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Status and Exploitation of the Madagascan Big-Headed Turtle, *Erymnochelys madagascariensis*

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ABSTRACT. – **Data on status and exploitation of *Erymnochelys madagascariensis* were collected during May and June, 1991, in western Madagascar. The species is fully protected by Malagasy law and commercial exploitation is negligible, but it is frequently incidentally caught during fishing operations. Virtually all turtles caught in this manner are slaughtered for local consumption. Increased commercial fishing pressure in the former strongholds of *Erymnochelys*, i.e., large lakes in the floodplains of streams in western Madagascar, is progressively depleting and exterminating the largest populations of the species. Decline and extermination of populations is retarded in very large water bodies and in habitats with areas that are unsuitable for seine net fishing. In such marginal habitats where fishing occurs only occasionally and with less intensity, populations of *Erymnochelys* seem to fare better. No significant populations are known to occur in fully protected areas. Establishment of a protected area for this species and a captive breeding program on its behalf are recommended.**

Erymnochelys madagascariensis (Grandidier, 1867) is a freshwater turtle endemic to Madagascar, and the only living member of the subfamily Podocnemininae (Family Pelomedusidae) in the Old World. Its closest relatives are the South American turtles of the genera *Podocnemis* and *Peltocephalus*. *Erymnochelys* inhabits rivers, backwaters, and lakes in the lowlands of western Madagascar between Lac Ihotry and the Mangoky River in the south and the Sambirano River in the north. Most distribution localities plotted by Bour (1985) represent old field notes and museum records, and the species' current range is poorly known. *Erymnochelys* is protected by Malagasy law and may not be hunted, killed, captured, or collected without the authorization of the country's highest wildlife regulatory authority, and then only if required in the national interest or for scientific purposes. In the case of *Erymnochelys*, enforcement is difficult.

Little is known on the present status of *Erymnochelys* populations, but the species is generally considered rare and possibly in decline (Groombridge, 1982; Jenkins, 1987). Few areas have been surveyed for *Erymnochelys* in recent times. Tronc and Vuillemin (1973) reported *Erymnochelys* to be abundant in permanent lakes along the Tsiribihina (Lac Andranomena and lakes around Berevo) and along its affluents (lakes in the region of Miandrivazo); Kuchling (1988, 1993) described a population in Lac Marofilao near Ambato Boeni, in the Betsiboka lowlands, and considered the population to be overexploited; and Jenkins et al. (1990) surveyed Lac Kinkony for *Erymnochelys*.

This paper presents results from a field survey in May-June, 1991, the main purpose of which was to collect preliminary information on *Erymnochelys* populations in different regions and habitats with the goal of facilitating the selection of study sites for a more comprehensive follow-up study. In addition, it was hoped the survey would provide information to estimate the degree of threat to the survival of *Erymnochelys* and to assess the urgency of conservation measures.

METHODS

Field work was conducted from 3 May - 10 June, 1991, in the areas of Ambato Boeni and Maevatanana (Fig. 1-A), as well as the area of Miandrivazo and Belo/Tsiribihina (Fig. 1-B), in collaboration with local representatives of the Direction des Eaux et Forêts (Mr. Rasoiamamama Celestin Rabelahy, Chef du Cantonnement des Eaux et Forêts Tsaramandroso/Ambato Boeni; Mr. Randriamanana Sebastian Veroni, Chef du Cantonnement des Eaux et Forêts Maevatanana; Mr. Rabearisoa Louis Theodore, Adjoint Technique Aff., Chef du Cantonnement des Eaux et Forêts Miandrivazo; and Mr. Ralaivao Martial, Chef du Cantonnement Forestier Belo/Tsiribihina).

Background information on *Erymnochelys* was gathered by visiting localities and habitats where *Erymnochelys* was presumed or reported to occur, and interviewing local fishermen. Specific, standardized questions were asked about methods and rates of capture and exploitation of freshwater turtles, the identities of which were confirmed by presenting photographs of the different aquatic turtle species in the area (*Erymnochelys madagascariensis*, *Pelomedusa subrufa*, and *Pelusios castanoides*) to the fishermen.

Most localities were inspected by pirogue and several times the senior author accompanied fishermen who were fishing with nets. When encountered, empty shells of recently slaughtered turtles were examined. Four *Erymnochelys* and one *Pelomedusa subrufa* were caught by fishermen during the survey period and were examined while alive. Seven juvenile *Erymnochelys* were caught by hand while diving with mask and snorkel. These were measured and weighed, the stomach contents flushed (Legler, 1977), and then released at the site of capture.

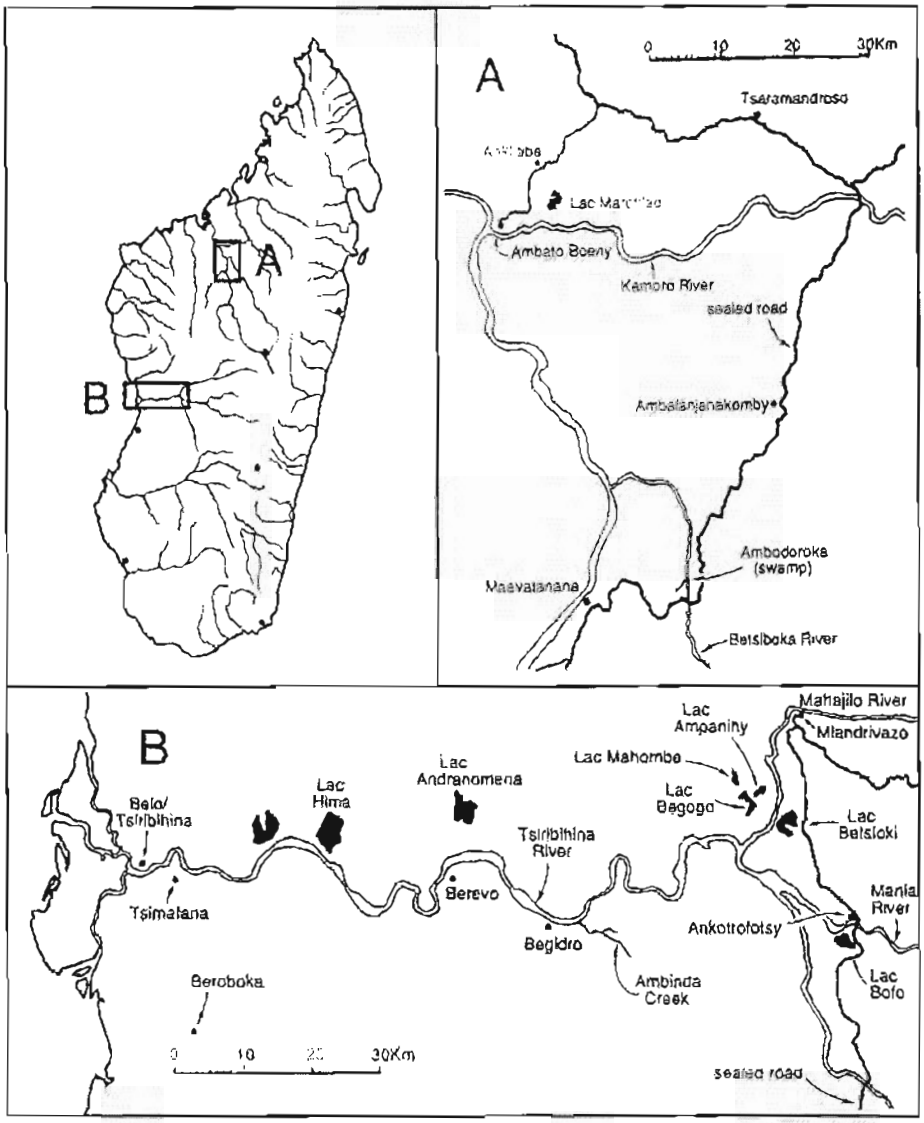

Figure 1. Maps of study locations in Madagascar. A. Ambato Boeni - Maevatanana area. B. Miandrivazo - Belo/Tsiribihina area.

It proved difficult to make reliable estimates of the surface area of lakes in this region, because of pronounced seasonal fluctuations and lack of quantitative topographical data. All lake surface area estimates in this report are based on planimetry of permanent lake areas on 1:500,000 maps of Madagascar, but they provide only a rough indication of the area of particular habitats.

RESULTS

Information concerning the occurrence and abundance of *Erymnochelys* was obtained for Lac Marofilao near Ambato Boeni, the small lake and swamp area of Ambodoroka near Maevetanana, Ampanihy, Begogo, Mahombe, Bofo, and Betsioky lakes in the area of Miandrivazo, and Andranomena and Hima lakes in the Tsiribihina area. A summary of the status of turtle populations in these lakes is given in Table 1. However, this list may not accurately represent the species' status throughout its range, as the areas selected for these surveys may, or may not, represent some of the best remaining habitats and populations.

A dramatic interview finding was that the last *Erymnochelys* at Lac Marofilao had been caught during 1987, and, according to fishermen, the turtles must now be considered extirpated. During the last survey in November, 1986 (Kuchling, 1988), *Erymnochelys* appeared to be fairly abundant, and the fishermen at Marofilao were able to catch 10–15 individuals (including juveniles) per week with two seine nets. Lac Marofilao is one of a chain of more than a dozen lakes along the Kamoro River stretching between Ambato Boeni and Anjiajia. During the wet season, the lakes are interconnected and flooded by the Kamoro River. Generally, *Erymnochelys* seem to migrate into inundated areas during the wet season, from rivers into lakes and swamps. Particularly high flood levels of the Kamoro River were recorded in the years 1953, 1959, 1990, and 1991, with 1991 being the most severe flood on record. It is puzzling that apparently no new turtles moved into the lake with the floods of recent years.

Several changes have occurred in the area of Marofilao

Table 1. Habitat size, fishing pressure and estimated status of *Erymnochelys* populations.

Lake	approx. area (ha)	general access to lake	fishing pressure	use of seine nets	estimated status of population	source of data
Marofilao	230	fairly good	very high	high	extirpated since 1988	present study
Ambodoroka	25	very good	high	no	seasonally moderate	present study
Ampanihy	40	rather diff.	moderate	low	moderately abundant	present study
Begogo & Mahombe	300	rather diff.	relat. low	no	abundant	present study
Bofo	300	very good	very high	high	depleted	present study
Betsioky	500	very good	very high	very high	extirpated?	present study
Andranomena	750	fairly	very	high	depleted	present study
Hima	1500	fairly good	very high	very high	heavily depleted	present study
Kinkony	10,000-15,000	rather diff.	high – very high?	high?	depleted?	Jenkins et al. 1990

and the other lakes since 1986. During 1987, a large area of reeds, *Phragmites mauritianus*, inundated during the wet season, was cleared for a cotton plantation. Throughout the region of Ambato Boeni, cotton crops have increased during recent years and many seasonally flooded areas are used to grow cotton during the dry season. These crops receive heavy applications of insecticides and herbicides. The human population has increased in the area, and many more fishermen are now exploiting the lakes. According to the older fishermen, the fish catch has decreased dramatically in recent years and they assume that, in a few years, professional fishing will no longer be profitable. Due to the declining fish catch, some fishermen are now using very fine nets to catch fish fry to be dried or sold fresh in markets for food, an activity that will further exacerbate the situation.

Ambodoroka is a backwater and swamp area of the Betsiboka River, a few hundred meters below the last waterfalls, west of the bridge on the road from Maevatanana to Mahajanga. It extends from the river into a valley bordered by hills ("Ambodoroka" means "in the bosom of the rocks"). The water level and the inundated area fluctuate significantly with the season, with highest levels from December to March or April. Both *Erymnochelys madagascariensis* and *Pelusios castanoides* occur here. *Pelusios* is found throughout the year, whereas *Erymnochelys* is caught only "after the water starts to get red" when the floodwaters of the Betsiboka River enter the swamp. Young *Erymnochelys* are caught as well as adults, but fishermen there do not know where the females lay their eggs. During May, *Erymnochelys* begins to disappear and is rarely caught during the subsequent cool, dry season (in contrast to *Pelusios*).

Between Miandrivazo in the north and Ambatolahy in the south there is a chain of lakes in the floodplains of the Mahajilo, Mania, and Akeny rivers (which flow together and form the Tsiribihina) between the Bemeraha massif in the west and the highlands (Bongolava) in the east. This river and lake system is bordered on its eastern side by the paved road from Morondava to Antsirabe. This road facilitates the transport and marketing of fresh fish between the lakes close to the road and cities in the highlands. Much of the alluvial land is cleared and used for agriculture. For this survey, several lakes were chosen according to their accessibility from the main road and level of the fishing pressure. Lakes surveyed included Ampanihi, Begogo, Mahombe, Bofo, and Betsioky.

Lakes Adranomena and Hima are located in the floodplain of the Tsiribihina River. Commercial fishing is a major occupation in the area and many people from other areas also come to fish there during the dry season. Several motorboats are employed and fishing is accomplished mainly with seine nets, though many hoop nets are also used. Fish are dried, salted, and traded to the central highlands. Theoretically, the lakes are closed to net fishing from November to February.

During this survey, we descended the Tsiribihina River by pirogue from its origin to Belo/Tsiribihina, where the water becomes brackish. It was more difficult to collect information on turtles in the rivers than in the lakes, due to fishing being more difficult and fishermen scarcer. In addition, the river water is red from suspended sediments, hampering direct observations.

The Tsiribihina meanders for about 30 km in gorges through the Bemeraha massif with either steep and rocky or steep and narrow muddy shores with forested slopes behind. At the end of May, 1991, sand and mud banks were lying dry in the riverbed, but on a previous descent in January, 1985, during the high water season, the entire riverbed was inun-

Figure 2. *Erymnochelys madagascariensis* from the Kirindy River area, 1986. Photo by R.A. Mittermeier.

dated. Several relatively short, partly ephemeral creeks flow into the river from the slopes of the Bemeraha massif. The longest and most important is the Ambinda, which enters the Tsiribihina from the south, about 5 km before the gorge ends and the river enters the western plain. The Ambinda descends the Bemeraha massif in a rocky bed with many waterfalls and rocky basins. In the last 100 m before it joins the Tsiribihina, the bed is sandy and muddy and the creek forms several basins and more or less stagnant, shallow meanders with water of reasonable visibility.

The lower part of Ambinda Creek was searched by mask and snorkel, and seven juvenile *Erymnochelys* were caught by hand in the basin directly below the last rapids. The three smallest animals had carapace lengths (CL) of 50.6, 54.4, and 51.0 mm. They must have hatched a few months earlier and very likely in that area. The closest swamp areas and backwaters are either 5 km downstream or 25 km upstream. Two animals of 90.8 and 99.4 mm CL may have been yearlings, and two animals of 126.0 and 134.8 mm CL may have been two years old. Interestingly, no *Erymnochelys* were found in basins above the first rapids, although these were rather low, with rocky steps. The basin with the seven turtles was about 15 m long, 5-6 m wide, and 2-3 m deep. One side was a sandy slope and the other a rock wall. The bottom consisted of sand and big rock boulders with some leaf litter.

As recently as 1985, the species still occurred in the Kirindy River region as well. Two live specimens were seen and photographed in 1985 and 1986 in the private collection of Monsieur Jean de Heaulme at Analabe, north of Morondava (Fig. 2). These were said to have been captured in the Kirindy River, but no further information on their occurrence in this river system is available.

DISCUSSION

Erymnochelys madagascariensis has a wide distribution over much of western Madagascar, but it is restricted to certain habitats, including slow moving rivers, backwaters, and floodplain lakes. The most suitable wetlands are along certain rivers and their tributaries, e.g., the Betsiboka, the Mahavavy (including Lac Kinkony), the Tsiribihina, and the Mangoky, as well as such lake systems as Bemamba, Masama, and Befotaka, and Ihotry in the south. In the northern parts of its distribution, the area of Port Berge may offer good habitat. It is likely that small populations of *Erymnochelys* still live, or previously lived, in areas not cited above, but these localities were almost certainly the core areas with the largest populations of the species.

Most recent authors have considered overexploitation for food as the main threat to *Erymnochelys* populations (e.g., Groombridge, 1982; Kuchling and Mittermeier, 1987; Kuchling, 1988; Nicoll and Langrand, 1989; Jenkins et al., 1990), although the increasing conversion of margins of large lakes and rivers to agriculture (Blanc, 1984) and possibly competition with introduced and rapidly expanding populations of the genus *Pelusios* (Pritchard, 1979; Groombridge, 1982) have also been suspected to threaten its existence. Kuchling (1988) considered the population at Lac Marofilao near Ambato Boeni to be depleted and overexploited. Jenkins et al. (1990) surveyed Lac Kinkony for *Erymnochelys* and stated, "There is some exploitation of the turtles for food but this appears to be low and the turtle does not appear to be in immediate danger if current fishing practices continue." This assessment will be discussed in more detail below in light of the results of the current survey.

The most significant finding regarding the status of *Erymnochelys* was the possible extirpation of the population at Lac Marofilao near Ambato Boeni during 1987. In November, 1986, fishermen at the lake were still able to catch ca. 15 *Erymnochelys* (including juveniles) per week. Imminent extirpation did not appear likely, although size distribution of the animals caught indicated an apparent lack of large adults.

This demonstrates that *Erymnochelys* populations may crash very rapidly under increasing or sustained high exploitation pressure. The main reasons for the high susceptibility of the species to exploitation may be the protracted juvenile stage, large size at maturity (which means that animals are highly prized as food long before reaching sexual maturity), and, presumably, a very long life span, with old and large animals having a higher reproductive output than younger ones. At Lac Marofilao, the local fishermen were surprised by the sudden disappearance of *Erymnochelys*. Although a few old fishermen reported that the turtles were decreasing some years before extirpation apparently occurred, the general opinion of fishermen was that there were plenty of turtles until they suddenly disappeared.

Apart from exploitation pressures, factors that may render *Erymnochelys* populations extremely vulnerable to extirpation may be both the size and structure of its habitats. Obviously, relatively small, shallow, open lakes can be more effectively depleted with seine nets than waters where deep areas and obstacles such as tree trunks or dense vegetation hinder net fishing. Under such conditions, a population may be able to persist longer at low density.

This may be the case at Lac Kinkony, where the data of Jenkins et al. (1990) indicate, in contrast to their assessment,

a dramatically depleted population. During three months of field study, only three specimens of *Erymnochelys* were caught by fishermen at Lac Kinkony, and a total of only four empty carapaces were found in villages around the lake; further, *Erymnochelys* was reportedly not found in nearby smaller lakes, and elderly Sakalava fishermen remembered good numbers of turtles in the past (Jenkins et al., 1990). The only reason for the persistence of *Erymnochelys* in Lac Kinkony may be the size of the lake (10,000-15,000 ha, second largest in Madagascar) and the fact that not all areas are suitable for fishing with seine nets. In any case, the statement of Jenkins et al. (1990), that *Erymnochelys* at Lac Kinkony is not in immediate danger, is not supported by their own data.

The results of the current survey confirm that exploitation pressure is the main reason for the decrease of *Erymnochelys* populations and that physical characteristics of its habitats, especially size, water depth, and obstructions to net fishing, are factors that affect its changing status. *Erymnochelys* populations appear to be more heavily depleted in areas where seine nets are used compared to those areas where only hoop nets and lines are in use.

Subsistence fishing by small, local communities does not seem to seriously threaten *Erymnochelys* populations, at least not in the habitats surveyed. In the range of *Erymnochelys*, two forms of commercial fishing operations occur. In areas with good and quick access to major population centers (that are close to paved roads), fish are freshly marketed and even small bodies of water may be subjected to heavy fishing pressure. The second marketing strategy is to dry (and salt) fish, especially around the larger lakes in western Madagascar where access is difficult (e.g., Lacs Hima, Andranomena, and Kinkony). This often involves a heavy seasonal influx of fishermen from the highlands, equipped with good nets and, increasingly, with motor boats.

In the area of Miandrivazo, fishing pressure is negatively correlated with increasing distance of a habitat to the main road into the highlands. In lakes close to the road, fishing pressure, particularly with seine nets, is much higher than in lakes that can be reached only from the road by a walk of several hours or a day. Most of the commercially caught fish in this area are marketed as fresh fish in the highlands, and this does not allow for long transport times between the catch and the middlemen, who buy them up along the road. At the same time, *Erymnochelys* populations in habitats close to the main road seem to be more heavily depleted than in areas farther from the road.

Ambodoroka in the Betsiboka River lowlands may be exceptional in the persistence of its *Erymnochelys* population. It is a small lake and swamp area, close to a main road and to Maevatanana, a situation in which rapid depletion of the population might be expected. Ambodoroka is the only habitat surveyed where reportedly no *Erymnochelys* are caught during the annual dry season (corresponding with lower water levels). It may well be that all *Erymnochelys* are normally collected by the beginning of the dry season and that, at the beginning of each wet season, new animals migrate into the lake with the flood waters of the Betsiboka River. However, the possibility that some turtles migrate from the lake into the Betsiboka River cannot be discounted. Movements between the river and lake may be encouraged by the waterfalls and rapids, which are only a few hundred meters upstream of Ambondoroka and may hamper upstream migration by turtles. Such a scenario certainly requires the persistence of a river population, from which animals are fed into the lake and swamp area on a yearly basis.

River populations of *Erymnochelys* are generally less studied than are populations in lake habitats. The presence of young turtles of different age classes at the confluence of the Ambinda and the Tsiribihina rivers demonstrates that breeding and successful recruitment of *Erymnochelys* occur in riverine habitats located far from swamp areas and lakes. The relationship between river populations and those in lakes needs investigation.

In summary, large size (up to 50 cm carapace length), presumed longevity and delayed maturity, coupled with the use of open water bodies as preferred habitat, render *Erymnochelys madagascariensis* more prone to extirpation through overexploitation than the other freshwater turtles of Madagascar. Some fairly robust, but small, *Erymnochelys* populations still exist in lake and swamp areas that are difficult to reach, and because of their relatively small size, are still marginal resources for the inland fisheries of Madagascar. The exact size and structure of these populations is unknown and should be investigated. In its former core habitats, the large lakes and backwaters of western Madagascar, *Erymnochelys* populations are heavily depleted or extirpated due to overexploitation for food, a consequence of the high fishing pressure in these habitats. At present, the status of river populations cannot be estimated due to a lack of information.

The trend of *Erymnochelys* populations as a whole over recent decades appears to be one of non-cyclical decline demonstrated by the extirpation at Lac Marofilao in the late 1980s, as well as the decline of *Erymnochelys* in the lakes in the areas of the Tsiribihina and of Miandrivazo since the early 1970's, where Tronc and Vuillemin (1973) described the species as abundant. Earlier still, Voeltzkow, at the end of the 1800's, considered *Erymnochelys* to be very abundant in lakes and ponds in the area of the lower Betsiboka River (Voeltzkow, 1901; Siebenrock, 1903). Voeltzkow sent a large series of more than 60 specimens from Majunga to the Museum of Natural History in Vienna. Today, *Erymnochelys* appears to be very rare and locally extirpated in this area; most local people are not even aware of its existence.

The main problem for *Erymnochelys* is that its core habitats are important areas for the inland fisheries of Madagascar. In the areas of Ambato Boeni, Maevatanana, Miandrivazo and Belo/Tsiribihina, where the current survey took place, the fish catch is 5,948 tons per year (figures for 1989/1990, provided by the Statistics Division of the "Direction de la Peche"). This is abut 20% of the total freshwater

fish production of Madagascar (inland fisheries and aquaculture together account for about 30,000 tons). According to the five-year plan (starting in 1986), the total production of Madagascar should have increased to 118,000 tons by 1990, but over this period, it remained fairly static at about 30,000 tons. The stagnation occurred despite improvements and increased availability of fishing gear, particularly seine nets. As the example of Lac Marofilao demonstrates ("Marofilao" means "many fish"), both fish production and *Erymnochelys* populations will suffer if fishing pressure increases beyond a certain level.

The human population in Madagascar increased from about 2.2 million in 1901 to 5.4 million in 1960 and to 11.7 million in 1986; the current population growth rate is 2.9% annually. It is calculated that there will be 28.1 million in the country by 2025. Without doubt, the consumption pressure on *Erymnochelys* is increasing. The expansion of the inland fisheries in Madagascar and the improvement of fishing technologies and materials (e.g., nets) are official goals of the Malagasy government and seem inevitable in order to feed the growing human population. These efforts, however, may be disastrous for *Erymnochelys* if no action is taken to manage at least some of its populations.

In a follow-up study, *Erymnochelys* populations will be surveyed over the whole range of the species and selected populations will be studied in more depth to provide a basis for conservation measures. Generally, approaches to the conservation of the species could include education of local people and better enforcement of the laws protecting *Erymnochelys*; rigorous protection of crucial breeding habitats in different parts of its distribution; collection and incubation of eggs with the release of hatchlings or head-started juveniles to restock populations; and development of better fishery practices in general throughout western Madagascar.

Two additional priority activities include the establishment of protected areas and development of a captive breeding program for this unique species. Further survey work is needed to locate the most appropriate site for a protected area, probably in the Malagasy category of Special Reserve. Semi-captive breeding is also being considered in a lake in the Ankarafantsika National Reserve, just across from the Ampijoroa Station where breeding efforts are currently underway for the endangered tortoises *Geochelone yniphora* and *Pyxis planicauda*. A captive breeding effort outside Madagascar, at one of the institutions committed to conservation of the fauna of Madagascar, should be given serious consideration as well.

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