# The Changes in Fish Species Living in Tanks Due to Renovation of Small Tanks in the Dry Zone in Sri Lanka (Case Study in Galgamuwa Division in Kurunegala District)

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**Abstract**
*From ancient times, multi propose institutes and organizations have involved with small tanks renovation in Sri Lanka. Small tanks have an irrigated command area of 80 ha (1 ha = 2.47 acres) or less. Renovators applied remove soil from tank, renovate tank bund, remove plant cover on the tank, slues repairing, spill (Wana) repairing and channel repairing as types of tank renovation. This renovation steps directly have an effect on fish species living in the tank. In this research it has been identified that fish species change as a result of small tanks renovation. The study was conducted based on 12 small tanks in Galgamuwa DS division in Kurunegala District. The population of fish spices that was not changed were, Thilapiya, Banded etroplus, Flying barb, Clinbing perch, Spiny eel, Eel and Freshwater catfish. Snakehead, Steiy catfish, Orange fin labeo and Walking catfish showed a negative change in their population after renovation. Orange fin labeo was found rarely in tanks before the renovation but it is not reported at present from the renovated tanks. Hypothesis testing at 5 percent significance level indicates that the populations of Oryzias species and Olive barb have grownup after the tank renovation. According to the results obtained through the transect analysis there are no changes in frequency, relative frequency, density, relative density, abundance and diversity of the fish species in the renovated and non-renovated small tanks. Accordingly, there is no ecosystem damage related to the fish species living in small tanks due to small tank renovation.*

**Key words:** Small tanks, Dry zone, Renovation, fish species, Eco system.

## Introduction

There are number of small tanks in the north part of the Kurunagala district which preserve the water requirement of people. In Galgamuwa District Secretariat (DS) division this minor irrigation system is providing not only the water needs but also it conserve the environmental

quality of the whole area of the dry zone. Therefore, it is a man made Eco friendly ecosystem which is neglected recently. This can be developed as a solution for the water scarcity in the dry zone area which is studied under this research.

Further, it is identified that the changes in fish species living in tanks effect from the renovation that was taken place after the dilapidating of small tank which compare with past significant of eco friendly environment of small tanks. The findings can be used to other development programs of small tanks to concern with their eco-friendly environment which helps to improve the village ecology and economy.

This experience can be also applied in other development programs such as reservoirs. Therefore this problem is very important to be studied.

Small tanks are used for collecting runoff water during the monsoon for irrigation and domestic water supply. They are created by constructing an earthen bund across a natural drainage basin. According to Aheeyer (2005), Darmasena (1991, 1995), Madduma Bandara (1980,1985), Thennakoon (2002, 2004) tanks are developed in response to the need for more intensive cultivation when traditional forms of extensive cultivation can no longer support the growing population. Small tanks in Sri Lanka are those having an irrigated command area of 80 ha (1 ha = 2.47 acres) or less.

**Objective of the Research**

To identify the factors that affect the fish species living in the tank after renovation of small-scale tanks.

**Methodology**

**Study area**

The selected site is located in Kurunegala District of North West Province in Sri Lanka covering an area of 278km. The area is representative of a wider agro ecological region known as the Lowland Dry Zone, which experiences high levels of rural poverty associated with short rain fed growing seasons and degrading, nutrient-poor red soils. North West Province is the Province in Sri Lanka most richly endowed with small-scale tank systems which situated between and $7^0$50’ north latitude and $8^0$15’ and 79 $^0$57’ and $80^0$45’ East longitude and 300m above sea level.

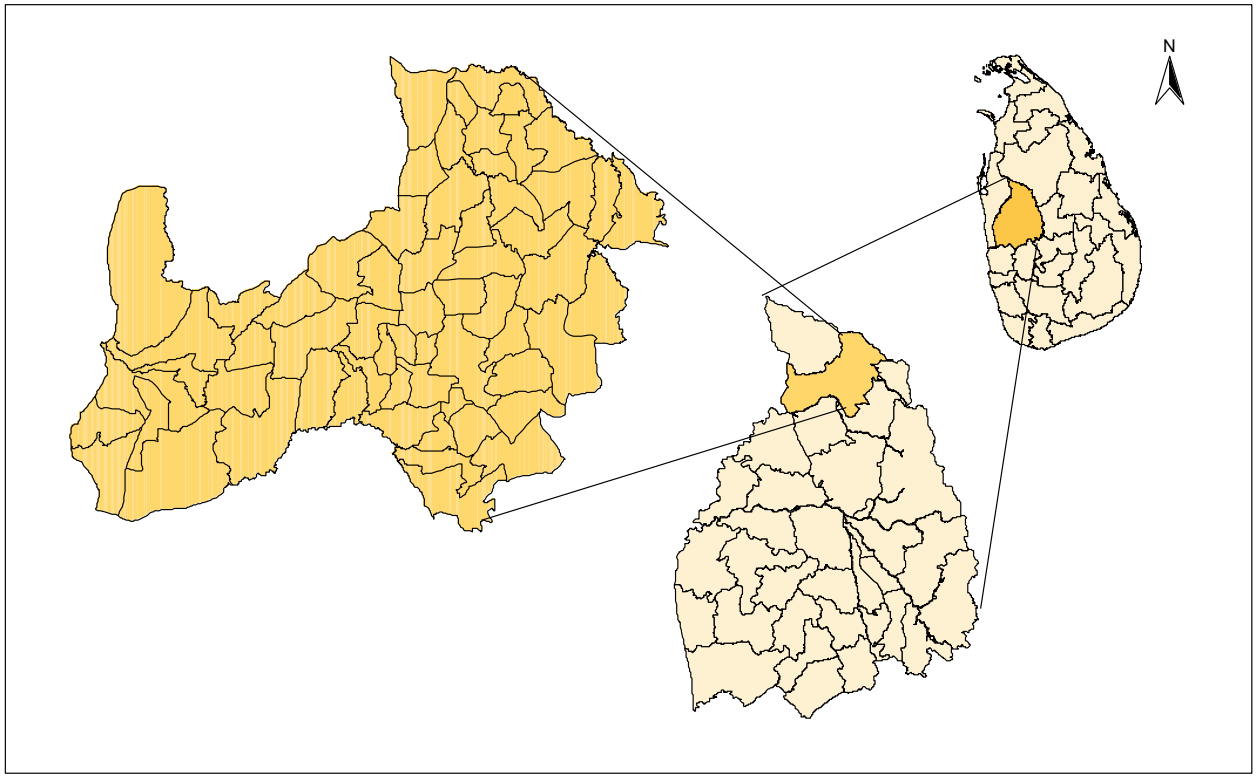


Figure 1 Location of the study area and Gramaniladhari divisions (GN) of selected tanks
Source-: Land-use planning unit- Kurunegala.

The Division has 182 nos. of small villages and 62 nos. of Gramaniladhari Divisions with the number of service institutes such as Police Stations, Banks, Schools, Hospitals, etc.

**Methods used for Data collection**

In order to collect information for this study, primary and secondary data collection methods are used. Primary data refer to which are collected by the researcher; individually. There are several techniques to collect primary data.

- Questionnaire Method
- PRA
- Focus Group Discussion
- Interviewing
- Observing
- Field plot transects

Secondary data refer to which are directly taken from Government or Private Publications. There are several types.

- Government Publication
- Institutional Publications

- News Magazines
- Journals
- Internet

**Primary Data**

The primary data for this research was collected through the questionnaire method. Each questionnaire was filled by the researcher while he was discussing with the people in towel small tank villagers, who were selected using stratified sampling techniques (table 1,2, and 3). Further, focus group discussion was included in the primary data. Discussions were also made with group of people while supervising the tank environment. Those facts are also considered for this research paper. The other primary data collection method was field observation; the researcher gained a clear understanding about the exact field by observing them.

Table 1 - **Selection method for Tank samples (Step I)**

| No of farmers<br><br>Command area ( Acres) | 0 - 59 | 60 - 119 | 120 - 189 | 190 – 249 | Total |
|---|---|---|---|---|---|
| 0 – 35 | 55 | 3 | 1 | 0 | 59 |
| 36 – 71 | 10 | 3 | 0 | 0 | 13 |
| 72 – 107 | 0 | 3 | 0 | 1 | 04 |
| 108 – 143 | 0 | 1 | 0 | 0 | 01 |
| Total | 65 | 10 | 01 | 01 | 77 |

Table 2 - **Selection method for Tank samples(Step II)**

| No of farmers<br><br>Command area (Acres) | 0 - 59 | 60 - 119 | 120 - 189 | 190 - 249 | Total |
|---|---|---|---|---|---|
| 0 – 35 | 55/77 ×12 = 8 | 0 | 0 | 0 | 08 |
| 36 – 71 | 10/77× 12 = 2 | 3/77 × 12 = 1 | 0 | 0 | 03 |
| 72 – 107 | 0 | 3/77 × 12 = 1 | 0 | 0 | 01 |
| 108 – 143 | 0 | 0 | 0 | 0 | 00 |
| Total | 10 | 02 | 00 | 00 | 12 |

Table 3 - **Name of selected tanks using random table and no of selected villagers for sample**

| In no | Random No | Name of The Tank | No of villagers | Command area (Acres ) | no of selected villagers for sample |
|---|---|---|---|---|---|
| 01 | 118 | Pahala Pulachchiya wewa | 58 | 08 | 15 |
| 02 | 87 | Ihalagama wewa | 13 | 08 | 3 |
| 03 | 41 | Pahala koon wewa | 31 | 34 | 8 |
| 04 | 05 | Ihala Palukendawa wewa | 40 | 12 | 10 |
| 05 | 11 | Ottukulama wewa | 18 | 18 | 5 |
| 06 | 83 | Dullawa wewa | 49 | 30 | 13 |
| 07 | 16 | Kurundankulama wewa | 35 | 35 | 9 |
| 08 | 10 | Monnankulama wewa | 46 | 27 | 12 |
| 09 | 02 | Pahala Palukendawa wewa | 35 | 35 | 9 |
| 10 | 29 | Bulnewa wewa | 59 | 54 | 16 |
| 11 | 90 | Medawachchiya wewa | 105 | 71 | 27 |
| 12 | 93 | Mahagalkadawala wewa | 90 | 75 | 23 |
| | | Total | 579 | | 150 |

**Secondary data**

Secondary data was collected by using Government reports, periodicals & other publications which have published by Government or any other institutions. The divisional secretariat office in Galgamuwa was vital in providing data for the research. Further, the agrarian office and other sub institutions which relevant to farmers' affaires provided much secondary data.

**Results and Discussion**

**The changes in fish species living in tanks**

Some fish species lived in the studied tanks few decades ago have either reduced in population or disappeared due to various reasons (Gunathilaka, 2007; Maduranga, 2003; Pethyagoda, 1991; 2005, 2006, 2008a, 2008b; Silva et al., 2008). Renovation process impacts many changes in the tank and its surroundings leading to positive and negative trends in the biodiversity (Shagi, 2002). The fish species living in the studied small tanks that are common and well known to the tank community are given in Table 4.

Table 4- **Common fish species identified by the villagers from the study area**

| Common name (English) | Common Name (Sinhala) | Scientific Name | Occurrence | |
|---|---|---|---|---|
| | | | Before renovation | Present situation |

| | | | | |
|---|---|---|---|---|
| Tilapia | Tilapia | *Tilapia nilotica & mossambica* | All tanks | All tanks |
| Banded Etroplus | Koraliya | *Etroplus suratensis* | All tanks | All tanks |
| Flying Barb | Dandiya | *Esomus danricus* | All tanks | All tanks |
| Climbing perch | Kawaiya | *Anabas testudineus bloch* | All tanks | All tanks |
| Steiy Catfish | Hunga | *Heferopneustes lossilis* | All tanks | RT2,3,4,5,7,8,9,10 and all NRT tanks |
| Orange Fin Labeo | Hirikanaya | *Labeo lankae* | RT1,4,5,7,8,11,12 | Not at all tanks |
| Spiny eel | Theliya | *Mastacembelas armatus* | All tanks | RT 1, ,8,10, 11,12 |
| Eel | Ada | *Anguilla bicolor* | All tanks | RT 9,10,12 |
| Walking Catfish | Magura | *Clarias brachysoma* | RT1, 3, 8, 11,12 & NRT4, 6,7,10 | RT8,11,12 & NRT4, 6,7,10 RT 1,8,10,11,12 |
| Oryzias species | Thiththaya | *Puntius sp (vittatas)* | RT 10,11,12 | RT 1,3,5,8,9,11,12 & All NRT tanks |
| Olive Barb | Pethiya | *Puntius sarana* | All tanks | All tanks |
| Freshwater catfish | Ankutta | *Mystus vittatus* | All tanks | All tanks |
| Snakehead | Loola | *Csanna sriata* | All tanks | All tanks |

Source :- Field observations during 2007 - 2012

It was attempted to link the effect of removal of the aquatic plant cover and expansion of the water capacity by dredging during the renovation with the existence and abundance of the fish species and their growth. It was observed that the fish species of Tilapia and Banded etroplus live in large numbers in the tanks selected for the study before renovation and at present. Out of the tanks selected for this study, formal fishery is being systematically practiced only in RT 11 and RT 12 tanks while informal (non-systematical) fishing is practiced in other tanks. The specialty of the RT 11 tank is that fingerlings (Tilapia, Catla and Carp sp.) are released and captured once those are grown (culture-based fisheries or CBF) but in RT 12 tank CBF is not practiced although traditional fisheries is prominent. Only under these two tanks, the fishery is overviewed by the respective farmer organizations.

**Effect of renovation on common fish species**

As per the hypothesis testing (Mann-Whitney Test) performed at 5 percent significance level, the population of fish spices that was not changed were of Thilapiya, Banded etroplus, Flying barb, Clinbing perch, Spiny eel, Eel and Freshwater catfish. As per the questionnaire survey and field observations, Thilapia lived in large numbers in the tanks even before the tank renovation. The results obtained from the questionnaire survey are presented in Table 5. At 5 percent significance level (Mann-Whitney) snakehead, Steiy catfish, Orange fin labeo and Walking catfish showed a negative change in their population after renovation. PRA tool and t-test also confirm the above results (Table 6). According to the tank villagers, the Orange fin labeo was found rarely in tanks before the renovation, but it is not reported at present from the renovated tanks. Hypothesis testing (Mann-Whitney Test) at 5 percent significance level indicates that the populations of Oryzias species and Olive barb have grownup after the tank renovation (Table 5) and the same is confirmed through the PRA tool and the t-test (Table 6). Olive barb is a fish, which prefers clean water, and the conditions of the tank after renovation seems to be preferable to this fish.

Table 5- **Evaluation of the changes in fish species before and after renovation in the study tanks**

| Fish species | Steps of Renovation | Tank villagers' Response * | | | | Significant change in population** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| Snakehead | Before Renovation | 0 | 57 | 43 | 0 | Yes (N) |
| | After Renovation | 5 | 92 | 3 | 0 | |
| Tilapia | Before Renovation | 0 | 15 | 84 | 1 | No |
| | After Renovation | 0 | 1 | 92 | 7 | |
| Banded etroplus | Before Renovation | 0 | 9 | 85 | 6 | No |
| | After Renovation | 2 | 5 | 91 | 2 | |
| Flying barb | Before Renovation | 0 | 93 | 7 | 0 | No |
| | After Renovation | 0 | 77 | 21 | 2 | |
| Climbing perch | Before Renovation | 0 | 9 | 90 | 1 | No |
| | After Renovation | 0 | 15 | 85 | 0 | |
| Steiy catfish | Before Renovation | 0 | 70 | 30 | 0 | Yes (N) |
| | After Renovation | 33 | 66 | 1 | 0 | |
| Orange fin labeo | Before Renovation | 15 | 66 | 19 | 0 | Yes (N) |
| | After Renovation | 99 | 1 | 0 | 0 | |
| Spiny eel | Before Renovation | 16 | 71 | 13 | 0 | No |
| | After Renovation | 99 | 1 | 0 | 0 | |
| Eel | Before Renovation | 26 | 69 | 5 | 0 | No |
| | After Renovation | 99 | 1 | 0 | 0 | |
| Walking catfish | Before Renovation | 3 | 83 | 14 | 0 | Yes (N) |
| | After Renovation | 77 | 23 | 0 | 0 | |
| Oryzias species | Before Renovation | 0 | 96 | 4 | 0 | Yes (P) |
| | After Renovation | 3 | 29 | 67 | 0 | |
| Olive barb | Before Renovation | 0 | 94 | 6 | 0 | Yes (P) |
| | After Renovation | 5 | 65 | 30 | 0 | |
| Freshwater catfish | Before Renovation | 1 | 86 | 13 | 0 | No |
| | After Renovation | 6 | 94 | 0 | 0 | |

Source -: Field data 2008

Tank villagers' observations

*1 (Not present) 2 (1-5 per month) 3 (6 -10 per month) 4 (More than 10 per month)
Yes (N) = negative change Yes (P) = Positive change ** 5 percent significance level

The process of tank renovation directly affects the fish population. As an example, the breeding sites of the fish are disturbed by the limitation of the sunlight to the tank water that is covered by the aquatic plant cover (Courtenay et al., 1974). The removal of the above aquatic plant cover during the tank renovation process directly affects the growth of the fish population (Talwor and Jhingran, 1991). The renovation of tank bund and spillway in some cases increased the water capacity of the tank and this will have a direct effect on the fish population. Some water can be

retained in the renovated tanks even after distributing water to the paddy fields by the enhancement of the water level of the tank, otherwise in the drought period, they can fall prey to fishermen or other animals. Even though the population of some fish species reduced immediately after the tank renovation, they can recover again after few years. Considering the above facts, small tank renovation was not negative significantly effect to the aquatic fauna ecosystem.

**Ranking matrix analysis of fish species before and after renovation**

The Participatory Rural Appraisal (PRA) ranking matrix tool was used to get the population levels of the fish in the sample tanks before and after the renovation (Table 6). The presence of fish has been ranked based on the knowledge of the tank villagers on their population. The tanks too have been ranked on the population of the various fish living in the tank. All the data were analyzed using "t" test. Based on the results shown in the Table 6, it is found that the fish most abundantly and widely distributed before and after renovation in all the studied tanks was Tilapia. The tanks with the highest density of fish species were the RT 11 and RT 12. Both tanks (RT 11 and RT 12) are the biggest tanks and the ones, which will not dry up during the dry period. On the other hand, the culture-based fishery is practiced in tank RT 11 where fingerlings are introduced. These could be the main reason for the highest density of fish in the tank.

According to the analysis shown in Table 6 and Figure 2, the population levels of some fish species have changed after the renovation. The rank of Tilapia, the most abundant fish before the renovation (46 marks) and the second ranked Climbing perch (41 marks) are not changed. Ranks from one to five except the 4$^{th}$ (1 Tilapia, 2 Climbing perch, 3 Banded etroplus, 4 Oryzias species, 5 Flying barb) according to the rank marks received after the renovation are not significantly changed on population levels.

Table 6- **Evaluation of abundance of fish species before and after renovation in small tanks using ranking matrix PRA tool and T test**

| Fish species → / Tank Name ↓ | Renovation* | Snakehead | Tilapia | Banded etroplus | Flying barb | Climbin perch | Steiy catfish | Orange fin labeo | Spiny eel | Eel | Walking catfish | Oryzias species | Olive barb | Fresh water cat fish | Total Marks | Rank For Tank | P value | Significant change at 5 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 1 | B | 4 | 4 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 4 | 37 | 8 | 0.636 | No |
| | A | 2 | 4 | 4 | 3 | 4 | 3 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 34 | 5 | | |
| RT 2 | B | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 33 | 12 | 0.082 | No |
| | A | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 27 | 12 | | |
| RT 3 | B | 3 | 4 | 3 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 40 | 5 | 0.025 | YN |
| | A | 2 | 4 | 3 | 3 | 4 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 32 | 7 | | |
| RT 4 | B | 3 | 4 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 36 | 9 | 0.047 | YN |
| | A | 2 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 29 | 10 | | |
| RT 5 | B | 3 | 4 | 3 | 2 | 4 | 4 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 38 | 7 | 0.054 | No |
| | A | 3 | 4 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 33 | 6 | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RT 6 | B | 4 | 4 | 3 | 3 | 3 | 4 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 39 | 6 | 0.025 | YN |
| | A | 2 | 4 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 31 | 8 | | |
| RT 7 | B | 3 | 4 | 3 | 2 | 3 | 4 | 2 | 2 | 3 | 3 | 3 | 1 | 3 | 36 | 9 | 0.014 | YN |
| | A | 2 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 28 | 11 | | |
| RT 8 | B | 4 | 4 | 4 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 3 | 2 | 4 | 44 | 3 | 0.22 | No |
| | A | 3 | 4 | 3 | 3 | 4 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | 2 | 35 | 4 | | |
| RT 9 | B | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 | 34 | 11 | 0.165 | No |
| | A | 2 | 3 | 3 | 2 | 4 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 30 | 9 | | |
| RT 10 | B | 4 | 4 | 4 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 3 | 2 | 4 | 43 | 4 | 0.075 | No |
| | A | 2 | 4 | 3 | 3 | 4 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 36 | 3 | | |
| RT 11 | B | 4 | 4 | 4 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 4 | 3 | 4 | 46 | 1 | 0.025 | YN |
| | A | 3 | 4 | 4 | 4 | 4 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 38 | 1 | | |
| RT 12 | B | 4 | 4 | 4 | 3 | 4 | 4 | 2 | 3 | 4 | 3 | 4 | 2 | 4 | 45 | 2 | 0.014 | YN |
| | A | 3 | 4 | 3 | 3 | 4 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 37 | 2 | | |
| Total Marks | B | 41 | 46 | 38 | 30 | 39 | 44 | 24 | 31 | 40 | 35 | 37 | 22 | 42 | 471 | | 0.068 | **No** |
| | A | 28 | 46 | 38 | 34 | 41 | 31 | 12 | 19 | 23 | 29 | 36 | 30 | 26 | 390 | | | |
| Rank for fish | B | 4 | 1 | 7 | 11 | 6 | 2 | 12 | 10 | 5 | 9 | 8 | 13 | 3 | | | | |
| | A | 9 | 1 | 3 | 5 | 2 | 6 | 13 | 12 | 11 | 8 | 4 | 7 | 10 | | YP = Significantly changed /Positive | | |
| P value | | *0.000* | *0.339* | *0.339* | *0.199* | *0.504* | *0.000* | *0.050* | *0.12* | *0.14* | *0.007* | *0.006* | *0.001* | *0.16* | *0.27* | YN = Significantly changed / Negative | | |
| Significant change at 95percent | | YN | No | No | No | No | YN | YN | No | No | YN | YP | YP | No | **No** | No = No significant change | | |

Source – Field data 2008

Tank villagers' observations

Marks = 1 (Not present) 2 (1-5 per month) 3 (6 -10 per month) 4 (More than 10 per month)

* B = Before Renovation A = After Renovation

The rank of Snakehead has decreased from four to nine, which indicates that its population has reduced after the renovation. The widely seen Freshwater catfish is reported rarely after the renovation (rank decreased from 3 to 10). Steiy catfish, Orange fin lebeo, and Walking catfish populations are also significantly changed (negatively) after the small tank renovation. There is an increase in the abundance of Olive Barb after the renovation.

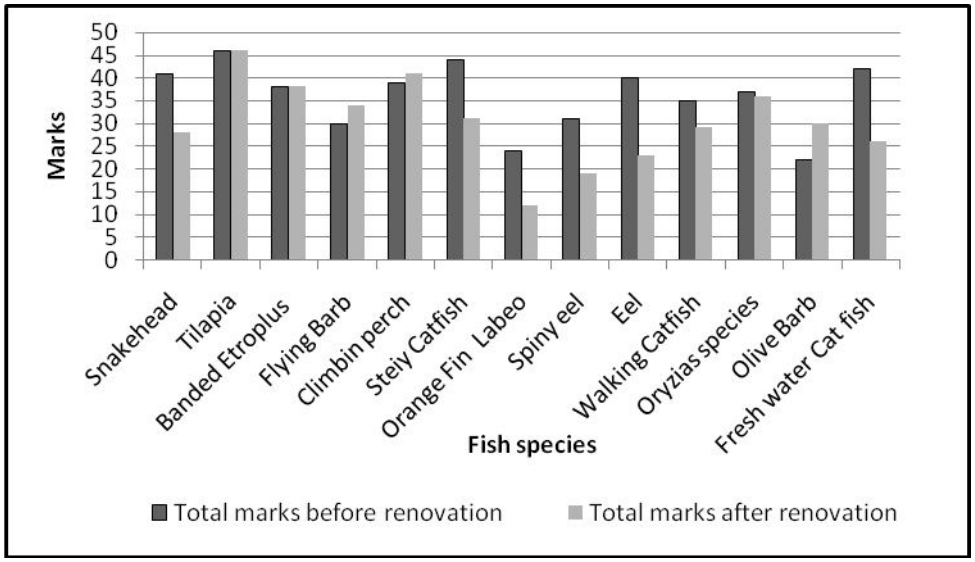


Figure: 2 Evaluation of abundance of fish species before and after renovation of small tanks using ranking matrix PRA tool

Even though the total rank marks before the renovation reduced from 471 to 390 after the tank renovation, there is no significant change in aquatic fauna after the tank renovation (Table 6). Table 6 also represents changes in fish population in different tanks after the tank renovation. Except the tanks RT 1, RT 2, RT 8, RT 9 and RT 10, the fish populations in the other tanks have significantly changed at 5 percent significance level. Figure 3 shows some changes in fish population after the small tank renovation.

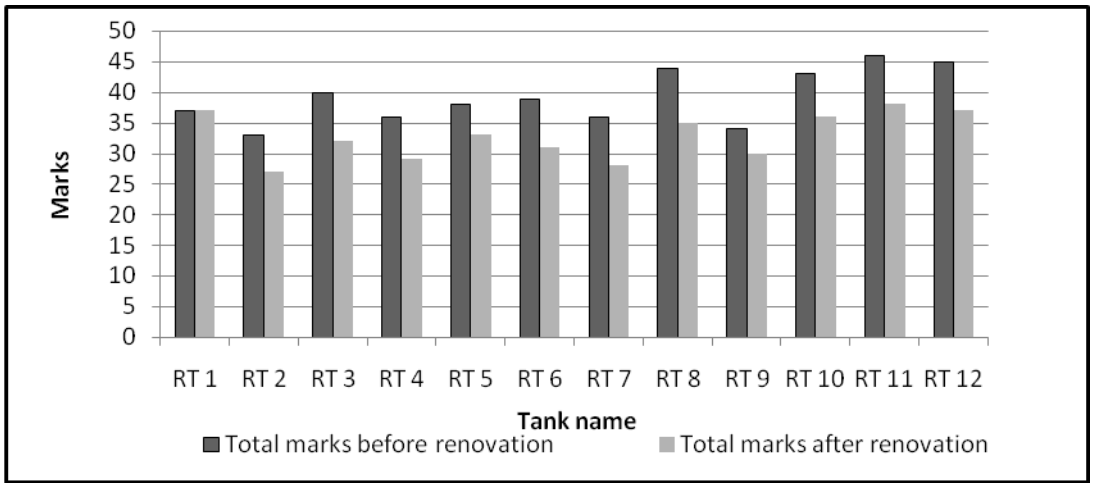


Figure: 3 Evaluation of tanks according to the abundance of fish species before and after renovation of small tanks using ranking matrix PRA tool

According to the t-test at 5 percent significance level, there is no difference between the total rank marks of the abundance of fish species before and after renovation. There is no significant decrease in the abundance of fish species after the renovation of small tanks ($P = 0.068$). In terms of fish abundance in the tanks, there is also no significant decrease in the abundance of fish species in the tanks ($P = 0.072$).

Snakehead, Walking catfish, and Spiny eel are carnivorous and endemic fish species inhabited in the small tanks (Talwar and Jhingran, 1991). Because of dredging in the renovation process, tank water gets muddy and unclear. The endemic fish species populations such as Snakehead and Freshwater catfish were affected due to the deposition of silt on eggs and gills. This has caused the disappearance or reduction of the population of local carnivorous fish (Shaji et al., 2000). The pray fish of the above carnivorous species increased due to the reduction in population of their predators. The population of omnivorous fish species that were newly introduced and living in the tank environment have grown up after the tank renovation. Even though few changes in some fish species are reported, there is no significant difference between the population of fish species and the tanks before and after renovation. Table 7 shows the changes in the population of fish species living in the non- renovated small tanks during last 10 years.

Table 7- **Changes in fish species during the past 10 years in the selected non- renovated small tanks**

| Fish species | Time duration | Tank villagers' Response * | | | | Significant change in population** |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| Snakehead | Before 10 years | 0 | 57 | 43 | 0 | No |
| | Present situation | 0 | 63 | 37 | 0 | |
| Tilapia | Before 10 years | 0 | 24 | 75 | 1 | No |
| | Present situation | 0 | 10 | 87 | 3 | |
| Banded etroplus | Before 10 years | 0 | 14 | 81 | 6 | No |
| | Present situation | 2 | 10 | 84 | 4 | |
| Flying barb | Before 10 years | 0 | 82 | 18 | 0 | No |
| | Present situation | 0 | 78 | 20 | 2 | |
| Climbing perch | Before 10 years | 0 | 7 | 92 | 1 | No |
| | Present situation | 0 | 11 | 89 | 0 | |
| Steiy catfish | Before 10 years | 0 | 67 | 28 | 5 | No |
| | Present situation | 0 | 72 | 26 | 2 | |
| Orenge fin lebio | Before 10 years | 28 | 55 | 17 | 0 | Yes (N) |
| | Present situation | 98 | 2 | 0 | 0 | |
| Spiny eel | Before 10 years | 16 | 66 | 18 | 0 | No |
| | Present situation | 22 | 64 | 14 | 0 | |
| Eel | Before 10 years | 14 | 70 | 16 | 0 | No |
| | Present situation | 26 | 62 | 12 | 0 | |
| Walking catfish | Before 10 years | 6 | 72 | 22 | 0 | No |
| | Present situation | 9 | 71 | 18 | 2 | |
| Oryzias species | Before 10 years | 8 | 45 | 47 | 0 | No |
| | Present situation | 6 | 34 | 60 | 0 | |
| Olive barb | Before 10 years | 8 | 63 | 29 | 0 | No |
| | Present situation | 12 | 56 | 32 | 0 | |
| Freshwater catfish | Before 10 years | 1 | 84 | 15 | 0 | No |
| | Present situation | 6 | 82 | 12 | 0 | |

Source -: Field data 2008

Tank villagers' observations

1 (Not present) 2 (1-5 per month) 3 (6 -10 per month) 4 (More than 10 per month)

Yes( N) = Negative change Yes(P) = Positive change ** 5 percent significant level

Fish species living in the non-renovated small tanks have not changed as taken place in the renovated tanks. Although some of the fish species show some changes, only Orange fin labeo shows a change that is at 5 percent significance levels. Orange fin labeo is included in the international red list and there is no information on the fish in the recent times (IUCN, 2007; Pethiyagoda, 1996). The populations of all the other fish species exist unchanged and this revealed that tank renovation has affected the population of fish species living in tanks, which

are renovated. Future renovation activities could consider this fact and initiate renovations that will not affect the fish populations which are endangered, threatened or has some economic significance.

**Transect analysis of fish and other aquatic fauna**

According to the questionnaire survey, field observations and PRA study, the population of Orange fin lebio, Steiy catfish, Eel, Walking catfish, and Snakehead were decreased after the small tank renovation. Above fish species are very sensitive to environmental changes (IUCN, 2007). The chemical fertilizers and other chemicals, which are used for agricultural activities, have negatively affected on the above species. For an example, Orenge fin lebio is not recorded in the small tanks in Sri Lanka during the last two decades (IUCN, 2007; Pethiyagoda, 1996). As a whole the several varieties of the population of fresh water fish species in Sri Lanka were decreased during the following three decades (Pethiyagoda, 1996). Tank renovation is considered as one of the reasons that has influence of these changes.

According to the results obtained through the transect analysis there are no changes in frequency, relative frequency, density, relative density and abundance of the fish species (Agrawal, 1996) in the renovated and non-renovated small tanks. Accordingly, there is no ecosystem damage related to the fish species living in small tanks due to small tank renovation. Table 8 compares the abundance of fish and other aquatic fauna in the renovated and non-renovated tanks in the Galgamuwa DS division.

Table 8- **Comparison statistics of abundance of fish and other aquatic fauna in the selected renovated and non-renovated tanks in Galgamuwa DS division**

| | | Frequency | | Relative frequency | | Density | | Relative density | | Abundance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Name | Species name | RT | NRT | RT | NRT | RT | NRT | RT | NRT | RT | NRT |
| Thilapiya | *Tilapia nilotica & mossambica* | 89.3 | 100 | 14.7 | 17.0 | 264.3 | 235.7 | 16.4 | 14.5 | 296.0 | 235.7 |
| Banded etroplus | *Etroplus suratensis* | 42.9 | 35.7 | 7.1 | 6.1 | 60.7 | 67.9 | 3.8 | 4.2 | 141.7 | 190.0 |
| Flying barb | *Esomus danricus* | 64.3 | 39.3 | 10.6 | 6.7 | 132.1 | 60.7 | 8.2 | 3.7 | 205.6 | 154.5 |
| Climbing perch | *Anabas testudineus bloch* | 35.7 | 46.4 | 5.9 | 7.9 | 50.0 | 96.4 | 3.1 | 5.9 | 140.0 | 207.7 |
| Steiy catfish | *Heferopneustes lossilis* | 25.0 | 21.4 | 4.1 | 3.6 | 28.6 | 28.6 | 1.8 | 1.8 | 114.3 | 133.3 |
| Orange fin labeo | *Labeo lankae* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Eel | *Anguilla bicolor* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Walking catfish | *Clarias brachysoma* | 10.7 | 14.3 | 1.8 | 2.4 | 10.7 | 14.3 | 0.7 | 0.9 | 100.0 | 100.0 |
| Oryzias species | *Puntius sp (vittatas)* | 100 | 92.9 | 16.5 | 15.8 | 700.0 | 682.1 | 43.4 | 41.9 | 700.0 | 734.6 |
| Olive barb | *Puntius sarana* | 39.3 | 17.9 | 6.5 | 3.0 | 64.3 | 39.3 | 4.0 | 2.4 | 163.6 | 220.0 |
| Freshwater catfish | *Mystus vittatus* | 28.6 | 21.4 | 4.7 | 3.6 | 28.6 | 21.4 | 1.8 | 1.3 | 100.0 | 100.0 |
| Snakehead | *Csanna sriata* | 85.7 | 96.4 | 14.1 | 16.4 | 167.9 | 214.3 | 10.4 | 13.2 | 195.8 | 222.2 |
| Tortoise | *Lissemys punctata* | 3.6 | 3.6 | 0.6 | 0.6 | 3.6 | 3.6 | 0.2 | 0.2 | 100.0 | 100.0 |
| Crocodile | *Crocodylus palustris* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Monitor | *Varanus salvator* | 17.9 | 17.9 | 2.9 | 3.0 | 17.9 | 17.9 | 1.1 | 1.1 | 100.0 | 100.0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water snake | *Xenochorophis piscator* | 25.0 | 21.4 | 4.1 | 3.6 | 25.0 | 21.4 | 1.5 | 1.3 | 100.0 | 100.0 |
| Unknown 1 | | 17.9 | 32.1 | 2.9 | 5.5 | 35.7 | 75.0 | 2.2 | 4.6 | 200.0 | 233.3 |
| Unknown 2 | | 7.1 | 17.9 | 1.2 | 3.0 | 10.7 | 25.0 | 0.7 | 1.5 | 150.0 | 140.0 |
| Unknown 3 | | 10.7 | 10.7 | 1.8 | 1.8 | 10.7 | 25.0 | 0.7 | 1.5 | 100.0 | 233.3 |
| | | 607 | 589 | 100 | 100 | 1614 | | 100 | 100 | | |
| T - value | | **0.40** | | **0.01** | | **-0.12** | | **0.03** | | **-0.90** | |
| P value | | **0.695** | | **0.990** | | **0.906** | | **0.997** | | **0.379** | |
| Significantly difference at 95 percent | | **No** | | **No** | | **No** | | **No** | | **No** | |

Source – Field transect data 2012 RT – renovated tanks NRT – non-renovated tanks

Table 9. Shows the richness (S), evenness (J), diversity (H′) and dominancy (1-J) of aquatic fauna in the renovated and non-renovated study tanks (Shannon & Weiner 1949).

There is no difference between aquatic fauna abundance in renovated and non-renovated small tanks (table 10). According to the richness (S), evenness (J), diversity (H′) and dominancy (1-J) of aquatic fauna in the renovated tanks (Table 9 and 10), there is no change in their diversity when non-renovated small tanks and renovated tanks are compared. According to these results, we can conclude that there is no significant damage caused to the ecosystems related to aquatic fauna due to tank renovation. Mean diversity values of renovated and non-renovated small tanks which are given in table 10 do not show any critical differences between RT and NRT.

Table 9- **Diversity of aquatic fauna in the renovated and non-renovated tanks**

| Selected small tanks | Transect plots Indicators | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 | Plot 6 | Plot 7 | For total |
|---|---|---|---|---|---|---|---|---|---|
| RT 5 | Diversity (H') | 1.79 | 1.65 | 1.92 | 1.39 | 0.96 | 0.6 | 1.23 | 1.78 |
| | Richness (S) | 20 | 23 | 24 | 16 | 12 | 11 | 10 | 116 |
| | Evenness (J) | 0.60 | 0.53 | 0.60 | 0.50 | 0.39 | 0.25 | 0.53 | 0.37 |
| | Dominancy (1-J) | 0.40 | 0.47 | 0.40 | 0.50 | 0.61 | 0.75 | 0.47 | 0.63 |
| RT 9 | Diversity (H') | 1.41 | 1.44 | 1.58 | 1.67 | 1.36 | 1.52 | 1.15 | 1.83 |
| | Richness (S) | 19 | 16 | 16 | 14 | 10 | 13 | 7 | 95 |
| | Evenness (J) | 0.48 | 0.52 | 0.57 | 0.63 | 0.59 | 0.59 | 0.59 | 0.40 |
| | Dominancy (1-J) | 0.52 | 0.48 | 0.43 | 0.37 | 0.41 | 0.41 | 0.41 | 0.60 |
| RT 10 | Diversity (H') | 1.59 | 1.38 | 1.89 | 1.64 | 0.41 | 0.96 | 1.63 | 1.81 |
| | Richness (S) | 15 | 18 | 20 | 11 | 7 | 7 | 12 | 90 |
| | Evenness (J) | 0.59 | 0.48 | 0.63 | 0.68 | 0.21 | 0.49 | 0.66 | 0.40 |
| | Dominancy (1-J) | 0.41 | 0.52 | 0.37 | 0.32 | 0.79 | 0.51 | 0.34 | 0.60 |
| RT 12 | Diversity (H') | 1.77 | 1.87 | 1.61 | 1.89 | 1.8 | 1.67 | 1.98 | 2.02 |
| | Richness (S) | 31 | 29 | 31 | 19 | 13 | 16 | 12 | 151 |
| | Evenness (J) | 0.52 | 0.56 | 0.47 | 0.64 | 0.70 | 0.60 | 0.80 | 0.40 |
| | Dominancy (1-J) | 0.48 | 0.44 | 0.53 | 0.36 | 0.30 | 0.40 | 0.20 | 0.60 |
| NRT 4 | Diversity (H') | 1.75 | 1.06 | 1.71 | 1.52 | 1.74 | 1.58 | 1.75 | 2.08 |
| | Richness (S) | 12 | 9 | 15 | 12 | 9 | 9 | 10 | 76 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Evenness (J) | 0.70 | 0.48 | 0.63 | 0.61 | 0.79 | 0.72 | 0.76 | 0.48 |
| | Dominancy (1-J) | 0.30 | 0.52 | 0.37 | 0.39 | 0.21 | 0.28 | 0.24 | 0.52 |
| NRT 8 | Diversity (H') | 1.71 | 1.12 | 1.7 | 1.62 | 1.71 | 1.72 | 1.05 | 2.05 |
| | Richness (S) | 13 | 12 | 16 | 19 | 15 | 11 | 5 | 89 |
| | Evenness (J) | 0.67 | 0.45 | 0.61 | 0.55 | 0.63 | 0.72 | 0.65 | 0.46 |
| | Dominancy (1-J) | 0.33 | 0.55 | 0.39 | 0.45 | 0.37 | 0.28 | 0.35 | 0.54 |
| NRT 9 | Diversity (H') | 1.73 | 1.65 | 1.78 | 1.4 | 0.74 | 1.5 | 1.39 | 1.71 |
| | Richness (S) | 46 | 37 | 45 | 35 | 16 | 29 | 16 | 222 |
| | Evenness (J) | 0.45 | 0.46 | 0.47 | 0.39 | 0.27 | 0.45 | 0.50 | 0.32 |
| | Dominancy (1-J) | 0.55 | 0.54 | 0.53 | 0.61 | 0.73 | 0.55 | 0.50 | 0.68 |
| NRT 10 | Diversity (H') | 1.57 | 1.42 | 1.86 | 1.55 | 1.37 | 1.33 | 1.33 | 2.02 |
| | Richness (S) | 14 | 13 | 16 | 7 | 11 | 6 | 6 | 69 |
| | Evenness (J) | 0.59 | 0.55 | 0.67 | 0.80 | 0.57 | 0.74 | 0.74 | 0.48 |
| | Dominancy (1-J) | 0.41 | 0.45 | 0.33 | 0.20 | 0.43 | 0.26 | 0.26 | 0.52 |

Source -: Field transect data 2012

Table 10- **Comparison statistics of transect plot diversity of aquatic fauna in the renovated and non-renovated tanks**

| Transect plots | Mean for richness | | Mean for evenness | | Mean for dominancy | | Mean for diversity | |
|---|---|---|---|---|---|---|---|---|
| | RT | NRT | RT | NRT | RT | NRT | RT | NRT |
| Plot 1 | 21.25 | 21.25 | 0.55 | 0.6 | 0.45 | 0.4 | 1.64 | 1.69 |
| Plot 2 | 21.25 | 17.75 | 0.52 | 0.49 | 0.48 | 0.52 | 1.59 | 1.31 |
| Plot 3 | 22.75 | 23 | 0.57 | 0.6 | 0.43 | 0.41 | 1.75 | 1.76 |
| Plot 4 | 15 | 18.25 | 0.61 | 0.59 | 0.39 | 0.41 | 1.65 | 1.52 |
| Plot 5 | 10.5 | 12.75 | 0.47 | 0.57 | 0.53 | 0.44 | 1.13 | 1.39 |
| Plot 6 | 11.75 | 13.75 | 0.48 | 0.66 | 0.52 | 0.34 | 1.19 | 1.53 |
| Plot 7 | 10.25 | 9.25 | 0.65 | 0.66 | 0.36 | 0.34 | 1.5 | 1.38 |
| T - value | | -0.54 | | -1.64 | | -1.53 | | -0.22 |
| P - value | | 0.611 | | 0.152 | | 0.177 | | 0.831 |
| 95 percent significant difference | No | | No | | No | | No | |

Source -: Field transect data 2012

Diversity of aquatic fauna compared using transects data as given in table 11. The diversities of Steiy catfish, Walking catfish and Snakehead in the renovated small tanks are less than the non-renovated tanks that is not significant. Accordingly, the differences in the diversities between renovated and non-renovated small tanks do not show negative effect on the aquatic fauna or the ecosystem of the renovated small tanks.

Table 11- **Comparison statistics of the diversity of fish and other aquatic fauna in renovated and non-renovated tanks in Galgamuwa DS division**

| Local name | Species name | Pi×PlnPi for Renovate tanks | | | | Pi×lnPi for Non-renovated tanks | | | | Pi×lnPi for total species - RT | Pi×lnPi for total species - NRT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RT 5 | RT 9 | RT 10 | RT 12 | NRT 4 | NRT 8 | NRT 9 | NRT 10 | | |
| Thilapiya | *Tilapia nilotica & mossambica* | -0.29 | -0.27 | -0.29 | -0.32 | -0.33 | -0.29 | -0.23 | -0.32 | -0.30 | -0.28 |
| Banded etroplus | *Etroplus suratensis* | -0.12 | -0.11 | -0.14 | -0.13 | -0.18 | -0.11 | -0.12 | -0.14 | -0.12 | -0.13 |
| Flying barb | *Esomus danricus* | -0.17 | -0.19 | -0.20 | -0.24 | -0.15 | -0.14 | -0.07 | -0.19 | -0.20 | -0.12 |
| Climbing perch | *Anabas testudineus bloch* | -0.15 | -0.11 | -0.11 | -0.06 | -0.24 | -0.22 | -0.12 | -0.14 | -0.11 | -0.17 |
| Steiy catfish | *Heferopneustes lossilis* | -0.07 | -0.11 | -0.05 | -0.06 | -0.10 | -0.09 | -0.04 | -0.10 | -0.07 | -0.07 |
| Orange fin labio | *Labeo lankae* | 0.00 | -0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 |
| Eel | *Anguilla bicolor* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Walking catfish | *Clarias brachysoma* | 0.00 | -0.05 | -0.08 | 0.00 | -0.06 | -0.05 | -0.02 | -0.06 | -0.03 | -0.04 |
| Oryzias species | *Puntius sp (vittatas)* | -0.35 | -0.35 | -0.36 | -0.37 | -0.36 | -0.37 | -0.33 | -0.36 | -0.36 | -0.36 |
| Olive barb | *Puntius sarana* | -0.12 | -0.11 | -0.16 | -0.13 | 0.00 | 0.00 | -0.15 | 0.00 | -0.13 | -0.09 |
| Freshwater catfish | *Mystus vittatus* | -0.09 | -0.05 | -0.05 | -0.08 | -0.06 | -0.05 | -0.06 | -0.06 | -0.07 | -0.06 |
| Snakehead | *Csanna sriata* | -0.22 | -0.24 | -0.22 | -0.25 | -0.27 | -0.31 | -0.24 | -0.28 | -0.24 | -0.27 |
| Tortoise | *Lissemys punctata* | 0.00 | 0.00 | 0.00 | -0.03 | 0.00 | -0.05 | 0.00 | 0.00 | -0.01 | -0.01 |
| Crocodile | *Crocodylus palustris* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Monitor | *Varanus salvator* | -0.04 | -0.05 | 0.00 | -0.08 | -0.10 | -0.05 | -0.02 | -0.06 | -0.05 | -0.05 |
| Water snake | *Xenochorophis piscator* | -0.04 | -0.05 | -0.05 | -0.10 | -0.10 | -0.05 | -0.04 | -0.06 | -0.06 | -0.06 |
| Unknown 1 | | -0.12 | -0.11 | -0.05 | -0.06 | -0.10 | -0.14 | -0.11 | -0.25 | -0.08 | -0.14 |
| Unknown 2 | | 0.00 | 0.00 | -0.05 | -0.06 | -0.06 | -0.14 | -0.04 | 0.00 | -0.03 | -0.06 |
| Unknown 3 | | 0.00 | 0.00 | 0.00 | -0.08 | 0.00 | 0.00 | -0.11 | 0.00 | -0.03 | -0.06 |
| Total | | -1.78 | -1.84 | -1.81 | -2.02 | -2.08 | -2.05 | -1.71 | -2.02 | -1.93 | -1.98 |
| Richness (S) | | 101 | 84 | 89 | 152 | 76 | 89 | 222 | 69 | 426 | 456 |
| H max | | 4.62 | 4.43 | 4.49 | 5.02 | 4.33 | 4.49 | 5.40 | 4.23 | 6.05 | 6.12 |
| Evenness (J) | | 0.39 | 0.42 | 0.40 | 0.40 | 0.48 | 0.46 | 0.32 | 0.48 | 0.32 | 0.32 |
| Dominancy (1-J) | | 0.61 | 0.58 | 0.60 | 0.60 | 0.52 | 0.54 | 0.68 | 0.52 | 0.68 | 0.68 |
| Shannon Winner diversity (H') | | 1.78 | 1.84 | 1.81 | 2.02 | 2.08 | 2.05 | 1.71 | 2.02 | 1.93 | 1.98 |
| | | | | | | | | | T - value | | 0.50 |
| | | | | | | | | | **P - value** | | **0.622** |
| | | | | | | | | | **Significantly different at 95 percent** | | **No** |

Source -: Field transect data 2012

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