CHAPTER VII

GENERAL DISCUSSION
The present study has been designed to evaluate the species diversity and the present position of amphibians in the Brahmaputra valley of Assam, India. The valley with its wide range of geographical conditions harbours different vegetational components and resources and is ideal for supporting species rich amphibian fauna. Assam includes the Brahmaputra and the Barak valley separated by the hill districts of Karbi Anglong and North Cachar Hills. However, due to difficult terrain and socio political conflicts most of its part remain unexplored so far and as a consequence only 35+ species have been described from the entire state of Assam (Chanda, 1994; Saikia et al., 2000; Dutta et al., 2000; Ahmed and Dutta, 2001; Choudhury 2001a, 2001b, 2001c).

The present study provides most comprehensive records of Amphibian fauna with several new inclusions supporting the assumption of high species diversity in the Brahmaputra valley. A total of 29 species of Anurans and one species of Gymnophiona have been recorded in this investigation.

The anurans according to relationship can be divided into three main groups viz. Primitive frogs, Transitional frogs and Advanced frogs (Zug, 1993). In the present study two species of primitive frogs of the family Megophryidae were observed which are moderate in size and terrestrial in habit with short, squat toad like body (Plate IV-1).

The genus *Leptoborachium* is predominantly found in high elevation (Zug, 1993; Das, 2002) but the present study has revealed that *L. smithi* occurred at low land at an elevation of around 100m above MSL. This forest restricted
species has been reported from Southern Thailand and adjacent Southern Myanmar (http://www.calacademy.org/research/herpetology/myanmar/checklistfrogs.html) and found to feed mostly on the insect of the order hymenoptera, orthoptera and coleoptera. *Xenophrys parva* is a forest floor frog and is large headed. The major part of the diet of *X. parva* in the present study was found to be constituted by orthopteran and isopteran insects (Table- V-4). However, there are no previous records of food and feeding habits of these two species. The present study suggests a partial trophic niche segregation of these two sympatric Megophryidae frogs. Niche analysis in the present study showed a high G^O of 0.82 while the specific overlap *L. smithi* on *X. parva* is higher than that of *X. parva* on *L. smithi*.

Megophryidae shares certain characteristics which includes presence of eight stegochordal procoeleous presacral vertebrae in adult, archipheral pectoral girdle, premaxillary and maxillary teeth. The present study revealed that the *L. smithi* has much flat head than *X. parva*, less prominent tympanum and smooth skin against prominent tympanum and warty skin of *X. parva*.

Both the species were reported to be found in hill and foot hills of N.E. Hill States (Pawar and Birand 2001; Sengupta et al., 2001). However, *Xenophrys parva* has wider distribution than the former (Chanda, 2002) and found in Assam, Meghalaya, Arunachal Pradesh, West Bengal and Sikkim in India (Chanda, 1994).
The advanced frog includes the member of all other family namely Bufonidae, Microhylidae, Ranidae and Rhacophoridae that were observed during the present study.

The family Bufonidae includes true toads and occurs in all over the terrestrial continents of the earth (Olher and Dubois, 1999). The genus *Bufo* shares wide distribution and is a polyphyletic genus representing different lineage in Asia, Africa and South America (Zug, 1993). In the present two species of the genus *Bufo* namely *B. melanostictus* and *B. stomaticus* were observed. *B. melanostictus* (Plate IV-1A), has a wide distribution, found all along South Asia including the entire Indian sub-continent. *B. stomaticus* has much westward distribution, Assam (type locality of the species) fall at its eastern most range of distribution and the population of Assam represent a distinct morphocline (Choudhury et al., 2001b). The present study also revealed that under the climatic condition of Assam *Bufo melanostictus* is more anthropophilous than that of *Bufo stomaticus*. However, in certain parts they are sympatric. The feeding habit analysis did not reveal specific food selection. *B. melanostictus* feeds mainly on coleoptera and hymenoptera (Table V-1) while *B. stomaticus* main diet includes orthopteran and hymenopteran insects (Table V-2) and confirms the earlier observations (Behura et al., 1971; Rangaswamy and Channabasavanna, 1973; Battish et al., 1989). The G^O between the two species was high while specific overlap of *Bufo melanostictus* on *Bufo stomaticus* was found to be low.
The Microhylids have a world wide, although discontinuous, distribution
and reflect the propensity for tropical moist habitats (Inger, 1966; Zweifel,
1986). The member of the genus are mostly small casually stout bodied with
sturdy short limbs and a small head. Microhylids are also characterised by 2-3
palatal folds, toothless premaxillae and maxillae, fermisternal pectoral girdle.
The type genus Microhyla is moderately diversified with five species found in
India (Das and Dutta, 1998). M. ornata which has wide distribution in both
south and South East Asia is an extremely common species (Chanda, 1994),
however, large morphological variation are found all along its range of
distributions (Schleich and Kästle, 2002). Another species M. berdmorei which
diffs from the former in having longer hind limbs and full toe webs is a South
East Asian species (Pillai and Chanda, 1981). The western most limit of its
distribution has been recorded as Chakrasila Wildlife Sanctuary in the present
investigation. Both the species are leaf litter species frequently occurring also in
moist grass blades during nights. Microhyla ornata showed diet specialization
feeding mostly on hymenoptera (formicidae) supporting the view of many early
workers. (Mohanty – Hezmadi and Acharya, 1982; Chanda, 1993; Maeda and
that Microhyla ornata also consumes plant material in summer to maintain
energy budget. M. berdmorei has restricted distribution in Myanmar and N.E.
India (Pillai and Chanda, 1981; Chanda, 1994, 1995; Pawar, 1999; Sengupta et
al., 2000; Borah and Bordoloi, 2003). In the present study the species was
observed only in the protected area and found to have generalized food habit,
frequently feeding on members of formicidae (Table-V-6). Result of the present research on these two species is in consistence with the views of Berry (1965), Hirai and Matsui (2000). The G'O between the species is very high with a higher niche overlap value (Table V-27).

Another genus of the family Microhylidae observed in the present study was *Uperodon*. The genus *Uperodon* includes two species *U. globulosus* and *U. systoma* in India. Both the species are endemic to Indian subcontinent (Chanda 2002) and in the present study *U. globulosus* was only observed from the protected areas of the north bank of the River Brahmaputra. In comparison to other Microhylids, *Uperodon globulosus* is much larger, stalky, almost globular frog with only the distal part of the legs is visible as their proximal part covered by the abdominal skin.

*Uperodon globulosus* was observed only during monsoon. With the exception of the short reproductive period during monsoon, the frog remains hidden. This frog is mostly subterranean and emerges following heavy rains (Mohanty-Hejmadi and Acharya, 1982). *U. globulosus* is an Indian endemic and the N.E. Region constitutes the eastern most limits of its distributions (Choudhury et al., 1999, Borah and Bordoloi 2001). Isopteran insects were found to be the most dominant food items and the food items without mud in the stomach suggest surface feeding habits and the feeding schedule probably restricted to the breeding season when it appears to be over ground. This finding is in agreement with Whitaker et al. (1977) and Mohanty Hejmadi et al. (1979). The analysis of food spectrum of the three species of the Microhylidae revealed
a high niche overlap and the specific niche overlap has been higher while compared between \textit{M. ornata} and \textit{M. berdmorei}. Further, \textit{U. globulosus} has much greater overlap on \textit{M. berdmorei} than \textit{M. ornata} (Table V-28).

The \textit{Ranids} represent another advance group of frogs and are an extremely diverse. They occur world wide and in South East Asia 101 species have been reported (Das 2001). Six genera under the family \textit{Ranidae} were observed during the present study which supports the view of (Zug, 1993). The genus \textit{Rana} is paraphylactic and in the present study recorded four species namely \textit{Rana alticola}, \textit{R. tyleri}, \textit{R. leptoglossa} and \textit{R. humeralis}. \textit{R. leptoglossa} and \textit{R. humeralis} are sympatric and both are South East Asian species. The former is distributed from Thailand and Amman (Vietnam) to Assam, India while the later is restricted in the Indomyanmar Biogeographic zone. The western most limit falls in Nepal (Pawar and Birand 2001; Ao et al., 2003).

Species of the Genera \textit{Amolops}, \textit{Euphlyctis}, \textit{Limnonecis}, \textit{Pterorana} and \textit{Phrynoglossus} were observed during the present study. Each of the genus is represented by a single species in the present study site. \textit{Euphlyctis cyanophlyctis} has wide distribution and is one of the most dominant species of aquatic amphibians. This frog can be seen through out the year in water bodies except the fast flowing streams. \textit{Amolops gerbillus} and \textit{Limnonecis laticeps} have distribution extended up to Eastern Himalayan range from far South East and the study fills up the gap in the range of distribution of the species. The genus \textit{Pterorana} is monotypic, \textit{Pterorana khare} is monotypic and is endemic to N.E states (Kiyasetu and Khare, 1986; Pawar, 1999; Pawar and Birand,
2001). The specific character of the species includes lateral fold skin in the body but it is suspected that these frog to be a sexual morph of *Rana danieli* (Pawar and Birand 2001).

*Phrynoglossus borealis*, a tiny stream frog has been reported only from Arunachal Pradesh, Assam and Meghalaya and Nagaland (Annadale, 1912b; Pawar and Birand, 2001; Ao. et al., 2003). In the present study the species was observed from the Nameri National Park supporting the records of Pawar and Birand (2001).

Diet was analysed in *Amolops gerbillus*, none of the species show specific foods habits. However, in *A. gerbillus* orthoptera, in *E. cyanophlyctis* hymenoptera and in *L. laticeps* coleopteran were the most abundant food item. The present is in confirmatory with the records of Chanda (1993), Batish and Sandhu (1988). Batish and Sandhu (1988) and Khera (1972). However Mohanty- Hejmadi and Acharya (1982) reported earthworm as the most preferred food.

*F. limnocharis* and *F. syhadrensis* are the two species of the genus *Fejervarya* that were recorded in the present study. Both the species found to have wide distribution of which *F. syhadrensis* has only recently been reported from Assam with range extension of 820 km (Sengupta et al., 2001). In the present study *F. limnocharis* show wide range of phenotypic variation and four distinct morphs were identified. Dubois (1986, 1987a, 1987b, 1992) suggested that *F. limnocharis* represent a species complex and is probably composed of at least 15 species. Further Dubois and Ohler (2000) suggested that *F. limnocharis*
only apply to species which has distribution covers in Indonesia and Malaysia. The present study suggests that there are few species of this complex group which are yet to be identified.

The diet analysis of *F. limnocharis* revealed that the species did not show any type of food preference and the diet is highly diversified and is in confirmatory with the finding of Mohanty –Hejmadi and Acharya, 1982; Ray, 1987.

*Hoplobatrachus tigrinus* and *H. crassus* are endemic to Indian subcontinent. The present search has revealed that *H.tigerinus* is more abundant and widely distributed compared to that of the *H. crassus*. The two congeneric species can be distinguished from one another by the shape of the inner metatarsal tubercles which is shovel shaped in *H. crassus* and elongated in *H.tigerinus*. Chanda (2002) noted that this genus is found in the flood plain and absent in high altitude. However, Bordoloi and Borah (1999), Borah and Bordoloi (2003) recorded *H. crassus* from different parts of Arunachal Pradesh at an altitude of 500m above MSL. Both the species did not show selectivity in food items which support the view of Khan (1973), who reported that the frog fed indiscriminately on invertebrates and vertebrates. These two species show high overlap with a little resource partitioning.

*Rhacophorids* are the tree frogs of Asia, Madagascar and Africa (Zug, 1993). Each of these geographical areas has a distinct set of genera and *Philautus, Polypedates, Rhacophorus, Theloderma* and *Chirixalus* genera are distinctive to Asia. *Rhacophorids* are strongly arboreal, and have the typical tree
frogs habits with expanded digit tips. Two sub families are included under Rhacophoridae - Philautinae, for Philautus and Rhacophorinae for all other genera. In the present study four genera were recorded namely Philautus, Chirixalus, Rhacophorus and Polypedates. The genus Philautus is reproductively similar to Theloderma and in most cases the development is direct without larval period. Chirixalus, Polypedates and Rhacophorus lay their eggs in foam nest above water, hatching tadpoles are dropped into water.

The genus Philautus is highly diversified and in India large numbers of species of this genus remains unidentified (Biju, 2002). In the present study four species namely P. garo, P. andersoni, P. amadalii and P. jerdoni were recorded from different forest areas of the Brahmaputra valley.

The genus Chirixalus is characterised by the presence of opposable finger and is represented by one species, Chirixalus vittatus in the study sites. This species is already has been reported from Myanmar and different parts of N.E. India (Romer, 1949, Dutta, 1997b; Choudhury et al., 2001c; Ahmed and Dutta, 2001). In the present study Chirixalus vittatus was found to be common in dense as well as light forest areas of west to 92° E longitude. However Ahmed and Dutta (2001) recorded it from Nalbari District (east to 92° E). This species is mostly accumulated near aquatic bodies and foam nest were observed hanging from the herbs and shrubs at a height of 2.5 - 2.7 m from water level. The gut analysis revealed that the frog concentrated mostly on hymenopteran and dipteran insects (Table V-9). Its wide distribution (Dutta, 1997b; Choudhury et
al., 2001c; Borah and Bordoloi, 2003) and low niche width value suggested that the frog occupies specialized microhabitat.

The genus Rhacophorus is moderately diversified and two species viz. *R. bimaculatus* and *R. maximus* were observed in the present search. The species *Rhacophorus bimaculatus* has been record for the first time in the country while the previous records include Thailand, Myanmar and Singapore. (Taylor, 1962; Berry, 1975; Lim and Lim, 1992). *R. maximum* is a large, green coloured frog and is widely distributed in Arunachal Pradesh, Assam, Meghalaya, Nepal, China and Thailand (Dutta, 1997b).

The *Rhacophorus maximus* and *R. bimaculatus* were observed to partitioned resource by occurring at different heights and tree maturity. *R. maximus* was mostly observed on trees with large foliage cover at a height more than three meters from the ground level while the *R. bimaculatus* available in immature trees whose girth diameter is about 7-10 cm. Further, this frog was found mostly at a height of 1-1.7 m from ground. *R. maximum* is an early breeder and found in plenty during April and May at the onset of monsoon, while the *R. bimaculatus* was observed from May to August in abundance. Both these frogs are, however, rare and found only in tropical evergreen and semi evergreen forests.

The genus *Polypedates*, was revived from the synonyms of *Rhacophorus* by Liem (1970), upon finding a suitable anatomical and osteological character that separate the two genera of Old World tree frogs. *Polypedates* contain species, distributed over Srilanka, India and east wards to Indonesian Island
(Frost, 1985). About 21 species of these frogs have been described (Das, 1995, Dutta and Arachchi, 1996) of which *P. leucomystax* and *P. himalayensis* were recorded in the present study. *P. leucomystax* is a widely distributed frog occurring from Eastern India to Philippines. Schmalz and Zug (2002) opined that the Asian *Polypedates* have distribution that extended from the Indian sub peninsula to the coast and Islands of Eastern Asia and are mostly compositive in nature. Dubois (1987 a, 1987b) recognized the Indian and Nepal population of the species as *Polypedates teraiensis* but recently Schleich and Kastle (2002) made *P. teraiensis* as a synonym to *P. leucomystax*. In the present study, this frog was observed in extremely variable habitat from human habitation to dense woodland forest and were mostly crepuscular and nocturnal and its reproductive season coincided with the extent of monsoon (Hussain et al., 1999). This frog hunt a very wide spectrum of food and show preference to hymenopteran insects. However, Chanda (1993) observed miscellaneous items as the most preferred food followed by dipteran, coleopteran and hymenopteran insects respectively. *P. himalayensis* has a global distribution in China and India (Molur and Walker, 1998). In India it is reported from Namdapha National Park and Debong Valley of Arunachal Pradesh. The present study extends its range upto Nameri National Park (92°45' longitude) and confirms its presence on either side of the Brahmaputra river.

Diet analysis has revealed higher degree of overlap, but in the present study partitioning of resource was observed during the breeding in terms of habitat utilization. *P. leucomystax* remained arboreal and constructed foam nest
on overhanging branches of bushes and trees, where as *P. himalayensis* call beneath the leaf litter during breeding seasons and construct nest in highly moist water logged leaf letter area or on emerging grass blades of ephemeral bodies.

Two species of Gymnophiona was described from Assam namely *Gegeneophis fulleri* and *Icthyophis garoensis* (Dutta, 1997b; Pillai and Ravichandran, 1999; Choudhury et al., 2001a). *G. fulleri* was described back in 1904 from southern Assam (Alcock, 1904) and since then no further records of the species could be made and the present status is obscure (Pillai and Ravichandran, 1999).

*I. garoensis*, was described recently from Garo hills by Pillai and Ravichandran (1999). Choudhury et al. (2001a) recorded the species from Garbhanga Reserve Forest with a range extension of 170 km. In the present study this was also recorded from Govindapur Reserve in addition to Garbhanga Reserve Forest and recorded a range extension of 90 km. north. The study also confirmed distribution of the species on either side of the river Brahmaputra.

The present study amphibians were evaluated in seven different habitat categories. The moist deciduous and semi evergreen forest were found to be highly diversified. Joypur Reserve Forest, a tropical evergreen forest showed rich concentration of Rhacophorids indicating a good canopy cover in the forest. Nameri National Park was found to support wide varieties of anurans and all the families of Indian frogs except Hylidae were observed. Similar observation of species rich amphibian assemblage was also made by Pawar and Birand (2001)
as well as Borah and Bordoloi (2001). The present study revealed a low diversity of amphibian in Dibru-Saikhowa National Park and Pobitora Wildlife Sanctuary which was probably due to frequent flooding of the area during monsoon and high rate of siltation as aftermath effect of flood.

In the present study, IUCN declared endangered species, namely Chirixalus dorie and C. simus could not be recorded from the study sites. Further Rana danieli, Rana livida, Thelodermataasperum and Hyla anectans which were previously recorded from the Brahmaputra valley (Chanda, 1994; Pawar and Birand, 2001), could not be found. It was possibly due to habitat alteration they got restricted to certain specific forest patches and presently they are represented by highly vulnerable population.

It was found that the occurrence of anurans of depends mainly on the relative humidity and moistness of the environment. Most of the frogs were found in almost total moist condition with relative humidity of 92% - 99% and this range appears to be ambiance for the anurans. With the decrease in the relative humidity, the diversity decline and except couple of anthropophilus species like Bufo melanostictus, E. cyanophlyctis. No frogs could be observed at a relative humidity lower than 80%.

The present study revealed the presence five families of anurans and one family of Gymnophiona to be present in the Brahmaputra Valley. 18 genera of amphibian were noted in the present study to be present in the respective study areas of which Leptobrachium, Xenophrys, Uperodon, Chirixalus, Amolops, Euphlyctis, Limnonectes, Phrynoglossus, Pterorana and Ichthyophis were
represented by one species each. *Bufo*, *Microhyla*, *Polypedates*, *Rhacophorus* and *Fejervarya* were represented by two species each; *Philautus* and *Rana* include four species each. Further based on distribution the amphibians of the study site, could be classified into five groups.

a) **Species of South Asia**, occurring in Afghanistan, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh, Myanmar, China, Thailand and Far East.

This group includes *Bufo melanostictus*, *Microhyla ornata*, *Hoplobatrachus tigerinus* and *Fejervarya limnocharis*.

b) **Species of Western India** that occur in Afghanistan, Pakistan, India, Nepal and Bangladesh. *Bufo stomaticus* and *Euphlyctis cyanophlyctis* are examples of this group.

c) **Species of Indian subcontinent** which have distribution in India, Nepal and Bangladesh and include species like *Uperodon globulosus*, *Rana tytleri*, *Fejervarya syahdrensis* and *Hoplobatrachus crassus*.

d) **Species endemic to Eastern Himalaya** like *Philautus annandali*, *Philautus jerdoni*, *Philautus garo*, *Pterorana khare* and *Ichthyophis garoensis*.

e) **Species of China**, **Myanmar** and **Far East**, example of which are *Leptobrachium smithi, Xenophrys parva, Microhyla berdmorei*, *Philautus andersoni, Chirixalus vittatus, Polypedates leucomystax, Polypedates himalayensis, Rhacophorus bimaculatus, Rhacophorus maximus, Phrynoglossus borealis, Limnonectes laticeps, Amolops gerbillus, Rana alticola, Rana leptoglossa* and *Rana humeralis*. 
It appears that Brahmaputra valley is a highly rich biodiversity ecozone where admixture of species of different regions occurs along with few endemic species of the broad zone of Eastern Himalaya. However, the valley is the part Indo-Myanmar biogeographic zone and therefore endemism to Eastern Himalaya alone is not as high as it noted in Western Ghat (Krishnamurthy, 1999). Further, it is evident that the fauna of the region is more closely related to Myanmar and China due to similarities in ecological condition (Chanda, 1994) and the region acts as a biogeographic gateway for species of China and Myanmar to the Indian subcontinents.

Chanda (1994) recorded species of all the six families of anurans which are found in India, including the North East India. He recorded 18 genera, of which four are endemic to this region. However, he opined that the anurans fauna of N.E. India is more closely related to the anuran fauna of North and South India rather than Myanmar, China and Far South East amphibian fauna.

The landscape and vegetation complex of South and South East Asia have been altered significantly in the last millennium (Maloney, 1985) and these changes are most dramatic in the North East India in the last three decades. The state of Assam has suffered a loss of 1.82 % forest cover from 1993 to 1995 against all India average of 0.08% (Baruah and Sengupta, 1998) and the rate of deforestation is absolutely 10% per decade (Whitmore, 1997). The consequence is obvious and has been described for a variety of taxa (Brook et al., 1997; Vasudevan, 1998) including amphibians (Blaustein, 1994; Pechmann and Wilbur, 1994; Singh, 2003). Beside these, decline of the amphibian fauna due to
A. Flood in Dibru-Saikhowa National Park.

B. Rampant destruction of forest in Garbhanga Reserve Forest

Plate -VII-1.
the change in land use pattern (Demaynadier and Hunter, 1998; Lannoo, 2003; Krishna, 2003; and Anonymous, 2003), ozone layer depletion (Blaustein et al., 1994), infection by virulent micro organism (Collins, 2003; Halliday, 2000), poisoning by pesticides and fertilizer (Baker and Waights, 1994; Macro et al., 1999a, 1999b), drying up of wetlands (Fellers et al., 2003), monoculture plantation (Krishnamurthy, 1999), combination of several factors (Das, 2002) have been reported from different parts of the World.

In the present study the main threats are identified as loss forest cover due to unsustainable exploitation of forest for timbers, change in land use patterns, flood and siltation and pollution of the habitat. However the threats and the ultimate target group differed in different study area. In Dibru-Saikhowa National Park the major threats recorded were topographic change due to flood (Plate VII-1A) and poisoning of the water bodies, the major sites of breeding. The agriculture related habitat alteration, use of chemicals, fertilizers and pesticides causing major problems to amphibians in the Reserve Forests, Pobitora Wildlife Sanctuary and Podumoni Borjan Bherjan Wildlife Sanctuary. Unsustainable exploitation for timber and other forest products also causing damage to the habitat of amphibians (Plate VII-1B).

Amphibians are long being recognized as indicators of ecosystem health (Victor and Onaghise, 1988). Considering amphibians as indicators it is apparent that Nameri National Park and Joypur Reserve Forest are well diversified ecosystems and could be maintained as the abode of different rare and endangered fauna.
Threats to the region's amphibian fauna include overt as well as covert alternation and destruction of habitat. The IUCN Red list of Threatened Animals lists species and subspecies known or suspected to be threatened with extinction as well as those known or believed to have become extinct. In India 202 species of amphibians have been assessed to priorities species for conservation action, based on the IUCN threats categories and listed 10 as critically endangered, 42 as endangered and 46 as vulnerable (Molur and Walker, 1998). However the North Eastern Indian scenario is much grim and seven out of the total 10 critically endangered species have been recorded from this region. The N.E. region also includes 12 endangered, seven vulnerable and a long list of Data Deficient and Not Evaluate species (Molur and Walker, 1998). In the last five years extensive study in the region (Choudhury et al., 1999; Ahmed and Dutta, 1999; Ahmed and Lahkar, 1999; Hussain et al., 2000; Deuti et al., 2000; Dutta et al., 2000; Borah and Bordoloi, 2001, 2003; Sengupta et al., 2000, 2001, Choudhury et al., 2001a,b,c; Pathak et al., 2001; Pawar and Birand, 2001; Ahmed and Dutta, 2001), results into accumulation of new information along with description of new species, sought for renewal of assessment of the species of the region based on IUCN threat categories to priorities amphibian species for conservation action.

Inger and Stuebing (1992) reported high species diversity as well as regional endemicity of the Montane amphibian fauna of Borneo and emphasized the need for protection of Montane habitat. Existing protected area (PA) network in the North East region of India donot cover important ecoregions for
species diversity and the present study emphasized on including Garbhanga Reserve Forest, Kholaghat Reserve Forest and Joypur Reserve Forest under the protected area network to ensure the long term survival of threatened species and exclude threats posing on the amphibians of these Reserve forest.

Another threat for the survival of anurans in the Reserve Forests are the large scale habitat modification (plantation) along with increased of human pressure on forest for grazing, fodder collection and agricultural expansion and settlement. The present study suggests restriction on collection of forest products and use of pesticides and fertilizers in the neighboring agricultural filed fields. Dubois (1991) suggested that a buffer zone of 100-500m along the sides of watercourses would protect a large portion of amphibian using the site. Further the present study recorded several species which are limited to the secondary forest which suggest partial disturbance in the protected areas for the long time survival of such species.