Wetland Study of Lake Manguao as Special Co-management Area for Eco-tourism in the Province of Palawan

Benjamin J. Gonzales and Joie D. Matillano

Western Philippines University
Palawan
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EXECUTIVE SUMMARY

Lake Manguao was identified as one of the Key Biodiversity Areas for its global significance on biodiversity conservation. As the largest lake in mainland Palawan, Lake Manguao is a natural heritage not only for the people of Taytay but for the entire province in general. As part of PCSD’s initiatives in protecting Palawan’s natural resources, it partnered with Western Philippine University to assess the socio-economic and biophysical profile of Lake Manguao, in relation to the lake’s potential as an ecotourism destination. The study will ascertain the biophysical, social, economic and environmental conditions of the wetland and come up with the Profile of Lake Manguao and assess its ecotourism potential.

Forest Cover. The forest cover of Lake Manguao was estimated to be between 50-60% in 1990 and about 60% in 2004. The floral elements of Lake Manguao were among the least studied biophysical component of the lake. The floral species of the Lake’s catchment was known through the Protected Area Suitability Assessment (PASA) conducted by DENR (1999). During this assessment, about 50 tree species were identified, mostly of commercially valuable and more common species listed.

Overall, there is a need for more forest cover, land use and floral assessment in Lake Manguao, particularly in the catchment forest. The non-volant mammal species of the lake were threatened by hunting in the area, particularly the bearded pig, porcupine, and the Palawan pangolin. Non-volant mammals were: *Sundasciucus juvencus*, *Tupaia palawanensis*, *Macaca fascicularis*, *Mydaus marcehi*, *Manis culionensis*, *Hylopetes nigriceps*, *Paradoxurus hemaphroditus*, *Prionailurus bengalensis*, *Arcticis binturong*, *Amblyonyx cinereus*, *Sus ahoenobarbus*, *Maxomys panglima*, *Rattus exulans*. The volant mammals (bats) were: *Cynopterus brachyotis*, *Macroglossus minimus*, *Rousettus aegyptiacus*, *Megaderma spasma*, *Rhinolophus acuminatus*, *Kerivoula hardwickii*, *Tylonycteris pachypus*

Herps. (Amphibians and reptiles). Three species of freshwater turtles was recorded in the Lake: the Critically Endangered Philippine forest turtle *Siebenrockiella leytensis*, the Malayan box turtle *Cuora amboinensis* and the Asian leaf turtle *Cyclomys dentata*. Other reptilian species encountered in the lake were the water monitor *Varanus salvator* and a crocodile species believed to be the *Crocodylus porosus*. Several species of amphibians were also encountered in the lake, notably *Staurois natator*, *Occidozyga laevis*, *Bufo philippinicus*, and *Rana sanguinea*.

Birds. Lake Manguao is also an important stronghold for seven species of globally threatened birds. The birds of Lake Manguao are the second most studied vertebrate group in the lake. Researchers recorded 135 bird species from 47 families. This represents 48 per cent of the total bird species recorded thus far in Palawan. Of
these, 14 were Palawan-endemic while seven were widely distributed Philippine-endemics. Several species were under threatened categories of IUCN (2006).

There were 5 near-threatened bird species in the Lake, while four globally threatened species. As for migratory bird species, a sudden decline in the number of birds in the roosting site was observed from February to May 2006, coinciding with the winter and spring migration. Hunting still persists within Lake Manguao, mainly for local consumption. There is a source of staple food and livelihood i.e. tilapia fishery. The absence of the critically endangered Philippine cockatoo confirmed that it is already extinct within the lake's catchments. The most popularly hunted birds belong to family Columbidae or the pigeons and doves, intended mainly for consumption. Hunters are mainly residents.

**Fishes.** Five species where recorded from 1914-1924. After then, seven species were recorded in 1990. Potentially new fish species were collected in 2002, increasing the total number of fish diversity in the Lake to 14. The latest species inventory revealed 14 fish species from ten genera belonging to the families Anabantidae, Channidae, Cichlidae, Claridae, Cyprinidae, Eleotridae, Hemiramphidae and Siluridae, of which four were endemic to the lake. The two endemic *Puntius* species described by Day in 1914 as *P. manguoensis* and *P. bantolanensis* were verified. Furthermore, *Pterocryptis taytayensis* was collected and the synonymy of *Penesilurus palawanensis* with *P. taytayensis* confirmed. In a more recent study in 2010, another Palawan endemic species was collected, the pygmy *Rasbora R. taytayensis*.

For tilapia studies in the lake, the gonadosomatic index (GSI) of males ranged from 0.01% to 0.70% and the female GSI ranged from 0.04% to 3.55%. GSI values of females were higher than males. The *O. niloticus* in Lake Manguao were sexually mature at a length of 9.4cm TL for males and 9.6cm TL for females. As such *O. niloticus* in Lake Manguao matures at a smaller size within compared to its conspecifics outside the lake.

**Socio-political.** The entire catchment of Lake Manguao was technically under Barangay Poblacion and Barangay Bantulan. However, most of the geopolitical affiliation was with Poblacion since the village center was situated within the boundaries of this barangay. As a Sitio of Barangay Poblacion, it was headed by a Sitio Leader, which is responsible in the political affairs of the Sitio. However, Lake Manguao somehow enjoys direct supervision from LGU of Taytay, being a unique community in Taytay and having regular rangers that oversee the day to activities within the lake. Compared with other Philippine lake side communities, Lake Manguao has a very small population with only 65 families and 302 individuals; a population density of 6.82 persons per km² is considerably low. The residents belong to five ethnic groups with the Cuyuno comprising more than 60% of the entire populace. Religious affiliation was mainly Roman Catholic, and the community has one chapel that is visited by a lay minister once a month.
In terms of land holdings, more than 80% of the populace has either declaration of rights or tax declaration as their tenured instruments on their properties. More than 90% of the populace owns both residential and farm lands, with an average of 1093m² as residential area and an average of 5.97 hectares of farmed area. This was made possible by the provision of the municipal government of a community subdivision with the lake, which relocated most of the residents into an area (sitio) where all residential houses are now concentrated, in effect, centralizing the village of Lake Manguao.

The educational background of majority of the population was elementary or high school graduate, with less than 10 individuals making it to college level education or a college degree. The community has one day care center but no elementary school. There was no Sitio Clinic, but access to the Northern Palawan Hospital is within 10 minutes by private motorbike transport. Access to medical clinics was at least 25 minutes by motorbike. There was no regular public transportation going to Lake Manguao. As such, motorbike is the most common means of going to the town center of Taytay or taking a 45 minute walk to the highway and taking public transport via the national road adjoining the feeder road to the lake. Within the lake, transportation was paddle boats.

Information source in the lake, particularly local news was mainly by radio programs broadcasting from Puerto Princesa. At least one household has satellite TV with access to cable channels. Recreational facilities in the lake are also limited, except for the basketball court and a light-material cock fighting arena near the village center. On the other hand, cellular phone signal was scars and internet communication was not popular at all. The residents of the lake were mainly farmers and fishermen. Almost all families were fishing most of the year and engaged in farming. The average monthly income from fishing in Lake Manguao was Php2500-Php5000. Fishing was inherently focused on the introduced Nile tilapia.

Ecotourism. The lake could be considered as an ideal ecotourism site and an alternative inland ecotourism destination. However, until today, facilities were lacking in order to provide basic comfort to community members as well as tourists. Having a surface area of more than 600 hectares and a catchment area of at least 4000 hectares, the lake has a big potential for sustainable eco-tourism activities that will not only promote conservation of the Lake Manguao Biosphere but at the same time provide additional income to local residents.

Tourists visiting Lake Manguao included both local and foreign visitors. From January 2013-August 2014, 338 foreign tourist visited the lake, the top three groups were from France (48%), Germany (7.4%), and Singapore (6.2%). Among the locals,
visitors from Taytay, Puerto Princesa, and Roxas topped the list while the top three visitors from outside Palawan were residents of Manila, Cebu, and Bulacan.

Several activities like hiking, birdwatching, camping, fishing, fish spa, butterfly watching, and kayaking can be established within the lake. Annual events in the Lake were: 1) Annual tree planting activities – in the same way that Pista y ang Cagueban is to Puerto Princesa, *Pista y ang Danao*” 2) Lake Manguao Amazing Race – annual triathlon event that will be held every year in Lake Manguao. 3) Fishing tournaments – this annual fishing tournaments will focus on tilapia and snakehead in the lake.

Lake Manguao is definitely an ecosystem that necessitates sound management intervention, particularly through the local government where it is located. As a tourism site, the lake has very rich, untapped resources and with proper development of this tourism potential, the lake will serve as another tourism attraction for the province of Palawan, especially for the municipality of Taytay.

Like any emerging tourism destination in Palawan, Lake Manguao has its unique features worth developing while at the same time it has its own issues that have to be addressed in order for tourism development to flourish. The current situation in Lake Manguao can be considered as right at the point of a tourism destination gearing up for opening to a booming tourism market.

Although there had been many issues identified at present, the LGU of Taytay has also realized the potential of Lake Manguao as one of its tourism assets. Recognizing this, the LGU had initiated very concrete and strong steps to effectively manage and develop Lake Manguao and its catchment area not only as an ecotourism destination, but primarily as a Municipal Conservation Area through a local ordinance and by implementing an externally funded project that will develop a more thorough management plan for Lake Manguao.
INTRODUCTION

Being an island ecosystem with rich natural resources, tourism is one of the lead sectors of development in the province of Palawan. This makes ecotourism an important tool for biodiversity and cultural conservation hence an instrument tool for sustainable development. Among the province’s ecotourism attractions are beaches, islands, forest areas, and inland waters such as lakes, rivers, and waterfalls.

One of the lakes in Palawan that has been identified as ecotourism sites is Lake Manguao. Lake Manguao is the only freshwater lake in mainland northern Palawan. The lake is endorheic (no surface outflow) and was formed after a volcanic eruption blocked an ancient river valley that drained to the east coast of Palawan Island in Bantulan Bay. Lake Manguao has a surface area of 640 hectares and a catchment area of 4,425 hectares, with about 50% still covered with primary and residual old growth forest. The lake has a maximum depth of 14 meters during rainy season and about 11 meters during dry season.

Although smaller compared to other Philippines lakes, Lake Manguao is considered as one of the most biologically important lakes in the Philippines (CI 2007). The lake is home to three lake-endemic freshwater fishes and also harbors an additional four more fish species that are endemic to northern Palawan and its satellite islands. The associated habitat within Lake Manguao is also an important stronghold for seven species of globally threatened birds. As such, it was identified as one of the Key Biodiversity Areas for its global significance on biodiversity conservation (CI 2007). As the largest lake in mainland Palawan, Lake Manguao is a natural heritage not only for the people of Taytay but for the entire province in general.

While the lake has been subject of many scientific researches in the past, much remains to be looked into in order to ensure the sustainable management of this wetland. As part of PCSD’s initiatives in protecting Palawan’s natural resources, it partnered with Western Philippine University to assess the socio-economic and biophysical profile of Lake Manguao, in relation to the lake’s potential as an ecotourism destination.

The output of this study will highlight the ecotourism potentials of Lake Manguao and will recommend institutional arrangements/co-management schemes and the proposed legal instruments to ensure that the resource is sustainably-managed. This will likewise require the review of related policy issuances concerning Lake Manguao.
The following are the specific objectives of this study:

1. Ascertain the biophysical, social, economic and environmental conditions of the wetland, using secondary data and information and come up with the Profile of Lake Manguao;

2. Recommend institutional arrangements specifically co-management/partnership structures to ensure sustainable management of the resource.

3. Identify legal instruments to support the proposed management structures.

Expected study outputs:

a. Profile of Lake Manguao to include Assessment of its Ecotourism Potential.

b. Ecotourism Management Plan of Lake Manguao incorporating the co-management arrangements and relevant legal instruments.

METHODOLOGY

Most of the data for the biophysical aspect were based on secondary information gathered by the team from municipalities and libraries. However, for the socio-economic profile, we conducted interviews within Lake Manguao, including a community consultation meeting sometime in September 14-16, 2014.

The results presented herein are those of the authors of published and unpublished data that we have cited and should be treated as such, in relation to intellectual property rights.
RESULTS

BIOPHYSICAL PROFILE

Forest Cover and Floral Component

The forest cover of Lake Manguao was last estimated in 1990 (Davies and Green, 1990), which was pegged at between 50-60%. Esseslstyn et al. (2004) on the other hand provided an estimate of about 60% forest cover. The floral elements of Lake Manguao were among the least studied biophysical component of the lake. To date, the floral species component of the Lake’s catchment was never completely studied except for the Protected Area Suitability Assessment (PASA) conducted by DENR (1999). During this assessment, about 50 tree species were identified, mostly of commercially valuable and more common species listed.

In terms of its aquatic flora, the most comprehensive study was conducted by Dolorosa in 2003, which documented about 20 species of aquatic macrophytes in the lake. The macrophytes recorded during Dolorosa’s study were mainly emergent species, particularly sedges such as *Cyperus* spp. and two species of herbaceous plants, the water lily *Nymphaea nouchali* and its close relative *Monochoria vaginalis*.

In 2000, Bastmeijer and Morco reported the presence of a Palawan endemic submerged macrophyte *Cryptocoryne pygmaea*, which were abundant in streams draining into Lake Manguao. The latest study on aquatic macrophytes of Lake Manguao was that of Puno (2013), which assessed the occurrence of the invasive water hyacinth *Eichornia crassipes* that was introduced in the lake sometimes in 2005. It was worth noting that in the 1990 study of Davies and Green in Lake Manguao, they noted that there were many beds of *Mimosa* sp. in the shallow littoral zone of the lake. This particular species however was not encountered in later studies and was presumed lost after the Nile tilapia *Oreochromis niloticus* was introduced in the lake in 1991 (Matillano, 2004).

Overall, there is a need for more floral assessment in Lake Manguao, particularly in the forests in the catchment (Fig. 1). There should also be an updated assessment of current forest cover and land use in the lake to determine present day forest cover and species diversity of the terrestrial plants. In addition, another assessment of the lake’s aquatic plants is also due to date since the last comprehensive study was conducted more than 10 years ago.
Mammals

The only study of mammals in Lake Manguao was that of Esselstyn et al. (2004). He recorded about 20 species in the Lake. Esselstyn et al. (2004) mammalian record of the lake, including the species recorded by the second author is presented in Table 1. Of these species, non-volant mammal species were identified as threatened due to hunting in the area, particularly the bearded pig, porcupine, and the Palawan pangolin.

Table 1. Mammal species recorded in Lake Manguao.

<table>
<thead>
<tr>
<th>Species name</th>
<th>Local/common name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-volant mammals</strong></td>
<td></td>
</tr>
<tr>
<td>Sundasciucus juvencus</td>
<td>Northern Palawan tree squirrel/bising</td>
</tr>
<tr>
<td>Tupaia palawanensis</td>
<td>Palawan tree shrew/itim na bising</td>
</tr>
<tr>
<td>Macaca fascicularis</td>
<td>Long-tailed macaque/Philippine macaque/unggoy</td>
</tr>
<tr>
<td>Mydaus marchei</td>
<td>Palawan stink badger/pantot</td>
</tr>
<tr>
<td>Manis culionensis</td>
<td>Scaly anteater/ Palawan pangolin</td>
</tr>
<tr>
<td>Hylopetes nigrepes</td>
<td>Flying squirrel/ buyatat</td>
</tr>
<tr>
<td>Paradoxurus hermaphrodites</td>
<td>Civet cat/pasla</td>
</tr>
<tr>
<td>Prionailurus bengalensis</td>
<td>Bengal cat/singgarong</td>
</tr>
<tr>
<td>Arctictis binturong</td>
<td>Palawan bearcat/manturon</td>
</tr>
<tr>
<td>Amblonyx cinereus</td>
<td>Asian small-clawed otter/dungeon</td>
</tr>
<tr>
<td>Species</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><em>Sus ahoenobarbus</em></td>
<td>Bearded pig/ baboy-damo</td>
</tr>
<tr>
<td><em>Maxomys panglima</em></td>
<td>A species of rat</td>
</tr>
<tr>
<td><em>Rattus exulans</em></td>
<td>Common house rat</td>
</tr>
</tbody>
</table>

**Volant mammals (bats)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cynopterus brachyotis</em></td>
<td>Fruit bat</td>
</tr>
<tr>
<td><em>Macroglossus minimus</em></td>
<td>Fruit bat</td>
</tr>
<tr>
<td><em>Rousettus aplexicaudatus</em></td>
<td>Fruit bat</td>
</tr>
<tr>
<td><em>Megaderma spasma</em></td>
<td>Insect bat</td>
</tr>
<tr>
<td><em>Rhinolophus acuminatus</em></td>
<td>Insect bat</td>
</tr>
<tr>
<td><em>Kerivoula hardwickii</em></td>
<td>Insect bat</td>
</tr>
<tr>
<td><em>Tylonycteris pachypus</em></td>
<td>Insect bat</td>
</tr>
</tbody>
</table>

**Herpetofauna**

In terms of herps (amphibians and reptiles), Schoppe et al. (2010) has studied the freshwater turtle populations of Lake Manguao, particularly at the permanent inflow called Manguao Stream. Three species of freshwater turtles has been recorded: including the Critically Endangered Philippine forest turtle *Siebenrockiella leytensis*, the Malayan box turtle *Cuora amboinensis* and the Asian leaf turtle *Cyclemys dentata* (Schoppe et al. 2010).

Other reptilian species encountered in the lake were the water monitor *Varanus salvator* and a crocodile species believed to be the *Crocodylus porosus*. Several species of amphibians were also encountered by the authors in the lake, notably riffle from *Staurois natator*, *Occidozyga laevis*, *Bufo philippinicus*, and *Rana sanguinea*.

**Birds**

Perhaps next to its freshwater fish fauna, the birds of Lake Manguao are the second most studied vertebrate group in the lake. A survey by Matillano (2007) and Echaure and Matillano (2008) recorded 135 bird species from 47 families. This represents 48 per cent of the total bird species recorded thus far in Palawan. Of these, 14 were Palawan-endemic while seven were widely distributed Philippine-endemics. Several species were under threatened categories of IUCN (2006).
Table 2. Total Species recorded in Lake Manguao

<table>
<thead>
<tr>
<th>Restricted Range (Palawan-endemic)</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippine Endemic</td>
<td>7</td>
</tr>
<tr>
<td>Migratory</td>
<td>25</td>
</tr>
<tr>
<td>Resident</td>
<td>84</td>
</tr>
<tr>
<td>With Migratory and resident population</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total Species</strong></td>
<td><strong>135</strong></td>
</tr>
</tbody>
</table>

**NEAR-THREATENED SPECIES**

*Parus amabilis* – Palawan tit

This species was frequently heard and seen high in the canopy of primary and residual forest within the lake’s catchment. Palawan tit is endemic to Palawan Faunal Region.

*Cyornis lemprieri* – Palawan blue flycatcher

Rarely encountered during the survey, two females of this species were captured in a mist net set adjacent to a small hill stream in a residual forest (Fig. 2). This Palawan-endemic bird was more common in higher elevation within the lake’s catchments and in areas where high quality or less disturbed forest exist.

Figure 2. A female Palawan blue flycatcher.
**Tersiphone cyanescens – Blue paradise flycatcher**

This bird is one of the most common flycatchers recorded in Lake Manguao. Although recorded within undisturbed forest habitats. It is usually encountered in degraded lowland forest and along the small tributaries draining into the lake (Fig.3).

**Tanygnathus lucionensis – Blue-naped parrot**

This species was rarely seen or heard in Lake Manguao in 2005-2006 surveys but was more commonly seen during the latter part of the 2006-2007 fieldwork. The highest number observed during the survey was five individuals. It is listed under Appendix II of CITES (Fig. 4).

**Oriolus xanthonotus – Dark-throated oriole**

This very vocal bird species was often recorded high in the canopy of old growth forest within the lake's catchment. This species was never recorded in brush lands and secondary forest patches in lower sections of the catchment, suggesting of a forest specialist.
GLOBALLY THREATENED SPECIES

*Egretta eulophotes* - Chinese Egret

VULNERABLE

This migratory species was first encountered in the lake in October 2005 sampling. One individual was observed in October, three in November, and at least five individuals each in January, February and March 2006. Individuals seen on February 2006 were already changing into breeding plumage and leg and bill coloration.

*Ptilocichla falcata* – Falcated ground babbler

VULNERABLE

This species was encountered in primary to residual forest in the catchment of the lake. It is fairly common in the area, usually recorded in association with ashy-headed babbler.

*Anthracoceros marchei* – Palawan hornbill

VULNERABLE

Among the threatened species recorded in Lake Manguao, Palawan hornbills were the most common next to Blue-headed racquet tails. Lake Manguao may boast the highest population density of this bird in an unprotected area, with an average of two birds for every hour of survey. A flock of seven birds is not uncommon in the lake.

*Ficedula plateni* – Palawan flycatcher

VULNERABLE

One individual was seen up close in the thick understory of a residual forest northwest of the lake. The record of this species in the lake indicates a northward extension of its range. The species was previously recorded only in Mantalingahan and Victoria-Anepahan Range in south and central Palawan.

*Polyplectron emphanum* – Palawan peacock pheasant

VULNERABLE

One individual was heard along a trail in an area dominated by thin bamboo grooves west of the lake. Locals claimed that this ground bird was more common in...
areas where good stands of forest exist, often heard calling during dusk.

*Prioniturus platenae* – Blue-headed racquet tail

VULNERABLE

This Palawan-endemic parrot species was a common sight in the lake. According to the residents, it is more commonly seen in banana plantations, where it feeds on ripening fruits. Some of the locals consider the species as pest.

*Ducula pickeringii* – Grey imperial pigeon

VULNERABLE

This species was seen only during the September 2005 fieldwork. One individual was seen with a flock of Green imperial pigeons. The present data is the second record of the species in mainland Palawan. Widmann et al (2005) first recorded the species in Malampaya Sound. Kennedy et al (2000) mentioned that the species was only recorded in small islands off Palawan and in the Sulu Sea area.

*Anas luzonica* – Philippine duck

VULNERABLE

The record of Philippine duck in the lake constitutes the first record of this Philippine-endemic duck in northern Palawan and the first record for Palawan after 22 years. The species was previously recorded only in Mantalingahan Range in southern Palawan. At least 147 individuals were counted in a roosting site northwest of the lake in March 2006. A flock of up to 325 individual birds was observed in May of the same year.

\[\text{MIGRATORY SPECIES}\]

Generally, there was an increase and decrease in diversity and abundance of migratory birds within the lake during the survey, particularly for family Ardeidae represented by egrets and herons (Figure 8).
An increase in population of white egrets was evident based on counts in the communal roosting site, with highest numbers counted in January 2006. Likewise, a sudden decline in the number of birds in the roosting site was observed from February to May 2006 (Figure 8), which coincides with the winter and spring migration.

IUCN threatened species were among the birds hunted e.g. Palawan Hornbill.
Local information implies that the lake has been one of the favorite hunting grounds for game birds in the 1990s, when even rich hunters from Puerto Princesa go to the area to hunt. Interviews revealed that hunting still persist within Lake Manguao, mainly for local consumption. However, this was not considered as a subsistence activity due to the presence of a more stable source of staple food and livelihood i.e. Tilapia fishery.

The absence of the critically endangered Philippine cockatoo confirmed that it is already extinct within the lake’s catchments. The locals said that there used to be hundreds of cockatoos in the lake sometime in the 1960’s. However, local trappers lured by buyers extirpated the remaining population in the 1980’s to early 1990’s. The most popularly hunted birds in the lake were those that belong to family Columbidae or the pigeons and doves, which were intended mainly for consumption. Hunters are mainly residents but at least in two occasions we have encountered non-resident hunters.

We did not encounter any trade related poaching of birds, however, we have found out that the locals do keep some of the species they have caught and when visiting people from outside the lake wants to buy the caged birds, locals do sell them if the price is right.

**Fishes**

The fish fauna of Lake Manguao was first studied by Day (1914) and Herre (1924). For these two studies, a total of five species were recorded. After then, a 1990 study of Davies and Green recorded seven species, including those recorded by Day (1914) and Herre (1924). The number of species almost doubled (12) in 2002 when Matillano (2002) recorded five additional fish species never previously caught in Lake Manguao. Consequently, in another fish survey conducted by Matillano in 2010 and 2012, one potentially new fish species were collected, making the total species diversity of fish in Lake Manguao 14 (Tab. 3).
Table 3. Number and year of fish species recorded in Lake Manguao.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of species</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>1924</td>
<td>5</td>
<td>Day (1914) Herre (1924)</td>
</tr>
<tr>
<td>1990</td>
<td>7</td>
<td>Davies and Green (1990)</td>
</tr>
<tr>
<td>2010</td>
<td>13</td>
<td>Matillano and Saclet in prep.</td>
</tr>
</tbody>
</table>

In Matillano’s 2002 study in Lake Manguao, 12 fish species from ten genera belonging to the families Anabantidae, Channidae, Cichlidae, Claridae, Cyprinidae, Eleotridae, Hemiramphidae and Siluridae, of which 4 were endemic to the lake were. In addition to species previously accounted for in earlier studies by Day (1914) Herre (1924) and Davies and Green (1990), two new fish species were recorded, *Clarias macrocephalus*, a native catfish of the Philippines and a so far undescribed *Puntius* species.

The two endemic *Puntius* species first described by Day (1914) as *P. manguaoensis* and *P. bantolanensis* were found and their taxonomic status verified. Furthermore, *Pterocryptis taytayensis* was collected and the synonymy of *Penesilurus palawanensis* with *P. taytayensis* confirmed. In a more recent study by Matillano and Saclet in 2010, another Palawan endemic species was collected in Lake Manguao, the pygmy *Rasbora R. taytayensis*. This brings the total number of fish species in the lake at 13. In 2011, Matillano also collected an additional undescribed species from Lake Manguao, which if added will bring the total fish fauna in the lake at 14 (Appendix 2).

The lake fishery focuses on the exotic Nile Tilapia, which was introduced in 1992. Of secondary fishery importance are other introduced species while the native lake fishes are of minor or no interest to fisheries.

**Species Specific Studies on Lake Manguao Fishes**

**Diet of *O. niloticus* (Tilapia)**

*Oreochromis niloticus* has the most economic importance in the lake. Thus its biology has to be studied. Diet composition of fish is important in the population interaction within a lake community. Hence, its dietary items in Lake Manguao have been studied by Amador (2013), specifically the relative diet composition for each size classes during different water levels (low and high).
The results of the study showed that cyanobacteria, leaf particles, wood particles and sand particles constitute the diet of *O. niloticus*. Cyanobacteria were found to be the most preferable food of all the size classes. In addition, the composition of stomach content of *O. niloticus* did not vary with the different water levels of the lake. Higher percentage of sand particles was found in juvenile than in adult individuals, which was attributed to the preferred niche and habitat of different life history stages.

Results of this study imply that *O. niloticus* in Lake Manguao are herbivorous and detritivorous, feeding in different trophic levels within the lake. This study showed that *O. niloticus* were not feeding on the endemic cyprinids of the lake. However, the researcher recommends further study on the diet of *O. niloticus* through controlled feeding environments and additional studies on the diet of other fish species within the lake to verify the degree of food competition (Amador 2013).

**Sexual Maturity of *O. niloticus***

A study of sexual maturity of *Oreochromis niloticus* was conducted in Lake Manguao, Taytay, Palawan last February 2013 by Bantiling. The study aimed to determine the gonadosomatic index of *O. niloticus* in relation to total length (TL) and total weight and as well of the former with gonad weight and determine the sexual maturity and length at maturity of *O. niloticus*. Collecting of samples was done using one type of fishing gear, the gill net. All fish were measured for total length and total weight to the nearest 1g for the gonadosomatic index calculation. The stages were determined after the specimen were dissected and the gonads were examined after separating the sexes.

Out of 222 samples, only 49 gonads were matured (35 males and 14 females). The results showed that Gonadosomatic index (GSI) of males ranged from 0.01% to 0.70% and the female GSI ranged from 0.04% to 3.55%. GSI values of females were higher than males. Even though, there is a positive relationship between GSI and Total length (TL) (R2=0.022), the value of GSI coefficient (R2=0.001) was low. Linear regression analysis showed that there is no distinct relationship between GSI and Total weight (TW) (R2=0.017) whereas, the TL and Gonad weight (GW) showed a positive relationship (R2=0.010).

Based on the results, the sexual length at maturity for the female ranged from 9.4cm to 20cm TL while for males it ranged from 9.6cm to 20.5cm TL. This shows that the *O. niloticus* in Lake Manguao were sexually mature at a length of 9.4cm TL for males and 9.6cm TL for females. As such *O. niloticus* in Lake Manguao matures at a smaller size within compared to its conspecifics outside the lake (Bantiling 2013).
Socio-economic Profile of Lake Manguao

Political Subdivisions

The entire catchment of Lake Manguao was technically under the jurisdiction of Barangay Poblacion and Barangay Bantulan. However, most of the geopolitical affiliation was with Poblacion since the village center was situated within the boundaries of this barangay. As a Sitio of Barangay Poblacion, it was headed by a Sitio Leader, which is responsible in the political affairs of the Sitio. However, Lake Manguao somehow enjoys direct supervision as well from the LGU of Taytay, being a unique community in Taytay and having regular rangers that oversee the day to activities within the lake.

Population Demographics

Compared with other Philippine lake side communities, Lake Manguao has a very small population with just 65 families and 302 individuals; a population density of 6.82 persons per km$^2$ is considerably low. The residents belong to five ethnic groups (Table 4), with the Cuyuno comprising more than 60% of the entire populace. Religious affiliation is mainly Roman Catholic, and the community has one chapel that is visited by a lay minister once a month.

Table 4. Population data for Lake Manguao.

<table>
<thead>
<tr>
<th>Population data as of August 2014</th>
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<tbody>
<tr>
<td>Number of families/household</td>
</tr>
<tr>
<td>Total Population</td>
</tr>
<tr>
<td>Average family size</td>
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<tr>
<td>Male to female ratio</td>
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<tr>
<td>Population density (catchment)</td>
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<tr>
<td>Ethnicity</td>
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<tr>
<td>Religious Affiliation</td>
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Land Ownership

In terms of land holdings, more than 80% of the populace has either declaration of rights or tax declaration as their tenured instruments on their properties. More than 90% of the populace owns both residential and farm lands, with an average of 1093m$^2$ as residential area and an average of 5.97 hectares of farmed area. This was made possible by the provision of the municipal government of a community subdivision with
the lake, which relocated most of the residents into an area (sitio) where all residential houses are now concentrated, in effect, centralizing the village of Lake Manguao.

**Access to education and other basic government services**

The educational background of majority of the population was elementary or high school graduate, with less than 10 individuals making it to college level education or a college degree. The community has one day care center but no elementary school. Hence, students have to transfer either to Barangay Poblacion or Bato for basic education access. There was no Sitio Clinic, but access to the Northern Palawan Hospital is within 10 minutes by private motorbike transport. Access to medical clinics was at least 25 minutes by motorbike.

There was no regular public transportation going to Lake Manguao. As such, motorbike is the most common means of going to the town center of Taytay or taking a 45 minute walk to the highway and taking public transport via the national road adjoining the feeder road to the lake. Within the lake, transportation was limited to paddle boats and at times the motorboat owned by the municipality. There were trails connecting two coves of the lake but to travel to the many other coves, the use of boat was the only means of transport.

Information source in the lake, particularly local news was mainly by radio programs broadcasting from Puerto Princesa. At least one household has satellite TV with access to cable channels. Recreational facilities in the lake are also limited, except for the basketball court and a light-material cock fighting arena near the village center. On the other hand, cellular phone signal was scars and internet communication was not popular at all.

**Livelihood and other source of income**

The residents of the lake were mainly farmers and fishermen. Almost all families were fishing most of the year and engaged in farming. The average monthly income from fishing in Lake Manguao was Php2500-Php5000. Fishing was inherently focused on the introduced Nile tilapia. Interestingly; there was no seasonal variation of fish catch within the lake. The fluctuation of income from fishing was more of a reflection of fishing effort and market demands for tilapia. Other sources of income within the lake include daily labor (pasuhol) and income derived from animal husbandry and harvesting of non-timber forest products.
ECOTOURISM POTENTIAL OF LAKE MANGUAO

Lake Manguao’s potential for ecotourism activities was unparalleled in mainland northern Palawan. Its location within a few minutes of the town proper of the municipality of Taytay and within two hours from El Nido and San Vicente makes it an ideal ecotourism site and an alternative inland ecotourism destination. However, until today, facilities were still lacking in order to provide even basic comfort to tourists that visit the lake.

Having a surface area of more than 600 hectares and a catchment area of at least 4000 hectares, the lake has a big potential for sustainable eco-tourism activities that will not only promote conservation of the Lake Manguao Biosphere but at the same time provide additional income to local residents.

Tourists visiting Lake Manguao included both local and foreign visitors. From January 2013-August 2014, 338 foreign tourists visited the lake, the top three groups were from France (48%), Germany (7.4%), and Singapore (6.2%). Among the locals, visitors from Taytay, Puerto Princesa, and Roxas topped the list while the top three visitors from outside Palawan were residents of Manila, Cebu, and Bulacan.

Several activities like hiking, birdwatching, camping, fishing, butterfly watching, and kayaking can be established within the lake. Below each activity was discussed and potential development sites were also presented in the accompanying map.

Regular tourist activities

a. Birdwatching – boasting more than 130 species of birds, with at least 10 Palawan endemics inhabiting its catchment, Lake Manguao is the place to be when bird watching in Taytay. Birdwatchers can use the same hiking trails but more adventurous ones can kayak to have a close encounter with giant kingfishers, feeding herons and eagles, and wandering ducks. Observation towers (Fig. 11) can be erected at strategic sites that can also act as research and sampling stations for visiting researchers (Fig. 12).

b. Boating/kayaking – one of the best ways to explore Lake Manguao is by kayaking. With more than 640 hectares of open water, there is more than enough room for exploring and testing your rowing skills.

c. Camping – Lake Manguao’s natural beauty will be a big draw for campers that want to enjoy nature. Several areas in Lake Manguao are ideal camping grounds that can cater to weekend campers and even to institutionalized
camping programs like the Boys and Girls Scouts of the Philippines (Fig. 11 and 12).

d. **Carabao rides/horseback riding in the lake** – these activities will provide an alternative way of hiking around the lake or getting into the lake itself. This is also a good way of involving the locals in tourism activities in community.

e. **Fishing** – for those that wants to try their luck in sports fishing, Lake Manguao has several game fishes, most of which are native species except for Tilapia. Snakeheads (dalag), catfishes (pantat and labiyog), as well as several species of minnows (paitan, papait) are very abundant in the lake. Selling of fishing permits can augment local income from tourism. Annual fishing tournaments in Lake Manguao will encourage tourism activities. **WARNING: Only existing fish species should be used for sports fishing in the lake. NO INTRODUCTION of non-native game fishes!**

Figure 11. Clockwise from top left: fishing, birdwatching, camping and boating in Lake Manguao.
f. **Fish spa** – the small minnow fishes in the lake are good candidates for spa fish species. As we have observed in the lake, soaking ones feet attracts many small minnows that tirelessly nibble on your toes.

g. **Hiking** – with its undulating terrain and the very dendritic (finger-like) shape of the lake’s coastline, it offers a huge potential for thrill seekers that wanted to hike around lake Manguao. Hikers can walk around the lake. Enjoy the scenic vista and even visit the volcanic crater that was responsible for the formation of the present day Lake Manguao. The trail can be made in such a way that it goes deep into the forest then swing back to the lake’s coastline and more gentle slopes to provide a challenging, yet relaxing hike (Fig. 12).

**Annual events in the lake**

h. Annual tree planting activities – in the same way that Pista y ang Cagueban is to Puerto Princesa, *Pista y ang Danao*” will be one way to rehabilitate Lake Manguao’s forest and encourage people to visit the lake, at least once a year.

i. Lake Manguao Amazing Race – annual triathlon event that will be held every year in Lake Manguao, coinciding with the Pasinggatan Festival of Taytay every first week of May.

j. Fishing tournaments – this annual fishing tournaments will focus on tilapia and snakehead in the lake. Again, this can be scheduled with the Pasinggatan festival in Taytay.
Figure 12. Location map of Lake Manguao showing the trail and potential tourist activity areas. Green line around the lake shows the proposed hiking trail.

The abovementioned activities will not only draw visitors in the lake but at the same time, it may also provide a source of income to local residents. These activities are also geared towards low-impact tourism within Lake Manguao so that the welfare of wildlife and the local community vibe can be maintained.
ECOTOURISM MANAGEMENT PLAN FOR LAKE MANGUAO

This report presents issues on ecotourism development in Lake Manguao as well as recommendations and potential solution to these issues. This report details the ongoing initiatives of the local government of Taytay in terms of management of the lake and its resources, including: current projects, plans, collaborations, and partner institutions.

Issues and Concerns for Ecotourism in Lake Manguao

Ecotourism is definitely a viable option for Lake Manguao. However, several issues have been identified during the assessment in the lake.

1. Lack of Basic Necessities for the Community

During the community meeting that we held in Lake Manguao, the locals identified three major problems like lack of electricity (power), source of potable water, and basic (elementary) education. Thus these basic needs problems should be resolved first before any eco-tourism initiatives could come in. This contradicts with the tourism development of the lake since the basic needs of the local community has to be addressed first before the implementation of the ecotourism development plan. Thus eco-tourism plan of the lake should include this concerns.

2. Lack of Tourism Facilities and Support Structure

Lake Manguao nowadays is basically in the raw condition, in terms of ecotourism facilities and support structure. The road going to the lake is still a dirt road that is sometimes not passable during rainy season. Some sections of the road are well-paved all weather road, however, there are still sections albeit short, that remains impassable or at least difficult to negotiate during times of heavy rainfall since the road becomes too muddy even for four-wheel drive vehicles.

There is no visitor center within the lake where tourists gets registered and monitored. At present registration of visiting tourists remains a responsibility of the two rangers in the lake. There are also no signages that can provide direction, location, or some form of educational information for Lake Manguao. Although the lake has some forest trails, these are not on the map and are therefore not utilized for tourism purposes. Lastly, there are no organized paddle boat or kayak tours within the lake, which in the absence of a trail along the lake's coastline, would have been the only alternative way of exploring Lake Manguao. The main driver of tourist visits in Lake Manguao are the tours offered by Casa Rosa, aside from this, there are no tour operator nor agencies that market Lake Manguao as a tourism site mainly due to lack of
tourism support facility. To date, the only existing support structure is a unisex public toilet facility.

3. The local community in Lake Manguao is not ready for tourism just yet

Just with any community that has never been exposed to mainstream tourism, we perceived that the local community in Lake Manguao is definitely not prepared just yet for ecotourism development in the lake. The locals, who have been mainly exposed to fishing and farming type of livelihood, have some very vague idea of tourism related livelihood in the lake. However, we see this as an opportunity to have the locals’ complete participation in the development of the tourism management plan for Lake Manguao. During the consultation with the locals, residents have signified interest and willingness to be trained in tourism related livelihood opportunities. Such enthusiasm will be instrumental in fine-tuning the tourism involvement of the community for them to reap benefits from the tourism potential of Lake Manguao. Right after our consultation the community formed their local association, manifesting that they will be cooperative and supportive of eco-tourism opportunities in the lake.

4. Environmental Resources Management for Lake Manguao

Perhaps this is the biggest challenge for tourism development in Lake Manguao. Special as it is, Lake Manguao until today has no protected area status, may it be under the NIPAS law or through the auspices of the Fisheries Code or Local Government Code of the Philippines. As such, there is no concrete management structure that specifically regulates Lake Manguao as a vital resource of the municipality of Taytay. Prior to year 2000, Lake Manguao has been populated by immigrants that took advantage of the booming Tilapia fisheries in the lake, which resulted to rapid deforestation along the lake’s shoreline to give way for the construction of temporary and semi-permanent informal settlements for migrant fishermen. However, due to the immediate action of the LGU back then, a municipal resolution has been passed that resulted to the eventual translocation of the informal settlers within the lake’s catchment. What remained today in the lake are community members that have been in residence in Lake Manguao since the 1960s.

Although technically belonging to DENR as a resource due to its classification as timberland and partly with the BFAR for its aquatic resources, most of the management of Lake Manguao is currently being implemented by the local government of Taytay. Since the 1990s, Lake Manguao has two designated forest rangers that are on plantilla position with the local government unit of Taytay, under the present day Taytay-MENRO. These two rangers, together with the other Taytay-MENRO officers and other employees has been the main regulatory arm that enforces for the environmental
protection of Lake Manguao, with some assistance from the rangers of DENR-CENRO in Taytay.

Management Tools and Current Initiatives of the Municipality of Taytay

The current condition of ecotourism in Lake Manguao may be deplorable, however, it is also very evident that there are currently on-going initiatives that the local government of Taytay and its partners have been doing to address these issues.

Development of tourism facilities and support services

As part of the tourism development plan of Lake Manguao, Taytay is going to implement a major ecotourism development for Lake Manguao which will be implemented in 2015. This was made possible through the efforts of the municipal government in setting aside of a multimillion budgets specific for the development of Lake Manguao. In addition, this will also be provided with counterpart funding from the provincial government. Included in this project is the construction of tourism support facilities in the lake such as picnic areas, board walks, and hiking trails. Part of this initiative is the provision of the basic needs of the local residents to prepare them in ecotourism activities and organization of the local residents into tourism-ready players.

1) LGU Initiatives for resource management in Lake Manguao

Presently the current administration of the municipality has been very strong in terms of providing a concrete management structure for Lake Manguao. Taytay has secured a funding from the German Development Agency through the DENRs Protected Area Management Enhancement Project (PAME Project). The main objectives of this project is to a) formulate a management plan for Lake Manguao, which includes mapping all of the lake’s resources both social and biophysical, b) strengthen the enforcement of the municipalities rangers and provide training and equipment for the rangers and other enforcement officers and c) provide funds for environmental education initiatives that will uplift conservation awareness of the community not only in the lake but for the municipality itself to ensure the protection and conservation of Lake Manguao. This project will be implemented in partnership with Western Philippines University, of which the LGU has a Memorandum of Agreement in the pursuit of managing the resources of Lake Manguao. In addition, The LGU has funded the construction of a ranger station for Lake Manguao which will be used as the main enforcement and environmental center of the municipality in the lake.
More importantly, the Sangguniang Bayan of Taytay is on the final stage of enacting an ordinance declaring Lake Manguao as a Municipal Conservation Area and Ecotourism Zone. Through this ordinance, it is envisioned that the management of the natural resources of Lake Manguao will be strengthened and its tourism development will be regulated effectively. In particular, the management of Lake Manguao will be through the Municipal Conservation Area Management Board which will be headed by the municipal mayor, and composed by a multisectoral body representing all stakeholders of Lake Manguao, including tourism stakeholders, peoples organizations, academe, and technical advisers from PCSD and DENR.

2) **LGU Partnership with Western Philippines University**

Since 2002, the municipality of Taytay and the Western Philippines University has been in constant collaboration in terms of research programs in Lake Manguao. This collaboration was finally formalized in December of 2013 through a memorandum of Agreement between the LGU of Taytay and Western Philippines University to foster research, conservation, and development initiatives in Lake Manguao in particular and in Taytay in general. A major output of this collaboration is the joint implementation of the GIZ-PAME funded project that will be jointly implemented by WPU and Taytay LGU starting last quarter of 2014 to Last quarter of 2016. In addition, WPU will also finance a Biological Field Station and Visitor Center that will be constructed on a property that will be donated by the municipality of Taytay. This research and visitor center will serve both educational and scientific as well as tourism development of Lake Manguao.

3) **Policy Related Development**

In terms of tourism related policies in Taytay, the municipality is one of the first to craft and enact a municipal tourism code in Palawan. Presently, the LGU, through its Municipal Tourism Council (MTC) is finalizing the IRR of its Municipal Tourism Code. The MTC has representation from all the major stakeholders of tourism in the area, including from the academe and private institutions and industry players. The MTC is recognized as a body that has the mandate to regulate and scrutinizes any tourism related development plan or policy with regard to tourism specifically in Lake Manguao and generally in the whole municipality of Taytay. As such, any tourism related project should be fully endorsed first by the MTC before it could go to the Sangguniang Bayan and eventually get the approval from the Mayor’s office. The same will be true for any initiative that may potentially be drawn out of this report.
RECOMMENDATIONS FOR ECOTOURISM

It is advantageous that the Taytay LGU has developed the lake tourism plan, thus other future plans and activities for the lake should be anchored, harmonized, and integrated with the existing local plan. As such, stakeholders and partners should support and assist in the realization and enactment of the plan. Strategies incorporated in the plan should have budget allotments. If there is budgetary constraint, budget allotment may be done by phasing on priority basis. Monitoring and evaluating the plan implementation will save effort, time, and money towards attaining management goals.

Additional policies should as well complement existing policies and regulations, while the effectiveness of existing laws should be studied in the process for further improvements.

Since Lake Manguao has been declared as a Municipal Conservation Area, the municipality should enter into a Memorandum of Agreement with DENR so as to take advantage of collaborative efforts, like patrolling the forests in the catchment.

PCSD and DENR, as national agencies shall provide technical/financial support and legal advices to LGU of Taytay in connection with the LGUs initiatives for the lake’s sustainable development. At the same time, the DENR and PCSDS should take advantage of the devolved function of the municipality of Taytay in terms of managing the resources within its jurisdiction, e.g., Lake Manguao. Likewise, DENR and PCSD shall consider the lake as a priority project site in such large projects funded by national or foreign entities.

DENR and PCSDS’ expertise should be tapped by the LGU in the formulation of the IRR of the municipal tourism code of Taytay to ascertain that such IRR is in harmony with the existing national policies and laws pertaining to the development of tourism destinations. The resource/tourism map provided in this report can be use as basis for zoning of the lake in terms of sustainable use.

The academe (WPU) should continue to support the management of the lake in terms of research, educational fieldworks, information campaigns, educating the young and the youths. Thus the partnership should be institutionalized. A learning center or a research facility should be afforded to accommodate WPU, to enable their researchers to do studies dedicated to the protection, conservation, and sustainable development of the lake and its resources. This will ensure long term provision of technical/scientific assistance for management not just in Lake Manguao, but in the entire municipality of Taytay as well.
The Lake management shall use an adaptive management wherein best suitable management scheme shall be sought for the Lakes specific needs and features. At the moment the LGU has the largest stake in its management, hence the LGU must receive all the support from other stakeholders and agencies. However, LGU management scheme and performance shall be closely monitored for efficiency and effectiveness.

The Lake’s sustainable tourism documents do not contain specifics on strategic and action plans yet, thus this documents shall be improved to contain the elements of plans that will easily guide the managers and decision makers on their day-to-day activities in managing the sustainable development of the Lake.
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