Housing Development is a Possible Contributing Factor to the Decline of Frog Species Prevalence in the City of Salisbury

Katherine Nightingale [a]

[a] University of South Australia, Adelaide, South Australia

7 March 2016

Abstract

Urbanisation is known to contribute to the habitat loss, fragmentation or isolation of many species of flora and fauna. With frog populations declining globally this is an increasingly important issue. The City of Salisbury in Adelaide, South Australia, has seen the development of houses throughout the late 1990s and 2000s, however the impact this has had on the frog populations in the area was not assessed at the time of development. To try and understand the impact of the housing development on the frog population during the study period, the Environmental Protection Agency Frog Census was used which was compiled as part of the citizen science project Frogwatch, and from 1994 to 2005 the change in the mean number of frog calls was assessed for all species combined and each individual species. This was compared against the change in private dwelling numbers and population for the study area using data collected in the Australian Bureau of Statistics Census for 1996, 2001 and 2006. Results suggest that the overall decline in mean frog calls of all species could be attributed to the housing development in the study area, however further study is required to assess this as a causation. The individual species showed no significant result and this could be due to small sample sizes. To provide more conclusive results a larger study of the area would be recommended, including any secondary impacts housing developments may have.

Frogs, while not often seen, are an important component of many ecosystems. They can be found in almost any habitat which provides access to water, on every continent, except Antarctica. Both humans and frogs exhibit a common need for water and as a result are often found in close association (Tyler, et al., 2007). However, frog species numbers and populations are declining worldwide and this was first highlighted in 1989 at the First World Congress of Herpetology. Since then there has been immense research into the possible causes and the rate of decline, with one suggestion being habitat alteration (Stuart, et al., 2004).

Human settlement in Australia, both pre and post European, has resulted in significant land use changes, including the restructure of forests, wetlands and plains, to suit the needs and desires of the human population. This has resulted in mass land clearing activities, particularly as the human population and socio-economic demands increase (Bradshaw, 2012). Clearing of vegetation has been linked to the decrease in fauna populations and species richness due to the loss, fragmentation or isolation of habitats available. This is a trend increasingly associated with urbanisation (Chace &

Walsh, 2006). Urbanisation has been a major factor of the frog species decline including habitat fragmentation, destruction and isolation (McKinney, 2002). This is primarily due to the clearing or modification of land to enable the construction of roads and infrastructure (Vos & Chardon, 1998).

While amphibian populations are found naturally in patches, the increasing urban landscapes create additional stressors for species survival as a disconnect may be created between aquatic and terrestrial habitats, essential to fulfil their complex life cycle requirements (Marsh & Trenham, 2001; Pope, et al., 2000). In urban environments this disconnect is often due to the construction of roads and infrastructure such as buildings, fences, and in some cases, open areas (Vos & Chardon, 1998). Roads, buildings and fences create physical barriers which can block access or pose potentially life threatening obstacles between habitats. However, as some species are known to move up to one kilometre between aquatic and terrestrial habitats, land clearing to create large open areas may be detrimental as the populations become more susceptible to predators, or their terrestrial habitat is removed. Roads and infrastructure are normal factors in urban development; however do contribute greatly to the fragmentation, loss or isolation of habitats (deMaynadier & Hunter Jr, 2000; Carr & Fahrig, 2001; Gibbs, 1998).

In this study, an 11 year long citizen science survey, the Frogwatch program, will be used to detect changes in the prevalence of frog species in the City of Salisbury council area between 1994 and 2005. The changes in frog prevalence will be compared against the increase in private dwelling numbers and population over the study period. Based on prior research conducted into the impact of habitat fragmentation, loss or isolation on frog species, it is hypothesised that an overall decline in frog prevalence will be seen and this is due largely to the disturbance and destruction of habitat caused by housing development.

Method

Study Area

The City of Salisbury is a local government area situated within the Adelaide metropolitan area of South Australia. The region has undergone extensive land use change and population increase since its colonisation in 1839. Post colonisation the land was used for agricultural purposes, including hay, wheat, oranges and dairy produce, however since the 1940s it has become an increasingly urbanised area (City of Salisbury, n.d.). In the late 1990s significant construction of the suburb Mawson Lakes commenced. This is currently the most recent housing development in the City of Salisbury and construction is still ongoing (profile.id, n.d.). Mawson Lakes is situated near the Greenfield Wetlands, a major created wetland system which is a habitat for many flora and fauna species, including frogs. Dry Creek feeds in to this wetland system after running though parts of the City of Salisbury, including Mawson Lakes (City of Salisbury, n.d.).

The City of Salisbury was explored as a whole rather than focusing on a single suburb. Data pertaining to the number of private dwellings and population were obtained from the Australian Bureau of Statistics (ABS) Census Reports. Due to the years in which the Census is conducted, data used was for 1996, 2001 and 2006 (ABS, 1997; ABS, 2002; ABS, 2007).

Data Set

In response to a global decline in frog populations the Frogwatch program was developed in each state and territory of Australia. In South Australia the program was initiated and coordinated by the Environmental Protection Agency (EPA). The program ran from 1994 to 2005 during the early weeks of September, a known breeding time for the majority of frog species (Environmental Protection

Agency, 1999). Members of the public of any age could participate in the data collection and the data was analysed by herpetologists to determine the species based on sound recordings (Ginninderra Catchment Group, n.d.). Data collected included time, date, location as both address and coordinates, species, common name, habitat type and a categorical approximation of the number of calls (Environmental Protection Agency, n.d.). As a citizen science project it was aimed to create public awareness on frog population declines, while also creating a database of the distribution and abundance of frogs throughout the state (Amphibian Research Centre, n.d.). This database was provided by Dr Stephanie Williams of Zoos South Australia.

The provided dataset included recordings for the whole state of South Australia and therefore not all recordings were required for this study. To refine the dataset any recording which did not meet the following requirements were deleted; Natural Resources Management Region (NRMREGION) of Adelaide & Mt Lofty Ranges, and National Parks and Wildlife Services Distribution (NPWSDISTRI) of Northern Lofty. The dataset was then further refined by removing any recording not within the suburbs of the City of Salisbury according to data in column LOCATIONCO. A list of qualifying suburbs can be seen in Table 1. If no suburb was listed the coordinates listed in columns LATITUDE and LONGDITUDE were searched using Google Maps to determine location.

Table 1: Suburbs of the City of Salisbury

Source: (City of Salisbury, n.d.)

Bolivar	Brahma Lodge	Burton
Cavan	Direk	Dry Creek
Edinburgh	Elizabeth Vale	Globe Derby Park
Green Fields	Gulfview Heights	Ingle Farm
Mawson Lakes	Para Hills	Para Hills West
Para Vista	Parafield	Parafield Gardens
Paralowie	Pooraka	Salisbury
Salisbury Downs	Salisbury East	Salisbury Heights
Salisbury North	Salisbury Park	Salisbury Plain
Salisbury South	St Kilda	Valley View
Walkley Heights	Waterloo Corner	

Statistical Analysis

To prepare the data for analysis the number of calls for each recording was extracted from the column SIGHTINGCO. As this information was categorical it was translated to a numerical mean value, i.e. one=1, few (2-9)=6 , many (10-49)=30, lots (<50)=50. The statistical program SPSS was used for all statistical analysis. To determine if there was a statistical significance in the population changes of all species over time a one-way ANOVA was used. A prediction of 0.05 or less was considered a significant result. The ANOVA was then repeated for each individual species; *Crinia signifera*, *Limnodynastes dumerilii*, *Limnodynastes tasmaniensis* and *Litoria ewingii*. No ANOVA was conducted on *Pseudophryne bibronii* as there was only one recording for this species across the study.

The overall trend of change in private dwelling numbers and human population were compared with that of the frog populations. Using Microsoft Excel to create a scatter graph with a trend line the overall change was determined as either an increase or a decrease.

Results

Frogs

Across each year there was at least one recording for each species in the study area, except *P. bibronii* which was recorded once only in 1998. *C. signifiera* was recorded more often than any other species across all years. *L. tasmaniensis* was the next most common species with the mean number of calls being higher than the remaining two species in every year except 2003 where *L. dumerilii* was marginally more prevalent. *L. dumerilii* varied in mean number of calls each year while *L. ewingii* showed a lesser value (Fig. 1). Figure 2 shows the trend in mean number of calls for each individual species with *L. dumerilii* and *L. ewingii* showing an overall increase while *C. signifiera* and *L. tasmaniensis* presenting an overall decline.

The one-way ANOVA showed no significance in the variation in mean number of frog calls across the timeframe of the study for the individual species. There was however a significance in the change in mean number of calls across all species. The overall population of frogs (n= 381) showed a p-value of 0.030 which is within the bounds for significance as outlined in the method (see Table 2 for summary of ANOVA results). As a significance was noted for the mean number of calls for all species the overall trend was assessed. This is seen in Figure 3 and shows an overall decline.

Table 2: Summary statistics for the number of frog calls

Species	**Sample Size**	**P-value**
All Species	381	0.030
Crinia signifera	220	0.143
Limnodynastes dumerilii	37	0.747
Limnodynastes tasmaniensis	98	0.479
Litoria ewingii	25	0.244

Private Dwelling and Population Changes in the City of Salisbury

There was negligible land size change for the City of Salisbury across the study period. Within the land space there was an increase in private dwelling numbers of 2837 (7.050%) between 1996 and 2006. Figure 4 shows the trend in private dwellings as a steady increase over the study period. As expected, with the increase in private dwellings the population within the City of Salisbury increased. The change in population was 9959 (9.182%) during the study period and Figure 5 shows the trend was a steady increase. A summary of the change in City of Salisbury statistics can be seen in Table 3.

Table 3: Land size, population and private dwelling numbers for 1996-2006

	1996	**2001**	**2006**	**± Change**	**% Change**
Land Size (km^2)	157.6008	158.1	158.1	-	-
Population	108 465	110 924	118 424	9 959	9.182
Private Dwellings	40 327	42 501	43 164	2 837	7.050

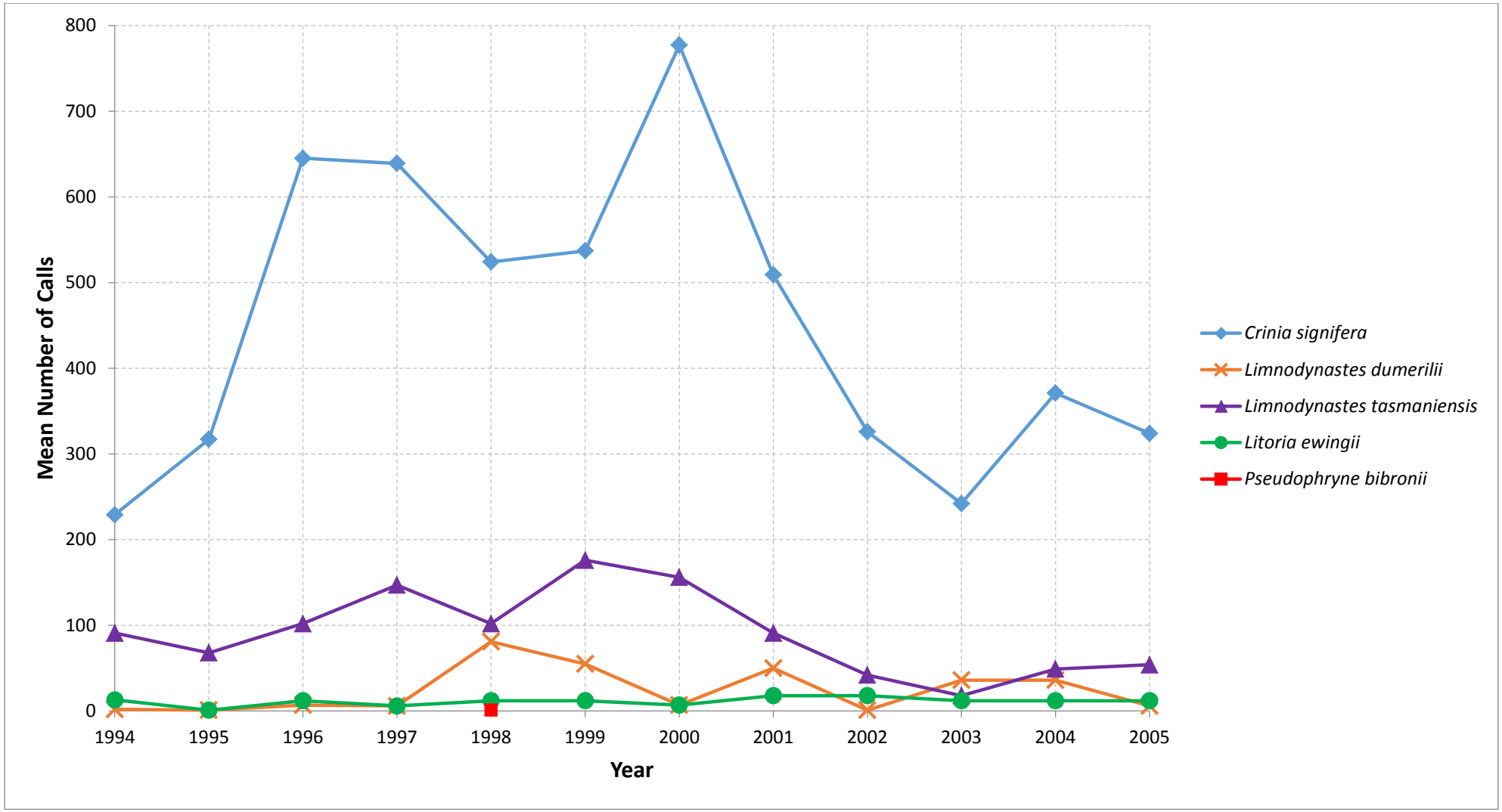

Figure 1: Comparison of mean number of calls per year for all frog species recorded within the City of Salisbury.

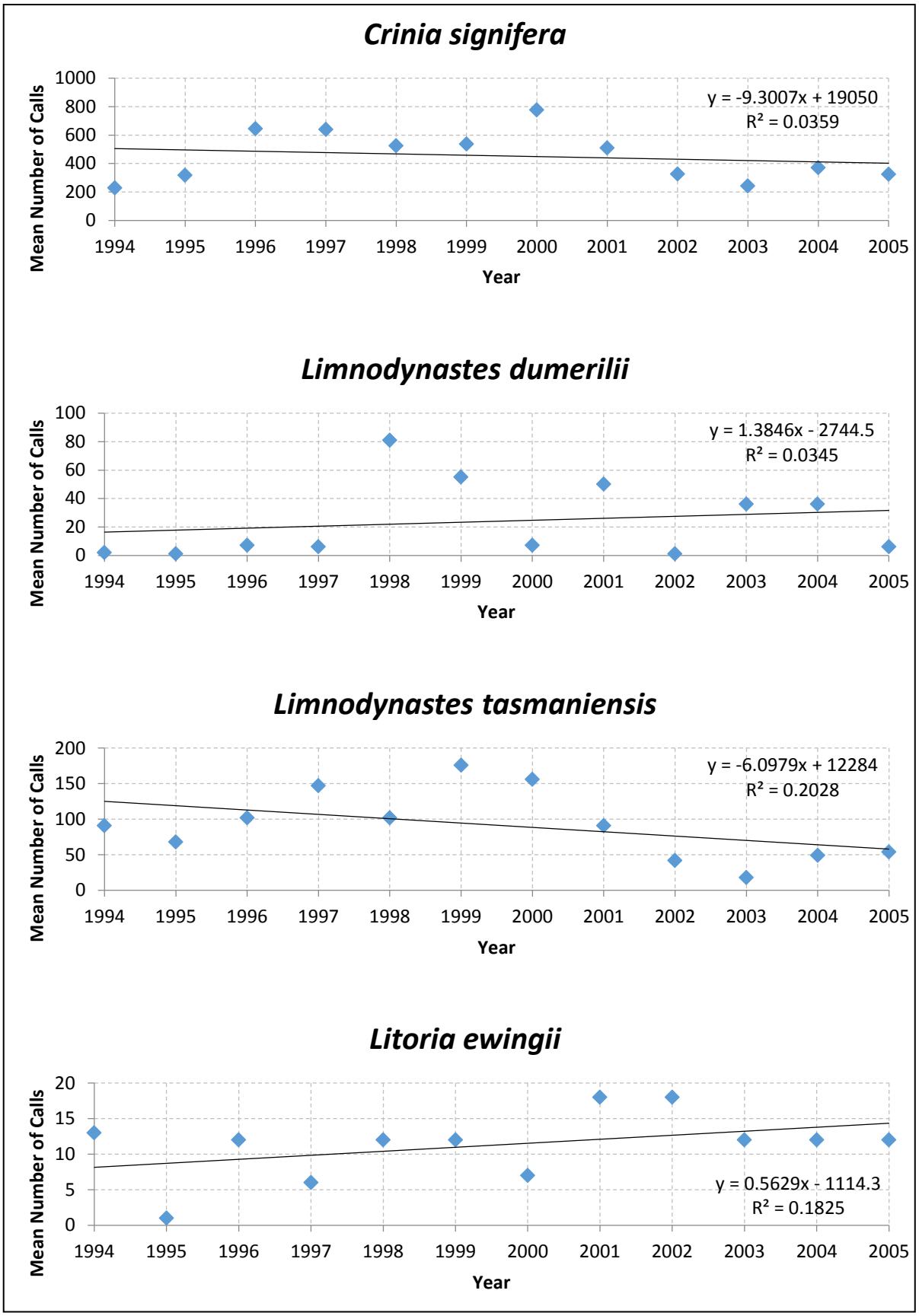

Figure 2: Variance in the mean number of calls each year by species.

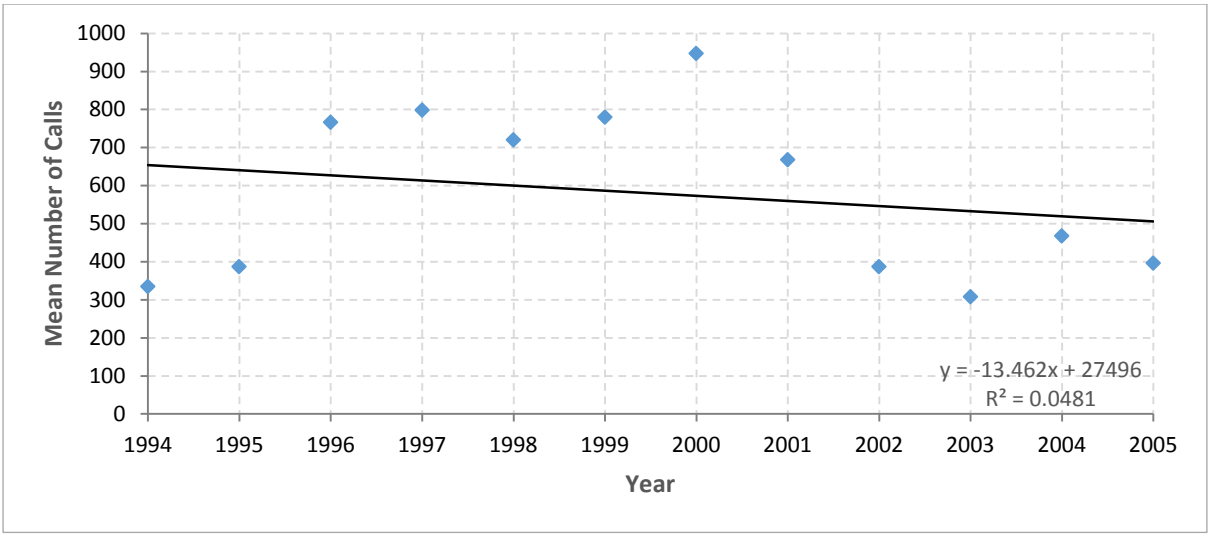

Figure 3: Variance in mean number of calls across all species recorded in the study area.

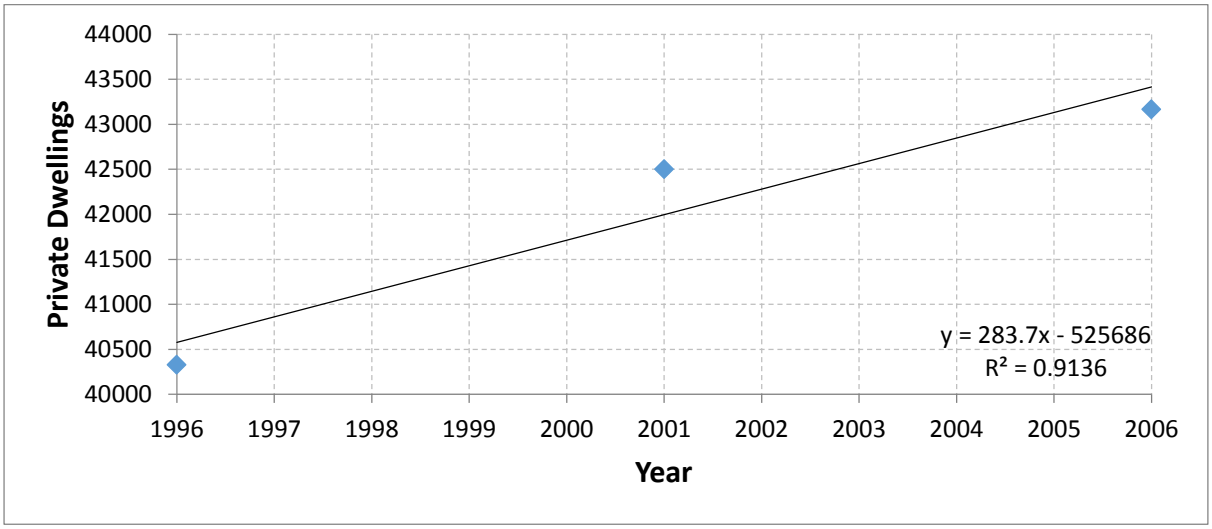

Figure 4: Number of private dwellings in the City of Salisbury for 1996-2006

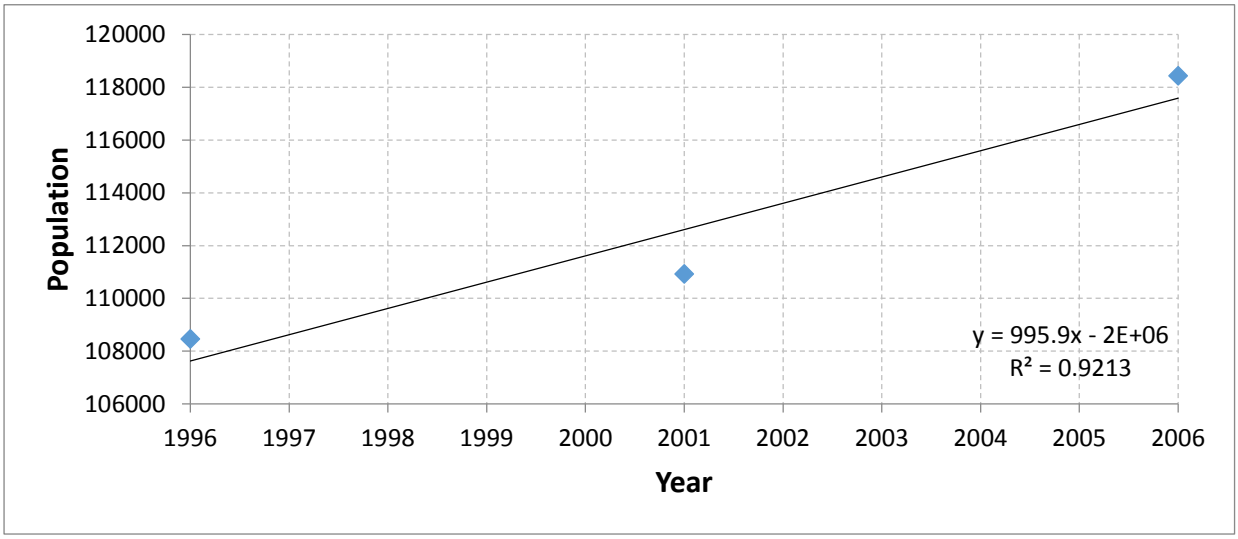

Figure 5: Population change in the City of Salisbury for 1996-2006.

Discussion

The change in land size of the City of Salisbury was negligible between 1996 and 2006 which suggests the 7.050% increase in private dwellings occurred on land which required modification. The increase in population of 9.182% is consistent with the increased private dwelling numbers. The majority of the new private dwellings were erected within the suburb bounds of Mawson Lakes, a concentrated area near the Greenfield wetlands, a major habitat for frog species. Urbanisation, as a form of habitat modification or destruction, is known to affect the biodiversity and species richness of an ecosystem, such as that surrounding Mawson Lakes (McKinney, 2002). For amphibians, the significant habitat changes are generally the destruction of aquatic habitats such as water bodies, wetlands and streams, in combination with the reduced area of accessible and suitable terrestrial habitat (Wells, 2007). This is a possible reason behind the decline in mean frog calls of all species across the study period in the City of Salisbury as it is located in close proximity to the wetlands. The decline in mean frog calls, as seen in Figure 3, for the study area was not strong; however this may have been due to the Greenfield Wetlands, a constructed wetland system located within the City of Salisbury. There is no prior evidence to determine if the area on which Mawson Lakes was constructed was a habitat or thoroughfare between habitats for the frog species. The wetlands began construction in 1989 with the third and final stage being completed in 1995. This is a major habitat area for all four species analysed in this report and is situated nearby the suburb of Mawson Lakes where the vast majority of housing construction occurred (City of Salisbury, n.d.). With the wetlands having already been established prior to the study period, the impact housing developments had on the frog species may be less than in an area without nearby wetlands.

It is interesting to note that while the overall trend for all species was a decline and showed significance, no individual species reported any considerable significance, with two species (*C. signifiera* and *L. tasmaniensis*) presenting a declining trend and the remaining two species (*L. dumerilii* and *L. ewingii*) showing an increase. It is possible the outcome of no significance could be due to insufficient sample size which would not give a normal distribution across the study period. While each species had recordings every year there were some years for *L. dumerilii* and *L. ewingii* which had few recordings and prevented a post-hoc analysis from being conducted. These were also the species which presented an increasing trend in mean number of calls. Being a citizen science project the number of recordings each year is restricted to the number of participants and their level of involvement. This can impact the results greatly and is highly likely to have skewed results in this study. The time of year during which the study is conducted, the early weeks of September, can also result in species which do not breed at this time of year being left unnoticed, for example *P. bibronii*. Or, if due to weather conditions the frogs call outside of the typical time period, this can also result in an inaccurate census. This study would have also benefitted from more frequent private dwelling and population data being available as this would have provided a better indication of the actual housing increase and greater scope for correlation.

This study only explores one element to habitat change at a superficial level as a possible effecter of frog prevalence change. Future studies could focus on the impact housing development has on the surrounding environment, for example water quality, at the time of, and after construction. There have been some studies conducted on the occurrence of stormwater runoff from roads and impervious spaces, such as concrete or asphalt, contaminating water systems due to the harmful pollutants, such as heavy metals and fertilisers, being displaced (Paul & Meyer, 2001; Vos & Chardon, 1998). Within the City of Salisbury the water system most affected by this would be the wetlands due to the stormwater runoff and creek flow being directed into this area, which in the urbanised environment, are an increasingly important habitat for frog species. However, the impact

of construction itself has not yet been explored. This could be furthered by exploring an established area with a developing area to assess the impact at the time, and after construction, while also exploring the potential resilience of each species.

The result of this study suggests that as expected, there was a decline in apparent frog prevalence within the City of Salisbury between 1994 and 2005. No causation can be suggested from this study as to whether the housing developments in the City of Salisbury directly caused the overall decline in mean number of frog calls. While the combined species showed significance in the overall decline, the individual species did not. The most likely factor to this is the small sample size and the abnormal distribution. Further study is recommended with a larger sample size and more frequent housing data, but also to explore the specific elements of housing developments and urbanisation which contribute to the decline frog populations.

Acknowledgements

This study was undertaken as part of the coursework for Bioapplications 301 Projects at the University of South Australia. Encouragement and assistance with project development was kindly provided by mentors; Dr Stephanie Williams, Dr Philip Ainsley and Mr Keith Smith. Further support was provided by the course staff; Prof Chris Daniels and Ms Katherine Faull. Thank you to those who have assisted in completing the study, including my peers; Vanessa Higgs and Emmanuel Kuol.

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