PROJECT ANURAN PHASE IV:
Preliminary Report

An ecological research project concerned with the assessment and monitoring of anuran populations in the region around Las Cuevas, Chiquibul Forest Reserve, Belize

Phase IV: Preliminary Report

By

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Summary

The international scientific community is continuously being alarmed by successive reports observing amphibian population decline in abundance and diversity. The phenomenon appeared almost two hundred years ago, but it is only now that scientists have taken action towards resolving it. This includes monitoring amphibian populations, investigating causes of their decline, research into their ecology, prioritising species conservation, evaluating methods of conservation and, finally, protecting some of the endangered species. However, there seems to still be a long way to go in successfully conserving amphibian populations.

Amphibians have great significance in both ecological and human environments, their decline, therefore, being a distressing factor for the balance of ecosystems. Moreover, due to their permeable skin and their bi-phasic lifestyle they can be excellent bio-indicators.

The aim of Project Anuran Phase IV is to carry out a comprehensive monitoring program, continuing the efforts of the last three Phases. The methods used were taken from the standard protocol of Phase I: vocalising species nocturnal surveys plus day and night transects for non-vocalising species. Our first statistical results indicate a general decline in vocalising species diversity compared to previous phases (see discussion). However, the prevalent explanation given to our observation is the dry conditions at the Las Cuevas location this summer.

This long-term undergraduate study fulfilled all the aims, mentioned in the protocol, October 2002. We feel that Project Anuran has made a considerable contribution towards producing the needed data for comprehensive monitoring programs, as well as being an excellent experience for its members.

Contents

1. Introduction

1.1 Global Amphibian Decline

Over the past two centuries, extensive human disturbance of the natural environment by urbanisation and pollution, leading to global climate change has –not surprisingly- led to a rapid worldwide decline in amphibian populations and biodiversity. Amphibian populations have been unchanged since the era of dinosaurs (Barinaga, 1990); underlining the importance of the current decline.

Looking back through the history of this alarming phenomenon, we find ourselves in the late 18th century American continent, where anecdotal reports of the phenomenon were written (Burry 1999). However, only after two centuries, herpetological reports have attracted the attention of the scientific and conservationist's community, as a more dramatic reduction in anuran populations has been observed. Alarming is the fact that Chapin, 2000, characterised this change as the sixth major extinction event in the history of life.

The First World Herpetology Conference, Canterbury, England, 1989 was the first movement towards dealing with the absence of scientific interest up to that time (Barinaga 1990). The event led to the formation of the DAPTF (Declining Amphibian Population Force Task) in 1991, supported by the Species Survival Commission (SSC) of the World Conservation Union (IUCN); essentially, the starting point of the past decade's effort to increase our knowledge on amphibians. DAPFT also organises advanced training in declining amphibian populations research in Central America supported by Research and Analysis Network for Neotropical Amphibians (RANA) and the IRCEB team studying Host-Pathogen Biology and the Global Decline of Amphibians[1]. Moreover, input towards this goal has been put in by researchers; monitoring efforts are being set up worldwide to keep track of the pace of the decline (Eterovick PC, 2003, Linzey DW 2003, Murphy JF et al 2003, Young BE, 2001, Campbell, A 1998). However, declines in vertebrate populations are still increasing in recent years (Blaustein 1994) and it has been observed that research on amphibians has been rather scarce compared with that on other vertebrates (Venturino et al 2003).

We, members of Anuran Project, feel that a better understanding of the declining phenomenon, its diagnostic characteristics and the best way of resolving the problem, is needed. This introduction provides some background information on:

a) Why are anurans ecologically important?
b) Evidence for the decline of amphibian populations
c) Possible factors responsible for the amphibian decline
d) The role of Project Anuran?

Amphibians have both ecological and human value in the environment. They constitute the highest fraction of vertebrate biomass (Beebee 1996), help maintain arthropod abundance and are a the main prey for many higher predators.(Guyer 1990). It is obvious that a change in amphibian population, can result in a great upset in the ecosystem energetics and carbon flow (Pearman 1997). The problem becomes enlarged in Neotropical forests, such as Belize, which host the highest anuran biodiversity (Lee 1996). Amphibians have physiological constraints and relatively low mobility, thus decreasing the possibilities of their successful recolonisation after natural local extinction (Blaustein 1994). As recent studies suggest, anurans occupy different positions on the trophic chain, not necessarily being able to be functionally variable (Chalcraft 2003). The two latter recent observations emphasise the importance of carefully organised conservation efforts.

Moreover, amphibians are excellent bioidicators of environmental change due to their susceptibility to chemicals during their freshwater cycles (Venturino et al 2003) and their highly permeable skin (Duellman & Trueb 1994). Some anurans are also herbivores during

[1] www.open.ac.uk/daptf/index.htm

their larval stages and carnivores as adults, thus providing information to scientists about changes in both the plant and animal kingdom.

Anuran declines are mainly reported from areas that were thought to be untouched from humans. Areas in which serious declines have been observed include the Atlantic forests, Brazil (Heyer et al. 1988), North West USA (Drost & Fellers 1996, Murphy JF et al 2003. Bulger JB et al 2003), Montane forests, Australia (Laurance et al 1996), Monteverde cloud forest of Costa Rica (Lips 1998, 1999), above 500m remote highlands in Central America and above 1000m in the Andes (Young BE et al 2001). Few examples of scientifically credible decines or threatened species include the Golden toad (Bufo periglenes) and Harlequin frog (Atelopus varius) (Pounds & Crump 1994), the Cascades frog (Rana cascade) (Fellers & Drost 1993), the Yellow and Red-legged tree frogs (Rana muscosa and Rana aurora) (Davidson C et at 2001, Bulger JB et al 2003) and the Black toad (Bufo exsul) (Murphy JF et al 2003).

It is difficult to estimate amphibian declines from a global perspective from individual research studies. The most recent reports that have attempted to draw wide conclusions are Alford &Richards (1999), Houlahan et al (2000) and Young BE et al (2001). The first, collected data over the period 1951-1997 and found amphibian populations decreased more than their model predicted. However, there was no evidence that the agents of decline were becoming more prevalent over time. Houlahan et al used data from 936 populations to assess variations in amphibian population trends on a global scale. Unfortunately, their results indicate relatively rapid declines from the late 1950s to the late 1960s, but a reduced rate of decline was observed to the present. There has been a debate between the two groups of scientists, which has appeared in Nature, 2 August, 2001. Alford at al argue that by emphasising the global mean, Houlahan et al have masked spatial and temporal variation in amphibian population trends (Houlahan et al –reply 2001). This is a problem emphasised by many herpetologists and can only be minimised if a long time series of monitoring data is provided. Finally, Young et al initiated an effort in Latin America, where they convened workshops with 88 Latin American herpetologists and conservationists. Studies in that area of the world indicate that at least 13 countries have experienced declines, affecting 30 genera and 9 families of amphibians (Young BE et al 2001).

There are numerous candidates for the cause of the amphibian decline phenomenon: habitat modification, increase in ultraviolet radiation, acidification and toxins, predation, disease climate and weather.

Habitat modification is the main factor held responsible for the observed loss of amphibian biodiversity and abundance. This includes deforestation, land drainage, introductions of exotic species to habitats and spread of contaminants. The ozone depletion results in increased UV-B radiation and, as the most recent studies suggest, (Davidson C et al 2003, Hatch AC et al 2003) that there is a positive correlation between increasing UV-B radiation and decreasing larval mass, as well as increasing rate of species decline. Evidence for the existence of such an effect though is still being investigated. Pollutants from industries and agricultural depositions have the exceptional ability to travel vast distances and have long persistence. This results in the widely observed phenomenon of increased acidity in rain, which enhances embryo and larval mortality (Alford & Richards 1999). As the most recent study on agrichemicals suggests, they are also a factor contributing towards amphibian declines, but little is known about which of them pose the greatest threat (Rohr JR et al 2003).

1.2 Role of Project Anuran, Phase IV

Project Anuran is an undergraduate research study which has completed its 4th year of study this summer, 2003. The project aims to undertake a comprehensive monitoring program of the anuran community in the neotropical area of Las Cuevas, Chiquibul National Park, Belize. Hopefully, Phase V will continue the monitoring process in summer 2004, so that 5 years of studies are completed, thus, making our results more statistically analysable. Belize, having vast protected areas, retaining some 75% of its natural vegetation (Harcourt 1996) and having a large percentage of its amphibian population remaining mysterious (Meyer & Foster

1996), is an excellent spot to collect our data. We feel that our contribution to the tackling of the global amphibian declining phenomenon, consists of the fact that we are in a place to offer a certain amount of time, personnel, resources and enthusiasm towards a scientifically useful monitoring program. Throughout our 7 week stay in Las Cuevas Research Station we followed the Phase I standard protocols of methodology, carrying out nocturnal vocalisation surveys, visual encounter surveys(day and night transects), quadrat surveys, weather monitoring and vegetation surveys around each of the ponds; and continually assessing these. Moreover, for the first time this year we managed to overcome the problem of covering all the rainy season, by training long-term research volunteers at the LCRS to carry out night surveys throughout their 6 month stay.

Most importantly, Project Anuran cooperates with MAYAMON (Maya Forest Anuran Monitoring Program), co-ordinated by the DAFT. The resulting species abundances will be fed into this program that covers the entire Selva Maya region (Belize, South Mexico and Peten, Guatemala), creating a regional picture of anuran species distribution and abundance.

2. Aims and Objectives

2.1 Research Aim :

To contribute to the understanding of the ecology and conservation of amphibian populations via intensive assessment of the status of species at the neo-tropical site of Las Cuevas (N16°44' W88º59').

2.2 Research Objectives :

1) To continue monitoring of ten sites previously assessed during 2000-2002 using tested profitable survey methods
2) To concentrate effort to compare alternative monitoring methods for assessing the diversity and population status of leaf litter anurans at sites identified as being suitable / known habitat type.
3) To conduct survey work to compare the diversity and population status of ground dwelling amphibian fauna at four sites in the Las Cuevas area, in order to assess the congruence of amphibian diversity with the presence/absence of four key umbrella species.

2.3 Further Objective

To continue efforts to establish firm links with a collaborative student group from the University of Belize and other local support.

3. Methodology and Approach

3.1 Site Description:

Our work is conducted in the vicinity of Las Cuevas Forest Research Station (N16^{0}44' W88^{0}59'), Belize. The station is maintained as a joint initiatitive between the Natural history Museum (London) and the Forestry Department of Belize, and is situated in the Chequibul Forest Reserve, North of the main Maya Mountains divide. It stands at roughly 500 m a.s.l. with an annual rainfall of between 1500 and 2000 mm, with vegetation consisting of mostly lowland subtropical moist forest (Hartshorn *et al.* 1984). Since the collapse of the Mayan civilisation c. AD 750-1000 there have been no permanent inhabitants of the region around Las Cuevas. However, the forest has experienced repeated subsequent disturbances, both natural and human (e.g. logging for mahogany, chicle extraction, fire, and periodic hurricanes)

3.2 Methodology

In order for our data to be useful for collaborative analysis, of changes in species diversity or population status, with previous years projects we were obliged to follow a well established standard protocol. The design of the protocol is such, that it allows wide applicability with respect to other, similar Mesoamerican survey work. Our methodological approach falls under two directions; that for vocalising species (Field Study 1), and that for non-vocalising species (Field Study 2).

3.3 Field study 1: Monitoring and assessment of vocalising species:

Most anuran species, especially in the tropics congregate *en masse* around breeding sites (Duellman & Trueb 1994; Beebee 1996), Making the monitoring of vocalising choruses often the most effective technique by which to assess a population (Alford & Richards 1999).

Ten breeding pond sites were chosen and consolidated during Phases I, II, and III. These represent a number of different sub-habitats of the forest surrounding Las Cuevas, which different compositions of Anuran favour. Surveys of these breeding ponds ran from 1900 hours to 0200 hours when possible and until at least 2300 hours otherwise. The varying times of surveys were the result of security concerns in the area. On this occasion only eight ponds were consistently monitored due to as considerable extension of the dry season in the area this year. Puzzle Pond and Cockspur pond remained dry for the duration of our study, while Guava, Elegans, Warrie and Marshy all fluctuated between having no water and very little, comparatively to previous years. Each pond was surveyed over at least 5 repeats in concordance with data from Phase II and III. Single repeats were carried out at dry ponds to investigate the presence of any anuran species. Measurements taken on arrival at each pond include; depth of pond (deepest part), collection of water sample for pH measurement and a summery weather report. Following this, half hourly recordings of species abundance and calling activity were made. Measures of abundance follow the MAYAMON protocol (Meyer 1999), which uses measures of vocalisation categories to assess the abundance of each species present for the first fifteen minutes of every hour (Table 1.)

In an attempt to assess the calling activity of the species present a measure of call intensity was devised during Phase I, which has proved to be an invaluable addition to the protocol in Phases I, II, III, and IV. This was done by measuring the frequency of calls of an average individual of each species for the first fifteen minutes of every hour. One call is taken as each noticeably distinct vocalisation per individual (Table 1).

Vocalisation Category (VC)	VC definition	Vocalisation Intensity (VI)	VI definition
1	1-5 individuals	A	1 or <1 calls per 15 minutes
2	6-20 individuals	B	2-14 calls per 15 minutes
3	21-50 individuals	C	5-10 calls per minute
4	>50 individuals	D	2-5 calls per minute
		E	6-10 calls per minute
		F	11-20 calls per minute
		G	21-40 calls per minute
		H	>40 calls per minute

Table 1: Vocalisation categories and intensities

In addition to these half hourly recordings the air and water temperature were recorded, allowing maximum and minimum temperatures for the entire night to be noted. Also recorded was the volume of rainfall, the duration and number of rainfall events (the former being done with transportable rain-gauges).

We identified individual species vocalisations through using reference recordings produced by J. Meyer and J.C Lee. In addition to this there were other recordings made available from previous Phases of the project, representing the majority of different species to be found specifically around Las Cuevas. Visual identification was aided by the use of the practical field guide compiled by Project Anuran (Phases I and II) with reference to texts; Meyer & Foster (1996), Lee (1996), Campbell (1998). This guide was excellent for confirming vocalisations with visualisations.

In addition to the standard protocol outlined above, all anecdotal recordings of these species were noted. The emphasis here was placed on species type, location, and time of day. Relevant natural history notes were also recorded. To try and relate the different species of Anurans found at the different ponds, to their natural history and distributions a floral diversity assessment of the ponds was made during Phase I. Phase III re-assessed this to identify any local changes. This year we chose to re-map the ponds using general vegetation types, noting any particular species of interest (These maps shall be included in the final report, due in September 04). We were unable to carry out a full floral diversity assessment due to the inherent difficulties with identification.

3.4 Field Study 2: Non-vocalising and leaf litter species:

The monitoring of leaf litter and stream dwelling frogs is subject to a variety of methods the effectiveness of which can vary greatly between geographic locations, amphibian species assemblages and local habitat conditions (Pearman *et al.* 1995). Phases I and II established six permanent transect lines as the most suitable method for the area. Of these six transect lines only five were used this year. This decision was made due to the fact that the San Pastor Trail Transect was being heavily disturbed by other people on a regular basis.

Transect lines were stratified around areas presumed to be of both high diversity (creeks and rivers), and areas noted to be ecologically distinct in terms of forest habitat. Each line was cut to be 500m in length and 2m in width. Transect lines were surveyed by two people (selected at random), who walked slowly down the line searching the leaf litter and branches up to eye level on one half of the transect. In order to standardise the search effort a time restraint of one hour was placed on each transect survey, producing an average search speed of 0.5 km per hour. All individuals sited were noted with respect to species, number, location (nearest 50m), time and any relevant behavioural observations. A minimum of 5 repeats were conducted per transect, for both day and night, with searches being spaced as evenly across the study period as possible. The latter point was only really an issue for the Monkey Tail transect approximately 8km away from the research station, where safety was an issue due to the likelihood of flash floods, made even more pronounced by the dry weather conditions this year. Identification of specimens for transect lines followed the relevant guides; Lee (1996), Meyer & Foster (1996), Campbell (1998), and Lee (2000)

3.5 Weather Monitoring:

Daily recordings were made at 0900 of rainfall volume and duration for the previous 24 hours, maximum and minimum temperature, relative humidity and cloud cover. These were taken using standard equipment from the weather station at the Las Cuevas site (we are awaiting the arrival of the LCRS weather data). In addition to this three more rain gauges were encorporated into the weather monitoring. These were placed at the Aguada (4 km East LCRS), Millionario (5 km West LCRS) and another at LCRS, creating a cross-sectional map of rainfall. Data collected from these will hopefully allow consideration of the spatial variability in rainfall patterns within the study area.

4. Results

4.1 Species accounts:

Family	Species	Common name
Rhinophrynidae	*Rhinophrynus dorsalis*	Mexican Burrowing Toad
Leptodactylidae	*Eleutherodactylus chac*	Chac's Rainfrog
	Eleutherodactylus laticeps	Broadhead Rainfrog
	Eleutherodactylus rhodopis	Lowland Rainfrog
Hylidae	*Agalychnis callidryas*	Red-eyed Treefrog
	Agalychnis moreletii	Morelet's Treefrog
	Hyla ebraccata	Hourglass Treefrog
	Hyla loquax	Loquacious or Mahogany Treefrog
	Hyla microcephala	Small-headed or Yellow Treefrog
	Hyla picta	Painted Treefrog
	Smilisca baudinii	Mexican Treefrog
	Smilisca cyanostica	Blue-spotted Treefrog
Centrolenidae	*Hyalinobatrachium fleischmanni*	Fleischman's Glassfrog
Bufonidae	*Bufo campbelli*	Campbell's Forest Toad
	Bufo marinus	Cane or Marine Toad
	Bufo valliceps	Gulf Coast Toad
Ranidae	*Rana berlandieri*	Leopard Frog
	Rana juliani	Maya Mountain or Julian's Frog
	Rana vaillanti	Vaillant's Frog

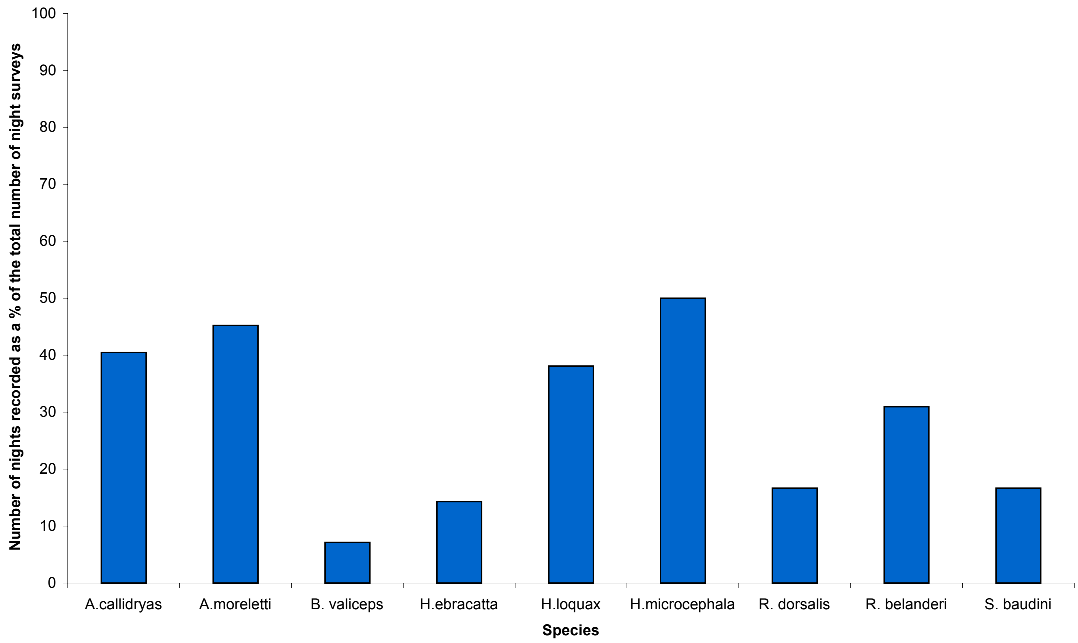
Table 2: Classifications and common names of anuran species found around LCRS (2003)

Table 2 above illustrates the classification and common names of the species of anurans found at Las Cuevas Research Station (LCRS) during Phase IV of Project Anuran. A total of 19 different species were found. During phases I, II, and III, there were 20, 21, and 18 species found respectively. Phase II encountered *Eleutherodactylus sabrinus* and *Gastrophyne elegans* which were absent from Phase IV findings, while Phase III was void of any *Hyalinobatrachium fleischmanni* sightings. This consistant high level of species richness helps confirm the site to be one of the most diverse throughout Belize, with respect to amphibian fauna (Miller & Miller, 1995). The last section of this report is an update of the Project Anuran field guide, incorporating descriptive details of every anuran species encountered during this years field research. We have also chosen to use as many new photographs as possible.

4.2 Vocalising species:

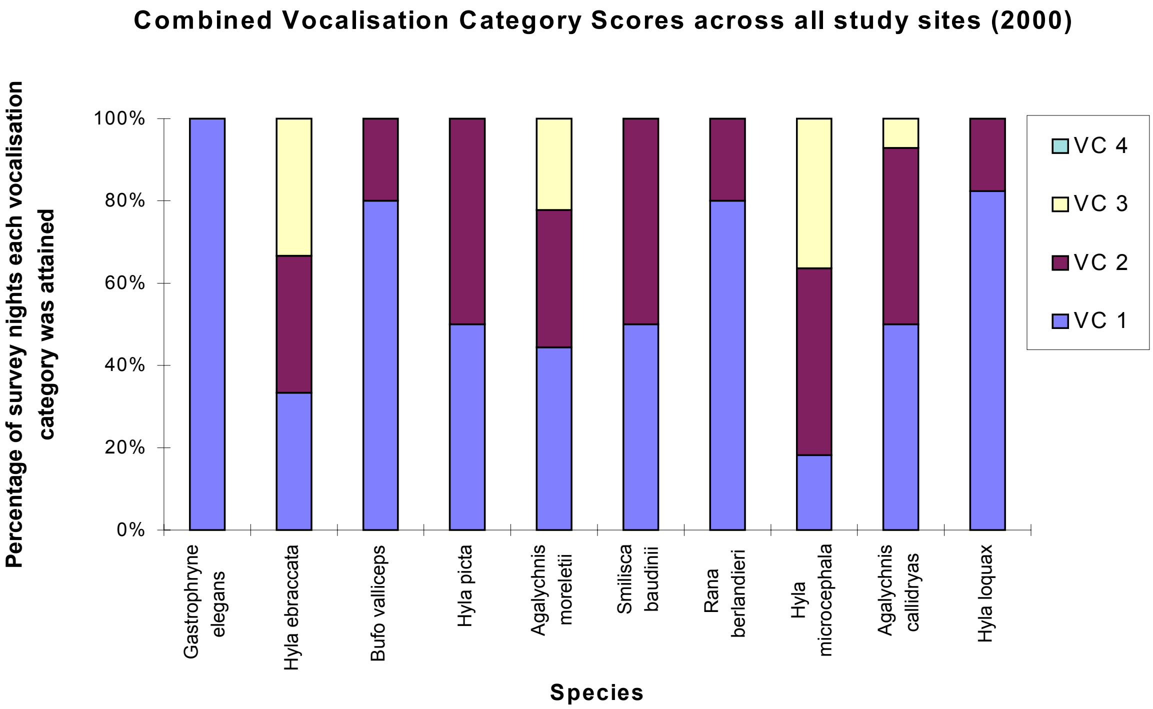
A total of 45 survey nights were carried out during the study, with five or more repeats at all of the ponds containing water. Of these repeats the five most representative from each pond have been selected for analysis (the others were excluded due to either early mistakes in identification of vocalisations, time shortages i.e. requested to return to LCRS, or poor time spacing). This amounts to a total of 280 hours of acceptable data.

Graph 1 below illustrates the relative abundance of vocalising anurans found at LCRS. With respect to last years results there are three species missing from the vocalisation records. These species are *Gastrophryne elegans, Hyla picta*, and *Smilisca cyanostica.*

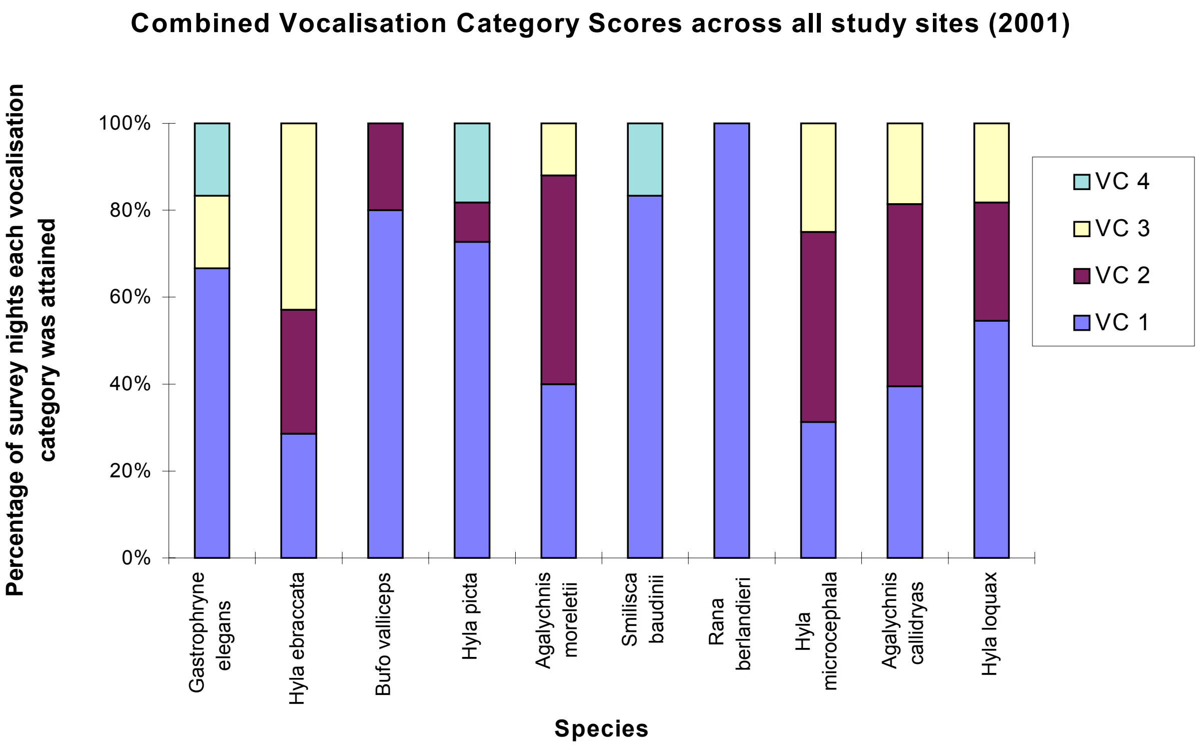


Graph 1: Relative abundance of vocalising anurans around LCRS

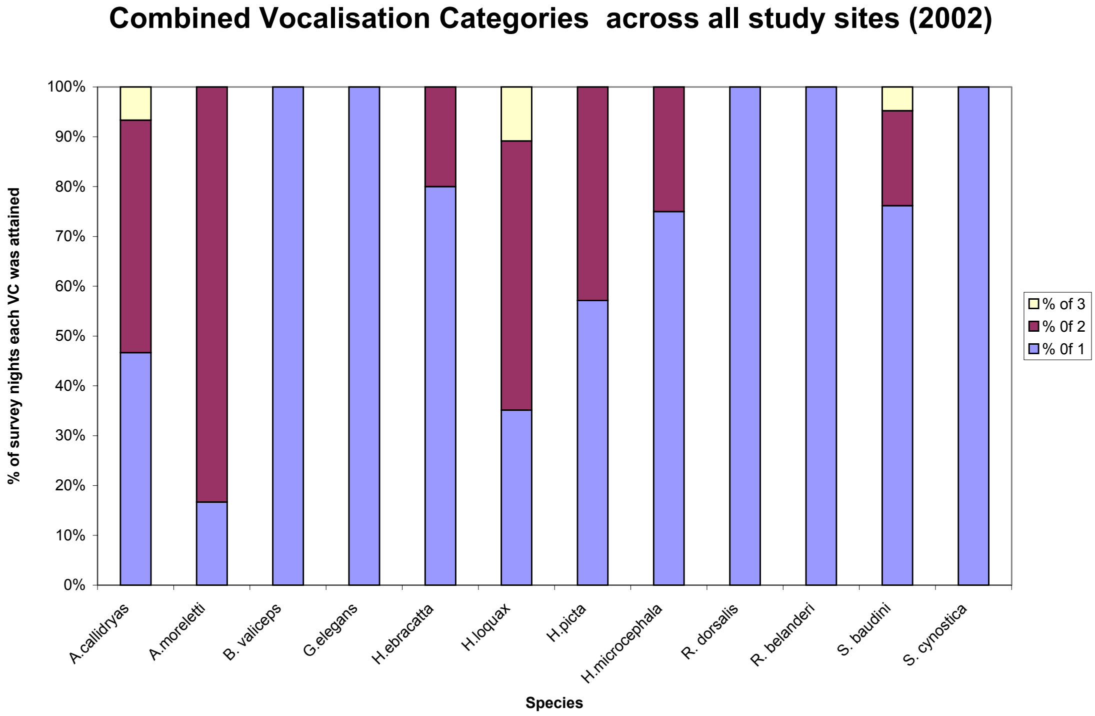
Graph 2 illustrates the proportion of survey nights in which a species was heard at each vocalisation category (VC) in the year 2000. It allows comparisons in reproductive activity to be made across species. The reproductive activity of some species is characterised by short periods of intense calling activities, where as other species exhibit a more constant calling pattern.



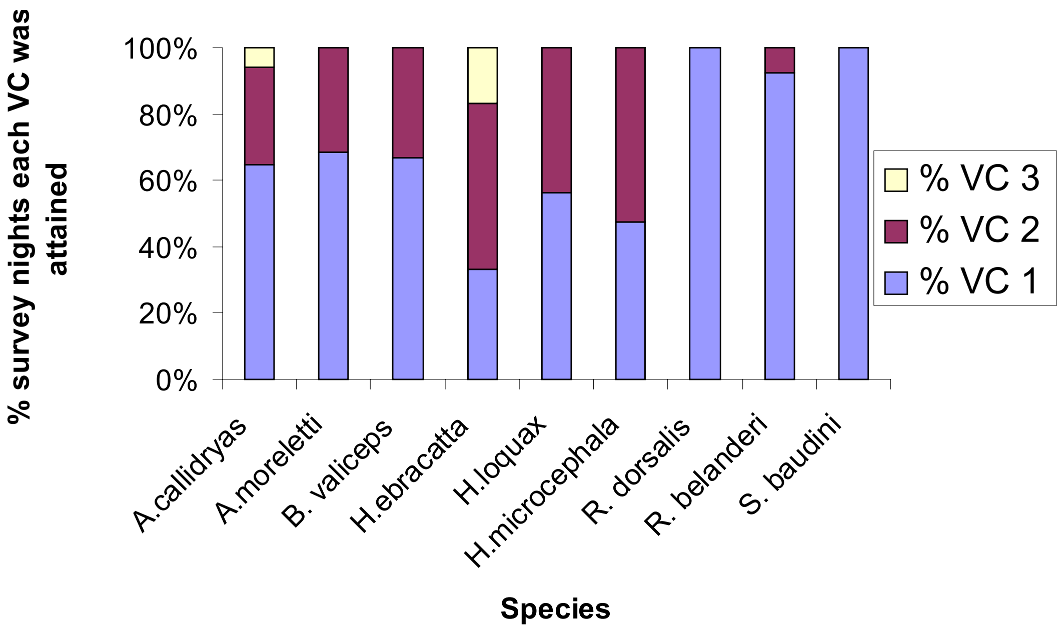
Graph 2: Combined vocalisation categories across all study sites (2000)



Graph 3: Combined vocalisation categories across all study sites (2001)



Graph 4: Combined vocalisation categories across all study sites (2002)



Graph 5: Combined vocalisation categories across all study sites (2003)

Graph 5 represents this years combined vocalisation categories across all the study sights and at first glance is visibly different from graph 4.

4.3 Non-vocalising species:

During Phase IV, 50 transect lines were surveyed, adding a further 50 hours (50:50, day:night) of acceptable data to this years project. Transect lines have proved the most profitable survey method in the assessment of ground dwelling anurans, hence a continued emphasis has been placed on this research method. Table 3 below highlights the findings from our permanent transect surveys.

Transect	No. of Transect Days/Nights	*B. campbelli*	*B. marinus*	*B. valliceps*	*E. rhodopsis*	*E. laticeps*	*H. fleishmanni*	*R. juliani*	*R. vaillanti*	Transect Success (individuals / transects)
Creek	10	0	0	0	0	0	1	2	3	0.6
Saffron Trail	10	0	0	0	0	1	0	1	0	0.2
Fifty Ha Plot	10	0	0	0	1	1	0	0	0	0.2
Nature Trail	10	0	0	1	1	0	0	0	0	0.2
Monkey Tail	10	2	1	0	0	0	0	6	1	1
Total	50	2	1	1	2	2	1	9	4	0.44

Table 3: Visual encounters of Anurans on five different, permanent transect lines.

Data which is not presented here shows that the majority of Anuran visualisations occurred during our night surveys (approximately 82%)

4.4 Weather:

The weather during our stay was unusually dry this year. From conversation with staff at the research station it was ascertained that the heavy rains expected to begin in June had never arrived. It is uncertain yet if the weather was an anomaly this year or if perhaps the loss of foliage (large albedo and transpiration change) from the neighbouring area, the Pine Ridge could be a cause. These landscape alterations will create changes in the land surface interactions and therefore perhaps the climate in surrounding areas. This is pure speculation at present, and indeed may be insignificant as the area of Pine Ridge regularly undergoes loss of vegetation resulting from fires. Undoubtably with relation to Project Anuran is that, the outcome of this dry weather was an evident lack of leaf litter and soil moisture, except after small rainfall events. More importantly it resulted in all of our ponds having particularly low, variable water levels and some (Puzzle and Cockspur pond) remaining dry for the duration.

5. **Discussion**

5.1 Vocalising species

The results from Phase IV graph 1 may at first glance suggest that there is a loss of diversity in anuran species numbers around LCRS. If we consider the transect and anecdotal observations as listed in table 1, we see that this is not the case. Reasons for this loss of diversity in the recorded anuran vocalisations is probably due to extended dry season this year making breeding conditions unfavourable for many species. We have yet to receive the weather data from LCRS which will strengthen this point. Both *Hyla picta* and *Gastrophryne elegans* are explosive breeders, congregating *en masse* around ponds to breed after the onset of heavy rains. There absence indicates a flaw in the sampling methodology for studying such species. *G. elegans* was never encountered this year, while *H. picta* was observed during daylight hours (16/07/03) after a heavy rainfall event the night before. Due to the anecdotal sightings of *H. picta* the absence of, and under-representation throughout the project of similar species suggests our study does not give a fair representation of their numbers and prevailance around LCRS. *Smilisca cyanosticta* another vocalising species encountered vocalising in the previous year was absent from this years counts. There was an anecdotal recording, where it was observed approximately 6 km down the Monkey Tail path (31/07/03), it has been observed in a similar manner in Phase I and II. The variability in the presence of *S. cyanosticta* in the vocalisation surveys, its known natural history and the anecdotal sightings, suggest that our study sites perhaps do not suitably cover its preferred habitat. It has been seen vocalising along water filled vehicle tracks in the Chiquibul National Park (Meyer, J. R. & Foster, C. F. 1996). From this years project that is not surprising as often it would seem there was a great diversity of anurans capitalising on these semi-permanent water pools. It is hypothesised that these pools retain water well due to high compaction of the soil underneath them, resulting from the weight of the vehicles passing over them.

The results from Phase IV as displayed on graph 5 further highlight the existence of variation in reproductive behaviour across species. Those species missing have already been mentioned so we will go on to discuss the values of those recorded. Our *Agalychnis callidryas* vocalisation categories (VCs) are similar to last year, involving categories 1, 2, and 3. VC 3 was only found in the latter species mentioned and *Hyla ebracatta* , during Phase IV. This represents the worst year for recording VCs 3 and 4. It is suspected that these results are probably connected to dry environmental conditions not favouring breeding. The results with respect to *H. ebracatta* contest a suggested decline in numbers made in Phase III, where only VC 2 was counted across all the survey nights. This was not backed up by this years data collection and highlights one of the difficulties involved in assessing anuran populations through our methodology. The problem being that our methodology incorporates breeding sites and therefore represents breeding patterns more strongly.

One decline that does seem to be consistent with reference to VCs can be found with *Agalychnis moreletti* scores. In Phase I and II it had VCs of 3 (<20% of the time) and in Phase III its highest score was VC 2 (>80% of the time), this year the VC seems to be reduced again to VC 2, less than 40% of the time. This of course could again just be a result reflecting the dry weather during this year, or it may be something more. For this reason it is suggested that more information should definitely be gathered on the species in the area.

The results for *Rhinophrynus dorsalis* are worth mentioning briefly in this report because of the nature of the species. *R. dorsalis* can burrow to great depths (reported at 4m by Carol Farneti Foster) avoiding desiccation and predation, and only emerging after the onset of prolonged heavy rains (Meyer & Foster, 1996). For this reason the fact that we recorded this species at all this year is unusual. Its VC category as can be seen on graph 5 never exceeded 1, from our anecdotal records we observed that there was never more than one individual and that they were sometimes calling from the depths of the forest in the middle of the day. Reasons for this shall be investigated in more detail in the main report.

5.2 Non-vocalising and leaf-litter species

Unfortunately due to the popularity of LCRS with other researchers one of the transect lines (San Pastor Transect Line) had to be excluded due to the excessive number of pedestrian traffic using the area. Many of the other transect lines, in particular the Nature Trail, also suffered from anthropogenic disturbances. The occurrence of such disturbances may upset species visualisations as anuran species may selectively avoid such an area. For this reason this years group also conducted a series of quadrat surveys, between Millionario and Monkey Tail River. This was done using random placement of a 4*4 quadrat off of the main track, between the two aforementioned points and off of the permanent transect lines. This constituted an extra 50 hours of daylight survey work. The validity of this survey to our project is unknown at present and therefore its results are not included in our preliminary report.

Having been involved in the collection of this data and considering the numbers seen in table 2 it becomes apparent, either a)How well these species hide in their respective habitats, or b) Just how low in numbers they are. Generally it is believed that the Leptodactylidae family thrive in suitable environments, there low representation in the transect survey may indicate the absence of suitable environmental conditions. There were no highly unusual discoveries this year, although the visual encounters of *Bufo marinus* and *Hyalinobatrachium fleischmanni* were particularly welcome. This is not just because they represent two very interesting species of frogs, (*B. marinus* is the largest known anuran growing up to1780 mm in length, while *H. fleischmanni* has a transparent ventral surface), but also because of their absence from last years encounters. *Bufo marinus*'s presence at the Monkey Tail Transect is perhaps indicative of the low levels of rainfall causing drying of surrounding streams and ponds. Typically *B. marinus* will avoid large rivers during the wet season due to their strong current. On the occasion it was seen at Monkey Tail River the volume of water in the river was exceedingly low. The deepest point along the transect was just 1 m and there were many still ponds effectively cut off from the main flow of the river. The presence of *H. fleischmanni* at the Creek Transect is understandable from what we know of its natural history, which is mainly that it enjoys clear streams to breed around.

6. Conclusions

The findings from Phase IV are limited at present until a more detailed analysis of results has been carried out. We did find that there are certain limitations to using Field study 1 methods to completely account for all anuran species around Las Cuevas and that an extended dry season results in a large decline in breeding activity of the frogs, which could potentially lead to a decline in future numbers. For this reason the continuation of the project into its fifth year is vitally important.

7. Future Outputs

- The aim of this report was to highlight some of our initial findings, making general comparisons with previous years and illustrate some of the challenges we faced in collecting this years data. A final report of all our results and a more in depth study will be submitted by September 2004. Within the final report we hope to investigate the potential effects of drought years on the overall balance of Anuran diversity in the area.
- The team will also be giving talks to various groups e.g Edinburgh University Exp-ed society, about this years project.
- The arrangement of a final phase of Project Anuran, to collect the fifth year of data is presently underway.

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