1982).

2.6.2 Current Distribution

Based on the latest available information, including acquisition records from the PWRCC, *C. mindorensis* would appear to now be restricted to areas in Mindanao and northern Luzon (Ortega, 1998; Hibaya *et al.*, 1999; Pontillas, 2000; van Weerd *et al.*, 2000; van Weerd *et al.*, 2003):

1. Mindanao:
 - Agusan Marsh and Liguasan Marsh.
 - the Pulangi River area in Bukidnon Province.
2. North-east Luzon
 - Various rivers, creeks, lakes and marshes in the foothills of the Northern Sierra Madre both on the western (Disulap River, Lake Dunoy, Lake Dungsog, Dinang Creek, Kamalaglagan Creek, Pinacanan de Ilaguen River, Disabungan River and Abuan River) and eastern (Lake Dicitian, Dibal River and Diana Creek) sides.

3. North-central & north-west Luzon

- Rivers in the Central Cordillera mountains.
- In Abra province on the western side and possibly on the eastern side (crocodile tracks recorded next to the Binongan River) as well (I.V. Barongan, pers. comm.) (Fig. 2).

In addition, verbal reports suggest that isolated populations or individuals may still be present in the Cagayan River system, Mindanao (A. Tugas, pers. comm.); and the Ilog River on Negros Island (Ortega, 1998). Reports of crocodiles on Jomalig Island, near Pollilo Island, are being investigated (M. Reyes, pers. comm.). Further, although reliable sightings of *C. mindorensis* occurred in the Busuanga and Dipuyai Rivers, Busuanga Island, since 1993, a survey in 1999 failed to sight any crocodiles (Regoniel & Pontillas, 1993; Hibaya *et al.*, 1999).

The last crocodile known to have come from the vicinity of Naujan Lake in Oriental Mindoro was obtained in 1993 (Ortega & Regoniel, 1993), and the area is now suffering from encroachment by local residents (Ortega, 1998). Indeed, even in 1982, the Lake was severely impacted by fishing and low numbers of only *C. porosus* were encountered (C. A. Ross, pers. comm.). There are recent reports of crocodile eye-shine from the Lake and these should be investigated (J.C. Gonzales, pers. comm.), although they are most likely *C. porosus*.

The general consensus in 1998 was that there was likely to be no more than 100 adult *C. mindorensis* remaining in the wild (Ortega, 1998). The confirmation of *C. mindorensis* breeding in the Northern Sierra Madre region of north-east Luzon may result in this estimate being increased.

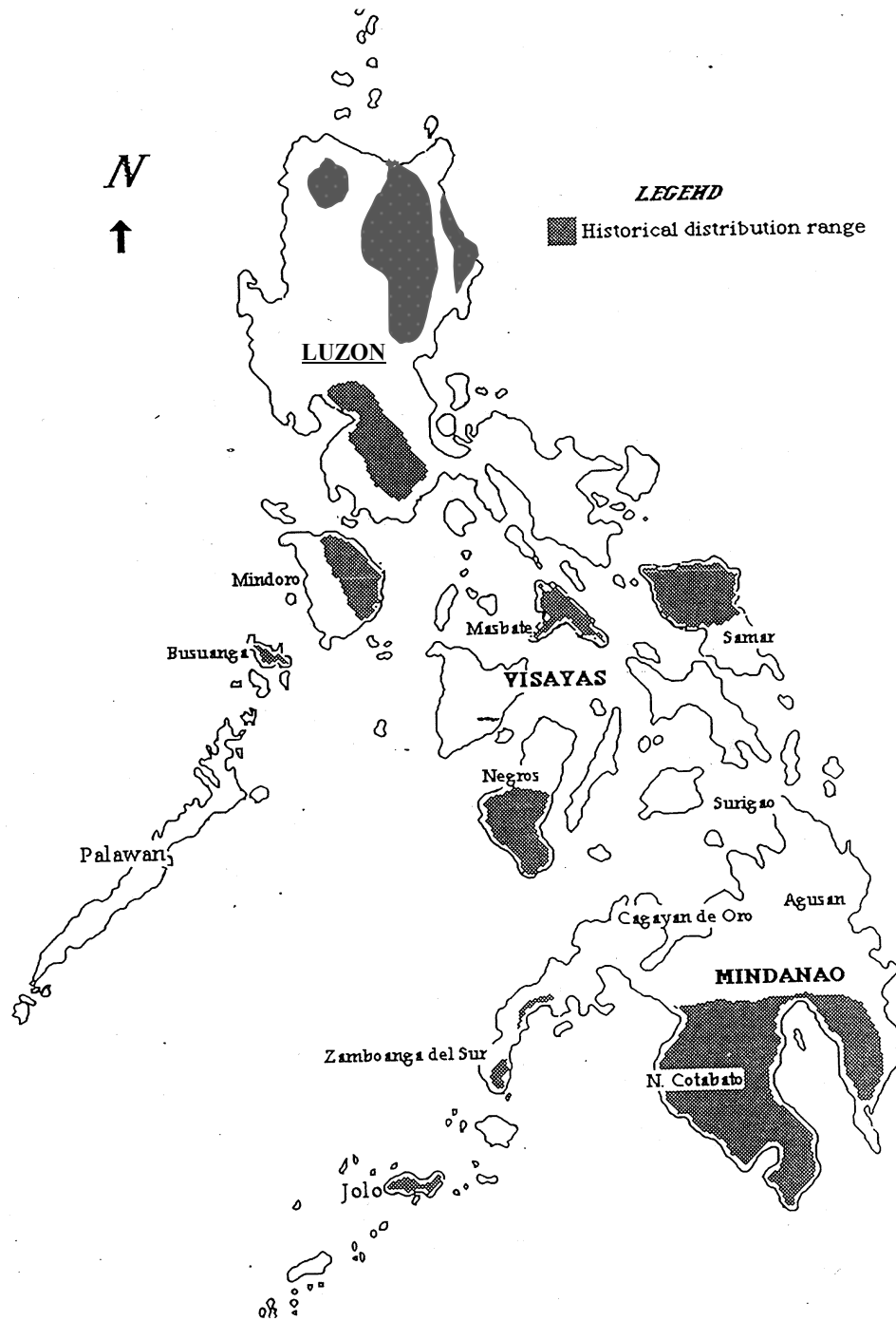


Figure 1 Historical distribution of *C. mindorensis* (Ross & Alcala, 1982; M. van Weerd & G. Rebono, pers. comm.).

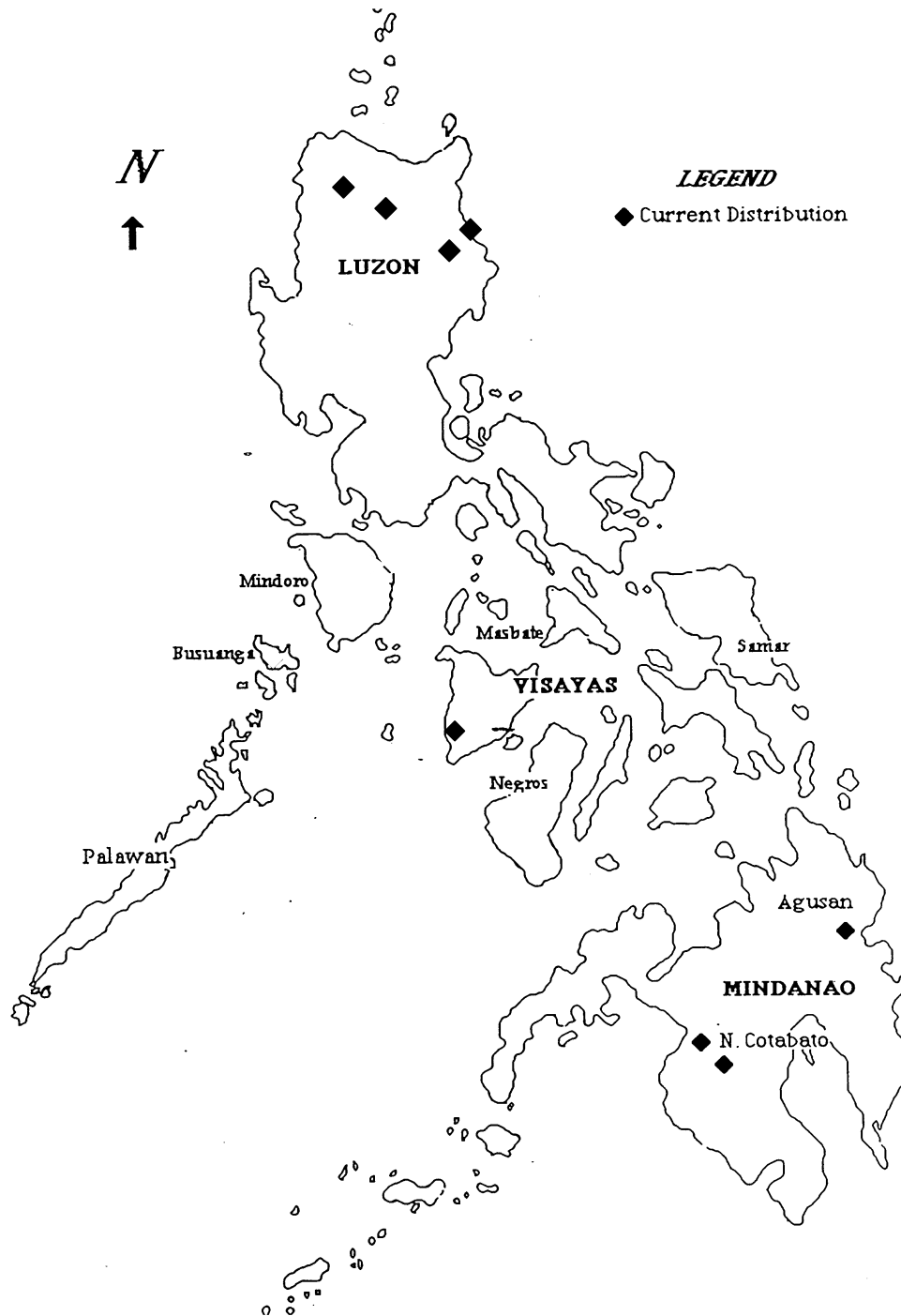


Figure 2. Current presumed distribution of *C. mindorensis* (Ortega, 1998; Van Weerd & General, 2003; G. Rehong, pers. comm.).

2.6.3 Tenure of land currently supporting *C. mindorensis*

Although three of the sites where *C. mindorensis* is known or is reported to occur are officially covered under the National Integrated Protected Areas System Act of 1992 (the NIPAS Act, or Republic Act No. 7586), ie. Naujan Lake on Mindoro, Agusan Marsh on Mindanao and the Northern Sierra Madre Natural Park in northern Luzon; and others such as the Mangyan Heritage Park on Mindoro have some form of protective listing, the reality is that no areas are protected to the point where the survival of this species can be assured. Indeed, this has been the position of the CSG since 1989 and was the basis for the decision to remove all remaining specimens from the wild and place them under captive management (Messel *et al.*, 1992). However, following extensive community consultation, a Philippine Crocodile Conservation Sanctuary was established in April 2001 along Disulap River in barangays San Jose and Disulap in San Mariano, Isabela Province, by the Local Government of San Mariano using local ordinances (Meneses, 2001; Tarun *et al.*, 2001; van Weerd *et al.*, 2001; Van Weerd & General, 2003).

Most, if not all areas are subjected to ongoing encroachment by local communities, illegal logging and fishing, slash and burn farming, conversion to agriculture, introduction of exotic species, downstream effects of mining and wildlife poaching (Apoyon, 1995; Ortega, 1998). In addition, problems of law and order have made it difficult to enter areas such as Lingausan Marsh in Mindanao, which has always been under the control of the Moro Islamic Liberation Front, a secessionist group (Ortega, *op cit.*). In theory, *C. mindorensis* is officially protected in the Ligausan Game Reserve and in the province of Palawan, but the species has not been recorded in Ligausan Marsh for many years (Messel *et al.*, 1992a).

The species is probably extinct on Mindoro, with Naujan Lake almost totally given over to fish farming and surrounding areas being heavily degraded (G. Ortega, 1998; J.C. Gonzales & W. Oliver, pers. comm.). Indeed, the endemic fish, the 'pait' is also believed to be extinct.

Agusan Marsh, which is believed to be the best of the last remaining habitats for *C. mindorensis*, was included in the IPAS program on 31 October 1996. However, it is being affected by the growing community of Manobo tribal people living in the Marsh, illegal logging, downstream effects of mining, illegal fishing, wildlife poaching and trading, exotic fish introductions and farming (Ortega, 1998). The Protected Areas Management Board (PAMB) of Agusan Marsh Wildlife Sanctuary has been undertaking community awareness work and the PWRCC has conducted spotlighting surveys in 1994 and 1998, with the intention of eventually achieving a crocodile management zone within the Sanctuary (Ortega, 1994). However, the last positive sighting of *C. mindorensis*, a single specimen, was in 1998 (G. Rebong & R. Manalo, pers. comm.).

The Northern Sierra Madre Natural Park was officially established in 2001. A Crocodile Habitat Management Zone has been included in the management plan of the Park. Illegal fishing, hunting and logging still occur in the Park, although at a lower level than before the establishment of the Park. However, most of the now identified Philippine Crocodile sub-populations live outside the Park boundaries in the foothills of the Sierra Madre and the Cagayan Valley (van Weerd *et al.*, 2000).

2.7 Species ability to recover

Evidence from the recovery of some other crocodylians, following protection and removal of the threatening processes (e.g. Webb *et al.*, 1987 for *Crocodylus johnsoni* and *C. porosus*; Elsey *et al.*, 1994 for *Alligator mississippiensis* and Rao *et al.*, 1995 for *Gavialis gangeticus*), would suggest

that *C. mindorensis* should recover in the wild if appropriate habitat can be protected and if, through education campaigns, the current negative feelings towards crocodiles in the Philippines can be reversed. The current moves to protect the species in the Northern Sierra Madre will be a good test of this approach.

3 ISSUES & CHALLENGES

3.1 Habitat loss

Loss and degradation of all habitat types is a significant problem throughout the Philippines. A few hundred years ago, at least 95% of the Philippines was covered by rainforest. By 1900, this had decreased to about 70% - some islands were relatively untouched, whereas others, such as Cebu, had been heavily deforested (Heaney & Regalado, 1998). However, the most recent forest survey, undertaken in 1992, showed that old-growth rainforest had declined to 8.6% (Heaney & Regalado, *op cit.*). Data from the World Bank suggest that 90% of lowland forest in the Philippines has been destroyed over the last 30 years and that only 5% of land area remains under natural forest (Braatz, 1992).

The magnitude of this loss of original forest habitat is the basis for including all the ‘Philippines moist forests’ in the “Global 200: the Earth’s Most Biologically Valuable Ecoregions”, and their listing as Critically Endangered (Olson & Dinerstein, 1988). This factor, plus issues of endemism and species endangerment, are also the reasons for the Philippines now being considered, by the World Conservation Union (IUCN), Fauna & Flora International (FFI) and BirdLife International (BLI), as one of the highest priority countries for conservation concern and urgent action (Oliver, 1993).

The Philippine Crocodile is restricted to freshwater lakes, swamps and rivers, a habitat type which has also suffered greatly. The National Wetland Action Plan (PAWB/DENR & Wetlands International, 1992) states “very few of the lakes are in their pristine state” and that the degree of protection afforded to those lakes contained partly or wholly in national parks is low or non-existent. Further, lakes, swamps, marshes and rivers are impacted by pollution from human population centres, industry, agriculture and aquaculture; over-fishing; siltation caused by deforestation of catchment areas; drainage and conversion to other uses such as rice crops and aquaculture; clearing of riparian vegetation; and the introduction of exotic fish species. These issues are known to be impacting known *C. mindorensis* habitats, including Agusan and Liguasan Marshes (DENR/UNEP/Bookmark, 1997), and Naujan Lake, where the species is believed to be extinct. Further, the last survey in the Agusan Marsh Wildlife Sanctuary, in 1998, failed to record any crocodiles and noted the “constant use of the waterways by motorised bancas and paddleboats, coupled with electric fishing” (G. Rebong & R. Manalo, pers. comm.).

Pollution of rivers is a particularly serious issue, with over 40 rivers in the Philippines now considered as biologically dead (PAWB/DENR & Wetlands International, *op cit.*). In 1976 alone, 18 mining companies in the Philippines discharged more than 14,000 tonnes of tailings per day into nine river systems; these included silty copper mine tailings into the Pagatban River in south-west Negros and gold mine tailings into a lake in Davao, Mindanao – likely to have been the final factors which resulted in the extirpation of *C. mindorensis* at both sites (Ross, 1989; E. Alcala, pers. comm.). However, at least one *C. mindorensis* was confirmed in the Pagatban River area in 2001 (E. Alcala, pers. comm.).

3.2 Community perceptions

Crocodiles in the Philippines, both *C. mindorensis* and *C. porosus*, have a poor image within the general populace and are viewed negatively at almost all levels of society. Locally known as “buwaya”, they are believed by rural people to be bearers of bad tidings and in league with the ‘dark forces of nature’. They are thus often referred to as “asuwang”, or witches (Ortega, 1998).

The perceived aggressive nature and dinosaur-like appearance of crocodiles do not endear them to the human population, and reported cases of problem crocodiles attacking people have reinforced the supernatural beliefs of rural people. This extends to crocodile hunters, who are revered and viewed as extraordinary beings in possession of amulets, or “anting-anting”, and gifted with courage and skill. They are very popular and admired individuals, whose slaughter of crocodiles are considered heroic acts and an exemplary service to the community.

Crocodiles are also the most maligned and ridiculed animals in the Philippines. In the Filipino culture, crocodiles are always compared to corrupt government officials, greedy businessmen, policemen, highway patrolmen, tax and customs collectors, and selfish athletes. Further, the average Filipino is unconcerned about, and indifferent to, crocodiles and in many respects even regard them as vermin.

However, there are areas where people and crocodiles still co-exist, such as in the Disulap area of San Mariano in Isabela Province in north-east Luzon (Rodriguez *et al.*, 2000). Indeed, interviews of people living in the San Mariano area showed that 76% of the people interviewed did not perceive crocodiles as dangerous (Oudejans, 2002). In contrast, 79% of people interviewed in the Benito Soliven area did feel that crocodiles were dangerous. This disparity could be explained by the fact that people in San Mariano have personal experiences with Philippine Crocodiles while people in Benito Soliven have not. Benito Soliven is located on the Cagayan River in an area where the Philippine Crocodile had been wiped out 30 – 40 years ago. The perception of the Philippine Crocodile as being a harmless animal (San Mariano) could have been replaced by a general idea that crocodiles are dangerous (Benito Soliven). This has consequences for the re-introduction of crocodiles in areas where the species no longer occurs in the wild, ie. local people first have to be convinced again of the harmless nature of the Philippine Crocodile. It also enforces the importance of *in situ* conservation of remnant populations - once the crocodiles are gone it will be hard to win local support for crocodile re-introduction and conservation.

On the Pagatban River, in south-west Negros, there are no records of human fatalities due to crocodiles, even though crocodiles did occur there and people used this river for fishing (A. Alcala, pers. comm.).

3.3 National policies

Although there are several laws that provide for the protection of Philippine wildlife and their habitats, only one piece of national legislation specifically includes crocodiles as animals to be protected. This is Republic Act 8485, otherwise known as the “Animal Welfare Act of 1998. All other existing legislation is general in scope and most of these were enacted earlier this century and, therefore, are already considered obsolete. The new Wildlife Resources Conservation & Protection Act, (Republic Act No. 91-47, dated 18 July 2001), whilst aimed at conserving threatened Philippine wildlife, does not specifically call for protection of those species that are listed as threatened by the IUCN. This has been recommended in discussions on the Implementing Rules & Regulations, but these are still under review.

3.4 Captive management

In most respects, captive management of *C. mindorensis* does not differ greatly from that of most other *Crocodylus* spp. However, an issue that does create difficulties is the seasonal incompatibility experienced in most pairing attempts, as well as intragroup intolerance that can occur at any time (Sibal *et al.*, 1994; G. Ortega, pers. comm.; C. Adams, pers. comm.). Studies at the PWRCC show

the highest peak in incompatibility in December, at the start of the pairing season as introduced crocodiles adjust to each other. This then declines until February, when egg laying begins, and then resumes an upward trend until April, which is just before the peak laying period. After this time, incompatibility decreases again until its lowest point, in July, which coincides with peak hatching. From April to July, the female is guarding her nest and receives little interference from the male. After most of the eggs have hatched, incompatibility increases again dramatically over the next 2-3 months, with the male becoming increasingly aggressive toward its partner. At this point, pairs at the PWRCC are separated until the following breeding season (Sibal *et al.*, *op cit.*).

This behaviour has clear implications for captive management, especially animal introductions, group composition and enclosure design. In particular, allowance must be made for separation of animals, either on a temporary or long-term basis.

Careful observations are required if young crocodiles are kept together in groups to avoid dominance-related mortality. Deaths have occurred within three months of hatching at Gladys Porter Zoo after individual animals assumed a dominant position within a group (C. Adams, pers. comm.).

Experiences in the Philippines, Australia and the United States have also shown that any changes to group composition and, indeed, any disturbances to crocodiles at all can have negative consequences, with injuries or even death resulting (C. Adams; C. Banks & G. Rebong, pers. comm.). If the dominant animal is removed from a group, the next most-dominant specimen will usually assume that position, sometimes within as short a period as only 3-4 days (G. Rebong & R. Sumiller, pers. comm.). If young crocodiles are to be placed into new surroundings or in new groups, it would appear that including a number of structures as visual barriers will assist in preventing stress-related trauma. Placing the crocodiles in groups of high density also assists in this regard.

3.5 Direct Killing

Whilst the widespread killing of crocodiles was the major factor in greatly reducing the wild population of *C. mindorensis* and *C. porosus* in the 1950s – 1970s, this has now been replaced by ongoing habitat loss as a major threatening process. This factor notwithstanding, crocodiles are still killed on occasion, either directly or during fishing activities and could be a factor in eliminating local populations (Oudejans, 2002; A. General, pers. comm.).

3.6 Ecology

The ecology of *C. mindorensis* remains very poorly understood, although ongoing studies in the Northern Sierra Madre are slowly adding to our knowledge of the species in that area (e.g. Oppenheimer, 2001). A range of projects targeting specific factors such as seasonal movement and breeding have been designed and will be implemented as soon as funds are available (J. van der Ploeg & M. van Weerd, pers. comm.). The CROC (Crocodile Rehabilitation, Observance and Conservation) Project, which is being implemented by the Cagayan Valley Program on Environment & Development (CVPED) and (ex)students of Isabela State University (ISU) and Leiden University of the Netherlands, has been awarded the Top Follow-up Award 2003 by the BP Conservation Programme. This funding will enable more sophisticated and in-depth research to be conducted, among other conservation directed activities.

3.7 Taxonomic definition

The taxonomic relationships among a number of south-east Asian freshwater crocodiles, including *C. mindorensis*, require further study, as a number of questions remain unanswered (Ross, 1998). This is the focus of a current project, which does confirm *C. mindorensis* as a distinct species (J. Gratten, pers. comm.). An additional ongoing project is examining the genetics of the various island populations of *C. mindorensis* (E. Louis & F. Pontillas, pers. comm.).

4 PREVIOUS & CURRENT INITIATIVES

4.1 *In situ* programs

The only *in situ* program is located in the Northern Sierra Madre Range in north-east Luzon Island. This commenced in 2000 following confirmation of the presence of *C. mindorensis* there in 1999. Since then, a number of crocodile surveys have been carried out by the PLAN-Philippines/Northern Sierra Madre Natural Park – Conservation Project (NSMNP-CP). Some of these were conducted as a joint effort between the NSMNP-CP and PWRCC. Others involved Louisiana State University, again in collaboration with the PWRCC. Two further, more detailed studies were undertaken by Dutch MSc students through a co-operative program between the NSMNP-CP and the Cagayan Valley Program on Environment & Development (CVPED), which itself is a partnership between Isabela State University at Cabagan and Leiden University in the Netherlands (Pontillas, 2000; van Weerd, 2000; Oppenheimer, 2002; Oudejans, 2002; Rodriguez *et al.*, 2000; van Weerd *et al.*, 2001, van Weerd *et al.*, 2003).

These links led to a short-term conservation plan with the Local Government Unit of San Mariano and the DENR/Protected Area Superintendent Unit (PASU) of the NSMNP (van Weerd, 2002).. This consisted of:

- Crocodile research and surveys.
- Awareness raising activities.
- Livelihood support.
- Local legislation and institutional arrangements.

Of particular significance is the enacting of four municipal resolutions by the Local Government Unit of San Mariano to:

1. Protect and conserve *C. mindorensis* in San Mariano, making it illegal to catch, possess, sell or hut crocodiles in San Mariano.
2. Declare the Philippine Crocodile as a flagship species of the municipality.
3. Enable the establishment of a crocodile rescue centre/holding pen in San Mariano for crocodiles retrieved from captivity.
4. Declare a portion of the Disulap River as a Philippine Crocodile Sanctuary, including the area where a *C. mindorensis* nest was found in 2000.

All these developments were presented and explored further at the “Philippine Crocodile (*Crocodylus mindorensis*) Conservation Workshop” from 16-19 May 2002 at Isabela State University in Cabagan (Anon, 2002) and summarised at the following Regional Conference on Environment & Development (Van Weerd & General, 2003). Developing the outcomes of the 2002 Workshop into local conservation action programs was the primary goal of a follow-up workshop in Cabagan in November 2004 (M. van Weerd, pers. comm.).

The previously mentioned CROC Project plans to continue with the community-based approach in San Mariano and in other municipalities with remaining wild crocodile populations, and has received funding from the BP Conservation Program for this purpose in 2003.

Lake Manguao was proposed as a ‘protected habitat’ for *C. mindorensis* in 1992, but this was vehemently opposed by the local residents. Agusan Marsh is another area that remains important

and protection options need to be pursued. A range of community awareness activities has been implemented, as outlined in Section 4.6.

4.2 *Ex situ* programs

4.2.1 *Ex situ* programs within the Philippines

Philippine Crocodiles are known to be held and bred at three facilities in the Philippines:

1. Palawan Wildlife Rescue & Conservation Centre (Crocodile Farming Institute)

The PWRCC (CFI) was established on 20 August 1987, as a five year joint partnership between the Philippine and Japanese Governments (Ortega, 1998). The bulk of financial technical support was provided through the Japanese International Co-operation Agency (JICA). The Joint Technical Co-operation was extended for an additional two years under a Memorandum of Agreement signed between the two parties on 17 August 1992 (Anon, 1992a). On the expiry of this Agreement in August 1994, the JICA decided to not resign the Agreement and withdrew their staff and other support. Hence, management of the PWRCC transferred wholly to the Philippine Government, under the Department of Environment & Natural Resources (G. Ortega, pers. comm.). In April 2002, management responsibility for the PWRCC was transferred to the Natural Resources Development Corporation (NRDC), which is the commercial arm of the DENR (W. Pollisco, pers. comm.). However, the PAWB remains involved for issues relating to *C. mindorensis*.

The project was officially opened on 4 March 1988 and has two main objectives:

- To conserve the two species of crocodiles in the Philippines.
- To promote the socio-economic well-being of the local communities through the development and introduction of suitable crocodile farming technology (Ortega, 1998).

The PWRCC is located on 10ha of land in Barangay Irawan, Puerto Princesa City on the central east coast of Palawan. Structurally, it consists of four main operational units:

- Experimental Farming Unit.
- Resource Management & Ecology Unit.
- Nutrition & Biochemistry Unit.
- Crocodile Clinics Unit.

From 1987-1994, the CFI/PWRCC pursued a policy of removing *C. mindorensis* from the wild, after agreement with the DENR-PAWB, as it was considered impossible to protect and conserve the species in the wild. This action was strongly recommended by the CSG, reiterated in 1992 at a CSG Workshop at the CFI (Messel *et al*, 1992b), and was approved by the DENR. Hence, 18 crocodiles were acquired in 1987 and a further 217 over the next seven years, for a total founder population of 235 animals (Sumiller, 1998).

The first successful breeding was recorded in 1989, when seven hatchlings emerged (Sarsagat & Sibal, 1991). The species has been bred every year since then, with the highest annual total being 253 hatchlings in 1996 and 1,280 hatchlings over the 1989-1997 period (Sumiller, 1998). The young crocodiles produced in 1989 have reproduced and the first F2 individuals hatched in 1999 (Rebong & Sumiller, 2002).

The PWRCC currently holds the bulk of the world's population of *C. mindorensis*. However, budgetary constraints, limited facilities to maintain these animals, and uncertainty about the genetic relationships within the population and placement of crocodiles led to the decision to cease breeding in 2001. Resolving these issues is an important action outlined later in this Plan.

2. Crocodile Breeding Facility, Silliman University

With technical assistance from the Smithsonian Institution/World Wildlife Fund Philippine Crocodile Project and a grant from World Wildlife Fund International, the Silliman University Environmental Centre (SUEC) created the Crocodile Breeding Facility at the SUEC Marine Laboratory, Dumaguete City, Negros Oriental, in 1980 (Messel *et al.*, 1992b). The facility was created to “provide suitable habitat to propagate and rear captive *C. mindorensis*” and, if suitable protected habitat is later available, to release captive-bred offspring to the wild (Alcala *et al.*, 1987).

The original captive group comprised three adult females and one male, although all breeding has resulted from the male and only one female (E. Alcala, pers. comm.). The female is from the Pagatban River in southern Negros Occidental, whilst the male originated in Mindoro; both are now thought to be quite old (E. Alcala, pers. comm.). Breeding commenced in 1981 and 21 captive-bred offspring were held as at 1 March 1984 (Alcala *et al.*, 1987). However, successful breeding has occurred since, although details are only available for 1994, when 22 young successfully hatched from 25 eggs (Alcala, 1997). No breeding has occurred since 1997, although eggs have continued to be laid (H. Calumpong, pers. comm.). The University held 19 crocodiles in November, 2004, including eight young crocodiles are currently on public display in the University's A.Y. Reyes Mini Zoo (E. Alcala, A. Cadelina & F. Tiempo, pers. comm.).

The Facility is based at and managed by Silliman University Marine Laboratory (SUML) with inputs by Dr. Ely Alcala from the University's Centre for Tropical Conservation Studies (CenTrop), who worked as a volunteer veterinarian for over eight years (H.P. Calumpong, pers. comm.). The CenTrop received funding assistance from Melbourne Zoo, Australia, from 1993-95 for staff support at the Mini Zoo and upgrading of holding facilities, both at the Marine Laboratory and the Mini Zoo. The program is maintained by SUML at the present time.

3. Manila Zoological & Botanical Garden

Manila Zoological & Botanical Garden (Manila Zoo) has maintained and displayed *C. mindorensis* for many years and recorded its first breeding of the species in 1989. As at 1 January 2002, the Zoo held 28 crocodiles - two adult pairs (both animals of one pair are reportedly from Occidental Mindoro, but the origins of the other pair are unknown), eight unsexed subadults hatched in 1989 and 16 juveniles hatched at the Zoo in 1998, 2001 and 2002 (R.C. Bernado, pers. comm.).

4. Other holdings

In addition to these three facilities, individual specimens and small groups of *C. mindorensis* are held throughout the Philippines in DENR Registered Facilities (J. de Leon, pers. comm.). As at May 2002, these were:

- Malabon Zoo & Aquarium: 3.
- Nanacayasan Mini Zoological Park: 20.
- Bassig Hilltop Resort Zoo: 1.
- E.T. World Mission International Foundation Inc.: 5.
- Crocolandia Foundation Inc.: 5.
- Cebu City Zoo: 2.
- Badak Beach Resort: 3.

- Mr. Erwin Uy: 7.
- Bangoy-Opitz Farm: 6.
- Davao Crocodile Park: 97.
- Ninoy Aquino Wildlife Centre: 3.
- Montalban Zoo: 3.
- Mr & Mrs Gamboa: 1.
- Villa Adoracion: 1.
- Immaculate Heart of Mary Seminary: 1.
- Dona Josefa Aqua Plaza & Inland Resort: 1.

4.2.2 *Ex situ* programs outside the Philippines

All Philippine Crocodiles transferred out of the Philippines remain the property of the Philippine Government. In addition, the transfer of any Philippine Crocodile from an overseas institution, where it is held under a Memorandum of Agreement (MOA) with the DENR, to another institution for breeding and other conservation-related purposes, is subject to prior written clearance from the DENR. Further, only parties with existing MOAs with the DENR are allowed to transfer *C. mindorensis* in their custody to other parties (W. Pollisco, pers. comm.).

There is an active program for *C. mindorensis* in North America and a public display at Melbourne Zoo; the latter is intended as the basis of a regional program involving a number of zoos in Australia and New Zealand:

1. Gladys Porter Zoo, Brownsville, Texas, USA

Gladys Porter Zoo (GPZ) initiated the North American Philippine Crocodile Co-operative Breeding & Conservation Program in 1988, following importation of an adult female crocodile from Silliman University to pair with a male already in the Zoo. The project's short-term goal is to establish a stable, genetically diverse population of Philippine Crocodiles within North American zoos and private collections, and is managed by the Zoo's Curator of Herpetofauna, Colette Adams. Since 1989, 35 offspring have been produced from this pair, five of which were reared for three years and repatriated to Silliman University, before being transferred to the PAWB Mini Zoo in Quezon City (C. Banks, pers. obs.). A further 14 were distributed to zoos and private collections in the United States for rearing. In 2000, three juveniles were repatriated to the Philippines and are currently held at the PAWB Mini Zoo & Rescue Centre in Quezon City. In 2002 and early 2003, 33 young crocodiles hatched at GPZ were transferred to five other US zoos under Breeding Loan Agreements between GPZ and the respective receiving zoo, under the auspices of the MOA between the DENR and GPZ:

- Pittsburgh Zoo & Aquarium, Philadelphia (four crocodiles transferred).
- The Cullen Vivarium, Wisconsin (16 crocodiles transferred).
- Alligator Adventure, South Carolina (three crocodiles transferred).
- St. Augustine Alligator Farm, Florida (six crocodiles transferred).
- Omaha's Henry Doorly Zoo, Nebraska (four crocodiles transferred).

The current group at the Zoo is 1.1.5 (C. Adams, pers. comm.). In addition, an adult male was transferred from the Zoo to Omaha's Henry Doorly Zoo, USA, in 1997. A pair of small adults that originated at GPZ have resided at Fort Worth Zoo in Texas since 1996.

The Zoo is also endeavouring to develop a new MOA with the DENR to support greater involvement with *C. mindorensis* from North American zoos.

The project's long-term goal is to support survival of the species in the wild. To that end, in conjunction with the American Zoological Association's (AZA) Crocodylian Advisory Group (CAG), and under the direction of the National Recovery Team, the GPZ works to co-ordinate conservation efforts that will serve to implement the Recovery Plan's goals. Upon establishment of the proposed Philippine Crocodile Trust Fund, participating institutions will be asked to contribute financially on an annual basis to ongoing *in situ* conservation activities as set out in this Plan.

2. Melbourne Zoo, Victoria, Australia

Melbourne Zoo signed a Memorandum of Agreement (MOA) for *C. mindorensis*, with the DENR and Silliman University on 14 January 1993. This provided the framework within which the Zoo provided funding and logistic support to the CenTrop, and allowed for the transfer of a pair of sub-adult *C. mindorensis* to Melbourne Zoo in August 1993 (Banks, 1996). One of the crocodiles succumbed to a trauma-induced infection in July 1995, but the remaining female is thriving in a large public display within the Zoo's Reptile House (C. Banks, pers. comm.).

The original MOA expired in January 1996 and a new MOA, between the DENR and Melbourne Zoo, was signed on 13 January 2001. This allowed for the transfer of six young *C. mindorensis* (three pairs) from the PWRCC to Melbourne Zoo in November 2002. Unfortunately, three specimens died soon after arrival as a result of stress accumulated over the preceding four months. The three remaining individuals recovered well and one of the females is on public display in the Zoo's Reptile House, adjacent to the adult female that arrived at the Zoo in 1993.

The Zoo has a strong commitment to the conservation of *C. mindorensis* and supported the development and publication of the first National Recovery Plan (Banks, 2000). A successful application to the Whitley Foundation, UK, resulted in a grant to support *in situ* work in the Northern Sierra Madre, with a strong emphasis on community awareness.

3. Other

A number of other zoological institutions, in Australia, New Zealand and the USA, have expressed interest in participating in regional/global conservation programs for *C. mindorensis*, including through public display, breeding, community awareness and *in situ* support (Lees & Johnson, 2003; C. Banks & C. Adams, pers. comm.). These options are being pursued through contacts at Melbourne Zoo, for Australia and New Zealand, and Gladys Porter Zoo, for the USA.

Interest has also been received from Europe, particularly from the Danish Croc Zoo in Esbjerg, Denmark, for participation in the conservation program (R. Hedegaard, pers. comm.). A draft MOA is currently being negotiated.

4.3 Surveys

A number of surveys have been undertaken for *C. mindorensis*, commencing with Ross' extensive 1980-81 study, during which 12 months were spent in areas expected to contain crocodiles (Ross, 1982). Indeed, this was a seminal point in assessing the conservation status of this species, with its major finding being that only 500 - 1,000 individuals remained in the wild.

Since that time, PWRCC researchers have also surveyed various areas for *C. mindorensis*:

- Busuanga Island, north of Palawan, in July and September 1990, July 1991, February 1992 and August 1999 (Anon, 1991; Regionel, 1993; Hibaya *et al.*, 1999).
- Agusan Marsh, Mindanao, in June 1994, 1998 and 1999 (Anon, 1994a; Ortega, 1998; Hibaya *et al.*, 1999).
- Diwakden Creek in the Northern Sierra Madre Natural Park, in north western Luzon, in July 1999 (Hibaya *et al.*, 1999).
- Lake Manguao, in northern Palawan, in 1989 and 1990 (Anon, 1990; Ortega, 1998).
- Pujada Island, in Davao Oriental, Mindanao, in 1990 (Regional & Kurata, 1991).
- Palawan rivers in 1998, ie. Bacungan, Inagawan and Irawan Rivers in/near Puerto Princesa City; Taritien, Calategas and Panacan Rivers in/near Narra; and Sayab River in Bataraza (G. Ortega, pers. comm.).
- Pulangi River, Bukidnon Province, Mindanao in August 1999 (Hibaya *et al.*, 1999).
- Liguasan Marsh in North Cotabato Province, Mindanao in August 1999 (Hibaya *et al.*, 1999).

Following the confirmation of *C. mindorensis* still extant in the Northern Sierra Madre in 1999, a series of surveys have been undertaken in that area. Most of these were carried out by PLAN International-Philippines, whilst some also involved personnel from the PWRCC, Isabela State University and Louisiana State University (Pontillas, 2000; van Weerd *et al.*, 2000; Tarun, 2000 & 2001; van Weerd *et al.*, 2001; Tarun & Guerrero, 2002). These showed that *C. mindorensis* had successfully bred in at least three different locations from 2000-2002, ie. Disulap River, Dinang Creek and Lake Dunoy. Further surveys are planned for other areas in the Northern Sierra Madre range.

Surveys involving personnel from Louisiana State University and the PWRCC, as well as local people, were undertaken in July, August and December 2000 (Pontillas, 2000):

- San Mariano, Isabela, Luzon (already cited).
- Dipuyai River and its tributaries on Busuanga Island (no *C. mindorensis* encountered).
- Pagatban River on Negros Island (no *C. mindorensis* encountered). This river was revisited in 2001, but, again, no crocodiles were seen, although local people reported seeing a crocodile at Sitio Lunoy in November 2000.

A survey was also undertaken in the Tineg area of Abra Province in north-west Luzon in February 2002 (G. Rebong, pers. comm.). Although three captive *C. mindorensis* were seen, no wild specimens were encountered. However, tracks and faeces were recorded and further surveys have been requested by the National Recovery Team.

4.4 Research

Most research on *C. mindorensis* prior to 1998 was carried out at the PWRCC and covered four main areas:

4.4.1 Reproduction

- Comparative growth studies (Sibal *et al.*, 1994).
- Captive breeding.
- Nest temperatures (Regionel *et al.*, 1990).
- Temperature Dependent Sex Determination (Sumiller & Cornel, 1997).
- Staging of dead embryos incubated at different temperatures (G. Ortega, pers. comm.).

- Sexual dimorphism in *C. mindorensis* and *C. porosus*.
- Dorsal scale patterning.

4.4.2 Husbandry

- Varied stocking rates of hatchlings (Sumiller & Gol-lod, 1998).
- Minimum vitamin requirements (Malolos & Elivera, 1995).
- Observations on aggressive behaviour.
- Protein and mineral requirements of hatchlings (Malolos *et al.*, 1997).
- Analysis of crocodile feeds.
- Food conversion rates in different age classes (Sarsagat *et al.*, 1992).

4.4.3 Veterinary Studies

- Mortalities & clinical cases (Jamerlan, 1991).
- Blood parasite infections (Villapa *et al.*, 1990).
- Digestive tract enzymes (Malolos, 1995).
- Blood serum analysis (Goh *et al.*, 1991).
- Development of a health care program.
- Disease characteristics in captive crocodiles (Sumagaysay, 1993).
- Use of cyanoacrylate adhesive for skin closures (Aquino, 1998).
- Age-size relationships.
- Anatomical differences between *C. mindorensis* and *C. porosus*.

4.4.4 Farming Technology & Sanctuary Establishment.

- Crocodile Farming Technology (Anon, 1994b).
- Sanctuary establishment.

4.4.5 Ecology

Preliminary studies have been undertaken under the auspices of the PLAN-Philippines/CVPED project in the Northern Sierra Madre:

- Population dynamics and ecology (Oppenheimer, 2000).
- Factors affecting distribution and population size (Oudejans, 2002).
- Human interactions (Rodriguez *et al.*, 2000).
- Distribution patterns, population size and population structure of Philippine Crocodile *C. mindorensis* in Northeastern Luzon (Van Alphen & Telan, 2002).
- Development of a standardized protocol for the ecological study of the Philippine Crocodile (*C. mindorensis*) and preliminary results (Van Gils *et al.*, 2003).

4.5 Habitat reservation.

As noted earlier, five sites known to contain *C. mindorensis*, either now or in the past, are officially protected under the NIPAS system:

- Naujan Lake, Mindoro, which was proclaimed as a National Park in 1956.
- Liguasan Marsh, Mindanao, a portion of which was gazetted as a Game & Wildlife Sanctuary.
- Agusan Marsh, Mindanao, which was proclaimed as a Wildlife Sanctuary in 1996.
- The province of Palawan.
- The Northern Sierra Madre Natural Park, Luzon, which was officially established in 2001

However, no effective habitat or wildlife management has been attempted or implemented in any of these areas (PAWB/DENR & Wetlands International, 1992; G. Ortega, pers. comm.).

Outside these sites, a Philippine Crocodile Conservation Sanctuary was created on the Disulap River in the Municipality of San Mariano, Isabela Province, Luzon, in May 2002, through Local Ordinance No. 01-17 (Meneses, 2001; Tarun *et al.*, 2001; van Weerd *et al.*, 2001). This excellent initiative was strongly supported by the Sangguniang Bayan of San Mariano and the Mayor is very active in pursuing its implementation.

Nevertheless, habitat reservation and protection has remained a strong recommendation of the CSG and earlier efforts to this end were pursued by the CFI in two areas (Messel *et al.*, 1992b):

4.5.1 Palawan

Lake Manguao: a freshwater lake in the municipality of Taytay, northern Palawan. The Lake was surveyed three times and a detailed proposal was submitted to the Third Joint CFI Committee Meeting and to the local community in 1990. However, the Taytay municipality was uncertain and the local residents opposed the project, which subsequently lapsed (Anon, 1990; Ortega, 1998).

4.5.2 Mindanao

Agusan Marsh Wildlife Sanctuary: this is still felt to be a good option for *C. mindorensis* protection in the wild. PWRCC and DENR staff surveyed the area in 1994 and 1998, but failed to see any crocodiles (Ortega, 1998). Despite this, discussions have continued with the Agusan Marsh PAMB to protect the Managed Wetland Reserve Zone of the Sanctuary, which covers approximately 10,580ha, or 16% of the Marsh's total area (Anon, 1994c). WWF-Philippines has expressed interest in supporting conservation of *C. mindorensis* in this area (J.L. Tan, pers. comm.).

Pujada Island: this is a privately-owned site near Mati in Davao Oriental. It covers 157ha and includes a 20ha marshy area in the interior of the island. Whilst it was reputed to contain crocodiles in the past, none were sited when the island was visited by PWRCC staff in late 1990. The island lacks appropriate habitat for crocodiles and its potential as a crocodile sanctuary would be further compromised by proposals to convert the island into a 'retirement resort'. It is not considered an option for *C. mindorensis* and has not been pursued (Regionel & Kurata, 1991)

4.6 Community involvement/education.

A widely-held negative community attitude towards crocodiles is one of the major barriers to crocodile conservation in the Philippines. Recognising this, the PWRCC implemented a wide range of information, education and communication strategies from 1988-98. Whilst some of this is still in place, funding and staff shortages have hindered further development since 1998.

Following confirmation of *C. mindorensis* in the Northern Sierra Madre in 1999, a suite of awareness raising activities was developed and implemented in that region through the PLAN-Philippines/Northern Sierra Madre Natural Park-Conservation Project (NSMNP-CP). Some of these were complemented by the Community-based Research, Observance & Conservation Project (CROC), which was funded through the BP Conservation Program in 2001 and jointly delivered by personnel from Isabela State University in Cagayan and Leiden University in the Netherlands.

4.6.1 Information Materials

At least 225,000 printed materials were produced at the PWRCC over the 1989-99 period. Whilst these were primarily for local circulation, they were also distributed to interested persons and groups overseas. They ranged from brochures about the PWRCC and its work, to calendars, posters about crocodiles in the Philippines, stickers, Christmas cards, post-cards and periodic reports. The NSMNP-CP produced 2,000 brochures in Tagalog and distributed these among local communities, together with information on the threatened status of *C. mindorensis*, the fact that this species is not dangerous to people, and “do’s and don’ts” regarding crocodiles.

CFI’s quarterly newsletter, “CFI News”, was distributed to research and government institutions in the Philippines and abroad (Ortega, 1998).

In addition to CFI’s materials, Melbourne Zoo funded production of 3,500 colour posters, featuring the Philippine Crocodile, in the “Only in the Philippines” series in 1995. The posters were produced in Tagalog, Cebuano and English, most of which were distributed throughout the Philippines.

Two posters have been developed for the Northern Sierra Madre – the first (2,000 copies) in 2000 in English and Tagalog and distributed to communities in San Mariano. The second poster (4,000 copies) was funded via a grant from the Whitley Foundation through Melbourne Zoo and produced in late 2002. This second poster was modelled on the 1995 “Only in the Philippines...” production and was printed in Tagalog, Ilocano and English. This poster has been distributed to all DENR offices in Region II and to Local Government Units, Barangay Halls and Schools in municipalities with existing or suspected crocodile populations in the Cagayan Valley region.

4.6.2 Media Coverage

Press releases about the PWRCC activities are regularly written and distributed, resulting in radio coverage in Palawan, as well as parts of Luzon, Mindanao and the Visayas. In addition, national newspapers and magazines, such as “Bulletin Today”, “The Philippine Star”, “Philippine Daily Enquirer”, “Malaya”, “Panorama” and “Liwayway”, regularly carry stories about the PWRCC and crocodile conservation (e.g. Anon, 1992b).

Video documentaries and slide presentations in Palawan were produced in Filipino and English for children and adults. In addition, two radio announcements about crocodiles in the Philippines were produced in co-ordination with the Philippine Broadcasting System. These were aired free of charge by 25 radio stations across the Philippines (Ortega, 1998).

The Philippine Crocodile has been featured several times in the Tagalog newspaper that the NSMNP-CP project distributes among local communities and in radio broadcasts on popular local radio stations.

4.6.3 Information-Education Campaigns

Numerous information-education campaigns were delivered by the PWRCC in crocodile-inhabited areas and schools all over Palawan in the early 1990s. These consisted of slide and video presentations; lectures on crocodile myths and facts; and open meetings. Those places with community television were given PWRCC documentary films for public viewing. Although focussing in Palawan, the campaigns were also conducted in parts of Luzon, Mindanao and the Visayas, with a particularly extensive campaign in 1998 (Ortega, 1998). Further campaigns are planned for northern Palawan, using the Philippine Crocodile as a flagship species for broader wildlife conservation in the area (G. Rebang, pers. comm.).

The municipality of Taytay and Lake Manguao, in northern Palawan, was a particular focus of the campaigns, following a 1991 survey of Lake Manguao residents on their level of awareness and acceptance of crocodile conservation and the PWRCC project. The survey showed that 59% of Lake Manguao residents had a below average knowledge about crocodiles and 49% were strongly or slightly unfavourable towards crocodiles and their conservation. A further 23% were neutral towards crocodiles (RSPSC, 1991). However, 39.5% expressed willingness to raise crocodiles in their backyard if they were taught the technology. In an effort to address this overall negativity, information campaigns were conducted in the municipality's secondary and tertiary schools in February 1994 (Anon, 1994d).

The PWRCC also participated in the annual Philippine Travelmart of the Department of Tourism, as part of the Palawan delegation, in 1991.

A comic album was produced on environmental issues by the NSMNP-CP and included a feature on the Philippine Crocodile. The species is also one of the topics of the community theatre groups (Dalaw Turo) that were established in the Sierra Madre by the Project and the DENR (van Weerd, 2002).

Five community consultations were held in the area around the Disulap River in 2000-2001 to inform local residents about the crocodiles and incorporate their comments in the design of a crocodile sanctuary. This was instrumental in those same communities voting for the establishment of the sanctuary on the Disulap River in 2001 (Tarun *et al.*, 2001).

The various field surveys and capture of crocodiles undertaken by NSMNP-CP and PWRCC staff also provide opportunities for improving understanding of crocodiles in the areas visited.

4.6.4 Livelihood Support & Legislative Implications

Building on the activities with local communities is essential. Livelihood support has had a direct impact on crocodile conservation near Disulap River. Agro forestry was supported to protect river banks from erosion and supply local fishermen and hunters with alternatives to riverine resources (van Weerd, 2002).

Such activities, in turn, underpinned the successful development of the Philippine Crocodile Conservation Sanctuary, as outlined in Section 4.1 of this Plan.

4.6.5 Educational & Promotional Activities at the PWRCC

The PWRCC is open to visitors from Monday to Saturday. It now has an average annual visitation of 40,000 people, for a total of almost 273,000 visitors since it opened in 1987. This places it as the number one tourist destination in Palawan (Ortega, 1998; G. Rebong, pers. comm.).

Lectures and guided tours are provided for students, tourists, politicians, diplomats and celebrities. These commence with a video presentation and close-up experience in the Centre's interpretation centre. Visitors are also exposed to a range of signs and other information as they tour the site.

A 1991 survey of 1,300 visitors to the PWRCC suggested that the information campaigns are having a positive effect, ie. 96% of respondents agreed that crocodiles should be conserved, 80% supported the PWRCC's conservation efforts and 74% said that there had been a positive change in the way they perceive crocodiles (Magbanua, 1991; G. Ortega, 1998).

In an effort to overcome the community attitude that crocodiles are ugly, fearsome and ferocious, the PWRCC created “Crokee”, a 202cm tall crocodile mascot. Commencing in June 1996, with the launch of “Crokee goes to Schools”, Crokee has since become a regular visitor at festivals, holiday celebrations and official functions, as well as schools (G. Ortega, 1998). This initiative is seen as another way of creating positive attitudes towards crocodiles in the Philippines, using an appealing and fun approach.

The PWRCC also produced “watch hatcha” in 1998 as a promotional activity to welcome baby crocodiles into the world.

4.6.6 Crocodile Conservation Week

At its February 1995 Council Meeting, the City Government of Puerto Princesa resolved to declare that 6-11 March every year would be “Crocodile Conservation Week”. The seven day celebration now includes essay writing and painting contests, conservation quiz shows, demonstrations of crocodile handling, film shows, t-shirt and poster design competitions, and drama activities (Ortega, 1998)

4.6.7 Awareness outside the Philippines

The arrival of the pair of Philippine Crocodiles at Melbourne Zoo in 1993 stimulated media coverage and subsequent presentations at two regional wildlife conferences (Banks, 1995 & 1996). The Zoo has also promoted the conservation of this species throughout the Australasian zoo region and established strong links with the Honorary Philippine Consul for Victoria, in support of the Philippine Crocodile.

The captive breeding program for *C. mindorensis* at GPZ, as well as their plight in the wild, was broadly publicised across the United States and within the North American zoological community with the Zoo’s first captive hatching of the species in 1989. In 1993 and again in 2000, the Zoo sent captive-hatched crocodiles back to the Philippines, once again raising awareness throughout the USA. Many zoological institutions expressed interest in participating in the conservation of the species as a result of this publicity.

However, because many US zoos had few facilities for, and little expertise in dealing with crocodilians of any species, the AZA-CAG began to offer an annual training course on crocodilian management in 2001. Taught by experts in crocodilian husbandry and exhibition, this course serves to familiarise personnel, who will be directly involved in crocodilian management, with care and handling protocols to encourage the establishment of more crocodilian holding space within the US. For the past two years, the course has been filled to capacity and very well received by participants. The AZA-CAG is confident that, as the ability to maintain and exhibit rare crocodilians, such as *C. mindorensis*, becomes more widespread within North America, so will awareness of the plight of threatened crocodilians.

5. RECOVERY PLAN OBJECTIVES, CRITERIA & ACTIONS.

Primary Objective

The primary conservation goal is to re-establish viable wild populations of *C. mindorensis* and ensure its long-term survival throughout its historic range. Recognising the implications of this objective, protection and survival within sections of its historic range is likely to be the reality over the short-term.

Implicit in this goal is maintaining the species' ability to survive, flourish and maintain its potential for evolutionary development in the wild and throughout its natural geographic range.

This primary objective is broken down into nine specific conservation objectives aimed at focusing resources on achieving the primary objective.

Primary Recovery Criterion

Viable populations of *C. mindorensis* are maintained and fully protected in reserves or other appropriately managed sites across the known distribution of the species.

5.1 Specific Conservation Objective 1.

- Establish protected wild populations of *C. mindorensis*.

Performance Criteria:

1. Full extent of current wild distribution of *C. mindorensis* is known.
2. Areas of habitat which are appropriate for *C. mindorensis* to breed and thrive are identified and secured.
3. Viable wild populations of *C. mindorensis* are established and maintained, either through enhancing existing populations, or re-introductions.

Actions required to achieve objective:

5.1.1 Reassess distribution and wild status of *C. mindorensis*

This action should be targeted in selected key areas which are known, or believed to still support *C. mindorensis*, building on surveys conducted over the past three years. Hence, surveys should now be focussed on:

- Northern Luzon: the species has been confirmed as present and breeding in Isabela Province and present in Abra Province. However, the full extent of its occurrence across northern Luzon remains unclear. Secondary information on crocodiles in Apayo, Mountain and Ifugao Provinces has yet to be assessed.
- Mindoro: recent eye-shine reports on Lake Naujan need to be explored.

- Negros: at least one *C. mindorensis* has recently been confirmed in the Pagatban River. This area needs further exploration, although law and order issues in the area may present difficulties.
- Mindanao: this island was a stronghold for *C. mindorensis* and it has recently been confirmed as still present in the Pulangui River in Bukidnon. Additional surveys are needed in that area and further work should be undertaken in Agusan Marsh, although the species was not encountered there in 1999. However, the current political unrest in Mindanao is acknowledged and these areas should only be surveyed when it is safe to do so.
- Sulu Islands: recent reports of crocodile eye-shine on Jolo Island need to be explored further, although the same security concerns apply as on Mindanao.

5.1.2 Establish a list of possible release sites in the Philippines and support development of conservation/management plans for those areas.

Philippine Crocodiles have been extirpated from most of their historic range. In order to re-establish the species throughout its previous distribution, possible release sites must be identified. The PAWB has been tasked with preparing this list, noting that these could be in protected areas or on private land, and in both natural or artificial environments. Once the sites are identified:

- Relevant protocols should be formulated and agreed.
- Surveys should be carried out.
- Management issues and recommendations should be identified and developed for the priority sites.

5.1.3 Develop a Philippine Crocodile release and restocking program.

Returning Philippine Crocodiles to the wild should only be considered when appropriate protection is in place. Once that point is reached, decisions will need to be made about the most effective methods of establishing viable wild populations. These options will include allowing remnant wild populations to recover naturally, restocking of remnant wild populations and reintroductions. It will also be important to identify which crocodiles are appropriate for release, depending on their provenance and capacity to adjust to wild conditions. A Reintroduction Protocol for *C. mindorensis*, following the guidelines set out by the IUCN Reintroduction Specialist Group (IUCN, 1998), has been written and endorsed by the Philippine Crocodile National Recovery Team (Banks & Rebono, 2003).

5.1.4 Develop options for the protection and management of existing and released populations

Arguably the most important factor in the long-term viability of *C. mindorensis* is a suite of properly protected and managed sites. Although some areas, which are within the known range of *C. mindorensis* and may well still contain crocodiles, have been included in the NIPAS system, they are not currently protected. Resources must be directed to achieve this goal as a high priority.

Protection of habitat for *C. mindorensis* will include managing water flows, preventing pollution from adjacent areas, managing access and monitoring the health of the protected areas themselves. Rehabilitation of the agreed areas may also be necessary.

The current process of establishing and maintaining protected areas in the Philippines involves a lengthy assessment and the creation of a Protected Area Management Board for each designated Protected Area (PAWB/DENR, 1992). It is vital that these processes proceed as quickly as possible, as successful delivery of this action is crucial for the survival of *C. mindorensis* in the wild. Implicit in achieving this goal is a team of appropriately trained and well-equipped field staff.

The steps taken to date in the Northern Sierra Madre are a good example of what is needed to achieve this goal and, most importantly, what is achievable. It is understood that the protection necessary for particular sites and *C. mindorensis* populations will differ, depending on the particular circumstances at each site.

5.1.5 Monitor protected wild populations of *C. mindorensis*.

Long-term monitoring of protected wild populations of *C. mindorensis* is essential and an integral component of any wildlife conservation program. This will require allocation of resources to train and fund appropriate personnel, which is a task that should be directed by the Recovery Team.

The only wild population of *C. mindorensis* that is currently subject to any level of monitoring is that remaining in the San Mariano area of the Northern Sierra Madre. This program is in its infancy, although its importance is well-recognised, both by the researchers in the area and the local communities. Further monitoring is planned with external funding support. Monitoring of wild crocodylians is routinely undertaken in many other countries for a range of species and input will be needed from the personnel involved, in order to develop appropriate monitoring criteria for *C. mindorensis*.

5.2 Specific Conservation Objective 2.

- Promote and encourage positive community attitudes to, and a good understanding of crocodiles in the Philippines.

Performance Criterion:

Crocodiles and their roles in the natural environment are understood, and their conservation is supported by the broad community in the Philippines.

Actions required to achieve objective:

5.2.1 Develop and deliver community awareness programs for crocodiles.

Reversing the overall negative community attitudes towards crocodiles in the Philippines is vital to the long-term survival of these reptiles, including *C. mindorensis*. A lot of work was undertaken by the PWRCC in this regard in the late 1980s and early 1990s, as outlined in Section 4.6.3 and 4.6.6 of this Plan, and led to more positive attitudes towards crocodiles in northern Palawan. Managers at the PWRCC plan to re-establish these initiatives when resources permit. Similar programs have been implemented in the Northern Sierra Madre and underpin the development of the Disulap River Crocodile Sanctuary (see Section 4.6 of this Plan). Such efforts need to be continued and expanded, with a particular focus in those areas still containing *C. mindorensis* and areas targeted for crocodile reserves or other forms of protective management. These campaigns should employ local resident community organisers and educators, as these will have much greater chances of success than those who can only visit such areas for short visits. As already indicated, such initiatives should be linked to livelihood support in relevant areas. These community awareness programs should also be integrated into broader wetland conservation programs in the Philippines.

Such programs should cover both species of crocodiles inhabiting the Philippines, as the second species, the Estuarine Crocodile (*C. porosus*), is a larger and potentially more dangerous animal than the Philippine Crocodile, but some of the more general negative community attitudes towards

crocodiles stem from concerns over this species. Whilst it would be preferable for local communities to differentiate between the two species, and come to value the endemic *C. mindorensis*, the more realistic goal should be for them to protect all crocodiles. It should be noted that *C. porosus* is also threatened in the Philippines.

5.2.2 Develop and deliver school & college-based educational programs for crocodiles.

Reaching students of all ages is important for establishing a community which is more understanding of, and knowledgeable about crocodiles, including *C. mindorensis*. The PWRCC has successfully directed efforts to this end in Palawan and there is interest in developing education programs in other sectors, e.g. the International School in Manila and Crocolandia Foundation in Cebu City. Current educational programs should be continued and expanded, but with a short to medium-term focus in those areas designated as crocodile reserves or having other forms of protective management.

Where appropriate, materials and teaching about crocodiles and their conservation should be included in established school curricula. They should also be integrated into programs targeting broader wetland conservation in the Philippines. Interpretive facilities at schools and colleges, especially those that include crocodiles, should be supported and strengthened.

Contact should also be established with colleges and universities that already deliver courses on vertebrate ecology and systematics, etc., again, especially in those regions where sites for protecting *C. mindorensis* still exist. These would be excellent venues for conducting conferences and symposia on crocodylian biology, systematics, evolutionary ecology and conservation.

5.2.3 Promote the Philippine Crocodile and its conservation in all relevant forums.

There are many opportunities to promote *C. mindorensis* and its conservation at meetings, conferences and other events, as well as through the media. These should be pursued as much as possible and every effort made to have material published.

5.3 Specific Conservation Objective 3.

- Co-ordinate the management of captive *C. mindorensis*.

Performance Criteria:

- All captive *C. mindorensis* in the Philippines and other countries are managed co-operatively, in support of the overall conservation of the species.
- All captive *C. mindorensis* in the Philippines and other countries are managed in a co-ordinated manner.

Actions required to achieve objective:

5.3.1 Maintain a national registry of all captive *C. mindorensis* in the Philippines.

In order to fully support government efforts to conserve *C. mindorensis* and maximise the conservation potential and value of captive crocodiles, it is important to register all captive specimens in the Philippines. Those crocodiles held in facilities that are registered and accredited by the DENR -PAWB are known, but there are other specimens which are held privately that are

not registered and their histories are unknown. All such facilities need to be registered by the DENR-PAWB and the crocodiles added to the database maintained by the PAWB.

5.3.2 Establish a co-ordinated global captive management program for *C. mindorensis*.

There are currently five captive populations and groups of *C. mindorensis*, in the Philippines, USA and Australia that are part of the conservation management program. The vast majority are held at the PWRCC in Palawan. The management of the crocodiles involved should be co-ordinated to maximise their value to the overall conservation of the species and there needs to be greater communication between the management facilities.

The captive populations in the Philippines, USA and Australia are best managed as regional subsets of the global program.. This is a standard approach for global programs of threatened species. The captive populations, particularly those outside the Philippines, should be used as vehicle to generate support for *in situ* programs.

Whilst it is noted that there are five current captive populations in three countries, there are other institutions which are interested in joining the program to support the conservation of *C. mindorensis*. All institutions, whether current or future, which hold or wish to hold *C. mindorensis* as part of the National Recovery Team's global captive management program, should be approved by the Recovery Team. It is very important that such interest is strongly encouraged and fostered through more streamlined approval processes.

The captive population should be managed from the perspective that, whilst it is critical to the survival of *C. mindorensis* now and will remain important for many years, the major long-term focus should be on establishing viable wild populations.

5.3.3 Improve the operational effectiveness of the PWRCC.

As of 17 March, 2003, the PWRCC held 1,169 *C. mindorensis*, most of them captive-bred (G. Rebong, pers. comm.). As such, the Centre is a very important component of the overall conservation strategy for this species. However, increasing concerns are held for both the viability of the Centre and the genetic importance of the *C. mindorensis* held there, primarily due to uncertain Government support to cover operational costs. This is preventing the PWRCC from fulfilling the full breadth of its important conservation and education functions. Apart from frustrations that this situation is causing the PWRCC staff, it is making it very difficult for potential donors to support the Centre.

The decision of the DENR to transfer management responsibility of the PWRCC from the PAWB to the NRDC, via an Administrative Order effective April 2000, will hopefully help to resolve the uncertainties and concerns, and lead to a much more effective and productive operation. A meeting on 15 July 2003 clarified the roles of the PAWB and the NRDC in the operation of the PWRCC, ie. the PAWB will continue to allocate funds for the maintenance of captive *C. mindorensis* and other animals at the PWRCC, while the NRDC will include the maintenance costs for captive *C. porosus* at the PWRCC in its budgetary proposals, commencing in 2006. The PAWB will also continue to issue the requisite permits to move crocodiles, including *C. mindorensis*, between approved institutions.

A particularly urgent issue for the NRDC-PAWB to address is the dispersal of numbers of *C. mindorensis* to other facilities and localities, to:

- Expand the number of institutions holding *C. mindorensis* through a disposition program. This would increase community awareness of the species and generate further support for its conservation.
- Reduce the potential impact on the species as a whole, in the event of a stochastic disaster affecting the PWRCC. Based on current population estimates, the *C. mindorensis* held at the PWRCC represents in excess of 80% of the total world population. Holding such a high percentage of a threatened species in one facility is not a sound management practice. Further, the 1,200 *C. mindorensis* held at the PWRCC are vastly more than the effective and economic carrying capacity of the institution, especially in view of the uncertain genetic value of a large proportion of the animals.

Noting these concerns and in view of:

- The key role played by the CSG in the original discussions to establish the CFI/PWRCC.
- The range of operational issues impacting on the PWRCC, e.g. improving the incubation and rearing procedures; and
- The dual management responsibility with the NRDC and PAWB.

It is recommended that the CSG evaluate all aspects of the Centre's operations in order to identify actions that will ensure maximum delivery of the Centre's support for conservation of *C. mindorensis*. Preferably, this should be undertaken by personnel who are experienced in crocodile farming methods and *in situ* crocodile conservation, especially in south-east Asia.

5.3.4 Conduct detailed analyses of the PWRCC *C. mindorensis* and records.

The PWRCC has been very successful in breeding *C. mindorensis*. However, whilst the origins of the founder breeding stock are known, the breeding strategy for the captive animals, both as a whole or as representative groups, needs to be reviewed. The recent suggestion of potential genetic differences between *C. mindorensis* from different parts of its distribution has added a degree of urgency to resolving this matter. Indeed, this issue, combined with the concerns outlined in Action 5.3.3, resulted in a decision to temporarily cease breeding *C. mindorensis* in 2002. Hence, a detailed analysis of the PWRCC records is needed to:

- Produce guidelines on future breeding and management strategies, including selected breeding of least represented founders and populations.
- Formulate rational dispersal strategies for surplus (especially 'hybrid') animals/lines.

A further related action, associated with this matter, is to extend this analysis to cover captive animals at other facilities, especially Manila Zoo and Silliman University, to maximise the potential value of all captive animals.

5.3.5 Develop guidelines for display, holding and transport of *C. mindorensis*

The natural behaviour of these crocodiles present challenges for their successful display, holding and transport. It is well-known that aggression can occur between individuals, of either sex and from a very early age. They are also animals that can be adversely affected by stress. Hence, it is important for the successful implementation of a number of actions in this Plan that guidelines are developed on the holding, display and transport of these crocodiles.

5.4 Specific Conservation Objective 4.

- Determine the ecology of *C. mindorensis*.

Performance Criterion:

- The ecology of *C. mindorensis* is well-understood.

Actions required to achieve objective:

5.4.1 Collate and assess all available ecological data on *C. mindorensis*.

Preliminary ecological studies of *C. mindorensis* have been undertaken in recent years, particularly by staff at the PWRCC and lately by the CVPED team in northern Luzon. The results of all such studies should be collated at a central information point and assessed to avoid duplication of research effort and ensure that research needs are tackled on a prioritised basis. The Recovery Team should be involved in this process.

5.4.2 Undertake further ecological studies of *C. mindorensis* as a high priority.

The ecology of *C. mindorensis* is very poorly known, including its role within wetland ecosystems as a keystone species, and many questions need to be answered to assist with captive management and underpin protection and management of wild populations. These should be strongly supported by the Recovery Team and pursued as soon as possible.

5.4.3 Encourage tertiary institutions and other groups to support and undertake agreed research into *C. mindorensis* ecology.

The contributions by tertiary institutions to the conservation of threatened species generally is significant. There is great potential for this approach to assist with *C. mindorensis* and all avenues should be explored, both within the Philippines and overseas. One option within the Philippines is to approach the Wildlife Conservation Society of the Philippines (WCSP) as a vehicle for promoting such research and encouraging students to participate.

5.5 Specific Conservation Objective 5.

- Clarify the population genetics of *C. mindorensis*.

Performance Criterion:

The population genetics of *C. mindorensis* across its range are clearly understood.

Action required to achieve objective:

5.5.1 Extend and complete the current mtDNA study to determine the extent of differences (if any) between the original populations in each of the main faunal regions in the Philippines.

A project to assess the population genetics of *C. mindorensis* across its range in the Philippines was commenced in 1998. Whilst samples have been collected from a number of crocodiles, the vast majority of the samples analysed to date have come from crocodiles originating in Mindanao. Other samples are stored in freezers awaiting necessary export permits. The analysis undertaken to date

has raised questions, as yet unanswered, about the level of genetic variation between *C. mindorensis* from different island groups.

It is imperative that adequate sample numbers are obtained from *C. mindorensis* originating from the other main faunal regions of the Philippines, especially Greater Luzon, the West Visayas (Negros and Panay), Mindoro and Palawan (including the Calamian Islands). Indeed, every effort should be made to identify and sample any crocodile known or reported to be from any location outside Mindanao, including any of the other smaller Pleistocene isolates.

The DENR encourages researchers to undertake such studies and will expedite issuance of the necessary permits upon receipt of the relevant requests. The project mentioned above is likely to involve collection and/or export of samples from the Philippines, as well as possibly from existing museum specimens. Such studies should include checking both mtDNA and morphological differences (and correlates) between animals of differing faunal region origins.

If significant differences are found:

1. The taxonomy of *C. mindorensis* should be assessed for possible sub-specific differences.
2. Any markers (especially external) should be identified and tested to assist identification of wild-born animals of uncertain origin, or captive-born animals of uncertain purity. This is especially important for the captive-bred stock at the PWRCC, as the constitution of the Silliman University (and, hence, the animals at Gladys Porter and Melbourne Zoos, and the PAWB Mini Zoo) is already known to be of mixed origin, ie. Negros x Mindanao.
3. Amend or produce relevant management plans, including prioritisation of wild and captive management plans for the rarest populations.
4. 'Hybrids' should be considered for elimination from captive management plans and strategies.

5.6 Specific Conservation Objective 6 .

- Integrate *C. mindorensis* conservation with the conservation of freshwater wetlands and other threatened freshwater wildlife in the Philippines.

Performance Criterion:

Where appropriate, *C. mindorensis* conservation is integrated into broader freshwater wetland conservation in the Philippines.

Actions required to achieve objective:

5.6 .1 Identify programs targeting conservation of freshwater wetlands in the Philippines.

The Philippine Crocodile is a critical freshwater species in the Philippines. Given the threats to all wetlands in the Philippines, it is logical that Philippine Crocodile conservation is integrated with conservation of freshwater wetlands in the Philippines, including the identification and conservation of RAMSAR sites. The National Wetlands Action Plan and the Philippine Biodiversity Assessment & Action Plan list a number of actions in support of wetland conservation and, whilst these make

no mention of *C. mindorensis*, its conservation should be part of these wider actions. PAWB/DENR members of the Recovery Team should be able to identify opportunities for integrating both sets of conservation actions.

5.6 .2 Identify programs targeting conservation of other threatened freshwater species in the Philippines.

Many species of native freshwater fish are believed to be threatened in the Philippines. Similarly, freshwater turtles across south-east Asia are threatened (Van Dijk *et al.*, 2000), some critically so, and whilst only a handful of such species occur naturally in the Philippines, they are likely to be under pressure from development of their habitats. There is likely to be overlap between conservation of these species and that of *C. mindorensis*.

5.6 .3 Assess above programs (as in 5.6 .1 & 5.6 .2) for relevance to Philippine Crocodiles and integrate materials/programs accordingly.

Not all conservation programs targeting freshwater wetlands in the Philippines will be relevant to Philippine Crocodiles or their conservation. However, where this is the case, every effort should be made to integrate the associated materials and goals such that Philippine Crocodile conservation efforts are enhanced, and the work required to achieve these outcomes are minimised. Noting the current negative perception of crocodiles in the Philippines, it is recognised that significant efforts will need to be directed to community awareness and education programs in those areas where crocodiles still occur, whether this is *C. mindorensis* or *C. porosus*.

5.7 Specific Conservation Objective 7.

- Build partnerships to support conservation of *C. mindorensis*.

Performance Criteria:

Partnerships are in place, both within the Philippines and overseas, to support *C. mindorensis* conservation.

Actions required to achieve objective:

5.7.1 Promote and facilitate breeding loan extensions for selected, priority lines/populations, both locally and internationally.

There is increasing interest, both nationally and internationally, in obtaining *C. mindorensis* to support the *in situ* conservation program through public display, captive breeding and generation of funds. To date, establishing all the required agreements and approvals has been a very lengthy process. In order to maximise the potential value to *in situ* conservation, in particular, of involvement by other institutions, further efforts should be directed to streamlining and expediting the review and approval process.

5.7.2 Establish *C. mindorensis* support groups.

The creation of community groups to support threatened species management programs is a widespread and successful approach in many countries. The lack of such a group in the Philippines to support conservation of Philippine Crocodiles is one factor that has prevented the current program from achieving its full potential. Hence, such a group(s) should be developed for the Philippine Crocodile as a priority.

5.7.3 Provide training in crocodile management and surveys

There is a strong need to train more Filipinos in crocodile management and survey techniques. Some people are currently well-versed in undertaking surveys, particularly at the PWRCC and NSMNP-CP, but this must be extended to other individuals and groups.

5.8 Specific Conservation Objective 8.

- Establish funding sources to implement conservation actions for *C. mindorensis*.

Performance Criteria:

Reliable funding been secured to support implementation of agreed conservation actions for *C. mindorensis*.

Action required to achieve objective:

5.8.1 Establish reliable funding sources.

The issue of funding implementation of conservation actions was covered in the first edition of the Recovery Plan and a Philippine Crocodile Trust Fund was suggested as one means by which funds for conservation could be received and allocated. This has not been established and its feasibility remains unclear. Whatever procedures are put in place, it is essential that they allow for easy and rapid acceptance, transfer and dispersal of funds, with a minimum of bureaucracy. These elements are critical if overseas donors, in particular, are going to commit to supporting conservation of *C. mindorensis* in the Philippines. And, in light of the current Government shortfalls in the Philippines, it is likely that overseas funding will play an increasingly important role.

5.9 Specific Conservation Objective 9 .

- Ensure that all relevant Philippine Government policies support the conservation of *C. mindorensis*.

Performance Criterion:

All relevant policies of the Philippine Government support the conservation of *C. mindorensis*, including, where appropriate, reference to the Philippine Crocodile National Recovery Plan.

Action required to achieve objective:

5.9 .1 Review all relevant Philippine Government policies to ascertain their support for the conservation of crocodiles, but specifically *C. mindorensis*.

Wildlife conservation in the Philippines would benefit from more and clearer national environmental policies. This includes those that relate to freshwater wetlands or crocodiles. In this regard, conservation of *C. mindorensis* could be further enhanced by ensuring that all relevant Government policies clearly support the conservation of crocodiles and that such policies are complemented by appropriate regulations.

6. CONSEQUENCES OF RECOVERY PLAN IMPLEMENTATION

6.1 Biodiversity Benefits/Values.

In taking actions to conserve *C. mindorensis*, there are considerable advantages for many other threatened species and communities in the Philippines. Freshwater wetlands throughout the Philippines are highly degraded and the Philippine Crocodile could well become a flagship species for this habitat, in the same manner that the Philippine Spotted Deer is a flagship species for rainforest conservation in the West Visayas (Oliver *et al.*, 1993).

The biodiversity of Philippine wetlands and, indeed, most other habitats, is far from completely inventoried and their wildlife poorly documented. The biology and ecology of many species is also not well understood and hundreds of species are threatened with extinction due to deforestation, habitat loss and direct exploitation (WCSP, 1997). Conservation of *C. mindorensis* means conservation of these other wildlife species, with consequent benefits for human communities, as a healthy crocodile population means that the associated habitat(s) are also healthy. Hence, if the associated wetland habitat is in good condition, then fish populations should also be healthy.

When promoting crocodile conservation, their role as large carnivores within food-chains should be emphasised. They are keystone species and are crucially important in nutrient cycling in freshwater ecosystems, as has been demonstrated by the PWRCC in the Philippines and by German ecologists in the Amazon with *Caiman crocodylus* (Alcala & Dy-Liacco, 1989; King, 1988). The importance of crocodiles in freshwater ecosystems may yet convince landowners to convert swampy areas to crocodile sanctuaries (A. Alcala, pers. comm.).

6.2 Social Consequences/Values.

There are both positive and negative social consequences of implementing this Recovery Plan. The major positive consequence is fulfillment of a community expectation for protection of biodiversity, and the long-term protection of both *C. mindorensis* and wetland habitat for the enjoyment of present and future Filipinos.

Because much of the remaining *C. mindorensis* habitat is on privately owned land or ancestral domain claims, or land still used by human communities, opportunities exist for indigenous people to make substantial contributions to the conservation of the species. Hence, it will be important to develop management agreements with stakeholders, which attempt to integrate conservation management practices with everyday rural land management, and to maintain a harmonious relationship between the various managers responsible for *C. mindorensis* populations.

Evidence from the PWRCC community information campaigns in Palawan and the NSMNP-CP initiatives in the Northern Sierra Madre demonstrate that it is possible to create a supportive attitude towards *C. mindorensis*, in which the crocodile comes to be seen as an important component of the natural heritage of Filipino communities.

The alteration or rejection of development proposals for areas containing *C. mindorensis* populations can have adverse social impacts. Where services are to be supplied by the development, the alteration or denial of these services may also have a substantial social impact. The extent of the impact will vary from site to site and will depend on the type of proposed development. The support

of politicians in conserving and protecting crocodiles, and gaining protection for relevant areas, especially those which may be the subjects of development claims, will also be important, as such persons usually figure in the decision making processes for such matters. This has proved to be the case in the Northern Sierra Madre, where strong local government support and involvement is benefiting *C. mindorensis* conservation in that area.

6.3 Economic Consequences/Values.

The actions proposed in this Plan, in support of *C. mindorensis* conservation, will have economic implications for individuals, community groups, local communities and various government organisations and agencies. These will be positive and negative, depending on the perspective of the affected party, and include:

1. Reserving wetland areas:
 - Negative impacts for developers and local communities/industries currently using such areas. This may include conflicts of interest for subsistence farmers and fisherfolk.
 - Positive impacts for local communities, through tourism income.
 - Negative impacts for government agencies, due to land purchase and protection, ie. allocation of funds and other resources.
2. Managing water flows and preventing pollution:
 - Positive impacts for local communities (improved water quality and health of fish stocks, etc.).
 - Negative impacts for local communities/industry currently using or impacting such areas.
 - Negative impacts for environmental monitoring bodies (increased responsibilities and resource requirements) and potential hazards due to insurgency problems.
3. Education & Information Campaigns:
 - Positive impacts in terms of a more knowledgeable and supportive community.
 - Negative impacts for government, non-government and other agencies/bodies undertaking such campaigns (resource allocations).
4. Farming of crocodiles (one of the primary goals in establishing the PWRCC was to pursue farming of *C. porosus*. When this is achieved, there will be direct benefits to local communities, which should convince them to co-operate in *C. mindorensis* conservation. This does not include farming of *C. mindorensis*):
 - Positive impacts for local communities in terms of direct financial returns.
 - Positive impacts through directing income from skins and other products of *C. porosus* to *in situ* conservation of *C. mindorensis*.
 - Negative impacts in terms of community perception (killing crocodiles).

6.4 Practical Considerations.

The actions proposed in this Plan have significant practical implications. Achieving properly protected wetland areas for *C. mindorensis*, and monitoring them and the crocodiles, will involve substantial allocations of time, money and commitment. However, the actions associated with these goals simply have to be undertaken if this species is to be truly conserved.

Similarly, surveys are time-consuming and expensive, and it may well not be practical for all areas to be fully surveyed. In such an event, all other means should be employed to obtain information on

current distribution. These should include making use of surveys being carried out for other purposes and establishing contact with community groups which are active in areas that may otherwise be difficult to access.

Delivery of education and information campaigns should be feasible, as there are many organisations and agencies in the Philippines which already have effective information networks and programs. Linking with such bodies should reduce the allocation of resources to these tasks.

One captive population is being managed now, but this needs to be extended to other facilities and populations. Hence, implementing the co-ordination proposed here will involve increases in direct funding requirements.

7. INSTITUTIONAL MECHANISMS TO IMPLEMENT THE PLAN

7.1 National Recovery Team.

An important element in successfully implementing the National Recovery Plan is the Philippine Crocodile National Recovery Team, which was created through signing of DENR Special Order No. 2000-231 on 3 March, 2000. The Team was created in order to address the continuing decline of the Philippine Crocodile and to strengthen international co-operation and partnerships in the conservation of the species. It is essential that all discussions, proposals and actions for *C. mindorensis* conservation, both immediate and strategic, are considered in the overall best interests of the species and by all agencies, institutions, groups and individuals that can contribute directly to this process. However, it is also critical that this occur expeditiously.

The Team is chaired by the DENR Undersecretary of Policy & Technical Services and has seven other members from the Protected Areas & Wildlife Bureau, Palawan Wildlife Rescue & Conservation Centre, Melbourne Zoo (Australia), Silliman University, Gladys Porter Zoo (USA), and the relevant Protected Area Management Boards and DENR Regional Offices (currently Region 2 and the Cordillera Administrative Region). The Team is assisted by a four person Secretariat.

The Team has nine primary responsibilities:

- Develop a “National Recovery Plan for the Philippine Crocodile (*Crocodylus mindorensis*) that will serve as the basic framework in addressing the causal factors in the population decline of the species. The said Plan shall include, among others, the strategic objectives, research and management priorities; detailed activities; and budgetary requirements to possibly carry out the identified priority actions.
- Oversee/lead in the implementation of the said Recovery Plan, in collaboration with all concerned parties.
- Endeavour to access financial support and other resources for the implementation of the Plan, and provide recommendations on their effective use.
- Foster community awareness, promote exchange of information and provide technical advice and advocacy on *C. mindorensis* and its conservation as required.
- Develop mechanisms to integrate *C. mindorensis* research and management with wider wetland conservation efforts and organizations in the Philippines.
- Through the National and International Co-ordinators, co-ordinate the implementation of the Plan and all conservation activities for *C. mindorensis* with concerned and/or relevant parties, both locally and internationally.
- Conduct annual review of the implementation status of the Plan and other activities under the DENR Special Order 2000-231.
- Perform other relevant duties as may be necessary and legally possible; and

- Submit annual progress reports to the Secretary, DENR.

7.2 Link the Recovery Plan to Government funding appropriations.

The Recovery Plan's budgetary requirements should be included in the Philippine Government's Annual Appropriation for the CFI, where relevant. This will help to ensure that the PWRCC's activities for *C. mindorensis* are in line with the Government's initiatives for the species. Given the PWRCC's holdings of the species and its breadth of activities, it is a critical stakeholder in *C. mindorensis* conservation.

7.3 Integrate the Recovery Plan with DENR operations and protocols.

It is essential that Recovery Plan actions and recommendations are integrated in the key operational requirements and outcomes of relevant DENR Regional Offices, and any other Government bodies and mechanisms as may be identified. The DENR and PAWB constitute the primary government body for wildlife management and conservation in the Philippines and, hence, they are crucial to the effective implementation of many aspects of the Plan. This now also involves the NRDC, in view of that body's management responsibility for the PWRCC.

7.4 Funding sources and strategy.

Full implementation of the Plan's agreed actions requires significant financial input. However, the Plan should proceed regardless of full funding being available, with the Recovery Team approving actions and financial allocation on a priority basis. One means by which funds may be able to be received and allocated is a Philippine Crocodile Trust Fund, which should be administered by the National Recovery Team. The fund should be independent of government control, but be able to receive funds from any source and incorporate streamlined payment mechanisms to allow for efficient allocation of expenditures for approved actions. Discussions are ongoing to explore this option.

REVIEW DATE

Three years from the signing of this Plan.

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APPENDIX 1.

Author of Recovery Plan:

Principal Author: Mr. Chris Banks, Melbourne Zoo, Australia.

Co-Authors: Members of the Philippine Crocodile National Recovery Team.

Composition of Philippine Crocodile National Recovery Team.

- Undersecretary for Planning & Policy Office, DENR - Chairperson.
- Director, Protected Areas & Wildlife Bureau (PAWB) – Vice Chairperson.
- Project Director, Palawan Wildlife Rescue & Conservation Centre – Member & National Co-ordinator.
- Mr Chris Banks; IUCN/SSC Crocodile Specialist Group & Melbourne Zoo – Member & International Co-ordinator.
- Dr Mundita Sison Lim; Assistant Director, PAWB – Member.
- Dr Angel Alcala, Silliman University – Member.
- Ms. Collete Adams, Gladys Porter Zoo – Member.
- Ms. Restituta Antolin: DENR, Region 2.
- Mr Jude Accos; DENR-CAR.
- Mr. Fochelle S. Mansibung: NSMNP, Region 2.
- President; Natural Resources Development Corporation (NRDC).