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Biology and Conservation of the Freshwater Turtles and Tortoises of Peru

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Abstract.—Little information has been published on Peruvian chelonians. Here we have compiled the available literature pertaining to Peruvian freshwater turtles and tortoises on four topics: Human consumption and ethnobiology, habitat use, status and abundance, and reproduction. In addition, we provide a map of the regions of Peru showing the number of research records and the number of species that occur in each region. Reproduction was the topic most frequently studied, although investigations were concentrated on only three species (*Podocnemis unifilis*, *P. expansa*, *P. sextuberculata*). The regions where the most studies were implemented are the Departamentos de Loreto and Madre de Dios, with studies tending to be concentrated in the vicinity of Iquitos, the Pacaya-Samiria National Reserve, and Manu National Park and its buffer zone. In general, regions in which more research effort was evident reported more turtle species, which suggests that the least-studied states could have more species, as they share the same types of habitats as the more intensely investigated regions. We identified major gaps in information and suggest future research in the following poorly studied Peruvian regions: Departaments of Junín, San Martín, Tumbes, Huanuco, Amazonas, Cusco, Ayacucho, Puno, Huancavelica, and Cajamarca. The status, distribution, and abundance of Peruvian populations of *Podocnemis expansa*, *P. unifilis*, *Chelonoidis carbonaria*, *Peltocephalus dumerilianus*, and *Mesoclemmys heliostemma* are in particular need of study. Conservation priorities are also discussed.

Keywords: Reptiles; Podocnemididae; Chelidae; Kinosternidae; Testudinidae.

The earliest studies of Peru's herpetofauna were conducted during the nineteenth century (Tschudi 1845). Recent information on the occurrence of reptilian species in the country is in reviews by Carrillo (1970, 1990), Carrillo and Icochea (1995), and Duellman and Mendelson (1995). Three hundred and sixty-five reptilian species have been reported in Peru (Carrillo and Icochea 1995), including 14 non-marine chelonians: Podocnemididae (*Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, and *Peltocephalus dumerilianus*), Chelidae (*Mesoclemmys gibba*, *M. heliostemma*, *M. raniceps*, *Phrynops geoffroanus*, *Platemys platycephala*, and *Chelus fimbriata*), Kinosternidae (*Kinosternon leucostomum* and *K. scorpioides*), and Testudinidae (*Chelonoidis carbonaria* and *C. denticulata*) (Pritchard and Trebbau 1984, Carrillo and Icochea 1995, Rueda-Almonacid et al. 2007). Most Peruvian freshwater turtles and all tortoise species are found in the Amazon Basin, except *K. leucostomum*, which is found only in the northwestern part of the country (Carrillo and Icochea 1995, Fritz and Havaš 2007, Rueda-Almonacid et al. 2007). No Peruvian turtles are endemic. All recorded species also occur in other countries in the Amazon Basin (Fritz and Havaš 2007).

Little information has been published on this group to date. Much of the non-marine turtle work was conducted by Pekka Soini and co-authors over the course of several

The Yellow-spotted River Turtle (*Podocnemis unifilis*) is one of 14 species of freshwater turtles and tortoises known to occur in Peru. Photograph by Bruno Ferronato.

years at the Cahuana Biological Station and was published in his annual reports, the "Reporte Pacaya-Samiria" (Soini and Cóppula 1980), and by Augusto Fachín-Terán and co-authors in the Pacaya-Samiria and Iquitos regions.

Gathering basic information on the distribution and natural history is the first step to providing the information necessary to guide successful conservation and management programs (Souza 2004). We have assembled the published information on four research topics for Peruvian non-marine turtles. We also have recorded the number of turtle species per state and identified the geographic regions in which the most and least research efforts have been expended in order to highlight major gaps in the current knowledge of turtles in Peru.

Methods

We summarized the information published on Peruvian non-marine turtles in four research topics: human consumption and ethnobiology, habitat use, status and abundance, and reproduction. We chose to focus our investigation on these topics because they represent basic data on biology (habitat use and reproduction) and on the exploitation and conservation (human consumption and ethnobiology, status and abundance). In addition, we summarized not only the information pertaining to the four research topics, but all of the available information on chelonians in Peru, using maps to

The Yellow-footed Tortoise (*Chelonoidis denticulata*) is consumed by local peoples throughout Peru. Photograph by Carlos Alberto Jimenez.

The Giant South American River Turtle (*Podocnemis expansa*) is highly prized for its flesh and eggs. Photograph by Rafael Bernhard.

illustrate the regions with the most and least research efforts and also where various species do or do not occur. This second set of information should provide an accurate base from which to prioritize areas of the country that are most in need of further chelonian research. Lastly, we indicated the number and the species of turtles that occur in each region/state of the Peruvian territory. In general, reproductive data are expressed as mean, standard deviation, minimum, and maximum; however; in some studies, this information was incomplete or not available.

Results

Human consumption and ethnobiology.—Peruvian freshwater turtles and tortoises are consumed by local people in the Amazon Basin, in particular *Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, and *Chelonoidis denticulata* (Dixon and Soini 1986, Fachín-Terán et al. 1996, Soini 1996). The freshwater turtles *P. expansa*, *P. unifilis*, and *P. sextuberculata* are highly prized for their flesh and eggs (Dixon and Soini 1986, Laso 2009). The tortoise *C. denticulata* is consumed throughout the Peruvian Amazon (Ríos et al. 1974, Rodriguez and Rylander 1984, Souza and Rivera 2006), and is captured and eaten by locals whenever it is found in central Peru (BOF, pers. obs.). Chirif (2005) reported the local culinary uses of *P. expansa*, *P. unifilis*, and *C. denticulata*; and Gálvez et al. (1999) described the nutritional value of *C. denticulata* meat, indicating a high protein and low fat content.

The smaller species (Chelidae and Kinosternidae) are also eaten, but probably to a lesser degree when compared to Podocnemididae and Testudinidae. *Mesoclemmys raniceps* is commonly caught by hook and line by local fisherman in the Iquitos region and cooked whole (Dixon and Soini 1986). In the Pichis River Valley in central Peru, *M. gibba* and *Phrynops geoffroanus* are also eaten when caught by hook and line in Ashaninkas communities (BOF, pers. obs.). *Platemys platycephala* and *Kinosternon scorpioides* are well known to natives in the Iquitos region, where the former is frequently eaten and the latter is eaten whenever encountered (Dixon and Soini

In central Peru, Gibba Turtles (*Mesoclemmys gibba*, above) and Geoffroy's Side-necked Turtles (*Phrynops geoffroanus*, below) are caught by hook and line and eaten in native communities. Photographs by Rafael Bernhard and Bruno Ferronato.

The Yellow-spotted River Turtle (*Podocnemis unifilis*) inhabits the large rivers and oxbow lakes of the Amazon Basin. During the wet season, these turtles move into the flooded forest in search of fruits. Photograph by Bruno Ferronato.

1986). *Chelus fimbriata* is also well known to locals, but is not usually considered a food source, although it is occasionally eaten (Dixon and Soini 1986, Fachín-Terán et al. 1996).

Many vernacular names are used for turtles in Peru. *Podocnemis expansa* is known as "charapa"; *P. unifilis* as "taricaya," "cabezuda," and "charapa"; *P. sextuberculata* as "cupiso"; *Peltocephalus dumerilianus* as "tortuga" or "guacamayo charapa"; *Mesoclemmys gibba* as "charapita de aguajal" and "ashna charapa"; *M. raniceps* as "charapita de aguajal"; *Platemys platycephala* as "charapita de aguajal," charapa de fango," "ashna charapa," "pancuchu," and "shutatu"; *Chelus fimbriata* as "mata mata"; *Kinosternon scorpioides* as "tortuga buitre," "modedora," "yacu motelo," "loro charapa," "ashna charapa," and "sachatortuga"; *Chelonoidis carbonaria* as "motelo"; and *C. denticulata* as "motelo," "cuncumi," "cuncuim," and "iguanch" (Foote 1978, Carrillo 1990). *Phrynops geoffroanus* is known as "teparo" in central Peru (BOF, pers. obs.).

Habitat use.—Podocnemis expansa, *P. unifilis*, and *P. sextuberculata* inhabit the large rivers and oxbow lakes of the Amazon Basin. During the wet season, they move into the flooded forest in search of fruits (Carrillo 1970, Soini 1999). *Podocnemis unifilis* basks on floating debris (Goulding et al. 2003); however, *P. sextuberculata* has never been observed basking (Soini 1996). *Peltocephalus dumerilianus* lives in streams in forested areas dominated by palms (*Mauritia flexuosa*) in the vicinity of the Itaya River, Peru (Rivera 1995).

Mesoclemmys gibba lives in streams (Morales and McDiarmid 1996, Ferronato et. al. 2010), small forest ponds, and rivers, mainly in closed-canopy situations and in bodies of water with muddy bottoms (Dixon and Soini 1986). *Mesoclemmys raniceps* inhabits oxbow lakes and lagoons (Carrillo 1970), as well as small forest streams and pools (Dixon and Soini 1986, Rodriguez and Cadle 1990). *Phrynops geoffroanus* lives in streams (Morales and McDiarmid 1996), lakes, creeks, and sometimes slow-flowing rivers (Goulding et al. 2003, Ferronato et al. 2011). *Platemys platycephala* is found in small streams and swamps of the primary forest (Dixon and Soini 1986, Rodriguez and Cadle 1990), as well as on the ground (Duellman and Sallas 1991). *Chelus fimbriata* is found on the bottoms of shallow pools and creeks in primary forest (Carrillo 1970, Dixon and Soini 1986).

Kinosternon scorpioides occurs in low flooded forests, swamps, and ponds (Dixon and Soini 1986, Rodriguez and

The Twist-necked Turtle (*Platemys platycephala*) is found in small streams and swamps of the primary forest. Photograph by Carlos Alberto Jimenez.

The Scorpion Mud Turtle (*Kinosternon scorpioides*) occurs in low flooded forests, swamps, and ponds. Photograph by Rafael Bernhard.

Cadle 1990). *Chelonoidis denticulata* is found in closed-canopy forests (Carrillo 1970, Dixon and Soini 1986), riparian forest (Catenazzi and Bustamante 2007), and in open areas along forest margins (Morales and McDiarmid 1996). Rodriguez and Rylander (1984) observed that during the dry season in the Iquitos region, *C. denticulata* preferred the low, humid areas near water, but during the height of the rainy season, many individuals moved to higher parts of the forest.

The Northwestern Amazon Toad-headed Turtle (*Mesoclemmys heliostemma*) is considered vulnerable on the Peruvian Red List, but as "data deficient" according to a new evaluation of its status (IUCN Red Listing cited in Turtle Taxonomic Working Group 2011). Photograph by William McCord.

Status and abundance.—Five turtle species are listed as threatened on the Peruvian Red List: *Podocnemis unifilis*, *Mesoclemmys heliostemma*, and *Chelonoidis carbonaria* are considered vulnerable; *P. expansa* is endangered, and *Peltocephalus dumerilianus* is critically endangered (Ministerio de Agricultura 2004).

Podocnemis expansa is not abundant at Pacaya-Samiria National Reserve due to the intense exploitation of eggs and adult females (Soini and Cóppula 1980), and it is rare at other localities in the Peruvian Amazon (Ríos et al. 1974, Dixon and Soini 1986, Rodriguez and Knell 2003). Using nesting females as an indicator of abundance, an estimated 500–600 females were reported for the Pacaya-Samiria watershed (Soini 1996, 1999). *Podocnemis unifilis* is considered a common species in Pacaya-Samiria National Reserve (Soini 1996) and Iquitos (Dixon and Soini 1986); however, it is rare at other localities in Peru (Ríos et al. 1974, Morales and McDiarmid 1996, Rodriguez and Knell 2003). A minimum number of

The Six-tubercled Amazon River turtle (*Podocnemis sextuberculata*) was thought to be abundant in the Iquitos region in the 1980s, but new evaluations are needed to assess its current status in Peru. Photograph by Rafael Bernhard.

Table 1. Reproductive parameters available for freshwater turtles and tortoises from Peru. Maturation age in years and incubation period in days.

Species	Maturation Age	Clutch Size	Incubation Period	References
Podocnemis expansa	7–9	132.4 ± 21.6 (61–172)	69 (56–86)	Soini 1996, 1999
P. unifilis	5–6	34.5 (6–52)	87 (66–159)	Soini 1996
P. unifilis		21 (16–29)		Ponce 1979
P. unifilis		31.3. ± 4.4 (22–43)	66.5 ± 9.2	Fachín-Terán 1992
P. unifilis		23.62 ± 0.22		Landeo 1997
P. sextuberculata	4	13.2 ± 3.1 (7–22)	88 (73–103)	Soini 1996
Mesoclemmys gibba		3	153	Mittermeier et al. 1978
Platemys platycephala		1		Dixon and Soini 1986
Chelonoidis denticulata		5 (3–19)		Rodriguez and Rylander 1984

14 adult females per km was estimated in the Pacaya River (Soini and Cóppula 1980, Soini 1996). Norris et al. (2011) and Pitman et al. (2011) showed an increase in *P. unifilis* abundance in four years of monitoring following the establishment of a protected area in southern Peru. *Podocnemis sextuberculata* is not common in Pacaya-Samiria National Reserve (Soini and Cóppula 1980), possibly due to natural causes (Soini 1996). Conversely, *P. sextuberculata* is locally abundant in the Iquitos region (Dixon and Soini 1986).

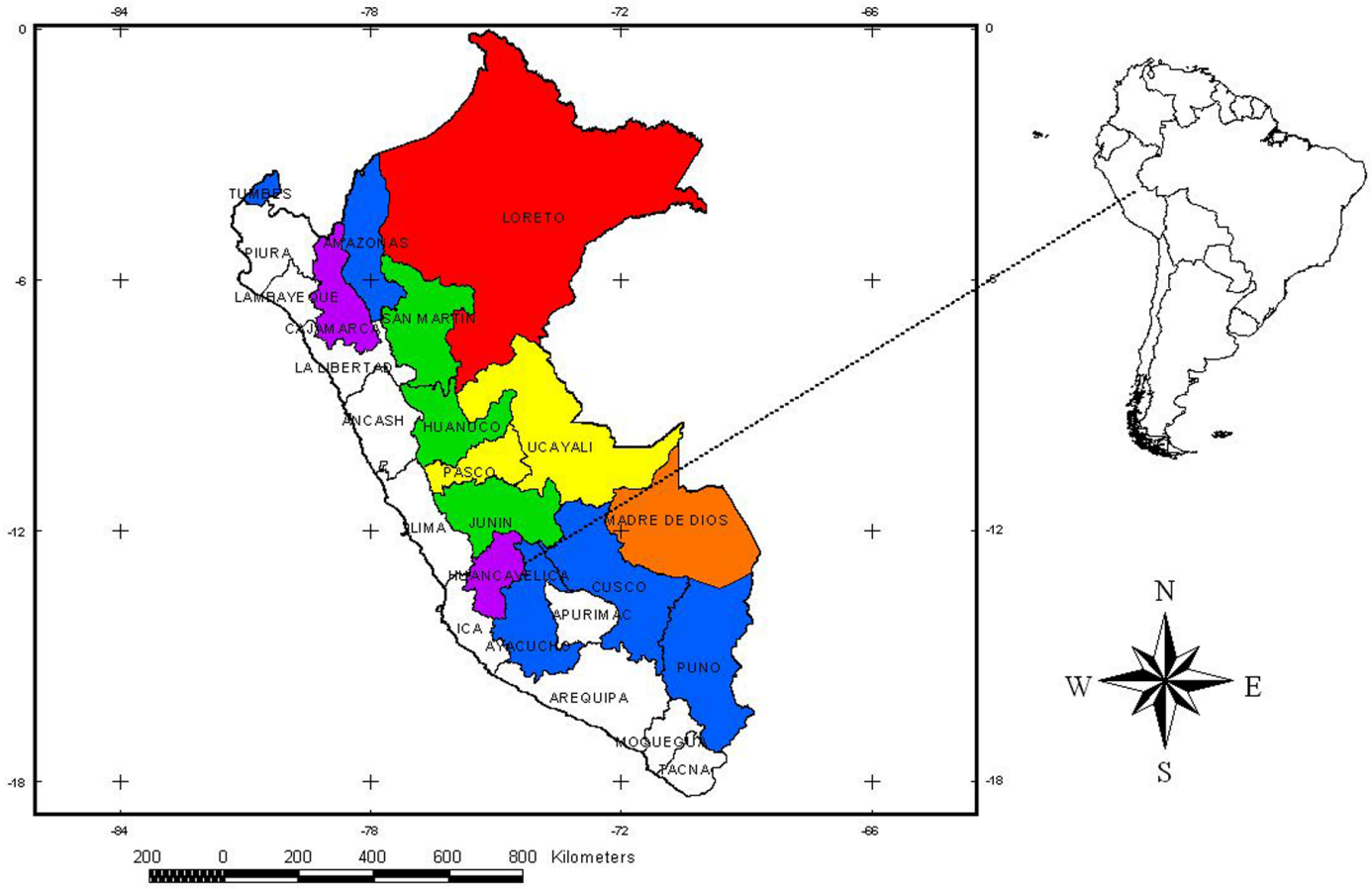
Mesoclemmys gibba is considered rare (Dixon and Soini 1986, Duellman and Sallas 1991) or uncommon in Peru (Morales and McDiarmid 1996), whereas *M. raniceps* is common in some localities, such as Mishana and Moropon, but relatively rare or absent from Centro Union and the Aucayo River (Dixon and Soini 1986). *Phrynops geoffroanus* is considered uncommon in Pakitza (Morales and McDiarmid 1996). *Platemys platycephala* is a relatively common species in the Iquitos region (Dixon and Soini 1986), but uncommon in other areas of the country (Duellman and Sallas 1991, Morales and McDiarmid 1996). *Chelus fimbriata* is also a common turtle of the Iquitos river system (Dixon and Soini 1986), but rare in other regions of Peru (Ríos et al. 1974).

Kinosternon scorpioides is a locally rare turtle in Iquitos (Dixon and Soini 1986) and in the Cuzco Amazonico Reserve (Duellman and Sallas 1991). *Chelonoidis denticulata* is considered an abundant tortoise in the Peruvian Amazon (Carrillo 1970); however, it could be considered uncommon in some regions (Duellman and Sallas 1991, Morales and McDiarmid 1996).

Reproduction.—Available reproductive data for turtles from Peru (*Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, *Mesoclemmys gibba*, *Platemys platycephala*, and *Chelonoidis denticulata*) are presented in Table 1. A long-term reproductive study of *Podocnemis expansa*, *P. unifilis*, and *P. sextuberculata* was conducted in Pacaya-Samiria National Reserve from 1979 to 1994 (Soini and Cóppula 1980; Soini 1994a, 1996, 1999). The reproductive seasons of these species are synchronized with river flood cycles, and eggs are laid during the dry season (Soini and Cóppula 1980, Soini 1996). *Podocnemis expansa* usually nests at night, and females tend to congregate near the beaches to explore potential nesting sites for several days (Soini 1996). At Pacaya-Samiria National Reserve, female *P. unifilis* also congregate, with as many as 46 females observed nesting together (Soini 1994a). Some evidence suggests that *P. unifilis* can nest twice in the same reproductive season, with intervals of 9–10 days (Soini 1994b). However, Ushiñahua (2006) reported that female *P. unifilis* usually lay only one clutch per year. Clutch sizes of *P. unifilis* vary in the Peruvian Amazon (Table 1), possibly correlated with female size.

Relocations of natural nests of *Podocnemis expansa*, *P. unifilis*, and *P. sextuberculata* have been employed in Pacaya-Samiria to avoid predation by humans and natural predators (Soini and Cóppula 1980, Soini 1996). Hatching success in artificial nesting beaches in Pacaya-Samiria for *P. expansa*, *P. unifilis*, and *P. sextuberculata* varies from 50 to 80%, 70 to 80%, and 50 to 80%, respectively (Soini 1996). Fachín-Terán et al. (1997) reported a hatching success of 27.6% for captive *P. unifilis* in Iquitos. Hatching success in natural nests of *P. unifilis* at Manu National Park was 95.43% (Landeo 1997).

The region with the largest number of investigations of turtle biology in Peru is the Departamento de Loreto (55 reports), and the second most-studied is the Departamento de Madre de Dios (14 reports) (Fig. 1). Few studies (five reports each) have been undertaken in the Departamentos de Pasco and



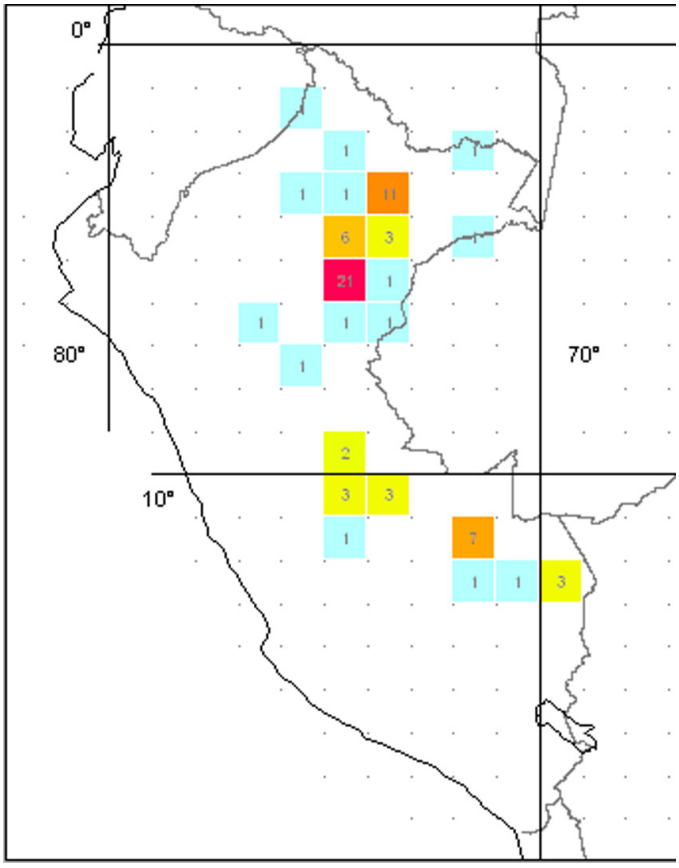


Figure 1. Freshwater turtle and tortoise research and the regions studied in Peru. The top map shows a gradient from the more- to less-studied regions (red, orange, yellow, and green). The regions in blue are known to support chelonians but no published natural history reports address populations in those states. States in purple are expected to have turtles in a small portion of their territories, and states in white support no non-marine turtles. The bottom map shows the regions where more studies have been conducted (colored boxes): Pacaya-Samiria National Reserve (21) and the vicinity of Iquitos (11) in the Departamento de Loreto, and Manu National Park (7) in the Departamento de Madre de Dios.

Ucayali. The Departamentos de Junín, Huanuco, and San Martín have only one study each. The Departamentos de Tumbes, Amazonas, Cusco, Ayacucho, and Puno are known or expected to have chelonians in at least parts of their territories (Carrillo and Icochea 1995), but no other specific published information is currently available for these areas. The Departamentos de Huancavelica and Cajamarca have lowland Amazonian vegetation ("Bosque Tropical Amazonico") in a small portion of their territories (Brack 1986), and some turtle species almost certainly occur there. The Departamentos de Piura, Lambayeque, La Libertad, Ancash, Lima, Ica, Apurimac, Arequipa, Moquegua, and Tacna support few if any chelonians due to climatic conditions such as deserts ("Desierto Costero") and the Andean Mountain ecosystems ("Serranía Esteparia," "Puna," "Páramo," and "Yungas") (Brack 1986) (Fig. 1).

Big-headed Amazon River Turtles (*Peltocephalus dumerilianus*) are used for medicinal purposes and are subject to numerous taboos in Brazil, but little is known about their use by locals in Peru. Photograph by Rafael Bernhard.

Although the Departamentos de Loreto and Madre de Dios are sites of the most turtle studies in the country, these investigations tend to be concentrated around a few locations in each region: Pacaya-Samiria National Reserve (21 reports), the vicinity of Iquitos (11 reports), and Manu National Park (7 reports) (Fig. 1).

Although some species of Peruvian turtles have been recorded from five or more states, others, such as the White-lipped Mud Turtle (*Kinosternon leucostomum*), are known from only one department. Photograph by German Forero-Medina.

The regions in Peru with the most chelonian species are the Departamentos Loreto, Ucayali, Madre de Dios, Huanuco, and Pasco; other regions have few or no species (Table 2). Species that occur in several regions are *Phrynops geoffroanus* (8 states), and *Podocnemis unifilis*, *Mesoclemmys gibba*, *Platemys platycephala*, *Kinosternon scorpioides*, and *Chelonoidis denticulata* (all found in five states) (Table 2). Other species are known from only one state, such as *Chelonoidis carbonaria* (San Martin), *Kinosternon leucostomum* (Tumbes), and *Mesoclemmys heliostemma* and *Peltocephalus dumerilianus* (Loreto) (Table 2).

Discussion

Amazonian turtles have long been consumed and exploited in the Amazon Basin (Smith 1979). They are part of the indigenous people's diet, traditions, and beliefs (Rebelo and Pezzuti 2000, Alves et al. 2009, Pezzuti et al. 2010). In Peru, turtles are much appreciated as food, but little is known of the traditional beliefs and magical uses of turtle species from riverine and indigenous communities. In the Brazilian Amazon, species such as *Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, *Peltocephalus dumerilianus*, *Phrynops geoffroanus*, *Chelus fimbriata*, *Kinosternon scorpioides*, *Chelonoidis carbonaria*, and *C. denticulata* are used for medicinal purposes (Moura and

Table 2. Species of freshwater turtles and tortoises and the Peruvian states in which they are known to occur.

Departamento*	Number of species	Species	References
Loreto	12	*Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, *Peltocephalus dumerilianus*, *Mesoclemmys gibba*, *M. heliostemma*, *M. raniceps*, *Phrynops geoffroanus*, *Platemys platycephala*, *Chelus fimbriata*, *Kinosternon scorpioides*, *Chelonoidis denticulata*	Ríos et al. (1974), Ponce (1979), Dixon and Soini (1986), Carrillo and Icochea (1995), Rivera (1995), Fachín-Terán et al. (1996), Oversluijs (2003)
Ucayali	10	*Podocnemis expansa*, *P. unifilis*, *P. sextuberculata*, *Mesoclemmys gibba*, *M. raniceps*, *Phrynops geoffroanus*, *Platemys platycephala*, *Chelus fimbriata*, *Kinosternon scorpioides*, *Chelonoidis denticulata*	Mittermeier et al. (1978), Carrillo and Icochea (1995), Lehr (2002), Rodriguez (2003)
Madre de Dios	7	*Podocnemis unifilis*, *Mesoclemmys gibba*, *M. raniceps*, *Phrynops geoffroanus*, *Platemys platycephala*, *Kinosternon scorpioides*, *Chelonoidis denticulata*	Rodriguez and Cadle (1990), Duellman and Sallas (1991), Guevara (1991), Carrillo and Icochea (1995), von May et al. (2006)
Huanuco	6	*Podocnemis unifilis*, *Mesoclemmys gibba*, *Phrynops geoffroanus*, *Platemys platycephala*, *Kinosternon scorpioides*, *Chelonoidis denticulata*	Carrillo and Icochea (1995), Schlüter et al. (2004)
Pasco	4	*Podocnemis unifilis*, *Mesoclemmys gibba*, *Phrynops geoffroanus*, *Chelonoidis denticulata*	Lehr (2001), Ferronato et al. (2011)
Amazonas	2	*Platemys platycephala melanota*, *Kinosternon scorpioides*	Morales et al. (1990), Carrillo and Icochea (1995)
Junin	1	*Phrynops geoffroanus*	Carrillo and Icochea (1995)
San Martin	1	*Chelonoidis carbonaria*	Carrillo and Lamas (1985), Carrillo and Icochea (1995)
Tumbes	1	*Kinosternon leucostomum*	Carrillo and Icochea (1995)
Cusco	1	*Phrynops geoffroanus*	Carrillo and Icochea (1995)
Ayacucho	1	*Phrynops geoffroanus*	Carrillo and Icochea (1995)

*No freshwater turtles or tortoises have been recorded from the Departamentos Puno, Huancavelica, Cajamarca Piura, Lambayeque, La Libertad, Ancash, Lima, Ica, Apurimac, Arequipa, Moquegua, and Tacna.

Marques 2008; Alves et al. 2008, 2009; Pezzuti et al. 2010) and subject to numerous taboos (Pezzuti et al. 2010). In addition to the traditional uses of Amazonian turtles by riverine peoples, diminishing numbers of Amazonian turtles have been reported (Smith 1979, Soini 1996, Conway-Gomez 2007), with illegal trade playing an important role (Kemenes and Pezzuti 2007, Schneider et al. 2011). Enforcement is necessary to protect species with economic importance from poaching (Schneider et al. 2011), and management programs need to be established within local communities in order to develop the sustainable use of turtle eggs and meat (Caputo et al. 2005, Townsend et al. 2005).

In general, the habitats in which Peruvian turtles live are similar to those of other populations within the respective species' ranges in South America (Pritchard and Trebbau 1984, Rueda-Almonacid et al. 2007, Vogt 2008). *Podocnemis expansa*, *P. unifilis*, and *Mesoclemmys gibba* also inhabit white and black-water rivers systems in Brazil (Rueda-Almonacid et al. 2007), and *Peltocephalus dumerilianus* is more abundant in black than white-water river systems, preferring the tributaries of large rivers and lakes (Rueda-Almonacid et al. 2007). *Phrynops geoffroanus* also lives in polluted urban rivers in Brazil (Ferronato et al. 2009), and *Chelonoidis carbonaria* can inhabit savanna-like ecosystems in Central Brazil (Wang et al. 2011).

So little information is available about all three Peruvian species in the genus *Mesoclemmys* that they were listed as "data deficient" in a new evaluation on their conservation status (IUCN Red Listing cited in Turtle Taxonomic Working Group 2011). This is the Amazon Toad-headed Turtle (*M. raniceps*). Photograph by Rafael Bernhard.

Some Peruvian turtles, including *Podocnemis sextuberculata* and *Chelonoidis denticulata*, which are not at risk in Peru, are at risk of extinction throughout their South American ranges. *Podocnemis expansa* was in the lower risk category, but "conservation dependent" in 1996 (IUCN 2012); today it is critically endangered (Turtle Taxonomy Working Group 2011). *Podocnemis unifilis* was vulnerable in 1996, today it is endangered. *Podocnemis sextuberculata* and *Peltocephalus dumerilianus* were and are both vulnerable. *Chelonoidis denticulata* was considered vulnerable and is now near threatened, whereas *C. carbonaria* was not listed in 1996 (= least concern) and is now vulnerable. The three species of *Mesoclemmys* are all listed as data deficient. The other species are listed as being of least concern (Turtle Taxonomy Working Group 2011).

Conway-Gomez (2007) determined that populations of *P. expansa* were less abundant close to the human communities in Bolivia, and Mogollones et al. (2010) concluded that increasing the survivorship of juvenile and adult *P. expansa*, more than fecundity, is the conservation action that could best reverse a population decline. Some chelid turtles, such as *Chelus fimbriata*, are difficult to locate throughout their range, but this is probably due more to a cryptic life style than rarity or low population densities (Pritchard 2008). Pitman et al. (2011) employed a river-based survey method for counting basking *P. unifilis* in southern Peru and detected signs of population recovery in the short to medium term when a reserve was created and actually protected. Such initiatives are critical

The bottom-dwelling Matamata (*Chelus fimbriata*) is a cryptic species found on the bottoms of shallow pools and creeks in primary forest. Photograph by Rafael Bernhard.

Threatened species, in particular those like the Red-footed Tortoise (*Chelonoidis carbonaria*), which appear to have restricted distributions in Peru, should receive special attention by researchers and conservationists. Photograph by Cassiano Zaparoli.

for detecting population trends over the years, and can actually help evaluate the long-term success of conservation and management programs of podocnemid turtles in South America.

Reproduction was the most intensely studied aspect of turtle biology in Peru; nonetheless, these initiatives have so far been concentrated on only a few species, such as *Podocnemis unifilis*, *P. expansa*, and *P. sextuberculata*, leaving the reproductive biology of most Peruvian species unknown or at best poorly understood (Table 1). Vanzolini (2003) has shown that *P. unifilis* exhibits geographic variation in clutch size and hatching success in South America, and Peruvian populations also vary in clutch sizes (Ponce 1979, Soini 1996), but more evident are differences in hatching success (Soini 1996, Landeo 1997). Relocation of nests of podocnemid turtles is a common practice in conservation and management programs in Peru (Soini 1996, 1999) and throughout South America (Caputo et al. 2005, Fachín-Terán 2005, Townsend et al. 2005). However, this practice tends to affect the mortality, morphology, growth rates, and locomotor performance of *P. expansa* hatchlings (Jaffe et al. 2008), and embryo survival in *P. unifilis* and *P. sextuberculata* (Malvasio et al. 2005, Haller and Rodrigues 2006). On the other hand, without relocation of the nests, these species are more prone to human predation if enforcement is not effective, or they can be lost to natural causes, such as flooding (Soini and Cóppula 1980, Caputo et al. 2005, Townsend et al. 2005). Future research should focus on improving procedures for relocating nests with less negative impact on hatchling development.

In general, a correspondence is evident between the number of research records and the number of turtle species in each Peruvian state (Fig. 1, Table 2). Loreto had more research effort and the highest number of species (Table 2). Considerable research has occurred in Madre de Dios, which also supports several species. However, this is not true for Ucayali, which has several chelonian species but only a modest research effort (Fig. 1, Table 2). Other regions with fewer species and research initiatives might have more turtles in their territory, which would be revealed with more intensive research. Some of those least studied regions have the same types of habitat (lowland Amazonian vegetation, "Bosque Tropical Amazonico"; Brack 1986) as regions subjected to more research. In order to elucidate the patterns of distribution of turtle species in the country, future investigation should focus on those least-studied regions (Junín, San Martín, Tumbes, Huanuco, Amazonas, Cusco, Ayacucho, Puno, Huancavelica and Cajamarca).

Most of the turtle studies conducted on status and abundance in Peru were done in the 1980s and 1990s (Soini and Cóppula 1980; Dixon and Soini 1986; Soini 1996, 1999). Consequently, new evaluations are needed to address the current status of the species. The endangered species should receive special attention, in particular *Chelonoidis carbonaria*, *Peltocephalus dumerilianus*, and *Mesoclemmys heliostemma*, all of which appear to have restricted distributions (Table 2), and *Podocnemis unifilis* and *P. expansa* , because of the extent to which they are subjected to illegal trade throughout Amazonia (Fachín-Terán et al. 1996, Soini 1996).

Considering the diversity of turtles in Peru and the economic and cultural importance of turtles in the entire Amazon Basin, surprisingly little published information exists on the chelonian fauna of the country. Clearly, a greater investigative initiative would benefit the country in helping to understand patterns of distribution, abundance, and natural history, and increased efforts toward turtle conservation would enhance the likelihood of the long-term survival of vulnerable species.

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