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# Status of Fish Aggregating Device Fishery in the River Titas of Bangladesh

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***Author's contribution***

*The sole author designed, analyzed and interpreted and prepared the manuscript.*

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## ABSTRACT

**Aims:** To examine the status of Fish Aggregating Device (*Katha*) fishery in the river Titas in Bangladesh and development of an alternative *Katha* fishery management strategy.
**Study Design:** All Fish Aggregating Devices (*Kathas*) were recorded through a census survey. Fish catch monitoring facilitated through a regular catch survey of *Katha*/gear/team in operation.
**Place and Duration of Study:** The study employed data collected from the river Titas in Brahmanbaria district of Bangladesh from 1997 to 2002.
**Methodology:** A census of all constructed Fish Aggregating Devices (*Kathas)* in the study sites was undertaken. Catch data, including information on species composition and abundance, were collected from *Katha* fishers during the harvest season. Simultaneously a robust catch assessment was observed for four days per month. Randomly selected samples of catch by species by gear are recorded for each gear type.
**Results:** *Katha* fisheries in this river accounted for 28%, 20%, 34%, 34%, 37% and 25% of annual fish production in 1997, 1998, 1999, 2000, 2001 and 2002 respectively. Significant ($p<0.001$) differences in species assemblages between *Katha* and survey catch were found in this river. However, species distributions in *Katha* catch are not significantly different in the years 1997 to 2002 at the 5% level.
**Conclusion:** *Katha* fishery in the river system generally has a detrimental impact on fisheries resources as well as reducing fishing opportunities for poor and marginal fishers.

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*Keywords: Fish aggregating devices; catch monitoring; species assemblage; biodiversity.*

## 1. INTRODUCTION

The fisheries sector in Bangladesh is the most important as a source of food, livelihoods and employment opportunity provider. The country's annual fish production has increased from 1.087 million tonnes in 1993-94 to about 3.41 million tonnes in 2012-13 [1]. Fish provides 60% of national animal protein consumption [2]. In addition, the fishing provides directly or indirectly employment to nearly 17.1 million people [1]. Inland fisheries remain the most important contributor to fish production in Bangladesh and administered to generate government revenue without due concern for sustainability [3]. Fish aggregating device (*Katha*) fishery in the river Titas is one of the important fishery. A *Katha* is actually a brush shelter used as a fish aggregating device. The main component of a *Katha* is a composition branches of local trees such as Mango, Blackberry tree (*Jam*), Wood Apple (*Bel*), *B. acutungula* (*Hizol*), *T. aspera* (*Shawra*) and aquatic weeds [4]. The *Katha* materials can be divided into two major types: underwater brushes and surface shade parts. Branches provide hiding places and shelter, and the floating aquatic weeds are used as shade as they provide a darker area where fish can hide easily. In a way *Kathas* mimic a flooded part of the river. Long bamboos and ropes are used to encircle the *Katha* boundaries and to fix aquatic floating weeds. It provides temporary shelter for many small, medium and large sized fishes. When the branches deteriorate, many organisms such as prawns feed on periphytes which grow on the branches. This is also thought to be an important source of food for omnivorous fish species. The small cat fish (*Mystus vittatus*) showed specific preference to *Khata* made by bamboo roots in the river [5]. The establishment of *Katha* as fish sanctuary in the *beel* (deeper depression in floodplains) had beneficial effects on the production of fish [6,7]. A census of Katha was conducted in Ashura beel, Goakhola beel and Dikshi beel in Bangladesh from 1997 to 2002 and species composition and abundance were assessed [8].

When water levels fall at the end of the monsoon, fishes start to migrate from floodplains to shelter in deeper waters during the winter (dry season). So *Kathas* are normally constructed from September onwards, following fish behaviour. The timing of *Katha* construction is also related to flood duration in each year. A late flood results in a delay in *Katha* construction. *Katha* are sometimes constructed in *beels* (Floodplain usually with a permanent water body), but are most common in rivers, where they are placed between the bank side of the river and the middle of the river. In some cases like closed rivers or the dead channel of rivers, mid-channel *Kathas* are also observed.

The study employed data collected from the river Titas (Goshipur to Gokornaghat) under Community Based Fisheries Management Project (CBFM) from 1997 to 2002. The river part is located in Brahmanbaria district of Bangladesh (Fig. 1). Status of *Katha* fisheries were examined in three ways. Firstly, by using data from *Katha* catch in estimates of fisheries production and biodiversity trends. Secondly, by using species data from *Katha* and survey catch for determining species abundance for open water fisheries resources management. Finally, by using cost-benefit data from *Katha* preparation and harvest for determining profit.

## 2. METERIALS AND METHODS

### 2.1 Katha (Fish Aggregation Device) Census

A census of all constructed *Kathas* in the study sites was undertaken from 1997 to 2002. Catch data, including information on species composition and abundance, were collected from fishers during the harvest season. Annual catches from *Kathas* were based on the total seasonal harvest and expressed as catch per hectare of *Katha* per year (kg/ha).

### 2.2 Catch and Gear Survey

Fishing activity was observed for four days per month (*m*), continuously for 72 months. Gear surveys involved a regular spot survey for a sample of gears in operation, and the total catch from each gear type (*g*). A gear census covered the number and types of gear operating in the study sites. The species-wise catch of gear g for month m was estimated as the product of the mean catch rate for gear g, the average number of fishing units operating of type g, and the number of days in the month. The average number of gear units per day was used to

estimate total gear-wise fishing effort for that month as well as for the whole year. Mean gear-wise catch rate was used to estimate total catch for that month, as well as for the whole year. Annual catch per unit area (CPUA) was employed as a measure of fish production in the river:

$$CPUA = \frac{\sum_{m=Jan}^{m=Dec} \sum_{g=1}^{n} Catch_{m,g}}{AverageArea}$$

Where $Catch_{m,g}$ is the estimated catch landed by gear type g, during month m as well as year in the river measured in kg/ha.

### 2.3 Multivariate Comparisons of Species Assemblage between *Katha* and Survey Catch

Multivariate comparisons of fish diversity were also performed by comparing abundance indices (annual catch rate per hectare (kg) by species from 1997 to 2002) of species forming the multispecies assemblage between *Katha* catch and Survey catch.

Similarities in the species assemblages at *Katha* catch and Survey catch were summarised in two-dimensional space using nonparametric multidimensional scaling (MDS) ordinations following a strategy proposed by [9]. The approach aims to construct a map or ordination of years (samples) such that their placement reflects the rank similarity of their species assemblages. Years positioned in close proximity to each other in the ordination have very similar species assemblages, whilst years that are far apart share few common species, or have the same species but at a very different levels of abundance. A "stress" measure indicates how well the ordination satisfies the (dis)similarities between Katha and Survey catches. Stress values <0.2 indicate acceptable fits to the data. The null hypothesis [$H_0$] was tested using a nonparametric permutation (analysis of similarity or ANOSIM) test based upon the difference in the average rank similarity within and between the *Katha* catch and Survey catch year groups (*r* statistic). The significance level of the test is calculated by referring the observed value of the *r* statistic to its permutation distribution generated from randomly sampled sets of permutations of site labels.

The species most responsible for the year groupings were then determined by computing the average contribution of each species to the overall average dissimilarity between all pairs of intergroup years. The MDS and ANSOSIM analyses were performed with the Community Analysis packages software [10] and employing the Bray-Curtis [11].

### 2.4 Shannon-Wiener Diversity Index

The Shannon-Wiener Index (H′) is one of several indices used to measure biodiversity. The function is defined as:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where $_S$ = number of species and $p_i$ = the proportion of individuals from the $i^{th}$ species in the sample.

### 2.5 Species Abundance and Distributions

Truncated log normal model is one of indicated to measure species abundance relationship. If the value of *p* is <0.05 then the distributions are significantly different at the 5% level.

The log series distribution is described by:

$$\alpha\times, \frac{\alpha\times}{2}, \frac{\alpha\times}{3}, \ldots\ldots \frac{\alpha\times}{n}$$

Where, each term gives the number of species predicted to have 1, 2, 3… n individuals in the sample. The parameter $\alpha$ is estimated by iteration, after which x is calculated.

The species abundance and distributions analyses were performed with the Species Diversity and Richness software [12] and employing the Truncated Log Normal model.

## 3. RESULTS AND DISCUSSION

### 3.1 Landownership Category of *Katha* Owner

*Katha* census data revealed that the total number of *Katha* was almost constant at 49 or 50 each year. All existing *Kathas* were categorised into 4 types according to the land ownership pattern of *Katha* main owner using following criteria:

**Table 1. Landownership category of Katha owner**

| No | Type | Land ownership patterns of main owner |
|---|---|---|
| 1 | Landless | < 0.2 ha |
| 2 | Small farmers | 0.2 – 1.01 ha |
| 3 | Medium farmers | 1.01 – 3.04 ha |
| 4 | Large farmers | > 3.04 ha |

The average size of *Katha* varied from year to year with a maximum of 1.19 ha in 1999 and a minimum of 0.75 ha in 1998. The size range of *Kathas* in different study years' reveals that most were in the size range of 0.5 – 1.0 ha during 1997 and 1998 however larger size ranges became more common during 2000 to 2002. More than 90% of *Katha*s lie within the size range of 0.8 – 1.3 ha.

Land ownership category of *Katha* owners reveals that Medium and Small farmers own the *Kathas* rather than fishermen or landless people. Analysis of *Katha* ownership characteristics (% by number of *Kathas*) for the six years (1997-2002) was 4.26%, 44.68%, 48.94% and 2.13% for Landless, Small farmer, Medium farmer and Large farmer respectively. The area covered by *Katha* according to ownership category was 3%, 33%, 60% and 4% for the Landless, Small farmers, Medium farmers and Large farmers' group respectively (Fig. 2). Overall, 93% of the area covered by *Kathas* is owned by the farmers' groups.

## 3.2 Setting and Harvesting Season

Setting of *Katha* started in *Aswin-Kartik*[*] (mid September to mid November) of the year following the draw-down phase of the monsoon. Harvesting started 1-2 months after the *Katha* was set, usually in the month of *Poush** (mid December to mid January) and continued up to *Jaistha** (May to June). The maximum numbers of Kathas are operated during the months of *Poush-Baisakh*[*] (mid December to mid May).

Harvesting is accomplished by encircling the *Katha* carefully with a small mesh seine net from the bottom to 0.6 meters above the water level before harvesting. Intensive harvest (> 20 numbers of *Katha* per month) continued for 3 to 4 months (Jan to April), and overall harvest (< 10 numbers of *Katha* per month) periods continued for up to 6 months (Dec to May) in a year. A single *Katha* was repetitively harvested 2 to 3 times in a season. The average harvested ratio (*Katha*: harvest) for *Kathas* in 1997, 1998, 1999, 2000, 2001 and 2002 were 1:2.18, 1:2, 1:2.33, 1:2.28, 1:3.12 and 1:2.45 respectively.

## 3.3 Analysis of *Katha* Catches

Analysis of *Katha* catches was done for the years 1997-2002 using catch monitoring records. During the study period, a total of 51 fishes/ prawns and two unidentified fish species were recorded. To simplify the analysis, fishes were divided into eight major groups based on taxonomic hierarchy, food habits and fish size as outlined in Table - 2.

In general, *Katha* catches are different from normal riverine catches. *Katha* catches in Titas Goshipur to Gokornaghat section were dominated by different kind of prawns, catfishes and carps. It is believed that small fish find shelter in *Kathas* whereas predatory species also find *Kathas* attractive as it is a good area for their prey. So *Katha* habitats are a unique mixture of predators and prey. The total catch from *Kathas* varied between years. Analysis of the catch data for the six years (1997-2002) gave annual estimates of fisheries production (kg/ha) of 304, 474, 558, 675, 763 and 762 respectively. The catch trend appears to be upwards with 2002 catch levels 151% higher than those in 1997. The trends in fish production from *Katha* fisheries are shown in Fig. 3.

## 3.4 Biodiversity and Species Abundance

The total number of species recorded varied from 28 species in 1998 and 2001 to 37 species in 2000. The actual numbers were 35, 28, 32, 37, 28 and 34 in the years between 1997 and 2002 respectively. The biodiversity measured using the Shannon-Weiner index (H') was found to be 2.77, 2.98, 2.92, 2.89, 2.81 and 2.85 in the years between 1997 and 2002 respectively. Preferences of fishes to different types of *Katha* materials has been studied by [13] from three rivers in Bangladesh and they found maximum number of species (40) in the traditional *Katha* (*Katha* with tree branches) and minimum (30) in the bamboo root *Katha*. A total number of 84 aquatic species (71 wild fishes, five prawns, one crab, four snails and three freshwater turtles) were recorded in the Haria beel in Bangladesh

[*] *Months of the Bengali year*

and Fish aggregating device (*Katha*) methods was detected as detrimental killing methods for all types of species [14]. The natural production of aquatic life in the Someswari River in northern Bangladesh declined dramatically during 2001-2005 and total production of the river decreased from 95.79 to 38.61 mt [15]. [16] also reported that the use of Fish Aggregating Device (Katha) was increased during 2008-2010 from 9.10% to 14.30% in the *Meduary beel* in Bangladesh.

The results of a Chi-Squared test for species abundance relationship from 1997 to 2002 are given in table 2. The p values were found >0.25 indicated that the species distributions are not significantly different in the years between 1997 and 2002 at 5% level. The data for each year fits a truncated log normal model. The species abundance classes show a plot of the observed (histogram) and expected (line) frequency distributions arranged by class for the six years (Fig. 4).

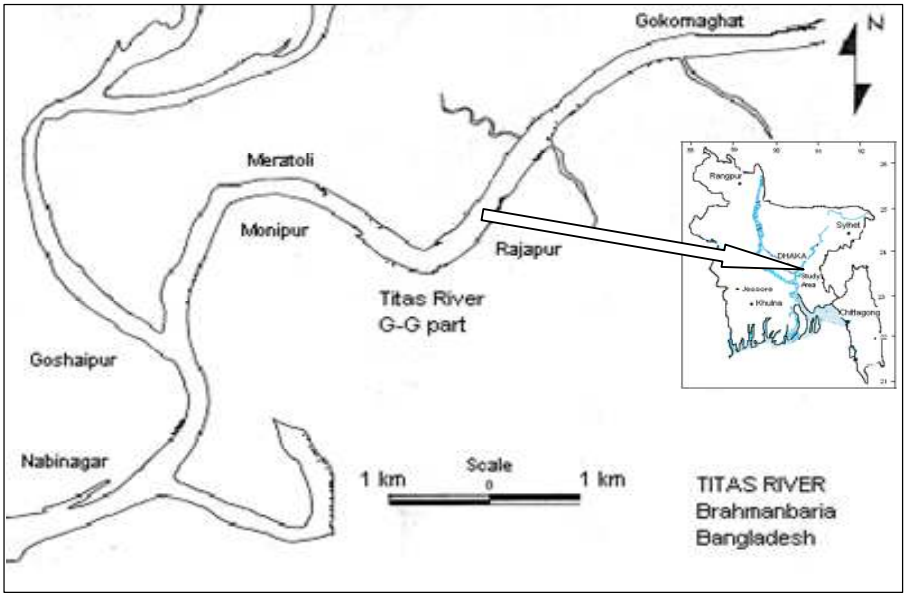


**Fig. 1. Study area of the river Titas (Goshipur to Gokornaghat section), Brahmanbaria district, Bangladesh**

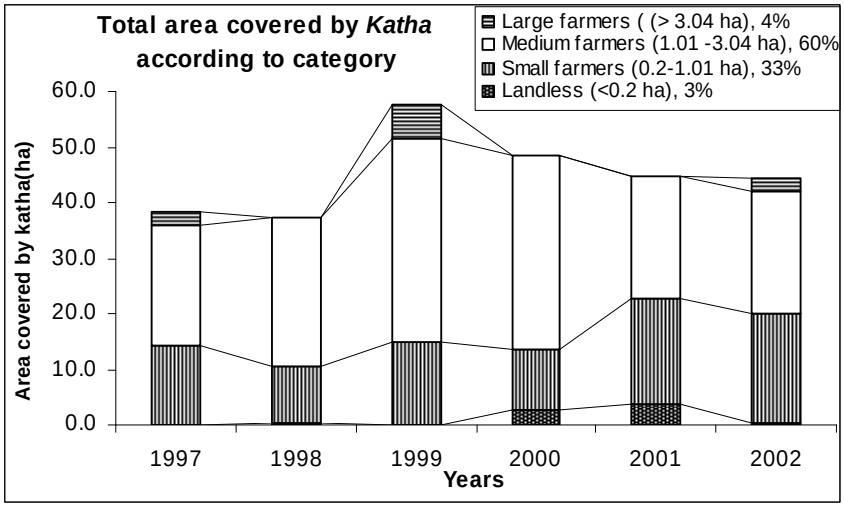


**Fig. 2. Area covered by *Katha* according to *Katha* owner categories**

**Table 2. The habitat group, scientific name and common name used in the *Katha* catch analysis of the river Titas G-G part**

| Sl No. | Habitat group | Taxonomic: Scientific name | Common name: Species within group |
|---|---|---|---|
| 1. | Large and medium sized cat fishes | *Sperata aor*, *Mystus bleekeri*, *Ompok pabda*, *Ompok bimaculatus*, *Wallago attu*, *Heteropneustes fossilis*, *Clarias batrachus*, *Rita rita* | Long-whiskered catfish, Day's maystus, Pabda catfish, Butter catfish, Wallago catfish, Stinging catfish, Philippine catfish, Rita |
| 2. | Small cat fishes | *Mystus vittatus*, *Mystus* sp., *Neotropius neotropius*, *Pseudeutropius* sp., *Sperata seenghala*. | Striped dwarf catfish, Catfish, Indian potasi, Batasi, Giant river-catfish. |
| 3. | Major and minor carps | *Labeo rohita*, *Gibelion catla*, *Cyprinus carpio*, *Cirrhinus mrigala*, *Labeo gonius*, *Labeo calbasu*, *Systomus sarana*. | Roho labeo, Catla, Common carp, Carps, Kuria labeo, Orangefin labeo, Olive bard |
| 4. | Prawns | *Macrobrachium malcolmsonii*, *Macrobrachium villosimanus*, *Macrobrachium rogenbergii*, *Macrobrachium lamarrei* and *Macrobrachium birmanicum* | Monsoon river prawn, Dimua river prawn, Giant river prawn, Kuncho river prawn and Birma river prawn |
| 5. | Snake heads | *Channa marulius*, *Channa striata* and *Channa punctata* | Great snakehead, Striped snakehead and Spotted snakehead |
| 6. | Small barbs | *Puntius sophore*, *Pethia gelius*, *Pethia conchonius*, *Pethia phutunio*, *Pethia ticto* | Pool barb, Golden barb, Rosy barb, Spottedsail barb, Ticto barb |
| 7. | Large and medium miscellaneous species | *Notopterus notopterus*, *Chitala chitala*, *Mastacembelus armatus* and *Nandus nandus* | Bronze featherback, Clown knifefish, Zig-zag eet and Gangetic leaffish |
| 8. | Small miscellaneous species | *Parambassis ranga*, *Parambassis* sp., *Trichogaster fasciata*, *Macrognathus pancalus*, *Trichogaster lalius*, *Chala cachius*, *Trichogaster chuna*, *Salmophasia* sp., *Nemacheilus* sp., *Osteobrama cotio*, *Tetradon* sp., *Amblypharyngodon mola*, *Gudusia chapra*, *Badis badis* and two unidentified fish species. | Indian glassy fish, Glassy fish, Banded gourami, Barred spiny eel, Dwarf gourami, Minnows, Honey gourami, Finescale razorbelly minnow, Loach, Minnows, Milkspotted puffer, Mola carplet, Indian river shad, Badis and two unidentified fish species. |

**Table 3. Chi-Squared results on species abundance in the river Titas**

| Years | Observed log 10 mean | Total species | Chi | Degrees of freedom | p values | Diversity of statistics |
|---|---|---|---|---|---|---|
| 1997 | 0.997 | 35 | 2.867 | 6 | 0.825 | 47.47 |
| 1998 | 1.281 | 28 | 6.417 | 5 | 0.267 | 48.93 |
| 1999 | 1.274 | 32 | 4.472 | 5 | 0.448 | 50.09 |
| 2000 | 1.152 | 37 | 6.193 | 6 | 0.401 | 47.11 |
| 2001 | 1.413 | 28 | 2.464 | 4 | 0.651 | 59.83 |
| 2002 | 1.127 | 34 | 5.342 | 6 | 0.500 | 45.69 |

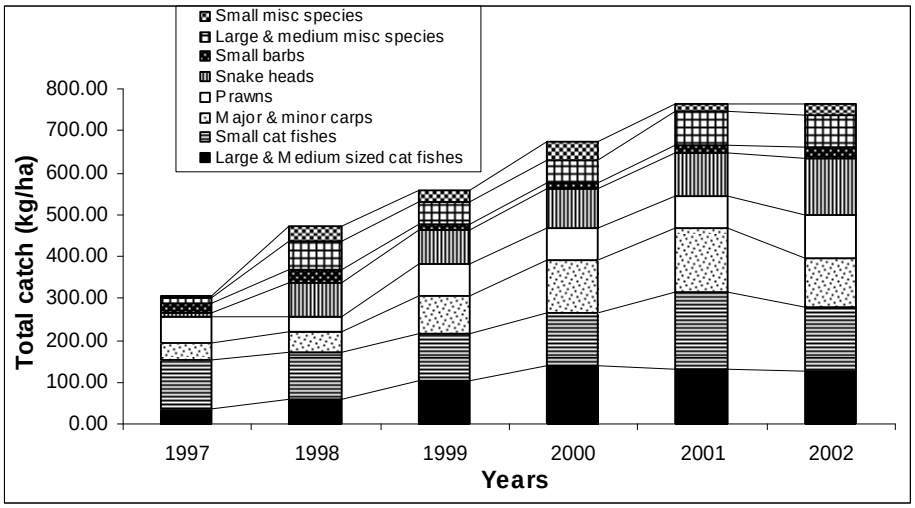


**Fig. 3. Annual trends of *Katha* catches in the river Titas (Legend: top to bottom; Small misc. species to Large and Medium sized cat fishes).**

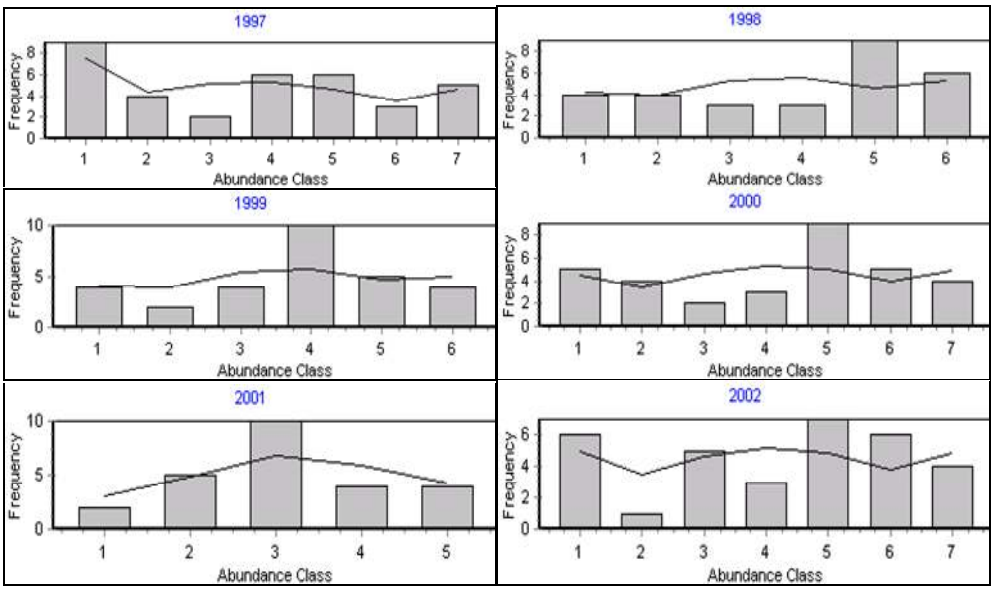


**Fig. 4. Abundance class of species in *Katha* fishery (observed and expected frequency as histogram and line)**

### 3.5 Multivariate Comparisons of Species Assemblage between *Katha* and Survey Catch

Significant ($p<0.001$) differences in species assemblages in *Katha* catch and Survey catch were found in the river Titas (Fig. 5). Results from the one-way ANOSIM to test for differences in species assemblages between *Katha* catch (6 years) and Survey catch (6 years) reveals sample statistics and permutations were found to be 0.957 and 462 respectively. Stress vs. dimension shows decreasing trends and final stress value found to be 0.152, 0.024 and 0.016 for dimension 1, 2 and 3 respectively.

### 3.6 Average Abundance of Species in *Katha* and Survey Catch

Species assemblages in the *Katha* catch from 1997 to 2002 comprised less species than those of Survey catch. Of the 28 major contributed species (90.82%), 22 were more abundant in

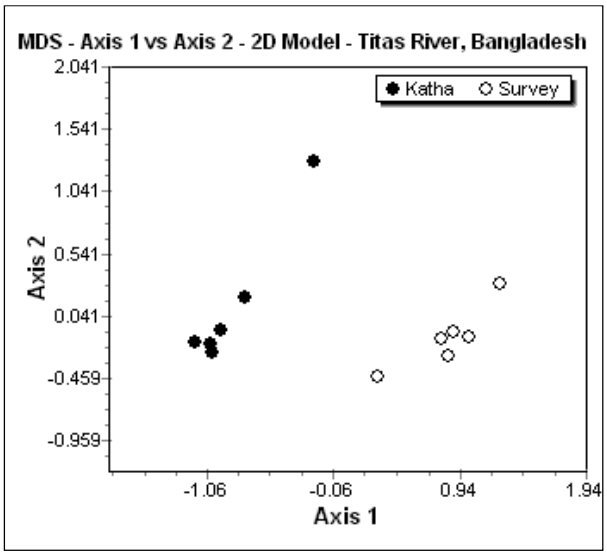


**Fig. 5. MDS ordinations comparing species assemblages in *Katha* and Survey catch (Values of each species combination on the right-hand side, Axis 1 and Axis 2, on the left-hand side)**

*Katha* catch. These included in descending order of their contribution to the average dissimilarity between the two types of fisheries: *Mystus vittatus, Channa marulius, Wallago attu, Gudusia chapra, Corica soborna, Labeo rohita, Neotropius atherinoides, Puntius sophore, Channa striata, Macrobrachium rosenbergii, Mystus sp., Notopterus notopterus, Systomus sarana, Mystus bleekeri, Sperata aor, Labeo gonius, Macrobrachium malcolmsonii, Mastacembelus armatus, Xenentodon cancila, Macrobrachium lamarrei, Macrognathus aculeatus, Nandus nandus, Parambassis ranga, Labeo calbasu, Parambassis sp., Sperata seenghala, Ompok pabda, Macrobrachium villosimanus*. These species are also members of both whitefish and blackfish. Only 6 species were more abundant at the Survey catch: *Gudusia chapra, Puntius sophore, Corica soborna, Xenentodon cancila, Macrognathus aculeatus* and *Parambassis ranga*. The species *Corica soborna, Xenentodon cancila* and *Macrognathus aculeatus* were absent in the *Katha* catch.

Species are arranged from top to bottom in descending order of their contributions to the average dissimilarity between the two fisheries (*Katha* and Survey catch) of different years. Only those species contributing to 67.94% of the cumulative average dissimilarity are shown in Fig. 6.

Among the taxonomic groups, Small catfish showed the highest catch, and followed by, Large-medium sized catfish (*Sperata aor* and *Wallago attu*), Major and minor carps (*Labeo rohita, Gibelion catla, Cirrhinus mrigala* and *Systomus sarana*), Snakeheads (*Channa marulius, Channa striata*, *Channa punctata*), Prawns (*Macrobrachium rosenbergii* and *Macrobrachium malcolmsonii*), Large and medium miscellaneous species and Small miscellaneous species. The *Pethia* sp showed the lowest catch rate in all study years. Analyzing the annual data for the six sampling years (1997-2002), the compositions of species when comparing *Katha* catches with survey catches indicated large changes among groups.

## 3.7 Detailed Description of Catches among Groups

### 3.7.1 Large and medium sized catfishes

Fishes under this group are mainly carnivorous and top predators. A total of eight species were observed in this group. *Wallago attu*, a carnivorous fish and major contributed species in this group which showed increasing trend in production from 1997 to 2002. Production of *Sperata aor* gradually increased and reached a peak (27.89 kg/ha) in 2000 however, considerably declined (7.4 kg/ha) in 2002. *Ompok pabda*, the most commercial valuable species, showed fluctuating in *Katha* catches and the highest catch (11.62 kg/ha) was found in 2001. The catch rate of *Ompak bimaculatus* was 4.73 kg/ha in 1997, and showed a decreasing

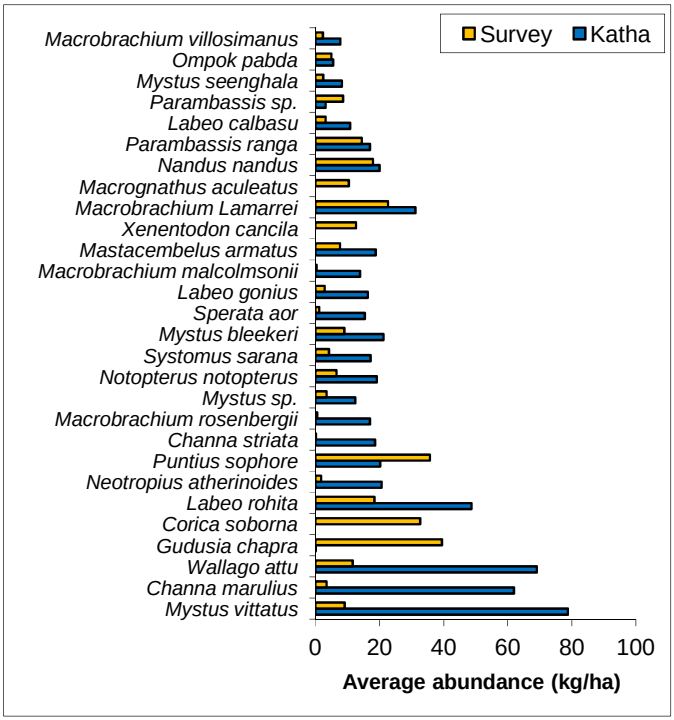


**Fig. 6. Average abundance (catch kg/ha) of species caught form *Katha* and Survey catch in the river Titas**

trend in following years and not found in *Katha* catches during 2001 and 2002. Species such as *Heteropneustes fossilis*, *Clarias batrachus* and *Rita rita* were made negligible contributions to the catches in this group. Family and species wise detailed results are given in Appendix-1.

### 3.7.2 Small catfish

Small catfish made up the highest contributions in *Katha* catches. *Mystus vittatus* is a small catfish of 3-5 cm (total length) and was the most prevalent species in this group. The production of *Mystus vittatus* increased with the highest catch of 130.82 kg/ha appeared in 2001. Family and species level detailed results are presented in Appendix-1.

### 3.7.3 Major and minor carps

Fishes under this group are mostly the local major carps (*Labeo rohita, Gibelion catla, Cirrhinus mrigala, Labeo gonius, Labeo calbasu*), and Cyprinus carpio (Common carp) and Systomus sarana (olive barbi). Among the major carps the most important commercial species *Labeo rohita*, makes up the maximum contribution and followed by *Labeo calbasu* and *Labeo gonius*. The highest catch (65.63 kg/ha) of *Labeo rohita* was recorded in 2001 which remained almost the similar from 2000 to 2002. Family and species level detailed results are also presented in Appendix-1.

### 3.7.4 Prawns

Prawns are one of the major contributory group in *Katha* catches and small prawns make up a large part of this. The highest catch (20.02 kg/ha) of giant freshwater prawn *Macrobrachium rosenbergii* was recorded in 2000 and 2002 and lower catches (9.74 kg/ha) were recorded in 2001. Family and species level detailed results are also presented in Appendix-1.

### 3.7.5 Snakeheads

Three species of snakeheads (*Channa* spp.) made up this group. Snakeheads ranked third among the group catches. Highest production (135 kg/ha) of snakehead was recorded in 2002. *Channa marulius* showed the highest catch (117.02 kg/ha) within the Snakehead group in 2002. The catch of *Channa striata* decreased after showing a maximum catches of 35.24 kg/ha in 1999. The catch of *Channa punctata* was always the lowest within this group. The catch of *Channa punctata* remained very unpredictable

varying from 9.91 kg/ha in 1998 to only 0.89 kg/ha 2002. It is worth noting that *Channa punctata* is one of the species severely affected by ulcerative disease (EUS) which must have impacted catches [17]. Catches of *Channa punctata* may also have been affected by recruitment over-fishing in floodplains where they breed. Family and species level detailed results are presented in Appendix-1.

#### 3.7.6 Small barbs

Small barbs were represented by five species of barbs of the genus *Puntius and Pethia*. The catch remained about 2-10% of total *Katha* catch during study years. *Puntius sophore* constituted the highest catch about 29.90 kg/ha in 1998, and gradually decreased until 2000 but increased to 26.76 kg/ha in 2002. Analysis of catches from *Kathas* in this river showed that *Pethia* sp made up the smallest species group. Family and species level detailed results are presented in Appendix-1.

#### 3.7.7 Large and medium miscellaneous species

The fishes of this group are large and medium sized fishes such as feather backs (Chitata *chitala, Notopterus notopterus*), *Mastacembelus armatus*, *Nandus nandus*. Like barbs, the contribution of this group was one of the lowest and varied between 4 to 15% of the total *Katha* catch. The lowest catch (12.80 kg/ha) was recorded in 1997 and the highest catch (78.96 kg/ha) was recorded in 2001. The catch of other years fluctuated. The catch of contributing species in this group showed irregular pulses over years. Family and species level detailed results are presented in Appendix-1.

#### 3.7.8 Small miscellaneous species

A number of small sized fish from different groups of fish constitute this group. The contribution of this group ranged from 1.7% (1997) to 7.7% (1998) of the total catch. The catch of other years remained similar. The highest catch of around 44 kg/ha was recorded in 2000. *Parambassis ranga* showed the highest catch of about 34.78 kg/ha in 2000. Family and species level detailed results are also presented in Appendix-1.

### 3.8 Overall Catch Trends of Fishes

The variation of main species in different years and their catch pattern in the Khata reveals that eight species (*Mystus vittatus*, *Wallago attu*, *Channa marulius*, *Labeo rohita*, Macrobrachium lamarrei, *Mystus sp*, *Nandus nandus* and *Labeo gonius*) showed increasing catch trends and nine species (*Mystus seenghala, Noptoterus notopterus, Channa striatus, Puntius sophore, Systomus sarana*, *Neotropius atherinoides*, *Sperata aor*, *Macrobrachium rosenbergii* and *Macrobrachium malcolmsonii*) showed decreasing trends. This reveals that among the 18 main species the 'increasing trends' species contributed 61.0% and the 'decreasing trends' species contributed 28.0% of the overall catch. Present study shows that *Katha* catches were dominated by six main species (*Neotropius atherinoides*, *Mystus vittatus*, *Labeo rohita*, *Wallago attu*, *Channa striatus* and *Channa marulius*) and the combined overall catch was 589±180 kg/ha/year. *Neotropius atherinoides*, which was the most abundant species in 1997, showed a huge decrease in catch the following years, so that it was no longer within the list of abundant species. *Channa marulius* appeared as the most abundant species through succession and replacing other overexploited species.

It is worth noting that *Katha* fisheries in the river Titas showed a minor change in species composition (most abundant species). Good examples were the species Mystus *vittatus*, *Wallago attu*, *Channa marulius* and *Labeo rohita*, and their combined contribution was about half of the annual *Katha* catch. In a study during 2001 and 2002 from an adjacent section of the same river it was found that *Wallago attu*, *Notopterus notopterus*, *Macrobrachium rosenbergii* and *Macrobrachium malcolmsonii* contributed 12.48%, 2.57%, 2.88% and 1.18% during *Katha* fishing season [18] which compares well with the present findings. In the *Katha* fishery, the perennial component of the catches were *Mystus vittatus*, *Wallago attu*, *Channa marulius* and *Labeo rohita* which accounted for 13.72%, 11.46%, 10.05% and 8.02% of the overall catch.

### 3.9 Costs and Benefits

Cost - benefit analysis over the study period (1997-2002) found that annual costs and benefits varied proportionately overtime. *Katha* census records showed increased costs for *Katha* construction in 1999 compared to 1997 and costs remained steady until 2002 due to economic scale. However, benefits increased suddenly in the 1999 season compared to previous seasons and remained steady from 2000 to 2002. The lowest net benefit (BDT 9,885 or USD 225) per

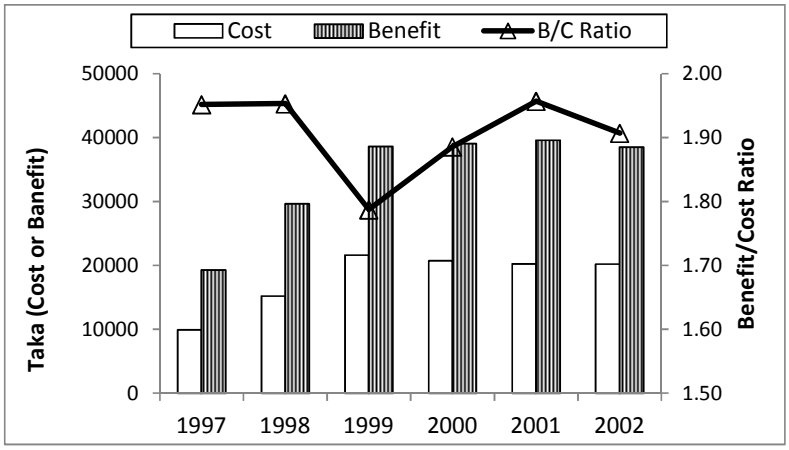


**Fig. 7. Cost-benefits of *Katha* catch in the river Titas**

*Katha* was found in 1997 and the highest net benefit (BDT 21,629 or USD 446) per *Katha* was found in 1999. The benefit/cost ratio for *Kathas* during 1997- 2002 were found to be 1.95, 1.95, 1.79, 1.89, 1.96 and 1.91 respectively. Cost-benefit analysis of *Kathas* has been studied by [18] from an adjacent section of the same river and found net benefit of BDT 10430 per *Katha per year* during 2001-2002. Titas G-G is in the mainstream of the river Titas and is comparatively deeper compared to [18] study area, and may represent a better area for fish to stay safely. The trends for costs and benefits of the Titas G-G *Katha* fishery from 1997 to 2002 are shown in Fig. 7.

## 4. CONCLUSIONS

Control measures are necessary to limit the deployment of *Katha* fishing considering the appropriateness of its extent, the number of *Kathas* in a waterbody, and the species mix of fish at a site. *Katha* fishing may be considered as harmful as brood-fish of many of the riverine resident species are easily caught. The study has provided evidence that the Katha fishery restricts recruitment to the inland openwater fishery and therefore results in an overall lowering of production. Also the relative abundance of top predators in *Kathas* could be an indication of biological over fishing. On the other hand it is a very efficient device to harvest big carnivores (top predators) like *Wallago attu*, *Channa marulius*, *Channa striatus* etc. So from the point of view of fisheries management, *Kathas* represent a dilemma. Although this study may not be solely conclusive, it appears that the *Katha* fishery in the river system generally has a detrimental impact on fisheries resources as well as reducing fishing opportunities for poor and marginal fishers. Further research is needed on this to reach to a decision on this fish aggregating device, whether it should be continued or fully stopped in the inland open water fisheries management system, where community based fisheries management has to real alternative to promote.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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## APPENDIX

**Appendix-1. The taxonomic group used in the *Katha* catch analysis of the river Titas and the taxa contributed to each group by weight (kg/ha) to the *Katha* catches**

| Group | Family | Scientific name | Common name | Catch (kg/ha) | Catch (kg/ha) | Catch (kg/ha) | Catch (kg/ha) | Catch (kg/ha) | Catch (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Large and | Bagridae | *Sperata aor* | Long-whiskered catfish | 6.32 | 13.53 | 19.30 | 27.89 | 17.81 | 7.40 |
| medium sized | Bagridae | *Mystus bleekeri* | *Day's mystus* | 0.00 | 4.90 | 22.50 | 8.48 | 2.83 | 10.66 |
| Catfishes | Siluridae | *Ompok pabda* | *Pabda catfish* | 3.80 | 2.58 | 1.21 | 5.14 | 11.62 | 8.71 |
| | Siluridae | *Ompok bimaculatus* | *Butter catfish* | 4.73 | 0.00 | 0.61 | 1.79 | 0.00 | 0.00 |
| | Siluridae | *Wallago attu* | *Wallago Catfish* | 21.83 | 36.99 | 61.10 | 94.54 | 100.09 | 100.23 |
| | Heteropneustidae | *Heteropneustes fossilis* | *Stinging catfish* | 0.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Clariidae | *Clarias batrachus* | *Philippine catfish* | 0.00 | 0.00 | 0.07 | 0.29 | 0.00 | 0.00 |
| | Bagridae | *Rita rita* | *Rita* | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Small | Bagridae | *Mystus vittatus* | *Striped dwarf catfish* | 7.54 | 59.53 | 84.31 | 92.94 | 130.82 | 97.39 |
| catfishes | Bagridae | *Mystus sp.* | Catfish | 48.48 | 0.00 | 0.00 | 8.16 | 12.30 | 5.34 |
| | Schilbeidae | Neotropius *atherinoides* | Indian potasi | 54.38 | 20.26 | 9.47 | 9.09 | 15.33 | 15.63 |
| | Bagridae | *Sperata seenghala* | *Giant river-catfish* | 5.92 | 31.83 | 17.25 | 17.8 | 22.32 | 32.01 |
| | Sisoridae | *Gagata gagata* | *Gangetic gagata* | 0.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Major and | Cyprinidae | *Labeo rohita* | *Roho labeo* | 29.35 | 16.11 | 53.00 | 64.05 | 65.63 | 63.69 |
| Minor carps | Cyprinidae | *Gibelion catla* | Catla | 4.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cyprinidae | *Cyprinus carpio* | *Common carp* | 0.75 | 0.00 | 0.00 | 0.00 | 8.68 | 4.06 |
| | Cyprinidae | *Cirrhinus mrigala* | *Carps* | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cyprinidae | *Labeo gonius* | *Kuria labeo* | 0.53 | 0.22 | 5.11 | 28.37 | 34.62 | 29.22 |
| | Cyprinidae | *Labeo calbasu* | *Orangefin labeo* | 4.30 | 6.18 | 11.70 | 15.72 | 20.76 | 5.70 |
| | Cyprinidae | *Systomus sarana* | *Olive barb* | 0.21 | 26.98 | 18.04 | 16.69 | 23.51 | 17.43 |
| Prawns | Palaemonidae | *Macrobrachium malcolmsonii* | Monsoon river prawn | 14.18 | 3.02 | 16.81 | 1.03 | 18.62 | 29.62 |
| | Palaemonidae | *Macrobrachium villosimanus* | Dimua river prawn | 9.37 | 1.22 | 4.49 | 20.30 | 7.48 | 3.48 |
| | Palaemonidae | *Macrobrachium rogenbergii* | Giant river prawn | 19.39 | 15.81 | 16.48 | 20.21 | 9.74 | 20.02 |
| | Palaemonidae | *Macrobrachium lamarrei* | Kuncho river prawn | 19.25 | 16.87 | 34.07 | 31.34 | 43.19 | 42.30 |
| | Palaemonidae | *Macrobrachium birmanicum* | Birma river prawn | 0.00 | 0.54 | 4.67 | 2.53 | 0.00 | 4.86 |
| Snake heads | Channidae | *Channa marulius* | *Great snakehead* | 2.60 | 33.42 | 53.82 | 75.54 | 89.31 | 117.02 |
| | Channidae | *Channa striata* | *Striped snakehead* | 7.64 | 35.24 | 21.89 | 15.38 | 13.77 | 17.51 |
| | Channidae | *Channa punctata* | *Spotted snakehead* | 0.00 | 9.91 | 7.53 | 2.79 | 0.06 | 0.89 |
| Small barbs | Cyprinidae | *Puntius sophore* | *Pool barb* | 19.86 | 29.90 | 13.75 | 14.22 | 16.49 | 26.76 |
| | Cyprinidae | *Pethia gelius* | *Golden barb* | 2.34 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cyprinidae | *Pethia conchonius* | *Rosy barb* | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Group | Family | Scientific name | Common name | Catch (kg/ha) 1997 | Catch (kg/ha) 1998 | Catch (kg/ha) 1999 | Catch (kg/ha) 2000 | Catch (kg/ha) 2001 | Catch (kg/ha) 2002 |
|---|---|---|---|---|---|---|---|---|---|
| | Cyprinidae | *Pethia phutunio* | *Spottedsail barb* | 0.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.87 |
| | Cyprinidae | *Pethia ticto* | *Ticto barb* | 0.00 | 1.74 | 0.00 | 0.00 | 0.00 | 0.00 |
| Large medium species | Notopteridae | *Notopterus notopterus* | *Bronze featherback* | 1.33 | 31.28 | 14.98 | 23.99 | 23.16 | 20.40 |
| | Notopteridae | *Chitala chitala* | *Clown knifefish* | 0.00 | 0.00 | 0.00 | 1.52 | 0.00 | 0.15 |
| | Miscellaneous Mastacembelidae | *Mastacembelus armatus* | *Zig-zag eel* | 1.83 | 19.46 | 28.14 | 16.55 | 26.79 | 19.82 |
| | Nandidae | *Nandus nandus* | *Gangetic leaffish* | 9.64 | 19.91 | 11.05 | 15.10 | 29.01 | 35.27 |
| Small misc species | Ambassidae | *Parambassis ranga* | *Indian glassy fish* | 1.13 | 17.76 | 13.54 | 34.78 | 16.92 | 17.73 |
| | Ambassidae | *Parambassis sp.* | *Glassy fish* | 2.65 | 12.24 | 0.00 | 3.39 | 0.00 | 0.89 |
| | Osphronemidae | *Trichogaster fasciata* | *Banded gourami* | 0.00 | 4.21 | 5.86 | 2.63 | 1.91 | 0.58 |
| | Mastacembelidae | *Macrognathus Pancalus* | *Barred spiny eel* | 0.00 | 0.00 | 5.65 | 0.67 | 0.00 | 0.27 |
| | Osphronemidae | *Trichogaster lalius* | *Dwarf gourami* | 0.00 | 2.34 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cyprinidae | *Chela cachius* | *Minnows* | 0.00 | 0.00 | 1.09 | 0.00 | 0.00 | 0.00 |
| | Osphronemidae | *Trichogaster chuna* | *Honey gourami* | 0.00 | 0.00 | 0.13 | 0.84 | 0.21 | 0.00 |
| | Cyprinidae | *Salmophasia sp.* | *Finescale razorbelly minnow* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.18 |
| | Nemacheilidae | *Nemacheilus sp.* | *Loach* | 0.41 | 0.00 | 0.00 | 0.29 | 0.00 | 0.00 |
| | Cyprinidae | *Osteobrama cotio* | *Minnows* | 0.00 | 0.00 | 0.40 | 0.00 | 0.00 | 0.00 |
| | Tetradontidae | *Tetradon sp.* | *Milkspotted puffer* | 0.69 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cyprinidae | *Amblypharyngodon Mola* | *Mola carplet* | 0.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Clupeidae | *Gudusia chapra* | *Indian river shad* | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 |
| | Badidae | *Badis badis* | *Badis* | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | 0.00 |
| | | Unknown fish sp-1 | | 0.00 | 0.00 | 0.00 | 0.30 | 0.00 | 1.62 |
| | | Unknown fish sp-2 | | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 3.28 |



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