FISHES OF THREE BOLIVIAN RIVERS: DIVERSITY, DISTRIBUTION AND CONSERVATION

BARRY CHERNOFF, ANTONIO MACHADO-ALLISON, PHIL WILLINK, JAIME SARMIENTO, SORAYA BARRERA, NAERCIO MENEZES and HERNAN ORTEGA

The forested lowlands of most Amazonian tributaries remain poorly explored. Lists of freshwater fishes do not exist for more than one or two of the major arms of the Amazon, a feature that was prominently absent from an otherwise remarkable work on the fishes and fisheries of the Rio Madeira (Goulding, 1981). In Bolivia there have been attempts to bring together information for Amazonian streams (e.g., Lauzanne *et al*., 1991). More recently, a well documented fauna from the Rio Gaupore/Itenez was provided by Sarmiento (1998).

Lauzanne *et al.* (1991) recorded 389 species of freshwater fishes from the Bolivian Amazon to which Sarmiento (1998) added an additional 21 species bringing the total to 410 species. This work reports upon the ichthyological results of the first AquaRAP carried out in a relatively small area of the upper Rio Orthon. Two teams of ichthyologists surveyed aquatic habitats in the rivers Tahuamanu and Manuripi and their tributaries over 17 days in 1996. Amazingly, 313 species of fishes were recorded. This value includes a spectacular number of new records for Bolivia and several species new to science, including a new piranha, genus *Serrasalmus*.

The purpose of this contribution is to: (i) make known the general ichthyological results, including a breakdown by sub-basin; (ii) compare the diversity with those of other South American regions and discuss any distributional aspects of the data; (iii) discuss the economic and conservation importance of the results (iv) consider threats to the species richness; and (v) to propose recommendations for conservation.

Methods

Two teams, three-four persons each, made collections between 4 and 21 September, 1996. The teams were usually isolated and worked in different tracts of the Upper Rio Tahuamanu for the first five days. Eighty-five collection stations were established, each receiving a unique, sequential field number. The field stations were enumerated separately for each group, identified as P1 and P2. At each station, longitude and latitudes were registered from hand held GPS units.

At each field station a number of ecological variables corresponding to a description of the habitat were recorded. These included the shore, substrate, type of habitat (e.g., river, lake, flooded area, etc.) as well as the water type. The classification of water type (black, white, turbid) was checked with the results obtained by the limnology group.

Fishes were collected using a variety of nets and netting techniques. Each group was equipped with seines (5m x 2m x 1.25cm, 5m x 2m x .63cm, 1.3m x .7m x .37cm), dip nets and experimental gill nets (40m x 2m, monofilament, with five 8m panels, mesh size from 1.25cm to 6.25cm). Team 2 pulled an otter trawl (mouth 3m wide) with two 15kg doors where the depth of the water was >2m over sandy or muddy stretches in a manner modified from that described by Lopez-Rojas *et al.* (1984). Additionally, one of the river pilots threw a 2m cast net in some deeper lakes or cochas.

Fishes were preserved in buffered 10% formalin solution. All specimens captured at the same place and time were maintained separately from all other collected specimens. Larger specimens were tagged individually using fine wire and punched cardboard tags and either placed in large liquidpacks containing formalin with other specimens or were skeletonized, soaked in 40% isopropanol and dried. All material was wrapped and shipped to Chicago for sorting, identification and enumeration in the Division of Fishes, Department of Zoology, Field Museum of Natural History (FMNH). Fifty percent of the specimens are housed in the Museum of Natural History, La Paz, Bolivia; the remaining specimens were shared among the partici-

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Barry Chernoff **and** Phil Willink**: Field Museum of Natural History, 1400 Lake Shore Dr. Chicago, Illinois 60605-2496, USA. e-mail: chernoff@fmnh.org**
Antonio Machado-Allison**: Laboratorio de Ictiología, Instituto de Zoología Tropical, Universidad Central de Venezuela, Caracas, Venezuela and Field Museum of Natural History. e-mail: amachado@strix.ciens.ucv.ve**
Jaime Sarmiento **and** Soraya Barrera**: Museo Nacional de Historia Natural, La Paz, Bolivia.**
Naercio Menezes**: Museu de Zoologia, Universidade de São Paulo, São Paulo, Brasil.**
Hernan Ortega**: Museo de Historia Natural (UNMSM), Lima, Perú.**

pating institutions: FMNH; Museu Zoologia do Universidade do São Paulo, Brazil; Museo de Historia Natural San Marcos, Perú and Museo de Biología de la Universidad Central de Venezuela. The identifications were made in a careful but relatively rapid fashion. General works such as Eigenmann and Myers (1929) or Gery (1977) were used but preference was always given to systematic revisions (e.g., Vari, 1992; Mago-Leccia, 1994) and recent species descriptions (Stewart, 1985) if available. In many cases specimens were compared to types or historic material referenced in the literature and housed at FMNH. However, some identification to the level of species or even genus was not possible. To do so would represent a less than scholarly approach to the taxonomy. Instead we rely upon morphospecies – the number of distinguishable entities present in our samples. This bears the assumption that such discernable entities or morphospecies are putative taxonomic entities (i.e., species). We were careful to check for sexual and ontogenetic differences. All specimens were examined critically and identified to their lowest taxonomic level (Table I).

Another issue inheres in the appropriate selection of taxa across lists in order to judge new additional or new records. We chose a conservative approach and did not include all of the taxa that we had collected. We eliminated from comparison about 5% of those taxa whose identifications were ambiguous or unknown in our list and in published lists. So for example, if *Hemigrammus* sp. or *H.* sp. 1 occurred in both lists, it was not counted as a similarity or a difference because there is no way to ascertain that the taxonomic designations represent the same biological entity. However, *Gephyrocharax* sp. occurs in our list but only *G. chapare* is reported by either Lauzanne *et al*. (1991) or Sarmiento (1998). In this case we count the *G.* sp. as a new record because we compared our material to *G. chapare* and it is different. The possible error in this latter case is identical to the possible errors in a list containing misidentified species bearing specific epithets or not.

Collecting Stations

Eighty-five collections were taken in the Tahuamanu and Manuripi river basins from the on the border with Perú downstream to Puerto Rico (Figures 1 and 2). The entire region was divided into the following five subregions based on habitat diversity: Upper, Middle and Lower Tahuamanu, Upper and Lower Nareuda, and the Manuripi.

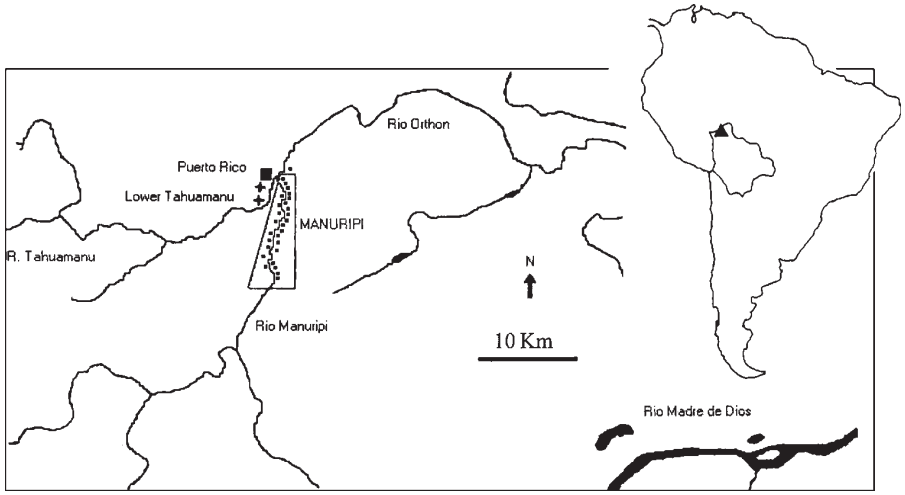

Figure 1. General Map of the Rio Orthon Basin, showing the Collecting Stations on the Manuripi (□) and Lower Tahuamanu (+) rivers (11º8-10'S to 67º33'W)

The Rio Nareuda is a major tributary of the Rio Tahuamanu.

The gear effort used to make the 85 field stations, were as follows: seine = 73; trawl = 6; gill net = 5; cast net = 2. This adds up to 86 because one station P2-04 included both gill net and seine collections. The gill nets were usually set for several days. Because no striking differences were noted for day and night samples within the gill nets, they were recorded as single stations.

Due to low water conditions during the time of the field sampling, motors had only limited use in the Upper Tahuamanu and could not be used in the Rio Nareuda except for in the vicinity of its confluence with the Rio Tahuamanu. During the first portion of the expedition team 1 worked in the Upper Tahuamanu and also in the lower end of the Rio Muymanu whereas team 2 collected in the Upper Nareuda as well as in a number of small streams (*garapés*) that drained independently into the Tahuamanu. The Upper Tahuamanu and the Upper Nareuda systems as well as their tributaries were surrounded by terra firme.

For the middle portion of the expedition, both teams were camped together but team 1 focused upon the Lower Nareuda down to its mouth in the Rio Tahuamanu. Team 2 collected upstream and downstream from this confluence to just below the village of Filadelfia; this region is referred to as Middle Tahuamanu. Conditions in the Middle Tahuamanu were such that trawling was accomplished successfully.

For the last period both teams camped on the Rio Manuripi upstream from Puerto Rico. Though both groups worked independently, they covered the same territory in the Rio Manuripi as well as in the Lower Tahuamanu, just above its mouth in the Rio Manuripi. River conditions permitted trawling.

Results and Discussion

Diversity and distribution: General

The species richness of fishes was spectacular. A total of 313 species were captured and identified. Because an additional 5% that could not be identified unambiguously were discarded from further evaluation, the actual number of species in the entire region is even greater. The fishes (Table I) included members of all trophic or activity groups, ornamentals (e.g., *Abramites hypselonotus*), food fishes (e.g., *Pseudoplatystoma fasciatum*), as well as miniatures (*Scoloplax* cf. *dicra*, <20 mm SL) and large fishes (e.g., *Prochilodus* cf. *nigricans*, *Doras* cf. *carinatus*, >200 mm SL).

Together Lauzanne *et al*. (1991) and Sarmiento (1998) record 410 species from all rivers within the Bolivian Amazon. The 313 species of fishes, therefore, represents a fauna greater than 76% of the number of species previously reported from all other Amazonian tributaries within Bolivia. The number of fishes discovered in a relatively small section of the Tahuamanu and Manuripi rivers is more than three times that reported for the entire Beni-Madre de Dios basin (n=101, Lauzanne *et al*., 1991), more than 1.3 times that reported for the Río Guaporé/Itenez (n=246, Sarmiento *et al*., 1998) and almost equal to (96%) that found over the entire Río Mamoré basin (n=327, Lauzanne *et al*., 1991). Furthermore, Santos *et al*. (1984) reported 300 species from the lower Río Tocantins of Brazil;

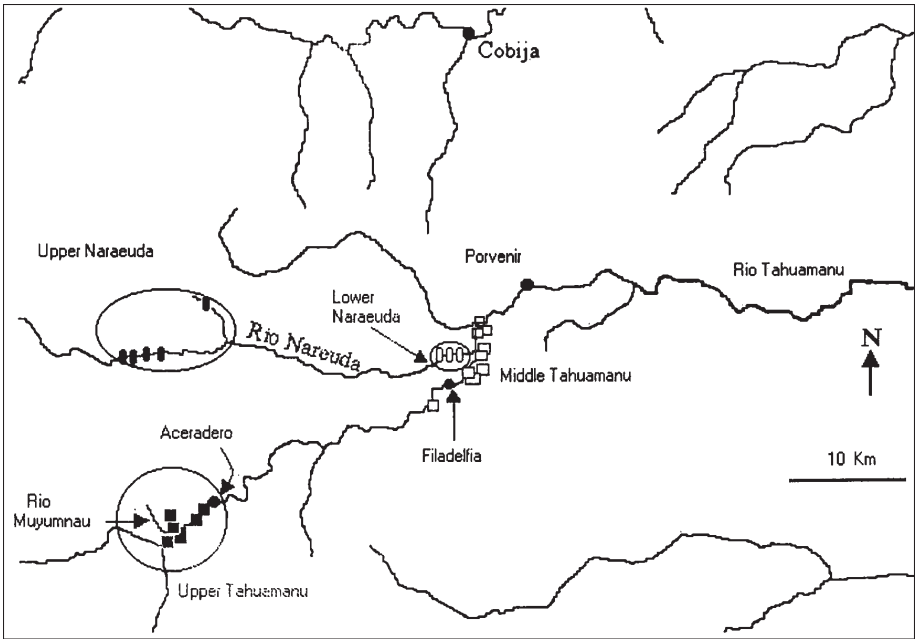

Figure 2. General Map of the Tahuamanu River Basin, showing the Collecting Stations on the Upper Nereuda (⧫), Lower Nereuda (◊), Upper Tahuamanu (■) and Middle Tahuamanu (□) (11°18-25'S to 68°45'-69°02'W)

Stewart *et al*. (1987) reported 473 species in the Napo River Basin of Ecuador; Goulding *et al*. (1988) reported 450+ species from the Río Negro Basin of Brazil and Machado-Allison *et al.* (2000) listed 136 species from the Río Cuyuní basin in Venezuela. In each of these latter cases, the areas surveyed exceed vastly that of the Tahuamanu-Manuripi region sampled in the rapid assessment.

It is important to consider that the number of species reported for both the Guapore/Itenez and Mamoré drainages included headwater habitats that usually contain fishes with restricted distributions. Even in the Upper Tahuamanu and Upper Nareuda, there were few habitats, perhaps the two *garapés*, that could correspond to headwater-like conditions.

Because of the paucity of knowledge concerning the distributions of the freshwater fishes of South America, it is difficult to state with any certainty the degree of endemism represented in samples from the upper Río Orthon. However, we have apparently uncovered not only a region with exceptional species richness but a region with an exceptional number of new records for Bolivia (Table I). Using the conservative approach discussed above, we document 91 species not previously recorded from Bolivia. Of the 91, 45 species include taxa with some questions associated with their exact name as well as include a number of new species (e.g., the new characid, *Hysteronotus* sp. 1). The newly documented fauna increases the total number of species inhabiting the Bolivian Amazon by ca. 22% to 501 and increases the total for all of Bolivia (using the previous total in Sarmiento, 1998) 16% to 641 species.

The significance of the Tahuamanu and Manuripi rivers for the Bolivian ichthyofauna is now clear. This limited region contains 62.5% of all fish species known from the Bolivian Amazon and 48.8% of all fishes known from Bolivia. Furthermore, the 91 species found in the Tahuamanu and Manuripi rivers that are not yet known elsewhere in Bolivia represent within-country "endemism" values of 18% and 14% relative to the ichthyofaunas for the Bolivian Amazon and Bolivia, respectively.

Based upon the relatively sparse information published for the ichthyofauna of Bolivia, of regions with more than 50 species, only Lake Titicaca has a higher within-country "endemism" percentage. No other region within Bolivia is currently known to contain as high a percent of the Amazonian or total country fauna. The impressive values reported for the Río Guapore/ Itenez basin within the Parque Nacional Noel Kempff reported upon by Sarmiento (1998) must now be adjusted downwards due to the new species totals. The adjusted values are well below those of the Tahuamanu and Manuripi rivers.

Potentially, the impressive nature of the Tahuamanu-Manuripi ichthyofauna could be tempered if, in fact, it was representative of a more widespread fauna within Bolivia. The most obvious possibility is that we used trawls to sample the bottom communities for the first time within Bolivian freshwaters. If the 91 novel records were largely due to trawl samples then the lists would not really be comparable. That is, we might expect to find similar bottom communities in other regions; the uniqueness of the Tahuamanu-Manuripi region would diminish even though its overall diversity would remain exceptional. However, this scenario did not obtain. The trawls captured 53 species (17% of the total) but only 15 species were captured in trawls exclusively. Of these, 10 were new records for Bolivia (Table I). Thus, 81 of the 91 species newly reported for Bolivia were captured by traditional means used commonly in ichthyological sampling.

We have no doubt that more careful sampling as exemplified in the Guapore/Itenez by Sarmiento (1998) and in the Tahuamanu-Manuripi by the AquaRAP team will lead to increasing the number of taxa found within Bolivia and will increase knowledge of the distribution patterns of the fishes. Nonetheless, it seems unlikely that the unique character of the Tahuamanu-Manuripi fauna will loose its uniqueness.

In fact with continued sampling, the ichthyofauna of the Tahuamanu-Manuripi region will continue to rise and the number of species new to Bolivia will be expected to increase. We base this assumption upon the species accumulation curves (Figure 3). The rate of accumulation of species new to the expedition had not diminished; the graph (Figure 3) displays no asymptote. During the last six days, even with both groups working the same region of the Manuripi, we increased the known fauna by 63 species. Species were being added at a rate of 10.5 species per day.

The total capture and accumulation rates were remarkably similar for each of the two collecting teams (Figure 3). Each group captured more than 200 species that were often complementary. By the end of the sampling period, the species collected by the groups differed as much as 50% which maintained the steep slope of the total accumulation curve. These data are evident in the differences of species captured by the two teams when they were both sampling in the Río Manuripi. The teams captured a total of 220 species in the Río Manuripi. Individually they netted 179 and 169 species based upon 17 and 18 collections, respectively. However, only 128 species were common to both sets of col-

lections, from which Simpson´s Index of Similarity is 75.7%. Thus, the additional effort increased the collected fauna by 62 species, or by 28.2%

Analyses of these data argue strongly that continued collecting will increase the size of the fauna known from the Tahuamanu-Manuripi region. Because the species that represent new records for Bolivia comprise more than 29% of all species captured, we expect that continued collecting will continue to uncover new records for the country as well. These data continue to exemplify that the Upper Orthon Basin is extremely diverse and may prove more diverse than even the Rio Mamore basin, which has received vastly more collecting effort.

The biogeographic relationships of the Tahuamanu-Manuripi region are difficult to ascertain, again because of how little that we know in general. There does seem to be a mix of taxa representing three distinct distributional elements. The first comprises widespread amazonian lowland species from the north and the east of the Madeira basin: e.g., *Serrasalmus rhombeus*, *Schizodon fasciatum*, *Anodus elongatus*, *Microschemobrycon geisleri*, *Cetopsorhamdia fantasia*, *Pimelodus* cf. *altipinnis*, *Tatia altae*, *Electrophorus electricus*, and *Rhabdolichops caviceps.* The second incorporates species found almost exclusively in black waters of the Guapore/Itenez system that derive from the Brazilian Shield: e.g., *Hypopygus lepturus*, *Carnegiella strigata*, *Aphyocharax alburnus*, *Hemigrammus* cf. *unilineatus*, *Pyrrhulina australe*, *Nannostomus trifasciatus*, *Potamorrhina latior*, *Tatia aulopygia*, *Corydoras hastatus*, *Cichla monoculus*, and *Aequidens* cf. *tetramerus.* The third describes those species in the small *garapés* that are most head-water like habitats: e.g., *Hysteronotus* sp., *Brachychalcinus copei*, *Bryconamericus* cf. *caucana*, *Creagrutus* sp., *Cyphocharax spiluropsis*, *Piabucus melanostomus*, *Tyttocharax tambopatensis*, *Corydoras trilineatus*, *Imparfinis stictonotus*, and *Otocinclus mariae*.

The discussions above show the nature of the uniqueness of the ichthyofauna of the Tahuamanu-Manuripi river basins. A relatively small region contains 62.5% of all the freshwater species known from the Bolivian Amazon. The fauna comprises 91 species that have never been recorded from Bolivia – a feature which does not seem to be an artifact of sampling or collecting methods. The region seems to contain an assemblage of fishes that may uniquely combine widespread Amazonian species, with blackwater Brazilian shield species in addition to head water species. Because we never reached the asymptote of the species accumulation curve, the number of species represented in this region is predictably larger than we can document at present. Furthermore, because the number of new records comprises 29% of the fauna of this region, it is reasonable to expect new records as well.

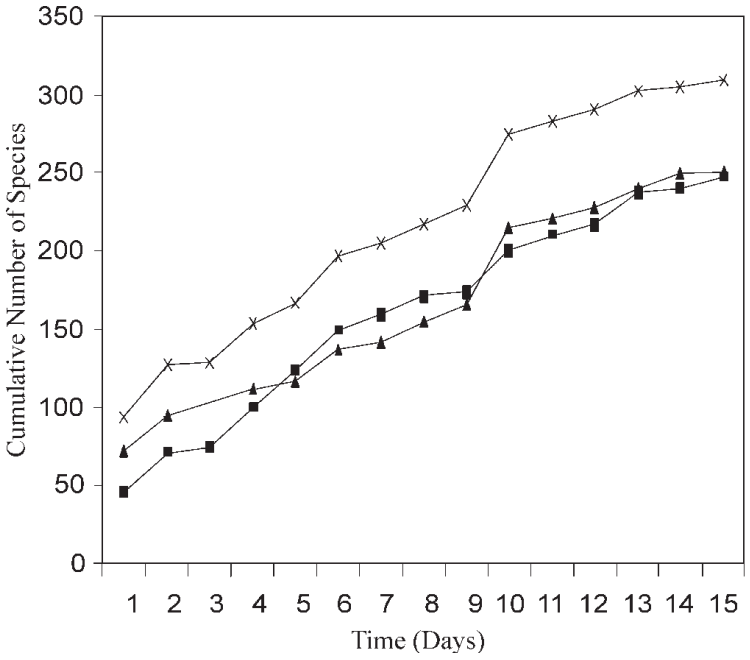

Figure 3. Species accumulation curves for fishes collected in the rios Tahuamanu, Nareuda, and Manuripi, Pando, Bolivia, 4-21 September, 1996.
Symbols: Group 1 (squares), Group 2 (triangles), and combined (X).

All of this leads to the conclusion that within Bolivia, the upper Rio Orthon basin must be considered as a potential hot spot for the species richness of freshwater fishes. Conservation efforts are needed to preserve the unique character of this fish fauna. At a secondary level, more field studies are needed to finish documenting the ichthyofauna of this amazing region.

Economic importance

Many of the fishes found in the Upper Rio Orthon basin are valuable as commercial resources for food and for the ornamental fish industry. We present a short discussion in order to stimulate immediate research both into the potential of these resources to provide an economic alternative to other activities that damage the environmental character of the region.

During the AquaRAP we employed local fishermen who were subsistence fishermen throughout the year and who fished commercially during the seasonal migrations. We also witnessed truck-side fish sales in Cobija and in Filadelfia and saw the following species for sale: *Pygocentrus nattereri*, *Pseudoplatystoma fasciatum*, *Prochilodus nigricans*, *Curimata* spp., *Hydrolycus pectoralis*, *Plagioscion squamosissimus*, *Mylossoma duriventre*, and *Myleus* sp. We were told by the fishermen that the fishes of highest commercial value were the tiger catfish, *Pseudoplatystoma*, and the serrasalmines including both the piranhas and the pacus. In our samples, we caught many other species that are either consumed for subsistence or caught for sales according to our guides. That list included the following: *Anodus elongatus*, *Cichla* cf. *monoculus*, *Cochliodon* cf. *cochliodon*, *Crenicichla* spp., *Duopalatinus* sp., *Hemisorubim platyrynchos*, *Hoplias malabaricus*, *Hoplosternum thoracatum*, *Hypostomus* spp., *Leiarius marmoratus*, *Leporinus* spp., *Myleus* sp., *Pimelodus* spp., *Pristobrycon* sp., *Rhamdia* sp., *Schizodon fasciatum*, *Sorubim lima*, and *Triportheus angulatus*. In that list the "spp." refers to a number of species within the genus that are eaten. Interestingly, the following armored catfishes are consumed in the Río Madeira basin of Brazil (Goulding, 1981) but were rejected as a source of food by our fishermen: *Doras* cf. *carinatus*, *Pseudodoras niger*, and *Liposarcus disjunctivus*.

Our discussions with local fishermen including others in Puerto Rico indicated that the commercial food fisheries are burgeoning in the Tahuamanu and Manuripi rivers. It was not

possible to obtain from our fishermen or from the truck-side sellers the annual totals for weight or value of the catch. However, the notion of increasing annual landings would not seem to make sense relative to the local populations that we encountered and interviewed for two reasons: i) the population of Pando while increasing is doing so slowly; and ii) the Bolivian residents have largely settled the region from cattle rearing areas or from La Paz and do not have strong traditions of fish consumption. Most of their demand is for premium species, tiger catfishes and pacus, species that are delicate in flavor. Apparently, much of the catch is exported across the border to Brazil and this exportation appears to be unregulated. Sarmiento (1998) also noted a similar pattern of unregulated exportation of several tons per month with a slightly increasing demand from populations living along the Río Itenez.

Peres and Terbourgh (1995), Goulding (1980, 1981) and Goulding *et al*. (1988) document not only the importance of rivers in structuring human settlements throughout Amazonia but also the increasing dependence of humans on aquatic resources for sustenance. At this time we cannot document the size of species specific harvests that are sustainable for the future. There is no accurate data on the nature of fish migration into the Tauhuamanu-Manuripi region. Many of the commercially important species such as the curimatids and prochilodontids move out of tributaries and forest habitats into the main rivers to spawn at the beginning of the flooding cycle (Goulding, 1981). While many of the larger catfishes migrate upstream to spawn and apparently ascend the cataracts in the upper Madeira into Bolivian waters (Goulding, 1981). The only relevant data that we collected was that the abundance of the most favored species was relatively low (see Machado-Allison *et al*. 1999, on the abundance and distribution). Even though it was the dry season and at relatively low water, there were still many suitable habitats for these species. The gill net samples did not yield the quantity of individuals for the commercially important species that would indicate bountiful populations, even though our fishermen guided us to their favorite areas (with monetary exchange for the catch). In our experience from similar habitats in other regions of the Amazon and Orinoco river basins where fish populations are apparently healthy, the commercially important species are reasonably well represented in gill net samples even in the dry seasons. We only suggest caution. And we recommend that the stocks must be surveyed immediately both within the Upper Río Orthon as well as downstream toward the Río Madeira. Statements such as that by Walters *et al*. (1982) advocating across the board increase in fisheries are premature in advance of the data on native stocks.

Economic potential also exists for the establishment of a harvest-based ornamental fishery. The extreme number of species, the number of cochas and inundated flooded habitats makes the Tahuamanu-Manuripi regions especially attractive. These habitats are easily collected while serving as natural critical rearing habitats for ornamental fishes. The ornamental fishes ranged from the common (e.g., *Moenhausia sanctofilamenae*, *Hemigrammus ocellifer*) to ornamentals that are more highly prized, including the folowing: *Astronotus crassipinnis, Apistogramma* spp., *Aequidens* spp., *Satanoperca* cf. *acuticeps*, *Eigenmannia* spp., *Apteronotus albifrons, Gymnotus carapo, Hypopygus lepturus, Heptapterus longior, Imparfinis stictonotus, Microglanis* sp., *Brachyramdia martae, Chirocerus eques, Scoloplax* cf. *dicra, Peckoltia arenaria, Parotocinclus* sp., *Otocinclus mariae, Hypostomus* spp., *Ancistrus* spp., *Agamyxis pectinifrons, Acanthodoras cataphractus, Brochis splendens, Corydoras* spp., *Bunocephalus* spp., *Dysichthys* spp., *Nannostomus trifasciatus, Pyrrhulina* spp., *Carnegiella* spp., *Tyttocharax* spp., *Poptella compressa, Phenacogaster* spp., *Prionobrama filagera, Metynnis luna, Paragoniates alburnus, Iguanodectes spilurus, Hemigrammus* spp., *Hyphessobrycon* spp. *Hysteronotus* spp., *Aphyocharax* spp., and *Leporinus* spp. The most important areas within the region surveyed for the ornamental fishes are the Upper Río Nareuda and the Río Manuripi (Machado-Allison *et al*., 1999). In some cases, trapped interior flooded forest lakes can be harvested entirely because these ephemeral environments either dry out completely or become anoxic. However, in the more permanent habitats the reproductive and population biologies of the ornamental fishes must be studied in order to support a sustainable enterprise.

Critical habitats

We identified a number of critical habitats that are required for continued survival of freshwater fishes and maintenance of the spectacular biodiversity. These are the same habitats that support the growth and reproduction of economically valuable species.

The habitats are described in detail in Machado-Allison *et al*., (1999). However, they fall into three main classes: i) flooded areas; ii) small tributaries; and iii) main channels. The flooded areas comprise the most critical and highly endangered areas, including the *varzea* (flooded forest), *cochas*, swamps, forest lakes, etc. These areas provide nursery grounds for perhaps 66% of the species that we captured (Goulding, 1980, 1981, Amazon; Lowe-McConnell, 1987 Amazon-Guianas; Machado-Allison, 1990, 1993 Orinoco). Furthermore, many species, including the pacus, feed on the fruits and nuts, including the Brazil nuts, dropped by the plants into the water (see Goulding, 1980, 1981, Machado-Allison, 1990, 1993). Goulding (1981) characterizes the Brazilian portion of the Rio Madeira as having a relatively narrow flood plane and margin. This is certainly true for the rivers Tahuamanu, Muymanu, Nareuda and Manuripi in the areas that we surveyed. Given such a narrow flood plain there is little buffer between logging and ranching activities and these critical flood zones. Extended development from Puerto Rico, Filadelfia and Aceradero threaten this flood plain zone.

In the Upper Tahuamanu and Upper Nareuda there were many smaller streams (*garapés*) and tributaries with both black and white water conditions. These smaller habitats are highly threatened by deforestation and cattle ranching. A number of the *garapés* crossing the main road and on cattle ranches are completely denuded of riparian vegetation. Furthermore, one team walked through dense forests into a number of forest streams and neither captured nor saw any fishes, crustaceans or aquatic insects in crystal clear water with sand bottoms. These streams were downstream from a ranch that was recently cleared and burned. We could only speculate that ashes which are toxic to aquatic organisms or pesticides poisoned these streams.

These upper areas are highly diverse. We captured 168 species in the Upper Tahuamanu and the Upper Nareuda; slightly more than half of all the species we discovered. Seventy-one species were found to inhabit both the Upper Tahuamanu and Upper Nareuda but 30 species were found only in these upper regions. These upper regions contain habitats that are similar to headwater areas with a unique and diverse fauna. These are among the most threatened habitats due to logging, deforestation and ranching.

The main river channels are not habitats that are usually focused upon. However, as pointed out above, the principal channels also contain a diverse

fauna with a number of unique or rare elements (e.g., *Cetopsorhamdia fantasia*). The Río Tahuamanu above Filadelfia contains a number of rocky outcrops, including some small rapids (*cachoeras*) and shallow regions with many downed logs. In the dry season the area near Aceradero was almost un-navigable because of the tree trunks and rapids. Such regions are prime candidates for spawning areas of the commercially important, large, pimelodid catfishes (e.g., *Pseudoplatystoma fasciatum, Leiarius marmoratus,* Barthem and Goulding, 1997). As development continues towards the Peruvian border pressure may be exerted on the river channelization to permit shipment of supplies or equipment up river.

Conclusions and Recommendations

The region of the Río Tahuamanu-Río Manuripi, upper Río Orthon basin, Pando, Bolivia is a potential hotspot for the diversity of freshwater fishes. A total of 313 species were discovered in the region of which 91 species represented new records for Bolivia. This region contains 62.5% of the fishes found in the Bolivian Amazon and 48.8% of the species found in the entire country. Based upon our analyses of the number of new records and the species accumulation curve (Figure 3), we predict that the number of fish species within this region will increase with continued sampling.

The region is further distinguished because the ichthyofauna comprises a unique assemblage of species. There are three distinct biogeographical elements as follows: i) widespread lowland Amazonian elements from the north and east; ii) Brazilian Shield elements from the Río Guapore/Itenez; and iii) headwater elements.

Because this region is a potential hotspot for freshwater fishes we are concerned that a plan be implemented to conserve this unique and valuable resource. The region should be managed in a sustainable way that will protect the biodiversity. We recommend that zones of critical habitats with varzea, *cochas*, main channels and upland areas should be created that will protect the biodiversity. Rather than the formation of a park, authorities may want to consider multiple use zones with some habitats restricted for modification. Because the region has a narrow floodplain, special care should be taken to minimize the impact on this important habitat. We recommend that development of a management plan include educational programs concerning the ecological relationships between the flora and fauna and the habitats that support their survival and life histories.

Protection of aquatic resources is critical not only from the standpoint of conserving biodiversity but also for protecting a critical resource for the people who live in the region. Many of the fishes are currently used for subsistence or commercial fishery and have a high value. The ornamental fishes also have a very high value.

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TABLE I
FISHES FROM THE BOLIVIAN AMAZONIAN REGION
(Explanation of localities and sources of information at end of table)

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Rajiformes					
Potamotrygonidae					
Potamotrygon cf. *hystrix*	-	-	✓	-	-
Potamotrygon motoro	✓	-	-	-	-
Potamotrygon cf. *motoro*	-	-	✓	✓	✓
Potamotrygon sp.	-	-	✓	-	✓
Potamotrygonidae sp.	-	-	✓	-	✓
Lepidosireniformes					
Lepidosirenidae					
Lepidosiren paradoxa	-	✓	✓	-	-
Clupeiformes					
Clupeidae					
Pellona castelnaeana	-	-	✓	✓	✓
Pellona flavipinnis	-	-	✓	✓	✓
Engraulidae					
Anchoviella cf. *carrikeri* **	✓	-	-	-	-
Engraulidae sp. 1	-	-	✓	-	✓
Engraulidae sp. 2	-	-	✓	✓	-
Characiformes					
Anostomidae					
Abramites hypselonotus	✓	-	✓	-	-
Anostomus cf. *gracilis*	-	-	✓	-	✓
Anostomus cf. *plicatus*	-	-	✓	-	✓
Anostomus proximus	-	-	✓	-	✓
Anostomus taeniatus	-	-	✓	-	✓
Laemolyta sp. **	✓	-	-	-	-
Leporinus cf. *cylindriformis*	-	✓	-	-	-
Leporinus fasciatus	-	-	✓	-	✓
Leporinus cf. *fasciatus*	✓	-	-	-	-
Leporinus friderici	✓	-	✓	-	✓
Leporinus cf. *friderici*	-	✓	-	-	-
Leporinus cf. *nattereri* **	✓	-	-	-	-
Leporinus pearsoni	-	-	✓	✓	-
Leporinus striatus	-	-	✓	-	-
Leporinus trifasciatus	-	-	✓	✓	-
Leporinus sp. nov. (*amazonensis*)	-	-	✓	-	-
Rhytiodus argenteofuscus	-	-	✓	✓	✓
Rhytiodus lauzannei	-	-	✓	-	-
Rhytiodus microlepis	-	-	✓	-	✓
Schizodon fasciatum	✓	✓	✓	✓	✓
Characidae					
Acestrorhynchus altus	-	-	✓	-	✓
Acestrorhynchus falcatus	-	-	✓	✓	-
Acestrorhynchus falcirostris	-	-	✓	-	✓
Acestrorhynchus guianensis	-	-	✓	-	-
Acestrorhynchus heterolepis	-	-	✓	-	✓
Acestrorhynchus microlepis	-	-	✓	-	✓
Acestrorhynchus cf. *minimus*	-	-	✓	-	✓
Acestrorhynchus sp.	-	✓	-	-	-
Aphiodite cf. *grammica*	-	-	✓	✓	-
Aphyocharax alburnus	✓	✓	✓	✓	-
Aphyocharax dentatus	✓	-	✓	-	-
Aphyocharax paraguayensis	-	-	✓	-	-
Aphyocharax pusillus **	✓	-	-	-	-
Aphyocharax rathbuni	-	✓	-	-	-
Aphyocheirodon sp. nov.	-	-	✓	-	-
Astyanacinus cf. *moori*	-	-	✓	-	-
Astyanacinus multidens	-	-	✓	-	-
Astyanax abramis	-	-	✓	-	-
Astyanax cf. *abramis*	✓	-	-	-	-
Astyanax bimaculatus	-	-	✓	-	✓
Astyanax cf. *daguae*	-	-	✓	-	✓
Astyanax fasciatus	-	-	✓	-	-
Astyanax lineatus	-	-	✓	-	-
Astyanax cf. *mucronatus*	-	-	✓	-	-
Astyanax sp.	✓	-	-	-	-
Astyanax sp. 1	-	✓	-	-	-
Astyanax sp. 2	-	✓	-	-	-
Brachychalcinus copei	✓	-	✓	-	-
Brycon cephalus	-	-	✓	✓	✓
Brycon erythropterus	-	-	✓	-	-
Bryconacidnus ellisi	-	-	✓	-	-
Bryconamericus bolivianus	-	-	✓	-	-
Bryconamericus cf. *caucanus* **	✓	-	-	-	-
Bryconamericus cf. *pachacuti* **	✓	-	-	-	-
Bryconamericus cf. *peruanus*	✓	-	✓	-	-
Bryconamericus cf. *peruanus*	-	-	-	-	-
Bryconamericus sp.	✓	-	-	-	-
Bryconops cf. *alburnoides*	-	-	✓	-	✓
Bryconops cf. *caudomaculatus*	-	✓	-	-	-
Bryconops melanurus	-	✓	✓	-	✓
Bryconops sp.	-	✓	-	-	-
Catoprion mento	-	-	✓	-	✓
Chalceus erythrurus	-	-	✓	✓	-
Chalceus macrolepidotus	-	-	✓	-	✓
Characidium bolivianum	-	-	✓	-	-
Characidium cf. *fasciatum*	-	✓	-	-	-
Characidium sp. 1	✓	-	-	-	-
Characidium sp. 2	✓	-	-	-	-
Charax gibbosus	✓	✓	✓	-	✓
Cheirodon fugitiva **	✓	-	-	-	-
Cheirodon piaba	-	-	✓	-	-
Cheirodon sp. 1	✓	-	-	-	-
Cheirodon sp. 2	✓	-	-	-	-
Cheirodon spp.	-	✓	-	-	-
Cheirodon sp.	-	-	✓	-	-
Cheirodon stenodon	-	-	✓	✓	-
Cheirodontinae sp.	✓	-	-	-	-
Cheirodontinae sp.	-	✓	-	-	-
Cheirodontinae sp. 1	-	-	✓	-	-
Cheirodontinae sp. 2		-	✓	-	-
Cheirodontinae sp. (gr. *Aphyodite*)	-	✓	-	-	-
Clupeacharax anchoveoides	✓	✓	-	-	-
Colossoma macropomum	-	-	✓	✓	✓
Creagrutus beni	-	-	✓	-	-
Creagrutus sp. 1	✓	-	-	-	-
Creagrutus sp. 2	✓	-	-	-	-
Creagrutus sp. 3	✓	-	-	-	-
Ctenobrycon spilurus	✓	✓	✓	✓	✓
Cynopotamus amazonus	-	-	✓	-	-
Cynopotamus gouldingi **	✓	-	-	-	-
Engraulisoma taeniatum **	✓	-	-	-	-
Eucynopotamus biserialis **	✓	-	-	-	-
Eucynopotamus sp. 1	-	-	✓	-	-
Eucynopotamus sp. 2	-	-	✓	-	✓
Galeocharax gulo	✓	-	✓	✓	-
Gephyrocharax chapare	-	-	✓	-	-
Gephyrocharax sp.	✓	-	-	-	-
Gnathocharax steindachneri	-	✓	-	-	-
Gymnocorymbus ternetzi	-	-	✓	-	✓
Gymnocorymbus thayeri	-	-	✓	-	-
Hemibrycon sp.	-	-	✓	-	-
Hemigrammus cf. *bellottii*	-	✓	-	-	-
Hemigrammus lunatus	✓	✓	✓	✓	✓
Hemigrammus cf. *marginatus*	-	-	✓	-	-
Hemigrammus cf. *megaceps* **	✓	-	-	-	-
Hemigrammus ocellifer	✓	✓	-	-	-
Hemigrammus cf. *pretoensis* **	✓	-	-	-	-
Hemigrammus sp.	-	-	✓	-	-
Hemigrammus? sp.	✓	-	-	-	-
Hemigrammus cf. *tridens*	-	✓	-	-	-
Hemigrammus unilineatus	-	-	✓	-	-
Hemigrammus cf. *unilineatus*	✓	✓	-	-	-
Holobrycon pesu	-	-	✓	-	✓
Hyphessobrycon agulha **	✓	-	-	-	-
Hyphessobrycon cf. *anisitsi* **	✓	-	-	-	-
Hyphessobrycon bentosi	-	-	✓	-	-
Hyphessobrycon cf. *bentosi*	-	✓	-	-	-
Hyphessobrycon callistus	-	✓	✓	-	-
Hyphessobrycon cf. *gracilior* **	✓	-	-	-	-
Hyphessobrycon cf. *herbertaxelrodi*	-	✓	-	-	-
Hyphessobrycon cf. *heterorhabdus*	-	✓	-	-	-
Hyphessobrycon cf. *minimus*	-	✓	-	-	-
Hyphessobrycon cf. *scholzei*	-	✓	-	-	-
Hyphessobrycon serpae	-	-	✓	✓	-
Hyphessobrycon? sp.	✓	-	-	-	-
Hyphessobrycon cf. *tucunai*	✓	✓	-	-	-
Hysteronotus sp. 1 **	✓	-	-	-	-
Hysteronotus sp. 2 **	✓	-	-	-	-
Iguanodectes spilurus	✓	✓	✓	-	✓
Jobertina lateralis	-	✓	-	-	-
Knodus breviceps		-	✓	-	-
Knodus cf. *caquetae* **	✓	-	-	-	-

TABLE I *(continued)*
FISHES FROM THE BOLIVIAN AMAZONIAN REGION
(Explanation of localities and sources of information at end of table)

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Knodus cf. *gamma* **	✓	-	-	-	-
Knodus cf. *heterestes* **	✓	-	-	-	-
Knodus cf. *moenkhausii*	-	-	✓	-	-
Knodus sp.	✓	-	-	-	-
Knodus sp.	-	✓	-	-	-
Knodus sp. 1	-	-	✓	-	-
Knodus sp. 2	-	-	✓	-	✓
Knodus cf. *victoriae* **	✓	-	-	-	-
Markiana nigripinnis	-	-	✓	-	✓
Megalamphodus megalopterus	-	✓	-	-	-
Megalamphodus sp.	-	✓	-	-	-
Megalamphodus sp.	-	-	✓	✓	-
Metynnis argenteus	-	-	✓	-	-
Metynnis hypsauchen	-	-	✓	-	✓
Metynnis cf. *hypsauchen*	-	-	✓	-	✓
Metynnis cf. *lippincotianus*	-	-	✓	-	-
Metynnis luna **	✓	-	-	-	-
Metynnis cf. *maculatus* 1	-	-	✓	-	✓
Metynnis cf. *maculatus* 2	-	-	✓	-	✓
Microschemobrycon geisleri **	✓	-	-	-	-
Microschemobrycon hasemani	-	-	✓	✓	-
Moenkhausia cf. *chrysargyrea* **	✓	-	-	-	-
Moenkhausia colletti	✓	✓	-	-	-
Moenkhausia cf. *colletti*	-	-	✓	-	✓
Moenkhausia cf. *comma* **	✓	-	-	-	-
Moenkhausia cf. *cotinho*	-	-	✓	-	✓
Moenkhausia dichroura	✓	✓	✓	✓	✓
Moenkhausia grandisquamis	-	-	✓	-	✓
Moenkhausia jamesi	-	-	✓	✓	✓
Moenkhausia cf. *jamesi*	✓	-	-	-	-
Moenkhausia cf. *lepidura*	✓	✓	-	-	-
Moenkhausia cf. *lepidura*	-	-	✓	-	✓
Moenkhausia cf. *megalops* **	✓	-	-	-	-
Moenkhausia oligolepis	-	✓	✓	-	✓
Moenkhausia sanctaefilomenae	✓	✓	✓	-	-
Moenkhausia sp. 1	✓	-	-	-	-
Moenkhausia sp. 2	✓	-	-	-	-
Moenkhausia sp. 3	✓	-	-	-	-
Moenkhausia sp. 4	✓	-	-	-	-
Moenkhausia sp. 5	✓	-	-	-	-
Moenkhausia sp. 6	✓	-	-	-	-
Moenkhausia sp. 7	✓	-	-	-	-
Moenkhausia sp. 8	✓	-	-	-	-
Moenkhausia sp.	-	✓	-	-	-
Myleus sp.	✓	-	-	-	-
Myleus cf. *rubripinnis*	-	-	✓	-	-
Myleus tiete	-	-	✓	-	✓
Mylossoma aureum	-	-	✓	-	-
Mylossoma duriventris	✓	-	✓	✓	✓
Odontostilbe cf. *fugitiva*	-	-	✓	✓	-
Odontostilbe hasemani	✓	-	✓	✓	-
Odontostilbe piaba **	✓	-	-	-	-
Odontostilbe paraguayensis **	✓	-	-	-	-
Odontostilbe sp. 1	✓	-	-	-	-
Odontostilbe sp. 2	✓	-	-	-	-
Odontostilbe sp.	-	-	✓	-	-
Parecbasis cyclolepis	-	-	✓	✓	✓
Paragoniates alburnus	✓	-	✓	-	-
Phenacogaster cf. *microstictus* **	✓	-	-	-	-
Phenacogaster cf. *pectinatus* **	✓	-	-	-	-
Phenacogaster sp. 1	✓	-	-	-	-
Phenacogaster sp. 2	✓	-	-	-	-
Phenacogaster sp. 3	✓	-	-	-	-
Phenacogaster? sp.	✓	-	-	-	-
Phenacogaster sp.	-	✓	-	-	-
Phenacogaster sp.	-	-	✓	-	✓
Piabucus melanostomus	✓	-	✓	-	✓
Piaractus brachypomus	-	-	✓	✓	-
Poptella compressa **	✓	-	-	-	-
Poptella orbicularis	-	✓	✓	✓	✓
Prionobrama filigera	✓	-	✓	✓	-
Pristobrycon sp. **	✓	-	-	-	-
Prodontocharax melanotus	-	-	✓	-	-
Pseudocheirodon sp.	-	✓	-	-	-
Pygocentrus nattereri	✓	-	✓	✓	✓
Roeboides affinis	-	-	✓	✓	✓
Roeboides cf. *descalvadensis*	-	-	✓	-	-
Roeboides myersii	-	-	✓	✓	✓
Roeboides cf. *myersii*	✓	-	-	-	-
Roeboides sp. 1	✓	-	-	-	-
Roeboides sp. 2	✓	-	-	-	-
Roeboides sp. 3	✓	-	-	-	-
Roeboides sp.	-	-	✓	-	✓
Roestes molossus	-	-	✓	-	✓
Salminus affinis	-	-	✓	-	-
Salminus brasiliensis	-	-	✓	-	-
Serrasalminae sp.	✓	-	-	-	-
Serrasalmus compressus	-	-	✓	✓	✓
Serrasalmus eigenmanni	-	-	✓	✓	✓
Serrasalmus elongatus	-	-	✓	-	✓
Serrasalmus hollandi	-	-	✓	-	✓
Serrasalmus cf. *hollandi*	✓	-	-	-	-
Serrasalmus marginatus **	✓	-	-	-	-
Serrasalmus rhombeus	✓	-	✓	✓	✓
Serrasalmus sp.	✓	-	-	-	-
Serrasalmus sp.	-	✓	-	-	-
Serrasalmus spilopleura	-	-	✓	✓	✓
Stethaprion crenatum	✓	✓	✓	-	✓
Tetragonopterinae sp. 1	✓	-	-	-	-
Tetragonopterinae sp. 2	✓	-	-	-	-
Tetragonopterus argenteus	✓	-	✓	✓	✓
Tetragonopterus cf. *chalceus*	-	-	✓	-	✓
Thayeria boehlkei	-	✓	✓	-	✓
Triportheus albus	-	-	✓	✓	✓
Triportheus angulatus	✓	✓	✓	✓	✓
Triportheus culter	-	-	✓	-	✓
Triportheus sp.	✓	-	-	-	-
Tyttocharax madeirae	✓	✓	✓	-	-
Tyttocharax sp. nov.	✓	-	-	-	-
Tyttocharax tambopatensis **	✓	-	-	-	-
Vesicatrus sp. nov.	-	-	✓	-	-
Xenurobrycon polyancistrus	-	-	✓	-	-
Curimatidae					
Chilodus punctatus	-	✓	✓	-	✓
Curimata roseni	-	-	✓	-	✓
Curimata vittata	-	-	✓	-	✓
Curimatella alburna	✓	-	✓	-	✓
Curimatella dorsalis	✓	-	✓	-	✓
Curimatella immaculata	✓	-	✓	-	✓
Curimatella meyeri	✓	-	✓	✓	✓
Curimatopsis macrolepis	-	✓	-	-	-
Cyphocharax notatus	-	✓	-	-	-
Cyphocharax plumbeus	-	-	✓	-	✓
Cyphocharax cf. *plumbeus*	✓	-	-	-	-
Cyphocharax sp.	✓	-	-	-	-
Cyphocharax sp. nov.	-	-	✓	-	✓
Cyphocharax spilura	-		✓	✓	✓
Cyphocharax cf. *spilura*	-	✓	-	-	-
Cyphocharax spiluropsis	✓	-	-	-	-
Cyphocharax cf. *spiluropsis*	-	✓	-	-	-
Eigenmannina melanopogon	-	-	✓	✓	✓
Potamorhina altamazonica	✓	-	✓	✓	✓
Potamorhina laitior	✓	-	✓	✓	✓
Psectrogaster curviventris	✓	-	✓	-	✓
Psectrogaster essequibensis	-	-	✓	-	✓
Psectrogaster rutiloides	✓	✓	✓	-	✓
Steindachnerina bimaculata	-	-	✓	-	-
Steindachnerina binotata	-	-	✓	-	-
Steindachnerina dobula	✓	-	✓	✓	-
Steindachnerina hypostoma	-	-	✓	✓	-
Steindachnerina guentheri **	✓	-	-	-	-
Steindachnerina leucisca **	✓	-	-	-	-
Steindachnerina sp.	✓	-	-	-	-
Steindachnerina sp.	-	✓	-	-	-
Cynodontidae					
Cynodon gibbus	✓	-	✓	✓	✓
Hydrolycus cf. *armatus*	-	-	✓	✓	-
Hydrolycus pectoralis **	✓	-	-	-	-
Hydrolycus scomberoides	-	-	✓	✓	✓
Rhaphiodon vulpinus	✓	-	✓	✓	-
Erythrinidae					
Erythrinus erythrinus	-	-	✓	-	-
Erythrinus sp.	-	✓	-	-	-

TABLE I *(continued)*
FISHES FROM THE BOLIVIAN AMAZONIAN REGION
(Explanation of localities and sources of information at end of table)

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Hoplias malabaricus	✓	✓	✓	✓	✓
Hoplerythrinus unitaeniatus	-	✓	✓	-	-
Gasteropelecidae					
Carnegiella marthae	-	✓	-	-	-
Carnegiella myersi	✓	-	✓	-	-
Carnegiella schereri	-	-	✓	-	✓
Carnegiella strigata	✓	✓	-	-	-
Gasteropelacus sternicla	✓	✓	✓	-	-
Thoracocharax securis	-	-	✓	-	-
Thoracocharax stellatus	✓	-	✓	-	-
Hemiodontidae					
Anodus elongatus **	✓	-	-	-	-
Hemiodopsis cf. *microlepis*	-	-	✓	-	✓
Hemiodopsis semitaeniatus	-	-	✓	-	✓
Hemiodopsis unimaculatus	-	-	✓	✓	✓
Parodon cf. *carrikeri*	-	-	✓	-	-
Lebiasinidae					
Nannostomus sp.	-	✓	-	-	-
Nannostomus harrisoni	-	✓	-	-	-
Nannostomus trifasciatus	✓	✓	-	-	-
Nannostomus unifasciatus	-	-	✓	-	✓
Pyrrhulina australe	✓	✓	✓	-	✓
Pyrrhulina brevis	-	✓	-	-	-
Pyrrhulina vittata	✓	-	✓	-	✓
Prochilodontidae					
Prochilodus nigricans	-	-	✓	✓	✓
Prochilodus cf. *nigricans*	✓	-	-	-	-
Prochilodus sp. 1	-	-	✓	-	✓
Prochilodus sp. 2	-	-	✓	-	-
Siluriformes					
Ageneiosidae					
Ageneiosus brevifilis	-	-	✓	✓	-
Ageneiosus cf. *caucanus* **	✓	-	-	-	-
Ageneiosus dentatus	-	-	✓	✓	-
Ageneiosus madeirensis	-	-	✓	-	✓
Ageneiosus sp.	✓	-	-	-	-
Ageneiosus sp.	-	-	✓	-	-
Ageneiosus ucayalensis	-	-	✓	-	-
Tympanopleura sp.	✓	-	-	-	-
Tympanopleura sp.	-	-	✓	-	✓
Aspredinidae					
Amaralia sp.	-	-	✓	-	-
Bunocephalus coracoideus **	✓	-	-	-	-
Bunocephalus sp. 1	✓	-	-	-	-
Bunocephalus sp. 2	✓	-	-	-	-
Bunocephalus sp. 3	✓	-	-	-	-
Bunocephalus sp.	-	✓	-	-	-
Bunocephalus sp. 1	-	-	✓	-	✓
Bunocephalus sp. 2	-	-	✓	-	-
Bunocephalus sp. 3	-	-	✓	-	-
Dysichthys bifidus **	✓	-	-	-	-
Dysichthys cf. *aleuropsis* **	✓	-	-	-	-
Dysichthys cf. *amazonicus* **	✓	-	-	-	-
Dysichthys cf. *depressus* **	✓	-	-	-	-
Xiliphius cf. *melanopterus* **	✓	-	-	-	-
Astroblepidae					
Astroblepus longiceps	-	-	✓	-	-
Astroblepus sp.	-	-	✓	-	-
Auchenipteridae					
Auchenipterichthys thoracatus	✓	-	✓	-	✓
Auchenipterus nigripinnis	-	-	✓	✓	✓
Auchenipterus nuchalis	-	-	✓	✓	✓
Auchenipterus cf. *nuchalis*	✓	-	-	-	-
Centromochlus cf. *heckelii* **	✓	-	-	-	-
Centromochlus sp. 1	-	-	✓	-	-
Centromochlus sp. 2	-	-	✓	-	-
Entomocorus benjamini	✓	-	✓	-	✓
Epapterus dispilurus	-	-	✓	-	✓
Parauchenipterus striatulus	-	-	✓	-	-
Pseudotatia? sp.	-	✓	-	-	-

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Tatia altae **	✓	-	-	-	-
Tatia aulopygia	✓	✓	✓	-	-
Tatia cf. *intermedia*	-	✓	-	-	-
Tatia cf. *perugiae* **	✓	-	-	-	-
Tatia sp.	-	✓	-	-	-
Trachelyopterus coriaceus	-	-	✓	-	-
Trachelyopterus cf. *galeatus*	✓	-	-	-	-
Trachelyopterus cf. *galeatus*	-	-	✓	-	-
Trachelyopterus maculosus	-	-	✓	-	-
Callichthyidae					
Brochis britskii	-	-	✓	-	-
Brochis multiradiatus	-	-	✓	-	-
Brochis splendens	✓	-	✓	-	-
Callichthys callichthys	✓	✓	✓	-	-
Corydoras acutus	✓	-	✓	-	-
Corydoras aeneus	✓	✓	✓	-	-
Corydoras armatus	-	-	✓	-	-
Corydoras bolivianus	-	-	✓	-	-
Corydoras geryi	-	-	✓	-	-
Corydoras hastatus	✓	✓	✓	-	-
Corydoras cf. *latus*	-	-	✓	-	-
Corydoras cf. *loretoensis* **	✓	-	-	-	-
Corydoras cf. *napoensis* **	✓	-	-	-	-
Corydoras punctatus	-	-	✓	-	-
Corydoras sp.	✓	-	-	-	-
Corydoras sp.	-	✓	-	-	-
Corydoras sp. 1	-	-	✓	-	✓
Corydoras sp. 2	-	-	✓	-	-
Corydoras trilineatus **	✓	-	-	-	-
Dianema longibarbis	✓	-	✓	-	✓
Hoplosternum littorale	-	✓	✓	✓	-
Megalechis thoractus	✓	-	✓	-	-
Cetopsidae					
Cetopsis sp.	-	-	✓	-	-
Hemicetopsis candiru	-	-	✓	-	-
Pseudocetopsis plumbeus	-	-	✓	-	-
Pseudocetopsis sp.	✓	-	-	-	-
Pseudocetopsis sp.	-	-	✓	-	-
Doradidae					
Acanthodoras cataphractus **	✓	-	-	-	-
Acanthodoras spinosissimus	-	✓	-	-	-
Agamyxis flavopictus	-	-	✓	-	-
Agamyxis pectinifrons **	✓	-	-	-	-
Amblydoras hancockii	-	✓	-	-	-
Amblydoras cf. *hancockii*	✓	-	-	-	-
Anadoras cf. *grypus* **	✓	-	-	-	-
Anadoras weddellii	-	-	✓	-	-
Astrodoras asterifrons	✓	-	✓	-	-
Doras cf. *carinatus* **	✓	-	-	-	-
Doras eigenmanni	✓	-	✓	-	-
Doras fimbriatus	-	-	✓	-	-
Doras punctatus	-	-	✓	-	✓
Doras sp.	-	-	✓	-	-
Hemidoras microstomus **	✓	-	-	-	-
Megalodoras irwini	-	-	✓	-	-
Opsodoras humeralis	-	-	✓	-	-
Opsodoras cf. *humeralis*	✓	-	-	-	-
Opsodoras stubelii	-	-	✓	-	-
Opsodoras cf. *stubelii*	✓	-	-	-	-
Opsodoras sp. 1	-	-	✓	-	-
Opsodoras sp. 2	-	-	✓	-	✓
Platydoras costatus	✓	-	✓	-	✓
Pseudodoras niger	✓	-	✓	✓	✓
Pterodoras granulosus	-	-	✓	✓	-
Trachydoras atripes	-	-	✓	-	✓
Trachydoras cf. *atripes*	✓	-	-	-	-
Trachydoras paraguayensis	✓	-	-	-	-
Trachydoras cf. *paraguayensis*	-	-	✓	-	-
Helogenidae					
Helogenes marmoratus	-	✓	-	-	-
Hypophthalmidae					
Hypophthalmus edentatus	-	-	✓	✓	-
Hypophthalmus marginatus	-	-	✓	-	-

TABLE I *(continued)*
FISHES FROM THE BOLIVIAN AMAZONIAN REGION
(Explanation of localities and sources of information at end of table)

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Loricariidae					
Ancistrus cf. *bolivianus*	-	-	✓	-	-
Ancistrus cf. *megalostomus*	-	-	✓	-	-
Ancistrus sp. 1	✓	-	-	-	-
Ancistrus sp. 2	✓	-	-	-	-
Ancistrus sp. 3	✓	-	-	-	-
Ancistrus sp. 4	✓	-	-	-	-
Ancistrus sp.	-	✓	-	-	-
Ancistrus sp.	-	-	✓	-	-
Ancistrus cf. *temminckii*	-	-	✓	✓	✓
Aphanotorulus frankei	✓	-	✓	-	-
Aphanotorulus unicolor **	✓	-	-	-	-
Cochliodon cf. *cochliodon* **	✓	-	-	-	-
Cochliodon sp. 1	-	-	✓	-	-
Cochliodon sp. 2	-	-	✓	-	-
Crossoloricaria sp. **	✓	-	-	-	-
Farlowella acestrichthys	-	-	✓	-	-
Farlowella cf. *oxyrryncha* **	✓	-	-	-	-
Farlowella sp. 1	✓	-	-	-	-
Farlowella sp. 2	✓	-	-	-	-
Farlowella sp.	-	✓	-	-	-
Farlowella sp. 1	-	-	✓	-	-
Farlowella sp. 2	-	-	✓	-	-
Glyptoperichthys lituratus	✓	-	✓	✓	✓
Glyptoperichthys punctatus	-	-	✓	-	-
Hemiodontichthys acipenserinus	✓	-	✓	-	✓
Hypoptopoma joberti	✓	✓	✓	✓	✓
Hypoptopoma sp.	✓	-	-	-	-
Hypoptopoma thoracatum	-	✓	✓	-	✓
Hypoptopomatinae sp.	-	✓	-	-	-
Hypoptopomatinae sp. nov. ?	-	-	✓	-	-
Hypostomus bolivianus	-	-	✓	-	-
Hypostomus cf. *chaparae*	-	-	✓	-	-
Hypostomus emarginatus	-	-	✓	-	✓
Hypostomus cf. *popoi*	-	-	✓	✓	✓
Hypostomus sp. 1	✓	-	-	-	-
Hypostomus sp. 2	✓	-	-	-	-
Hypostomus sp. 3	✓	-	-	-	-
Hypostomus sp. 4	✓	-	-	-	-
Hypostomus sp.	-	✓	-	-	-
Hypostomus sp. 2	-	✓	-	-	-
Hypostomus sp. 3	-	✓	-	-	-
Hypostomus sp. 1	-	-	✓	-	-
Hypostomus sp. 2	-	-	✓	-	-
Hypostomus sp. 3	-	-	✓	-	-
Hypostomus sp. 4	-	-	✓	-	✓
Hypostomus sp. 5	-	-	✓	-	-
Lamontichthys filamentosus	✓	-	-	-	-
Lamontichthys cf. *filamentosus*	-	-	✓	-	-
Liposarcus disjunctivus	✓	-	-	-	-
Liposarcus disjunctivus (sp. nov.)	-	-	✓	-	-
Loricaria cf. *simillima*	-	-	✓	-	-
Loricaria sp.	✓	-	-	-	-
Loricaria sp.	-	✓	-	-	-
Loricariidae sp.	✓	-	-	-	-
Loricariinae sp.	-	✓	-	-	-
Loricariichthys cf. *maculatus*	-	-	✓	✓	✓
Loricariichthys sp.	✓	-	-	-	-
Loricariichthys sp.	-	-	✓	✓	✓
Otocinclus mariae	✓	-	✓	-	-
Otocinclus cf. *mariae*	-	✓	-	-	-
Panaque sp.	✓	-	-	-	-
Panaque sp. n 1	-	-	✓	-	-
Panaque sp. n 2	-	-	✓	-	-
Parotocinclus sp. **	✓	-	-	-	-
Peckoltia arenaria	✓	-	-	-	-
Peckoltia cf. *arenaria*	-	-	✓	-	-
Planiloricaria cryptodon	✓	-	✓	-	-
Pseudohemiodon cf. *lamina* **	✓	-	-	-	-
Pseudohemiodon sp. 1	✓	-	-	-	-
Pseudohemiodon sp. 2	✓	-	-	-	-
Pseudohemiodon sp. 3	✓	-	-	-	-
Pseudohemiodon sp.	-	-	✓	-	-
Pseudohemiodon thorectes	-	-	✓	-	-
Pterosturisoma microps	-	-	✓	-	-
Pterygoplichthys sp.	-	✓	-	-	-
Rineloricaria beni	-	✓	✓	-	✓
Rineloricaria lanceolata	✓	✓	-	-	-
Rineloricaria cf. *lanceolata*	-	-	✓	-	✓
Rineloricaria sp.	✓	-	-	-	-
Rineloricaria sp.	-	✓	-	-	-
Rineloricaria sp.	-	-	✓	-	-
Scoloplax cf. *dicra* **	✓	-	-	-	-
Scoloplax sp.	-	-	✓	-	-
Spatuloricaria cf. *evansii*	-	-	✓	-	-
Sturisoma nigrirostrum	✓	-	-	-	-
Sturisoma cf. *nigrirostrum*	-	-	✓	-	-
Pimelodidae					
Brachyglanis? sp. **	✓	-	-	-	-
Brachyplatystoma filamentosum	-	-	✓	-	✓
Brachyplatystoma flavicans	-	-	✓	-	-
Brachyrhamdia martae **	✓	-	-	-	-
Callophysus macropterus	-	-	✓	-	✓
Cetopsorhamdia phantasia **	✓	-	-	-	-
Cheirocerus eques **	✓	-	-	-	-
Duopalatinus cf. *malarmo* **	✓	-	-	-	-
Hemisorubim platyrhynchos	✓	-	✓	-	✓
Heptapterus longior **	✓	-	-	-	-
Heptapterus sp.	✓	-	-	-	-
Imparfinis bolivianus	-	-	✓	-	-
Imparfinis cochabambae	-	-	✓	-	-
Imparfinis guttatus	-	-	✓	-	-
Imparfinis sp.	✓	-	-	-	-
Imparfinis stictonotus	✓	-	✓	-	-
Imparfinis cf. *stictonotus*	-	✓	-	-	-
Leiarius marmoratus	✓	-	✓	-	-
Megalonema platanum	-	-	✓	-	-
Megalonema sp.	✓	-	-	-	-
Megalonema sp. nov.	✓	-	-	-	-
Microglanis sp.	✓	-	-	-	-
Microglanis sp.	-	-	✓	-	-
Paulicea lutkeni	-	-	✓	✓	-
Phractocephalus hemioliopterus	-	-	✓	-	✓
Pimelodella cf. *boliviana* **	✓	-	-	-	-
Pimelodella cf. *chaparae*	-	-	✓	-	-
Pimelodella cristata	✓	-	✓	-	-
Pimelodella gracilis	✓	-	✓	-	-
Pimelodella hasemani **	✓	-	-	-	-
Pimelodella cf. *itapicuruensis* **	✓	-	-	-	-
Pimelodella mucosa	-	-	✓	-	-
Pimelodella roccae	-	-	✓	-	-
Pimelodella serrata	-	-	✓	-	-
Pimelodella cf. *serrata*	✓	-	-	-	-
Pimelodella sp.	-	-	✓	-	-
Pimelodidae sp.	✓	-	-	-	-
Pimelodidae sp.	-	✓	-	-	-
Pimelodina flavipinnis	-	-	✓	-	-
Pimelodus "*altipinnis*" **	✓	-	-	-	-
Pimelodus altissimus (sp. nov.) **	✓	-	-	-	-
Pimelodus armatus **	✓	-	-	-	-
Pimelodus cf. *blochii*	✓	-	-	-	-
Pimelodus cf. *maculatus-blochi*	-	-	✓	✓	✓
Pimelodus ornatus	-	-	✓	-	-
Pimelodus cf. *pantherinus* **	✓	-	-	-	-
Pimelodus sp. 1	✓	-	-	-	-
Pimelodus sp. 2	✓	-	-	-	-
Pimelodus sp. 3	✓	-	-	-	-
Pimelodus sp. 4	✓	-	-	-	-
Pinirampus pirinampu	-	-	✓	-	✓
Platysilurus barbatus	-	-	✓	-	-
Pseudopimelodus zungaro	-	-	✓	-	-
Pseudopimelodus sp. 1	-	-	✓	-	-
Pseudopimelodus sp. 2	-	-	✓	-	-
Pseudoplatystoma fasciatum	✓	✓	✓	✓	✓
Pseudoplatystoma tigrinum	-	-	✓	✓	✓
Rhamdia quelen	-	-	✓	-	-
Rhamdia sp.	✓	-	-	-	-
Rhamdia sp.	-	✓	-	-	-
Rhamdia sp.	-	-	✓	-	-
Sorubim lima	✓	-	✓	✓	✓
Sorubimichthys planiceps	-	-	✓	-	-
Trichomycteridae					
Acanthopoma cf. *bondi* **	✓	-	-	-	-
Apomatoceros sp.	-	-	✓	-	-
Gyrinurus batrachostoma	-	-	✓	-	-

TABLE I *(continued)*
FISHES FROM THE BOLIVIAN AMAZONIAN REGION
(Explanation of localities and sources of information at end of table)

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Homodiaetus cf. *maculatus*	-	-	✓	-	-
Homodiaetus sp.	✓	-	-	-	-
Homodiaetus sp.	-	-	✓	-	-
Ochmacanthus cf. *alternus* **	✓	-	-	-	-
Ochmacanthus sp.	-	✓	-	-	-
Ochmacanthus sp.	-	-	✓	-	✓
Paracanthopoma sp.	-	-	✓	-	-
Plectrochilus sp.	✓	-	-	-	-
Plectrochilus sp.	-	-	✓	-	-
Pseudostegophilus nemurus	✓	-	✓	-	-
Trichomycteridae sp.	-	✓	-	-	-
Trichomycterus cf. *barbouri*	-	-	✓	-	-
Trichomycterus sp.	-	✓	-	-	-
Tridentopsis pearsoni **	✓	-	-	-	-
Vandellia cirrhosa	✓	-	✓	-	-
Vandellia hasemani	-	-	✓	-	-
Gymnotiformes					
Apteronotidae					
Adontosternarchus clarkae **	✓	-	-	-	-
Adontosternarchus sachsi	-	-	✓	-	-
Apteronotus albifrons	✓	-	✓	-	-
Apteronotus bonapartii	✓	-	✓	-	-
Apteronotus sp.	-	-	✓	-	✓
Porotergus cf. *gimbeli*	-	-	✓	-	-
Porotergus cf. *gymnotus*	-	-	✓	-	-
Sternarchorhynchus oxyrhynchus	-	-	✓	-	-
Sternarchorhynchus sp.	-	-	✓	-	-
Electrophoridae					
Electrophorus electricus **	✓	-	-	-	-
Gymnotidae					
Gymnotus anguillaris	-	-	✓	-	-
Gymnotus cf. *anguillaris*	✓	-	-	-	-
Gymnotus carapo	✓	✓	✓	-	✓
Gymnotus cf. *coatesi* **	✓	-	-	-	-
Hypopomidae					
Brachyhypopomus brevirostris	✓	-	-	-	-
Brachyhypopomus cf. *brevirostris*	-	-	✓	-	-
Brachyhypopomus pinnicaudatus **	-	✓	-	-	-
Brachyhypopomus sp.	✓	-	-	-	-
Gymnotiforme	-	✓	-	-	-
Hypopomus cf. *artedi*	-	-	✓	-	-
Hypopomus sp. 1	-	✓	-	-	-
Hypopomus sp. 2	-	✓	-	-	-
Hypopygus lepturus	✓	✓	-	-	-
Rhamphichthyidae					
Gymnorhamphichthys hypostomus	-	-	✓	-	-
Rhamphichthys rostratus	-	✓	✓	✓	-
Rhamphichthys sp.	-	-	✓	-	-
Sternopygidae					
Distocyclus conirostris	✓	-	✓	-	-
Eigenmannia humboldtii	✓	-	✓	-	-
Eigenmannia macrops **	✓	-	-	-	-
Eigenmannia cf. *trilineata* **	✓	-	-	-	-
Eigenmannia virescens	✓	✓	✓	-	✓
Rhabdolichops caviceps **	✓	-	-	-	-
Rhabdolichops troscheli	-	-	✓	-	-
Sternopygus macrurus	✓	✓	✓	✓	✓
Cyprinodontiformes					
Rivulidae					
Cynolebias sp.	-	✓	-	-	-
Pterolebias sp.	-	-	✓	-	-
Rivulidae sp.	-	✓	-	-	-
Rivulus sp.	✓	-	-	-	-
Rivulus sp.	-	✓	-	-	-
Rivulus sp.	-	-	✓	-	-

TAXA	Bolivia AquaRAP	Noel Kempff Mercado	Bolivian Amazon	Madre de Dios	Itenez (or Guapore)
Beloniformes					
Belonidae					
Potamorrhaphis cf. *eigenmanni*	-	✓	-	-	-
Potamorrhaphis sp.	✓	-	-	-	-
Potamorrhaphis sp.	-	-	✓	-	✓
Strongylura sp.	-	-	✓	-	-
Synbranchiformes					
Synbranchidae					
Synbranchus marmoratus	✓	✓	✓	-	✓
Perciformes					
Cichlidae					
Aequidens dorsiger	-	-	✓	-	-
Aequidens sp. 1	✓	-	-	-	-
Aequidens sp. 2	✓	-	-	-	-
Aequidens sp. 3	✓	-	-	-	-
Aequidens cf. *paraguayensis* **	✓	-	-	-	-
Aequidens cf. *tetramerus*	✓	-	-	-	-
Aequidens cf. *tetramerus*	-	✓	-	-	-
Aequidens viridis	-	✓	✓	-	✓
Aequidens cf. *vittatus*	-	-	✓	-	-
Apistogramma inconspicua	-	-	✓	-	✓
Apistogramma linkei	✓	-	✓	-	-
Apistogramma sp. 1	✓	-	-	-	-
Apistogramma sp. 2	✓	-	-	-	-
Apistogramma sp. 3	✓	-	-	-	-
Apistogramma sp. 4	✓	-	-	-	-
Apistogramma sp. 1	-	✓	-	-	-
Apistogramma sp. 2	-	✓	-	-	-
Astronotus crassipinnis	✓	✓	✓	-	✓
Batrachops sp.	-	-	✓	✓	✓
Biotodoma cupido	-	✓	✓	-	✓
Chaetobranchiopsis orbicularis	✓	-	✓	✓	✓
Chaetobranchus flavescens	-	✓	✓	-	✓
Cichla monoculus	-	✓	✓	✓	✓
Cichla cf. *monoculus*	✓	-	-	-	-
Cichlasoma boliviense	-	-	✓	-	✓
Cichlasoma severum **	✓	-	-	-	-
Cichlidae sp.	✓	-	-	-	-
Crenicara sp.	-	-	✓	-	-
Crenicara cf. *unctulata* **	✓	-	-	-	-
Crenicichla cf. *heckeli* **	✓	-	-	-	-
Crenicichla johanna	-	-	✓	-	✓
Crenicichla lepidota	-	-	✓	-	✓
Crenicichla semicincta	-	-	✓	-	-
Crenicichla sp. 1	✓	-	-	-	-
Crenicichla sp. 2	✓	-	-	-	-
Crenicichla sp.	-	✓	-	-	-
Crenicichla sp.	-	-	✓	-	✓
Geophagus megasema	-	-	✓	-	✓
Heros sp.	-	✓	-	-	-
Heros sp.	-	-	✓	✓	✓
Laetacara dorsigera	-	✓	-	-	-
Mesonauta festivus	✓	✓	✓	✓	✓
Mesonauta cf. *insignis* **	✓	-	-	-	-
Microgeophagus altispinosa	✓	-	✓	-	✓
Satanoperca cf. *acuticeps* **	✓	-	-	-	-
Satanoperca jurupari	-	-	✓	✓	-
Satanoperca pappatera	-	-	✓	-	✓
Satanoperca sp.	✓	-	-	-	-
Eleotridae					
Eleotridae sp.	-	-	✓	-	-
Sciaenidae					
Pachypops sp.	-	-	✓	-	-
Pachyurus sp.	✓	-	-	-	-
Plagioscion squamosissimus	✓	-	✓	✓	✓
Pleuronectiformes					
Soleidae					
Achirus achirus	-	✓	✓	-	-

✓: Presence; -: Absence of given species; **: Species collected by AquaRAP and believed to be new records for Bolivian Amazon.

Locality information for fishes in Noel Kempff Mercado is from Sarmiento (1998). Locality information for fishes in the Bolivian Amazon, Madre de Dios, and Itenez (or Guapore) columns is taken from Lauzanne *et al.* (1991). Note that Madre de Dios and Itenez (or Guapore) are subsections of the Bolivian Amazon, and that the Bolivian Amazon includes additional basins not indicated in this table.