Minor Research Project in Zoology

On

Distribution of *Bufo melanostictus, synonyms (Duttaphrynus melanostictus)* in the Tumkur Urban Ecosystem, Karnataka, India

Submitted by

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Submitted to

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SOUTH WESTERN REGIONAL OFFICE
PK BLOCK,PALACE ROAD, BANGALORE

March – 2013

ACKNOWLEDGEMENTS

We express our Pranamas to His **Holiness Dr. Sree Sree Shivakumara Swamiji,** President, Siddaganga Math, Tumkur and **His Holiness Sree Sree Siddalinga Swamiji** Vice President, Siddaganga Math, Tumkur for their blessings.

Our respectful thanks to Sri. T.K. Nanjundappa, Secretary, SSES, S. Shankaraiah Special officer, SSES and former Principal Dr. H.S. Niranjan Ardhya for their co-operation. Our special thanks to Dr. H.P. Gurushankara, Assistant Professor, Central University, Kannur for his guidance.

Our thanks to the Sri. B.L. Vaidyewsara, Principal and staff of Sri Siddaganga College of Arts, Commerce and Science, Tumkur.

This research work is financially supported by **UNIVERSITY GRANTS COMMISSION** vide Letter MRP(S) – 706 /10-11/KABA050/UGC –SWRO.

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CONTENTS

SYMBOLS AND ABBREVATIONS

C °	-	degree Celsius
cm	-	centimeter
et al	-	and others
e.g.,.	-	for example
etc.	-	and so forth
gm	-	gram
mg	-	milligram
M	-	mean
mm^2	-	square millimeter
nm.	-	nanometer
µg/ml	-	microgram / millilitre
l	-	litre
hr.	-	hour
no.	-	number
wt.	-	weight
ppm	-	parts per million
rpm	-	rotations per minute
s	-	seconds
SD	-	standard deviation
SE	-	standard error
±	-	plus or minus
%	-	percentage
&	-	and
i.e.,	-	that is

Distribution of *Bufo melanostictus*, synonyms *Duttaphrynus melanostictus* (Indian Toad) in the Tumkur urban ecosystem Karnataka.

INTRODUCTION :

Taxonomy and Habitat: *Bufo melanostictus* (Indian Toad) synonyms *Duttaphrynus melanostictus* is a member of the Class Amphibia , order Anura, family Bufonidae, genus Duttaphrynus and the Species *melanostictus* comprises the true toads, is commonly called Asian Common Toad .They have been recorded from sea level up to 1,500 m altitude. In Tumkur Urban area, we have noticed that they live mostly in lowland habitats to human-dominated agricultural and urban areas. Adults are terrestrial and may be found under ground cover such as stones, leaf-litter, logs and are also associated with human habitations. Indian common toads breed in temporary and permanent ponds and pools. They are often seen at night. They have been noted to feed on a wide range of insects and worms.

Morphology of *Bufo melanostictus* : Adults Toads reportedly range from 85–120 mm in body length. Males reach a maximum of 85 mm snout-vent length –SVL (Figure: 3) and Females exceeding 110 mm snout-vent length (SVL). The size disparity between males and females is typical. The top of the head has several bony ridges along the edge of the snout. The snout is short and blunt and the space between the eyes is broader. The ear drum or tympanum is very distinct. Warty tubercles are seen on the dorsal side in almost all the adults.. The dorsal side is yellowish or brownish and the spines and ridges

are black. Frog lets and Juveniles are brown in colour.The underside is unmarked or spotted. Males have a subgular vocal sac and black pads on the inner fingers.

Fig :1 Adult Female *Bufo melanostictus* (Tumkur)

Fig : 2 Adult Male *Bufo melanostictus* (Tumkur)

Amphibians commonly use wetlands as breeding grounds. In urban areas, wetlands have less forest cover and are concentrated by buildings and roads. It is

hypothesized that amphibians are sensitive to the effects of urbanization. Hence, the effects of urbanization on the breeding and distribution of these species need to be investigated. Adults were found in all the sites throughout the study period; while tadpoles were observed during the months of July, August, September and October signifying the breeding period.(Biju, S.D, I.V. Bocxlaer, V.B. Giri, S.P. Loader, 2009) . Analysis of habitat variables and abundance of toads and tadpoles are significantly variable among the study sites. (Odum H.T., 1956) . Some of the habitat variables showed significant relationships with the occurrence of tadpoles only.

Fig :3 Marking of Snout – Vent – Length (SVL) of *D. melanostictus*

The changes in the water quality due to the entry of domestic and industrial effluents and conversion of these breeding grounds into domestic/commercial purposes have influenced the occurrence of both adults and tadpoles. This study clearly demonstrates that urbanization would have deleterious effects on the distribution of adults and tadpoles of *B. melanostictus* in the urban ecosystem of Tumkur. The wide spread decline of amphibian population raised a warning among biologist throughout the world for the last few decades (Blaustein, A. R., and D. B. Wake., 1990) .A number of possible factors for the decline of amphibians including habitat loss and fragmentation, climate change, UV radiation, diseases and infections, introduced species,and chemical pollution of the environment. (Gurushankara et, al. 2007, Krishnamurthy et,al.2008, Mann et,al.2009). Among all these factors habitat loss and fragmentation create a problem to suffer an aquatic and terrestrial life rendering amphibians, in which urbanization can play a major role. (McDonnell, M.J., Pickett S.T.A., 1990).

REVIEW OF LITERATURE :

Urbanization is an extreme form of land use.Urban land cover is significantly correlated with species richness and endemism (Myers et,al.2000).Urban land threatens natural ecosystems through habitat conversion and habitat fragmentation. Fragmentation occurs when once continuous habitats are divided into separate fragments (Manjunatha Reddy, A.H, 2004).Human associated fragmentation causes biodiversity decline, because it destroys species, disrupts community interactions and interrupts evolutionary processes, resultingin irreversible losses of biological diversity, (McKinney, M. L. 2006).Human over populations globally has been linked with habitat loss and associated habitat degradation isthe primary source of loss of biological diversity worldwide. The estimated fraction of land transformed or degraded by humanity are calculated to be as much as 50%. (Ingram, G. J. 1990).The United Nations (UNPD 2006) revised population estimate for 2005 projects an Urban population of 52.9 l% in 2015. The WorldResource Institute (WRI 1997) has projected that 61% of the world population will be urban by 2025.In 1900 only 14% of the world population lived in urban communities it had reached to 49.2% at present (United Nations 2005).Over 90% of urban growth will occur in developing Cities.These Cities which are predicted to found in the worlds biodiversity hot spots (Daniels, R.J.R ,1992).The biodiversity hot spots are 32 areas from across the globe that are extremely rich in endemic species and particularly threatened by Human activities. Daniel, J.C. 2000) reported that in 1995 nearly 20% of global population was living within the hot spots, an area covering about 12% of earth terrestrial surface. They determined that growth rate in the hot spots was 1.8%, substantially higher than the 1.3%

world average. It was even above the annual average of 1.6% for developing Countries. The extensive human induced environmental changes are linked to urbanization at reasonable scale and will remain an important factor in global biodiversity conservation.

Urban habitats are expanding throughout the world, and the processes of urbanization threaten the persistence of many plant and animal species.When cities are constructed large areas of native vegetation are often removed and replaced with exotic plants and concrete; Open space is filled with urban infra-structure such as housing and roads;rivers, ponds and wet lands are modified or destroyed and new artificial aquatic habitats are constructed. Habitat suitable for native plants and animals are often fragmented,isolated and altered from their pristine state .(Gibbs J P.,1998).

Urbanization currently threatens over 1/3rdof the world's known amphibian species. TheMajor threats of urbanization to amphibian population are habitat loss and habitat fragmentation, isolation and degradation of habitat quality. A complex array of biotic and abiotic interacting factors influences the amphibians in Urban and urbanizing areas. These factors may lead to a decrease in species richness, the abundance of individual species and ability of their dispersal significantly reduced in urban and sub urban landscapes. (Dinesh K.P., C. Radhakrishnan, K.V. Gururaja and G.K. Bhat, 2009).Amphibian species that are highly specialized habitat generalist and have relatively low dispersal requirements appear to be better adoption to survive in urbanizing areas. There is insufficient information on the ecology and distribution of amphibians in urbanizing areas in the tropical countries, despite worldwide declines reported over past

decades. India is also a tropical country harbors hot spots and rich in biodiversity which has the highest rates of urbanization due to over population, so too do demands for residential, industrial, commercial, and recreational space. (Ingram, G. J, 1990)

Hence a study was conducted on habitat variables and distribution of the tadpoles and adults of *Duttaphrynus melanostictus* in Tumkur, Karnataka a province experiencing rapid sub urban growth in India. From this experimental approaches would determine the proximate causes of species response to human modification of their natural habitat. This study clearly demonstrates that urbanization would have deleterious effects on the distribution of adults and tadpoles of *D. melanostictus* in the urban ecosystem of Tumkur.

MATERIALS AND METHODS :

Description of Study Area: Tumkur is the one of the largest urbanizing city in Karnataka,India lies between 12º 45´ N and14º 22´ N latitude and between76º 24´ and 77º 30´ E longitude. Elevation is 822 m.a.s.l (Figure: 4).The population of the city approximately 3 lakhs (Indian Censes, 2011). Tumkur has a semi-arid climate with an annual mean temperature of 31^0C and rainfall 20 mm. The diversity and distribution of amphibians in this city is not reported. But frogs and toads are inhabited in the urban Tumkur and these are known to breed in lentic aquatic habitats such as ponds, ditches and stagnant pools (author observation). Four water bodies were selected for the present study.Site: 1**.Ammanikere tank** (Fig :5) located in the center of the city,Altitude: 803 m.a.s.l; altitude: N13 20' 41. 8^0 E 77 06' 33.4^0 largest pond in Tumkur city surrounded by dense human population; Pond receives moderate rain water at monsoon season.This pond is threatened by the entry of the domestic waste water and industrial effluents; and Habitat fragmentation due to construction of theme park by the City Corporation. **Site: 2.East MaidalaTank** (Fig:.6) altitude: 789 m.a.s.l; Latitude: N13 19' 24. 30 E 77 10' 22.40.It is a Fresh water tank located outskirt of the city; surroundedby agricultural fields and less human population; water is using for drinking purposeand this tank is experiencing usual eutrophication. **Site: 3.West Gubbi Gate pond** (Fig: 7) Altitude: 812 m.a.s.l; Latitude: N13 19' 14. 20 E 77 08' 16.70 It is a stagnant water body located north of the urban; surrounded by roads, paddy fields, small industries and less human population . This pond receives domestic and industrial effluents entry through the

municipal open drainage system. S**ite: 4 North Shettihallypond** (Fig:8**)** altitude: 844 m.a.s.l; Latitude: N13 19’ 04. 30 E 77 11’ 24.20 .It is a stagnant water body surrounded by buildings and roads; tank receives rain water at the time of monsoon; in summer tank will be completely dried.This pond is threatening by domestic waste water entry; habitat encroachment for construction of layouts.

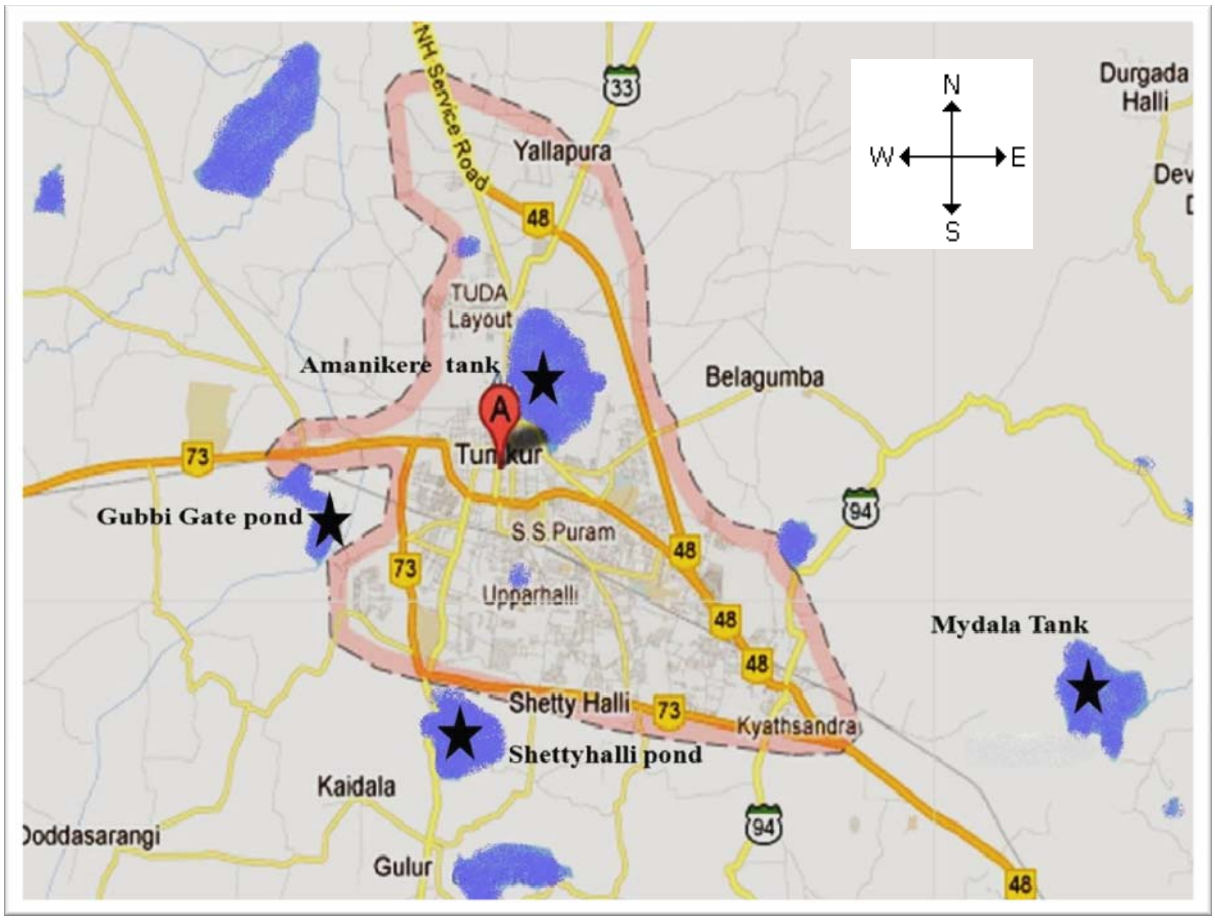


Figure: 4 Map of the study area (City of Tumkur) showing the locations of four different sites (marked in asterisk)

AMMANI KERE (SITE- 1)

Altitude: 803 msl; Latitude: N13 20’ 41. 8^0 E 77 06’ 33.4^0

Largest pond in Tumkur city surrounded by dens human population; Pond receives moderate rain water at monsoon season

Threats: Entry of the domestic waste water and Industrial effluents; Habitat fragmentation due to construction of theme park.

Fig:5 AMMANI KERE (Site - 1)

MAIDALA TANK (SITE - 2)

Altitude: 789 msl; Latitude: N13 19’ 24. 3^0 E 77 10’ 22.4^0

It is a Fresh water tank located outskirt of the city; surrounded by agricultural fields and less human population; water is using for drinking

Threats: Eutrophication

Fig:6 MAIDALA TANK ((Site - 2)

GUBBI GATE (SITE - 3)

Altitude: 812 msl; Latitude: N13 19’ 14. 2^0 E 77 08’ 16.7^0

It is a Stagnant water body located north of the urban; surrounded by roads, paddy fields, small industries and less human population

Threats: Domestic and industrial effluents entry through the municipal open drainage.

Fig:7 GUBBI GATE (site – 3)

SHETTY HALLY POND(Site-4)

Altitude: 844 msl; Latitude: N13 19’ 04. 3^0 E 77 11’ 24.2^0

It is a Stagnant water body surrounded by buildings and roads; Tank receives rain water at the time of monsoon; in summer tank will be completely dried

Threats: Domestic waste water entry; Habitat encroachment for construction of layouts, parks and market shops.

Fig:8 SHETTY HALLY POND (site – 4)

Survey of *Bufo melanostictus*: Common Indian Toad *B..melanostictus* is non-endemic listed as least concern of IUCN Red List category. It breeds in still and slow flowing river associated withtemporary and permanent ponds and pools. Adults are terrestrial and found under ground cover and are also associated with human habitation. The larvae are found in still and slow moving water bodies. This species could be severely threatened by rapid processes of urbanization in human dominated areas. There are no reports available on the decline of this amphibian populationin urban areas. Hence this species have been selected as a model and realistic organism to study the impact of urbanization.

Each site was surveyed for the presence of adult and tadpoles of *B.melanostictus* from the period from **February2011 to January 2012**. Every habitat was visited twice in a month. The population size of the adult toad was estimated using Schnabel method of mark recapture as described by (Sutherland,2000) using **knee tagging** as described by (Heyer, W.R,M.A.Donnely and. R.W.McDiarmid, 1994).The numbers of marked and unmarked toads were recorded in a 25X25 m^2 quadrate sampling method. The density of adult of adult in each quadrat is taken directly for all calculation. The tadpoles were sampled using hand nets in a four 1X 1 m^2 quadrate randomly sampled in each sites. We documented each toad and tadpoles using Sony Handy cam, make Japan. We estimate our field hours to total of 200 hrs. between the period February2011 to January 2012**.**

Fig:9 Tagging of Toads using Silk Threads

Habitat variable analysis: Ecologists have always been interested on how abiotic factors affect living organisms. Many studies have analyzed how amphibians are affected by different habitat variables. Hence, we have measured the various habitat variables. In every survey, important habitat variables namely, air, soil temperature, pH, dissolved oxygen, carbon dioxide, conductivity, free ammonia, phosphate, sulphate and nitrate were recorded. The mercury bulb thermometer (make: Japan, precision 0.1 ^{0}C) was used for the air temperature. The soil temperature was recorded using a mercury soil thermometer (make: Japan,precision 0.1 ^{0}C). The pH of the water is recorded using the pH papers. Dissolved Oxygen (mg/L) in water was measured using Winkler's method. Carbon dioxide and sulphate in water was measured using the titrimetric method. Conductivity of water was recordedby electrometric method. Using spectrophotometric method free ammonia, phosphate and nitrate in water were analyzed.

DATA ANALYSIS :

The presence of adult and tadpoles of *D. melanostictus* and habitat variables in the four sites of Tumkur were subjected to **(ANOVA)** and Duncan **Multiple regression test** to find out the significant difference between the sites**. Karl Pearson correlation co-efficient** was used to check the relationship between the distribution of tadpoles and adults and habitat variables. **The regression analysis** was carried out to find the linearity between the proportion of marked toads in each catch and number of toads previously marked. All the statistics were made using the **SPSS 16 for windows**.

The following methods are used for analysis of various Parameters. (APHA 1995)

Table (1- 10) showing the results of water variables in the different sites of Tumkur Urban Ecosystem :

Parameters	**Methods**
Temperature	Thermometer
P^H	P^H paper
Dissolved Oxygen	Wrinklers Method
Chloride	Titrimetric method
Alkalinity	Titrimetric method
Acidity	Titrimetric method
Calcium hardness	EDTA Titration Method
Magesium Hardness	EDTA Titration Method
BOD	Titrimetric method
Free CO2	Titrimetric method
Phosphate	SpectroPhotometric Method

RESULTS AND DISCUSSION:

The population distribution of adults and tadpoles of the *B. melanostictus* in Ammanikere, Mydala, Gubbigate and Shettihalli are given in the (Table 11-14.) During the Study Period, a total of 45, 105, 60 and 62 toads in 25m^{2}quadrate were collected from Four sites respectively. Out of these collections, from Ammanikere - 71.11%, Mydala-76.19%, Gubbigate - 61.66% and Shettihalli- 61.29% frogs were recaptured. The Schnabel method of *B. melanostictus* population estimate shown Mydalakere (n=21.68) has more toads compare to other three habitat Ammanikere (n=8.34), Gubbigate (n=17.41) and Shettihalli (n=16.68). The proportion of marked individuals of toads in each catch was increased linearly with increasing number of toads previously marked in Mydala site (Fig 1b: y=0.0285x+0.2924; R^2= 0.7465). The Figure 1b clearly indicating the population is constant in Mydala site. The compared to other three sites, non-linearity of marked individuals of toads in each catch with increasing number of toads previously marked observed in Ammanikere (y= 0.0314x+0.4416;R^2= 0.0351); Shettihalli (y= 0.0029x+0.5479; R^2= 0.0082) and Gubbigate (y=0.0096x+0.4791; R^2= 0.1112). The non-linearity in there sites are clearly depicts the violation of Schnabel method of mark recapture population principle. The marc-recapture of non-linearity of slope (Fig1) indicates the some of the marked toads were moved away from the respective sites over the study.

The data on the habitat variables in different studied sites of Tumkur are presented in Table -13 . The significant differences in habitat characters among the sites were

observed in air and soil temperature, pH, dissolved oxygen, carbon dioxide, conductivity, free ammonia, phosphate, sulphate and nitrate. Compared to other 3 sites, Mydala tank shows a favorable healthy habitat. For example dissolved oxygen ranges from 9.70 to 17.20 mg/L in Mydala tank, in other sites it is below the range of 4 mg/L. In the analyses of carbon dioxide, all the three sites are having in the range of 12.40 to 18.60 mg/L. But in Mydala it is between 1.20 to 1.90 mg/L range. The higher level of conductivity, free ammonia, phosphate, sulphtae and nitrate were observed in Ammanikere, Gubbigate, and Shettyhalli sites. The disparity in the habitat variables among the studied sites is due to the changes in the habitat structure by human activity such as domesticated and industrial effluents, eutrophication of agricultural fertilizers and manures. The Karl-Pearson co-relation of habitat variables and distribution of adults and tadpoles of *B.* melanostictus in urban sites of Tumkur is presented in the Table - 11. The variation in habitat variables in Ammanikere site is clearly shows the air and soil temperature, pH, Dissolved oxygen, carbon dioxide and phosphate are negatively correlated with adult toad distribution. Some of the habitat variables show significant relationship with the occurrence of tadpoles only (Table 11).

Although our understanding of the relationships between amphibian abundance and various types of environmental degradation has improved immeasurably over the past decade or so, there have still been no explicit tests of amphibians as biological indicators and there are few data to suggest that they are better than other taxa in this respect.(Baskaran, N. and D. Boominathan,2010). Two features of amphibians, their use

of both aquatic and terrestrial habitats and their sensitive skin are often quoted as making them particularly vulnerable to environmental change and therefore good indicators (Blaustein and Wake, 1990; Wyman, 1990; Lips, 1998). (Abraham, S and P.S. Easa.,1999). This assumption may be over-simplistic. Very few amphibians divide their time equally between water and land, either within or between life-history stages. Moreover, a large number of species lead either entirely terrestrial or entirely aquatic existences through direct development or paedogenesis. Consequently, there is likely to be a considerable imbalance between the relative impacts of aquatic and terrestrial stressors for most species, and where both types of stressor are important (Trevor J.C. Beebee, and Richard A. Griffiths). With reference to *B. melanostictus,* our study revealed both type of stressor has a role in distribution and abundance of this particular species. Proving deleterious effects of pesticides at the population (as opposed to the laboratory, field enclosure or mesocosm) level is a difficult problem, but increasingly sophisticated analyses taking account of historical pesticide application data have strongly linked organophosphates and carbamates with the declines of four Californian anurans (Lips, K.R., Reeve, J.D., Witters, L.R., 2003).

Table: 1Air Temperature (^{0}C) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-Value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	30.00 ± 0.00	30.00 ± 0.00	30.00 ± 0.00	30.00 ± 0.00	-	-
March 2011	31.00 ± 0.00	31.00 ± 0.00	31.00 ± 0.00	31.00 ± 0.00	-	-
April 2011	32.25 ± 0.50	31.00 ± 0.00	32.25 ± 0.50	30.00 ± 0.00	38.00	0.0001
May 2011	31.00 ± 0.00	30.75 ± 0.50	31.00 ± 0.00	30.00 ± 0.00	14.33	0.0001
June 2011	*	30.00 ± 0.00	30.00 ± 0.00	29.00 ± 0.00	-	-
July 2011	*	29.00 ± 0.00	31.00 ± 0.00	28.00 ± 0.00	-	-
August 2011	*	29.00 ± 0.00	32.25 ± 0.50	27.00 ± 0.00	337.00	0.0001
September 2011	*	28.25 ± 0.50	31.00 ± 0.00	27.00 ± 0.00	201.00	0.0001
October 2011	*	27.25 ± 0.50	24.50 ± 0.58	27.00 ± 0.00	47.57	0.0001
November 2011	*	27.00 ± 0.00	25.00 ± 0.82	27.00 ± 0.00	24.00	0.0001
December 2011	*	26.00 ± 0.82	24.75 ± 0.96	26.25 ± 0.50	4.22	0.051
January 2012	*	28.50 ± 0.58	27.75 ± 0.96	29.00 ± 0.00	3.80	0.064

Table:2 Soil Temperature (^{0}C) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	28.00 ± 0.00	28.00 ± 0.82	28.00 ± 0.00	28.00 ± 0.00	0.00	1.000
March 2011	29.50 ± 1.29	28.50 ± 0.58	29.50 ± 1.29	29.50 ± 1.29	0.75	0.543
April 2011	30.00 ± 0.00	29.00 ± 0.00	30.00 ± 0.00	28.00 ± 0.00	-	-
May 2011	29.00 ± 0.00	27.75 ± 0.96	29.00 ± 0.00	29.00 ± 0.00	6.82	0.006
June 2011	*	28.00 ± 0.82	28.00 ± 0.00	27.00 ± 0.00	6.00	0.022
July 2011	*	24.00 ± 0.82	29.50 ± 1.29	24.00 ± 0.00	51.86	0.0001
August 2011	*	20.00 ± 3.16	30.00 ± 0.00	24.00 ± 0.00	30.40	0.0001
September 2011	*	22.75 ± 2.06	29.00 ± 0.00	24.00 ± 0.00	30.88	0.0001
October 2011	*	23.50 ± 1.00	25.00 ± 2.00	24.00 ± 0.00	1.40	0.296
November 2011	*	24.25 ± 0.50	24.00 ± 0.00	24.00 ± 0.00	1.00	0.405
December 2011	*	25.00 ± 0.00	24.25 ± 1.50	24.00 ± 0.00	1.44	0.286
January 2012	*	26.00 ± 0.00	25.75 ± 0.50	27.00 ± 0.00	21.00	0.0001

+

Table :3 pH (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	6.64 ± 0.14	7.34 ± 0.18	6.76 ± 0.04	6.64 ± 0.14	24.98	0.0001
March 2011	5.73 ± 0.14	7.44 ± 0.15	6.84 ± 0.06	5.73 ± 0.14	168.97	0.0001
April 2011	6.11 ± 0.44	6.61 ± 0.34	6.60 ± 0.12	6.11 ± 0.44	2.557	0.104
May 2011	6.54 ± 0.44	7.26 ± 0.11	6.76 ± 0.03	6.54± 0.44	4.69	0.022
June 2011	*	7.27 ± 0.08	6.64 ± 0.14	6.64 ± 0.14	35.01	0.0001
July 2011	*	7.21 ± 0.16	6.02 ± 0.10	5.73± 0.14	129.54	0.0001
August 2011	*	7.28 ± 0.12	6.71 ± 0.07	6.11± 0.44	19.14	0.001
September 2011	*	7.30 ± 0.11	6.77 ± 0.03	6.54 ± 0.44	8.97	0.007
October 2011	*	7.38 ± 0.25	6.76 ± 0.01	6.64 ± 0.14	23.11	0.0001
November 2011	*	7.23 ± 0.10	6.71 ± 0.07	5.73± 0.14	201.11	0.0001
December 2011	*	7.15 ± 0.03	6.71 ± 0.07	6.1± 0.44	16.28	0.001
January 2012	*	7.00 ± 0.12	5.77 ± 0.01	6.54 ± 0.44	22.99	0.0001

Table:4 Dissolved Oxygen (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	3.55 ± 0.13	10.45 ± 0.17	3.55 ± 0.13	2.31 ± 0.30	1423.00	0.0001
March 2011	3.19 ± 0.59	10.20 ± 0.00	3.19 ± 0.59	3.19 ± 0.59	186.12	0.0001
April 2011	2.06 ± 0.21	9.80 ± 0.08	2.21 ± 0.09	2.06 ± 0.21	2244.00	0.0001
May 2011	2.14 ± 0.70	10.33 ± 0.10	2.43 ± 0.16	2.14 ± 0.70	255.62	0.0001
June 2011	*	10.43 ± 0.28	3.55 ± 0.13	3.55 ± 0.13	1732.00	0.0001
July 2011	*	13.30 ± 0.55	3.19 ± 0.59	3.19 ± 0.59	407.18	0.0001
August 2011	*	15.63 ± 0.17	2.17 ± 0.04	2.06 ± 0.21	9656.00	0.0001
September 2011	*	16.88 ± 0.25	2.42 ± 0.18	2.14 ± 0.70	1450.00	0.0001
October 2011	*	12.40 ± 0.08	3.46 ± 0.54	3.55 ± 0.13	1001.00	0.0001
November 2011	*	12.50 ± 0.24	2.17 ± 0.04	3.19 ± 0.59	939.67	0.0001
December 2011	*	12.38 ± 0.10	2.17 ± 0.04	2.06 ± 0.21	7572.00	0.0001
January 2012	*	10.85 ± 0.29	2.17± 0.04	2.15 ± 0.04	3508.00	0.0001

Table:5 Carbon dioxide (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	15.30 ± 2.74	1.25 ± 0.06	14.60 ± 0.08	17.35 ± 0.06	114.90	0.0001
March 2011	14.78 ± 2.01	1.38 ± 0.19	15.45 ± 0.24	14.78 ± 2.01	90.86	0.0001
April 2011	14.43 ± 2.03	1.69 ± 0.24	14.43 ± 2.03	14.43 ± 2.03	52.50	0.0001
May 2011	14.56 ± 2.50	1.37 ± 0.26	14.56 ± 2.50	13.45 ± 0.79	50.16	0.0001
June 2011	*	1.27 ± 0.05	15.30 ± 2.74	15.30 ± 2.74	52.50	0.0001
July 2011	*	1.25 ± 0.02	14.13 ± 1.09	14.78 ± 2.01	133.23	0.0001
August 2011	*	1.29 ± 0.05	14.43 ± 2.03	14.43 ± 2.03	84.14	0.0001
September 2011	*	1.37 ± 0.09	13.58 ± 0.88	14.56 ± 2.50	92.04	0.0001
October 2011	*	1.20 ± 0.01	14.70 ± 0.14	15.30 ± 2.74	101.40	0.0001
November 2011	*	1.52 ± 0.01	17.23 ± 1.00	14.78 ± 2.01	169.82	0.0001
December 2011	*	1.53 ± 0.11	12.55 ± 0.13	14.43 ± 2.03	140.97	0.0001
January 2012	*	1.65 ± 0.02	14.18 ± 0.10	17.53 ± 0.15	26170.00	0.0001

Table:6 Conductivity (µs/cm) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	873.75 ± 39.02	262.50 ± 22.17	817.50 ± 9.57	857.50 ± 18.93	563.02	0.0001
March 2011	886.25 ± 65.75	260.00 ± 14.14	867.50 ± 17.08	832.50 ± 18.93	281.84	0.0001
April 2011	926.50 ± 42.69	275.00 ± 5.77	926.50 ± 42.69	836.50 ± 26.75	358.21	0.0001
May 2011	913.00 ± 129.55	282.50 ± 9.57	947.50 ± 29.86	1092.50 ± 12.58	115.32	0.0001
June 2011	*	277.50 ± 9.57	873.75 ± 39.02	873.75 ± 39.02	453.25	0.0001
July 2011	*	267.50 ± 5.00	886.25 ± 65.75	886.25 ± 65.75	176.62	0.0001
August 2011	*	277.50 ± 5.00	926.50 ± 42.69	926.50 ± 42.69	459.12	0.0001
September 2011	*	276.00 ± 2.71	875.00 ± 5.77	967.50 ± 9.57	12780.00	0.0001
October 2011	*	267.50 ± 5.00	755.00 ± 5.77	873.75 ± 39.02	783.30	0.0001
November 2011	*	262.50 ± 5.00	762.50 ± 12.58	886.25 ± 65.75	290.43	0.0001
December 2011	*	255.00 ± 5.77	755.00 ± 5.77	926.50 ± 42.69	773.24	0.0001
January 2012	*	260.00 ± 0.00	755.00 ± 5.77	870.00 ± 0.00	37820.00	0.0001

Table:7 Free Ammonia (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	0.06 ± 0.04	0.005 ± 0.001	0.007 ± 0.001	0.025 ± 0.016	6.48	0.01
March 2011	0.36 ± 0.59	0.050 ± 0.051	0.007 ± 0.001	0.027 ± 0.017	1.27	0.33
April 2011	1.08 ± 0.78	0.006 ± 0.001	0.750 ± 0.911	0.025 ± 0.016	3.20	0.06
May 2011	0.01 ± 0.00	0.008 ± 0.002	0.009 ± 0.001	0.008 ± 0.002	0.39	0.77
June 2011	*	0.006 ± 0.001	0.063 ± 0.039	0.063 ± 0.039	4.27	0.05
July 2011	*	0.005 ± 0.002	0.004 ± 0.001	0.357 ± 0.586	1.44	0.29
August 2011	*	0.006 ± 0.002	1.251 ± 0.104	1.083 ± 0.785	8.74	0.01
September 2011	*	0.005 ± 0.002	0.008 ± 0.002	0.008 ± 0.002	1.94	0.20
October 2011	*	0.004 ± 0.002	0.005 ± 0.003	0.063 ± 0.039	8.96	0.01
November 2011	*	0.005 ± 0.001	0.046 ± 0.049	0.073 ± 0.045	3.21	0.09
December 2011	*	0.005 ± 0.001	0.007 ± 0.002	0.042 ± 0.042	3.09	0.10
January 2012	*	0.004 ± 0.000	0.008 ± 0.001	0.095 ± 0.004	1700.00	0.0001

Table:8 Phosphate (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	7.14 ± 0.51	1.29 ± 0.06	7.14 ± 0.51	7.14 ± 0.51	173.71	0.0001
March 2011	7.67 ± 0.61	1.80 ± 0.05	7.67 ± 0.61	7.67 ± 0.61	121.81	0.0001
April 2011	8.47 ± 0.33	1.77 ± 0.01	8.47 ± 0.33	8.47 ± 0.33	547.88	0.0001
May 2011	7.36 ± 0.46	1.71 ± 0.07	7.36 ± 0.46	7.36 ± 0.46	198.90	0.0001
June 2011	*	1.66 ± 0.02	7.14 ± 0.51	7.14 ± 0.51	229.74	0.0001
July 2011	*	2.33 ± 0.02	7.67 ± 0.61	7.67 ± 0.61	151.22	0.0001
August 2011	*	3.56 ± 0.12	8.47 ± 0.33	8.47 ± 0.33	413.67	0.0001
September 2011	*	4.28 ± 0.05	7.36 ± 0.46	7.36 ± 0.46	89.12	0.0001
October 2011	*	3.43 ± 0.01	3.00 ± 2.94	7.14 ± 0.51	6.99	0.015
November 2011	*	2.32 ± 0.01	1.37 ± 0.38	7.67 ± 0.61	265.94	0.0001
December 2011	*	1.76 ± 0.01	1.64 ± 0.31	8.47 ± 0.33	899.44	0.0001
January 2012	*	1.30 ± 0.05	1.32 ± 0.06	7.36 ± 0.46	669.10	0.0001

Table: 9 Sulphate (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	91.25 ± 17.00	33.00 ± 1.41	82.50 ± 2.89	75.50 ± 3.79	34.11	0.0001
March 2011	99.25 ± 23.98	30.00 ± 0.00	85.50 ± 0.58	77.75 ± 1.26	25.12	0.0001
April 2011	122.50 ± 50.47	34.25 ± 0.50	87.00 ± 0.00	86.75 ± 0.50	8.30	0.003
May 2011	112.50 ± 11.00	33.25 ± 0.96	85.25 ± 0.50	88.50 ± 0.58	145.48	0.0001
June 2011	*	31.50 ± 0.58	80.00 ± 0.00	93.50 ± 4.04	765.42	0.0001
July 2011	*	44.00 ± 1.15	98.00 ± 8.52	98.00 ± 0.00	157.62	0.0001
August 2011	*	47.50 ± 0.58	122.75 ± 1.89	109.75 ± 0.50	4659.00	0.0001
September 2011	*	44.50 ± 2.89	120.00 ± 0.00	122.25 ± 1.50	2221.00	0.0001
October 2011	*	38.00 ± 4.62	110.00 ± 0.00	107.50 ± 12.58	111.55	0.0001
November 2011	*	35.00 ± 0.82	94.00 ± 4.62	92.50 ± 1.00	590.39	0.0001
December 2011	*	36.75 ± 0.50	90.75 ± 3.77	95.50 ± 3.70	453.74	0.0001
January 2012	*	34.75 ± 0.96	85.00 ± 0.00	87.00 ± 0.00	11470.00	0.0001

Table: 10 Nitrate (mg/L) (Mean ±SD) in the different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	115.00 ± 4.97	24.00 ± 0.00	53.00 ± 1.15	103.50 ± 1.29	1059.00	0.0001
March 2011	108.50 ± 12.71	25.00 ± 0.00	56.50 ± 0.58	108.50 ± 0.58	167.10	0.0001
April 2011	92.00 ± 5.72	24.00 ± 0.00	57.50 ± 1.00	101.75 ± 0.96	579.65	0.0001
May 2011	110.25 ± 11.09	25.00 ± 0.00	62.50 ± 3.00	114.25 ±5.91	172.74	0.0001
June 2011	*	28.00 ± 0.00	56.50 ± 0.58	123.00 ± 2.31	5033.00	0.0001
July 2011	*	34.25 ± 0.50	80.00 ± 0.00	119.75 ± 0.50	43930.00	0.0001
August 2011	*	37.50 ± 0.58	90.00 ± 4.08	122.75 ± 1.89	1078.00	0.0001
September 2011	*	37.50 ± 0.58	110.25 ± 11.09	117.75 ± 5.19	157.01	0.0001
October 2011	*	33.25 ± 3.86	94.00 ± 4.62	114.50 ± 4.20	397.37	0.0001
November 2011	*	29.25 ± 1.50	73.25 ± 0.96	120.00 ± 0.82	6447.00	0.0001
December 2011	*	28.50 ± 0.58	68.25 ± 2.50	119.50 ± 5.07	774.43	0.0001
January 2012	*	27.00 ± 0.00	68.25 ± 0.50	121.00 ± 1.41	11840.00	0.0001

Table:11 Distribution of tadpoles of *B. melanostictus* in different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	-	-	-	-	-	-
March 2011	-	-	-	-	-	-
April 2011	-	-	-	-	-	-
May 2011	-	-	-	-	-	-
June 2011	-	-	-	-	-	-
July 2011	-	229.75 ± 22.81	83.00 ± 6.27	35.25 ± 5.38	277.68	0.0001
August 2011	-	129.50 ± 5.45	51.25 ± 6.40	32.75 ± 5.12	499.76	0.0001
September 2011	-	46.00 ± 10.42	13.25 ± 2.75	18.25 ± 7.41	34.99	0.0001
October 2011	-	12.75 ± 2.50	9.25 ± 1.89	10.00 ± 1.83	37.32	0.0001
November 2011	-	-	-	-	-	-
December 2011	-	-	-	-	-	-
January 2012	-	-	-	-	-	-

Table:12 Distribution of adult *B. melanostictus* in different sites of Tumkur city

Months	Habitats				F-value	p-value
	Ammanikere	Mydala	Gubbi Gate	Shettyhally		
February 2011	1.25 ± 0.50	3.00 ± 0.82	1.50 ± 0.58	1.25 ± 0.50	7.56	0.004
March 2011	1.50 ± 0.58	3.25 ± 0.50	2.25 ± 0.50	1.25 ± 0.50	11.92	0.001
April 2011	1.50 ± 0.58	3.00 ± 0.82	2.25 ± 0.50	1.00 ± 0.00	9.80	0.002
May 2011	1.50 ± 0.58	2.75 ± 0.50	2.25 ± 0.50	1.25 ± 0.50	7.00	0.006
June 2011	1.25 ± 0.50	3.25 ± 0.50	2.00 ± 0.82	1.25 ± 0.50	10.06	0.001
July 2011	1.25 ± 0.50	5.00 ± 0.82	2.25 ± 0.50	1.75 ± 0.96	21.56	0.0001
August 2011	1.25 ± 0.50	4.75 ± 1.26	1.75 ± 0.50	1.50 ± 0.58	17.76	0.0001
September 2011	1.50 ± 0.58	3.00 ± 0.82	1.75 ± 0.50	1.25 ± 0.50	6.44	0.008
October 2011	1.00 ± 0.00	2.50 ± 0.58	2.00 ± 0.82	1.25 ± 0.50	6.07	0.009
November 2011	1.25 ± 0.50	2.25 ± 0.50	1.75 ± 0.50	1.25 ± 0.50	3.67	0.044
December 2011	1.00 ± 0.00	2.50 ± 0.58	2.00 ± 0.82	1.00 ± 0.00	9.00	0.002
January 2012	1.25 ± 0.50	2.50 ± 0.58	1.75 ± 0.50	1.00 ± 0.00	8.40	0.003

Table: 13 Correlation of habitat variables and distribution of adult and tadpoles of *B. melanostictus* in the urban ecosystem of Tumkur

Habitat Variables	Ammanikere		Mydala				Gubbi Gate				Shettyhally			
	Adults		Adults		Tadpoles		Adults		Tadpoles		Adults		Tadpoles	
	r	p	r	p	r	p	r	p	r	p	r	p	r	p
Air Temperature (^{0}C)	0.098	0.719	0.115	0.437	0.765	0.001	-0.011	0.939	0.559	0.025	0.012	0.937	0.568	0.022
Soil Temp (^{0}C)	0.035	0.898	-0.319	0.127	0.022	0.934	-0.053	0.720	0.545	0.029	-0.031	0.835	0.044	0.871
pH	-0.96	0.723	0.212	0.148	-0.302	0.256	-0.172	0.242	-0.865	0.0001	-0.023	0.877	-0.579	0.019
Dissolved Oxygen (mg/L)	-0.340	0.198	0.368	0.010	-0.097	0.720	-0.052	0.725	-0.005	0.986	0.077	0.602	-0.318	0.230
Carbon dioxide (mg/L)	0.499	0.049	-0.316	0.029	-0.076	0.780	-0.089	0.549	0.079	0.771	0.131	0.374	-0.129	0.634
Conductivity (µs/cm)	0.584	0.017	0.127	0.390	-0.100	0.713	0.138	0.349	0.565	0.023	0.040	0.789	-0.037	0.892
Free Ammonia (mg/L)	-0.0178	0.509	-0.011	0.939	0.191	0.479	0.046	0.758	0.230	0.391	-0.035	0.813	0.475	0.063
Phospahte (mg/L)	0.296	0.266	0.250	0.087	-0.778	0.0001	0.121	0.412	0.521	0.038	-0.141	0.341	0.639	0.008
Sulphate (mg/L)	-0.151	0.576	0.550	0.0001	0.429	0.097	-0.069	0.639	-0.523	0.038	-0.013	0.932	-0.363	0.167
Nitrate (mg/L)	0.256	0.339	0.439	0.002	-0.027	0.922	-0.020	0.891	-0.748	0.001	0.149	0.311	0.716	0.002

Table: 14 Distribution of adult and tadpole of *B. melanostictus* in the urban ecosystem of Tumkur (Values in parenthesis denote the range).

	Habitat				*F*	*p*
	Ammanikere	**Mydala**	**Gubbigate**	**Shettyhalli**		
Adult Toads (mean n/25m^2± SD)	3.75±1.54 (2-6)	8.75± 1.28 (7-12)	5.0 ±1.53 (2-7)	5.1±1.46 (3-8)	25.93	0.0001
Tadpoles (n/m^2± SD)	-*	104.50 ± 87.41 (10-250)	39.19 ± 31.42 (8-90)	24.06 ± 11.74 (8-42)	10.00	0.0001

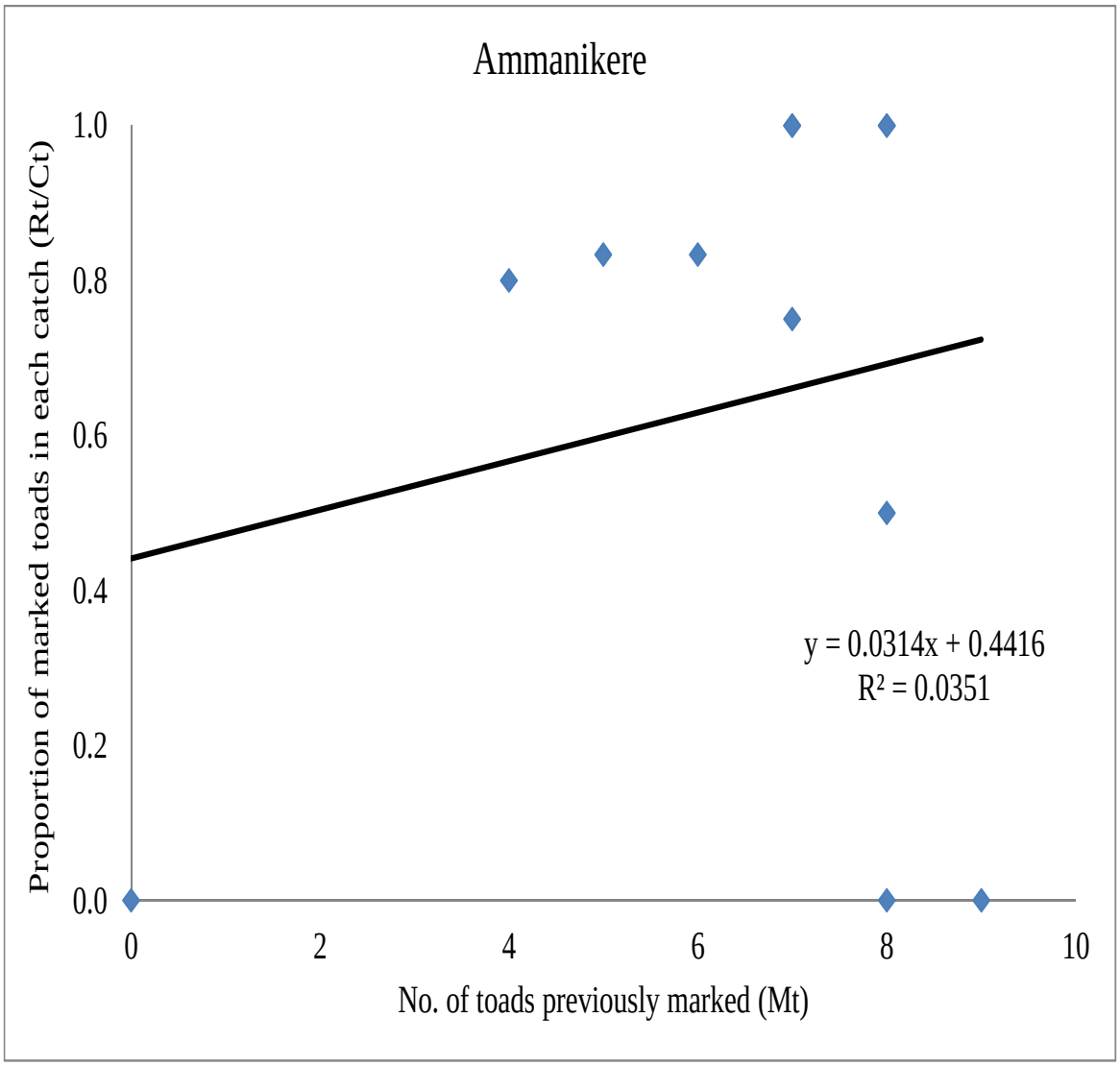
***Tadpoles were not observed due to conversion of breeding sites into theme park.**

Table 8: Habitat variables (Mean ± SD) of different sites of adults and tadpoles of *B. melanostictus* in the urban ecosystem

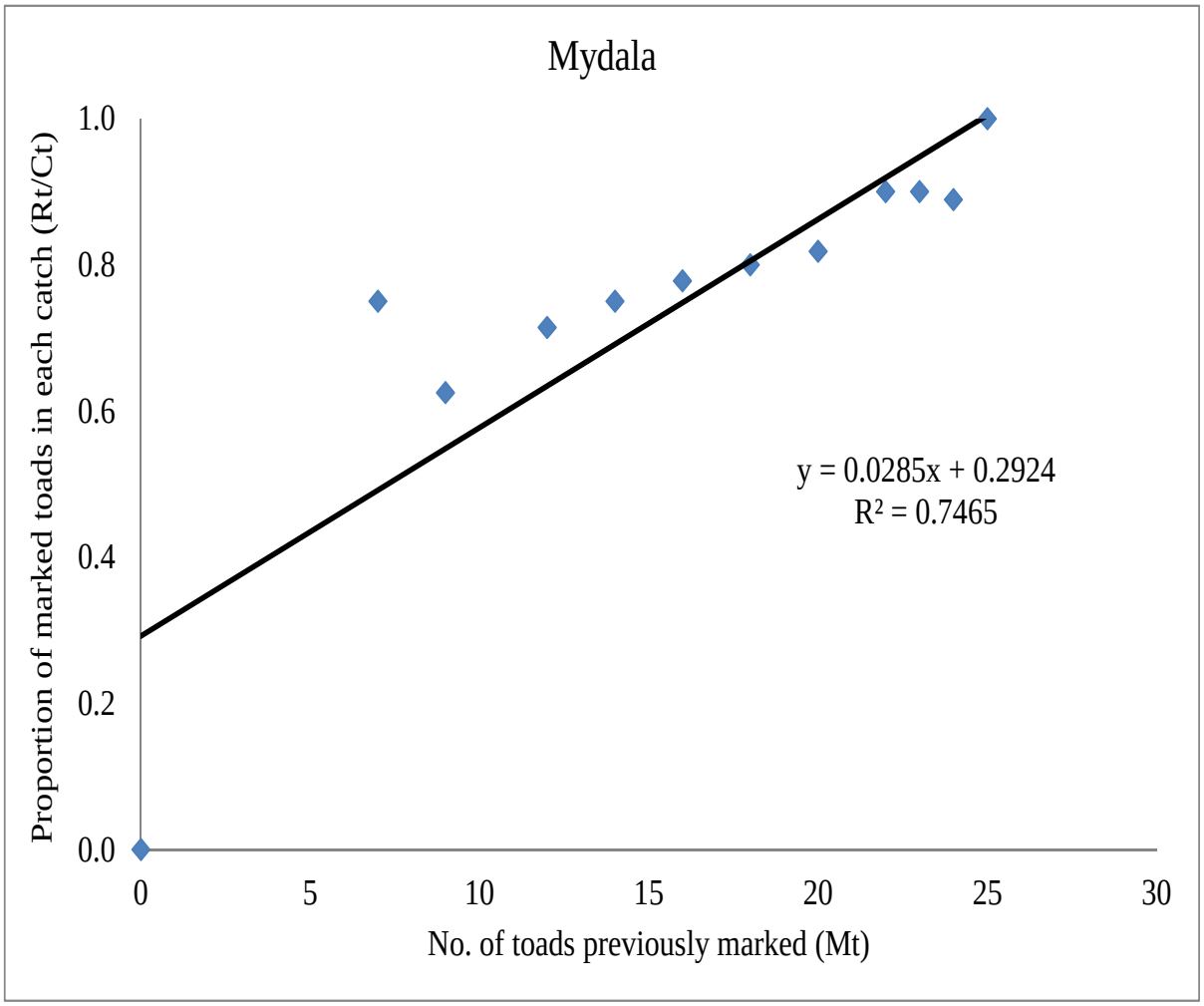
Habitat Variables	Ammanikere (n=16)	Mydala (n=48)	Gubbi Gate (n=48)	Shettyhally (n=48)	F_{156}	p
Air Temperature (^{0}C)	31.06 ± 0.85 (30.00 - 33.00)	28.98 ± 1.63 (25.00 - 31.00)	29.21 ± 2.87 (24.00 - 33.00)	28.44 ± 1.54 (26.00 - 31.00)	6.87	0.0001
Soil Temp (^{0}C)	29.13 ± 0.96 (28.00 - 31.00)	25.56 ± 2.90 (17.00 - 29.00)	27.67 ± 2.35 (22.00 - 31.00)	26.04 ± 2.19 (24.00 - 31.00)	12.90	0.0001
pH	6.25 ± 0.47 (5.56 - 6.78)	7.06 ± 1.07 (0.00 - 7.75)	6.58 ± 0.33 (5.76 - 6.89)	6.25 ± 0.46 (5.56 - 6.78)	12.80	0.0001
Dissolved Oxygen (mg/L)	2.73 ± 0.79 (1.10 - 3.75)	12.09 ± 2.20 (9.70 - 17.20)	2.72 ± 0.64 (2.12 - 3.78)	2.63 ± 0.72 (1.10 - 3.75)	552.58	0.0001
Carbon dioxide (mg/L)	14.76 ± 2.12 (12.40 - 18.60)	1.40 ± 0.19 (1.20 - 1.90)	14.59 ± 1.67 (12.40 - 18.60)	15.09 ± 2.07 (12.40 - 18.60)	785.69	0.0001
Conductivity (µs/cm)	899.88 ± 73.19 (782.00 - 1090.00)	268.63 ± 11.83 (230.00 - 290.00)	845.67 ± 76.00 (750.00 - 980.00)	902.46 ± 76.50 (820.00 - 1110.00)	1030.48	0.0001
Free Ammonia (mg/L)	0.38 ± 0.62 (0.01 - 1.87)	0.01 ± 0.02 (0.00- 0.10)	0.18 ± 0.45 (0.00 - 1.87)	0.16 ± 0.39 (0.00 - 1.87)	4.21	0.007
Phosphate (mg/L)	7.66 ± 0.68 (6.73 - 8.96)	2.27 ± 0.94 (1.23 - 4.32)	5.72 ± 2.95 (1.08 - 8.96)	7.66 ± 0.67 (6.73 - 8.96)	86.99	0.0001
Sulphate (mg/L)	106.38 ± 29.33 (67.00 - 197.00)	36.88 ± 5.61 (30.00 - 48.00)	95.06 ± 14.50 (80.00 - 124.00)	94.54 ± 13.50 (70.00 - 123.00)	191.89	0.0001
Nitrate (mg/L)	106.44 ± 12.19 (85.00 - 123.00)	29.44 ± 4.96 (24.00 - 39.00)	72.50 ± 17.60 (52.00 - 123.00)	115.52 ± 7.57 (101.00 - 125.00)	490.08	0.0001

Table 9 : Co relation of habitat variables and distribution of Adult and tadpoles of *B. melanostictus* in the urban ecosystem of Tumkur

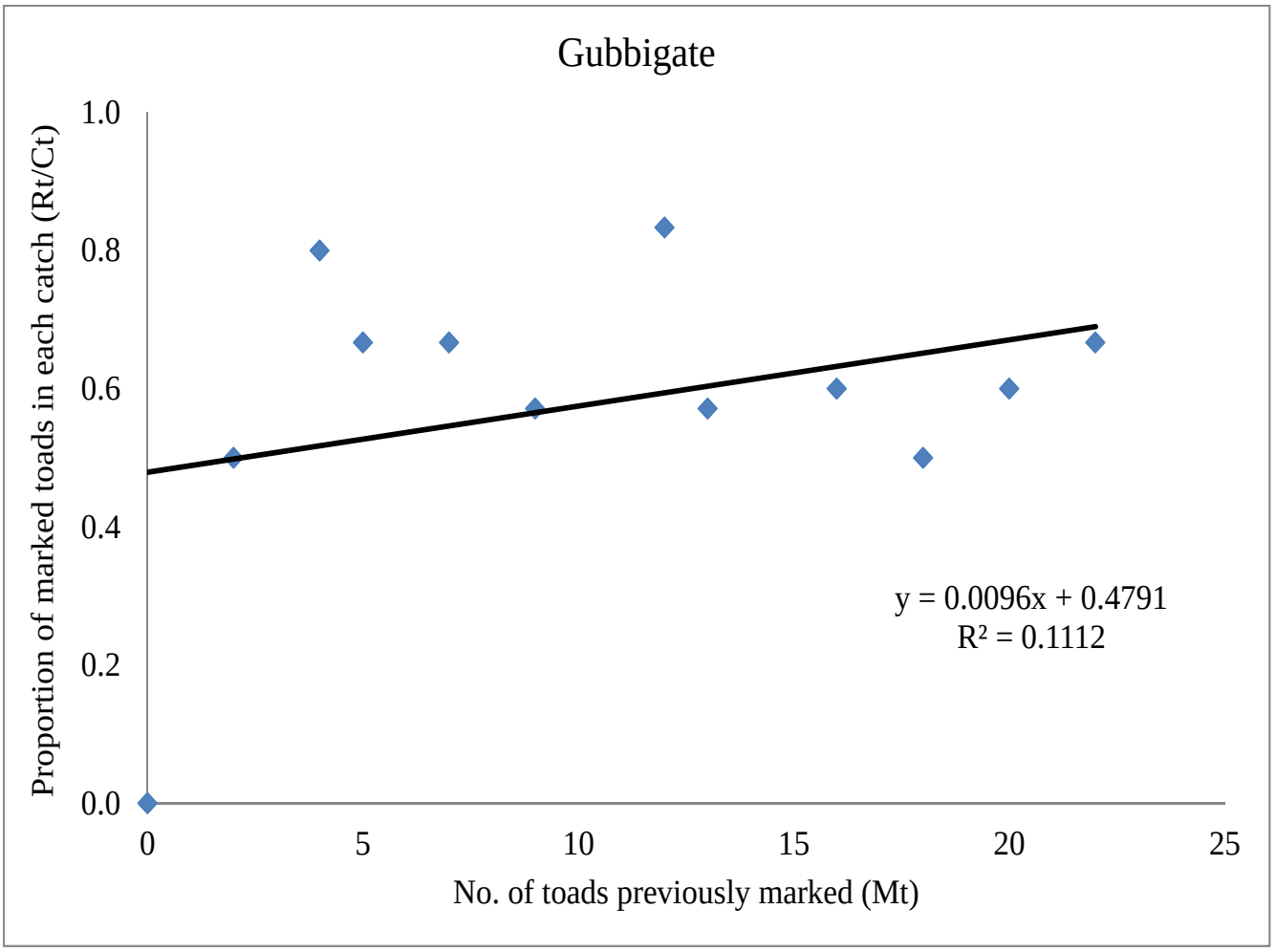
Habitat Variables	Ammanikere		Mydala				Gubbi Gate				Shettyhally			
	Adults		Adults		Tadpoles		Adults		Tadpoles		Adults		Tadpoles	
	r	*p*	*r*	*p*	*r*	*P*	*r*	*p*	*r*	*P*	*r*	*p*	*r*	*p*
Air Temperature (^{0}C)	-0.717	0.009	0.717	0.009	0.765	0.001	0.360	0.250	0.559	0.025	0.210	0.513	0.568	0.022
Soil Temp (^{0}C)	-0.655	0.009	0.366	0.241	0.022	0.934	0.175	0.586	0.545	0.029	0.000	1.0	0.044	0.871
pH	-0.791	0.002	-0.076	0.814	-0.302	0.256	0.485	0.110	-0.865	0.0001	0.638	0.036	-0.579	0.019
Dissolved Oxygen (mg/L)	-9.02	0.001	-0.582	0.047	-0.097	0.720	0.159	0.621	-0.005	0.986	0.250	0.432	-0.318	0.230
Carbon dioxide (mg/L)	-0.705	0.011	0.413	0.182	-0.076	0.780	0.009	0.977	0.079	0.771	0.010	0.976	-0.129	0.634
Conductivity (µs/cm)	-0.235	0.465	0.350	0.265	-0.100	0.713	0.189	0.556	0.565	0.023	-0.007	0.984	-0.037	0.892
Free Ammonia (mg/L)	0.224	0.414	0.281	0.802	0.191	0.479	0.308	0.330	0.230	0.391	0.435	0.157	0.475	0.063
Phosphate (mg/L)	-0.716	0.009	0.728	0.007	-0.778	0.0001	0.327	0.299	0.521	0.038	0.193	0.548	0.639	0.008
Sulphate (mg/L)	-0.430	0.163	-0.006	0.334	0.429	0.097	-0.761	0.004	-0.523	0.038	-0.213	0.506	-0.363	0.167
Nitrate (mg/L)	0.120	0.711	0.430	0.163	-0.027	0.922	0.701	0.008	-0.748	0.001	0.500	0.098	0.716	0.002



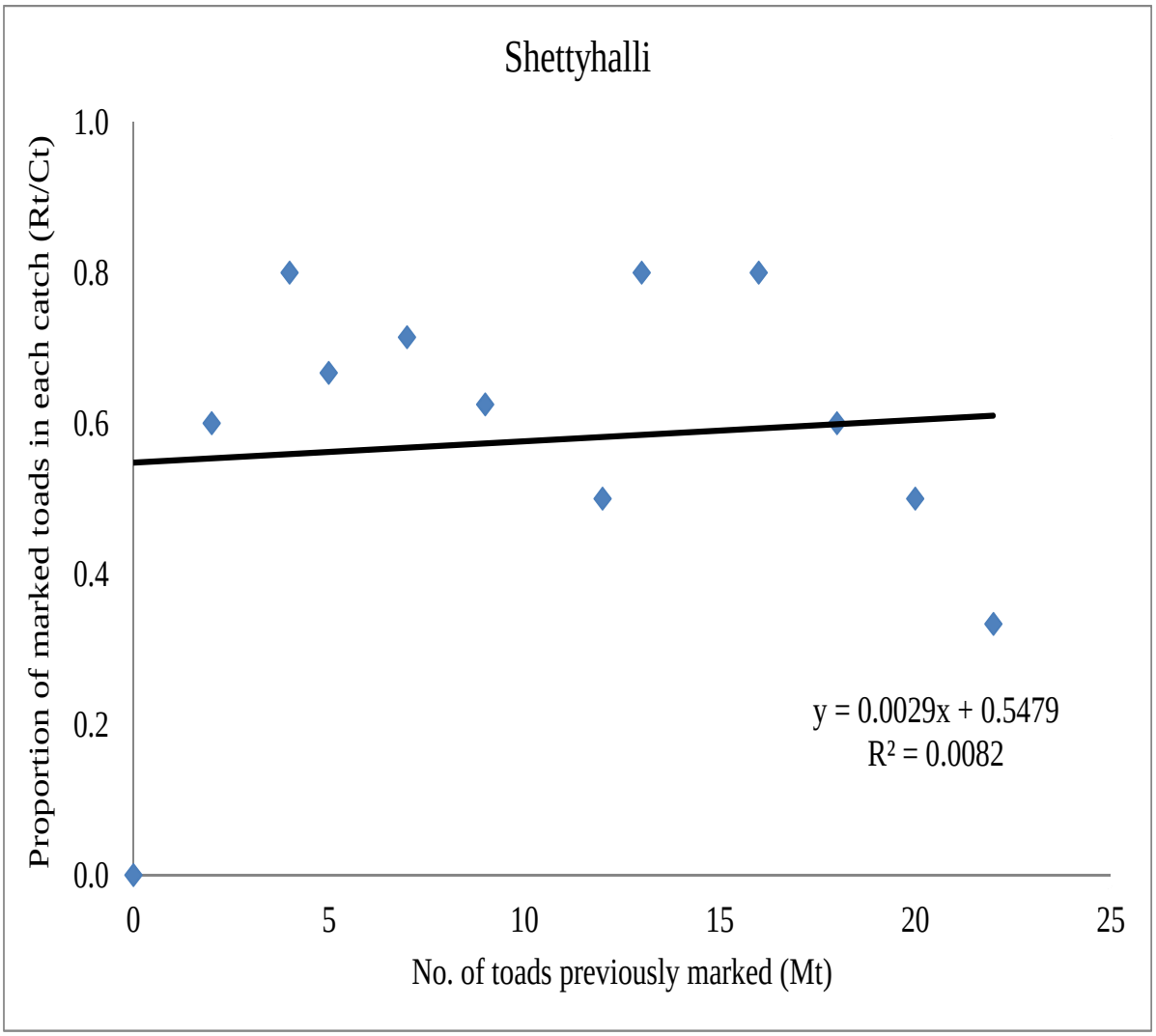
Graph:1 Proportion of marked Toads in Site – 1 of Tumkur (AMMNIKERE)



Graph:1 Proportion of marked Toads in Site – 2 of Tumkur (MYDALA)

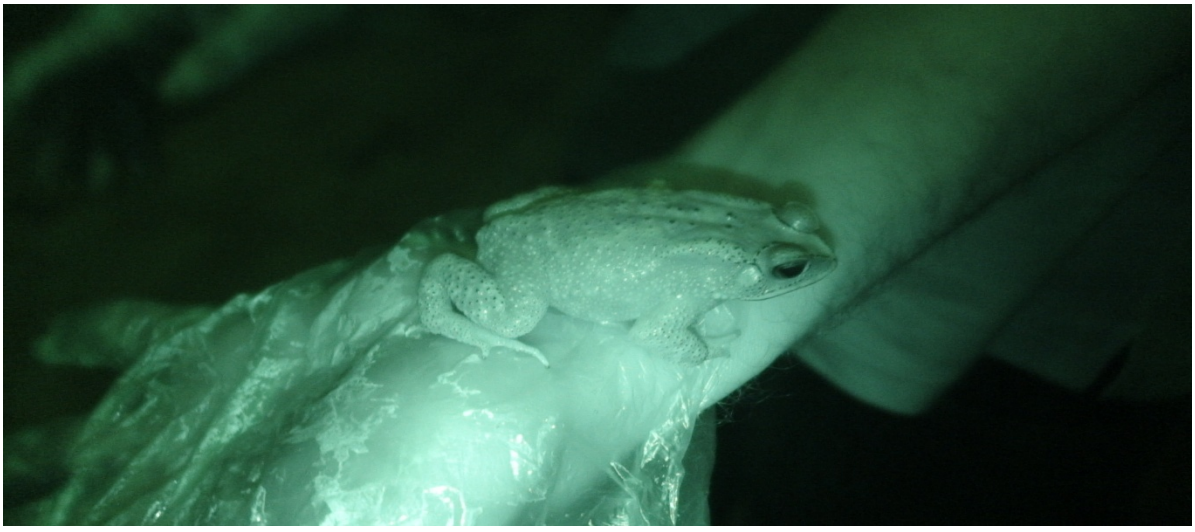


Graph:1 Proportion of marked Toads in Site – 3 of Tumkur (GUBBIGATE)



Graph:1 Proportion of marked Toads in Site – 4 of Tumkur (SHETTYHALLY)

Conversion of Ammanikere (Site – 1) into Park by the Corporation (during the study period tadpoles of *B.melanostictus* were not observed).



Distribution of *Bufo melanostictus* in the different study area of Tumkur Urban Ecosystem.

***B.melanostictus*(Tumkur Urban Ecosystem)**

***B.melanostictus*(Tumkur Urban Ecosystem)**

***B. melanostictus* in Amplexus (Tumkur Urban Ecosystem)**

Spawning

Tadpoles of *Bufo melanositctus* in Tumkur Urban Ecosystem

Conclusion:

There is a significant negative correlation between Urbanization and Species richness. The plausible causes of decline of *B. melanostictus* have been identified. We still do not fully understand how they operate at the population level. The effects of direct exploitation and habitat loss are often self evident. In others use of pesticide is fatal. Proving deleterious effects of pesticides at the population level is a difficult problem. More problematic are the consequences of climate change, pollutants and diseases.

In recent years, attention has been shifted to other possible factors such as increased exposure to ultraviolet radiation, emerging diseases, the spread of alien species, direct exploitation and climate change. Hence we propose during environment impact analysis at the time of urban planning and management amphibian study need to be considered as biological indicators though there are few data to suggest that they are better than other taxa in this respect.

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