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# AMAZONIAN MANATEES, *Trichechus inunguis*, IN PERU: DISTRIBUTION, EXPLOITATION, AND CONSERVATION STATUS

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## SUMMARY

Amazonian manatees, *Trichechus inunguis*, are regularly hunted and trapped in the blackwater lakes and streams within and near the Pacaya-Samiria National Reserve in northeastern Peru. Much of the exploitation of manatees in this region is ancillary to the capture of paiche, *Arapaima gigas*. Manatees are also hunted opportunistically and taken incidentally in fishing gear elsewhere in Peru. While the current conservation status of manatees is uncertain, there is no doubt that their effective range has shrunk and their numbers have declined to a considerable extent. Although the species has been legally protected since 1973, exploitation for local consumption of meat has continued without any practical restrictions. If human activities are not managed to reduce their impact on manatees, these valuable animals will be extirpated throughout an ever-greater percentage of their range. **KEY WORDS** / Amazonian manatee / *Trichechus inunguis* / Distribution / Conservation / Exploitation / Peru /

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The Amazonian manatee, *Trichechus inunguis*, was once widely distributed and abundant in much of the Amazon Basin (Husar, 1977; Rosas, 1991, 1994). It is now rarely seen in most of Peru, and apparently has been extirpated from all areas near human population centers. There is a general consensus that hunting for meat has been the main cause of the manatee's severe depletion (Grimwood, 1968, 1969; Pacheco, 1984; Pinedo-Vasquez, 1988). Although legally protected in Peru since 1973, the species continues to be hunted and trapped for food (Fig. 1). Catching of manatees is

often ancillary to the catching of paiche, *Arapaima gigas*, a large osteoglossid fish known in Brazil as pirarucú.

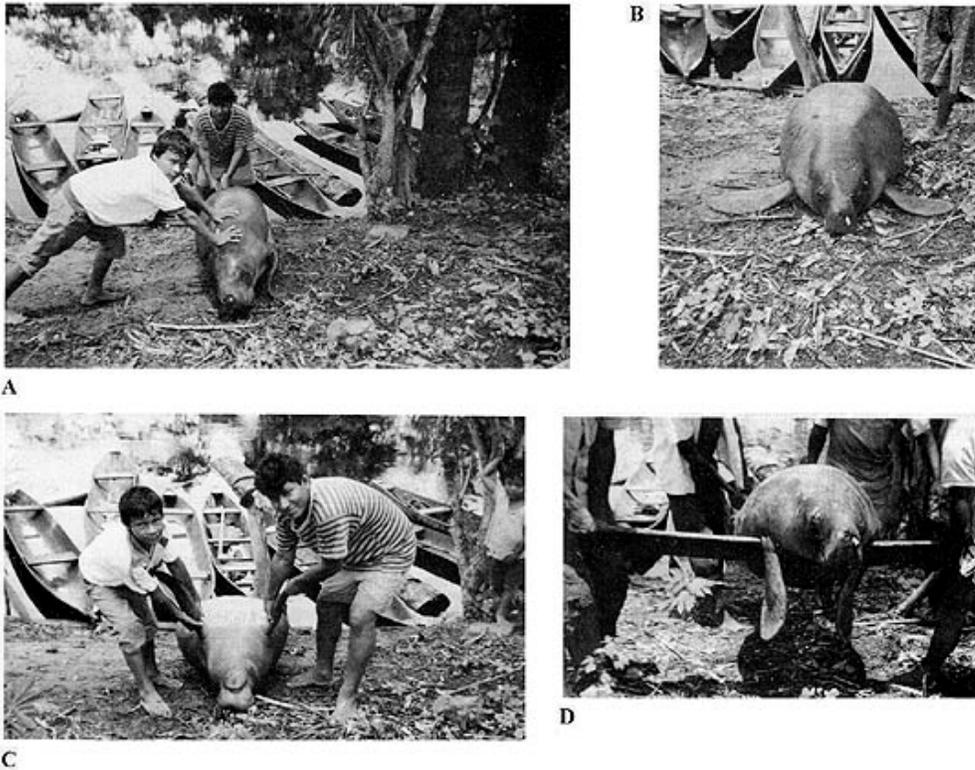


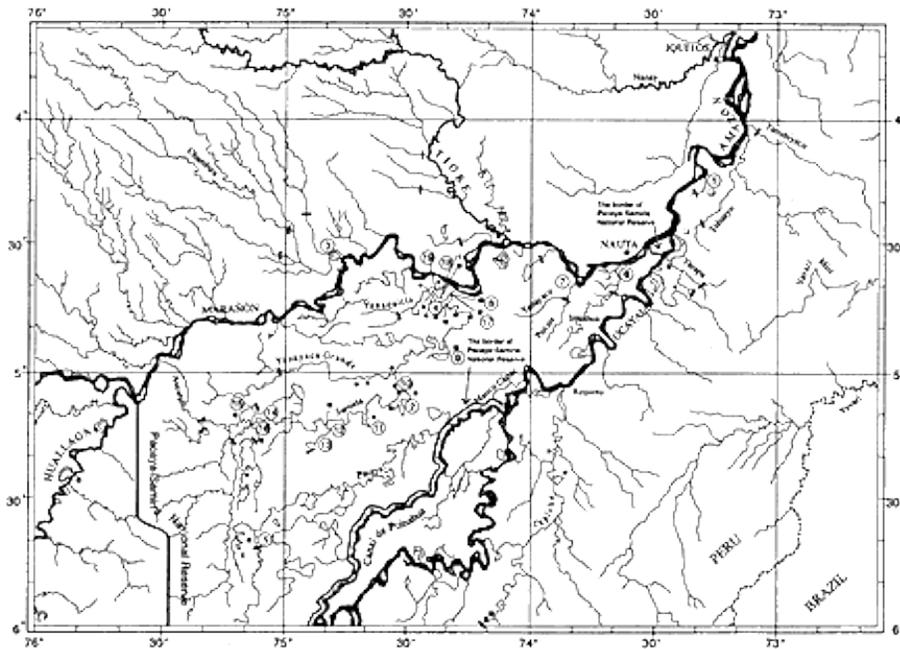
Figure 1. A female manatee brought ashore for butchering at San Martín, Tipishca de Samiria, near the Samiria-Marañón confluence, 21 March 1994. Photos: Geiner Icomena.

In Peru, the 2,080,000 ha Pacaya-Samiria National Reserve (hereafter, the Reserve), where human population density is low and the flooded-forest biome relatively undisturbed, has been cited as an area where a relatively secure population of Amazonian manatees survives (Grimwood, 1969; COREPASA, 1986; Pulido, 1991). Manatees were said to be 'especially abundant' during the 1970s in a small blackwater stream, the Yanayacu Santa Elena, deep inside the Reserve (Neville *et al.*, 1976; also see Timm *et al.*, 1986). An estimate of 0.2-0.4 manatees km<sup>-1</sup> was suggested for the middle Pacaya River in the early 1990s (Bayley *et al.*, 1992). Our recent studies of river dolphins - the boto, *Inia geofftensis*, and the tucuxi, *Sotalia fluviatilis* - in the Reserve provided us the opportunity to investigate the recent distribution, exploitation, and conservation status of manatees in the Rio Samiria system and other areas of Peru.

## Methods

We made 17 one-to-two week expeditions to Peru between 1991 and 1995 as leaders of trips sponsored and organized by Oceanic Society Expeditions, San Francisco, California, USA. In addition, Henningsen spent five months in the Peruvian Amazon between October 1994 and May 1995 engaged in doctoral field research. All of our expeditions began in Iquitos and covered portions of the rivers Amazon, Marañón, Ucayali, and Tigre and their associated blackwater river and lake

systems (Fig. 2). Multi-decked, shallow-draft riverboats powered by inboard diesel engines served as our bases of operation. Outboard-powered skiffs were often used for excursions into narrow channels, lakes and, occasionally, the flooded forest.



**Figure 2.** Study area in Peru (redrawn from Peru HIDRONAV-5100 chart). Bars perpendicular to river axes indicate upstream limits of authors' surveys. Dots indicate positions of live manatee sightings (Table II); closed squares indicate positions where caught or killed specimens (including bones) were observed; open squares indicate positions of hearsay records; asterisks indicate sites where drop traps (see Fig. 3) were observed. Numbers in circles refer to the following locations:

- |                               |                              |
|-------------------------------|------------------------------|
| 1 San Juan de Yanayacu        | 11 Pithecia Guard Station    |
| 2 Ungurahui                   | 12 Santa Elena Guard Station |
| 3 Tipishca de Chambira        | 13 Yanayacu Santa Elena      |
| 4 Tipishca de Samiria         | 14 Hamburgo                  |
| 5 Rio Alfaro                  | 15 Pasto Cocha               |
| 6 Nauta Caño                  | 16 Río Inglés                |
| 7 Yanayacu-Pucate             | 17 Bolívar                   |
| 8 Leonzio Prada Guard Station | 18 San Martín                |
| 9 Tacshacocha Guard Station   | 19 Nuevo Arica               |
| 10 Ungurahui Guard Station    |                              |

The primary objectives of our research in the Peruvian Amazon were related to dolphin research, so data on manatees were collected as a secondary activity. Because manatees fall within our scientific specialty of studying marine and aquatic mammals, however, we were consistently vigilant for them while searching for or watching dolphins. Apart from observing manatees and their habitats, we routinely questioned local people and park rangers about the occurrence and exploitation of these animals. Whenever possible, we examined and photographed tangible evidence of manatees and manatee hunting or trapping. Skulls and other bones were collected from refuse piles or acquired

from local residents.

## Results

### *Past Exploitation*

Commercial exploitation of manatees on a scale comparable to that in the Brazilian Amazon (Smith, 1980-81; Domning, 1982; Beg, 1984) is not known to have occurred in Peru. However, Grimwood (1969) referred to an occasion in 1958 when two traders were found to be in possession of 10 000 kg of dried manatee meat, obtained from the Rio Putumayo system in far northern Peru. Grimwood estimated that this amount of meat would have required the killing of some 220 average-sized adult manatees. Timm *et al.* (1986) described commercial manatee hunting near the Ecuador-Peru border as recently as the mid 1980s.

Manatees have been legally protected under Peruvian law since 1973, and no catch statistics have been officially collected (Luis Moya Ibáñez, pers. comm., 30 July 1993). Under Supreme Decree 934-73-AG, the hunting and commercial use of most rain-forest animals, including manatees, is prohibited. This decree includes an explicit exemption allowing certain species, but not the manatee, to be hunted by rural people for food. Although the decree has had a noticeable impact on the animal export trade, it has not been enforced against hunting for food (see Neville *et al.*, 1976; Padoch, 1988; Pinedo-Vasquez, 1988; Bodmer, 1994). Another decree issued in 1979 makes the selling of any wild animal meat illegal in cities with more than 3000 inhabitants, yet the meat of many rain-forest animals is sold openly at markets in Iquitos, a city of more than 350 000 residents, and other smaller cities such as Nauta and Requena.

### **Present-day Hunting Methods**

Meat hunting for manatees continues in areas where sufficient numbers are available to make it worth the effort. Two principal methods are used in the areas that we have visited: hand harpoons and set traps. Many Indians and ribereños (settlers of diverse origins) hunt paiche with long-shafted harpoons tied to wooden floats. Although some of these hunters also take manatees opportunistically, most manatee hunting seems to be done by a small percentage of the fishermen. It is a specialized skill, requiring an ability to find the animals and to exercise great patience in waiting for them to surface within throwing range (<15 m; ca 6 m may be an optimal distance - Timm *et al.*, 1986).

'Drop traps' are set across narrow waterways, usually secondary streams or constrictions in the main channels of larger rivers and lakes (Fig. 3). Apparently these traps are intended primarily to catch paiche, but they take any large animal that approaches closely enough. The traps are constructed as follows: Poles are driven into the mud bottom at close intervals to form a fence. Crosspieces and lacing are often used to tie the fence posts together for strength and stability. The fence is interrupted at one point by two taller poles supporting a crossbeam. The opening between these two poles is wide enough to admit a large paiche. Within the opening is a trigger, consisting of two flexible, vertical trigger poles, notched above water level. The harpoon shaft is a heavy timber, sharpened at the lower end so that it fits snugly into the cone-shaped socket of a metal harpoon head. To arm the trap, the hunter draws a line attached to the unsharpened end of the harpoon shaft over the crossbeam and sets it by placing the ends of a small wooden crosspiece attached to the line into the notches in the

trigger poles. The harpoon head, which is detachable, is then tied to a suitable anchor, such as a tree, to prevent the captured animal from escaping. When an animal enters the trap, its head or body spreads the trigger poles, thereby releasing the crosspiece and causing the harpoon to fall. The principle and detailed structure of the Peruvian traps are remarkably similar to those of traps used to capture West African manatees *Trichechus senegalensis* in Sierra Leone (Reeves *et al.*, 1988).

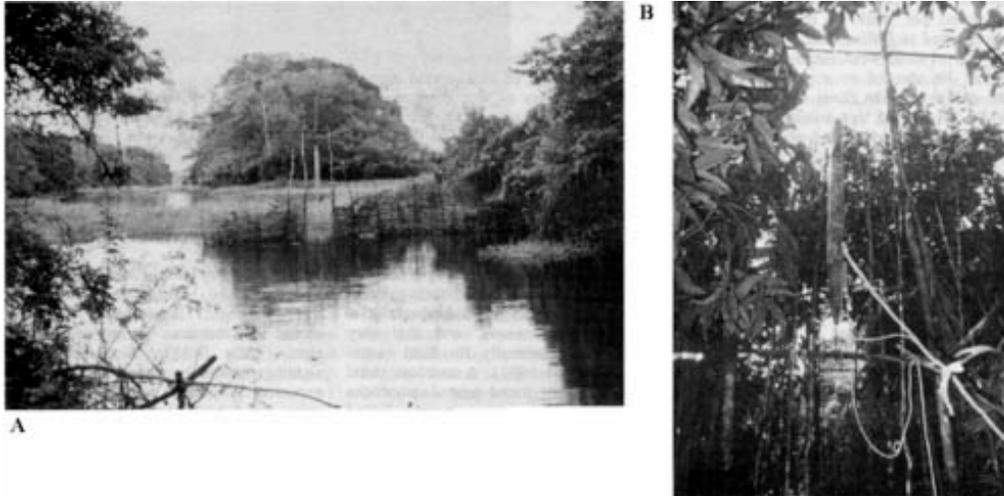


Figure 3. Drop traps set in the entrance of Lago Sapota, San Juan de Yanayacu, April 1991 (A) and in a small tributary of Tipishca de Samiria, August 1993(B). Photos: S. Leatherwood.

Manatees are also caught in gillnets set principally for fish (Neville *et al.*, 1976; Bayley *et al.*, 1992).

## Products

The main incentive for hunting and trapping manatees is clearly to obtain meat (Fig. 4). A large (~50 kg) chunk of salted meat, a pile of blubber, and a pan of oil from a manatee killed three days previously were seen at San Martín on 6 July 1993. About 25 kg of salted, sun-dried manatee meat was available for sale in San Martín at 3 soles/kg (\$US 1.35/kg) on 2 March 1995. It was from an animal killed a few days earlier by a hunter from neighboring Nuevo Arica. The seller told us that manatee meat commanded the same price in Nauta.

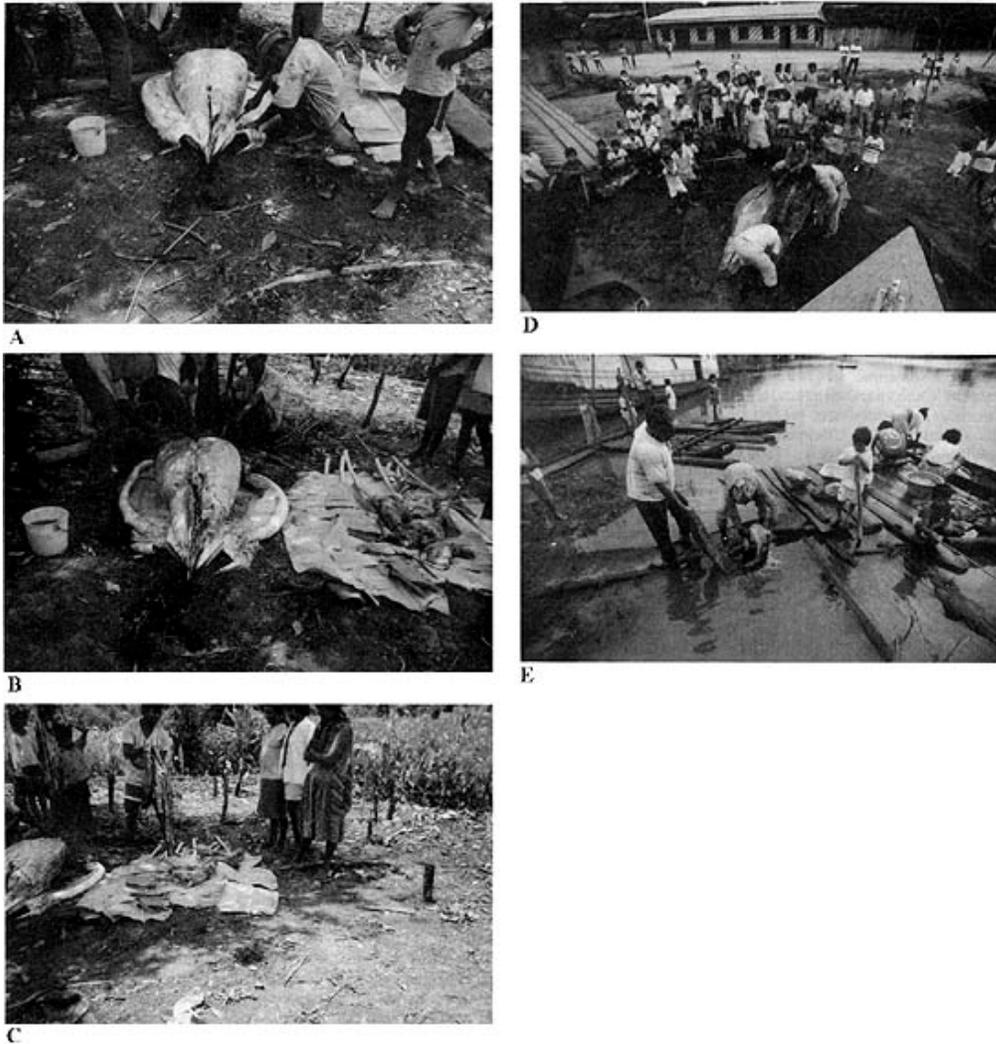


Figure 4 Manatees being butchered at San Martín, Tipishca de Samiria (A-C; female, 21 March 1994) and St. Helena, Rio Tapiche (D-E; see Fig. 5). Photos: Geiner Icomena (A-C; see Fig. 1) and T. Henningsen (see Fig. 5).

Parts of butchered manatees, discarded in the area of Tipishca de Samiria, were observed on two occasions: some skin and adhering blubber in the forest in June 1993 and a pectoral flipper floating in the lake in July 1993. Henningsen observed in April 1995 that the entire skin and blubber of two manatees butchered at St. Helena, far up the Rio Tapiche, were discarded. Manatee skin and bones apparently are not used for medicinal or therapeutic purposes, as they were in other parts of Amazonia as recently as the 1970s (cf. Domning, 1981). Some manatee oil (manteca) may be used for cooking. A Peruvian naturalist mentioned seeing a whip made of manatee skin in the Napo drainage of northern Peru about 30 years ago (Beder Chavez, pers. comm., 28 March 1993).

### Effort and Magnitude of Catch

Some fishermen claimed that manatees are usually hunted at night, whereas others told us that they are just as likely to be seen and hunted during daytime. Our few observations (see Table II, below)

were made during daylight hours, but we did not spend more than a few hours in directed searches for manatees during the night.

Manatees are probably easiest to find and harpoon during the low water season when they are forced to concentrate in areas of sufficient water depth and food availability (Best 1981, 1983). This is probably also true of paiche and other fish, so it should not necessarily be assumed that the relative amount of effort devoted to manatee hunting increases during this season (locally, paiche meat is about twice as expensive as manatee meat). The drop traps used to capture paiche and manatees can be completely submerged during high water and fully exposed during the dry season (when they are more likely to capture terrestrial and semi-aquatic animals such as deer, rodents, or caimans). These traps are said to be most effective during the period from January to May or June, when the water level is rising and the manatees are following constricted channels to reach good feeding areas.

In the two villages on the banks of Tipishca de Samiria, San Martín and Nuevo Arica, some manatees are taken every year. In 1993 at least three men in Nuevo Arica and six in San Martín hunted manatees. These numbers apparently did not take account of all the people living in houses scattered along the lake and river banks outside the villages. The six hunters from San Martín reported taking a total of seven manatees in Tipishca de Samiria during 1992 and one during the first seven months of 1993 (interview, 27 July 1993; but see below). Five were killed by these hunters between December 1993 and July 1994 (interview, 21 July 1994).

One hunter at Tipishca de Samiria claimed that he usually took 1-3 manatees per year (interview, 28 March 1993). He showed us ribs and a scapula from two animals killed near Ungurahui in 1992. The daughter of another hunter told us that her family had eaten parts of eight manatees during the preceding year (interview at Tipishca de Samiria, 28 March 1993) She showed us the mandibles of a large one that had been caught in a nearby lake on 20 March 1993. This animal was still alive when delivered to her home, where it was killed and consumed within three days. The school teacher at Bolívar told us in 1992 that approximately one manatee was taken in the region (including Bolívar, San Martín, Nuevo Arica, and environs) per week. A man (Hunter A) interviewed at Bolívar had taken a manatee the previous week (interview, 29 June 1992). He showed us a piece of rib and the partial cranium (total length 28.5 cm, width 15 cm) of this animal, as well as the scapula of one killed several months earlier. Another man (Hunter B) at San Martín had taken his last one approximately a month previously (interview, 2 July 1992). Hunter A claimed to have killed a total of only five manatees in his lifetime. Another San Martín hunter (Hunter C) reported that he had taken five manatees during the two years preceding our interview (6 July 1993). A manatee was delivered at San Martín in early April 1993 (interview, 13 April 1993). Also, a large female was taken in the Yanaquillo, a blackwater affluent of Tipishca de Samiria, in early July 1993 (interviews, 6 and 20 July 1993). These separate accounts of two manatees taken by San Martín hunters contradict the statement that only one was taken there during the first seven months of 1993 (see above). Such inconsistencies demonstrate the softness of this kind of recall data. We obtained tissue samples for molecular genetic analyses from 11 manatees, including seven delivered by hunters or trappers at San Martín between 24 March and 10 June 1995 (Table I).

**TABLE I MANATEES FROM WHICH TISSUE SAMPLES HAVE BEEN OBTAINED FOR MOLECULAR GENETIC ANALYSES; ALL FROM RIO SAMIRIA SYSTEM EXCEPT AS NOTED**

Date	Location	Sex	Est. length (cm)
21 March 1994	Tipishca de Samiria	Female	
2 March 1995	Yanayaquillo Creek		
24 March 1995	Posa de Pintal	Female	250
25 March 1995	Huisto Cocha	Male	200
26 March 1995	Rio Samiria	Male	210
28 March 1995	Posa de Pintal	Male	180
5 April 1995	Huarapapa Cocha	Male	250
17 April 1995	Near St. Helena, Rio Tapiche	Male	
17 April 1995	Near St. Helena, Rio Tapiche	Male	
2 May 1995	Huisto Cocha	Female	Large
10 June 1995	Posa de Pintal	Male	250

The rangers at the Santa Elena guard station, in the middle of the Reserve, offered us bones from manatees that had been killed in nearby Yanayacu Santa Elena. They reported seeing manatees often near the station, especially at the low water season, and that they killed one occasionally for food (interview, 10 April 1993). A cranium (total length 20.7 cm) found near Tacshacochoa guard station was from a manatee killed by the rangers there on 18 March 1993 (interview, 25 March 1993).

These scattered bits of information suggest that, in a typical year, at least a few tens of manatees are killed in the Rio Samiria system. More are killed in surrounding areas both within and outside the Reserve (Fig. 5; Anonymous, 1993; see below). If a meaningful estimate of the manatee harvest in the Peruvian Amazon is to be obtained, a much more systematic and sustained approach to collecting the data will clearly be necessary.



**Figure 5.** Two manatees harpooned in the Rio Tapiche near St. Helena, 16 April 1995, being towed to the village for butchering. Photo: T. Henningsen.

## Observations of Living Manatees

Collectively, we observed live manatees on only eight occasions (Table II, Fig. 2). Most of the sightings have been opportunistic and unexpected; it usually was not possible to carry out a prolonged, focused watch to verify or supplement initial observations. The records in Table II do not include the surface swirls, observed fairly often, that could have indicated manatees, but also may have been caused by reptiles, fish, otters, or diving birds. We sighting by a local crew member was included only because we were satisfied, after thorough questioning, that the observation was reliable.

TABLE II SIGHTINGS OF LIVE MANATEES

Date	Location	Comments
5 July 1992	Rio Samiria(4°48'S, 74° 15'W)	Midriver, moving downstream.
6 April 1993	Yanayacu Grande, 100 in from the Samiria confluence	Large, at edge of flooded forest, headed downstream.
9 April 1993	Rio Samiria, at entrance to Pasto Cocha	Moving from sidestream into main river (seen by crew of riverboat).
6 July 1993	Tipishca de Samiria	Head and part of back seen; animal "dropped" straight down and did not reappear during 22 min of quiet watching.
23 July 1993	Rio Samiria(4°57'S, 74°31'W)	Large, resting at surface downstream of tree snag; startled, dived.
30 May 1994	Rio Inglés(English River)	After 1 hr silent watching, a brown muzzle was seen (see text).
18 Nov. 1994	Rio Alfaro, a Pacaya sidestream	Near where the river had been blocked by floating vegetation for the last 8 yr.
25 March 1995	Rio Samiria (5°03'S, 74°32'W), 2 km downriver of Ungurahui guard station	Two animals drifting in current during heavy rain.
27 March 1995	Rio Ungurahui, a Samiria sidestream	One, possibly 2, animals surfaced through floating vegetation, muzzle and back seen.

## Manatee Distribution

Husar (1977) stated that the Amazonian manatee had been recorded in Peru from the Napo, Tigre Marañón (upstream to the Pastaza junction), Samiria, Pacaya, Ucayali, Huallaga, and Purus drainages. Her main source was Grimwood's (1969) monograph. Reference to the species presence in the Rio Purus and the blackwater lakes between the Purus and Madeira systems, however, was based on a personal communication from Diana Magor, who studied manatees in the 'Central Amazon' during the mid 1970s (see Magor *et al.*, 1977). Inclusion of the Rio Tigre in Husar's list apparently was based on an unpublished document circulated by the International Union for the Conservation of Nature, which she had not seen. We have no direct evidence that manatees inhabit the Tigre, and we doubt that the mainstem of this large clearwater river would offer much suitable manatee habitat, although its blackwater tributaries and associated lakes may. Pulido (1991) seems to have simply repeated Husar's (1977) general description of the species' distribution in Peru. Mármol (1995) listed the Pastaza, Nanay, Orosa, Yavari, Yaguas, and Putumayo as additional river systems where manatees occur in Peru. In the Ucayali system, manatees recently were reported to be present in the Bajo Puinahua (at Manco Cápac; and Urarinas) and at Iricahua (Anonymous, 1993).

Our observations confirm that manatees are still present in the Samiria, Yanayacu Grande, Pacaya,

and Tapiche systems. They also have been reported from various other blackwater affluents of the Marañón and Amazon during the past decade. According to local hunters, manatees are present and hunted in Tipishca de Chambira and the Rio Chambira (interviews, 25-27 July 1994) and in Me Yanayacu branch of the Yanayacu-Pucate (Anonymous, 1993). The skull of a small manatee killed in the Nauta Caño in March 1993 was offered to us for sale at Nauta in April that year, and another manatee was maintained alive in a small quarry pond at Nauta for several months in 1991. Fishermen report seeing manatees in the Nauta Caño occasionally. A small manatee was taken in a fishing net in Maringo Cocha, a small Yarapa tributary, in 1989 or 1990 (Paul Beaver, pas. comm., 31 July 1993), and a sighting reportedly was made in the Yarapa during the high water season of 1991 (José Luis Valles P., pers. comm., 31 July 1993). A manatee was said to have been killed in a gillnet in the San Juan de Yanayacu sometime in 1993 (Fernando Ahuanari Caño, pers. comm., July 1994). Manatees apparently are present in the Tamshiyacu-Tahuayo Communal Reserve, bounded by the rivers Tamshiyacu, Tahuayo, and Yavari Mid (Bodmer, 1994).

Two small manatees were being held alive in a pool near the Rio Atacuari, along the Peru-Colombia border, during 1991-92. These animals were shown regularly to riverboat tourists (Alfredo Chávez, pers. comm., June 1994). A live newborn manatee (70 cm total length; unhealed umbilicus) was confiscated by authorities in Iquitos on 8 May 1995. The fisherman who was trying to sell the animal claimed that it had been caught in a fishing net in Quebrada Yanashi, an Amazon affluent approximately 80 km downriver from Iquitos. Efforts organized by Henningsen and Reeves to feed and care for the infant were unsuccessful, and it died in late May.

## Discussion

### ***Relative Abundance and Problems of Detection***

Mármol (1995) estimated that a few thousand manatees survive in Peru, but it is impossible, on the evidence presently available, to make a rigorous estimate for any area. The animals are simply too cryptic and inaccessible (Rosas, 1994).

Most of our observations of manatees were in the mainstems of narrow, slow-flowing rivers, but the most favorable habitats for manatee foraging are probably lakes, oxbows, and lagoons (Husar, 1977). Because our main searching effort was directed at dolphins, rather than manatees, we spent less time in the placid, heavily vegetated areas preferred by manatees. This may help explain our paucity of sightings.

Husar (1977) cited 14 minutes as the longest documented submergence for an Amazonian manatee in captivity. Captive Amazonian manatees were observed to make long dives (up to 10 min duration) followed by series of short dives (Gallivan and Best, 1980). A manatee hunter in Ecuador told Timm *et al.* (1986) that, in his experience, manatees came to the surface roughly every 40 minutes. Particularly if they occur in low densities, manatees would probably remain unnoticed by all but very quiet, patient observers. On the one occasion in the present study when a dedicated watch, under ideal conditions, resulted in a sighting (30 May 1994), the manatee's secretive behavior was evident: it simply raised its nostrils above the surface, respired and sank vertically, leaving a scarcely perceptible ripple.

Best (1983) referred to the floating feces of manatees as indicative of the animals' presence in a large Brazilian lake. Other authors have claimed that feces and the disturbance of vegetation caused by feeding activities make Amazonian manatees relatively easy to detect (Timm *et al.*, 1986; Pulido, 1991; Dunstone, 1993). Although we often searched for feces and browsed plant material, especially in areas with little current but abundant vegetation, we found no such evidence.

Hunters in the settled areas near the mouth of the Rio Samiria consistently reported that manatees were not as abundant in Tipishca de Samiria as in areas deeper inside the Reserve. We suspect that there is sufficient hunting, trapping and fishing activity in this lake to ensure that most manatees entering it are killed. The observation by Neville *et al.* (1976) that the middle Samiria was the biologically richest segment of the river system, particularly in terms of diversity and abundance of primates, seems to hold true for manatee abundance as well.

### **Habitat Condition**

Before the Reserve was officially recognized in 1972, human settlement was more extensive than it is today (COREPASA, 1986). Now only a few areas have permanent settlements. These include the shoreline of Tipishca de Samiria, the banks of the Samiria downstream of the mouth of Tipishca de Samiria, the small vestigial settlement at Hamburgo, and the active guard stations. The Samiria River system, as a whole, is relatively unaffected by development. There is no large-scale agriculture, timber extraction, or commercial fishing; nor have any dams been constructed. Little evidence remains of the seismographic and other activities related to oil exploration discussed by Neville *et al.* (1976; also see COREPASA, 1986). Oil from the only producing well, far up the Yanayacu Grande, is transported by pipeline to refineries in western Peru. Most of the traffic in the rivers and lakes consists of dugout canoes propelled by hand. The danger of collisions and noise disturbance comes mainly from the powered vessels that are brought to the area occasionally by tour groups or oil and gas companies. From a manatee perspective, habitat throughout most of the Reserve is unspoiled; it provides a generous food base and an enormous interconnected network of waterways. If large, slow-flowing blackwater systems with deep connections to big rivers and abundant macrophytes represent key habitat requirements for Amazonian manatees (Timm *et al.*, 1986) then the Samiria portion of the Reserve is a potentially ideal manatee sanctuary. The Nauta Caño and Chambira systems also provide large amounts of similarly unspoiled manatee habitat.

In contrast, the lower RRo Yarapa has been relatively intensively developed through both slash-and-burn agriculture and tourism. During the short period of five years that we worked in the area, obvious changes occurred. Powered vessels became increasingly common, and the forest was cleared for cultivation and settlement in many new places. The villages were expanding, and large families lived in stilted houses along the river and its lakes. In view of the rapid proliferation of human activity in the lower Yarapa, it is not surprising that manatees are essentially extirpated there.

### **Conservation Prospects**

Unlike in the Cuyabeno region of Ecuador, where the local Siona were said to practice a self-imposed ban on manatee hunting... because of low manatee populations (Timm *et al.*, 1986), there does not

appear to be any cultural check on manatee exploitation in Peru. The animals apparently are hunted and trapped wherever they are available.

It was discouraging to discover that some of the people occupying guard stations in the Reserve, and nominally functioning as self-deputized rangers, avidly hunted manatees. In fact, access to game in remote areas was seen as a benefit that came with being a guard. As others have noted (Neville *et al.*, 1976), the initial siting of guard posts in the Reserve was influenced by the proximity of good areas for netting paiche (and presumably also manatees). During the political upheaval and economic recession of the early 1990s in Peru, hunting opportunities were often the only form of salary provided to guards. The stations at Tacshacocho and Ungurahui were abandoned for long periods.

It is unrealistic to expect manatees to survive in Peru, or to recover from depletion there, as long as protective laws remain unenforced and human populations in rural areas continue to grow and expand. To date, the core of the Reserve has functioned as a reservoir that supplies fish and game to peripheral areas, where harvesting is intensive.

Many biologists have been disabused of the idea the biodiversity can be preserved, in the strictest sense, while at the same time humans reap economic benefits from the rain West (e.g. see Redford and Sanderson, 1992; Robinson, 1993). Entrepreneurs and politicians nevertheless continue to trumpet the desirability and feasibility of attaining economic development without having to sacrifice biotic diversity and the integrity of ecosystems. The rhetoric of sustainable use is easy to formulate and promote. It is much more difficult to develop and apply concrete measures that ensure the sustainability of resource use. While it may not be possible to construct an argument that the Amazonian manatee is a keystone species, its fertilization effect on phytoplankton production could be quite important, particularly in lentic or lacustrine systems (Best, 1984). The ecological impact of extirpating manatees in a given area is probably not measurable, but their serious depletion or removal undoubtedly brings costs to the environment as a whole, quite apart from loss to rural people of a valuable source of protein.

If manatee exploitation in the Pacaya-Samiria Reserve is to be managed, with the goal of sustainable use, both scientific and political feasibility need to be considered. Even if an appropriate survey of these cryptic animals in their labyrinthine, often inaccessible habitat could be designed and financed on a one-time basis, problems would remain in monitoring the population through time to detect trends, or alternatively estimating sustainable yield. The relatively straightforward task of documenting the catch would require an efficient self-reporting scheme or a logistically daunting patrol network. However formidable the scientific challenges would be, the need would remain for a functioning management regime to regulate the take. This would require both a political will and a suitable infrastructure, neither of which currently exists.

It is difficult to be optimistic about the future of manatees in Peru. Expanding human populations create an ever-growing demand for meat, and manatees will continue to be caught by fishermen and hunters whose most compelling immediate concern is to feed their families. Economic development, including tourism, will continue to bring noise, chemical pollution, indiscriminate fishing methods, motorboats, and artificial changes to the water regime. Without a commitment by governments to maintain reserves as reserves and parks as parks, and a concomitant willingness on the part of local residents to accept legitimate regulations of their activities, the few remaining pockets of manatee abundance in Peru will become depleted and the species will be exterminated from more and more areas

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