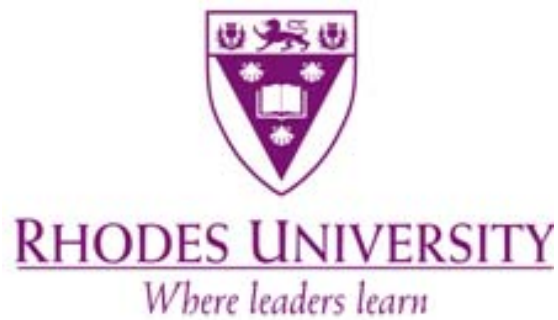




**ENVIRONMENTAL CITIZENSHIP IN CITIZEN SCIENCE: A CASE
STUDY OF A VOLUNTEER TOAD CONSERVATION GROUP IN
NOORDHOEK, SOUTH AFRICA.**

Half-thesis submitted in partial fulfilment of the requirements for the degree
MASTERS IN EDUCATION
(Environmental Education)

at

RHODES UNIVERSITY

by

Sheraine van Wyk

Student Number: g13V5164

Supervisor: Dr Ingrid Schudel

February 2015

ABSTRACT

The endangered Western Leopard Toad (*Ametophrynus pantherinus*) is endemic to the winter-rainfall parts of the Western Cape, areas which are also favoured for human settlement. Residents in the Noordhoek area witnessed many toads being killed on roads during their annual migration to breeding ponds. Concerned citizens mobilised a volunteer group to mitigate this threat to the species. Toad NUTS (Noordhoek Unpaid Toad Savers), a well-established and successful citizen science group is explored as a case study of how environmental citizenship emerges in a citizen science group.

This research has three research goals. Firstly to probe the enabling and constraining factors shaping the Toad NUTS practices, secondly to investigate the learning dynamics in the citizen science group and thirdly to understand how participation in citizen science develops environmental citizenship. Practice architectures theory (Kemmis & Grootenboer, 2008) was used to explore how cultural-discursive, economic-material and social-political arrangements shape the practices of the Toad NUTS group. The Toad NUTS group was identified as a community of practice, therefore Lave and Wenger's (1991) communities of practice theory was used to better understand the social learning processes within the group. The Global Citizenship Education international policy document was used to capture the aims of citizenship education as it relates to environmental issues and identifies the competencies that citizenship education initiatives should develop. The practices of the Toad NUTS group were investigated for evidence of the goals and competencies identified in the Global Citizenship Education policy documents of environmental citizenship.

Data was generated through documentary research, surveys, a questionnaire, semi-structured interviews and observations. The data was stored, organised and analysed using NVivo data management software in three phases corresponding to the three research goals. With respect to Goal 1, the evidence suggested that there are various shaping arrangements of cultural-discursive, material-economic and social-political configurations which influence Toad NUTS practices. Volunteers must learn to navigate these arrangements in order to successfully implement conservation strategies. The shaping features identified were the WhatsApp group communication system used by volunteers; public awareness and education strategies; equipment, material and funding required for implementing the group's practices; power balances and exchanges between stakeholders in the conservation field; bureaucratic processes and scientist-lay person exchanges. Very important for facilitating social-political

connections to various stakeholders, is the membership Toad NUTS enjoys on the Western Leopard Toad Conservation Committee.

With respect to Goal 2, four interconnected components of learning were investigated. These were learning as belonging, learning as doing, learning as meaning-making experience and learning as becoming. Members learn by doing things together like training, patrolling and deliberating problems in the field. They learn by exploring what is collectively known from past and unfolding experiences. Evidence showed that learning deepens as Toad NUTS members perceive their praxis as meaningful and their identities evolve as their knowledge and experience grows. This strengthens members' sense of belonging and identification with the Toad NUTS group. In time the group develops a reputation and the wider community acknowledges the expertise and knowledge that resides with the group.

With respect to Goal 3, it was found that volunteers who have a predisposition for environmental citizenship are more likely to join a citizen science group. Although volunteers care about nature and want to make a difference, it is after gaining access to the embedded knowledge and knowledge processes of the citizen science group that they realise meaningful sustainable solutions to the issue(s) that the project is concerned with. It was found that knowledge paired with reasoned practice enables the agency of volunteers to bring about positive and meaningful change in the local environment. If facilitated carefully, citizen science can make positive contributions to the field, in this instance, conservation, while allowing volunteers to exercise environmental citizenship engaging in participative governance with regard to the project.

ACKNOWLEDGEMENTS

My sincere gratitude goes to my supervisor, Dr Ingrid Schudel, who helped me extensively in many different ways to bring this thesis to fruition. Her professionalism throughout the different phases of the M.Ed. course, her wisdom, critical insights, support, patience and encouragement made a profound impact. I acknowledge also the valuable input made by the other M. Ed lecturers and ELRC community which enriched the learning experience during this time.

I thank my fellow M. Ed. Students for the collaborative learning experiences, many interesting and stretching theory discussions, the encouragement, support, laughter and fun. The camaraderie, help during difficult times and the lasting friendships, I take with me.

I am grateful for the patience and understanding of my work colleagues while spending time away from office at Rhodes on course, gathering data, endlessly researching and refining my thesis.

I am also grateful to the Toad NUTS group for graciously agreeing to be researched. For supplying data, being observed and interviewed and patiently enduring strings of questions. I have great admiration for their selfless commitment to the Western Leopard Toad and conservation and their numerous achievements. They give me hope that a more sustainable future is possible and that ordinary but willing people can make a difference.

Finally I thank my family for walking this road with me. My husband, children and mother for filling the gaps during my absences and for sharing me for many days, weeks and months with my computer and endless readings. Lastly I honour my God and the faith that sustained and guided me.

TABLE OF CONTENTS

SECTION		PAGE
	ABSTRACT	i
	ACKNOWLEDGEMENTS	iii
	TABLE OF CONTENTS	iv
	LIST OF TABLES	vii
	LIST OF FIGURES	viii
	LIST OF APPENDICES	viii
	ACRONYMS	ix
	CHAPTER 1: Introduction to the research	
1.1	Introduction	1
1.2	The broader context of the study	1
1.3	Historical and contextual description of the Toad NUTS citizen science group.	2
1.4	Research rationale, question and goals	6
1.5	My interest in this study	7
1.6	Overview of the study	8
	CHAPTER 2: Locating the study relative to current theory	
2.1	Introduction	9
2.2	Citizen science	9
2.3	Theory of practice architectures	12
2.4	The power/knowledge dynamic	15
2.5	Communities of practice theory	17
2.5.1	Learning as belonging	20
2.5.2	Learning as doing	21
2.5.3	Learning as meaning-making experience	22
2.5.4	Learning as becoming	22
2.6	Environmental citizenship	23
2.6.1	International policy	23
2.6.2	Features of environmental citizenship	25

2.7	Conclusion	28
	CHAPTER 3: Research methodology	
3.1	Introduction	30
3.2	Research methodology	30
3.2.1	Research orientation	30
3.2.2	Case study approach	31
3.3	Data generation methods	31
3.3.1	Documentary research	31
3.3.2	Survey	32
3.3.3	Questionnaire	32
3.3.4	Semi-structured interviews	33
3.3.5	Observations	34
3.3.6	Data indexing	35
3.4	Data analysis	37
3.4.1	Analytic phase 1	38
3.4.2	Analytic phase 2	39
3.4.3	Analytic phase 3	40
3.5	Research ethics	40
3.6	Validity	41
3.7	Conclusion	43
	CHAPTER 4: Data presentation	
4.1	Introduction	44
4.2	Toad NUTS practices	44
4.2.1	Co-ordination of the WLT-CC	45
4.2.2	Patrolling for toads	46
4.2.3	Managing the temporary barrier intervention	48
4.2.4	Marketing the Toad Saver	48
4.2.5	Recruitment and training of new members	50
4.2.6	Communicating using the WhatsApp system	51
4.2.7	Public outreach, awareness and education	53
4.2.8	Raising funds	57

4.2.9	Establishing new citizen science groups	58
4.2.10	Habitat restoration	60
4.2.11	Use of road signage	60
4.2.12	Co-ordinating multiple stakeholders	62
4.2.13	Scientific processes and data management	63
4.3	Learning dynamics in the Toad NUTS community of practice	66
4.3.1	Learning as belonging	67
4.3.2	Learning as doing	69
4.3.3	Learning as meaning-making experience	73
4.3.4	Learning as becoming	75
4.4	Conclusion	78
	CHAPTER 5: Discussion of findings	
5.1	Introduction	79
5.2	Practice architectures features shaping Toad NUTS practices	79
5.2.1	Cultural-discursive arrangements	79
5.2.2	Material-economic arrangements	81
5.2.3	Social-political arrangements	82
5.3	Learning dynamics in the Toad NUTS community of practice	85
5.4	Environmental citizenship	87
5.4.1	GCE Goal 1	88
5.4.2	GCE Goal 2	88
5.4.3	GCE Goal 3	89
5.4.4	GCE Goal 4	89
5.4.5	GCE Competence 1	90
5.4.6	GCE Competence 2	91
5.4.7	GCE Competence 3	92
5.4.8	GCE Competence 4	92
5.4.9	GCE Competence 5	93
5.5	Conclusion	94
	CHAPTER 6: Recommendations and conclusion	
6.1	Introduction	95

6.2	Summary of research findings	95
6.2.1	Research Goal 1	95
6.2.2	Research Goal 2	96
6.2.3	Research Goal 3	96
6.3	Recommendations	97
6.3.1	Recommendations to the biodiversity sector	97
6.3.2	Recommendations for further research	99
6.4	Critical review of the research process	99
6.5	Conclusion	101
	Poem: Flower	102
	REFERENCES	103
	APPENDICES	108

LIST OF TABLES

		PAGE
TABLE 3.1	Observation sessions of Toad NUTS practices	34
TABLE 3.2	Inventory of data produced showing the index code given to each piece.	36
TABLE 3.3	Table indicating the analysis of learning dynamics.	39

LIST OF FIGURES

Figure A	Earth Hour child art entitled ‘Dancing with frogs’.	ix
Figure 1.1	A female Western Leopard Toad.	3
Figure 1.2	Patrollers looking for toads.	5
Figure 1.3	Patroller on a ‘bucket run’.	5
Figure 2.1	The theory of practice and practice architectures	14
Figure 2.2	Social theory of learning comprises four components	20
Figure 4.1 & 4.2	Toad NUTS volunteers host a public display in a local shopping centre.	55

LIST OF APPENDICES

		PAGE
Appendix 1	Document log	108
Appendix 2	Toad Barrier Report 2013	110
Appendix 3	Survey – Noordhoek community members	121
Appendix 4	Summary of survey done with Noordhoek residents	123
Appendix 5	Questionnaire to novice volunteers	124
Appendix 6	Interview schedule with the WLT-CC secretary	125
Appendix 7	Observation description	128
Appendix 8	WhatsApp group communication	146
Appendix 9	Extracts from the NVivo interface.	150
Appendix 10	Access letter	154
Appendix 11	Final Toad Breeding Report	156
Appendix 12	Analytic memo – communication system	163
Appendix 13	Extract from research journal	168
Appendix 14	A newspaper article written by a Toad NUTS member.	169
Appendix 15	Example of a journal article which was co-authored by a Toad NUTS leader	170

ACRONYMS

ESD	Education for Sustainable Development
EWT	Endangered Wildlife Trust
GCE	Global Citizenship Education
NEAG	Noordhoek Environmental Action Group
SANBI	South African National Biodiversity Institute
Toad NUTS	Noordhoek Unpaid Toad Savers
WLT-CC	Western Leopard Toad Conservation Committee



Figure A: Earth Hour child art entitled ‘Dancing with frogs’. Anonymous.

CHAPTER 1: Introduction to the research

1.1 Introduction

In this chapter the broader and the specific context for this research is presented. The case study is introduced and I position myself, the researcher, in relation to the research and the research subjects. Contextual information on the case is presented. The research rationale, research question and goals are introduced and a brief overview of the thesis is mapped out.

1.2 The broader context of the study

The context of the study described below was explored through an internet search of the relevant websites, the perusal of various articles written about the Toad NUTS group and conversations with members of the Western Leopard Toad Conservation Committee (WLT-CC).

The National Environmental Management Biodiversity Act (South Africa, Department of Environmental Affairs, 2004, Chapter 3, part 1, p. 40) states,

the national biodiversity framework must provide for an integrated, co-ordinated and uniform approach to biodiversity management by organs of state in all spheres of government, non-governmental organisations, the private sector, local communities, other stakeholders and the public.

The act allows for participative governance in the monitoring and management of species and encourages many different parties including government, formal and civil bodies, to cooperate in this.

Amphibians are the most threatened group on earth, 32% threatened as opposed to 21% of all mammals and 12% of birds (Measey, 2011). South Africa has a high and significant amphibian biodiversity and a “severely under-capacitated South African amphibian research community” to do the research and conservation work that is needed to safeguard these and in cases of threatened and rare amphibians, nurture and grow the remaining populations (*ibid.*, p. 6). This is a problem globally where the biodiversity sector suffers from insufficient resources and capacity for effective and efficient biodiversity monitoring and conservation (Humewood, 2013). As is the case nationally and globally, wetland integrity is impacted in the Western Cape mainly by agriculture, urban development and pollution. This threatens the

survival of the amphibians that inhabit these habitats. Therefore a need exists to support the efforts of herpetologists¹ and conservators in creative ways.

Gordon (2009) urges that the awareness of the fragility of amphibians should be raised not just in schools but in all social strata, emphasising the general public responsibility for the survival of amphibians. She recognises the value that zoos, aquaria and centres for environmental education have in fulfilling conservation mandates. A senior environmental professional with the City of Cape Town feels that there is a real need for interest groups in the public sector, especially for conservation initiatives which are generally regarded as low priorities. She feels that there are limitations to what can be done from the governmental side and that these partnerships are vitally important to achieve different goals. She also maintains that passionate interest groups are critically important in creating awareness among the general public and in bringing issues of concern to the political and decision-making level (S. Dorse, personal communication, June 9, 2014).

Measey (2011, p. 38) calls on schools, youth and the other members of the public to get involved with the collection of basic monitoring data in their “own back yards”. Literature reveals that citizen science projects hold the promise of making valid contributions to supplement the efforts of a sector straining to fulfil its mandate (Bonney, Ballard, Jordon, McCallie, Philips, Shirk & Wilderman, 2009a; Toerpe, 2013; Bonney, Cooper, Dickinson, Kelling, Philips, Rosenberg & Shirk, 2009b; Freitag & Pfeffer, 2013; Measey, 2011). The learning in and development of such groups is however, under researched. The purpose of this study is to gain a better understanding of these aspects in groups that are active and effective in participative governance.

1.3 Historical and contextual description of the Toad NUTS citizen science group

The Western Cape has a high level of amphibian endemism that is, species that only occur in this area and nowhere else (Measey, 2011). Twenty eight species of amphibians are recorded for the Western Cape, fourteen of which are threatened (*ibid.*). One endangered species is the Western Leopard Toad, *Amietophrynus pantherinus* (Figure 1.1) (*ibid.*).

The Western Leopard Toad is mainly associated with sandy coastal lowlands in the Western Cape Province (Rebelo, Measey, De Villiers & Dorse, 2013). The species is not restricted to pristine natural habitats and is often found in modified habitats such as farmlands, urban open

¹ Herpetology is the study of reptiles and amphibians.

spaces and suburban gardens. The toads are usually found in the general vicinity of wetland habitats such as rivers, coastal lakes, vleis and pans (*ibid.*).



Figure 1.1: A female Western Leopard Toad (Photo: S van Wyk, August 3, 2014).

The Western Leopard Toad is regarded as a flagship species unparalleled on the urban-rural interface, bringing wildlife into the urban garden and creating an awareness of the threatened nature of Cape ecosystems (WLT-CC homepage, 2014). Urban development, particularly on the Cape Peninsula and Cape Flats, has resulted in permanent habitat loss and population fragmentation, although it is possible that gardens are more benign than the summer-arid Sand Fynbos (Rebelo, *et. al.*, 2013). While breeding generally takes place in larger, more secure wetlands, urban development poses an obvious threat around these wetlands by causing habitat fragmentation and restricting foraging area and movement of toads (*ibid.*).

In the urban environment, toads are forced to negotiate roads and barriers for example curb stones, walls, embankments and canals while foraging and migrating to and from breeding sites. It is generally thought that the toads have a foraging area covering a two kilometre radius from its breeding pond (Rebelo *et. al.*, 2013). Expanding urban development and increased road traffic results in the death of large numbers (estimated in the hundreds) of toads each year especially during the breeding season. Artificial water bodies with steep vertical sides, such as canalized rivers and swimming pools, represent additional death traps that pose a threat to local populations (*ibid.*).

To help this species survive, a sizable volunteer effort is mounted annually in consultation with the WLT-CC. This committee is comprised of representatives of the City of Cape

Town, South African National (SAN) Parks, Cape Nature, South African National Biodiversity Institute (SANBI), Table Mountain National Park and the Nature Conservation Corporation and representatives of volunteer groups. The WLT-CC provides a co-ordinating and a communication role in the conservation of the Western Leopard Toad, facilitating the mobilisation of volunteer groups such as Toad NUTS (WLT-CC homepage, 2014).

Volunteers from across the Cape region participate in what is perceived as one of the largest volunteer efforts of its kind to save a species in South Africa (Rebelo, *et al.*, 2013). To give an idea of the effort, during the 2010 Western Leopard Toad breeding migration a total of 752 patrol hours were recorded by approximately 100 volunteers across the Cape Peninsula. As a result roughly 1715 toads were moved off the roads (Faraday & Day, 2011). A herpetologist from the University of North West Province states that "it's impossible to collect the numbers that the volunteers are collecting at the moment. So, in terms of man hours, I think that they can contribute magnificently," (D. Kruger, personal communication, July 11, 2014).

There are five known citizen toad conservation groups in the Western Cape roughly divided according to suburbs (M. Day, personal communication, July 5, 2014). Toad NUTS was initiated by Alison Faraday and Suzie Jirachareonkul in 2007 and has been operating for many years. Toad NUTS is a group of residents of the greater Cape Town suburb of Noordhoek who have formed a group dedicated to the active conservation of the Western Leopard Toad. Its purpose is the protection of the Western Leopard Toad in the Noordhoek area of the Western Cape. Faraday explains that the ideal group size for Toad NUTS is around fifty (A. Faraday, personal communication, January 31, 2014). She adds that roughly 75% of the membership consists of women and 25% of men.

Toad NUTS have successfully initiated conservation interventions (Hanks, 2013).

Volunteers chaperone the endangered Western Leopard Toad across busy roads on the way to their breeding pools during the breeding season which typically occurs in August (*ibid.*) (Figure 1.2). They designed the toad saver which is a device which prevents toads drowning in pools and they encourage Noordhoek residents to install this. They also install a temporary barrier and bucket system at high mortality spots (Figure 1.3). This has significantly reduced the mortality of the endangered toad. Volunteers have kept detailed records of their activities and have developed an extensive database of observations. After a number of years of careful data recording the pattern of movement of the toads was well established. Data

recording involved noting the position and number of toads seen crossing safely and killed on the roads in Noordhoek.



Figure 1.2: Patrollers looking for toads. (Photo: S van Wyk, August 3, 2014).



Figure 1.3: Patroller on a ‘bucket run’ (Photo: S van Wyk, August 3, 2014).

Toad NUTS have experience of working with the public, schools, scientists, biodiversity managers, conservation bodies and government structures. The Toad NUTS group is a

member of the WLT-CC. Faraday is quoted as saying that “a feeling of caring” towards, and awareness of, the toad and its plight is building in the community (Hanks, 2013, p. 14). In a heavily altered landscape with many unnatural dangers to wildlife, humans may need to take measures, however unnatural, to protect a species like the Western Leopard Toad from unnecessary decimation.

The Toad NUTS group was selected as a case study for researching situated social learning because of the accumulated, detailed record keeping and the varied activities and history of interactions with other groups in the conservation and biodiversity management landscape.

1.4 Research rationale, question and goals

This research aims to examine the practices of the Toad NUTS citizen science group and the learning processes occurring while members participate in Toad NUTS practices. It also aims to explore the emerging environmental citizenship evident in this group with particular attention to positive change achieved by Toad NUTS in the form of solutions to local environment challenges.

The question asked of this research is, how are the practices of the Toad NUTS citizen science group shaped and how does the project embrace learning and shape environmental citizenship?

The goals of the study are:

Goal 1 - To investigate the enabling and constraining factors shaping the practices of the Toad NUTS citizen science group.

Goal 2 - To examine the learning dynamics of the Toad NUTS group.

Goal 3 - To explore how participation in the practices of the Toad NUTS group develops environmental citizenship.

1.5 My interest in this study

I live and work in the Overstrand area in the Southern Cape, Western Province, South Africa. I am an environmental educator with a community learning focus and an interest in informal learning spaces.

I facilitate three projects, a shark egg case project, a sea plant herbarium collection project and a frog² monitoring project, that involve citizen scientists. I have found that citizen scientists can support official management action to achieve biodiversity and conservation management goals. Citizen science can draw in local stakeholders and citizens to explore sustainable solutions to socio-ecological issues at a local level. I have observed the educational benefits to volunteers of ordinary citizens of various ages, of participating in a citizen science project and have experienced the unique and creative results of co-produced sustainability solutions. When searching for information on this, I found the topic under-researched and I was inspired to study this aspect.

I have interacted with the Toad NUTS group on a number of occasions in the past with initiatives like the annual Leap Day for Frogs and so was familiar with the group and their work before embarking on this study. I chose to use the Toad NUTS group instead of one of my own project contexts to research as I felt that the integrity of the study would be stronger if I were not a member of the group.

As an environmental educator I align my work to trends in the international environmental education arena and am aware of international policy developments calling for citizenship education initiatives globally. This research incorporates an attempt to interpret this policy in the local context.

² Amphibians are a group of vertebrate animals comprising salamanders, newts, caecilians and anurans (Du Preez & Carruthers, 2009). Anurans (an order in the class Amphibia), comprise what is commonly known as frogs (*ibid.*). In Southern Africa there are thirteen families of anurans (or frogs) of which toads is one. It is therefore incorrect to separate frogs from toads regardless of differences in skin, back leg structure, movement and habitat preferences of which there are exceptions (*ibid.*). It is most correct to use the term anuran to generally refer to frogs (and toads) but commonly the word frog is used outside of the formal field of herpetology (as in this study).

1.6 Overview of the study

There are six chapters in this thesis that are orientated towards responding to the research question described above. Chapter 1 introduces the broader context of the research interest and the research project. I introduce myself as the researcher and explain the motivation for exploring this interest. The research question and goals are set out. The motivation for the choice of research subject for the case study is given and the history of the citizen science group Toad NUTS is described.

Chapter 2 is a discussion of the literature relevant to this study. A historical overview of citizen science is made. Practice architectures theory is explained and how it will be applied in this study. Theory relating to communities of practice and situated learning as social participation is explained. Ideas around the international Global Citizenship Education policy are expanded on and the concept of environmental citizenship is explored.

Chapter 3 provides a description of the methodology and research design decisions taken. The research orientation is introduced, the approach to the study is outlined and the methods used to generate data are described. The use of the NVivo software to store, manage and analyse the data is discussed. Finally, research ethics, validity, trustworthiness of data and the research process are discussed before concluding the chapter.

Chapter 4 presents the data generated in response to the research goals. The practices of the Toad NUTS group and prominent practice architectures features are given and evidence is presented relating to the four components of learning occurring in the community of practice.

Chapter 5 relates the data presented in Chapter 4 to the conceptual and theoretical frameworks and ideas in Chapter 2. This discussion addresses the research goals detailing the practice architectures features shaping the practices. The discussion explores the learning dynamics found in the Toad NUTS citizen science group and then focusses on the development of environmental citizenship in the case.

Following the discussion in Chapter 5 recommendations stemming from the research findings are given in Chapter 6. The research process is reviewed and further research foci are suggested.

.

CHAPTER 2: Locating the study relative to current theory

2.1 Introduction

This chapter maps out the conceptual and theoretical framework of the study. Citizen science is presented as a key concept in this research. To gain an understanding of the practices in citizen science, practice architectures theory is explained with emphasis on the enabling and constraining influences that shape practices. Lave and Wenger's (1991) theory of communities of practice is described and applied to citizen science communities, particularly the type of project where volunteers work together in the field as in the case study. A second key concept in this study is environmental citizenship, positioned within the greater domain of Global Citizenship Education, which is the overarching theme for the next UNESCO decade of education. The international policy context for environmental citizenship is presented and the main features of this concept are described.

2.2 Citizen science

Citizen science has a long history. A well-known example is of citizen contributions made in the 1880s, in the field of ornithology with amateur birders participating enthusiastically in bird counts (Toerpe, 2013). Many citizen science projects have been established internationally, with ordinary citizens contributing to projects in astronomy, biodiversity monitoring, water sampling, traffic and digital number pattern detection amongst others (Toerpe, 2013). Digital projects provide website interfaces that have gaming elements to make the website more attractive to the user while the fun aspect of the website encourages further engagement in the project.

In South Africa, the citizen science website *Ispot* used by SANBI and the Animal Demographic Unit's virtual museum sites allows citizens to upload photos or sound recordings of animals they have spotted. These records are reviewed by experts who either provide or verify the identification of the animal or plant (Virtual Museum homepage, 2009). When data is recorded on sites such as these, a species distribution map is built up which is used by scientists in their work (*ibid.*). This helps to verify the accuracy of data recorded by lay people involved in projects like a frog monitoring project. Barnard & De Villiers (2012) describe the atlasing (biodiversity mapping) projects and the Animal Demographic Unit's maps, the threatened plant project and the underwater monitoring of coral bleaching as the

citizen science projects that are facilitated or used by the SANBI. Further projects are being planned.

Projects are enriched by citizens who bring a different perspective and creative approaches to project challenges (*ibid.*). Scientists can benefit from projects like the atlassing projects, by gaining access to large volumes of data collected over large spatial scales and long time periods at a relatively low or no cost (Freitag & Pfeffer, 2013; Barnard & De Villiers, 2012; Krasny & Tidball, 2010; Tweddle, Robinson, Pocock, & Roy, 2012; Measey, 2011). Citizen science projects on the other hand, give citizens access to life-long learning, a community network, dialogue with scientists, relevant literature and at times also the opportunity to co-create a project (Bonney, Ballard, Jordon, McCallie, Philips, Shirk & Wilderman, 2009a; Bonney, Cooper, Dickinson, Kelling, Philips, Roseberg & Shirk, 2009b; Freitag & Pfeffer, 2013; Toomey, 2014). In some cases, citizens' co-author a paper or are at least accredited for research findings (Bonney *et. al.*, 2009a). Funding agencies at times push for outreach projects as they recognise the greater benefit when citizens are exposed to science and realise the value of practising the scientific process to society. This increases the support for conservation efforts, improves the public's scientific knowledge and thinking and inspires an appreciation and a stewarding regard for nature (Freitag & Pfeffer, 2013).

Typically there are three types of citizen science projects (Gray, Nicosia & Jordan, 2012). Contributory projects require that volunteers do simple data collecting. Collaborative projects are scientist structured but include volunteers in project design, data analysis and communication of the findings. Co-created projects are fully democratised with volunteers displaying full involvement and responsibility at every step. Commonly citizen science projects are initiated by scientists or academics. The Toad NUTS group is different as it is a group which was initiated by volunteers (not a scientist) in response to an environmental issue and the responsibility for the group is carried by the two leaders with contributions made by scientists now and then. What is unique in this situation is that the City of Cape Town established the WLT-CC to co-ordinate volunteer efforts in the conservation of the Western Leopard Toad and this gives volunteers access to scientists, conservators and municipal officials.

The literature highlights that recruitment and retention of volunteers are challenges of contributory projects as many fall away after collecting just a few data points. Retention is greatest when volunteers are involved to a greater extent as described in the co-created

projects (Toerpe, 2013). Gough & Scott (2012) advise that there are ways to increase the value of a project for the volunteer. Volunteers like projects that are scientific and use scientific methods and rigour thus strengthening this aspect will appeal to volunteers (*ibid.*). They value dialoguing with experts and having access to relevant literature (*ibid.*). Toerpe (2013) maintains that the most beneficial citizen science projects are co-created projects, where there is strong collaboration between scientists and volunteers, where skilled amateurs co-create the project and are involved in various stages of the project development including interpretation of findings and making conclusions. Clover, De O'Jayme, Hall & Follen (2013) however, caution that expert driven scientifically biased community initiatives can be disempowering and fatiguing to lay people. Science can problematically promote the belief that community members have no knowledge to offer and therefore will not be able to address environmental problems without 'proper facts' (*ibid.*). The knowledge / power dynamic between scientists and volunteers require a sensitive balance to nurture a beneficial and positive interaction.

Social-ecological crisis can lead to the development of advocacy types of project, like those monitoring water pollution. Advocacy types of projects have seen the breaking down of walls between scientists and the general public on issues of concern. Freitag & Pfeffer refer to this as "democratizing science" where the scientific enterprise has been accessed and findings used by citizens to influence policymaking or for example, fight pollution (2013, p. 1) (see also Toomey, 2014). This is also true for the Toad NUTS group in that they are addressing a social-ecological issue which is endangering the survival of a toad species. Measey, Dorse & Faraday (2012) describe how through the efforts of the WLT-CC, the City of Cape Town considers the presence and needs of the Western Leopard Toads when development applications are assessed by the City of Cape Town's environmental department. This consideration also informs land use management. Operational management of spaces and watercourses such as spraying and clearing, where the Western Leopard Toads are found have been amended to ensure the protection of the Western Leopard Toad during crucial stages of their life cycle (*ibid.*).

There is also an interest in what the information and communications technology element of citizen science can add with respect to response to sustainability challenges and better management of the citizen science project. For example, the atlassing projects allow volunteers to upload data (photos, sound recordings and location) to the virtual museum

repository which cuts out the need for a scientist to physically collect or a volunteer to deliver this (Virtual museum, homepage, 2009). Communication between scientist or project co-ordinator and volunteers is vital to the long-term maintenance of the group and is greatly facilitated by using social media like Facebook (*ibid.*).

2.3 Theory of practice architectures

Practices are not dependent on the experience, intentions and actions of individuals or groups of people alone, but are also influenced by arrangements, circumstances and conditions beyond the individual practitioner. Kemmis and Grootenboer (2008) describe how forms of action are shaped through previous actions, experiences and the way situations are arranged. These they call practice architectures and maintain that they prefigure practices. In response to Research Goal 1 of this study, the practice architectures features influencing the practices of a citizen science group like Toad NUTS, are used to explore the shapers of these practices.

The study of connections of many different kinds of communicative, productive and organisational relationships between people in socially-, historically- and discursively-constituted media of language, work and power, must be understood dynamically and relationally (Kemmis & Mutton, 2012). This understanding of practice architectures, reflected in Figure 2.1, allows us to think in terms of arrangements of discourses, work, social relationships, things and objects (*ibid.*). There are traditions in a practice about how things are generally to be understood and how practice architectures features relate to each other and to humans, resulting in a practice being one way or another (Kemmis & Mutton, 2012). Kemmis (2009) talks of a kind of exoskeleton of extra-individual features of arrangements which cause the practice to be realised in a particular way.

These arrangements could also be called the mediating preconditions of a practice which encompass the cultures and discourses, social and political structures, and material and economic conditions sculpting the practice. These preconditions prepare the way for a practitioner as they come into a practice in a particular place. Kemmis (2009) describes this as,

how things are said and thought about in this place, how things are done, the resources and facilities available, the other people involved and their established relationships create an always-already pre-structured framework that enable and constrain practice in that particular place. These structures or forms do not entirely constrain or limit what can be done or developed; they are simply a background

against which the practice can be conducted and from which different forms of practice might be developed. (p. 33)

Practices are action orientated. According to Kemmis and Grootenboer (2008), action is understood as more than a simple habitual action or reaction to circumstances but is carefully reasoned and thought through. The authors maintain that action itself is culturally-discursively, socially-politically and materially-economically shaped; and meaningful action typically occurs in these three dimensions simultaneously and is evidenced as “bundles” of interrelated “sayings”, “doings” and “relatings”. These sayings, doings and relatings form compound structures that are characteristic of different kinds of practice. How these practices, that is ‘sayings’, ‘doings’ and ‘relatings’ relate to practice architectures features is shown in Figure 2.1.

In the case of the Toad NUTS group for example, sayings would include what members think and say of their group in general, the environment, the toads, and the shared vocabulary they speak. Doings would include for example, Toad NUTS meetings, fundraising events, communication campaigns, patrolling, training of new recruits and the installation of barriers. When analysing relatings one pays attention to how members relate to their environment which includes toads and non-living entities, to each other, to others outside of the Toad NUTS group, like local government officials and scientists, and what power relations underpin their activities. Knowing who to relate to, how to relate to them appropriately and how to align one’s own responses to the responses of other professionals working on the same complex problem, is what Edwards calls “relational agency” (2011, p. 34).

Practitioners recognise specialist expertise distributed across practices and bring their own expertise to a practice but gel this with a ‘relational expertise’ (Edwards, 2011). This phrase refers to the confident engagement with one’s own expert knowledge and “the capacity to recognise and respond to what others might offer in local systems of distributed expertise” (*ibid.*, p. 33). The social-political dimension takes this and the power balances in these relations into account.

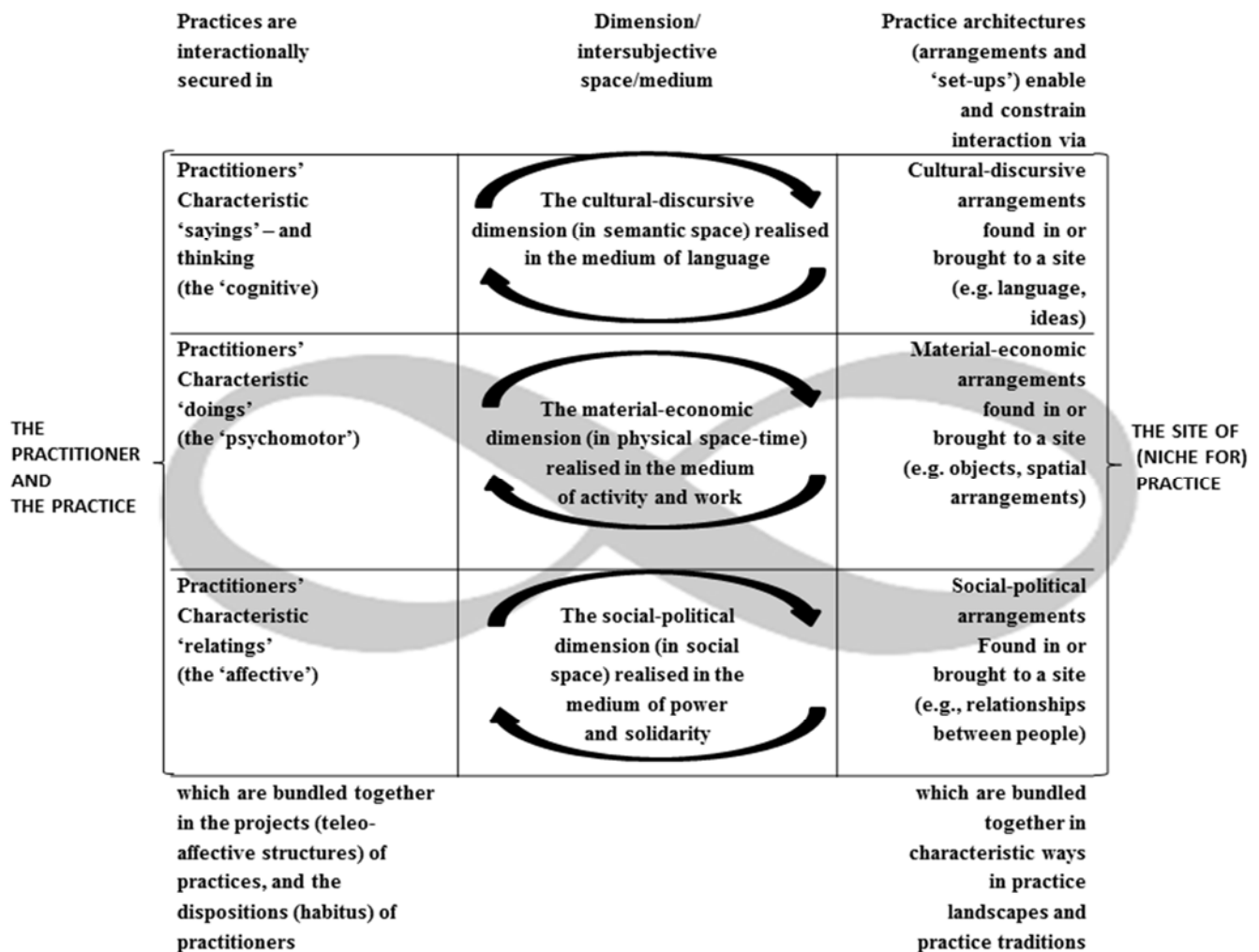


Figure 2.1: The theory of practice and practice architectures (Hemming, Kemmis & Reupert, 2013, p. 475).

In the case of a citizen science volunteer, expertise of local conditions and circumstances accrues with accumulated participation in the situated practices of the citizen science project. This emphasises the potential of working with others to strengthen purposeful responses to complex problems, appreciating that working alone is likely to miss some aspect that may be vital in arriving at a plausible solution. Recognising distributed expertise encompasses being a skilled networker, taking a pedagogic stance, being responsive to others, alert to their standpoints and willing to work with them towards shared goals (*ibid.*).

Enhancing practices may require altering arrangements of institutional and social conditions so that the practice can flourish. Changing things may require adjustments beyond the knowledge or control of individual practitioners. This would mean forms of collective change and forms of collaborative discussion and inquiry to explore alternate possibilities for

thinking, saying, knowing, doing and relating and ways that changes can influence the practice architectures which surround and support them.

2.4 The knowledge / power dynamic

The nature of citizen science is such that willing citizens, usually with little knowledge of the issue at hand, join the project. This means that the acquisition of knowledge and access to knowledge processes is needed by novices in order to participate effectively in the project as most projects are used to generate data. How knowledge processes and the flow of knowledge are managed in citizen science happens can be complicated because of the informal structure of citizen science. Because formal curricula or education processes do not exist in citizen science the arrangements and relationships that manage knowledge processes are vitally important however inconspicuous, to the successful functioning of the citizen science group and what the volunteers are able to achieve. This issue is key to grasp when exploring Research Goals 1 & 2 as it shapes the group's practices and the nature of learning occurring in the group.

Tàbara & Chabay (2013) define knowledge as that which makes it possible for individuals or societies to understand, intervene, or resolve problems or address particular situations in meaningful and satisfactory ways. This is different to a traditional perception of knowledge as existing in educational institutions and held in “closed, ahistorical, social-ecologically disembodied linear space” (*ibid.*, p. 71). A shortcoming of the traditional approach is that scientific and technological knowledge is produced in a way that is detached from the social-ecological contexts in which it is ultimately used or applied. It is not surprising that increasingly knowledge systems are now detected “operating in open spaces composed of multiple and diverse patterns of hybrid social-ecological practices and configurations embedded in time, space and context” (*ibid.*, p. 71).

Gibbons (1998) maintains that traditional academic institutions like universities are beginning to draw closer to other “knowledge workers” in industry and civil society as universities produce more graduates who are capable of producing knowledge. These graduates transition from academic institutions to work in industry and civil society resulting in a distribution of knowledge workers. He predicts that universities will align themselves to multiple knowledge producers in a complex dynamic, alternatively characterised by competitiveness and collaboration, and that universities will be ranked according to their connectivity to the distributed knowledge system. This is seen in the conservation of the

Western Leopard Toad where Cape Nature conservators (that is, government employees) with doctoral qualifications collaborate with university academics on joint projects (Measey, Dorse & Faraday, 2012). Collaboration in this instance may be more easily achieved because participants have similar academic qualifications and may have formed associations before their present employment perhaps having graduated from the same institutions or have studied together.

Gibbons (1998) distinguishes two modes of knowledge which he calls mode 1 and mode 2 knowledge. Mode 1 knowledge is recognised as being held in traditional knowledge hierarchies where those positioned at a low level on the hierarchical trajectory have limited legitimate access to knowledge in the field. Mode 2 knowledge has a flatter power structure where access to knowledge is available to those who seek it. Gibbons (*ibid.*) describes mode 2 knowledge as socially distributed, application oriented, trans-disciplinary, reflexive and demanding of new forms of power dynamics. Mode 2 knowledge (predominant in informal learning spaces) suffers legitimation from formal structures and, although there are instances where the two are drawing together, there are other examples where integration is not yet occurring in mutually beneficial ways (*ibid.*). Tàbara & Chabay (2013) are of the opinion that both types of knowledge will continue to coexist. In seeking access to knowledge structures to inform practices, citizen science groups have to negotiate with those within these structures particularly when wanting to make their data or findings known to a wider scientific audience.

In trying to understand power/knowledge interactions, it helps to consider the historical development of lay people and scientist interactions. Callon (1999) relays three models to describe this. The ‘public education model’ oppositionalises scientific and lay knowledge. In this model lay knowledge was perceived as being shaped by beliefs and superstitions and scientists have nothing to learn from the public. This model denies lay people any competence for participating in the production of the only knowledge that was thought of as valuable, that is, scientific knowledge.

Secondly Callon (*ibid.*) presents the ‘public debate model’ in which richer relations between lay people and scientists have developed and where the public consists of individuals who act as citizens or consumers. These groups are distinguished from one another by their level of knowledge. In the case of the ‘public debate model’, lay people have the opportunity to

express their opinions which before had no avenue of expression leading to the exclusion and oppression of groups and ‘other voices’ with resultant resistance and dissatisfaction.

The most recent is the ‘co-production of knowledge model’ which actively involves lay people in the creation of knowledge involving issues concerning them. This relates well to Tàbara & Chabay’s (2013) mode 2 definition of knowledge production. In this case, knowledge is a common by-product of a single process in which both specialists and non-specialists work together towards a negotiated goal of common good. The problem of trust or mistrust and lack of social recognition evaporate when stakeholders co-labour on equal footing constructing new and reconfigured identities. The legitimacy of this type of common enterprise rests on the role players being acknowledged for their contributions (Callon, 1999).

2.5 Communities of practice theory

Conventional theories which explain learning as transmission, acquisition and assimilation (internalisation) of knowledge have been criticised for being concerned with individual differences and comparisons, privileging decontextualized abstract knowledge and the transmitter’s point of view while ignoring the process of active participation in sociocultural communities (Lave & Wenger, 1991; Wenger 1998; Sfard, 1998). In contrast to the traditional learning approaches, situated learning theory offers a “fresh look at learning” (Lave & Wenger, 1991, p. 39). It provides a frame that is orientated towards a participation approach which focusses on learner participation in authentic, context-related activities (Lave & Wenger, 1991; Wenger, 1998; Sfard, 1998; Wenger, McDermott & Snyder, 2002).

Wenger (1998) refers to communities of practice as self-organizing systems, comprising of people united by a shared interest or common passion often in response to problems in a particular social context. Lave and Wenger (1991) presented the theory of communities of practice as a means to understand the relational interdependence of agent (person) and the world (setting), activity, meaning, cognition, learning and knowing. The theory highlights the social learning processes occurring in communities and will be used to explore the learning processes which occur in citizen science groups.

Wenger (2009) states that “the primary focus of this theory is on learning as social participation”, which refers to an encompassing process of “being active participants in the practices of social communities engaged in local events”, implying socially negotiated meaning (p. 210). This results in the constructing of identities in relation to these

communities. Concerning the nature of knowledge, knowing and knowers, Wenger (1998) makes four assumptions as to what matters for learning. Firstly we are social beings, which is a central aspect of learning; secondly knowledge is a matter of competence with respect to valued enterprises; knowing is a matter of participating in the pursuit of such enterprises which entails active engagement in the world; and finally meaning is derived from the ability to experience the world, and the engagement with it, as meaningful. Wenger (1998) feels that the final outcome of learning should be to produce meaning.

Due to the combination of elements of engagement in action, interpersonal relations, shared knowledge and negotiation of enterprise and free choice, communities of practice holds the potential for profound transformation both to the participants and the issue at hand. Citizen science provides the opportunity to explore radically new insights with the history of mutual engagement around joint enterprises which is an ideal context for cutting edge learning with the potential for knowledge creation (Wenger, 1998).

In their earlier work, Lave and Wenger (1991) argued against “the assumption that teaching or ‘intentional instruction’ is necessary prior to, or a precondition for, learning” (p. 41). Wenger (1998) reinforces this notion by stating that “much learning takes place without teaching...teaching does not cause learning” (p. 266). A criticism raised by Lerman (2000) and Adler (2000) is that the situated learning approach does not provide an explanation of how knowledge transfers occur in a community of practice.

In his later work with colleagues Wenger introduces knowledge in defining communities of practice as,

groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (Wenger *et. al.*, 2002, p. 4).

In the same work the authors introduce a structural model for a community of practice which describes “three fundamental elements: a *domain* of knowledge, which defines a set of issues; a *community* of people who care about this domain; and the shared *practice* that they develop to be effective in their domain” (*ibid.*, p. 27).

The authors describe *domain* as that which carries the topic the community focuses on. If well-developed, the domain becomes a statement of what knowledge the community will steward (*ibid.*). Wenger *et. al.* (2002) describe that there is a body of common knowledge

which they call baseline knowledge which all members of a community of practice are expected to know. For example, a community of biochemists will be expected to know basic chemistry; a community of lawyers will be expected to know the law. Communities of practice establish the baseline knowledge and standardise what all members are expected to know in order to participate in that practice. Indeed Sfard (1998) argued for pairing the acquisition of knowledge with participatory processes, as the ideal in learning.

Although useful to document what is known at a particular time, knowledge keeps expanding thus making it difficult to capture. Knowledge also takes on different forms and cannot be managed like a self-contained entity because knowledge is both explicit and tacit, residing in humans' knowing. Knowing is responsive to evolving situations making a community of practice a living repository of knowledge (Wenger *et. al.*, 2002).

The authors explain that the *community* creates the social fabric of learning and fosters interactions and relationships based on mutual respect and trust encouraging a willingness to share ideas, expose one's ignorance, ask difficult questions, and listen carefully (*ibid.*). The community determines the norms, standards and values that regulate the practices. The *practice* is a set of frameworks, ideas, tools, information, styles, language, stories, and documents that community members share relating to the specific knowledge the community develops in the environment they practice in. Of course the practice is about putting knowledge into action which requires explicit and tacit knowledge and knowing in practice.

The authors maintain that when these elements function together well, the community of practice becomes an ideal *knowledge structure*—a social structure that can assume responsibility for developing and sharing knowledge (Wenger *et. al.*, 2002). These elements also show the complexity of knowledge as it manifests in a community of practice. According to the authors, knowledge processes involve the head, the heart, and the hand; inquiry, interactions, and craft

Wenger (2009) maintains that a community of practice integrates four components that characterise social participation as a process of learning and knowing. These are, learning as belonging to a community of shared learning experience, learning as doing, learning as meaning-making experience, and learning as becoming. These components are depicted diagrammatically below in Figure 2.2.

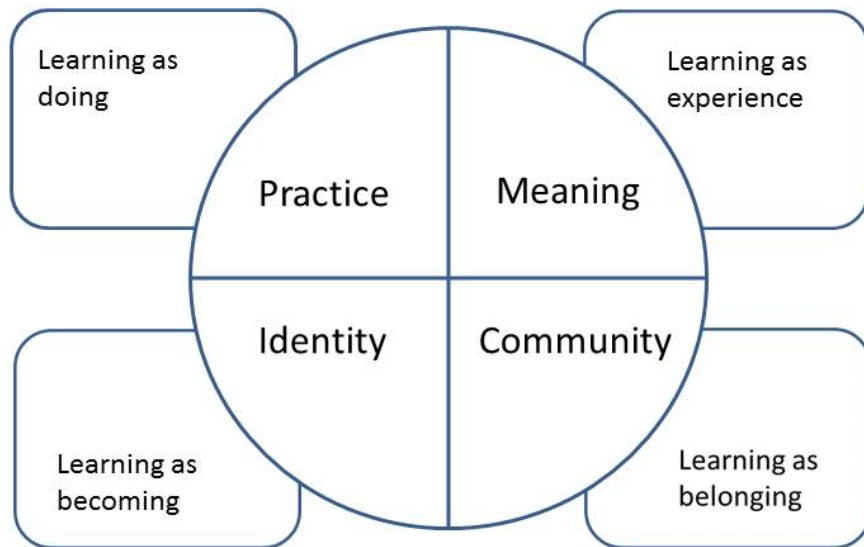


Figure 2.2: Social theory of learning comprises four components (Adapted from Wenger, 1998, p. 5).

The components of learning are connected and mutually defining (Wenger, 1998). Each component is further expanded below and the ideas shared have been used in the analysis of data in order to address Research Goal 2, which is to examine the learning dynamics of the Toad NUTS citizen science project.

2.5.1 Learning as belonging

‘Community’ is used in communities of practice theory to imply relations of mutual engagements organised around what participants do as they participate in community practices (Wenger, 1998). Communities of practice are unique in the sense that members engage in a practice that they understand to be their enterprise and have a shared repertoire which enhances the relationships that have formed and will further form in the group (*ibid.*). A community of practice is not just a website, a database, or a collection of best practices. It is a group of people who interact, learn together, build relationships, and in the process develop a sense of belonging and mutual commitment.

Wenger (1998) points out that a group is not necessarily homogenous but diverse and that relationships are not necessarily always harmonious but can involve conflicts, tensions and disagreements. These are all forms of participation with a complex mix of power and dependence, pleasure and pain, expertise and helplessness, ease and struggle, resistance and compliance (*ibid.*). The practice, as it unfolds, belongs to their community in a fundamental

sense. That is not to say that the way a practice is conducted cannot be influenced, manipulated, helped, supported and empowered by an outside entity (person, institution or structure like a by-law). The power that these outside influences (prescriptions, individuals and institutions) have over the practice of a community is however always mediated by the community's production of its practice as they interpret and make sense of this influence (*ibid.*).

As the practice of a community is honed, the community is recognised by its practice. Learning as belonging is detected in the way members talk about the social configurations in which enterprises are defined as worth pursuing and participation is recognised as competence.

2.5.2 Learning as doing

Wenger (1998) explains that “learning as doing” is built on historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action (p. 5). ‘Learning as doing’ engages prior knowledge and its influence in decision making in day-to-day practice. Pooling skills, perspectives and understandings of volunteers within a diverse group like Toad NUTS can give rise to unique and legitimate solutions to local issues derived from the interdisciplinary backgrounds and training of the participants. Practice includes the explicit and the tacit, what is done and said and what is not. Practice incorporates language, tools, documents, images, symbols, routines, well-defined roles, procedures, relations, conventions, cues, rules of thumb, intuition, perceptions, sensitivities, understandings, assumptions and world views (*ibid.*). Participating in practices is not mindless action but involves knowing, theory, ideas, ideals and talk. This is paired with knowledge and knowing how to use these things in combination so that the practice is meaningful and effective.

‘Learning as doing’ then involves learning while being engaged in the community’s practice which can be varied but determined by what is needed to be done at that time in that particular place (*ibid.*). The more experienced volunteers are, the greater their competence in doing and the deeper their knowledge of that practice in the local environments. Situated learning therefore leads to increasing refinement of practice sensibility and results in a well thought out, reasoned practice.

Wenger (1998) maintains that practices are recognisable in relation to a history of mutual engagement but they can also be re-engaged in new situations. Similarly locality is reflected

in the history of learning and learning can be reconfigured in relation to the geography of the practice. Such a spatiotemporal view of learning is relevant and useful to a study of a citizen science project as it opens up reflections on the different knowledge practices that members bring to the group in terms of their past and current knowledge, training and occupations.

2.5.3 Learning as meaning-making experience

This aspect of learning is understood as a way of talking about community members' changing ability, individually and collectively, to experience life and the world as meaningful as learning evolves (Wenger, 1998). As participants engage in group practices, growing in experience, the activities of the group become increasingly meaningful. The process of producing meaning is dynamic and historical and Wenger (*ibid.*) considers it the most important outcome of learning. It is the complex mix of a multiplicity of factors and perspectives. Meaning is constituted by the ability to affect and to be affected in a world of both resistance and malleability. This is appropriate to consider in terms of a citizen science project which attempts to bring about positive change in the environment.

2.5.4 Learning as becoming

Learning as becoming is detected in the way members talk about how learning changes who they are and creates personal histories of becoming in the context of the community. Learning by nature is transformative through a process of becoming a different person as meaningful learning progresses. The development of identity is central to the practice of newcomers in communities of practice and fundamental to the concept of legitimate peripheral participation (Lave & Wenger, 1991) or learning as social participation (Wenger, 1998). The authors feel that learning and a sense of identity are inseparable. "Identity" is understood to be the way a person views him or herself and is viewed by others. This is a perception of self which is fairly constant (Lave & Wenger, 1991). One way to think about learning is as the "historical production, transformation, and change of persons" (*ibid.*, p. 51). The authors maintain that knowing is "inherent in the growth and transformation of identities" (*ibid.*, p. 122). Participation shapes the experiences of individuals and communities and has the potential to transform the practice and the community by giving rise to a personal and social energy which catalyses social reconfiguration. Community changes contribute to a developing identity that places engagement in its practices in the context of a valued future (Wenger, 1998).

Learning as identity is significant in a citizen science project in terms of how volunteers perceive themselves as volunteers, as scientists and as agents of change and also how they and the groups to which they belong are perceived within the community that they serve. Attention will be given to how individual and community identities have developed over time and to what value Toad NUTS volunteers place on this identity.

2.6 Environmental citizenship

2.6.1 International policy content

UNESCO has made Global Citizenship Education (GCE) one of its key education objectives for the period 2014 – 2021 (UNESCO, 2014). This comes in response to increasing demand from member states to empower learners to become responsible global citizens with “emphasis on the importance of values, attitudes and skills that promote mutual respect and peaceful coexistence” (Tawil, 2013, p. 5). The notion of ‘global citizenship’ has gained prominence in international development discourse with the recently-adopted United Nations Secretary-General’s Global Education First Initiative in 2012.

The notion of citizenship has been changing with increased globalisation particularly with greater access to information and knowledge and greater exposure to other ways of thinking and different values through the World Wide Web and opportunities provided through various social media to get involved (Tawil, 2013). This is indeed the case with for example, environmental degradation associated with global climate change where people everywhere can tap into the global discourse on climate change.

GCE is a framing concept which expresses a collective purpose of education with “a concern for the relevance of knowledge, skills, and values for the participation of citizens in, and their contribution to, dimensions of societal development” (*ibid.*, p. 4; UNESCO, 2014).

UNESCO recognises the necessity to secure a world which is “more just, peaceful, tolerant, inclusive, secure and sustainable” and this includes a sense of identification with the local and national social, cultural and political spheres, an understanding and awareness of the challenges and the commitment to act in view of positive societal participation and transformation (Tawil, 2013, p. 9).

In the *State of the Planet Declaration*, the co-chairs of the *Planet under Pressure* conference made the following statement:

Assessments of current mechanisms for governing global environmental change show why existing international arrangements are not dealing quickly enough with current

global challenges such as climate change and biodiversity loss. There is growing evidence that diverse partnerships amongst local, national and regional governments as well as business and civil society provide essential safety nets should singular global policies fail – a polycentric approach for planetary stewardship (Brito & Stafford Smith, 2012, p. 2).

GCE incorporates a multifaceted approach drawing on four previously established education concepts. These are human rights education, peace education, education for international understanding and education for sustainable development. One of the four thematic areas identified in the GCE is the environment which includes the sustainable management of natural resources, impact of production and consumption, climate change and biodiversity preservation.

The *International Implementation Scheme for ESD* interweaves the four stands of human rights, social and economic justice, environmental issues and cultural diversity which overlap with the presently emerging GCE concept. One objective for ESD is the development of “respect and care for the greater community of life in all its diversity which involves the protection and restoration of the Earth’s ecosystems” (Tawil, 2013, p. 6). This objective is pertinent to citizen science projects like Toad NUTS whose goal is biodiversity and ecosystem protection and restoration.

While GCE has been applied in different ways in different contexts, regions and communities, common goals are recognised. These are to,

- encourage learners to analyse real-life issues critically and to identify possible solutions creatively and innovatively;
- support learners to revisit assumptions, world views and power relations in mainstream discourses and consider people/groups that are systematically underrepresented/marginalised;
- focus on engagement in individual and collective action to bring about desired changes; and
- involve multiple stakeholders, including those outside the learning environment, in the community and in wider society (UNESCO, 2014, p. 16).

GCE aims to equip learners with competencies to deal with the challenges of the twenty-first century and these competencies have been described as follows,

- an attitude supported by an understanding of multiple levels of identity, and the potential for a ‘collective identity’ which transcends individual cultural, religious, ethnic or other differences;
- a deep knowledge of global issues and universal values such as justice, equality, dignity and respect;
- cognitive skills to think critically, systemically and creatively, including adopting a multi-perspective approach that recognizes the different dimensions, perspectives and angles of issues;
- non-cognitive skills including social skills such as empathy and conflict resolution, communication skills and aptitudes for networking and interacting with people of different backgrounds, origins, cultures and perspectives; and
- capacities to act collaboratively and responsibly to find global solutions for global challenges, and to strive for the collective good (UNESCO, 2014, p. 9).

One of the GCE’s aims is to involve multiple stakeholders in the community and in wider society (see above goals) in citizenship education initiatives. GCE is also described as being built on a lifelong learning perspective claiming to include children, youth and adults (UNESCO, 2014). Citizen science typically involves a cohort of volunteers of different ages mostly post school adults but volunteers can also be school learners if they are slotted into the project in creative ways, usually alongside their parents or with a responsible adult. Citizen science may be an educative mechanism to consider using to achieve the objectives of citizenship education while also establishing more sustainable environmental solutions.

2.6.2 Features of environmental citizenship

Having described the global interest in citizenship education and environmental citizenship as positioned within this broad education objective in Section 2.6.1, it is useful to gain further clarity from literature on the topic. Academic exploration of the idea of environmental citizenship has fleshed out the concept since it was first coined by the federal Canadian Ministry of Environment in 1990. At the time it was used to link environmental concern, the public and policy processes (Szerszynski, 2006). Environmental citizenship is the idea that each of us is an integral part of a larger ecosystem and that we need to embrace the challenge

to live more sustainably, act responsibly and positively toward our environment.

Environmental citizenship encourages individuals, communities and organisations to think about the environmental rights and responsibilities residents of planet Earth have, at a local and global level, towards each other and the rest of nature and the planet (Dobson, 2007; Clover, De O'Jayme, Hall & Follen, 2013). The objective is to steer people towards living within the Earth's carrying capacity or planetary boundaries.

The GCE strategy is to encourage a global perspective with local actions. Nash & Lewis (2006) performed a survey that showed that although there is general support for environmental protection, most citizens surveyed assumed that industrial institutions will address environmental problems releasing citizens from needing to take steps to address the global environmental problems. The findings of the survey Nash & Lewis (2006) carried out suggest that environmental citizenship is effectively exercised in local areas where citizens have a sense of place, responsibility and ownership, rather than in the global arena. The authors conclude that citizenship must capitalise on bottom-up citizenship strategies.

In more recent years, advancing technology has seen the emergence of petition sites like Avaaz address issues of global concern. Avaaz is an online activist network which brings people-powered politics to decision making everywhere (Avaaz homepage, 2015). This means that ordinary people are informed of global issues and can get involved through the signing of a petition. With a membership of over 40 million people and a rising ethic of global interconnectedness, technology has enabled fast and focussed member reaction to issues of concern (see also Tawil, 2013). In explaining what Avaaz is and does, the website says,

... underlying Avaaz campaigns is a set of values—the conviction that we are all human beings first, and privileged with responsibilities to each other, to future generations, and to the planet ... together we can build the bridge from the world we have to the world we all want (Avaaz homepage, 2015).

This empowers citizens everywhere by facilitating participation in global initiatives and there are other petition sites like Avaaz that offer similar participation activist opportunities.

Clover *et. al.* (2013), who are collectively highly experienced in facilitating community learning initiatives, argue that all environmental problems are political in nature and therefore the educator cannot neglect the political. Limiting educational work to focus on individual actions ignores the politics of issues and the need for collective systemic change. Hayward (2012) argues that to realise all the advantages that environmental citizenship holds for

achieving the sustainability needs of future generations, strong democracies are needed. Arendt (cited in Hayward, 2012) maintains that democracies are strengthened when citizens participate in determining community choices. Participative democracy is foundational to participative governance which is the dominant discourse in the South African constitution and laws. Jansen (2013) urges ordinary South Africans to exercise their citizenship in the face of what he describes as widespread government incompetence and corruption, saying “we need to act” to bring about the ideal of a democratic, socially and environmentally just and thriving nation (p. xv).

Another important consideration is that Clover, *et. al.* (2013) advise that sharing information, statistics and scientific data by experts is important because ecological systems are complex and science can bring understanding and sometimes solutions. However they also warn that “although science matters, not everything is a matter of science” referring not only to the political but to values and ethics (p. 4). Parker (2010) states that a disposition of care along with knowledge results in an informed moral agency capable of enabling “mitigation, adaptation and regeneration strategies as effective responses of care” to deal with environmental problems (p. 205).

Environmental citizenship is not just about duty and volunteerism, it also requires obedience, charity, tolerance and other values like caring, confidence, courage, determination, service, dependability, idealism, honesty, reliability, self-discipline and service (Connelly, 2006 in Dobson & Bell, 2006). These values must be paired with knowledge, appropriate skills, active participation, critical thinking and decision making in real contexts and in collaboration with others to realise positive change through democratic processes (Krasny & Tidball, 2010; Sterling, 2009; Wals *et. al.*, 2014; UNESCO, 2014).

Clover *et. al.* (2013; and Tawil, 2013) also contend that while individuals are important, collective social action is more powerful. This is also echoed in the GCE. These authors feel that what is needed are opportunities to reflect collectively and critically upon root causes of environmental problems. Social learning is a way of organising learning and communities of learners to achieve this (Wals, 2007). This involves increased knowledge and awareness, questioning private interests and considering the best solutions for the collective good.

The Planet under Pressure conference delegates appealed for a transformation of “values, beliefs and aspirations towards sustainable prosperity” and for a development of “a new

strategy for creating and rapidly translating knowledge into action, which will form part of a new contract between science and society” (Brito & Stafford Smith, 2012, p. 4). Knowing what the desired product of citizenship education should be, educators design education programmes or projects in a way that is most likely to develop the competencies described by the GCE.

Dobson (2003) is of the opinion that the general topics in a school’s citizenship curriculum can be taught in a lively, engaging and relevant way by using environmental issues. These could be issues such as climate change, desertification, poverty, pandemics and war, which Wiek, Withycombe and Redman (2011) describe as complex anthropogenic challenges all featuring high degrees of damage potential and urgency, and all having no obvious optimal solution. Wals, Brody, Dillon & Stevenson (2014) also draw attention to the complex and contested nature of sustainability challenges and the need for competent citizens who can adequately respond to these challenges (see also Gough & Scott, 2006).

There is an interest in the conditions and learning processes that enable citizens of all ages to develop their critical and creative thinking capacities paired with a strong appreciation for environmental ethics (Wals *et. al.*, 2014). What has been identified as needed is the ability to appraise environmental situations, make informed decisions concerning these situations, with the capacity and commitment to act (independently and collectively) so that environmental sustainability is enhanced. The authors recognise that citizen science may enable and involve ordinary people in resolving complex socio-ecological issues.

Scott (2009) argues that environmental educators, working within schools and universities, have a significant role to play in progress towards achieving global social and environmental justice and motivating people to live more sustainably. If school learners and/or teachers are members of a volunteer citizen science group, the citizen science project is able to connect schools (young citizens) to communities and increase the relevance of learning and make positive impacts in the local environment (Wals *et. al.*, 2014; Wals & Dillon, 2013; Kemmis & Mutton, 2012).

2.7 Conclusion

This chapter outlined the nature of citizen science practices nationally and internationally. The section on practice architectures theory gave insight to the complexity of the shaping factors of the practices of a citizen science project. The power/ knowledge dynamics in the

interaction between citizen scientists and scientists was outlined as it relates to participants in citizen science projects engaged in knowledge exchanges. Communities of practice theory was discussed in order to support an exploration of the learning that is experienced by volunteers while participating in citizen science projects. This body of work describes a social learning theory composed of four learning components, learning as belonging, learning as doing, learning as meaning-making experience and learning as becoming. An outline of the international policy on Global Citizenship Education was given. Lastly environmental citizenship was discussed as it captures the aspiration for a citizenry that is knowledgeable of environmental issues globally and locally, and that possesses values, attitudes and skills that motivates positive change toward greater sustainability in local contexts.

CHAPTER 3: Research Methodology

3.1 Introduction

In this chapter the research process is described including the various data generation activities designed to probe the research question, how are the practices of the Toad NUTS citizen science group shaped and how does the project embrace learning and shape environmental citizenship? The research orientation, design and methods used are substantiated and are related to the research question and goals. This study has a qualitative, interpretive orientation and uses a case study approach which is justified in the light of the purpose of the research. A theoretical motivation for the data generation methods chosen is presented and a more detailed description of how each method was used is given. How the data was arranged, interpreted and analysed is explained. Finally maintenance of the validity of the study is discussed followed by an explanation of how sound ethical research principles were applied.

3.2 Research methodology

3.2.1 Research orientation

The components of a qualitative study form an integrated and interacting whole rather than a strictly linear research design and procedure (Maxwell, 2005). In such a study, the researcher reflexively considers each part of the process as it unfolds. As data is generated and analysed, the research question is adjusted and refocused while the researcher also quells validity threats as new developments arise. Colton & Covert (2007) refer to qualitative studies as being “rich and thick” and not limited to question and answer type inquiries (p 11). A researcher immerses her or himself in the context of the research to achieve a deep understanding of the dynamic forces relating to the particular study. This study delves into the historical and social contexts of the development and practices of the Toad NUTS citizen science group in order to understand what learning occurs in the practice of citizen science and how the practice is shaped by various enabling and constraining factors.

An interpretivist approach aligns with the form of a qualitative study in the sense that the phenomenon of interest is examined in a natural setting to gain deeper insights to the context and the research question (Cohen, Manion, & Morrison, 2007). With this research the interpretation of the practice architectures features influencing Toad NUTS praxis and the communities of practice components provides this contextual information and is necessary to

explain the nature of environmental citizenship developed within the project. Therefore this research will take a qualitative, interpretivist approach.

3.2.2 Case study approach

A case study approach was chosen because it allows for an in-depth exploration of the research question in a particular context. Such an approach uses multiple perspectives to describe an individual, group, organisation or situation (Colton & Covert, 2007). The strategy of using a case study approach has been used repeatedly in the field of the Social Sciences as it is useful when seeking to understand complex social phenomena like social learning or community change as in this study.

Bassey (1999) says that case studies tell a story of a situation, what happened, and what the information may mean in a larger context. He relates what Stenhouse describes as an “educational case study” as a method used by researchers to understand an educational action or phenomenon, the results of which are submitted to others in the field for consideration (*ibid.*, p. 28). Although case studies provide an opportunity for compelling narrative, they must still be based on thoughtful information gathering and analysis. In this present study the data generation methods were chosen to provide comprehensive and detailed information on the nature of the citizen science initiative being researched.

3.3 Data generation methods

In this research multiple methods for generating data have been used with the intention of gaining a rich, multifaceted body of information from which to address the research question. A diversity of data sources were used to validate the integrity of the data analysis by providing a means to cross-reference information and to build a composite response to the research question and goals.

3.3.1 Documentary research

Cohen *et. al.* (2007) state that documents can be the source of historical and contextual data from which to gain insight into the context of the area of study. Hammond & Wellington (2013) maintain that the study of documents can complement other forms of data collection. In this study an analysis of historical documents and the Toad NUTS website was performed. Minutes of meetings, magazine articles, the Toad NUTS database, reports and a Toad NUTS marketing video were studied. See Appendix 1 for a log of the documents used and

Appendix 2 for an example of one of the documents, the report on the barrier conservation intervention. The documents allowed for an identification of various stakeholders in the conservation of the Western Leopard Toad. In addition the documents clarified the nature of the activities (or practices) of the Toad NUTS volunteer group, gave examples of interactions with stakeholders and intervention initiatives providing data to address the research question.

3.3.2 Survey

A survey typically accesses a large representation of people from a population of interest with an extraction of small amounts of information (Kelley, Clark, Brown & Sitzia, 2003). This strategy was used to probe at a broad level whether people were aware of the Toad NUTS group and its activities and how easy or difficult it is for Noordhoek residents to join the Toad NUTS group. The survey was refined by piloting the instrument with fellow students on the Masters course. The survey was circulated to the members of the Noordhoek Tourism Association. The survey questions were closed (yes/no answers) and very short with space for comments at the end allowing respondents to clarify their survey answers. The survey was used to extract specific data but did not delve deeply. A completed survey is attached in Appendix 3. Seven people responded. The number of members on the database was never disclosed to the researcher. A school principal was asked to circulate the survey to the parents. Unfortunately this was not done. As the response was poor, the sample size was too small for the results to be representative of the entire community. The data from the survey sheets was summarised on a spreadsheet and used to add information relevant to Research Goal 1. The summarising spreadsheet is indexed in Table 3.2 further in this chapter and can be viewed in Appendix 4.

3.3.3 Questionnaire

To explore the experiences of new recruits participating in the community of practice, a questionnaire was given to new recruits following a volunteer drive. To refine the questionnaire, it was piloted with colleagues on the Masters course. This was to determine prior knowledge of Western Leopard Toads and frogs in general (towards Research Goal 2). A questionnaire is included at Appendix 5. The questionnaire also delved into the motivation for joining Toad NUTS and the nature and extent of the existing sense of environmental citizenship of the recruits (relating to Research Goal 3). The questionnaire had closed questions (yes/no answers) with the option of providing comments. Cohen, et.al. (2007) maintain that it is quicker and easier to code and analyse questionnaires with closed questions

than open-ended questions and the questions can be directed to address the research question. Three new volunteers joined the group in 2014. All three were given the questionnaire to complete and two returned completed questionnaires.

3.3.4 Semi-structured interviews

Semi-structured interviews allow researchers to ask premeditated questions while also probing for clarification, meaning and understanding (Colton & Covert, 2007). A list of interview questions was compiled for each respondent which was piloted with fellow students on the Masters course and with work colleagues. When approaching a potential interviewee, an access letter and the interview questions were sent to them before conducting the interview. An example of an access letter is shown in Appendix 10. After receiving the respondent's consent, arrangements were made for a suitable time and place for the interview. Semi-structured interviews were arranged with,

- two Toad NUTS founders,
- five other members from the active volunteer group,
- three members of the WLT-CC that is,
a City of Cape Town representative, a Cape Nature herpetologist and the secretary (previous City of Cape Town extension officer),
- a SANBI representative,
- a University of Cape Town citizen science specialist,
- an Endangered Wildlife Trust herpetologist,
- a researching herpetologist from North West University,
- a local veterinarian.

Through the semi-structured interviews rich data of the practices, history, context and learning within the Toad NUTS group was obtained. Data from these interviews was used to address all three research goals. Information on how the volunteers interacted with other stakeholders in the Noordhoek community and those involved in Western Leopard Toad conservation was gleaned from these interviews providing insight into practice architectures features. This information also gave different perspectives of the Toad NUTS practices and the contribution made to toad conservation.

The interviews and discussions were recorded and transcribed. Respondent checking was sought but only two respondents made any amendments to the transcripts possibly because

the interview schedule was sent to them before the interview and they had the opportunity to consider their responses. Others accepted the transcripts as they were. See Appendix 6 for a coded transcription of the interview with the secretary of the WLT-CC as an example.

3.3.5 Observation

Henning (2004, p 100) argues that observation as a method, “fills the gaps left unfilled” by interviewing and strongly recommends this approach is used for optimal data capturing. Observations were done of four Toad NUTS field patrols (two evening, one morning and one trip to put up road signage) on August 3, 4 and 5 2014. Details of each session are shown in Table 3.1 below.

TABLE 3.1: Observation sessions of Toad NUTS practices

Date	Time	Nature of activity
Aug 3	7:30pm – 10pm	Patrolling Noordhoek streets in a vehicle with a leader and novice Toad Nuts member. Meeting other members. Picking up toads and recording data about this on WhatsApp. Doing a bucket run with two novice members.
Aug 4	7am – 9am	Doing a morning bucket run on one stretch of road with a Toad NUTS leader.
Aug 4	7:30pm – 10pm	Doing a night bucket run on a different stretch of road. Meeting other Toad NUTS members on patrol.
Aug 5	7:30pm – 10am	Putting up road signage with a Toad NUTS leader.

As Toad NUTS activities generally occur at night when it is dark and raining, videoing patrols is impossible. Both lighting and water damage to equipment prohibited this from occurring. Instead photographs were taken aided by the camera’s flashlight and an audio recording was made. The recorder was kept in a raincoat pocket so that at times the recording was indistinct when the research subjects were on the move. A careful description of the activities during all four sessions was made shortly after the observations occurred. The observation schedule is a compilation of the audio recording, photographs and recall of events in all observation periods and is found in a document labelled Obs1 (see Appendix 7).

The data generated in this way provided evidence of the learning that occurs individually and collectively in the group, practice architectures features and environmental citizenship (Research Goals 1, 2 & 3). Two previously made videos of the Toad NUTS group were viewed and transcribed. These are labelled Vid1 and Vid2. Vid1 was a Toad NUTS promotional and educational video which featured one of the group leaders and her children.

This provided evidence of knowledge, public awareness and education materials. The other was a snippet from film footage for a nature programme telling the Toad NUTS story. The video follows one Toad NUTS member and shows another driving past.

3.3.6 Data indexing

All data produced through the methods described above was indexed to enable links to the data when the case study is presented and in the discussion in Chapters 4 and 5. The inventory is shown in Table 3.2 below. Data extracted from this raw data was referenced following a particular protocol. The reference occurs in brackets with the data stating firstly the data index given in Table 3.2, then the page number and thirdly the line or question number (in the case of an interview transcript) from which the data was extracted for example, (Doc13, 2, 20) or (Int7, 3, 7).

TABLE 3.2: Inventory of data produced showing the index given to each piece.

Index	Description of data
Doc1	Noordhoek Environmental Action Group email communication to its members. Sent 1 July, 2014. <i>Toad fundraiser succeeds – the barrier is going up.</i>
Doc2	Faraday, A., & Faraday, R. (2013). <i>An initiative to reduce road mortality of the Western Leopard Toad.</i> Toad NUTS report, Noordhoek, Cape Town.
Doc3	<i>The story of the Western Leopard Toad and the volunteers who rescue them: Toad NUTS.</i> (2013). Toad NUTS report, Noordhoek, Cape Town.
Doc4	City of Cape Town media release, 7 December 2012. <i>Successful Western Leopard Toad breeding season at restored Skilpadsvlei wetland.</i> Retrieved June 9, 2014 from http://www.capetown.gov.za/en/MediaReleases/Pages/Successful Western Leopard Toad breeding season at restored Skilpadsvlei wetland.aspx
Doc5	Recruitment Flyer 2010. Toad NUTS document, Noordhoek, Cape Town.
Doc6	Faraday, A., & Day, M. (2011). <i>Proposal: Evening radio toad traffic report.</i> Toad NUTS document, Noordhoek, Cape Town.
Doc7	Faraday, A., Faraday, R. and J’Kul, S. (2008). <i>Toad Breeding Report 2008.</i> (2008). Toad NUTS document, Noordhoek, Cape Town.
Doc8	Faraday, A. (date unknown). <i>Committee SWAT analysis.</i> <u>Toad NUTS document, Noordhoek, Cape Town.</u>
Doc9	Beach Chart. Toad NUTS document, Noordhoek, Cape town.
Doc10	Citizen Science and the Western Leopard Toad. (2013). <i>Quest</i> , 9(4), 18-21.
Doc11	Hanks, J. (2013). Toads off the road. <i>Africa Geographic</i> , October, 14.
Doc12	Smuts, S. (2014, July, 2). Toad NUTS member, Noordhoek, Cape Town. Personal email communication.
Doc13	Fennell, P. (2014, July 1). NEAG member, Noordhoek, Cape Town. Personal email communication.
Doc14	WhatsApp group conversation. (2014, 13 August). SPOTS, Noordhoek, Cape Town.
Doc15	Noordhoek Tourism. (2014, July 29). August newsletter
Doc16	Dorse, S., (2014, July 3). <i>Skilpadsvlei wetland.</i> Senior Environmental Professional, Environmental Resources Management Department, City of Cape Town, Cape Town. Personal communication.
Doc17	Faraday, A. & Bosch, S. J. (2011, June 2). Breeding spot for leopard toads? <i>Echo</i> , p. 10.
Doc18	Bosch, S. J. (2012, September 6). A hell run for hoppers. <i>Echo</i> , page unknown.
Doc19	Western Leopard Toads back at Skilpadsvlei. (2013, January 24). <i>Echo</i> page unknown.
Doc20	Lessons about the Western Leopard Toad. (2011, August 2). <i>People's Post</i> , page unknown.

Doc21	Toad-ally beautiful. (2012, July 10). People's Post, p. 9.
Doc22	Bosch, S. J. (2012, July 7). Drivers beware, mating leopard toads ahead. <i>Weekend Argus</i> , page unknown.
Int1	Interview transcript Toad NUTS member
Int2	Interview transcript Toad NUTS member
Int3	Interview transcript Endangered Wildlife Trust scientist
Int4	Interview Transcript with Noordhoek Veterinarian
Int5	Interview transcript Toad NUTS founder
Int6	Interview transcript Cape Town Environmental Specialist
Int7	Interview transcript WLTCC secretary
Int8	Interview transcript Toad NUTS member
Int9	Interview transcript Toad NUTS founder
Int10	Interview transcript Herpetologist and researcher
Int11	Interview transcript Toad NUTS media person
Int12	Interview transcript Toad NUTS database manager
Int13	Interview transcript Toad NUTS SANBI citizen science specialist
Int14	Interview transcript WLT-CC member and Cape Nature herpetologist
Int15	Interview transcript Toad NUTS UCT citizen science specialist
Obs1	Observation schedule
SS1	Spreadsheet summary of Noordhoek Resident survey
Vid1	Video 1 script
Vid2	Video 2 script

3.4 Data analysis

Data analysis is the process that a researcher employs to organise data so that information that is hidden in the data, is lifted out and becomes beneficial in a meaningful discussion of the research question (Maxwell, 2005). The software program NVivo, was used to aid the qualitative data analysis process as it allowed for the rigorous analysis of large data sets by grouping the data into categories (Welsh, 2002) with relative ease. All raw data produced through the methods described in Section 3.3 were uploaded to the NVivo data analysing system to be processed. Data was managed, organised, classified, coded and stored effectively using this software. Data was coded and sorted into analytic categories efficiently and quickly. Appendix 9 illustrates how NVivo functions. Analytic memos were produced

of each category. One analytic memo is shown in Appendix 12. Note that NVivo automatically indicates how many data extractions (called references) are made from each data source and indicates what percentage of the total data contents of the source this represents. This is indicated where the data source is listed and will be seen in the analytic memos appended. These statistics attest to the rigor of data analysis NVivo provides.

There were three phases of data analysis applied to the data relating to the three research goals. These are described below.

3.4.1 Analytic Phase 1: Exploring practice architectures

The first phase of data analysis addressed Research Goal 1 which was to explore the practice architectures features shaping the Toad NUTS practices. This follows the practice architectures theory discussion in Section 2.3. Phase 1 analysis comprised repeated reading of all data to identify the prominent practices to the Toad NUTS group. Kemmis, McTaggart, & Nixon (2014) advise that when investigating practices the researcher needs to establish what the project is by determining what the participants, including the researcher, say that they are doing, or have done or intend to do. This allows the researcher to diffuse from the data what the practices of a project are. The practices are described as bundles of doings, sayings and relatings.

One determines ‘doings’ (the activities which often produces or achieves something) by asking leading questions such as, what are participants doing, are there sequences or connections between activities, what outcomes are being achieved (Kemmis *et. al.*, 2014). One can detect the ‘sayings’ by asking, what do participants say while engaged in the practice, what ideas are important and how are participant’s language and ideas about the practice changing while engaging in the practice (*ibid.*)? Concerning ‘relatings’ one can ask, how are participants relating to each other and others involved or affected by the project, are there systems of positions, roles and functions, are there relationships of power and solidarity, who is included and excluded from what (*ibid.*)?

The analysis resulted in the identification of different practices. This in turn allows the practice architectures features to surface. An analytic memo was created for each practice comprising the bundles of sayings, doings and relatings. See Appendix 12 for an example of the way NVivo creates analytic memos. The analytic memo shows the communication

system used between members. This data is presented in Chapter 4, Section 4.2.6. Data relating to the Toad NUTS practices will be presented in Section 4.2.

3.4.2 Analytic Phase 2: Investigating the learning components of a community of practice

Phase 2 of the data analysis addresses Research Goal 2 which is to examine the learning dynamics occurring within the Toad NUTS citizen science group. To facilitate the discussion of learning and considering the model of structural elements of a community of practice presented by Wenger *et. al.* (2002), evidence of the knowledge domain that Toad NUTS community is rooted in, is presented (Section 4.3). Presentation of evidence pertaining to learning components is shown in Section 4.4. For analytic purposes evidence for each learning component will be set out separately. The four key learning components identified in communities of practice theory will denote the analytic categories (refer to Section 2.4). The analysis of the components was undertaken as shown in Table 3.3.

TABLE 3.3: Table indicating the analysis of learning dynamics.

Learning Component	Description of how data was identified and coded for the analytic category representing the learning component and which composed an analytic memo.
learning as belonging	The Toad NUTS group, as a community of practice, involves relations between volunteers constituted by mutual engagement in practices. Community comprises social configurations in which enterprises are defined as worth pursuing and participation is recognizable as competence.
learning as doing	Toad NUTS praxis is composed of unique and situated practices with historical and social resources, frameworks and perspectives. Involves knowing in practice .
learning as meaning-making experience	Toad NUTS members perceive their contribution to Toad NUTS practices as meaningful and they experience life and the world as meaningful because of their participation in Toad NUTS practices being both affected by participation in these practices and affecting environmental actions which are meaningful.
learning as becoming	Participation in Toad NUTS activities changes members' identity and creates personal histories of becoming in the context of the Toad NUTS community. Personal identities feed in and off the collective group identity contributing to the meaningfulness of belonging to the group and participating in the group practices

The key criteria for each analytic category are shown in bold script in the table. Data evidencing the learning components described was extracted from the source documents and used to create analytic memos for each of the components (which are also the analytic category) described above. This analysis resulted in the production of four analytic memos. The data forms the basis of the discussion on learning dynamics within the Toad NUTS community of practice in Chapter 5.

3.4.3 Analytic Phase 3: Identifying features of environmental citizenship

This phase of analysis involved inspecting the data presented in Chapter 4 for evidence of the goals and competencies identified in the GCE policy statement (Section 2.6.1). This relates to Research Goal 3 which probed how environmental citizenship is developed in the Toad NUTS citizen science project. Chapter 4 was uploaded to NVivo and the analysis was done using the NVivo program. Analytic memos were created for each goal and competency.

3.5 Research ethics

This study complied with Rhodes University's ethics policy. A number of measures were adopted to establish the ethical protocols for this research. Bassey (1999) maintains that the freedom to investigate, ask questions, exchange information, express ideas, opinions and findings, is subject to the responsibility to respect truth and persons (*ibid.*).

In order to uphold the truthfulness of research, care needs to be taken when generating data to ensure this. I am biased positively towards citizen science as I am a volunteer, educator and facilitator in more than one citizen science project. To minimise this bias I chose to research a group of which I am not a member. The Toad NUTS group members were able to speak freely to me as I am not part of the group while knowing that I understand the rigours of frog monitoring as I do frog monitoring myself within a citizen science context. I am sympathetic to the demands and challenges of being involved in volunteer science activities and also know the joys of making significant contributions to species and ecosystem health. Being an outsider, although empathetic, helped me to reduce bias as I could view the data more objectively. I also kept a research journal for field notes in an attempt to increase objectivity (see Appendix 13).

I was constantly aware of how I could be affecting the responses from the respondents I was interviewing and was careful with my questioning not to suggest possible answers. I was particularly attentive to this while transcribing the interview recordings. As said in Section

3.3.4, the data supplied during interviews was recorded and transcribed and verified by respondents. Respondents were able to amend or clarify what they had said in the interviews however; very few respondents chose to do so.

To further establish the truthfulness of the study, the research methods were varied, data was obtained from a number of different sources, large extracts of data was presented in Chapter 4 and triangulation of data occurred across the different data sources and generation methods. Section 3.6 on Validity, further establishes the trustworthiness of the data.

To respect the people in this research a number of actions were taken. Cohen, *et. al.* (2007) suggests that informed consent be obtained from the research respondents. In this research participants were asked for permission to be interviewed, observed, photographed, recorded or filmed. An access letter was given to research participants wherein the intent of the research was set out. It explained the process of interviewing and the nature of respondent checking of interview data and that respondents may withdraw at any point in the research process. Participants were asked to indicate their willingness to participate in this study by signing the access letter to indicate their consent (Appendix 10). The study and the purpose of the surveys, questionnaires, recordings, filming and interviews was repeated verbally to research subjects every time data was generated. To make the respondents more comfortable with the interviews, I sent them a copy of the interview questions before I met with them so that they had time to prepare their responses to the questions.

All names appearing in the data quoted in the thesis were changed to pseudonyms or codes to maintain the anonymity of respondents as much as was possible. The names of the Toad NUTS leaders however, do appear in the public domain in various media articles, journal articles and the Toad NUTS website. Because of this the identity of the facilitators could not be entirely hidden in appendices and when referring to the Toad NUTS website.

3.6 Validity

In case study research trustworthiness is “the extent to which a research fact or finding can be repeated, given the same circumstances, and validity is the extent to which a research fact or finding is what it is claimed to be” (Bassey, 1999, p. 75). Winter (2000, cited in Cohen *et.al*, 2007) feels that both trustworthiness and validity are addressed through honesty, depth, richness, and scope of data collected, the extent of triangulation and the objectivity of the researcher.

In this study multiple data generation methods (documentary research, surveys, a questionnaire, semi-structured interviews and observation) were used and different data was obtained as set out in Section 3.3. The numerous documents used for the documentary research were obtained from a number of different sources, a Toad NUTS facilitator, a member of the group and two different scientists. An internet search of three different websites, the WLT-CC, Toad NUTS and City of Cape Town websites, was done to verify the contents of the documents and substantiate information shared during interviews. Triangulation of data was done within and across different data generation methods. Cross-referencing of information was used when presenting and discussing the findings of the three analytic phases. The use of a variety of techniques ensures that there is consistency, validity and trustworthiness in the data collected (Cohen *et. al.*, 2007).

Bassey (1999) recommended the use of an adequate audit trail to enhance validity and trustworthiness during the interpretation and reporting stages. Through labelling data, links have been made to the data source and the specific location of text within sources. This makes raw data convincing and accessible to the reader and easy to trace where such references have been made to support claims. Section 3.3.6 details how data has been coded and indexed in this study and this has been applied carefully when presenting data in Chapter 4. The use of the NVivo software increased the accuracy of the data analysis and data management strengthening the validity and trustworthiness further.

Validity is not always about the methods one uses, but whether the conclusions made from the methods adhere to the purpose and context of the study (Maxwell, 2005). Throughout this study the research goals and question were referred to. Theoretical validity was also achieved by constant engagement with the theoretical framework used in relation to the data and research findings.

The research process itself must be carried out diligently, thoroughly, honestly and the researcher must invest the required time, effort and thought to do justice to the rich and complex process of learning being investigated (*ibid.*). This was indeed the case in this study. The study and research findings were also presented to peers and colleagues at three different academic conferences. This was useful in refining the research in various different ways. A number of different critical friends also read either portions or the entire thesis and provided comment to improve the presentation of the thesis and research process.

3.7 Conclusion

In this chapter the rationale for the structure of the study was set out with the intention of providing a clear account of the way the research was conducted. It was explained that this was a qualitative research study with an interpretive orientation. Data was obtained through documentary research, a survey, a questionnaire, semi-structured interviews and field observations. This data was analysed in three different phases to address each of the three research goals. A description of the analytic processes and categories used in each analytic phase was provided and how the NVivo software facilitated these analyses. The steps taken to ensure that ethical standards were maintained throughout the research process was set out and finally the validity of the study was argued.

CHAPTER 4: Data Presentation

4.1 Introduction

In this chapter evidence is presented to address the research goals outlined in Section 1.4. The data was analysed in three phases in which the practices comprising bundles of doings, sayings and relatings of the Toad NUTS group were explored and is presented in Section 4.2. The learning dynamics of the citizen science group were investigated and this data is presented in Section 4.3. The evidence of environmental citizenship was lifted from Chapter 4 and is discussed in Chapter 5. To orientate the presentation toward the discussion of enabling and constraining practice architectures features, a close look is taken at the Toad NUTS practices and the many different activities members undertake. Data is then presented describing the learning evidenced in the citizen science group.

4.2 Toad NUTS practices

This section draws on the theory presented in Section 2.3 and responds to Research Goal 1. A number of different activities that the Toad NUTS members perform surfaced from the data. These practices are comprised of “bundles” of interrelated doings, sayings and relatings which form comprehensible compound structures that are characteristic of Toad NUTS practices.

The following two quotes outline the issue at hand which led to the establishment of the Toad NUTS group.

Losing a high number of migrating endangered Western Leopard Toads annually could lead to its extinction (Doc6, 3, 11). A continuing decline in the extent and quality of its habitat, the area of occupancy, the number of locations, and the number of mature individuals is seen. For residents of Noodhoek this means that comprehensive conservation strategies cannot be put in place fast enough (Doc7, 7, 5).

The purpose of their project is to protect Western Leopard Toads during the toads’ mating season when they migrate to and from their breeding ponds (Int6, 1, 3; Int9, 6, 17; Int9, 12, 2). Everything that the group does can be linked to this overarching goal.

The leaders’ ultimate goal appears in a report written in 2008. This document reveals that “Operation Toad off the Road and the Toad NUTS group plan to be around for as many years as it takes to reduce the status of *Bufo pantherinus* from Endangered to Vulnerable and perhaps eventually to take our famous resident off the Red Data list altogether”. This was echoed in the 2014 interview with one of the leaders (Int5, 2, 4) when she says that she

dreams of a time when humans and toads will live in peaceful co-existence and when patrolling will not be necessary (Int5, 3, 9; Int5, 4, 2). The Toad NUTS members will then patrol for pleasure. This spurred them on to take steps that have brought them closer to realizing this dream. The Toad NUTS leaders and members have a vision for achieving permanent conservation structures like culverts or under road tunnels to safeguard the toad and other animals (Int9, 13, 5). The volunteers have researched various options and are completing feasibility studies towards this goal.

Members perform a number of activities all justified by the contribution the activity makes to protecting the toad. Not all members are involved in every practice. Some activities are performed by one or two people only. The different Toad NUTS practices are described in the sections that follow.

4.2.1 Co-ordination of the WLT-CC

The WLT-CC has provided a meeting point for all stakeholders, formal and informal, in the Western Leopard Toad conservation efforts. Toad NUTS leaders represent the group as members of the WLT-CC. Here the roles, capabilities and limitations of resources of various stakeholders surfaces (WLT-CC homepage, 2014). This space is valuable because here committee members listen and learn from each other and forge joint actions. One member stated,

The establishment of the WLT-CC has been incredibly successful in ensuring communication and coordination of all efforts involving the Western Leopard Toad. Government is more often than not perceived in a very negative light. It is important that there is continual communication and sympathetic understanding of unavoidable (and sometimes seemingly illogical) constraints within government despite officials' best efforts. Similarly, government officials must be sympathetic to the passionate and selfless efforts from civil society towards the cause. Ultimately each member of the committee must be willing to listen, learn and act while always keeping the primary objective in mind which is the effective conservation and protection of the endangered Western Leopard Toad in this case. It would be important to have a strong chairperson for such committees to ensure that issues of concern are addressed timeously and always in a constructive manner, but in the end it is each member of the committee's responsibility to be a positive part of the initiative (Int6, 1, 6).

The intention of the once a quarter meeting is to shape a multi-stakeholder conservation perspective. The City of Cape Town recognised the need for such a committee by appointing an extension officer for a two year period to facilitate communication. See Appendix 15 for a journal article written by three members of the WLT-CC. The extension officer acted as a facilitator and a more direct liaison between government and civil society as well as between

different volunteer groups to ensure a consistent and well-coordinated approach in the greater Cape Town area (Int6, 2, 6). A City of Cape Town representative offers insight on the extension officer position,

This position was also created in recognition of the capacity constraints of government. Officials serve voluntarily on the WLT-CC in addition to their substantial formal job descriptions and requirements. This facilitation position was incredibly valuable to ensure that all detail was attended to as it was solely dedicated to assisting the volunteering community and assisting officials with regard to the Western Leopard Toad. Unfortunately creating such a position is however not always practically possible (Int6, 2, 7).

The WLT-CC can at times be a place of conflict. For example, an interviewee explains that a few members of the committee are volunteers who don't work flexible hours. It is difficult for them to take off work four times a year and have to apply for leave to attend meetings (A. Faraday, personal communication, August 3, 2014). The scientists and officials however, want to meet during working hours and are perceived as inflexible on this point by refusing to change the 2pm meeting time or at least agreeing to an alternation between in and after office hours meeting times (Int9, 5, 13).

There has been an effort made in the past to make the committee function more optimally by doing a SWOT (strengths, weaknesses, opportunities and threats) analysis at one of the meetings (Int9, 5, 13). This member said that they needed to resolve some of the ongoing friction and misunderstandings between volunteers and working conservators and officials. The minutes of this analysis are available and labelled as Doc8 in table 3.2.

A respondent summed up the volunteer's contribution in the committee as

...we are the hands, so we do what we do and report it. Others are hands-on but a number attend meetings and give valuable information and that's it. It is for everyone to say "this is what I am capable of and what I am willing to do". The biggest problem is when someone says, that's not good enough and people being pushed away and then you have lost them (Int5, 4, 5).

4.2.2 Patrolling for toads

Migration typically happens during the Cape winter, late July to September, although migration timing can vary depending on the weather (Doc7, 3, 63). Toads prefer to move on nights when it rains, usually after dark from about 6:30pm (Int9, 12, 10; Doc11, 1, 71). As Noordhoek does not have street lights, visibility on the roads is impaired, and as this is peak traffic time with many people returning to their homes from work, the incidence of road kill for the toads is high (Int7, 2, 5). When the founders of the Toad NUTS group first became

aware of the plight of the toads, they took it upon themselves to do something about it. A leader describes how she searched everywhere for information about the toad. There was an article about the toad in a local newsletter and she contacted the author. She searched the internet, books and sought out experts (Int5, 1, 1). She knew she had to do something when she realised that the Western Leopard Toad was endangered (Int5, 1, 1). She managed to convince her friend to come out with her at night to rescue the toads. Two more people helped during the first year in 2007 (Int5, 1, 1). At the end of that year they decided that they needed help and approached NEAG with their idea for a volunteer group. Toad NUTS was established and the patrolling started (Int9, 1, 2).

The Final Breeding Report 2008 shows that in the first year there were fewer toads seen and a greater road kill percentage (Doc7, 3, 77). This indicated that more people and more patrols were needed but knowledge was gained during that year that could be passed on to others in the second year. When asked to describe a typical patrol event, a volunteer says,

When it is your turn on the roster you would do a session especially if it rains. I'll go out with whoever I am partnering with on that day but mostly with my children. You meet up at a predetermined point and you are allocated an area and you patrol that area. If there's nothing going on in that area and there's a lot of activity in another area, you might be reallocated or sent to the other area. If you know, there's like 120 toads crossing the road and they are just getting squished and there are only two patrollers there but nothing where you are, you would join them there to help. Basically you put your hazard lights on, you have your luminous jacket on, your patrol suits and the priority for me, cause I often take my kids, is safety. I always tell the kids we've got to count to five before we move. Cause if you see a toad, you can jump out and there could be another car coming and it's devastating if that toad gets squished but rather that and not me or the kids. So let's count to five, check our safety...Typically, you pick them up, you have your information sheets to fill in. An average shift is about two hours long. If there's nothing happening, you can stop after about an hour but if they are moving it might take longer. So then you stop, check your safety, put your hazard lights on, you're looking and it's amazing how your eye adjusts. You do often see leaves and twigs and stuff and then you see something that looks like a stone in the road. You have to check what direction it's going in cause if you put it on the wrong side of the road it will just turn around and move back. And then just do that for a couple of hours (Int8, 3, 15).

This information was confirmed by other respondents. Most often two volunteers travel in one car during a patrol (Int9, 3 15; Int8, 3, 15; Int1, 1, 1). They then drive along their route for at least one hour to see whether any toads are moving (Int9, 3, 18). If they do not encounter toads they can leave, if there are toads on the roads, they stay to the end of the shift which is typically a few hours long. When they encounter a toad they move it away from oncoming traffic and off the road (Doc3, 1, 14; Doc2, 4, 61). Roads are also checked on dry

nights during this period. There is agreement concerning patrolling methodology which is uniformly practiced.

Dead toads are scraped off the road with an egg lifter and thrown into the vegetation on the side of the road so that these are not counted more than once (Int1, 1, 4). Previously ‘flatties’ were collected in plastic bags and given to the WLT-CC chair for possible future DNA analysis (A. Faraday, personal communication, January 31, 2014; Int1, 1, 4). This is not done anymore. All these incidents are noted on a data sheet and called in, texted or emailed to the group co-ordinator at the end of the evening. Toad NUTS volunteers communicate their experiences briefly on WhatsApp (Doc14, 2, 9).

During the early years (2008 – 2009), toads were picked up, sexed, measured, photographed and their location was determined using Cybertracker (Int9, 6, 17; Doc7, 1, 2 (1); Doc2, 4, 66; Int1, 1, 3). Now priority is given to moving toads off the road as quickly as possible (Int9, 6, 17; Int1, 1, 3). Photographing and locating the toads have been abandoned as it took too long to do and seemed purposeless as no feedback was given to the volunteers.

4.2.3 Managing the temporary barrier intervention

Over the first six years of Toad NUTS activities, records show that approximately 20% of moving toads are lost through road kill despite patrolling. Toad NUTS concluded that “patrols are not enough and can be dangerous” (Doc3, 3, 71) therefore, road patrols should be reserved for work on quieter suburban roads, where traffic volumes are lower and where the risk to patrollers is less (Doc3, 3, 77). This quote reveals that Toad NUTS reflected on their data and actions, concluded that their main activity, patrolling, is dangerous in places and not effective enough in achieving the goal of eliminating road kill. The Toad NUTS group investigated various other strategies to improve their success rate as measured in toad deaths. The barrier intervention was an alternate strategy that they pursued.

The research and planning done by the Toad NUTS preceding the erection of the barrier is testimony of their ability to research and deliberate an issue. After the group and its work was featured on an episode of Carte Blanche, a national television show, an engineer volunteered his services and designed an underground tunnel system for toad movement (Int5, 4, 1). Unfortunately it was a very expensive system which the group did not have the funds for (Int5, 3, 9). Instead they adapted the idea to a simple and relatively inexpensive temporary barrier and bucket system which they could install at a fraction of the cost.

They identified where the most suitable place for this installation would be from previous experience substantiated by analysis of previous records. Having set the goal, a Toad NUTS leader sought permission to install the intervention from the relevant authorities and local residents. This was important, as certain residents proved to be obstacles to installing the intervention. A resident who was set against the barrier, runs a horse riding school and the students and horses use the affected road. She did not want the horses spooked by the intervention. With discussion and negotiation this resident eventually relented (A. Faraday, personal communication, August 3, 2014). After navigating this and other hurdles, the intervention was erected but was carefully monitored for the two month period that it was up.

A low barrier of shade cloth was erected on both sides of the road with buried buckets or pitfall traps at 50m intervals (Faraday, 2013). Photographs of the barrier system can be seen in Appendix 7. Faraday (*ibid.*) reports that since the erection of the fence, there have been no toad deaths on that stretch of road whereas previously, many deaths were recorded there during the breeding season.

The Toad NUTS patrols during the 2013 and 2014 breeding seasons, included doing 'bucket runs' (Doc14, 1, 2; Doc11, 1, 101). This report was made after the 2013 season.

Walking patrols of the barrier checking the buckets (i.e. "bucket runs") are conducted at least once every 24 hours either at night or early in the morning. A total of 105 bucket runs were carried out by 24 patrollers over the 59 nights. A complete patrol of both sides of the road (about 1000 metres) usually took patrollers about 30 to 45 minutes depending if any toads were found in the buckets. A bucket run took place between 6am and 7am every morning and there was often also a patrol in the evening. During peak periods of toad movement, bucket runs were carried out two or three or even four times over a 24 hour period. Records were kept of which barrier (east or west) the toads were found behind, and if they were found in a bucket or waiting behind the barrier. In addition, all other species found were noted (Doc2, 8, 154).

A question noted in the Toad Barrier Report is that it is unknown whether and how the barrier affects individual toad behaviour. It was suggested that a toad may possibly turn around when encountering the barrier but that was not observed (Doc2, 2, 23). It is hoped that this issue can be taken up in the following season when the barrier goes up again (A. Faraday, personal communication, August 3, 2014).

Another anomaly arose from the data during the two seasons. Approximately only 30% of the toads travelling to the barrier make the return journey using the same route. No one knows what happens to the other 70% of the toads which were carried across the barrier on their way to the breeding pond. Toad NUTS are baffled by this and are deliberating how to

determine where the toads are going after spawning. Toad NUTS members hope to seek answers through further observation and / or testing but these methods must first be researched.

4.2.4 Marketing the toad saver

Another example of a conservation initiative introduced by Toad NUTS is the ‘toad saver’. After observing toads drowning in swimming pools, Toad NUTS devised a simple solution and encourage residents to install a device to the side of their pools. Essentially the toad saver consists of a square of rubber mesh fixed to the side of the pool with marine glue. The toad saver allows the toads to safely climb out of a swimming pool (A. Faraday, personal communication, January 31, 2014). Alongside this Toad NUTS produced a DIY guide and pamphlet showing home-owners their proximity to the known breeding ponds, and how to ‘toad-proof’ their gardens and swimming pools. This information can be found on the Toad NUTS website.

4.2.5 Recruitment and training of new members

Toad NUTS worked with broader social structures already in place by first sharing their ideas with the Noordhoek Environmental Action Group (NEAG) and recruited their first volunteers from the NEAG member network (Int9, 2, 1). They also spread the news of the Toad NUTS volunteer group through their personal networks of contacts, newsletter articles, flyers and posters to gather the original group.

Attracting new recruits to the group is something that others on the WLT-CC maintain the Toad NUTS co-ordinators do very well (Int7, 2, 4; Int5, 2, 5). Volunteer drives occur before the start of the season. Often recruitment flyers are used, word of mouth, a personal invitation is given or an opportunity is sought at a special event like a public display, school talk or a fundraising concert (Doc1, Doc5). Toad NUTS use terminology (often scientific) that is specific to their practice for example, amplexus (breeding embrace) and gravid (with eggs) females and shorthand terms such as ‘hopper’ (frog), ‘flatty’ (dead toad) and ‘bucket run’ (patrolling a stretch of the barrier intervention) (Vid1; Vid2; Obs1,1,6; Obs1, 3,13). Members use shorthand in the WhatsApp communication like SV (Sun Valley) or LM (Lake Michelle) to denote places or areas where they patrol (Doc14, 4,12). There are phrases that Toad NUTS member use like ‘eggs / no eggs’ to convey the breeding status of the female toads when reporting data (Obs1,2,14). They have adopted code words like ‘toadally’ which they use in greeting (Doc21,1; Doc7,2,33).

Volunteers need to be able to identify the toads, understand the nature of their breeding season, know what weather patterns trigger the mass movement of toads, know where their breeding ponds are in the local landscape and the roads that they have moved on in the past to reach the breeding ponds (Doc 3, 2, 64; Doc 2, 3, 29; Doc14, 2, 15; Doc14, 2, 30; Doc14, 3, 10; Doc4, 4, 1). Volunteers should be able to sex the toad and be able to tell whether the female is carrying eggs or not (Obs1, 3, 14).

Knowledge of terminology is important (Doc7, 6, 114). This type of information is shared at an information session by a Toad NUTS leader or senior member with new recruits and is also spoken about amongst seasoned members (Int9, 14, 9; Int2, 2, 10; Doc3, 2, 47).

Mentoring and assessing a new volunteer's progress in the field allows a facilitator to assess whether they have the necessary knowledge and skills to operate appropriately and skilfully in the field (Int1, 2, 9; Int2, 2, 10; Doc3, 1, 17). Learning how to patrol in the field is very important as there are certain protocols to observe regarding reflective clothing, driving style, lights and signs on vehicles, safety procedures when stopping on a road and handling the toad (DOC 3, 2, 54).

Novice volunteers are teamed with a skilled member whom they will accompany on their first patrol (Int9, 14, 9). This relationship is very important in reinforcing the information shared during training. The novice volunteer will continue to be mentored by the more experienced volunteer until they feel confident in their own knowledge and abilities at which time they may make their own pairing or team with friends (Int9, 14, 9). Everyone interviewed indicated that they had experienced this themselves and had also mentored others (Int1, 2, 9; Int2, 2, 10). These relationships support learning as belonging to the Toad NUTS community. When asked "have you ever mentored another person?" an experienced Toad NUTS member replied, "Yes I have. Every year there is usually somebody that is paired up with you for hands on training. It's one thing to learn in a classroom and another to be out there doing it" (Int2, 2, 10).

4.2.6 Communicating using the WhatsApp system

A transcript of a few day's communication is given in Appendix 8 and a photograph of a texting volunteer can be seen in the observation schedule in Appendix 7. A comprehensive road patrol system was put in place and "manned" (Doc7, 2, 53). Patrolling was and still is rostered by the group leaders (Int5, 2, 5). In earlier years, they used old fashioned techniques to draw up a schedule paired with endless daily telephoning to arrange patrolling duties (Int9,

14, 11). Now a WhatsApp group has been created for Toad NUTS communication and has proven very successful (Int5, 1, 3; Doc14, Obs1, 2, 2). An extract from this communication is shown here,

8/13/2014 2:09 PM: Leader: We are expecting rain tonight and tomorrow. Mary are you checking Sun Valley as usual? Belinda you are scheduled to check Fish Hoek. Shireen can you go around Milkwood Park tonight and tomorrow please? Linda and Alice can I roster you for tomorrow night Milkwood Park?

8/13/2014 2:10 PM: +27 72 196 3755: Yes I am in

8/13/2014 2:11 PM: Leader: Great. Remember to send your stats and patrol times to Robert soonest. Enjoy! (Doc14, 4, 14)

According to one leader, the WhatsApp group communication network has revolutionised the way that they work (Int5, 1, 3). Communication with the volunteers has been a key factor facilitating the day to day practice of the Toad NUTS group. The Toad NUTS leaders both mentioned that the telephoning to organise the roster was very burdensome in the past needing many hours of phone calls which also carried a cost (Int5, 2, 5; Int9, 14, 11; Doc13, 2, 55). The WhatsApp group allows all members to know what is being said by whom and to respond as needed. For example, if someone could not do a particular duty slot in the past, it would entail notifying the leader, who would then go through the list of volunteers calling each one, repeating a request for substitution until a willing substitute is found. One facilitator said that,

for every single night that we had to get people out, each of us would spend a whole afternoon phoning to try to get people out. Now it is coming straight from the person and not the leader all the time, and people are more likely to go and help. Now the request to swop duties is posted, everyone sees it and individuals then offer to swop (Int5, 1, 3).

An example of this is taken from the WhatsApp conversation.

7/25/2014 7:36 PM: +27 71 198 7875: I can do a bucket run tomorrow am if anyone wants to swop. Do we partner?

7/25/2014 9:36 PM: I am showing Sharon the bucket run tomorrow at 7am. Could you do Sunday morning rather?

7/26/2014 9:26 AM: +27 71 198 7875: Can't do Sunday Alice. Will ring you later to go through it all. Is Capri on the map this year (Doc14, 2, 23)?

The WhatsApp communication mechanism facilitates the social connections between Toad NUTS members and is used as a quick feedback system to accommodate changes, adjustments, report back and questions. Essentially the WhatsApp system has created a network connection system that everyone taps into and gleans information from. A benefit of

the system has been that members can share difficulties which they encounter while patrolling in real time and get a response from others very quickly. Scientists and other experts are also members of the WhatsApp group and can give expert opinion when needed. This is one such conversation below:

7/24/2014 9:18 PM: Toad NUTS member: photo – toads in bucket

7/24/2014 9:22 PM: Scientist: Excited for you and the team Alice! Beautiful female you got there!! She will provide a few thousand offspring for next season! We are looking forward to our visit!

7/24/2014 9:23 PM: Toad NUTS leader: Do you like our bucket numbering system?

7/24/2014 9:24 PM: Scientist: Looks like it is working wonderfully!! You had a bright idea there (Doc14, 1, 20)!

This means that members can tap into collective deliberation processes and benefit from the collective group wisdom while in the field at the time that a tricky decision must be made.

4.2.7 Public outreach, awareness and education

The survey of Noordhoek residents probed whether residents knew about the toads in their suburb and the Toad NUTS group. It gave some insight into whether a resident was likely to join the group as a volunteer (Appendix 3 & 4). The data showed that all respondents were aware of the toad, all of them had found out about the toad by reading about it and four out of six had seen the road signs pertaining to the toads crossing the roads. Five out of the six respondents knew of an awareness campaign but only half knew about the Toad NUTS group. Many felt privileged to share the area with the toad (four out of six). Half the respondents would consider joining a citizen science group and only one would volunteer for a project involving a toad (and she was a Toad NUTS member) (SS1). The respondents indicated that the strongest motivator to volunteer would be their personal interest in the project and the benefit to the environment (SS1). The foremost reason given for not volunteering to join was the lack of time. As the number of respondents was low (seven), the survey summary cannot be seen as representative of the whole community. Therefore only very little data from the survey was useful however the data does indicate that it is likely that the public awareness campaign is effective. The media articles seem to be the most effective tool, road signs are slightly less effective but noticed none the less.

Toad NUTS leaders realised that not everyone will get involved in the project but their aim was that everyone be conservation minded about the toad in their own way because the toads need consideration from the people they come into contact with (Int5, 3, 10). Toad NUTS

leaders revealed that,

We knew that saving this animal from extinction could not be done by governmental agencies such as Cape Nature or SAN Parks alone. This animal lives in our gardens, walks down our roads and breeds in ponds that are mostly on private land (Doc3, 1, 24).

The Toad NUTS leader's approach has been to make the greater Noordhoek community feel included in toad conservation (Int9, 2, 2; Int5, 2, 4; Doc3, 1, 37; Doc9, 1, 1-8; Doc11, 1, 71). From the start they aimed to create a sense of community ownership for the toad (Int5, 1, 1; Int9, 2, 2). They wanted Noordhoek residents to be aware of the toads, have a good knowledge of the toad, and understand the motivation for and nature of the Toad NUTS activities. One leader explained that the toad occurs everywhere and their movements cannot be controlled. At best they hope that every resident knows and cares enough just to make their property toad-friendly, to allow the toad to coexist safely with them there and move unhindered through the area (Int5, 1, 1).

A 2010 recruitment flyer states, "as their habitat is now our gardens, we suburban residents hold the future of this animal in our hands" (Doc3, 2, 47). One Noordhoek resident interviewed on a video made in 2013 said,

I think that it's really important for the community to take care of this animal because they are crossing roads and people are just killing them, and it's completely decimating the population of Western Leopard Toad (Vid2, 1, 9).

This data seems to indicate that the presence and consideration for the toads has in time been woven into the Noordhoek community's identity. This has required a concerted and consistent communication effort.

Toad NUTS members have been very effective in creating public awareness through the use of newsletter and newspaper articles, information boards, information flyers, public displays and open meetings (Doc3, 2, 47). Articles describing the work of the Toad NUTS are featured in city papers like *The Argus* and in the local Noordhoek magazine, *The Full Circle* (Int 11, 2, 6) (Appendix 14). Information boards are permanently installed at the Noordhoek Village Center. Pamphlets, car signs, posters, bumper stickers and branded clothing are used (Doc7, 2, 37; Doc 7, 7, 174). This has a positive effect in the community who are also readied for the coming breeding season (Int1, 1, 2; Int5, 1, 1; Int6, 1, 6). They are alerted and are on the lookout for toads and volunteers on the roads. Toad NUTS members feel that communication with the greater Noordhoek community is important to make their "job" easier and to get co-operation and consideration for the toads and volunteers (Int 11, 1, 4; A.

Faraday, personal communication, August 3, 2014).

Toad NUTS members also host public displays where they share information and use the opportunity to sell items like bumper stickers, branded clothing, toad cupcakes, toad warning signs, calendars and toad games for children (Doc7, 7, 177). See Figure 4.1 and 4.2.



Figures 4.1 & 4.2: Toad NUTS volunteers host a public display in a local shopping centre (Photograph: WhatsApp group communication, Aug 2014).

A series of educational interventions are done by Toad NUTS members to encourage a greater awareness among Noordhoek and Sun Valley residents of the Western Leopard Toad and their vulnerability (Int5, 1, 1; Int9, 7, 39). Members use their social connections to arrange these presentations and sell bumper stickers, hats, t-shirts and other Toad NUTS merchandise which further familiarises people with the Toad NUTS brand/logo when used (Int5, 2, 8).

The Toad NUTS group make use of certain businesses to market their activities for example, the local veterinarian displays a Western Leopard Toad notice and a Toad NUTS information poster (Int4, 1, 2). The Noordhoek tourism office included a toad alert in their August newsletter with some information on its breeding habits and the Toad NUTS web address (Doc15, 3, 7). Occasionally bumper stickers will be sold at such places.

One strategy used from the start was to “include children – build awareness through talking at schools” (Doc3, 1, 31; Int5, 1, 1). One of the Toad NUTS leaders is a Montessori school directress and she created a presentation teaching children about the Western Leopard Toad. This presentation has been successfully offered at four Montessori schools, three in Noordhoek and one in Wynberg (A. Faraday, personal communication, January 31, 2014; Doc7, 7, 152). A presentation suited to children aged eight and older is given to Sun Valley Primary and Redham School classes (Int5, 4, 2, Doc7, 7, 152). Both sets of presentations have focused on what the children can do to help the cause. Students are given a bumper sticker for their parents’ cars (Doc7, 7, 151; Int5, 2, 8).

A member, who is a journalist, is dedicated to the task of writing articles. She says that she writes at least two articles per season, one before and one after, reporting on the findings of the season and inviting people to join the group (Doc17; Doc18; Doc19; Doc20; Doc21; Doc22). She has knowledge and experience of how to approach the various media authorities to have Toad NUTS material published. Other members have enabled radio broadcasts, flyers, posters and email communications. An “evening radio toad traffic report” was compiled by two members of the WLT-CC, one a Toad NUTS leader. The initiative was sanctioned by the committee (Doc6). Cape Talk interviewed a Toad NUTS leader just before the 2014 season started and have repeated a cautionary daily to listeners between 5 and 6pm during the season to watch out for the toads and drive slowly in the affected areas (Doc6, 5, 92, Int12).

A Toad NUTS website (Toad NUTS homepage, 2014) was created by one of the group’s leaders, which people are referred to and which carries a wealth of information. The website is listed first when googled. There are contact numbers listed on the website and members are frequently called by home-owners wondering what to do about the toad living in their garden or for other reasons (Doc7, 7, 169). The website is comprehensive, containing much information about the toad and the Toad NUTS activities. Residents, readers and audiences are referred to this website for information and contact details (Doc18, Doc19). The Noordhoek community is generally technologically resourced and enabled. The internet is widely used and Toad NUTS has capitalised on this to enhance their communication strategy with people outside of the group (Toad NUTS homepage, 2014).

It would appear that the community think that Toad NUTS have something interesting to present. Members are asked to give talks to various social groups (Int9, 7, 39). There are

frog walks at Lake Michelle with children. A Junior Rangers group comes for a weekend every year. On one night of the weekend they have a lesson in toad work and the next night an action is taken in support of the toads. In the past they have stopped cars to talk to the drivers and they have done a census (Int9, 8, 39).

Toad NUTS have been featured on two television shows, 50/50 and Carte Blanche which had a huge effect in that it reached a national audience and the Toad NUTS project was seen by many. The feedback received was very positive (Int5, 4, 1).

Hank (2013) is of the opinion that there is evidence of an ethical shift when community members become involved or basically aware of the project and its dynamics. There are photographs on the Toad NUTS website showing Noordhoek residents proudly displaying signs on their gates depicting that toads have right of way (Toad NUTS homepage, 2013). Residents also display the Toad NUTS bumper sticker on their cars (*ibid.*). People are learning about the ecology of the toads and how to protect and coexist with the endangered toad.

4.2.8 Raising funds

Toad NUTS is an informal volunteer service group. The group has no income or legal status nor bank account. Toad NUTS makes use of the NEAG's banking facilities to manage its money (Int9, 7, 39). Toad NUTS grew out of NEAG and is still considered as part of NEAG. Members need to be individually resourced in order to participate in Toad NUTS activities. As a minimum they own vehicles and can afford the fuel cost of patrolling (A. Faraday, personal communication, August 3, 2014). When equipment like reflective raincoats, car stickers, signs and rotating lights for vehicles were needed, money and equipment was donated by various local businesses (Doc7, 1, 24). This equipment is shared by volunteers with exchanges occurring at the change of duty shifts (Obs1, 1, 12; Int 2, 1, 3; Int8, 3, 15; Obs1, 11, 1).

Donations from NEAG and the Noordhoek Conservancy were used to produce stickers and t-shirts which were sold to raise more money at various opportunities (Doc7, 7, 174).

Our fundraising relied entirely on Cape Point Vineyards for a couple of years. Now that's fallen away. One of our volunteers is a very strong runner and she ran the puffer one year and got about R20 000 - R25 000 in sponsorship for that which was great. The only other thing that we use for fundraising is that I talk at schools and I charge R10 per child and then I give them a bumper sticker (Int9, 15, 12; Int5, 3, 8).

Funds are used to purchase equipment, finance marketing campaigns like posters or flyers and to enable conservation initiatives like the barrier and bucket intervention (Int9, 15, 12, Int5, 2, 8, Doc 1, Doc7, 1, 18).

For a few years a local wine estate donated a percentage of the profit from the sale of the Splattered Toad wine to the Toad NUTS group (Int9, 15, 12). When wanting to erect the barrier intervention, one year's allocation of funding was carried over to the following year and the funder got the impression that the money was not needed and withdrew the funding which created a funding shortage when it was needed most (Int9, 15, 14). This happened at the same time that the group wanted to install the first barrier, having spent a difficult four months of navigating bureaucratic processes to obtain the necessary approvals (Doc2, 6, 108). Simultaneously an accident occurred on the road where the barrier was to be installed when a drunk driver rear-ended the car of a patroller which made the need for the barrier more urgent (Int9, 15, 14; Int5, 5, 8). A Toad NUTS leader turned to EWT for help and the funding was granted (Doc2, 6, 110; Int9, 15, 14; Int3, 1, 7). The night the accident occurred coincided with the first day of toad mass movement. Many toads were killed. Four days later the barrier was up. During those few days 27% of toads trying to cross were killed.

Toad NUTS fundraise to pay for relatively big expenses like the barriers. Recently a community concert was held and R16 000 was raised. This money was used to purchase the material for the barrier and to pay a crew to install it. Three barriers were installed, two in Noordhoek and one in Tokai. (They used some of this money to install a barrier in a neighbouring suburb where there are insufficient volunteers.)

Toad NUTS practice and conservation interventions are strongly linked to available resources. Members have demonstrated the ability to raise funds using creative strategies when they need it. Their success in the field has attracted sizable funding from the Table Mountain Fund to do a feasibility study for the installation of permanent intervention measures (A. Faraday, personal communication, August 3, 2014).

4.2.9 Establishing new citizen science groups

There are a few areas where the WLT-CC operates collectively. There was agreement that more volunteer groups were needed to patrol all the areas where the Western Leopard Toads are found. The committee's approach is to identify potential facilitators and support them in establishing a functioning volunteer group (Doc8, 1, 16). In 2010, it was agreed that the

Toad NUTS leaders would attempt to establish other volunteer groups in areas neighbouring Noordhoek in the South Peninsula area. The Toad NUTS leaders and a few of the more experienced volunteers arranged an awareness drive and a big meeting at the Solole game reserve (Int9, 3, 7; Doc5). They sent out flyers and tried to involve all the relevant environmental organisations or champions operating in those suburbs (Doc5). Interestingly the flyer that was distributed at this time was loaded with toad information educating the reader even if they did not respond to the call. For example,

Every year from mid-July until September a migration of epic proportions happens across the Cape peninsula. Quietly, at night, individual Leopard Toads walk to their nearest ponds to breed. On route they face many dangers – swimming pools, dogs and open drains. But the biggest danger is from cars (Doc5, 1, 5).

In some areas things worked well and in others it did not.

We started stepping on toes without really understanding what was happening. So in 2010 we were having all these high hopes of what we would achieve and it just did not happen that way. Our volunteers could not handle the resistance and started pulling out. So I took over all the SPOTS areas and started trying to build up relationships with people in those areas (Int9, 3, 7).

The lesson learnt was that it is really important to work with the existing structures or people in an area and then to be very diplomatic or as one respondent says, develop “smoozing ability” when nursing a new volunteer group into being (Int9, 4, 10). In Noordhoek it happened in the same way, where the first cohort of volunteers started Toad NUTS after an appeal was made to NEAG members (Section 4.2.5). Each area is different and one cannot presume to know how things will turn out. One of the facilitators dispenses her advice:

Be respectful and really work hard on winning people over to the cause. They have to work out how they manage their volunteer group for themselves. If they need a conservation initiative which is often the case, the local members have to design strategies that suit their circumstances and implement this themselves. Toad NUTS can assist but not take over (Int9, 3, 7).

It has been the experience of the Toad NUTS leaders that people work best and remain volunteers for longer, when patrolling in their own areas rather than working in neighbouring suburbs. There are a few areas where volunteer groups have been established that work very well and other areas where the volunteer groups have struggled to maintain themselves. The committee gives the support that they can, as do neighbouring volunteer groups like Toad NUTS, but it is for the residents in a particular area to respond to the need and mobilise an active volunteer group in their own area in a way that works for them and their unique historical and social composition, circumstances, problems and resources.

4.2.10 Habitat restoration

An example of collaboration between WLT-CC members resulted in the successful restoration of a historic wetland in Kommetjie called Skilpadsvlei (Int9, 3, 7; Doc14, 3, 26). The Kommetjie Environmental Action Group project manager did not think that there was a problem with the Kommetjie Western Leopard Toad population but he went out patrolling accompanied by a few members of the Toad NUTS group when encouraged to do so by Toad NUTS members. In the first season, 2010, they only found one toad (Int8, 1,5; Doc14, 3, 29). Kommetjie has a historic wetland which had been filled thirty years earlier and only leaves about 3inches of water every year (Doc4, 1, 10). The traditional breeding grounds of the Western Leopard Toad had gone and the toads had gradually disappeared. It was a shocking reality (Int9, 3, 7).

After bringing this finding to the attention of the WLT-CC, a solution was devised and actioned. Skilpadsvlei was excavated, renovated and restored by the City of Cape Town (Doc16; Doc14, 3, 30; Doc4, 1, 13). The City of Cape Town representative on the WLT-CC took the lead on the project (Doc16, 1, 1). This involved planting indigenous plant species (that historically occurred there and from correct genetic source material), recreating habitat with on-going alien plant species control to facilitate the re-establishment of the locally indigenous plant species and putting in boardwalks. The toads have bred there for three consecutive years thereafter with large broods of toadlets reported late in each season leaving the wetland (Doc 4, 1, 18). Sadly road kill is also occurring on the roads surrounding Skilpadsvlei (Doc4, 1, 22). The toads there face an uncertain future and it requires that the Kommetjie residents take on the cause of this animal to ensure its survival.

Toad NUTS members feel that they played a part in drawing attention to the situation and figuring out what was going on (Int9, 3, 7; Doc14, 3, 30). An extract from the WhatsApp conversation reveals this sense of accomplishment,

7/30/2014 12:02 PM: At Skilpadsvlei in Kommetjie 10pm last night I saw 14 males in water and heard another 16 males calling in bushes on water edge. The chorus was louder than I can ever remember. Two gravid females also were spotted. This is a great success story as 3 seasons ago only 1 toad was spotted in the whole season and so KEAG organised the wetland to be rehabilitated. Last year I think 4 toads arrived and now 32 (Doc14, 3, 27)!

4.2.11 Use of road signage

Toad NUTS members feel that road signage is an important traffic calming measure (Int9, 11, 2). See Appendix 7 for various photographs of road signs. The WLT-CC arranges for the

making of sufficient information boards for all affected areas, getting the City of Cape Town's approval for installing these boards and the dissemination of these boards (Doc2, 3, 51, Int7, 2, 5). Volunteers specify how many of these signs they need in their areas at a WLT-CC meeting. After the City of Cape Town representative has obtained the signs and the approval to put them up, the volunteers are given their allocation (Int7, 2, 5). These temporary boards are erected by volunteers at the places where road kill is greatest. The City of Cape Town funds the posters and road signs and the local community volunteers on the WLT-CC coordinates the erection of the signs with their members (Obs1, 14, 11). This initiative works smoothly and is an enabling factor of Toad NUTS practices however there are some concerns with the signage. The Toad NUTS leader explains,

The committee will have a meeting by the middle of July to talk through all the plans. By that meeting we need to have all the stickers for the posters. They have to be up from the 15th July. We get given two months. That's really difficult for us because that could be a week too early and by the 15th Sept, those toads could still be walking. When the posters come down then we feel very vulnerable because they could still be moving. The season is determined by the weather so I cannot say (Int9, 10, 5).

The use and installation of road signs is regulated by various bylaws that affect the actions of the Toad NUTS members. Putting up road signage for instance, is a simple enough physical task but in reality many bureaucratic processes must be negotiated before permission is granted to do so. This is managed by the WLT-CC member who is also a City of Cape Town official. Approval must be applied for, the sign is stamped and the poster is signed. There are rules governing how and where the signs are to be placed which at times presents a problem. If the signs are installed in the wrong places, fines are issued as well as if they are still up after the allotted time. A challenge is the lack of lamp posts in Noordhoek which is stipulated as the preferred structure on which the City of Cape Town would like the posters placed. The Toad NUTS members realised that they could use estate agent boards upon the suggestion of another member of the WLT-CC, to put up the posters which works very well. Using this 'loophole' was a clever way to overcome the difficulty of applying the regulations in the local circumstances.

Permanent toad awareness signs, similar to road signs, were installed by the City of Cape Town in Noordhoek which Toad NUTS are not very satisfied with. Their concern is the false impression these signs create that toads are always on the move because the signs are always there (Int9, 11, 9). Toad NUTS feel that the signs lose the desired effect because residents are so used to them being there. They were told not to pursue the issue with the City of Cape

Town's works department, as there is a risk of losing the signs permanently. This department cannot manage the temporary installation of road signs. These incongruences impact the practices of Toad NUTS who hitherto have been unable to resolve the predicament.

4.2.12 Co-ordinating multiple stakeholders

The installation of the road barrier conservation involves burying netting and buckets at intervals along both sides of roads where road kill is high. (See Appendix 7 for various photographs of the installed barrier and bucket system.) When a Toad NUTS leader was asked about the process involved in installing the 2013 barrier, she answered that it took months to get the necessary permissions and that it involved an extended period of navigating bureaucratic processes (Int9, 14, 8; Doc2, 6, 103). She recalled some of the process as follows,

I had to go through the environmental people and they took about 6 weeks to get back to me and then they let me know that because I am digging into the ground for the buckets, I will have to get permission from Telkom and Eskom. Then I had to meet Telkom and Eskom at the side of the road and they said "Oh please there are no cables there". It's 30cm deep, there are no cables there. They [the City of Cape Town] then wanted to charge us a R2500 deposit and finally they agreed that we needed to pay R450 to put in the barrier (Int9, 14, 8).

In 2014 it took an equally long time that is, four months, to obtain the necessary permissions to install the barrier (Int9, 10, 6).

The main people to get approval from are the Roads and Storm water officials. They control the verges of the roads affected but they will only give their approval once all the other approvals are in place. An email to this department is required and then they direct you to Telkom and Eskom. You are required to get this and return to them (Int9, 10, 6).

After the first years' experience, the Toad NUTS leader knew who to speak to at Telkom and Eskom went directly to these people, and this part of the process went relatively quickly. The leader was then told that there are fibre optic cables under the road.

There is no real guide. One has to go from pillar to post discovering the procedure to follow for yourself. After getting these approvals, the Roads and Storm Water Department officials are still evasive because they are not exactly sure who to approach about the fibre optics (Int9, 10, 6).

The Toad NUTS facilitator was then given a list with names and contact numbers to work through to find out whom to get permission from concerning the fibre optics situation. After working through the list, it was discovered that the sanitation and water departments also have to approve the installation of the barrier. In total four permissions were needed before

the installation was signed off for Noordhoek and another four were required for the second area (Int9, 11, 6). By all accounts, it was a difficult process that required determination and tenacity to navigate.

The use of culverts and similar conservation interventions are mentioned in the draft biodiversity management plan for the Western Leopard Toad (Rebelo *et.al*, 2013). This document should prepare the way for the realisation of these types of measures (Int3, 2, 26). Even though authorities like SANBI and the Department of Environmental Affairs support this idea, the situation can be complicated because the problem will demand working across local government service departments. Even though putting in culverts would not require a huge engineering feat, it will take much co-ordination between many people and different government departments and other institutions. Existing bureaucratic structures have set processes which can make it very difficult to introduce a conservation strategy (Int3, 2, 26). Bringing about positive change can be an arduous process particularly if it means altering the practice configurations of entrenched processes and ways of doing things.

4.2.13 Scientific processes and data management

A contentious issue has been the generating of data by volunteers and has led to friction between the scientists in the WLT-CC and the volunteers.

[The SANBI scientist] did prescribe what he wanted and during the first couple of years he got what he wanted except for a couple of things which were impractical like taking a photograph and uploading on ISpot. You know you are working under huge pressure on the road. There are cars and you just wanting to get the toads off the road. Sometimes people take photos of the toad when the road is quiet but most times you are under huge pressure and don't have time for photographs. We did use Cybertracker and [the other leader] got some cybertrackers donated. But for me if anything is going to take more than thirty seconds, I'm not going to do it and neither will I recommend my volunteers do it, because it is dangerous. We are doing extreme conservation here and there are more animals being killed further down the road so you have to hurry (Int9, 6, 17).

What is sensible and safe to do in the local conditions when working on busy roads in dark and usually rainy conditions, is the volunteers' first consideration. They collate the data that they are able to and have dropped what is impractical or a hindrance to their practice. One respondent explained,

We have had this standoff on the committee where we have felt that they don't really get what we are doing. We are there to save toads ... and to keep the species from becoming extinct. They feel that we don't get what it means to do proper science ... and we don't really care about that as much as they feel we should but I think that the data that we keep is amazing for what we do (Int9, 12, 2).

The same member raised the concern that scientists have with the reliability of their data and explained that,

... you may have a person out there that does not know the difference between male and female. Some nights you are so busy that you don't record the data at that point and at the end of the evening you are likely to guess. That sort of thing, I'm sure happens. People have never done this sort of thing before (Int9, 8, 40).

Volunteers have become wary and suspicious of the scientists due to the friction and poor communication.

Volunteers are just not interested in added administrative tasks at the end. For example, we were requested to upload our photos to ISpot, the SANBI biodiversity mapping and identification website. I get that if I want different frogs identified that's good, but why would I upload 1800 records for the Western Leopard Toad? What is the point then? The scientist was very scathing about us not using ISpot. The other thing is that it is a lot of work. If you have picked up forty frogs it means that you have to photograph each one. Assuming that you do this on your cellphone, you need to download this to your computer after you have finished patrolling, and then upload every one individually to ISpot. ISpot is a step too far and it does turn people away. It's too much and it does nothing for us. The data recorded must be purposeful and doable by the volunteers while patrolling (Int9, 6, 18).

The co-ordinators also feel that they do not want to frighten volunteers away with too much data recording/collection and too much mathematics. Volunteers have to use their own equipment to photograph toads which is expensive and vulnerable to damage in rainy and dark conditions. Volunteers can feel abused when unreasonable demands are made of them and no feedback is given concerning how the data which they generated, is being used. A Toad NUTS co-ordinator relates a conversation which was a turning point for her,

When I started training the area co-ordinator in Clovelly, showing what is needed, she said "I'm not taking photographs. I can't ask my volunteers to use their expensive phones to take photographs. I've been part of so many environmental projects where they say they are going to keep this data and then use it and they never do." So I don't train my volunteers to take photographs anymore (Int9, 6, 19).

Toad NUTS members do feel that keeping records is important and has been key to detecting various important things like toad behaviour patterns and where the important toad breeding areas are (Int7, 2, 4; Int8, 3, 13). With data the success of patrolling can be measured. If data was not recorded, much information may have been missed. For example, it was found that one year a particular stretch of road could be busy and the next year it is quiet (A. Faraday, personal communication, August 3, 2014). It seems that the toads alter where they want to breed. These are some of the reasons why maintaining data is vital and why they will continue to generate and record data.

When asked about keeping records, a patroller answered,

We all keep a count and you hope that you put them in the right direction and that they don't turn around and come back. I don't keep an actual count, Richard keeps all the stats. You fill in your form each night and I think one night I got 27 which is a lot. I just turned down this road and it's amazing...they all decide to move on the same night. You know you look at the moon, the weather, the time of year, and yet it can pour and pour and pour in August and nothing, nothing, nothing and then in one night, they all move, and they all go and it's amazing. And then it's slipping on the road trying to stay safe. It's amazing. Again they keep our notes but they send all our stats on to Cape Town University. So there are professionals looking at our information. We still can't pinpoint why they all just go and sometimes it's against the odds really. If it has been a dry August which we had a couple of years ago they weren't leaving at all and I'm not sure whether they decide, but they must think, it's been four weeks now, we're gotta go, but how do they know that? How do they all know that? How do they all decide? It's amazing. It's incredible (Int8, 3, 13).

The Toad NUTS group have had contact with a few different herpetologists each making a different contribution and relating to the group in different ways. Some have made little input while others have been very involved. Only one or two have accompanied Toad NUTS members in the field to observe their practice, none from the WLT-CC. Having established a relationship with EWT, Toad NUTS were connected to an EWT scientist managing a road ecology project specifically recording road kill incidents (Int10, 1, 1). It was because of their association with EWT that the group was recommended to a researching herpetologist who use their data in his study of urban conservation interventions for endangered species (Int10, 1, 1). He took their data, justified its use and used this in his doctoral thesis (Int10, 1, 3). He also wrote a journal article based on his work (still in press) and acknowledged the Toad NUTS group as co-authors for the data which they supplied (Int10, 2, 9). He had high praise for their data and put it to good use. In an interview, a facilitator said,

...the scientist kept saying that he can't believe the data that we have been collecting for so long, the data is fantastic, why has no-one used it? It was such a breath of fresh air for us. The data can be used for research. He was very excited about using the data and the barrier data to generate funding and really start investigating leopard toads as a research project and he felt strongly that he could use our data to do that (Int9, 7, 21).

The scientist also advised them on how to improve their methodology and is available to advise them should they have questions (Int10, 2, 11; Doc14, 1, 24). The Toad NUTS facilitators feel that because of their intimate knowledge of the Western Leopard Toad in the local environment, they were providing information to the scientists that was new and unique (Int9, 2, 6).

The barrier intervention has been carefully documented and the numbers of frogs caught in the buckets and carried across the street is recorded. The numbers of toads killed on the road where the barrier is situated was also recorded. This data conclusively showed the effectiveness of the barrier intervention and forms the basis of a journal article as mentioned previously. This is a significant contribution to the scientific knowledge pool via the conventional method of publishing in a peer reviewed journal. Many consider information published in a peer reviewed journal as a qualifier of new knowledge (Int10, 2, 9). The association with EWT has also created associations with three scientists who made input to the report produced by Toad NUTS. This helped to guide the group in writing in a way that is acceptable to the scientific fraternity (Int3, 1, 19).

The Toad NUTS report on the barrier intervention demonstrates the rigor with which data was collected (Appendix 2). The report was written with a clear line of argument, has good structuring and an easy to follow, clear style of writing (Doc2, 7, 113; Doc2, 8, 131; Doc 2, 10, 180). Claims are made based on the results. It is hoped that Toad NUTS can develop stronger ties with scientists to inform the testing of the many questions that they have around breeding success and toad behaviour.

Two citizen science specialists both advise scientists to nurture the relationship with the volunteers (Int15, 1, 3; Int13, 1, 5). The scientist who controls the ADU virtual museums says that volunteers are “biodiversity champions” and require constant communication (L. Underhill, personal communication, July 10, 2014). He uses Facebook and posts regularly to volunteers using that medium (Int15, 1, 4). The relationship between lay person and scientist also depends on the disposition of the scientist. If the scientist takes trouble to understand what the volunteers are experiencing and doing in the field, they tend to be more understanding of what is feasible under the circumstances that they operate in (Int 13, 1, 6). One herpetologist was very complimentary saying that, “if it was not for the work of the Toad NUTS, the toads would have moved from endangered to critically endangered in the last seven or eight years” (Int9, 8, 41). This achievement is worth the effort of nurturing the volunteer-scientist relationship.

4.3 Learning dynamics in the Toad NUTS community of practice

The Toad NUTS group is viewed as a community of practice because it meets the description given by Wenger (1998), characteristic of a community of practice (Section 2.5.1).

Volunteers are mutually engaged in the protection of threatened Western Leopard Toads.

Members are mainly involved in the joint enterprise of patrolling roads at night during the toad's breeding season and a number of other practices orientated to protecting the toads (evidence presented in Sections 4.2.2; 4.2.3 & 4.2.4). Toad NUTS have a shared repertoire with a specific vocabulary choice and shorthand style for which data is presented in Section 4.2.5.

Wenger (1998) describes four components of learning that characterises social participation as seen in communities of practice (Section 2.5). The four components were used to describe the nuances in the learning detected in the Toad NUTS group. Data relevant to each component is presented below.

4.3.1 Learning as belonging.

The Toad NUTS group, as a community of practice, involves relations between volunteers constituted by mutual engagement in practices. Communities comprise social configurations in which enterprises are defined as worth pursuing and participation is recognizable as competence which underpins learning as belonging.

Establishing a successful volunteer group and maintaining it, is a challenge. The group has a reputation for being able to recruit and retain their volunteers, motivating them to continue even when volunteers lose heart because they see no toads moving for many days as would be the case in a dry season (Int7, 1, 3). A Toad NUTS leader relates how she has received comments from people who have said that they have tried for many years to get a group going and have not managed. Yet Toad NUTS has attracted many members and after many years the group is still flourishing. The leaders feel that this is because they pay attention to the social relations of the group. The leaders wanted to make road patrolling a fun event. There was the question of making sure that people were able and 'qualified' to perform the task but it was agreed that patrolling needs to be an adventure otherwise people will not do it. "You can't take it that seriously. We are picking up toads, let's be clear, we are not changing the planet but we need to make it fun so people can look forward to it" (Int9, 2, 2).

Toad NUTS leaders try to arrange one social group outing per season that involves a different nature interest. For example a visit to the Kenilworth race course to see the highly endangered micro frog. This was a fascinating visit that was positively received. The leader said that it was a relief to experience nature in a relaxed way with other members of the group rather than have the constant strain of dealing with toads in danger (Int9, 13, 7).

We have a start of season party and an end of season party. Only rule is that the start of season party has only tea and coffee and the end of season party has alcohol. So the start of season party tends to be serious (Int9, 4, 11).

This is where the plans for the coming season are discussed and everything is readied (Int9, 10, 5). Such an event draws the volunteers together and motivates them. The end of the season party is a celebration. Establishing a meeting place for volunteers and a space to get to know each other is important in creating the connections and friendships that lay the foundations for learning together. Meeting casually gives volunteers the chance to assess who they could work with, who they are less likely to work with, who has knowledge and who is less knowledgeable. This is a time to find potential partners for patrolling.

In the field patrol teams may have ad hoc meetings when passing to discuss what they have found where, where they have been, where they will be going etc. to co-ordinate their patrolling efforts (Obs1, 7, 24). This allows members to deliberate with others to make decisions in real contexts again reinforcing a sense of group dynamic and supporting learning as belonging.

The WhatsApp communication also allows a volunteer or patrolling team to tap into the collective knowledge base if they have a question (see Section 4.2.6). A type of virtual deliberation is possible and a collective decision can be made concerning a real problem encountered in the field by a patroller even if that person is on their own physically. In this way a volunteer can demonstrate reasoned practice which is the outcome of participative processes. This type of collective discussion and deliberation enabled through the WhatsApp facility supports learning as belonging.

Toad NUTS leaders have demonstrated their communication skills and aptitudes for networking and interacting with people many times and in different ways with respect to the group itself and the greater Noordhoek community. This was referred to in Section 4.2.7 on the topic of public awareness, outreach and education. The history of the group and the way in which they carry out the public awareness and education initiatives, has built the reputation of the group as competent. Toad NUTS are also considered competent based on the success of their conservation endeavours (Section 4.2.2; Section 4.2.3; Section 4.2.4). Toad NUTS are called by friends or community members, who use the contact numbers given on the Toad NUTS website, when they find toads in their garden or pool. This implies that the community has come to recognise the expertise residing within the group and regards

members as competent in matters regarding to the toad (Int1, 2, 33; Int2, 3, 11; Int5, 3, 10; Int9, 8, 39).

When a member of the Toad NUTS group was asked how the group is perceived by the Noordhoek residents she replied that in general there is a positive regard of Toad NUTS. She has not experienced any resistance (Int11, 1,5). Other members reported that they did receive some animosity when they started Toad NUTS (Int11, 1, 5; Int1, 2, 6; Int2, 2, 7). This animosity was due to patrollers driving slowly and stopping on the road thus halting traffic inconveniencing other drivers. With time and growing awareness, Toad NUTS members say that the community has become far more understanding, tolerant and encouraging of their activities. Drivers now wait patiently for them to remove toads off the roads. One member related how waiting drivers applauded after watching her struggle to pick up a toad from the road (Obs1).

Members were overwhelmed by the turn out of almost 200 community members supporting their recent fundraiser (Doc1, 2, 5; Int2, 3, 14; Int9, 9, 2). All the tickets were sold and there was standing room only. The community was excited to be there and members experienced the event as tremendously affirming. One Toad NUTS member stated, “you know what, I think that they [the community] genuinely think that Toad NUTS is doing a brilliant job” (Int2, 3, 12). It gave them a sense that the community values their efforts and sacrifices. The community rallies behind Toad NUTS showing support and encouragement for what they do. They recognise Toad NUTS as people with the expertise to do what they do (Doc1, 2, 1).

An email was sent to one of the Toad NUTS co-ordinators following the concert with the following comment, “...this event further pulled a somewhat distressed community together. It was heartening to see so many neighbours gather together. Thanks for enabling this side benefit” (Doc13, 1, 9)! The positive atmosphere and commentary also made Toad NUTS members conclude that their strategy to make saving the toads a community initiative had born fruit. This has resulted in a very aware and caring community with respect to the Western Leopard Toad. Of the same event, one Toad NUTS member commented that, “our community is incredible, they are very sensitive about where they live and the nature here” (Int1, 3, 6).

4.3.2 Learning as doing

Wenger (1998) says that learning as doing taps into the unique and situated practices of a

community which has historical and social resources, frameworks, and perspectives.

Evidence presented below indicates that Toad NUTS members bring their personal skills and knowledge to the community by virtue of their training and occupations. For example, one member is an actuary who has managed the data generation, recording and analysis from the inception start that is, 2007 (Int8, 3, 13). He has interpreted their data analysis and made sense of the data in a way that has refined the Toad NUTS understanding and practice.

Alice's husband is an actuarial scientist which is a huge help. They code or at least they try to record their data at the end of every night and put it all on disc and then upload it all onto his database. At the end they compile an interesting report. Their information is quite accurate (Int7, 2, 5).

Others have made contributions in other ways that have benefitted the group and improved its effectiveness. For example a journalist member is responsible for newspaper and newsletter articles (Section 4.2.6.). An educator member was responsible for the creation of the lesson material for Montessori schools (Section 4.2.6). Another member put her human resource management training to good use in the managing of relations within the group, with the Noordhoek community, neighbouring groups and with other stakeholders (Section 4.2.7; Section 4.2.1; Section 4.2.9; Section 4.2.12; Section 4.2.13).

Toad NUTS members learn from spending much time being in the field observing toad behaviour and interpreting what is known (formal or disciplinary knowledge) about the toads in the local environment. The situatedness of learning is key to the Toad NUTS expertise. Frogs are notoriously difficult to see in nature. Toads, even though large, are no exception especially when they are sitting still on the road and one is driving at some speed. The high road kill toll accounts for drivers who do not notice the toads on the roads because "they are very difficult to see, but your light normally picks up any type of reflection because they've got a white throat, then their little white throat reflects off the road" (Vid1, 1,11). Another patroller says "you're looking and it's amazing how your eye adjusts. You do often see leaves and twigs and stuff, and then you see something that looks like a stone in the road" (Int8, 3, 15; Section 4.2.2). Through doing patrolling, Toad NUTS volunteers have developed a search image (an acute visual perception) for the toads which enables their patrolling success. This was learnt as they gained patrolling experience.

Data capture is important and it needs to be done accurately. The group relies on each member to be diligent in their duties while on patrol to validate the dependability of their

data. There are protocols concerning sending the data on to the data keeper who builds and keeps all the records (Int8, 3, 13; Int9, 6, 18 & 19, Doc14, 4, 1).

Over the last seven years a comprehensive picture that describes localised toad breeding behaviour that is detailed and revealing has been built up (Doc2, 10, 179; Doc3, 2, 68; Doc7, 4, 90). The observations made during the first two years were summarised in a report, titled the Final Toad Breeding Report Aug 2008, which details facts of toad movements in the local context not known before (Appendix 11). This report states,

Over the peak period of 9 nights there were toads on the roads every night (100%), which is why this period was identified as the peak period. For the main season of 39 nights, toads were on the road on 21 nights (54%). Rain was a very important factor in the migration of toads (for example the 'early bird' start to the season on 19 June, the actual start of the season on 27 July, and the start of the peak period on 13 August, were all rainy nights). However, it was clearly not the only factor. For example there was rain on only 2 of the nights over the peak period of 9 nights. This pattern appears to indicate that once the toads start the main migration they do not stop just because it is not raining (Doc7, 3, 3c).

This type of detailed information is gained through observations made over time. It is meaningful because not only does it allow for an informed or reasoned practice it brings an expertise of local experiences that is defensible.

Now it is very interesting because we invited Prof. Michael Cherry to come and speak at our end of season party last year. He only did it for three years and he was based at Sun Valley's breeding ponds which we are also based at. He describes the leopard toad as an explosive breeder with only 3 to 8 breeding nights per season. That is totally not our experience. I have seen over the years that they will have a 3-8 day peak, then it will die down, then there will be another 3-8 day peak. Last year we had five peaks in the season (Int9, 2, 6).

The analysis of the data generated is important for interpreting how the toad responds to changing weather in different years (Doc6, 3, 62). The review of the data also allows for a review of practices and the consideration of amendments to practices as well as the deliberation of other strategies. Analysis of the data can also reveal hitherto unknown information about toad reproductive behaviour (Doc7, 2, 64). The volunteer must possess cognitive skills like critical, systematic and creative thinking skills to meet these demands. These skills are also evident in the writing of reports and newspaper articles (Doc2; Doc6; Doc10; Doc17; Doc18; Doc19).

The proposed toad traffic report suggests that short announcements be made,

before 6pm every night during the breeding migration. The migration period lasts from mid-July to early September. During this time, the toads are likely to move on rainy nights (Doc6, 5, 92).

This information shows that patrollers know that toads move after dark in winter (from 6pm) and that the season is likely to occur from mid-July but this is dependent on rainfall. If it is a dry season, movement will be delayed,

However, if there has been no rain for a week or more, the toads may start moving in dry weather. In a period of roughly 42 nights, the toads will probably move on half of those nights (Doc6, 5, 92).

This quote is loaded with information on what volunteers have learnt while doing patrolling, being in the outdoors with the toads, observing and finding out how toads respond to different conditions on different days. Through patrolling and recording how many toads the volunteers move off the road every day, they have discovered that there is a particular day in the season when regardless of the weather that the toads will start their breeding migration on.

A patroller was filmed saying “ponds like this are where female Western Leopard Toads lay their eggs before migrating back to gardens or parks” (Vid1, 4,106). Patrollers have learnt which particular ponds are used for breeding. Not all ponds are suitable for different reasons. By observation patrollers see which ponds toads are moving too. They become familiar with the pond and its characteristics. This is why it was mentioned in the WhatsApp communication,

7/26/2014 11:47 AM: Alice: I would love you and Lea to keep your eyes open on rainy nights in Capri. Note the roads on which toads were seen. We have very little idea of the toad situation there.

7/26/2014 11:48 AM: +27 71 198 7875: Ok cause there are 2 streams very full.

7/26/2014 11:53 AM: Alice: Fast flowing streams wash their eggs away. They need sluggish or still water.

7/26/2014 11:55 AM: +27 71 198 7875: But there are reeds and still water on edges lots of tadpoles in there

7/26/2014 12:01 PM: Alice: Ok good to monitor. Can you take a drive round there tonight?

7/26/2014 12:05 PM: +27 83 704 7049: I would like to know if the toads breed in the pond in the far corner near Kommetjie road so perhaps check those roads. If you see a few toads this season in Capri and if can figure out where they are going to breed then I think Capri should be put back on the Map for regular patrols.

In this conversation a sophisticated knowledge of physical conditions of water bodies relating to toad preferences and behaviour is evidenced between a Toad NUTS leader and volunteer. This almost intuitive knowing is linked to years of learning as doing and is being applied to predict what the situation in a new location could be. These predictions are being used to direct a volunteer and answer questions.

When designing the bucket and barrier system, the following quote illustrates how volunteers altered the buckets because they knew that rain is a factor when the toads move: "So what we did with these buckets was just to make sure that there's drainage, so there's holes in the bucket" (Vid1, 3, 45). The ground water rise turned out to be a limiting factor in the system, as many buckets filled up during the season and had to be closed (Obs1,16, 4; Doc14, 1, 19). This is something that was learnt and had to be taken into account while working the barrier. The buckets have drainage holes and lids. When the water table rises and the buckets fill, the bucket is closed with the lid and the toads cannot get in (Obs1, 16, 4). This prevents drowning. Toad NUTS know that toads can only float for about a day before drowning (Vid1, 4, 97).

Toad NUTS leader uses the WhatsApp communication system as a learning tool. One leader uploaded a number of the common frog calls to the system and sent them to the volunteers to learn to identify which frogs are calling when out patrolling. As the volunteers are out patrolling, they are learning to identify different frog calls.

7/30/2014 8:04 AM: Alice: While you are listening at the ponds you will hear this one: clicking stream frog

7/30/2014 8:04 AM: Alice: <audio omitted>

7/30/2014 8:05 AM: Alice: <audio omitted>

7/30/2014 8:05 AM: Alice: And these too

7/30/2014 8:06 AM: Alice: <audio omitted>

7/30/2014 8:07 AM: Alice: <audio omitted>

7/30/2014 8:08 AM: Alice: <audio omitted>

7/30/2014 8:09 AM: +27 82 659 0957 joined group

7/30/2014 8:59 AM: +27 72 196 3755: Brilliant. Now we can start identifying. 😊🐸

4.3.3 Learning as meaning-making experience

Evidence presented below suggests that Toad NUTS members perceive their contribution to Toad NUTS practices as meaningful. They experience life and the world as meaningful

because of their participation in Toad NUTS practices. They are both affected by participation in these practices and affect environmental actions which are meaningful.

A Toad NUTS leader relates the following story concerning how working with the toads was emotionally therapeutic, helping another volunteer to deal with grief.

A lady from Sun Valley joined the group after she lost her mother. She said that when she started saving toads it felt like everything had colour again. Everything had meaning again. Everything had seemed so drab and had lost meaning...People get very connected to them. It shows people want to be connected to the environment and in her case it helped her to get over the grief of losing her mother (Int2, 1, 6).

A member described a euphoric experience when a Carte Blanche film crew was with them one evening. She describes the evening as unusually still and dry and that they were at the breeding pond at the base of the Cape Point Vineyard. Looking into the pond, shining a light into the pond, there were well over a 100 toads floating in the pond calling.

It was a magical scene where everything just came together perfectly. Usually we are experiencing the toads on the roads in the pouring rain, getting squashed or getting back on the road even after you have saved them. And you see two or three at a time and here there were so many all calling, trying to outdo each other. It was amazing (Int2, 1, 4).

The primary source of meaning in a volunteer's membership to Toad NUTS, is the protection given to the Western Leopard Toads (Doc 3, 1, 18). The members of Toad NUTS all gave their love for the environment and nature as reasons that motivated them to joining Toad NUTS and that they desired to serve the community. This is the reason for their continued efforts since 2008, to get the toads off the roads (Int1, 1, 2; Int7, 2, 9). The volunteers interviewed claimed that in the first year of the Toad NUTS existence, 2008, members recorded seeing approximately 250 toads in Noordhoek, of which 75% were alive and 25% were dead (Doc7, 1, 6). Toad NUTS members have recorded 39% of toads observed, and possibly more, dead without patrolling while with patrolling that number can drop to 20% dead (Doc10, 2, table 2).

Another type of toad movement occurs when the toadlets leave the breeding ponds. This is explained in the Final Breeding Report 2008,

The Western Leopard Toad is an explosive breeder, using the strategy of numbers to overcome the odds of predation. As a result, all the baby toadlets leave the breeding ponds together approximately 3 months after fertilization. We know that this occurs early (6am) on a wet late November or early December morning. Thousands of 5c piece-sized toadlets disperse from the ponds and into our gardens looking for shade and suitable foraging. (Damp areas, compost heaps and veggie gardens are particularly attractive to them.) (Doc7, 6, 4)

Toad NUTS members keep a look out for toadlet movement and assist with this too. The Toad NUTS website shows photographs of Toad NUTS children carrying buckets of toadlets. Again, protecting the toadlets will safeguard toad numbers and so this different conservation action is meaningful.

The Toad Barrier Report 2013 (Doc2, 9, 167) records that no dead toads were found in that area after the barrier intervention went up. This was extremely meaningful to the group who had found a way to achieve their objective of zero toad road kill during the breeding season and the barrier made conditions much safer for volunteers (Int9, 14, 8). When asked whether the barrier was considered the most important achievement of the Toad NUTS group to date, one of the Toad NUTS leaders answered, “definitely, it changed everything for us” (Int9, 14, 8). Following the primary purpose of the group, the knowledge accumulated through learning as doing and the accumulating data, has been meaningful in allowing for other strategy developments.

This has given the Toad NUTS the confidence to contribute to the WLT- CC meetings meaningfully and make submissions to the Department of Environmental Affairs concerning biodiversity management and conservation policy (Int9, 3, 7). Being able to make input into national policy documents is a meaningful experience and makes the time in the field that led to the acquisition of this knowledge valuable.

Another account of the actions of Toad NUTS perceived by the volunteers as meaningful, has been aiding volunteer action in neighbouring suburbs. Toad NUTS assisted Kommetjie residents to initiate toad monitoring in their suburb in 2010 (Int9, 3, 7) which led to the restoration a wetland (See Section 4.2.10).

The Toad NUTS group have learnt many things through experience over the nine years of its existence that have been meaningful to them: They have refined their patrolling practices which have resulted in a reduction of road kill numbers. The success of different conservation strategies particularly the barrier system along certain stretches of road has reduced road kill to 0%. The education and awareness initiatives that they present are meaningful as they have reaped the benefit of greater sensitivity to the plight of the toads and a greater understanding and support in the Noordhoek community of the Toad NUTS practices and initiatives.

Experience has meant learning new things about the toads in the local environment which has given Toad NUTS members a voice in the community and in the conservation field and enabled members to participate in management or government processes.

4.3.4 Learning as becoming

Personal identities feed in and off the collective group identity thus contributing to the meaningfulness of belonging to the group and participating in the group practices.

One of the leaders explains that giving a volunteer group a name facilitates the establishment of a group identity.

The way the Toad NUTS system works is that Sharon handles the bottom of Noordhoek, and then there is an off shoot of Toad NUTS called SPOTS which stands for South Peninsula Outstanding Toad Savers because we like our acronyms. Names are important for volunteers to feel like they belong to something like KERMITs or whatever. So SPOTS were now my area (Int9, 3, 7).

Toad NUTS volunteers also wear a type of uniform (reflective raincoats and the Toad NUTS logo) to identify themselves as members (see Photographs 4.1 & 4.2). There is a Toad NUTS website which displays their logo (Toad NUTS homepage, 2014).

A Toad NUTS leader reports that,

a lot of the volunteers, when the season is over, we've seen no toads, we're quitting. If we see any more toads, we'll let you know. They say "on no, already...", they do look forward to it I think, a lot of them. It is a type of an adventure. It's a whole other world. It's the closest to a night drive in the Kruger Park in a suburb. Just that it's wet, rainy and cold (Int 9, 14, 11).

Even after many years of belonging to Toad NUTS, members still find interacting with the toads thrilling (Doc14, 2, 4). One of the co-ordinators called it “extreme conservation” where every toad picked up is significant and volunteers are “toadally” enthusiastic, dedicated and passionate (Doc7, 2, 33). The nature of Toad NUTS activities creates an image of excitement and danger which lifts ordinary winters’ nights to a thrilling adventure which by implication makes the volunteer adventurous.

All interviewees maintain that their Toad NUTS activities both increased their knowledge of the Western Leopard Toad and their competence in handling the toads (Int1, 2, 5; Int 9, 1, 2). When asked to describe how being a Toad NUTS member has changed them, one member said,

it's feeling that you can make a difference. You know I was feeling like the situation was so out of control and ... there's so much I can't do, this empowers me to do something. And it's a small thing but for every toad you catch you make a difference for the local community (Int8, 3, 12).

Being a volunteer changes one from feeling helpless to feeling empowered and feeling able to make a positive contribution to an environmental problem (Int 8, 3, 12).

A member commented that she is more knowledgeable of other frog species now because of her experience with the Western Leopard Toad. She says that she sometimes picks up other frogs and she has downloaded their calls on her cell phone. She has bought numerous books on frogs and she shares her knowledge with her children (Int2, 2, 6). One of the coordinators has also mentioned the same thing concerning becoming aware of the plight of other animals in their area and is concerned for their survival too.

Their intense involvement with the toad also makes them more aware, interested and sensitive to other animals. A member said that being involved with Toad NUTS activities made her more intimately connected to her local surroundings and other animals.

I had a phobia of reptiles and I never really had much affection for toads or frogs either. Now I am always aware of everything where ever we go and I just want to find out all there is about this. I absolutely love it and I am thrilled that I love them, that I have made this connection with amphibians. I love nature and my holidays are often in nature, in the bush, diving in the sea with fish and I have that with the frogs as well (Int2, 1, 6).

All the Toad NUTS members interviewed said that they loved nature and being outdoors and environmental issues like toads being killed on the roads were a concern that motivated them to join the group (Doc3, 1, 10; Int8, 3, 13). The Toad NUTS members in many ways demonstrate a heart connection to the toads as if they are allies in the battle for survival (Doc14, 3, 13). Members care deeply for the toad and its survival and they are prepared to make personal sacrifices to ensure their survival.

Another member is championing the cause of porcupines who also suffer road kill (Int9, 13, 7). A third member volunteers for an NGO focussed on elephants. Shortly after being interviewed, this member made the decision to switch career paths from business to a nature based career. She sent an email to all her friends and family that said, "I am sending you all my CV asking you to keep me in mind if you ever hear of something where I can work in conservation in any shape or form" (Doc12, 1, 7).

A member relates that her family and friends are very supportive and interested in what she does. They listen when she talks to them about her Toad NUTS experiences. Her husband jokes with her about her involvement but he knows that it means a lot to her. When he drives around and happens to see a toad, he will pick up the toad and proudly tell her afterward (Int1, 2, 10). They think of her as ‘a bit different’ and respect her Toad NUTS involvement.

4.4 Conclusion

The data collected was presented in this chapter in a way that aligns to the research design plan described in Chapter 3. Practices were set out in narrative form as it was detected in bundles of sayings, doings and relatings. The practices described were the conservation interventions of patrolling, monitoring the temporary barrier and the toad saver, recruitment and training of novices, the WhatsApp communication system, public outreach, awareness and education, fundraising, representation at WLT-CC, establishing new citizen science groups, habitat restoration, road signage, managing multiple stakeholders and scientific processes and interactions. Data describing the learning dynamics detected in the case study were arranged in four sections, each representing a component of this learning. These were learning as belonging, learning as doing, learning as meaning-making and learning as becoming.

CHAPTER 5: Discussion of findings

5.1 Introduction

To facilitate the discussion chapter, the purpose of the study is revisited. The discussion addresses the research question, how do citizen science projects embrace learning and shape emergent environmental citizenship? This chapter is arranged according to each research goal. The data gathered during the research process and presented in Chapter 4 will be reconciled to the ideas shared in the literature review of Chapter 2.

5.2 Practice architectures features shaping Toad NUTS practices

The discussion of practice architecture features was guided by the review of the ideas which Kemmis and Groetenboer (2008) proposed (See Section 2.3). The authors describe how practices are shaped by practice architectures features such as previous actions, experiences and the way situations are arranged which are often beyond the control of a particular volunteer or group. Practice architectures structures occur within three dimensions which the authors list as cultural-discursive (in the medium of language), material-economic (in the medium of work), and social-political (in the medium of power). They link this to bundles of ‘sayings’, ‘doings’ and ‘relatings’ which in this case, are detected in the practices of Toad NUTS volunteers. It is these bundles of prominent Toad NUTS practices that are presented in Section 4.2.

5.2.1 Cultural-discursive arrangements

Cultural-discursive arrangements refer to specialist language used that is appropriate to the field. It also refers to the meaning derived from this language and the norms and standards in the way communication occurs which includes ideas and understandings. The Toad NUTS founders describe how they probed many sources seeking information about the toads when they first noticed them. These sources included texts, conversing with experts, associating with professional communities, the internet and others (Section 4.2.2; Section 4.2.5).

Specialist terminology was gleaned during their search for information as well as concepts and ideas relating to the toad (Section 4.2.2). Toad NUTS leaders joined the WLT-CC gaining access to the larger social field including other stakeholders, scientists and conservation specialists (Section 4.2.1). The terminology is part scientific for example, biodiversity, ICUN, endangered and part herpetological for example, amplexus, gravid, *bufo*. Toad NUTS knowledge of the specialist discourse helped to consolidate their membership of

the WLT-CC because it allowed them to participate in discussions and collaborate on writing reports. An example, of such a report is, the *Proposal: Evening radio toad traffic report*, written by a Toad NUTS leader and the WLT-CC secretary (listed in Table 3.2). This includes making joint comments on the Western Leopard Toad biodiversity plan, writing reports and media articles (Section 4.2.1; Section 4.2.2; Section 4.2.6; Section 4.2.13). To introduce new recruits to the cultural-discursive dimension, pertinent information, ideas and terminology is conveyed during their training and is reinforced during their mentorship and further established while they participate in Toad NUTS practices (Section 4.2.5; Section 4.3.2).

Another aspect of the cultural-discursive dimension is the WhatsApp group communication platform that the toad NUTS group uses which allows for free, quick and easy texting to all members of the group at the same time (Section 4.2.6). It was noted that the volunteers also developed terminology that is unique to the group, a type of shorthand terminology. For example, the term flatty was developed to refer to a toad that has been run over by a vehicle, and initials were utilised to shorten place names such as NH for Noordhoek. These abbreviations aid the WhatsApp style of messaging (Section 4.2.6). Using the WhatsApp communication system is important when considering the nature of collective participatory processes occurring in the group allowing members to relate to each other as well as to experts or scientists that are also in the group (Section 4.2.6). The WhatsApp communication system strongly enables volunteers' practice.

A further aspect of the cultural-discursive dimension is the consistent release of media items, outreach and education programmes to ensure that the toads remain in the public domain. Toad NUTS members wanted Noordhoek residents to have a basic understanding of the toads, the annual migration and need to be alert when it happens, and to be aware of the nature of Toad NUTS activities. The internet and its associated technology are used effectively to communicate with the public providing information in a way that is popular and commonly used by Noordhoek residents. Road signage creates public awareness and enables Toad NUTS practices by alerting residents of toads on the road at the time that they are there. The signs often are of a pictogram which conveys the warning message. The awareness created over the years has resulted in the Toad NUTS group being more effective in their conservation strategies and new initiatives are more readily accepted (Section 4.2.6).

Cultural-discursive arrangements in the case study also pertain to the creation of knowledge in the local environment and the communicating of these findings through standard scientific communication mechanisms. Through their continuous observation and data generation practices in the field, Toad NUTS have documented toad behaviour not seen before, possibly unique to the Noordhoek area however, not tested elsewhere. In this sense they have generated new knowledge. Should Toad NUTS want to present their work to the conservation or herpetological fraternity, they not only need to use the correct herpetological/scientific discourse but also the commonly accepted communication means. The standard practice in the scientific field is for new knowledge to be submitted to peer review and published in a recognised scientific journal. The doctoral thesis using Toad NUTS data and a co-authored, peer reviewed journal article is evidence that Toad NUTS is able to access standard scientific communication mechanisms (Section 4.2.13).

5.2.2 Material–economic arrangements

Material-economic arrangements refer to the physical and financial needs that the Toad NUTS project creates. Toad NUTS need certain equipment, material and funds to facilitate their practices and these needs are met in various ways (Section 4.2.8). Literature highlights that citizen science is known as a low cost option for generating large volumes of data. This cost is however carried by the volunteers (Section 2.2; Section 4.2.8). To patrol, volunteers need a vehicle, fuel, rain suits, one or more torches, a cell phone and the material or equipment necessary to report their data. This could be a computer for emailing, telephone for calling or texting or even paper and pen. Some equipment like buckets, flashing car lights, car signage, plastic bags and other sundries, is provided through sponsorships and is shared. Members swap equipment when changing shifts but there is not enough for everyone (Section 4.2.2; Section 4.2.8).

To tap into the collective communication system, volunteers require a cell phone and must download the WhatsApp software. The cell phones and WhatsApp technology are the practice architecture features, within the material-economic domain, that enable this communication. Scientists and experts uploaded as members on this group also need cell phones with WhatsApp technology. Temporary road signs are also used annually and are obtained from the WLT-CC. This is paid for by the CoCT.

Another material-economic arrangement is the cost of conservation interventions. Members contemplate and deliberate over conservation strategies. They cost the expense carefully and if needed, raise money for a particular need (Section 4.2.8). Toad NUTS members strategize and contemplate on how to raise funds. They plan and execute the fundraising campaign. Communication, work and relating to others (members and funders) is required. Volunteers reflect on the funding campaigns, assess the success and future action is discussed. An example of a successful fundraising campaign was the community concert held in 2014, where the funds raised were applied to purchasing material and the installation of three separate lengths of temporary barrier and bucket schemes.

5.2.3 Social-political arrangements

Social-political arrangements are detected in the way that Toad NUTS relates to the Noordhoek community and in the regard that the community has for Toad NUTS. The ongoing media campaign to embrace the wider Noordhoek community in Toad NUTS conservation efforts has resulted in an evolving Toad NUTS public image that has strengthened the connection between the Toad NUTS group and the general public (Section 4.2.7). The decision to publicise Toad NUTS news has enabled Toad NUTS practices by creating a group reputation for being passionate, knowledgeable and competent (Section 4.2.7). Hanks (2013) reports that the awareness initiatives have caused an ethical shift in the Noordhoek community and has resulted in a community that are more caring and responsive to the toad and the environment (Section 4.2.7).

The social-political arrangements within WLT-CC are marked. The committee is a meeting place of various stakeholders in the field of Western Leopard Toad conservation. The purpose of the committee is to forge a cohesive and co-ordinated conservation strategy and to facilitate communication between its members (see Section 4.2.1). The establishment of new volunteer groups (Section 4.2.9), exchange of knowledge and the restoration of wetlands (Section 4.2.10) have been achieved through collaborations with other committee members. The various connections, within the committee was described in Section 4.2.1. These social-political relationships need to be nurtured even in the face of conflict. Accounts of the tensions between members, concerning for instance the timing of meetings and the scientist's insistence on each toad being photographed and the photo being uploaded to ISpot, have been reported in Section 4.2.1 and Section 4.2.13. Collaborations with other members, such as seen with the wetland restoration project involving the CoCT committee member, and the

obtaining of temporary road signs, extends the conservation success and practices of the volunteer group.

Socio-political set-ups are also reflected in the various regulations, by-laws and policies which determine the ways in which roads can be used and what can be done in these public spaces (Section 4.2.11). An example is the use of road signage and the installation of temporary barriers. Obtaining road signs is made possible by the social connections to others on the WLT-CC and involves relationships that evolve from previous and present social orders and arrangements based on the Toad NUTS group being represented on the WLT-CC. The City of Cape Town official on the WLT-CC assists with this process making it easier for Toad NUTS to gain permission to use road signs (see Section 4.2.11). The restricted ways in which the road signage is installed and managed however does cause tension. Difficulties exist around the rigidity of the two month timing of display of the road signs and the position for sign display. This is discussed in Section 4.2.11.

Bureaucracy is another aspect of the socio-political arrangements that are significant in shaping Toad NUTS practices. The installation of the barrier intervention requires permission from various government departments' (Section 4.2.12). Volunteers learn the nature of bureaucratic structures and build relationships with key governmental personnel so that repeating the process becomes easier the following season (Section 2.4). This is what Edwards (2011) calls relational agency. The Toad NUTS leader mentioned that because she had gone through the process the year before, gaining permission from Eskom and Telkom was quick the second time because she knew who to approach and what the procedure was (Section 4.2.12).

The socio-political dimension also includes the power relations between Toad NUTS members and others or other institutions or structures. The WLT-CC was established to facilitate knowledge sharing with stakeholders of different expertise and perspectives involved in the Western Leopard Toad conservation. Toad NUTS associate with a SANBI official, Cape Nature conservators and a CoCT representative. These people represent institutional authority which Toad NUTS members do not have. They (and others) also possess scientific expertise gained through academic qualifications and in their present employment. In the WLT-CC knowledge is socially distributed, application orientated (particularly for volunteer citizen science groups), inter-disciplinary and reflexive which makes the committee unusual. What is seen in the WLT-CC interactions embodies what

Gibbons (1998) describes as mode 2 knowledge which establishes a flatter power structure where volunteers have freer access to knowledge. Without the WLT-CC, volunteers may have limited legitimate access to knowledge held in the more traditional knowledge or academic institutions.

Further to power relations is a consideration of the benefit of the Toad NUTS project to members, scientists and the environment. Although volunteers report conflict and devaluing of their efforts (see Section 4.2.13), they remain committed to the project. The way the group was created may have resulted in a lack of dependence on a scientist and a greater sense of volunteer ownership of the project. The social relationships with scientists is a practice architectures feature that is very important to nurture in order to get the most out of a citizen science project so that all parties benefit. The evidence (in Section 4.2.13) also shows that volunteers are vulnerable to abuse. The cost of the generation of the data is carried by the volunteers (Section 4.2.8) benefiting the scientist, institution or community.

Collaboration and ownership are further key interests in considering power relations. Toerpe (2013) and Gray *et. al.* (2012) maintains that the science component of the project is what attracts and keeps volunteers in the project (Section 2.2). They advise a strong scientist-volunteer collaboration where volunteers or lay-people are given the opportunity to co-create the project. This means that volunteers are included in every aspect of the project and take ownership of the project.

When there is a positive and affirming scientist / lay-person relationship in place, data generated by the volunteers can be used in valuable ways. For example a doctoral thesis and a journal article were produced using the Toad NUTS data (Section 4.2.3; Section 4.2.13). The scientist's regard for the volunteers was different to before (Section 4.2.1; Section 4.2.13). The data had not changed but the scientist could see the potential of using it. The scientist associated with a citizen science project can be the gatekeeper controlling the flow of the findings from the project to the scientific world and holds power in this regard, validating what the citizen science group is able to achieve and share with the scientific community.

Interesting echoes of the models of lay people / scientist interactions proposed by Callon (1999) are evidenced in the case study. There is tension with a WLT-CC scientist who rejects the Toad NUTS data because he doubts the validity of the data. He has been

unforgiving when Toad NUTS failed to photograph every toad found and upload this to ISpot. The weak relationship between the scientist and non-scientists, in this case the Toad NUTS members, has denied the lay people any opportunity of knowledge production (Section 4.2.13). What was seen in the case study is that mistrust and lack of acknowledgement maintain power relations that block the possibility of co-produced solutions and hinder the flow of knowledge. This reflects what Callon (1999) described as the public education model. Evidence in this study also suggests that a scientist willing to embrace citizen scientists enables the possibility of co-production of knowledge (third model), giving lay people the chance to be involved in producing knowledge around issues that concern them. This was seen in the case where Toad NUTS interacted with a different researching scientist who thought that their data was valid and used it in his doctoral thesis and to write an academic article (Section 4.2.13). In this case the scientist worked with the Toad NUTS members to refine the temporary barrier system (Section 4.2.3). He is also uploaded as a member of the WhatsApp group and monitors their communications daily giving input when it is needed (Section 4.2.6).

5.3 Knowledge processes and learning dynamics in the Toad NUTS community of practice

An integral part of this study, addressing Research Goal 2, involves an investigation of the learning dynamics of a citizen science project. Wenger *et.al.* (2002) describe a community of practice as a knowledge structure where members facilitate the sharing of knowledge and steward knowledge development. New members experience a process of knowledge transfer and social integration (Section 4.2.5). Toad NUTS share knowledge with the public and in the scientific field (Section 4.2.7; Section 4.2.13). All members of the community are expected to have baseline knowledge of the field in order to be effective in its practices. This entails being proficient in the specialised discourse used by Toad NUTS (Section 4.2.5) and ways of doing things (Sections 4.2.2; Section 4.2.3; Section 4.2.4).

Lave and Wenger's (1991) conceptualisation of four interconnected components of learning in social learning spaces is detailed in Section 2.5. Learning is enhanced through the social configurations of a citizen science group which supports learning as belonging (Section 4.3.1). Belonging to the Toad NUTS groups means that members build friendships and trust with others especially those they partner with (Section 4.2.2; Section 4.2.5). In working with others in the field they are exposed to different perspectives and ways of working which

implies that they learn while working together. Members interact, do things together, negotiate new meanings and learn from each other (Section 4.2.2; Section 4.2.3). The way Toad NUTS carefully observe toads on the road to assess direction of movement before moving the toad is one example of a negotiated practice (Section 4.2.2). Another is that volunteers have been amending the way they handle buckets in the temporary barrier intervention which fill with water (Section 4.2.3; Section 4.3.2). The reporting on toads in buckets with photos of buckets and orientation to show numbers is a further example of negotiating practice.

Situated learning practices make Toad NUTS members experts in the local context. Being on patrol, in contact with the toads, observing and interpreting toad behaviour and making sense of this in relation to physical conditions and disciplinary knowledge (Section 4.3.2), has meant that volunteers learn as they do. Experienced volunteers have an acute sensitivity to applying their head knowledge to what they and others are observing and experiencing at any particular time as is evidenced in the WhatsApp conversation between a leader and volunteer concerning investigating where toads could be breeding in the neighbouring suburbs of Capri and Kommetjie (Section 4.3.2).

Toad NUTS members feel that saving toads is a first priority and new conservation strategies are meaningful because they add to the ability to save more toads. Generating data and keeping records is meaningful because it allows volunteers to achieve their objective (saving toads) more effectively, refine their practices and make positive contributions to the conservation and management of the Western Leopard Toad. This recorded information also puts Toad NUTS members in a position to contest claims made. For example, a previous herpetological study claimed that toads breed explosively over an eight day period (Section 4.3.3). However, working in the same area that this previous study was done, Toad NUTS found the season to have more than one phase of eight days. The breeding period is therefore much longer than reported in literature and differs every year depending on the rainfall patterns experienced (Section 4.3.3). To have a more intricate understanding of the nuances of toad movement is important for volunteers who adjust their patrolling habits and the timing of installation and removal of the barrier intervention. As this information can benefit the other volunteer groups, it is important that it is communicated both at WLT-CC meetings and more widely in the scientific literature (Section 4.2.1; Section 4.2.13). The Toad NUTS group have made contributions to the broader scientific field by way of their accumulated

data and findings and reporting on this (Section 4.2.13). Aiding volunteer groups in neighbouring suburbs to monitor and implement conservation interventions and ecosystem restoration is another significant area in which Toad NUTS appears to be finding meaning in their work (Section 4.2.9; Section 4.2.10). This was seen where Toad NUTS funded the materials for a temporary barrier in a neighbouring area where there are very few volunteers (Section 4.2.8). Learning as meaning-making experience results in volunteers being affected by and affecting environmental actions which are meaningful. Meaning is constituted by the ability to positively affect the survival of the toad and also affect a community in the process.

Learning transforms volunteer's personal and collective identity. Being a member of the Toad NUTS group, opens opportunities for volunteers to become more knowledgeable, be adventurous, braver with wildlife, more confident in handling wildlife, experience the thrill and excitement of being connected to nature, specifically the toads, and understanding more of nature than before (Section 4.3.4). The affect is manifested in a changed person who has altered their lifestyles, habits and interests, due to the knowledge, experience and meaningfulness of their Toad NUTS involvement. Wenger (1998) maintains that changing individual identities has the potential to catalyse social reconfiguration. A shift in environmental ethics is evident in the elevation of importance of the toad in the Noordhoek community perception and the change in interest and tolerance of Toad NUTS on the roads that members have reported (Section 4.2.7; Section 4.2.8).

5.4 Environmental citizenship

The need to respond to many global problems, of which a number are environmental, was emphasised in the GCE policy document (Section 2.6.1). The education program is hoped to equip citizens with the necessary “values, attitudes and skills to promote mutual respect and peaceful coexistence”, fostering just, peaceful, tolerant and inclusive societies (UNESCO, 2014). Education for Sustainable Development is one pillar of the GCE which aims to promote the “respect and care for the greater community of life in all its diversity which involves the protection and restoration of the Earth's ecosystems” (Section 2.6.1). GCE has a social justice perspective while ESD has an environmental protection perspective which is an important distinction which will surface in the discussion to follow.

The GCE lists the common goals of citizenship education (Section 2.6.1). These goals were used to view the evidence in the case study to determine the extent to which these goals are met through participation in the Toad NUTS citizen science project. This addresses Research

Goal 3 to assess emergent environmental citizenship which is discussed in Sections 5.4.1 to 5.4.4 below. The GCE further identifies competencies needed across the goals to deal with various challenges requiring a sense of citizenship. Whether participation in citizen science projects lends itself to the development of these competencies is taken up in Sections 5.4.5 to 5.4.9.

5.4.1 GCE Goal 1 – “to encourage learners to analyse real-life issues critically and to identify possible solutions creatively and innovatively”

The real-life issue that Toad NUTS address is the loss of the endangered Western Leopard Toad through road kill (Section 4.2). Toad NUTS members analysed the problem critically and identified various solutions. The first step was to establish walking and driving patrols of the streets where road kill was occurring, and physically move toads off the road (Section 4.2.2). This solution lessened the road kill but did not eliminate it and was also dangerous to members. The Toad NUTS researched and deliberated over other more successful conservation strategies to replace patrolling. A simple temporary barrier of shade cloth and buckets was installed along certain stretches of road which proved to be very successful eliminating road kill (Section 4.2.3). However, this intervention cannot be used everywhere and the use of other interventions is being investigated. The Toad Barrier Report reveals that Toad NUTS members have the capacity to act collaboratively, responsibly and reflexively in determining the nature, materials, placement, design and various other features of the barrier (Section 4.2.3).

Toad NUTS observed frogs drowning in pools for which they designed a simple device which they encourage Noordhoek residents to use, called a toad saver (Section 4.2.4). Toad NUTS members are presently in the process of investigating permanent road structures to mitigate the problem. Toad NUTS therefore are analysing real life problems critically and are identifying, investigating and initiating creative and innovative solutions.

5.4.2 GCE Goal 2 – “to support learners to revisit assumptions, world views and power relations in mainstream discourses and consider people/groups that are systematically underrepresented / marginalised”

Toad NUTS have confronted the local authorities and the policies, by-laws and procedures regulating the installation of road signage and temporary barriers along roads. Even though Toad NUTS members had to persevere against opposing forces and rigid structures when

wanting to safeguard the toads, they managed to do this and achieved their goal. The power relations in the social-political structures and arrangements that Toad NUTS have to confront are described in Sections 4.2.1, Section 4.2.9, Section 4.2.11, Section 4.2.12 and Section 4.2.13 with respect to interactions with local government authorities, the WLT-CC and scientists. Members have to learn to navigate this opposition at times relenting, at other times negotiating and winning over and sometimes contesting. The evidence shows that Toad NUTS members tenaciously press on to achieve their desired outcome in difficult circumstances.

The case study is not about a social justice issue which requires consideration of underrepresented or marginalised people. The Toad NUTS project addresses an environmental problem and therefore has an eco-centric approach. This is not explicitly addressed by the GCE which has an anthropocentric focus. In this regard, the case study partially meets the intended outcome of GCE goal 2.

5.4.3 GCE Goal 3 – “to focus on engagement in individual and collective action to bring about desired changes”

There are various initiatives undertaken by the Toad NUTS group. At times these are done by individuals such as public outreach, awareness and education initiatives (Section 4.2.7), representation at WLT-CC meetings (Section 4.2.1) and pursuing bureaucracy to obtain permission for the installation of the temporary barrier scheme (Section 4.2.12). At other times these initiatives are undertaken as a group. For example, patrolling, bucket runs and fundraising (Section 4.2.2; Section 4.2.3; Section 4.2.8). The number of members involved in the various practices described in Section 4.2 varies from one or two to many at different times. The nature of a community of practice is collective action for changes in the local context to reduce toad loss. There is clear evidence that all members are involved in collective processes.

5.4.4 GCE Goal 4 – “to involve multiple stakeholders, including those outside the learning environment, in the community and in wider society in seeking solutions to the problem at hand”

It was reported that the Toad NUTS group set out to involve the whole community in the conservation of the Western Leopard Toad (Section 4.2.7). Toad NUTS undertook to keep the public informed of their activities and progress in the conservation situation. There are many ways in which they do this which is listed in Section 4.2.7.

The Toad NUTS group stay abreast of latest events and progress in toad conservation through their membership of the WLT-CC and their association with other herpetologists, scientists and organisations (Section 4.2.1; Section 4.2.13). Here they meet with stakeholders in academic institutions and the formal conservation and biodiversity protection services (Section 4.2.1). Toad NUTS have developed a network of scientific advisors whom they consult when they need scientific advice and guidance (Section 4.2.13). Toad NUTS therefore do involve multiple stakeholders in the Noordhoek community and wider society creating awareness of their work, the problem and receiving input on solutions to the problem.

5.4.5 GCE Competence 1 - “An attitude supported by an understanding of multiple levels of identity, and the potential for a ‘collective identity’ which transcends individual cultural, religious, ethnic or other differences”

The GCE raises the need for a collective identity to address pressing issues like environmental problems (Section 2.6). Citizens need aptitudes for networking and interacting with different people, acting collaboratively to create solutions to local challenges for the collective good. Volunteers to the Toad NUTS group are continuously sought and welcomed regardless of their cultural, religious, ethnic or other differences in favor of accepting help from willing citizens in the effort to save the toads. Toad NUTS activities require the active participation of its members in collective action (Section 4.2.2; Section 4.2.3; Section 4.2.4; Section 4.2.7; Section 4.2.9; Section 4.2.11; Section 4.2.13). Members act with others, making decisions in real contexts both while on patrol and in deliberation of possible conservation and other strategies necessary to achieve their goal of protecting the toads. Toad NUTS act as a team exploring every possible way to safeguard the toads in Noordhoek and where possible, beyond. Member’s individual identities change with growing participation in the Toad NUTS practices as the sense of meaningfulness of Toad NUTS practices grows (Section 4.3.4). The Toad NUTS group identity is described in Section 4.3.4. The evidence therefore demonstrates that the Toad NUTS group has a collective identity and a strong focus on the problem which transcends considerations that could cause division and discrimination.

5.4.6 GCE Competence 2 - “a deep knowledge of global issues and universal values such as justice, equality, dignity and respect”

Knowledge is a key element of environmental citizenship (Dobson & Bell, 2006). This is important in the citizen science context because volunteers need specific disciplinary knowledge with contextually relevant information of the local environment to guide their actions in the field. This was discussed in Section 5.3 where it was pointed out that without a baseline knowledge volunteers cannot participate effectively in the practices of the community which in this case are various conservation actions (Section 4.2.).

Within the knowledge domain of the Toad NUTS community there is a strong knowledge of global issues like biodiversity, biodiversity loss, ICUN status, altered habitats, mitigation strategies, ecosystem preservation and restoration (Section 4.2.1; Section 4.2.2; Section 4.2.7). This knowledge is interpreted in the local context and is evidenced in the Toad NUTS reports and articles. Tawil (2013) indicates the opportunities that the World Wide Web gives for global citizens to tap into global knowledge, values and international best practice examples. Toad NUTS use the World Wide Web effectively to research best practice solutions to their conservation problems for example, permanent and safe road crossing pathways using tunnels (Section 4.2.3).

Toad NUTS members demonstrate a grasp of universal values such as equality, dignity and respect. Toad NUTS treat all their members equally, with dignity and respect even though members demonstrate different levels of involvement and commitment. As one leader said, it is up to everyone to determine what they can do, but that the leaders value every contribution regardless how small (Section 4.3.1). This was repeated with regard to upholding the dignity and respect for all members of the WLT-CC (Section 4.2.1). Another leader echoed a similar attitude for residents in neighbouring suburbs. She said that when encouraging such a group to start a volunteer group one has to be respectful and work hard at winning people over to the cause but that they have to take ownership of issues in their areas and create their own responses or solutions to the problem (Section 4.2.9).

As mentioned in the discussion of GCE goal 2, the Toad NUTS project deals with an environmental issue and not a justice issue and evidence of partially meeting GCE Competence 2 was found. The case is silent on issues of social justice.

5.4.7 GCE Competence 3 – “cognitive skills to think critically, systemically and creatively, including adopting a multi-perspective approach that recognizes the different dimensions, perspectives and angles of issues”

Toad NUTS members demonstrate the individual capacity for reasoned practice employing critical, systemic and creative thinking during the process of “learning as doing” while engaged in Toad NUTS practices (Section 4.3.2). Collectively the Toad NUTS group demonstrates critical, systematic and creative cognitive skills when deliberating group practices, analysing and interpreting data, also when seeking new conservation solutions or dealing with problems such as funding needs (Section 4.2.2; Section 4.2.3; Section 4.2.8; Section 4.2.9; Section 4.2.13). Membership of the WLT-CC has allowed Toad NUTS members to adopt a multi-perspective approach more easily because of the different perspectives, dimensions, approaches and ways of interpreting and doing things represented here (Section 4.2.1). This springs from the different mandates of the committee members depending on which institution they come from. Toad NUTS members appreciate that the Toad NUTS method and approach is best suited to Noordhoek and cannot be imposed on different groups in different areas (Section 4.2.9). This competency is mirrored in the GCE Goal 1 which is to analyse real-life issues critically and identify possible solutions. Toad NUTS members have the cognitive skills to think critically, systemically and creatively, and volunteers adopt a multi-perspective approach that recognizes the different dimensions, perspectives and angles of issues.

5.4.8 GCE Competence 4 – “non-cognitive skills including social skills such as empathy and conflict resolution, communication skills and aptitudes for networking and interacting with people of different backgrounds, origins, cultures and perspectives”

Toad NUTS have well developed social skills. They demonstrate their social and communication skills in the way the group is managed and the way members interact with the public and other stakeholders in the conservation field (Section 4.2.1; Section 4.2.7). When trying to establish new citizen science volunteer groups in neighbouring areas, Toad NUTS members experienced the difficulty of motivating a community to establish similar projects to Toad NUTS in their own area (see Section 4.2.9). What was learned is that the different backgrounds, ways of working, the role players and perspectives need to be respected.

When there was conflict between members of the WLT-CC, a Toad NUTS leader led a SWOT analysis with the committee in an attempt to address misunderstandings and resolve the conflict (Section 4.2.1). Toad NUTS members have shown their ability to network and interact with multiple people of local, multicultural backgrounds and international origin (Section 4.2.7). They host international herpetologists and maintain contact with them. They also maintain contact with numerous herpetologists, scientists and conservation specialists from various parts of South Africa (Section 4.2.13). The Toad NUTS group therefore do show well developed non-cognitive skills such as those listed in GCE Competence 4.

5.4.9 GCE Competence 5 – “capacities to act collaboratively and responsibly to find global solutions for global challenges, and to strive for the collective good (with a sense of commitment and decision-making skills)”

The Toad NUTS project is aimed at the sustainable management of natural resources and biodiversity preservation (Section 4.2). Toad NUTS have a global perspective and understanding of the problem and biodiversity loss is a global challenge. Toad NUTS are active in devising local solutions in the area where they are situated. Respect and care for the environment and non-human species and nature is often mentioned by the Toad NUTS volunteers as their motivation for joining and maintaining the Toad NUTS project (Section 4.2). Toad NUTS also understand the social-ecological implications of the project. They feel that good stewardship of the environment benefits the human community (Section 4.2.7; Section 4.3.3).

Being active Toad NUTS members means being part of a team, acting collaboratively where members rely on each other to do their duties diligently and responsibly. Displaying personal values like commitment, reliability, and dependability in patrolling duties is of critical importance in order for the team to operate optimally. Members exercise self-discipline in patrolling and in reporting the data from their patrolling sessions. As members relieve each other between shifts and exchange equipment, it is obvious when volunteers have not arrived. Members are truthful about the patrolling hours they are able to do and they understand the importance of reporting their patrolling data accurately and honestly. Volunteers are courageous, confident and determined. This is demonstrated in many instances for example, patrolling roads in the dark in dangerous conditions. Participating in Toad NUTS practices requires confidence to make decisions in pressing circumstances. Toad NUTS demonstrate

many of the personal values that Connelly (2006, in Dobson & Bell, 2006) identify as the personal values of people showing environmental citizenship (see Section 2.6; Section 4.2).

Wals (2007 and Clover *et. al.*, 2013) maintains that collective social learning and action is more powerful and effective than individual action alone. Collective learning deepens reflection and reflexivity. Through reflexivity the Toad NUTS group refines their actions and interventions, questioning and evaluating their processes while they strive for a time when there is peaceful coexistence of man and other species including the toad. Toad NUTS therefore demonstrate GCE Competence 5.

5.5 Conclusion

In this chapter the prominent practice architectures features shaping Toad NUTS practices were explored, highlighting how these features constrain and enable the practices of the Toad NUTS group. Knowledge processes and learning dynamics of the Toad NUTS project was discussed. At the start of the UNESCO decade of Global Citizenship Education, citizen science is investigated as an educational tool which may be effective in achieving GCE goals. The case study was used to show the extent to which the desirable competencies listed in the international policy document for the GCE are developed and how the goals of GCE are achieved by the Toad NUTS group. This makes the case for considering the use of citizen science projects in environmental education initiatives towards meeting the desired outcomes of the GCE.

CHAPTER 6: Conclusion and recommendations

6.1 Introduction

This chapter gives an overview of the research findings and the implications of these findings for the education and biodiversity sectors. Also discussed are the implications of this research for potentially achieving sustainability goals in urban contexts. Lastly the research process is reviewed and recommendations are made regarding further research.

6.2 Summary of research findings

The findings of this research will be presented against the research goals they address.

6.2.1 Research Goal 1: Practice Architectures shaping Toad NUTS practices

There are a number of prominent practice architectures features that shape the practices of the Toad NUTS group that surfaced in this research. Presented within the cultural-discursive domain is the discourse used by the group which includes herpetological and Toad NUTS terminology and phrases as well as ideas and concepts that are used when members communicate with each other and other stakeholders outside of the Toad NUTS group. The group communication system, using cellphones and WhatsApp technology, used by volunteers are the public outreach, awareness and education mechanisms employed by the group. Within the material-economic domain, material and equipment used and funding are important. Within the social-political domain, power balances and exchanges amongst various stakeholders particularly within the WLT-CC is key and strongly effects the conservation practices of the group such as use of road signage, processing of bureaucratic processes and scientist – lay person exchanges. Social-political arrangements between Toad NUTS and the Noordhoek community and within the Toad NUTS group, is also important. This is not an exhaustive list but highlights the most prominent features that surfaced. The delicate balance of power relations between Toad NUTS members and various other stakeholders in the practice landscape highlights the need for a critical management of these relations so that benefits are realised in the actualisation of conservation strategies. Volunteers learn to work with or around these features to best facilitate their practices keeping in mind their objectives. This motivates them to be creative in how they negotiate these architectural features when they encounter obstacles to their processes.

6.2.2 Research Goal 2: Learning dynamics of the toad conservation project

The learning dynamics found in the citizen science group closely follows the description given by Lave and Wenger (1991) for communities of practice. Novice volunteers learn and are inducted to the Toad NUTS group by a process of situated learning. Through repeatedly participating in Toad NUTS practices, learning as belonging to the Toad NUTS group engaged in mutual enterprises, members negotiate practices together. Volunteers are confronted with many different scenarios where they need to apply their knowledge and use deliberative participatory processes to refine their decision making skills in the spatiotemporal setting. This deepens their knowledge and practice expertise through learning as doing. Wenger (1998) describes that in the final outcome learning be about creating meaning. Learning as meaning-making experience culminates in the Toad NUTS group making meaningful contributions to the conservation of the Western Leopard Toad in the local context achieving a more secure coexistence of humans and non-human species. Learning as becoming is seen in how individual and collective Toad NUTS identities change as meaningful steps are taken towards the goal of securing a world which is more just, peaceful, tolerant, inclusive, secure and sustainable.

6.2.3 Research Goal 3: Environmental Citizenship development

Citizen science appeals to a certain type of person. Not all will participate and of those that do, only a small percentage will be interested in any particular subject. Those that volunteered for the Toad NUTS group expressed a desire to do something of value for the environment and the community. Volunteers make the link between the social and ecological realms intuitively. When engaged in Toad NUTS practices as fully incorporated members, volunteers show a well-developed environmental citizenship. Their passion for the toad and the project catalyzes inventive solutions in the local context.

The evidence in the case study was set against the desired goals and competencies identified in the international policy document for the GCE and it was found that the Toad NUTS citizen science project meets the goals sought by the GCE and that members develop the competencies required by the GCE by participating in Toad NUTS practices. However there is a disparity between the case study and the GCE. The Toad NUTS group is concerned with a conservation issue and has an ecocentric approach to citizenship. GCE is predominantly anthropocentric and highlights social issues and problems. If a citizen science project were to

be focused on a social justice issue, it would fit the GCE objectives more closely however, in terms of meeting ESD objectives, the Toad NUTS project is a good fit.

In terms of achieving the goals that GCE highlight, Toad NUTS analyses a real-life issue critically and has initiated creative solutions. Toad NUTS have confronted societal norms and destructive ways of doing things as well as power relations in order to action their conservation strategies. Toad NUTS members use individual and collective action in their practices and involve multiple stakeholders, both within and outside of the group in seeking solutions to conservation issues.

Toad NUTS members exhibit values, knowledge and skills with respect to their practices that produce sustainable outcomes in the conservation of the toads in their context. They are able to negotiate effectively resistant practice architecture structures to achieve their goals.

Volunteers demonstrate competence in carrying out Toad NUTS practices. Competencies include a perception of multiple levels of identity, knowledge of global issues and universal values, higher order cognitive and non-cognitive skills such as communication and conflict resolution abilities and collaboration to produce sustainable solutions to problems.

Volunteers operate using participatory processes, working together actively to patrol roads and conceptualize solutions to conservation problems in the field. Volunteers are strongly agential demonstrating the capability to make positive changes in often complicated circumstances.

These findings would suggest that citizen science projects could be considered as a mechanism to develop competencies towards environmental citizenship with the aspiration of achieving GCE goals. In essence this involves ordinary citizens in establishing sustainable solutions to environmental issues.

6.3 Recommendations

6.3.1 Recommendations to the biodiversity sector

Drawing citizens into a scientific project has many benefits but careful consideration must be given to the portion of the study that citizens can do. Literature reveals that citizen science is ideal to use in studies where large volumes of data, often of a repetitive nature, is generated over a long period of time. Depending on how many volunteers are drawn into the project, the geographic area where data is collected can be large. This research highlighted the unease scientists have concerning the validity and trustworthiness of data generated by many

different volunteers where there is less control over issues of data collecting protocols.

Literature and evidence in this case suggests that citizen science projects be designed so that data is easy to gather with a clearly communicated protocol which will ensure the repeatability and dependability of the data.

Volunteer commitment may be enhanced by an open and easy communication between them and the scientist(s) associated with the project. It is important to bear in mind the potential of volunteers to bring a fresh or different perspective or different skills to the project which can lead to a novel approach or way of doing things. It will require time and effort from the scientist to maintain contact with the group of citizen scientists and *visa versa*. Using volunteers in a citizen science project requires that novice volunteers are trained by being introduced to the terminology, ideas and practices of the project. Learning support materials like field guides, books and the internet, are useful in training.

Scientific input is important is determining protocols for data generation and management, the knowledge and skill gained by volunteers in the project, and for nurturing the knowledge generated by the group. Scientists control the successful communication of new knowledge generated through the project, albeit in local applications, to the scientific world through meeting accepted standards and norms for scientific communication. Scientists may need to consider their involvement in this aspect of the project.

The case study suggests that scientists need to be aware of how the social-political power balance between them and the volunteers manifests in the group. If this is managed so that volunteers' scientific knowledge, understanding and skills improve, volunteers may be more likely to champion the project in the public arena, becoming local environmental advocates for the project drawing others from their social networks. Volunteers may also be more likely to become involved in participatory democratic processes in areas where their knowledge gives them the confidence to be actively involved in governance issues.

The involvement of volunteers in taking responsibility for environmental issues in the spaces where they live, work and play is an important consideration for urban sustainability practices. In this process they may be more likely to make judgments to attain possible solutions and participate in governance processes like commenting on management policies and proposed developments. The evidence in this study showed that public awareness and education of the citizen science project enhanced the achievement of sustainability solutions.

At times a need for interdisciplinary expertise to address complex and contested environmental questions surrounding urban sustainability practices may arise. The search for expertise or advice can be facilitated by the social networks of stakeholders that are positively disposed toward the citizen scientists. Conversely the process of looking for answers may be complicated by detrimental power relations affecting access to the needed expertise. If there is an appreciation for the advantages citizens can bring to a project, facilitating social-political arrangements between volunteers and other stakeholders may be necessary. The value of the contribution can be honed by the input of knowledgeable and experienced people in the field so that the outcome, whether in the form of an intervention, a technological advancement, a report or a peer reviewed scientific paper, is sound.

6.3.2 Recommendations for further research

Concerning this research, the scope of the existing study was relatively narrow in that it focussed on one successful citizen science group. Incorporating the study of different citizen science groups would deepen the insights into the research findings.

Concerning further research, the question of how citizen science can be utilised by the formal education system to support core science knowledge and skills acquisition, should be explored.

An investigation of the benefits of citizen science to learners in existing citizen science projects is recommended while also drawing attention to how school learner incorporation in such projects can be achieved. A sub-study focussing on how the design of the citizen science project can facilitate the incorporation of school learners is suggested.

Researching the benefits to teachers of participating in citizen science both on a personal and professional level is a third recommendation.

A fourth recommendation is to probe how outside agencies like non-governmental organisations, environmental educators or tertiary institutions can partner with schools to facilitate citizen science projects.

6.4 Critical review of the research process

The research journey has been enriching, challenging and at times surprising. As a citizen science volunteer and facilitator, my knowledge of the processes occurring in informal spaces, characterised by citizen science, was increased by doing a literature review of the subject and intense investigation of the case. It helped to sensitise me to the practice

architectures features influencing the research group particularly when analysing the numerous documents given to me by the Toad NUTS group. I was grateful for the records that they kept. This provided material that gave me insight to the group's approach to their tasks and allowed me to substantiate claims that were made during the interviews with members. I was able to gauge the development of their reporting style and science literacy and the way in which they were generating data and reporting on their findings. A very valuable source of data was the WhatsApp communication. My inclusion in the group and the transcript of this was important for my understanding of participatory processes.

The semi-formal interviews preceded well providing rich information on how the group operates, how volunteers experience patrolling, the nature of participatory processes, how data management occurs and information on how volunteers navigate various practice architectures structures. It was disappointing that the chair of the WLT-CC, who also is the scientist the volunteers interact with most, would not agree to be interviewed which is a silence in this work.

I experienced problems with the recording of interviews on three occasions when the quality of the recordings was very poor and the interviews needed to be redone. More effective equipment would have been useful.

Observations of the Toad NUTS activities were done over a three day period. This period could have been longer but was restricted by cost and time availability. Upon reflection, it would have been beneficial to be in the field for a longer time doing observations with a larger group of volunteers. An observation of a meeting of the WLT-CC, would have been revealing however, as the chair was not agreeable, this was not arranged.

It was very difficult to capture observation of Toad NUTS members in the field because they work mostly on rainy nights in the dark when standard audio-visual equipment is difficult to use. The study would have benefitted from more effective ways of capturing observation data of the Toad NUTS members in the field.

On the whole I am satisfied that I gathered sufficient data to satisfy the demands of a masters half thesis. It would have been interesting to spend time observing sister citizen science groups, also working on the Western Leopard Toad in the Cape Peninsula, but this was beyond the scope of this study which was focussed on one case study only.

I am indeed grateful to have interacted with volunteers that are well organised, accomplished and passionate about their work. It has made me realise that it is possible to achieve amazing things with ordinary people who are determined to make a difference. It is also possible to learn new skills and gather information tenaciously in a field that has traditionally limited access to the uninitiated. This has given me hope that environmental citizenship can hold many answers to complex environmental issues and difficult problems. If traditional power structures allowed citizen scientists access to their knowledge resources, expert networks and practice conventions and supported citizen groups in establishing data generation protocols and guidance with their reporting, it is possible that much will be achieved by both parties in terms of doing good science and reaching local solutions to various problems.

6.5 Conclusion

Citizen science can be effective in raising the general science knowledge and skills of ordinary people of all ages. Citizen science can potentially make a significant contribution to the education and the biodiversity sectors. Citizen science provides a platform for nurturing environmental citizenship with positive benefit to the environment and the community making it an educative tool that Education for Sustainability Development and Global Citizenship Education practitioners could consider using.

Flowers

Sunflower

1

Family – Compositae.
Genus – Helianthus,
Species – Giganteus,
Globulus, Multiflorus,
etc.

Capitulum – a convex disc
with multiple florets
that riffle open
in centripetal series.

Calyx – an involucre
of green bracts

Its florets yellow rays
etc.

A heliotrope
revolving its inflorescence
better to absorb

2

The seed earthed
the earth
rained and sunned upon
the husks crack
and soft as snails
root-ends nudge
downwards
and stalks
surge upwards
in throngs

commuters
emerging from subways
in dank metropolises
who reaching the street

pause
and tilt their faces
up towards

the sun.

Mann (2010, p43)

REFERENCES

- Avaaz homepage (2015, February 2). Retrieved February 4, 2015, from <http://www.avaaz.org/>.
- Adler, J. (2000). Social practice theory and mathematics teacher education: a conversation between theory and practice. *Nordic Mathematics Education Journal*, 8(3), 31-53.
- Barnard, P., & De Villiers, M. (Eds.). (2012). *Biodiversity early warning systems: South African citizen scientist monitoring change*. South African National Biodiversity Institute, Pretoria.
- Bassey, M. (1999). *Case study research in educational settings*. Open University Press, Philadelphia.
- Bonney, R., Ballard, H., Jordon, R., McCallie, E., Philips, T., Shirk, J., & Wilderman, C. C. (2009a). *Public participation in scientific research: Defining the field and assessing its potential for informal science education*. Centre for Advancement of Informal Science Education (CAISE): A CAISE inquiry group report, [Online]. Retrieved August 29, 2013, from <http://caise.insci.org/uploads/docs/PPSR%20report%20FINAL.pdf>.
- Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Philips, T., Rosenberg, K.V., & Shirk, J. (2009b). Citizen Science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, 59, 977-984. Retrieved August 29, 2013, from DOI:10.1525/bio.2009.59.11.9.
- Brito, L., & Stafford Smith, M. (2012). *The State of the Planet Declaration*. Proceedings of the Planet Under Pressure conference. Retrieved February 1, 2015 from http://www.planetunderpressure2012.net/pdf/state_of_planet_declaration.pdf
- Callon, M. (1999). The role of lay people in the production and dissemination of scientific knowledge. *Science, Technology & Society*, 4(1), 81-94.
- Clover, D.E., De O'Jayme, B., Hall, B.L., & Follen, S. (2013). *The nature of transformation. Environmental adult education*. Rotterdam: Sense Publishers.
- Colton, D., & Covert, R.W. (2007). *Designing and constructing instruments for social research and evaluation*. San Fransisco: Jossey-Bass.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). Oxon: Routledge.
- Dobson, A. (2003). *Citizenship and the environment*. Oxford: Oxford University Press.
- Dobson, A., & Bell, D. (2006). Introduction. In A. Dobson & E. Bell (Eds.), *Environmental citizenship* (p. 1-18). Cambridge: MIT Press.
- Dobson, A. (2007). Environmental citizenship: Towards sustainable development. *Sustainable Development*, 15, 276-285.
- Du Preez, L., & Carruthers, V. (2009). *A complete guide to the frogs of Southern Africa*. Cape Town: Struik.

- Edwards, A. (2011). Building common knowledge at the boundaries between professional practices: Relational agency and relational expertise in systems of distributed expertise. *International journal of educational research*, 50, 33–39.
- Faraday, A, & Day, M. (2011). *Proposal: Evening Radio Toad Traffic Report*. A WLT-CC report, Cape Town.
- Faraday, A. (2013). *An initiative to reduce road mortality of the Western Leopard Toad*. Report
- Freitag, A., & Pfeffer, M. (2013). Process, not product: Investigating recommendations for improving citizen science “success”. *PLOS ONE*, 8(5), 1-5.
- Gibbons, M. (1998). Higher education relevance in the 21st century. *Proceedings to the UNESCO World Conference on Higher Education*, p. 3-72, Washington, Human Development Network/Education.
- Gordon, L. (2009). *An investigation of prior knowledge about amphibians amongst grade 7 learners and educators: Towards the development of a resource pack*. Unpublished master’s thesis, Rhodes University, Grahamstown.
- Gough, S. & Scott, W. (2006). Promoting environmental citizenship through learning: Toward a theory of change. In A. Dobson & E. Bell (Eds.), *Environmental Citizenship* (pp. 263- 286). Cambridge: MIT Press.
- Gray, S.A., Nicosia, K. & Jordon, R.C. (2012). Lessons learned from citizen science in the classroom. *Democracy & Education Journal*, 20(2), 1–5.
- Hammond, M., & Wellington, J. (2013). *Research methods. The key concepts*. Oxon: Routledge.
- Hanks, J. (2013, October). Toads off the roads. *Africa Geographic*, p. 14.
- Hayward, B. (2012). *Children, citizenship and environment. Nurturing a democratic imagination in a changing world*. Oxon: Earthscan/Routledge.
- Hemmings, B., Kemmis, S., & Reupert, A. (2013). Practice architectures of university inclusive education teaching in Australia. *Professional Development in Education*, 39(4), 470-487.
- Henning, E. (2004). *Finding your way in qualitative research*. Pretoria: Van Skuik Publishers.
- Humewood, C. (2013). Monitoring and evaluating the socioeconomic impacts of conservation projects on local communities. In B. Collen, N. Pettorelli, J. E. M. Baillie & S. M. Durant (Eds.), *Biodiversity, monitoring and conservation* (pp. 335-345). West Sussex: Wiley-Blackwell.
- Jansen, J. (2013). *We need to act*. Johannesburg: Bookstorm & Pan Macmillan.

- Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. *International Journal of Quality Healthcare*, 15(3), 261-266.
- Kemmis, S. (2009). Understanding professional practice: A synoptic framework. In B. Green (Ed.), *Understanding and researching professional practice* (pp 19-38). Rotterdam: Sense Publishers.
- Kemmis, S. & Grootenboer, P. (2008). Situating praxis in practice: Practice architectures and the cultural, social and material conditions for practice. In S Kemmis & J. Smith (Eds.), *Enabling praxis: Challenges for education* (pp.37-62). Rotterdam: Sense Publishers.
- Kemmis, S., & Mutton, R. (2012). Education for sustainability (EfS): Practice and practice architectures. *Environmental Education Research*, 18(2), 187-207.
- Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research*. Singapore: Springer.
- Krasny, M., & Tidball, K. G. (2010). Civic ecology: Linking social and ecological approaches in extension. *Journal of Extension*, 48(1), 1 – 5.
- Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. New York: Cambridge University Press.
- Lerman, S. (2000). The Social Turn in Mathematics Educational Research. In J. Boaler, *Multiple Perspectives on Mathematics Teaching and Learning* (pp. 19-44). Westport C T: Ablex Publishing.
- Mann, C. (2010). Home from home, new and selected poems. Fish Hoek: Echoing Green Press.
- Maxwell, J.A. (2005). *Designing qualitative research*. Los Angeles: SAGE.
- Measey, G.J. (Ed.) (2011). *Ensuring a future for South Africa's frogs: a strategy for conservation research*. SANBI Biodiversity Series 19. South African National Biodiversity Institute, Pretoria.
- Measey, G.J, Dorse, S., & Faraday, A. (2012). Conservation of the Western Leopard Toad by a dedicated Multi-Stakeholder Group in the City of Cape Town. *Froglog*, 20(4), 14-16.
- Nash, N., & Lewis, L. (2006). Overcoming obstacles to ecological citizenship: The dominant social paradigm and local environmentalism. In A. Dobson & E. Bell (Eds.), *Environmental Citizenship* (pp. 153-184). Cambridge: MIT Press.
- Parker, J. (2010). Towards a dialectics of knowledge and care in the global system. In R. Bhasker, C. Frank, K. G. Hoyer, P. Naess & J. Parker (Eds.) *Interdisciplinarity and climate change: Transforming knowledge and practice for our global future*. (pp. 205-226). London: Routledge.
- Rebelo T., Measey J., De Villiers A., & Dorse C. (2013). *Biodiversity Management Plan for*

the Western Leopard Toad *Amietophrynus pantherinus*. Unpublished draft for comment, South African National Botanical Institute, Cape Town.

Scott, W. (2009). Environmental education research: 30 years on from Tbilisi. *Environmental Education Research*, 15(2), 155-164.

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4-13.

South Africa. Department of Environmental Affairs. (2004). *National Environmental Management: Biodiversity Act 10*. Pretoria: Government Printer.

Sterling, S. (2009). Towards ecological intelligence. In A. Stibbe. (Ed.), *The Handbook of Sustainability Literacy*. Green Books, Dartington.

Szerszynski, B. (2006). Local landscapes and Global Belonging: Toward a Situated Citizenship of the Environment. In A. Dobson & D. Bell. (Eds.), *Environmental Citizenship* (pp. 75-100). Cambridge: MIT Press.

Tàbara, J. D., & Chabay, I. (2013). Coupling human information and knowledge systems with social-ecological systems change: Reframing research, education and policy for sustainability. *Environmental science and policy*, 28, 71-81.

Tawil, S. (2013). Education for 'global citizenship': A framework for discussion. UNESCO: Education research and foresight. Retrieved November 30, 2014, from <http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/pdf/PaperN7EducforGlobalCitizenship.pdf>.

Toad NUTS homepage. (2013, September 2). Retrieved September 2, 2013, from <http://toadnuts.ning.com/>.

Toerpe, J. (2013). The rise of citizen science. *The futurist*. July-August, pp. 25 – 30.

Toomey, D. (2014, January 28). How the rise of citizen science is democratizing research. *Yale Environment 360*. Retrieved March 1, 2014, from <http://E360.Yale.edu/feature/interview-Caren-Cooper-how-the-rise-of-citizen-science-is-democratizing-research/2733/>.

Tweddle, J.C., Robinson, L.D., Pocock, M.J.O., & Roy, H.E. (2012). *Guide to Citizen Science: developing, implementing and evaluation citizen science to study biodiversity and the environment in the UK*. Natural History Museum and NERC Centre for Ecology and Hydrology for UK-ECF. Available online: www.ukEOF.org.uk.

UNESCO. Education Sector. (2014). *Global Citizenship Education. Preparing learners for the challenges of the 21st century*. France: UNESCO printers. Available online at <http://unesdoc.unesco.org/images/0022/002277/227729E.pdf>.

Virtual Museum. Animal Demographic Unit homepage. (2009, January 12). Retrieved July 6, 2014, from <http://vmus.adu.org.za>.

Wals, A.E.J., Brody, M., Dillon, J., & Stevenson, R.B., (2014). Convergence between science and environmental education. *Science*, 344, 583-584.

- Wals, A.E.J., & Dillon, J. (2013). Conventional and emerging learning theories. Implications and choices for educational researchers with a planetary consciousness. In R. Stevenson, N. Brody, J. Dillon & A. Wals (Eds.), *International handbook of research on environmental education* (pp. 253 – 261). London: Routledge.
- Wals, A.E.J. (2007). Think Piece: Learning in a changing world and changing in a learning world: Reflexively fumbling towards sustainability. *South African Journal of Environmental Education*, 24, 35-45.
- Welsh, E. (2002). Dealing with Data: Using NVivo in the Qualitative Data Analysis Process. *Forum: Qualitative Social Research / Sozialforschung*, 3(2), Article 26. Retrieved September 21, 2014, from <http://nbn-resolving.de/urn:nbn:de:0114-fqs0202260>.
- Wenger, E. (1998). *Communities of practice: learning, meaning and identity*. Cambridge: Cambridge University Press.
- Wenger, E. (2009). A social theory of learning. In K. Illeris (Ed.), *Contemporary theories of learning* (pp.209 - 218). New York: Routledge.
- Wenger, E., McDermott, S., & Snyder, W. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Boston: Harvard Business School Press.
- Western Leopard Toad Conservation Committee homepage (2014). Retrieved July 10, 2014 from <http://www.leopardtoad.co.za/>.
- Wiek, A., Withycombe, L., & Redman, C.L. (2011). Key competencies in sustainability: a reference framework for academic program development. *Sustainability Science*, 6, 203–218. Retrieved January 21, 2015 from <http://sustain.indiana.edu/~sustain/education-research/docs/key-competencies-in-sustainability.pdf>

Personal communication

- Day, M. (2014, July 5). Facilitator and treasurer of the Western Leopard Toad Conservation Committee, Cape Town.
- Dorse, S. (2014, June 9). Senior Environmental Professional, Environmental Resources Management Department, City of Cape Town.
- Faraday, A. (2014, January 31). Co-Founder, Toad NUTS, Noordhoek, Cape Town.
- Kruger, D. (2014, July 11). Researching herpetologist, North West University, Potchestroom.
- Measey, G.J. (2013, August 18). Senior Lecturer, Department of Zoology, Nelson Mandela Metropolitan University, Port Elizabeth.
- Underhill, L. (2014, July 10). Head, Animal Demographic Unit, University of Cape Town, Cape Town.

APPENDIX 1 - DOCUMENT LOG

Document	Code	Date produced	Value	Content
Toad NUTS has a fundraiser	Doc1	2014	Good	Community support for Toad NUTS fundraiser.
Toad barrier report	Doc2	2013	Good	Document relays the history of the intervention, the installation of the fence and reports on the effectiveness of the barrier.
The Story of the WLT and Toad NUTS	Doc3	2009	Good	Document gives the history of the Toad NUTS group.
Skilpadsvlei CoCT media release	Doc4	2012	Good	Gives details of multi-stakeholder wetland renovation as a conservation intervention.
Recruitment Flyer	Doc5	2010	Fair	Appeal to community members to volunteer to the Toad NUTS group.
Proposed road traffic report	Doc6	2011	Excellent	Intended as a marketing tool to the general public informing them both about the toad and alerting them to the movement of the toads during the breeding season. Document highlights the activities of the volunteer groups, information and also relays a practical, localised, conservation solution.
Final Toad breeding Report	Doc7	2008	Excellent	Document shows careful data recording and findings. Localised species knowledge gained by volunteer group.
Committee SWOT minutes	Doc8	2011	Very valuable	The SWOT analysis done with the WLT Committee reveals how the different communities within the practice landscape interact, communicate and relate to each other. Essentially the document sets out how the various role players, institutions and volunteer groups in the practice landscape interact. Explores the boundary space and describes the resources, power or roles, and authority. Also describes power relations, grievances and shortcomings. Boundary interactions
Beach Chart	Doc9	2012	Average	A notice to non-Toad NUTS Noordhoek community members about movement of toads. Gives insight to agency and knowledge of toad movement. Describes a Toad NUTS intervention for conserving the WLT.
Quest Magazine article	Doc10	2013	Fair	Gives a good coverage of the barrier intervention but basically repeats what is in the 'Road barrier report 2013'.
Toads off the road	Doc11	2013	Fair	Details the work of the Toad NUTS group. Repeats information given in 'Final toad breeding report'.
Email - member	Doc12	2014	Fair	Gives one piece of data
Email – Fundraiser attendee	Doc13	2014	Fair	Gives one piece of data

WhatsApp group conversation	Doc14	2014	Excellent	Rich data of how the Toad NUTS communication system works.
Noordhoek Tourism August newsletter	Doc15	2014	Poor	Indicates one piece of data
Skilpadsvlei report	Doc16	2014	Good	Gives full details of the Skilpadsvlei renovation process.
Toad NUTS newspaper article: Echo	Doc17	2011	Fair	Gives insight to public awareness messages and summarises the findings of the season to come.
Toad NUTS newspaper article: Echo	Doc18	2012	Fair	Gives insight to public awareness messages and summarises the findings of the season just past
Toad NUTS newspaper article: Echo	Doc19	2013	Fair	Gives insight to public awareness messages and summarises the findings of the previous season.
Toad NUTS newspaper article: People's Post	Doc20	2011	Fair	Gives insight to public awareness messages and summarises the findings of the season to come.
Toad NUTS newspaper article: People's Post	Doc21	2012	Fair	Gives insight to public awareness messages and summarises the findings of the season in anticipation.
Toad NUTS newspaper article: Weekend Argus	Doc22	2012	Fair	Gives insight to public awareness messages and summarises the findings of the season to come.

APPENDIX 2 – TOAD BARRIER REPORT 2013



SAVING A SPECIES ONE TOAD AT A TIME

Amphibian Barrier: Noordhoek Main Rd, Cape Town

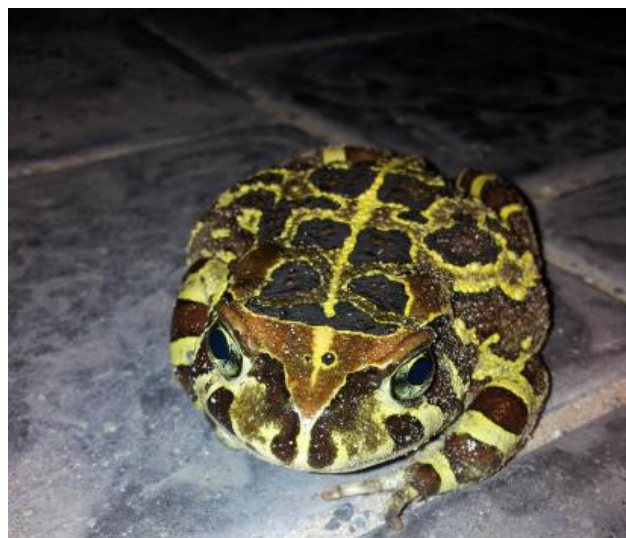
August – October 2013

An initiative to reduce road mortality of the Western Leopard Toad

(Amietophrynus Pantherinus)

Report written by Alison N Faraday

Statistics collated by Richard Faraday



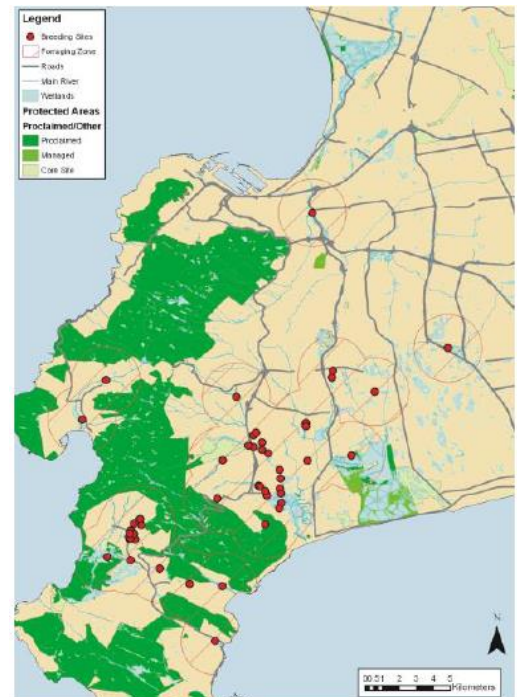
Executive Summary:

- This article discusses the Western Leopard (WL) toad population living in Noordhoek in the Western Cape, and efforts by the local volunteer group ToadNUTS to save the toad from becoming critically endangered.
- We provide some information and summarise our experiences relating to the introduction of a temporary barrier that was constructed at the start of the 2013 breeding season. The GPS co-ordinates showing the extent of the barrier are provided in the report.
- The purpose of the barrier is to prevent WL toads crossing a busy and dangerous 500 metre stretch of Noordhoek Main road. The barrier has been used in conjunction with a pitfall trap system to collect the toads to be carried across the road.
- The migrating toads were picked up from behind the east-side barrier (usually found in the pitfall traps and a few along the barrier) and were carried across the road to the west-side, therefore reaching the breeding ponds on the west side of the road safely.
- The returning toads were picked up from behind the west-side barrier (usually found in the pitfall traps and a few along the barrier) and were carried across the road to the east-side, therefore enabling them to return to their homes located in suburban gardens.
- We do not know if the barrier may have affected individual toad behaviour, such as the toad turning around on seeing the barrier, thereby not achieving its objective to cross the road. It is important to note that we did not observe any toad turning round at the Barrier, so we only regard this as a possibility.
- In conclusion we believe that the toad barrier was a great success and will be constructed again next year before the start of the season.

The current status of the Western Leopard Toad (*Amietophrynus Pantherinus*)

In 1998 the **Western Leopard Toad (*Amietophrynus pantherinus*)** was distinguished from its less colourful cousin the **Eastern Leopard Toad (*Amietophrynus pardalis*)**. The WL toad is a coastal toad found along the southern Cape coastline of South Africa in sand fynbos stretches. Due to the desirability of this land for human habitation, the numbers of the WL toads have declined drastically in recent years. The map below shows the range of its current habitat. It is now listed on the Red Data list of Species as “endangered in the wild”. There are several reasons for this:

- **Loss of habitat.** The greater Cape Town area in which the WL toad lives and breeds is now filled with houses and roads.
- **Road mortality.** The WL toad migrates annually to the nearest suitable pond during the month of August to breed. The ponds which they choose are in low-lying areas and are all surrounded by roads. Toads can be difficult to see during rainy nights and many are killed.
- **Suburban hazards.** Toads make excellent neighbours and will live happily in our gardens, emerging at night to eat worms, crickets, snails and other ‘bugs’. But often our properties can be dangerous to toads. Swimming pools, open drains, gardening spades etc can all kill toads.
- **Invasive species in ponds:** Ponds are often filled with alien fish and ducks. These fish and birds are protein hungry and can easily consume vast numbers of tadpoles.



Conservation Strategies:

Since its inception in 2008, the Toad NUTS (Noordhoek’s Unpaid Toad Savers) volunteer group in conjunction with Western Leopard Toad Conservation Committee (WLTCC)*, has employed the following strategies to increase awareness and decrease toad deaths in 18 areas within the greater Cape Town area:

1. Recruitment and training of volunteers who patrol during the winter migration to remove toads from roads.
2. Generating awareness of leopard toads with local homeowners
3. Educating children at local schools
4. Advising pond owners.

*The following organisations are represented on the WLTCC: SAN Parks, Cape Nature, SANBI, City as well as all volunteer groups directly involved in conserving the Western Leopard Toad. Their aim is to co-ordinate efforts to conserve the WLT.

Toad NUTS begins:

It was in August 2007 that we (Suzie J'kul and myself Alison Faraday) first saw that migrating toads were being run over and killed by cars on the Noordhoek roads. The following year in 2008, we established a group of volunteers to help us patrol the roads and to move the toads to the side of the road. We decided to call our group of volunteers ToadNUTS (where NUTS stands for Noordhoek Unpaid Toad Savers)

Over the years from 2008 to 2013 we have organised road patrols each evening during the winter breeding season in Noordhoek. At the start of each breeding season since 2008, we have trained the ToadNUTS patrollers to do the following:

- Move the toad off the road to the side taking account of the direction in which the toad was facing;
- Record the general location of the toad (i.e. name of road).
- Keep a record of all alive and all dead toads and to also move dead toads off the road to avoid double-counting;
- Determine the gender of the toad;
- Measure the toad (not compulsory);
- Take a photograph of the toad's back to enable identification from the unique markings (not compulsory)

The main objective is to ensure patrols are out on the busy roads over the period from darkness at 6.30 p.m. until the traffic quietens down, or until the toads have stopped moving. On any night when toads are moving, patrols may continue until midnight. If no toads are observed and if there is little likelihood that they will emerge later in the evening, the patrols may be finished by 8pm.

Main threat facing WL toads in Noordhoek

The main issue for the WL toads in Noordhoek is the two busy roads (Silvermine Road and Noordhoek Main Road) that bisect the whole suburb and are close to the main breeding ponds and are therefore a major hazard for the WL toads trying to reach the breeding ponds.

When toad patrols started in 2008, our main focus was in Noordhoek which included Silvermine Road and the northern end of Noordhoek Main Road close to the intersection with Silvermine Road, and all the surrounding minor roads.



Map showing location of barrier

Orange: East Barrier

Green: West Barrier

It was only from 2010 that we were able to turn our attention to the large numbers of toads crossing the southern end of Noordhoek Main road between the two entrances to the Lake Michelle residential estate. Approximately 30% of the toads seen were being killed. We commenced full patrols of this area in 2011.

The main difficulty faced patrolling this section of road is the high speed that cars reach on this road and the high volume of traffic in the early evening. This presents a real danger in picking up toads off the road.

Our worst fears were realised when a patroller's car was rammed from behind by a drunk driver in July 2013, fortunately with only very minor injuries, mainly shock.



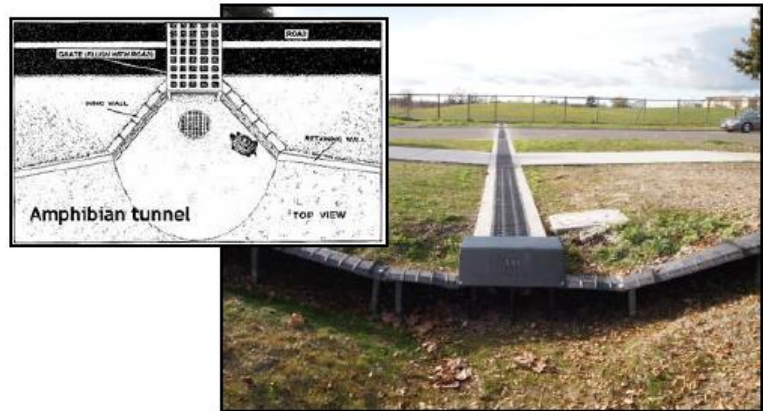
It was mainly to prevent this type of accident that steps were taken before the start of the 2013 season to try to improve the situation on this section of road by constructing a barrier to prevent the toads crossing the road without the assistance of a volunteer.

The Introduction of an Amphibian Barrier in Noordhoek

We carried out some research between the 2012 and 2013 breeding seasons into what other countries do to prevent toads from being killed on the roads. Once we established that a temporary barrier could be a feasible solution we experimented with some suitable materials and decided in this first year to keep it as simple as possible.



Drift fences and
Pitfall traps near Amsterdam



Permanent funnel and tunnel system :
Sweden

We obtained the necessary approvals from the various Municipal authorities which took many months to arrange and the construction of a temporary barrier was only finally approved in June 2013, shortly before the start of the 2013 breeding season.

Unfortunately our intended funder for this barrier (a local wine farm that uses the WL toad to promote its wine claiming that donations are made towards the cause of the WL toad) pulled out of the project, as soon as the approvals were received and the funding requested. This was an unexpected blow since we were led to believe that the only condition for the funding of this project was that it should be legal and approved by the authorities.

Fortunately, the Endangered Wildlife Trust took over the funding of the barrier project at very short notice. Costs were also kept to an absolute minimum by using simple materials some of which was donated and by using labour that was provided at little cost to the project, as detailed below.

Toad NUTS Barrier: Noordhoek Main Road South (running from S 34° 06.780 E 018° 22.900, to S 34° 06.950 E 018° 23.140).



The factors that we took into account in the design and construction of the barrier were as follows:

- 1. Affordability:** Toad NUTS is a volunteer organisation, and as such funding is always scarce. The barrier had to be constructed with cheap and easily accessible materials.
- 2. Not tempting for thieves:** We chose emergency-coloured shade cloth as the material for the barrier as this seemed more “official” than the alternative green shade cloth and therefore was less likely to be stolen.
- 3. Wind-resistant:** The winter storms in Noordhoek can bring strong winds and the fabric of the barrier needed to withstand such storms.
- 4. Toad-proof:** The barrier needed to prevent toads from climbing over it or burrowing under it.
- 5. Toad-safety:** The barrier needed to direct the toads towards buckets (i.e. the pitfall traps) where they could be held safely until they could be carried across the road. The buckets needed to be deep enough to prevent toads from climbing out and also needed to have drainage holes to prevent buckets filling up with rain water and drowning the toads and any other creatures that had fallen into the buckets.
- 6. Easy to patrol:** The location of the barrier needed to be fairly easy to walk along so patrollers could check buckets in the evening and early morning. The use of buckets obviously assisted finding the toads
- 7. Ease of construction and removal:** The Barrier is a temporary barrier which must be erected and removed each year.

Barrier specifications

On the **east-side of Noordhoek Main Road** we used 500m x 1m emergency shade cloth. The cloth was fixed in place with cable ties attached to wooden poles knocked into the ground at a roughly 60° angle. Roughly 70cm of shade cloth was fixed above ground and 30cm of cloth was buried into a trench running the length of the barrier. The cable ties and buried section of cloth ensured that the barrier was securely fixed and impervious to wind.

On the **west-side of Noordhoek Main Road**, and within the residential estate of Lake Michelle, we used green shade cloth of 400m x 70cm with buckets buried every 40m. We used green shade cloth in order to blend in with the natural surroundings.

The “buckets” used were plastic plant pots with 6 drainage holes in each.

The buckets were 28cm high and had a diameter of 30cm. These were buried in the ground with approximately 10cm drainage below each bucket, and at approximately 40m intervals. The location of the buckets was

indicated by means of reflective tape. Lids were provided next to each

bucket in case of flooding. Volunteers could then check the flooded bucket for any frogs or other critters, and then secure the lid on top of the bucket using a rock. This prevented any other creatures from being trapped or drowned in that bucket.



Construction of the Barrier:

Due to the long process and delay obtaining official approval and then a last-minute problem with funding, the barrier could only be erected on 4th and 5th of August which was a week or so after the start of the season.

The barrier was erected by a team supplied by Wally Petersen of KEAG (Kommetjie's Environmental Awareness Group) together with and under the guidance of Wally Peterson and Alison Faraday. Lake Michelle garden staff also assisted with the erection of the barrier on the west side. The barrier was taken down on 2nd October – having remained in place for 59 nights without a single toad managing to breach the barrier.

Patrolling the Barrier:

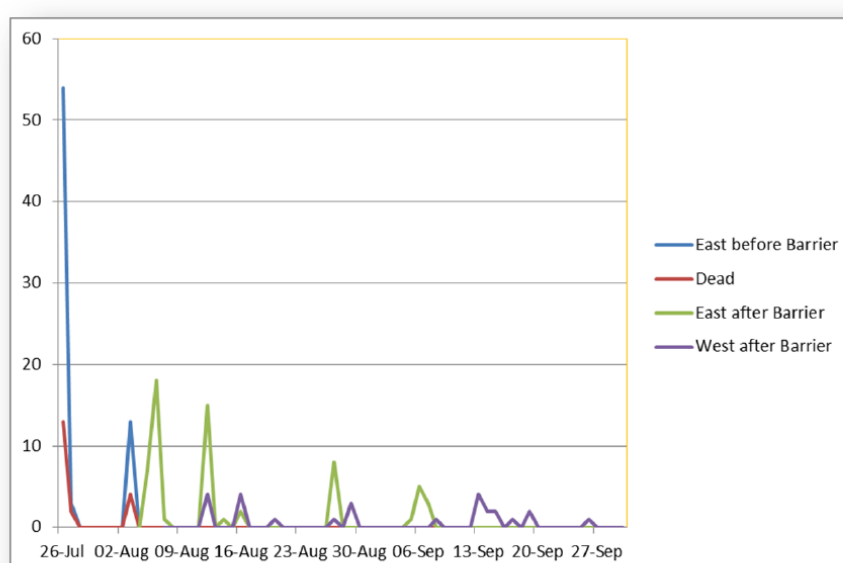
Walking patrols of the barrier checking the buckets (i.e. “bucket runs”) were conducted at least once every 24 hours either at night or early in the morning. A total of 105 bucket runs were carried out by 24 patrollers over the 59 nights. A complete patrol of both sides of the road (about 1000 metres) usually took patrollers about 30 to 45 minutes depending if any toads were found in the buckets. A bucket run took place between 6am and 7am every morning and there was often also a patrol in the evening. During peak periods of toad movement, bucket runs were carried out two or three or even four times over a 24 hour period.

Records were kept of which barrier (east or west) the toads were found behind, and if they were found in a bucket or waiting behind the barrier. In addition, all other species found were noted. Aside from WL toad

these included sand frogs, clicking stream frogs, a sand toad, common platannas, slug eater snakes, cape river crabs, skinks, a terrapin, tiger moth caterpillars, and stink bugs.



Results of the Barrier:



The graph above shows the following:

1. Prior to the erection of the barrier on 4 August a large number of toads (70) attempted to cross this stretch of Main road and a relatively large number (19) of these were found dead on the road, in spite of regular road patrols trying to prevent this.
2. The east-side barrier was erected on 4th August and the west-side barrier was erected on 5th of August. No toads have been found on this stretch of road (either dead or alive) since the construction of the barrier.
3. There have been 61 toads found behind the barrier and in buckets on the east side of Main Rd (these are toads heading towards Lake Michelle to breed).
4. There have been 27 toads found behind the barrier and in buckets on the west side of Main road (these are toads presumed to have finished breeding and trying to return home)
5. All toads found behind the barrier and in buckets were carried across to the opposite side of Main Rd and placed safely behind the barrier.

Did the barrier reduce the death toll?

The number of toads dead and alive found on the 500 metre stretch of road in 2013 is shown in the following table, before and after the implementation of the Barrier on the east-side of the road (to catch the migrating toads) and on the west-side of the road (to catch the returning toads).

	Alive	Dead	Total	% Dead
Total migrating Before Barrier (East-side)	51	19	70	27,1%
Total migrating After Barrier (East-side)	61	0	61	0,0%
Total migrating to the breeding ponds	112	19	131	14,5%
Total returning Before Barrier (West-side)	0	0	0	0,0%
Total returning After Barrier (West-side)	27	0	27	0,0%
Total returning from the breeding ponds	27	0	27	0,0%
Total (east and West)	139	19	158	12,0%

Below are the comparative statistics for this section of road in 2011 and 2012.

	Alive	Dead	Total	% Dead
2011 (no barrier)	84	35	119	29,4%
2012 (no barrier)	121	49	170	28,8%
2013 (before barrier)	51	19	70	27,1%
2013 (after barrier)	88	0	88	0,0%

Conclusions:

We believe that the Barrier has reduced the number of dead toads and that this was for two main reasons:

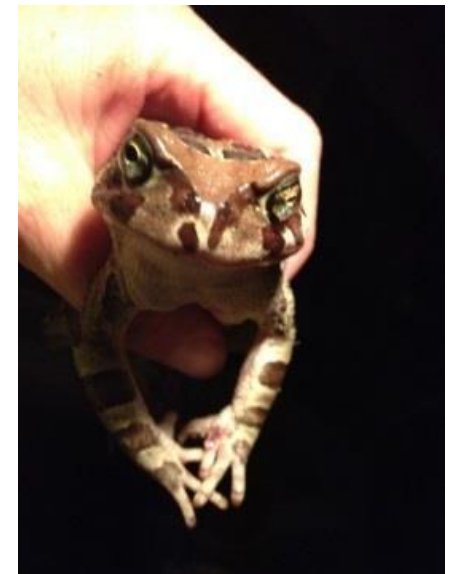
1. At the start of this season we recorded 19 dead toads out of 70 migrating toads found crossing this 500 metre section of Main road opposite Lake Michelle prior to the construction of the Barrier. Over the next few weeks we found 61 toads behind the Barrier presumably also migrating (i.e. also crossing from east to west). We then found 27 toads behind the Barrier presumably returning (i.e. crossing from west to east).
2. The fact that the Barrier was in place from quite early on the season (4 August) and because not a single toad was found on that stretch of road over the remainder of the breeding season, this enabled patrollers to focus on other areas where there was no Barrier in place. The patrolling of the Barrier always took place at times in the evening and early morning when there was no longer anything happening on the roads, therefore did not take any patrollers away from the roads. This has resulted in a number of toads in other areas being picked up alive off the road, by patrollers who would have been patrolling this section of Main road if the Barrier had not been in place.

We have determined by means of simple proportioning previous death rates that approximately 24 toads out of the 88 toads found behind the two Barriers could have been found dead on the road, if the barrier had not been in place. However, it is not possible to estimate the number of toads saved in other areas as an indirect benefit of the barrier eliminating the necessity for patrols on that section of road. We are therefore unable to estimate the total number of toads saved because of the existence of the Barrier.

We are puzzled that only 27 toads were found at the Barrier returning from west to east, since this was far lower than the 112 toads that successfully migrated from east to west. We currently are seeking an explanation for this. One theory would be that not all the toads return home after the breeding season. If that is the case then our previous understanding of toad behaviour may be incorrect.

We do have anecdotal evidence that at least some toads do return to the same locations after the breeding season, but possibly not all toads try to return.

In the 2014 breeding season we plan to put up the Barrier again, this time before the season starts.



APPENDIX 3 – SURVEY – NOORDHOEK COMMUNITY MEMBERS

This survey is intended to probe how the community of Noordhoek regard local environmental initiatives as part of research probing citizen science. Please take a few minutes to answer the questions below. Cross the most appropriate response.

1. Are you aware that an endangered frog, the Western Leopard Toad, inhabits the Noordhoek area?

Yes	No
-----	----

2. How do you know this? Tick the relevant answer(s)

Read about it	
Someone told me	
I saw a road sign	
I heard a Toad NUTS presentation	
Other- As locals we know about the Leopard Toad	

3. How do you feel about living with this animal?

Irritated	
Privileged	
Indifferent	
Other	

4. Do you know of the Toad NUTS group?

Yes	No
-----	----

5. Is there an awareness campaign in Noordhoek, for the Western Leopard Toad that you are aware of?

Yes	No
-----	----

6. Are there any measures that you take to ensure the survival of these toads?

Yes	No
-----	----

If so, tick the measures that you do practise.

I drive carefully on rainy nights	
I have a Toad saver on my swimming pool or drain	
I have a Toad NUTS sticker on my bumper	
I support the Toad NUTS group financially	
Other – always aware of them in and around property	

7. Are you a member of the Toad NUTS group?

Yes	No
-----	----

8. If you are not, are you interested in participating in citizen science in a different field?

Yes	No
-----	----

9. If so, which fields interest you? Can you number your choices please, starting with 1 as your first choice.

Sharks		Reptiles	
Birds		Frogs	
Maths		Astronomy	
Plants		Insects	
River testing		Photography	
Diving		Digital project	
Weather mapping		Technology	
Mammals		Sea Plants	

10. What would motivate you to join a volunteer citizen science group? Number your response from 1 as the most important influence. Do not mark any that would not be an influence.

If the project focussed on an area that interests you	1
If the project made a meaningful contribution to a conservation or environmental problem that occurs in your area.	2
If a friend joined too	
If you worked with scientists	
Only during the day	
Only at night	
If it occurred at a time that suited you	
If you could learn new skills through the project	3
If the project occurred in your area and it did not require travelling	4
If you were paid	
Other	

If other, can you explain? _____

11. If you choose not to join a volunteer citizen science group, can you say why not?

No time	
Not interested in working with others	
Not interested in science	
Don't like nature	
Do not have transport	
Other	

If other, please elaborate _____

Thank you for taking the time to participate in this survey.

Sheraine van Wyk

APPENDIX 4 - SUMMARY OF SURVEY DONE WITH NOORDHOEK RESIDENTS

Noordhoek Survey summary XL1 - Microsoft Excel																				
File Home Insert Page Layout Formulas Data Review View Add-Ins																				
L40																				
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Summary of Noordhoek citizens responses to citizen science																			
2	Responda ques 1		Ques 2		Ques 3															
3	Yes	No	Read	Told	road sign	Toad NUT	Others	Irritated	Priviledge	Indifferen	Other									
4	Res 1	Yes	x		x		Just know		x											
5	Res 2	Yes	x	x	x				x											
6	Res 3	Yes	x							x										
7	Res 4	Yes	x							x										
8	Res 5	Yes	x		x				x						frustrated at not being able to help them					
9																				
10																				
11																				
12		Citizen	Science																	
13	Yes	No	Sharks	birds	maths	plants	rivers	diving	weather	mammals	reptiles	frogs	astronom	insects	photograp	digital	technolog	Sea Plants		
14	Res1	x								x										
15	Res 2		x																	
16	Res 3		x												x					
17	Res 4																			
18	Res 5	Yes			x		x				x	x	x	x			x	x		
19																				
20		Ques 4		Ques 5		Ques 6						Member	of Toad N							
21	Yes	No	Yes	No	No	drive	Toad saver	Bumper	Funds	Other	Yes	No								
22	Res1	x		x						Aware		x								
23	Res 2	x		x		x						x								
24	Res 3		x	x	x					none		x	maybe							
25	Res 4		x	x																
26	Res 5		x			x				x		x								
27																				
28		Motivation																		
29	Interest	Contribut	Friend	Scientist	Day	Night	Any time	New skills	No travell	Paid										
30	Res 1	1	2					3	4											
Sheet1 Sheet3 Sheet4 Sheet5 Sheet2 Sheet6																				
Ready																				



APPENDIX 5 - QUESTIONNAIRE TO NOVICE VOLUNTEERS

Questionnaire – New Toad NUTS Volunteers

Name: Belinda & Reg Date: 09 /8/2014

Thank you so much for your effort in responding to this questionnaire. Please circle or tick the most appropriate answer where this is given otherwise a short response is needed.

1. Are you a member of an environmental group other than the frog monitoring group? No
2. Have you commented on an Environmental Impact Assessment before? No
3. Are you familiar with the environmental acts?

NEMA	no
NEMBA	no
NEMWA	no
NEM: AIR QUALITY	no
Marine Living Resources Act	no
NEM: Protected Areas Act	no
NEM: Integrated Coastal Management	no
Other	no

4. Do you read environmental magazines or newsletters?

Veld 'n Flora	yes	WCC Newsletter	no
Environment	no	Other	no
Green Times	no		

5. How many different frog species do you know? ____ NOW 3
6. How many different frog calls can you identify? ____ 3 ____
7. Are you confident that you are able to identify a Western Leopard Toad ie. will you recognise it's call and the colouration of the toad? yes ____
8. Do you know where frogs occur in your neighbourhood? ____ yes ____
9. Are you involved in any other environmental initiative? ____ no ____

APPENDIX 6 - INTERVIEW SCHEDULE WITH THE WLT-CC SECRETARY

Name: Matthew Davies

Date: 5/7/2014

- | | Timespan | Content |
|---|-----------------|--|
| 1 | 0:00,0 - 2:40,0 | <p>M D = extension officer for Clifford Dorse, a biodiversity co-ordinator for the City and also for the fire protection association, so in summer I would be doing fire prevention and in winter I'd be working on the Western Leopard Toad project for the City. That was two years. Essentially that was funded by the fire prevention association but then they wanted someone to work on that full time and the funding for the WLT project fell away but I continued with the committee after that. I'm working for a private environmental consulting firm called Enviroworks. The City of CT has a magazine called Enviroworx.</p> |
| 2 | 2:40,0 - 3:50,0 | <p>1. Were you involved in the establishment of the Western Leopard Toad Conservation Committee? If so, can you describe the role of the committee?</p> <p>MD - No, the committee was established in 2007 and I arrived in 2008 and served in my capacity as an extension officer. Since then and I still am the secretary, so I take minutes, and send out notices etc.</p> <p>S - Who represents San Parks on the committee? Leane Mosshoff</p> |
| 3 | 3:50,0 - 7:00,0 | <p>2. Please describe your interaction with the Toad NUTS group.</p> <p>MD - Toad NUTS is a member of the committee. The founding members of Toad NUTS, Alice & Sharon are on the committee. They essentially function as area co-ordinators. There are about five areas and these areas comprise of about seven suburbs on average. Their area would be Noordhoek, Sun Valley, Clovelly, Fish Hoek, Kommetjie, Glencairn. Kirmits, Sam Williams, covers Marina Da Gama, Fish Hoek, Lakeside, Kirstenhof, that whole area. Currently I'm holding onto Hout Bay, for whom we don't have someone to oversee at the moment, it does not seem to require many volunteers as there isn't much traffic at night, there isn't much road kill. Hout Bay, Bergvliet, Heath field, Princessvlei, Grassy Park, Zeekoeivlei, Lotus River, Phillipi but I do have some help from another lady in Grassy Park who runs it herself there. Hout Bay is a funny area as we have not had consistent support over the years. There are no observation data for there, just anecdotal reports. It's not something that we can predict very well for Hout Bay.</p> <p>S - On the other side?</p> <p>M - They are getting quite good stats for that area. The toads move over Fisherman's Walk road, and a road that goes out to Zeekoeivlei, there's only one entrance. So the toads tend to cross between Rondevlei NR to Zeekoeivlei NR, they tend to move over that road. We have a good record of what's happening there.</p> <p>S - Is there a road kill issue on that road? I'm interested to know the size of the toad population.</p> <p>M - Well I can send you the stats for that. It's the same kinds of threats all over. On Hout Bay I'm getting swimming pools and electric fences.</p> |

- 4 7:00,0 - 12:00,0
3. Have you observed the Toad NUTS activities?
- M - Yes, quite a few years ago, but when it is breeding season, we tend to do our own thing as our areas need our presence. They are doing an excellent job. They have quite a jacked up system. They are doing a good job recruiting and retaining their volunteers and motivating their volunteers. One of the issues with volunteers is that they lose motivation if they go out for a few times and don't see anything, and then fall away. If movement occurs quite late in the season ie late august or September. Volunteers can get disheartened and don't stay around when the toads do move. We do also have volunteers that are more dedicated to the cause.
- S - What is your impression on the rigor for recording data?
- M- Alice's husband is an actuarial scientist which is a huge help. They code or at least they try to record their data at the end of every night and put it all on disc and then upload it all onto his database. At the end they compile an interesting report. Their information is quite accurate.
- 5 12:00,0 - 15:00,0
4. Have you worked with them on a conservation issue before? If so, will you describe this please?
- M - No, only with toad related work.
- S - Yes, I mean a toad related conservation initiatives.
- M- The barrier is quite unique to the Noordhoek area where they have quite a long stretch of road where there are no street lights. They need an intervention like the barrier to protect their volunteers and toads. Signage is something that we all do and has been done since 2008. So we have a collective effort. Each co-ordinator will identify where they need signs, where a lot of toads crossing and then we have a tally of how many signs we need. Then we basically need permission from the City and we get stickers to stick on our posters so that they are legal. We go through an application process. We all have posters.
- We have standardised signs. At one point we had about three different signs, but now they are standardised. We put in one application for all the areas.
- 6 15:00,0 - 17:00,0
5. In your opinion is there a need for volunteer groups like Toad NUTS to extend of the conservation efforts of the biodiversity sector?
- M - Ideally for urban conservation in a social-ecological landscape and species exist in the human layer of living and it is difficult for their conservation to proceed without the public buy in. A large portion of their input would be on top of what someone does in times of their health. Especially for migrating species So I definitely agree that volunteer involvement is crucial as a joint effort between local government, volunteers and awareness within the community. A whole spectrum really. Also indirectly the kind of work that we try to do, creating awareness with residents, toad friendly gardens, toad savers and that kind of thing which benefits the residents and the toads. That is why the toad is considered a flagship species for urban conservation in that sense that also brings

conservation benefits for other species.

8 18:20,0 -
21:00,0

6. How important is public awareness are you for or against it?

M - I'm definitely for it. My experience of it has been positive. The majority of public interaction I've had has been positive not necessarily to mobilise people, but to plant the seed of consideration that they are living in a space that is habitat for wild life as well as for their own needs. So it opens up their mind to what they don't see or what they have not previously considered as valuable. If something has an endangered status it is significant in some way and it's now threatened. It tends to wake people up when you tell them this. We have only been a few incidents of possible foul play and for the most part my experience has been positive. The benefits outweigh the negatives. People have become familiar with the toads. Also consider that what we are doing is not strictly lawful. We don't have permits to move the toads. We do have a Cape Nature representative on the WLTCC so they are aware of what we are doing.

APPENDIX 7 – OBSERVATION DESCRIPTION

Observation description – 3 - 5 August

Aug 3	7:30pm – 10pm	Patrolling Noordhoek streets in a vehicle with a leader and novice Toad Nuts member. Meeting other members. Picking up toads and recording data about this on WhatsApp. Doing a bucket run with two novice members.
-------	---------------	---

The Toad NUTS group was observed over a period of two days which involved going out on patrol in the night approximately 8pm to 10:30pm and again in the morning at approximately 6:30am to 8am. Toad NUTS members typically drive along all the roads in the area where there has previously been toads found on the road, patrolling for toads. This is alternated with a ‘bucket run’ which involves walking along the length of a particular length of barrier to see whether there are any toads stuck along the barrier or in the buckets which act as pit fall traps. These are then collected and taken to the other side of the road where there is another barrier and the toads are released on the other side of this. That barrier is also checked for toads and if found these are then moved to the opposite side of the road on the safe side of the barrier to continue on their way.



Toad NUTS vehicles are signed and identifiable as a patrol vehicle. Members put flashing lights on their roofs and drive with their hazard lights on. (Photo: S van Wyk, August 3, 2014).



Toad NUTS members wear reflective raincoats and miners torches. (Photo: S van Wyk, August 3, 2014)

Driving in a Toad NUTS patrol vehicle. Dialogue in car.

S1: Melanie: Two females on the gravel road. Brigatine should be quiet – that's Sun Valley. Just shout if you see anything and I will be sure to stop.

Suzie says calling at Lake Michelle new entrance. So we can go there.

Why do people take pictures of all the squashed toads? Yuck, that's horrible. Especially Ann, she loves taking pictures of dead things.



Toad NUTS member checking WhatsApp group communication. (Photo: S van Wyk, August 3, 2014).

S2: This place here seems to be quite wet.

S1: But there aren't really permanent bodies of water deep enough for leopard toads.

S2: There's a little stream along the side.

S1: I don't believe that toads like running water.

S3: Oh there's something....oh, oh...no it's a leaf.

S1: Thank you for that leaf pointing outing.

S3: You're welcome

S1: Oooh what is this?

S2: Looks like a skateboarder with lights on.

S1: Those must be their dogs.

S2: Are they walking?



S1: No, just walking. With torches.

Toad NUTS patrollers on foot met by Toad NUTS leader patrolling by vehicle. (Photo: S van Wyk, August 3, 2014)

S1: Hello, looking for toads? Hi Steven. Have you seen anything?

Walker 1: Yes, we've seen one hopper on the road.

S1: Eggs no eggs? Female or male?

W1: Female

S1: Was she heading this way?

W1: I don't know, she was sitting in the middle of the road.

S1: OK, last time we were down here, there were two females no eggs, so leaving...

W2: How do you tell whether they have eggs? Suzie is going to teach Steve tomorrow night.

S1: Well they either look bloated or they look a little bit skinny. If they look chubby... When they drop their eggs they literally just shrink in the middle. Like we all wish we could. The females have the creamy throats.

S2: Now do you have that waxed? If it's a female she has a cream throat.

S1: This is Sheraine, she is going citizen science research. Females are more triangular.

So you have seen one tonight.

W1: Ja, there were a lot more last night.

W2: And then Saturday night we found three

S1: Oh fantastic

W2: We were just going to go down Kraal. Have you been done there?

S1: No, we came from that side and saw nothing. We found a couple of flatties tonight, but higher up in Noordhoek and I think they were from last night actually and we'll do bucket patrol just now.

W2: And we have heard not croaking yet this evening.

S1: But you already had calling at Mile's pond, hey?

W2: Yes, but the biggest, I was speaking to Suzie, was in the Docker's behind us.

S1: Oh really?

W2: (3:45) And they're right close and they have never, ever been so loud.

S1: Are they calling tonight?

W2: Nobody's calling tonight yet. They were calling last night and they were calling this morning until about 10.

S1: Oh really? And you'll see a lot more rain tomorrow as well.

Ok we'll turn around considering that you are on the prow.

W2: We'll just find our dogs. Calls dogs...

S1: I'll go very slowly

W2: OK

S1: Cheers

S2: Bye

S2: Where is this?

S1: This is Sleepy Hollow, so we could actually just...

S2: No, no, what corner is she talking about?

S3: I ride on the Docks as well

S2: The Dock?

S1: See now it is starting to rain so we might actually get some toads coming in. What we can do is turn right here. Where that wooden thing that you can see.

S2: Oh, is this not the wetland that you were pointing out yesterday.

S1: Yes, but we are further down now. We can actually go there now but we never really actually go to the wetland 'cause it does not actually feel safe at night.

S3: We can go and visit Greengin? My horse.

S2: Oh that must be a male.

S3: Yes he's a gelding. He's 16,3 hands

S2: Oh that's pretty big. Is he a chestnut?

S3: Yes, pure chestnut.

S2: No Blaze? No pure chestnut, black tail.

S1: So if that lot is calling we should really be seeing them moving here.

S3: I've asked Heather. She comes down really early and can keep an eye out for them.

S2: (6:00) I'm really intrigued by our conversation earlier about them being cold blooded but being really energised in this cold weather.

S1: What's that there?

S1, S2 & S3: Yes, jay

S1: Well I'm prepared to get drenched

S2: And now I can't take a photo

S1: No you can't but Shan you have to get out, I'm sorry but this is your first toady.

S3: Ok, I'm going to get out.

S2: Now what are you going to do now with this, are you just going to put her on the side there or...?

S1: Ja, oh look it's a small...

S2: Where's she heading?

S1: She's heading home. It's a small road, we can only hope

Windscreen wipers going... no talking while everyone is outside attending to the toad.



Toad NUTS members attend to a frog on the road. (Photo: S van Wyk, August 3, 2014).

S1: (8:37) Well this is where my special beanie comes in, with the peak. The main thing is that I wanted a peak with a lip otherwise I cannot see anything when it starts raining which is the main thing during winter.

S2: But these little roads are so quiet...

S1: Yes, exactly, you can only hope that it's fine. You come down here just for your own interest. It's not about saving the toads as much.

S2: You know, we've gotten out and gotten wet and all that but what have we done for the toads, it wasn't really necessary.

S1: no, no, nothing

S2: nice to do,

S3: I see a toad

S1: She is crossing the road, we will see here and watch. Look she's getting there.



Western Leopard Toad on the road verge. Creamy throat of female visible. (Photo: S van Wyk, August 3, 2014).

Do frogs hop in rhythms? I've noticed a one, two, three stop.

Everyone watching while the toad hops along and crosses the road.

S3: Come on, keep hopping

S1: Saved by us – not

S2: Well we watched him

S2: In Hermanus we don't have that many wetlands and most of them have been filled in.

And we don't have these big guys so I can't really say.

Lots of driving...

It's pouring with rain. We advise our patrollers that when it is pouring to pull over and stop because you may be driving over toads and you won't know. And when the wind blows and you have leaves blowing everywhere it's extremely hard to see what is going on.

More driving... with idle chatter, recording crackly. (16:30)

S2: That wasn't a squashed one was it?

S1: I was looking to the right. I don't really know. It's so hard to see.

I am always amazed at what people are thinking in the other cars. Damn it!

S2: Well the other motorists may be thinking something entirely different.

S1: Like, "Wow, these people are so dedicated, "Slow down Mom, I also want to see..."

S1: Exactly, I once stopped the car to pick up a frog. It was not a toad but another type of frog. I bent down to pick it up but I just could not get a handle on this thing. There were a few cars watching me. Eventually I caught it and they all applauded me.

Laughter... 18:06 – 20:37

Car stops, everyone hops out, windscreen wipers heard in the background. Recorder in car. A toad was spotted on the road and while approaching to have a look at it, it disappeared into a drain on the road verge. Toad NUTS members try to get it out but the toad is unreachable.

S2: (21:57) Don't worry, you did what you can to get him out.

S1: I always imagined that the water in there would wash them down there and out at the other end. All of these drains are open. Where do these toads end up?

S2: Well where would the outlet of the drainage system be? Generally near the sea?

S1: That's only if it gets washed away. That toad is not going to come out willingly. Gee that was really a shock to me. I always imagined that they wouldn't go down there unless they were swept down there. I can go home and fetch some shade cloth but the trouble is that if he tries there is nothing to anchor it down. It will just flop around. It won't work, will it?

S2: I think what he saw was a patch of dark that he could get into and be safe.

S2: Oh, oh, hang on, stop, stop.

See another Toad NUTS patrol car.

S1: Do you want to take a picture of them?

S1: We are taking a picture of you. (To S2) Hurry up.

Stops to chat to other Toad NUTS members.

S2: No that didn't work very well.



Toad NUTS members meeting up on patrol and exchanging experiences (Photo: S van Wyk, August 3, 2014).

S1: We just had a horrible experience. We were watching a toad hop up the road and it hopped into a storm water drain and it is now marooned 1,5m underground and we cannot get to it. It's sitting there just waiting.

S4: What? Oh no. Lol just thought that she saw one over there. Did you see it?

S1: No we were behind you.

S4: What about a pool net?

S2: That might work!

S1: I think that I just recently threw one away. We will go home and get it.

S5: Oh no. I was thinking about that the other day worrying whether my penguins would get into the drains. Are we still going to meet down at the bottom there later?

S1: Well we can meet here.

S5: We have a dead one, do you want me to keep it?

Everyone out of the cars exchanging equipment and gear. Another car.

S1: It's a Toad nerd convention. Now you can take your photos. It's almost half past, I have to get you home. (to S3)

S4: Where is it?

S1: Just up there in Turquoise.

More talking on the road while talking on the road while the equipment is being exchanged.

S1: I used to have those small guy nets but I threw them out because they were getting scruffy.

S2: If you have two thinnish sticks you can weave it through shade cloth strip. Then you will have a ladder of sorts. A pool net might have to fit a pole to fit through the slots in the drain cover.

S1: Maybe he will get out by the time we get there. Like the mouse this morning.

S2: Platannas can crawl everywhere.

S3: Good bye, nice meeting you. Let me know about the toad.

S2: Nice meeting you too

S2: Platannas can crawl overland. So a manmade wetland can be populated by platanna and one never knows how they get there.

S1: Is that a smelling thing?

S2: I don't know but I would love to find out.

S1: Shame Shan is standing in the rain. I'll sms. Do you want to get back into the car. Get back in and I'll phone your mom. Is your gate not working?

S3: Clearly

Mom: Hi, should I open the gate.

S1: No, I'll take Shan home with me. She feels rejected.



A Toad NUTS patrol vehicle. (Photo: S van Wyk, August 3, 2014).

A car with lights passes and stops. They are patrolling Toad NUTS. They stop.

S1: Hello, how has it been tonight?

Answer indistinct

S1: Only the one? It's been very quiet tonight. Cheers Shan

Another indistinct answer.

S1: Ok good, enjoy your evening.

S2: Now who were those people?

S1: I don't know laughter, [the other leader] organised them. I've given up, there are so many new people and you cannot see them in the dark. They seem friendly and nice. They are good guys, doing a good job.

So far we have had a flatty in Seascapes, a flatty in Sea Cottage, a male in Paddock and a male in Turquoise

S2: ...that ended up in the drain.

S1: yes [sigh]

S2: Ok let's see if we can find any more.

31:20 Driving & looking

S2: Where are we now?

S1: Silvermine

S2: What is this?

S1: Nothing...

S2: Oh a sign... [a road sign] I'd like to take a photo of it.



A Toad NUTS road sign. (Photo: S van Wyk, August 3, 2014).

S1: Oh a hoppy, what are we going to do? Leave it there?

S2: Let's just watch and see what it does.

S2: Oh, there's another patrol vehicle.

S1: Yes, it look choreographed, everyone knows what they are doing.

S1: This is A... behind us. I'm going to turn around over there and then we better go do toad rescue 101.

S2: This is quite addictive.

S1: There is something weirdly soothing about it. This is all you have to think about. You are actually doing something useful. Just when you start feeling tired it starts to rain, and then you think, I'll just do a few more laps. I'll just look over here again...

S2: But there is a bit of adrenalin involved.

S2: Oh another dog.

S2: Dog

S1: Oh no, it's an old guy, he knows where he's going. He knows his way around. Another Noordhoek thing, people just let their dogs wonder around.

S2: We have the same thing in one of our suburbs, Vermont, where there is a pack of dogs that wonder around being very destructive.

S1: I'm going to wait her and sms her that we are waiting here.

S2: Look at that isn't it wonderful? Those two cars.

Car pulls over. Beeper going off because the door is open and the lights are on. Another patrol vehicle has stopped and equipment is exchanged. A quick report of the evening's experiences is given.



**Two patrol vehicles meeting to exchange equipment and swop patrol experiences.
(Photo: S van Wyk, August 3, 2014).**

S2: Do you hear? There is a toad calling right here. Everyone moves over to listen.

S1: It's a bit far from the wetland. Far from the water's edge here.

Movement and chatting as the other patrollers join.

S1: Is it in the bucket? Oh, look at that. Two dead juveniles. So sad. Found in Kommetjie. Oh shame. The sign of the night.



Two juvenile toad victims of road kill. (Photo: S van Wyk, August 3, 2014).

S2: What is this place?

S1: It's a vineyard.

Background chatting about the rain clothes.

S1: Here is the pants. You are probably the right size. I find that they are a bit tight. They are not made for women.

S4: Now what happened to the toad in the drain? Will it be washed away?

S1: Well if it does, it will be fine but I think that it just sits there waiting and eventually dies.

S4: Is it in, in a

S1: Well if you look down it looks like a mine shaft.

S4: You should be able to get it out.

S1: Well we are going to try.

S2: Now those juveniles that were killed are very young.

S1: This is the problem, if you don't stop for every hopper.

S1: They seem to just come to the party and hang around. Some nights there are loads of juveniles and those guys would probably be 1 or 2 years old.

S1: Now those girls are two single ladies and they are quite clear that they don't patrol on weekends. They say Friday and Saturday they are 'jolling'.

Stop at drain where the toad fell in.

S1: Where is it?

S2: Don't know, where can it be?

S1: It's gone. Do you think that it got out?

S2: May I use your light?

Lot's of background noises while members look for the toad, it's gone! It is either in the storm water systems or it got out.

S2: (46:52) One can become besotted with the toads. I spent time today looking at that proposal today working through that Table Mountain Fund but it is very useful as it forces you to go through every step. I'm beginning to get the hang of it. It's really beneficial to go through

Phone rings...

"Alison speaking hello"

"Yes, how can I help you?"

47:42

Where about do you live? Ok. Well they generally know which way to do

S3: Well toads naturally know which way to go so I wouldn't move them if I were you. When the come back there will be quite skinny and will be hungry.

Well they find their own way around. Well do you have lights on at home? We find that people with their outside lights on will have them hunting there.

51:25: Oh, I thought that there was a newspaper article about Toad NUTS last week. I thought S... had submitting something with my name it. But no...Oh look there...

Everyone out of car for a while, windscreen wipers can be heard.

S2: They are very camouflage

S1: You know the best thing in these situations, is to put the light on you.

S2: I was hoping to turn the platanna around to see the underside but he got away...I am not too familiar with the differences between the two species, I can't tell the differences.

S1: I am hoping to get some of them in our pool. I don't know what to do with the pool.

S2: In my area I'd know exactly who to get to sort out your problem. You need to have a specialist to look at what is going on.

S1: Well we had that. He said that we need more plants, but you know how difficult it is to get more plants. They take out all the nutrients and release oxygen into the water. They do all the good things in the pool.

S2: Oh another sign...is that the sign the committee gives you.



Temporary sign the ward councillor commissioned that go up in Noordhoek during the breeding season. (Photo: S van Wyk, August 4, 2014).

S1: (57:30) No in fact that is a sign that came about when I spoke to the water committee they said speak to your ward councillor to get some support. So I emailed her and said, we need a way to slow down the traffic. How are we going to do this? So she said no, you have to speak to this one and that one...blah, blah. But it is in everyone's interest to slow down the traffic. Eventually, these signs appeared and are now used.



A dead female toad is found on the road. She is picked up and placed on the verge. (Photo: S van Wyk, August 3, 2014).

Aug 4	7am – 9am	Doing a morning bucket run on one stretch of road with a Toad NUTS leader.
Aug 4	7:30pm – 10pm	Doing a night bucket run on a different stretch of road. Meeting other Toad NUTS members on patrol.

Toad NUTS member patrol the barrier system at the end of the patrolling session, usually at about 10pm at night. They still wear their reflective gear but take a bucket along to load up and carry the toads that they find in the pitfall traps. They have to walk along the entire length of the barrier looking for toads sitting along the barrier and also inside the pit fall traps (or buckets).

	Toad NUTS member starting out on a ‘bucket run’.
	The shade cloth was installed at an angle and is not very high. At night when it is dark the barrier has to be inspected closely to see toads on the inside of it.
	Each bucket has a number and the GPS location is known. There is a lid alongside the bucket so that it can be closed when flooded.



The buckets are closely checked for other animals too. Often mice, other types of frogs, snakes, spiders and bugs are found in the buckets.



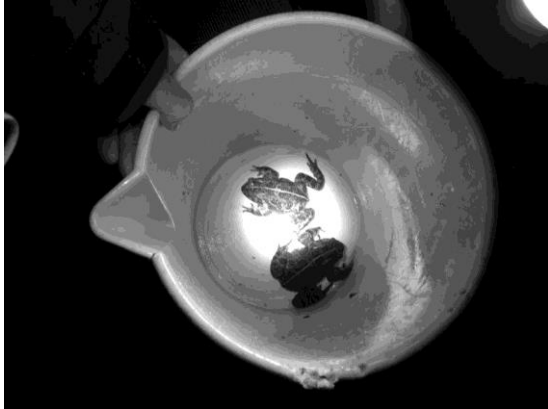
Often toads are found in the pit fall traps. Here is one male and one amplexus pair. The buckets with toads are photographed so that the bucket number is visible. This is submitted with data to the record keeper.



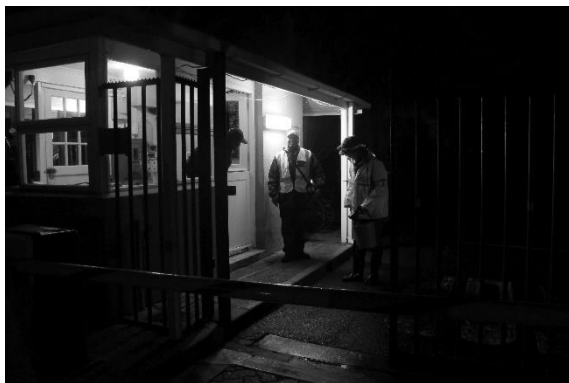
Toads are taken out of the pit fall trap and put in the transport bucket so that they can be safely moved to the other side of the road and placed behind the next barrier.



A toad found in a flooded bucket. The ground water level is so high that it enters the bucket. These toads are removed and the lid of bucket secured in place with a rock to prevent any more animals falling in the pit fall trap and drowning.



Toads found in the buckets are carried over to the other side of the road and released safely on the other side of the opposite barrier.



Toad NUTS member shows the security guards at a security estate the toads in the buckets. Toads are taken inside the estate where there is a breeding pond.



After being released the toads are photographed.



Five toads are watched after being released as they continue on their way.

The bucket patrols were difficult to capture as it is done when it is very late and dark which makes video recording the activity impossible. Both nights that observations were done, it was raining hard and so not many photos were taken. The audio recorder was used but did not really serve any purpose as not much talking occurred. A series of annotated photographs will serve to illustrate the activity.

Aug 5	7:30pm – 10am	Putting up road signage with a Toad NUTS leader.
-------	---------------	--



Toad NUTS leader fixing a sign to a lamppost near a toad breeding pond. (Photo: S van Wyk, August 3, 2014).

APPENDIX 8 – WHATSAPP GROUP COMMUNICATION

1 7/24/2014 2:40 PM: Alice: The barrier is open and ready for business! 41 buckets behind
2 1.5km of netting, which took about 200 man (and woman) hours to erect is fully operational
3 before tonight's rain. Kim you have the privilege of doing the first bucket run for 2014.

4 7/24/2014 3:00 PM: +27 83 745 3060: Yay!! Looking fwd. will be there with bells!

5 7/24/2014 7:33 PM: Alice: Fair bit of movement in Noordhoek tonight. Some in SV too

6 7/24/2014 8:33 PM: Alice: photo of a large female WLT

7 7/24/2014 8:34 PM: Alice: Look at the size of this female in Noordhoek tonight!

8 7/24/2014 8:35 PM: +27 72 196 3755: WOW lucky:)

9 7/24/2014 8:54 PM: +27 83 745 3060: 2 fm, 1 m vet

10 7/24/2014 8:55 PM: My pet while at Rhodes: Amazing girl. What a beaut!

11 7/24/2014 8:56 PM: Alice: So hoping you find toads in buckets K!

12 7/24/2014 9:10 PM: +27 83 745 3060: photo showing toads in bucket

13 7/24/2014 9:11 PM: +27 72 196 3755: Yay😊

14 7/24/2014 9:11 PM: Alice: Great! Take a pic of toads in the bucket you found them with
15 nucket number showing next time

16 7/24/2014 9:11 PM: Alice: I meant bucket number

17 7/24/2014 9:15 PM: +27 83 745 3060: photo of toads in bucket

18 7/24/2014 9:16 PM: Alice: Perfect!

19 7/24/2014 9:17 PM: Alice: That bucket looks flooded?

20 7/24/2014 9:18 PM: +27 83 745 3060: photo – toads in bucket

21 7/24/2014 9:22 PM: +27 73 295 3816: Excited for you and the team Alice! Beautiful female
22 you got there!! She will provide a few thousand offspring for next season! We are looking
23 forward to our visit!

24 7/24/2014 9:23 PM: Alice: Do you like our bucket numbering system?

25 7/24/2014 9:24 PM: +27 73 295 3816: Looks like it is working wonderfully!! You had a
26 bright idea there!

27 7/24/2014 9:25 PM: +27 83 704 7049: All we need to do is note the gps...home in 2.Or do
28 you need me to go anywhere Alice?

29 7/24/2014 9:26 PM: Alice: Lucy had road kill opp Common. There?

30 7/24/2014 9:27 PM: +27 83 704 7049: Took a drive round there already a few mins ago but
31 saw nothing.

1 7/24/2014 9:29 PM: +27 83 704 7049: Also saw 3 cars flashing lights so think noordhoek is
2 well covered.

3 7/24/2014 9:30 PM: Alice: □

4 7/25/2014 7:41 AM: +27 83 745 3060: <image omitted>

5 7/25/2014 7:41 AM: +27 83 745 3060: <image omitted>

6 7/25/2014 7:43 AM: +27 83 745 3060: Sorry for bucket photo overload. Prob best to just
7 record data rather. Was just so excited to find so many! Carried away.... 10 males in total. 7
8 in buckets, three on road near vet.

9 7/25/2014 7:44 AM: +27 83 261 0570: Wow it's almost as if they know we are there to help.
10 Very exciting!

11 7/25/2014 7:50 AM: +27 83 704 7049: Well done Kim! Will just need a summary of last
12 night and tonight including bucket numbers how many toads in each. Also totals per gender.

13 7/25/2014 7:52 AM: Alice: Wow - I am always relieved when the barrier and buckets do their
14 job! ☺ Nothing at Caravan park barrier this morning when I checked

15 7/25/2014 10:00 AM: +27 78 740 3020: So great to see so many beautiful toads well done
16 every one! I look forward to helping out next week □

17 7/25/2014 10:02 AM: Alice: No rains forecast for next week but we will still need scouts

18 7/25/2014 10:04 AM: +27 78 740 3020: Ok thanx Alice

19 7/25/2014 5:41 PM: +27 82 883 5911 left group

20 7/25/2014 7:32 PM: +27 82 876 9531: Alice are you covered for the bucket run tonight?

21 7/25/2014 7:34 PM: +27 82 476 1016: Yes

22 7/25/2014 7:36 PM: +27 82 876 9531: Thanks Sharon

23 7/25/2014 7:36 PM: +27 71 198 7875: Alice I can do a bucket run tomorrow am if anyone
24 wants to swop. Do we partner?

25 7/25/2014 9:36 PM: Alice: Hi Lindsay. I am showing Susan the bucket run tomorrow at 7am.
26 Could you do Sunday morning rather?

27 7/25/2014 9:38 PM: Alice: Sorry for late reply Shireen - was at the buckets! Nothing in any
28 buckets.

29 7/25/2014 9:40 PM: +27 82 876 9531: Thanks Alice.

30 7/26/2014 9:26 AM: +27 71 198 7875: Can't do Sunday Alice. Will ring you later to go
31 through it all. Is Capri on the map this year?

32 7/26/2014 11:47 AM: Alice: I would love you and Lea to keep your eyes open on rainy
33 nights in Capri. Note the roads on which toads were seen. We have very little idea if the toad
34 situation there.

35 7/26/2014 11:48 AM: +27 71 198 7875: Ok cause there are 2 streams very full.

1 7/26/2014 11:53 AM: Alice: Fast flowing streams wash their eggs away. They need sluggish
2 or still water.

3 7/26/2014 11:55 AM: +27 71 198 7875: But there are reeds and still water on edges lots if
4 tadpoles in there

5 7/26/2014 12:01 PM: Alice: Ok good to monitor. Can you take a drive round there tonight?

6 7/26/2014 12:05 PM: +27 83 704 7049: I would like to know if the toads breed in the pond in
7 the far corner near kommetjie road so perhaps check those roads. If you see a few toads this
8 season in Capri and if can figure out where they are going to breed then I think Capri should
9 be put back on the Map for regular patrols.

10 7/26/2014 12:05 PM: Alice: Agreed!

11 7/29/2014 1:57 PM: Alice: <audio omitted>

12 7/29/2014 1:59 PM: Alice: Just in case you need reminding. This is what a love-struck male
13 toad sounds like • • . Listen out at your local ponds from tonight onwards.

14 7/30/2014 8:01 AM: +27 83 607 6706: Nothing in buckets this morning

15 7/30/2014 8:02 AM: Alice: •

16 7/30/2014 8:04 AM: Alice: While you are listening at the ponds you will hear this one:
17 clicking stream frog

18 7/30/2014 8:04 AM: Alice: <audio omitted>

19 7/30/2014 8:05 AM: Alice: <audio omitted>

20 7/30/2014 8:05 AM: Alice: And these too

21 7/30/2014 8:06 AM: Alice: <audio omitted>

22 7/30/2014 8:07 AM: Alice: <audio omitted>

23 7/30/2014 8:08 AM: Alice: <audio omitted>

24 7/30/2014 8:09 AM: +27 82 659 0957 joined group

25 7/30/2014 8:59 AM: +27 72 196 3755: Brilliant. Now we can start identifying. 😊🐸

26 7/30/2014 10:17 AM: +27 73 295 3816: • •

27 7/30/2014 12:02 PM: +27 83 704 7049: At Skilpadsvlei in Kommetjie 10pm last night I saw
28 14 males in water and heard another 16 males calling in bushes on water edge. The chorus
29 was louder than i can ever remember. Two gravid females also were spotted. This is a great
30 success story as 3 seasons ago only 1 toad was spotted in the whole season and so wally of
31 keag organised the wetland to be rehabilitated. Last year I think 4 toads arrived and now 32!

32 7/30/2014 12:03 PM: +27 83 704 7049: <image omitted>

33 7/30/2014 12:04 PM: +27 83 704 7049: If you wish to listen to this amazing chorus and see
34 what we are all doing this for feel free to go along over the next few evenings. It is at the

1 corner of Benning drive and Kelp Way. Please note the ground is still being rehabilitated so
2 tread lightly when off the boardwalk and dont shine light too much onto the toads.

3 8/8/2014 3:17 PM: Alice: With this very warm and dry weather we are not expecting
4 movement this weekend. However if you do see any of our spotty friends on the roads let us
5 know asap. Morning bucket runs will continue as planned. Have a hoppy weekend •

6 8/8/2014 4:16 PM: +27 83 607 6706: Yeah there was nothing in buckets this morning

7 8/10/2014 3:55 PM: Alice: <image omitted>

8 8/10/2014 3:57 PM: Alice: This is the pond in front of Noordhoek Chalets at the end of
9 Houmoet by BP. Perfect toad breeding spot. Shireen and Margie - no sign of our injured
10 female. Let's hope she made it to the water.

11 8/10/2014 3:59 PM: +27 82 876 9531: I was just about to ask about her.

12 8/10/2014 4:01 PM: Alice: Thats her

13 8/10/2014 4:03 PM: Alice: <image omitted>

14 8/13/2014 2:09 PM: Alice: We are expecting rain tonight and tomorrow. Melanie are you
15 checking SV as usual? Bev you are scheduled to check FH. Shireen can you go around
16 Milkwood Park tonight and tomorrow please? Lea and Ash can I roster you for tomorrow
17 night Milkwood Park?

18 8/13/2014 2:10 PM: +27 72 196 3755: Yes i am in

19 8/13/2014 2:11 PM: Alice: Great. Remember to send your stats and patrol times to Ray
20 soonest • . Enjoy!

21

APPENDIX 9 – EXTRACTS FROM THE NVIVO INTERFACE TO DEMONSTRATE THE ANALYTIC PROCESSES THAT OCCUR

Name	Nodes	References	Created On	Created By	Modified On	Modified By
WLT_Citizen Science_Stanford Market_28 Feb 2014 Susan Wishart	1	2	2014-04-04 01:23 PM	SM	2014-07-06 07:39 AM	SM
Video 2 script	4	13	2014-03-24 01:35 PM	SM	2014-07-11 08:24 PM	SM
Toad NUTS video script VID1	3	19	2014-07-11 08:24 PM	SM	2014-08-13 08:15 PM	SM
Toad NUTS has a fundraiser	3	4	2014-07-02 08:01 AM	SM	2014-07-06 07:40 AM	SM
Toad Barrier Report 2013	7	28	2014-03-24 01:36 PM	SM	2014-07-06 07:41 AM	SM
The Story of the Western Leopard Toad and Toad NUTS	3	3	2014-03-24 01:36 PM	SM	2014-07-06 07:41 AM	SM
Skilpadsvei wetland	4	6	2014-07-05 05:51 PM	SM	2014-07-06 07:41 AM	SM
Sheet1 (2)	0	0	2014-07-11 08:30 PM	SM	2014-07-11 08:30 PM	SM
Sheet1	0	0	2014-07-11 08:28 PM	SM	2014-07-11 08:28 PM	SM
Sarah Smuts	4	6	2014-06-30 08:42 PM	SM	2014-07-08 06:16 PM	SM
Sarah Jane	0	0	2014-08-12 06:24 AM	SM	2014-08-31 04:52 PM	SM
Sarah 2	5	6	2014-06-30 08:42 PM	SM	2014-07-08 06:15 PM	SM
SANBI Ismail Ebrahim	0	0	2014-07-26 01:19 PM	SM	2014-07-26 01:21 PM	SM
Richard Faraday	0	0	2014-09-16 12:12 PM	SM	2014-09-16 12:14 PM	SM
Recruitment Flyer 2010	4	12	2014-03-24 01:36 PM	SM	2014-07-06 07:43 AM	SM
Quest article on barrier fence DOC 10	0	0	2014-07-11 08:22 PM	SM	2014-07-11 08:22 PM	SM
Proposal Toad Traffic Report	3	9	2014-03-24 01:36 PM	SM	2014-07-06 07:43 AM	SM
Proff Les Underhill UCT	0	0	2014-07-11 12:52 PM	SM	2014-07-11 12:54 PM	SM
Observation Svan/vlyk	0	0	2014-08-31 11:34 AM	SM	2014-08-31 11:34 AM	SM
Observation recording	0	0	2014-08-12 06:27 AM	SM	2014-08-12 06:29 AM	SM
Lucinda Cruikshank	6	14	2014-07-01 08:20 AM	SM	2014-07-08 05:49 PM	SM
Jeanne Tarrant ElvT	10	19	2014-06-11 07:15 AM	SM	2014-07-06 07:44 AM	SM
Interview Transcript with Veterinarian Caren	3	4	2014-06-11 07:16 AM	SM	2014-07-06 07:45 AM	SM
Interview Sonja 2	5	7	2014-05-07 07:51 PM	SM	2014-07-06 07:45 AM	SM
Interview Sonja 1	7	11	2014-05-07 07:44 PM	SM	2014-07-06 07:45 AM	SM
Interview Schedule - Suretha Dorse	5	6	2014-07-02 07:59 AM	SM	2014-07-06 07:45 AM	SM
Interview recording M Day	5	7	2014-07-05 03:27 PM	SM	2014-09-20 03:04 PM	SM
Interview Karen	5	12	2014-05-07 07:36 PM	SM	2014-07-07 06:45 AM	SM
Interview Alison Faraday	12	55	2014-05-02 01:00 PM	SM	2014-07-10 08:33 AM	SM
INT 10 D Kruger	3	10	2014-08-13 08:03 PM	SM	2014-08-13 08:21 PM	SM

Figure 1: Main NVIVO page showing a list of 30 of the 38 raw data files uploaded to the program. The toad barrier report 2013, the Observation transcript and the interview with the secretary of the WLT-CC are listed on this page as sources.

Name	Sources	References	Created On	Created By	Modified On	Modified By
E C knowledge & learning	8	35	2014-05-06 02:42 PM	SM	2014-08-13 08:31 PM	SM
E C Agency	8	18	2014-05-06 03:35 PM	SM	2014-08-13 08:30 PM	SM
E C virtues	7	14	2014-05-08 08:22 PM	SM	2014-08-13 08:29 PM	SM
E C participatory processes	5	10	2014-05-08 08:22 PM	SM	2014-08-13 08:30 PM	SM

Figure 2: The three analytic phases used in this research are seen in the left hand column of the next figure with analytic categories for the first phase shown in the main part of the figure. When a phase is selected, the analytic categories are shown.

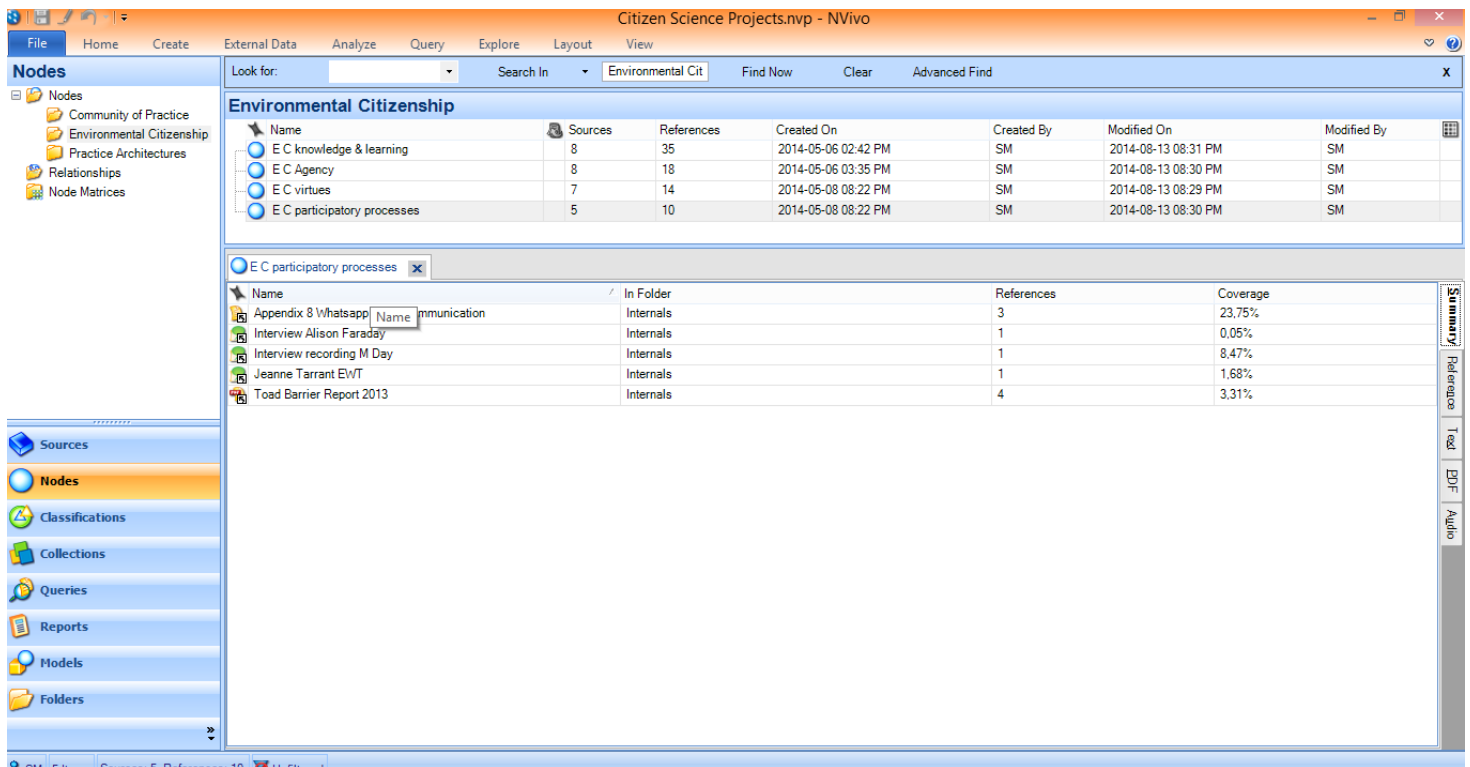


Figure 3: The analytic memo for participatory processes which is an analytic category within the environmental citizenship phase, because the raw data shown in the appendices 1, 5 and 8 are shown as being the sources of data extracted for this category. The tabs on the right hand side give various views of the analytic memo. This is a summary of the data sources

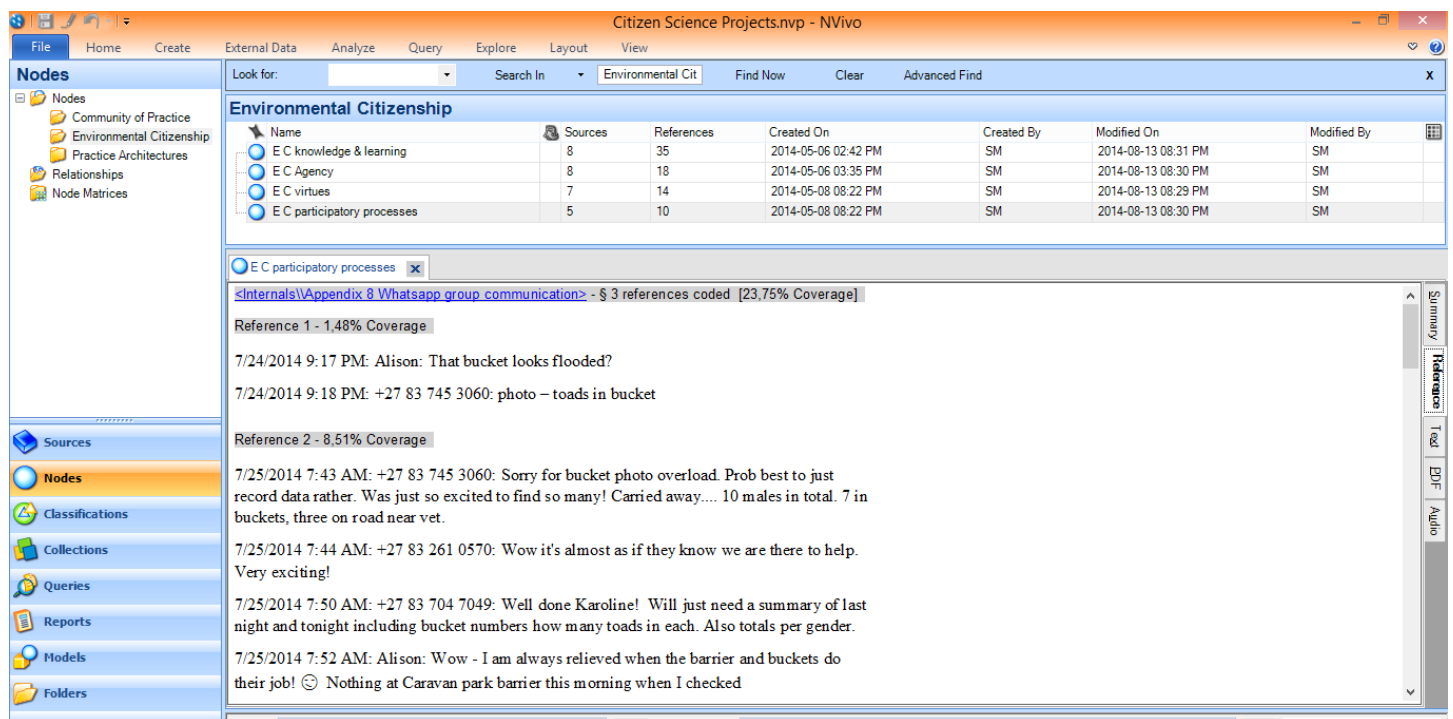


Figure 4: This view shows the actual reference data and where the data is extracted from.

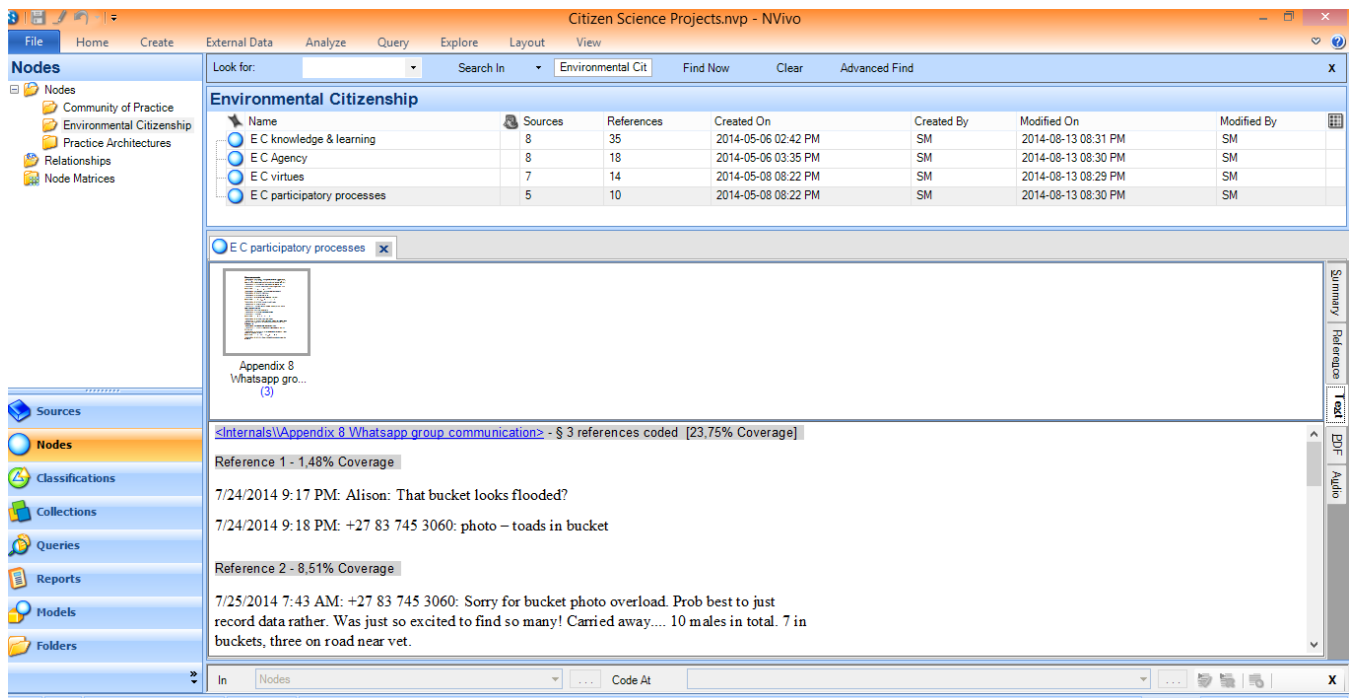


Figure 5: This gives the Text or Word documents used to extract data from of which there was only one.

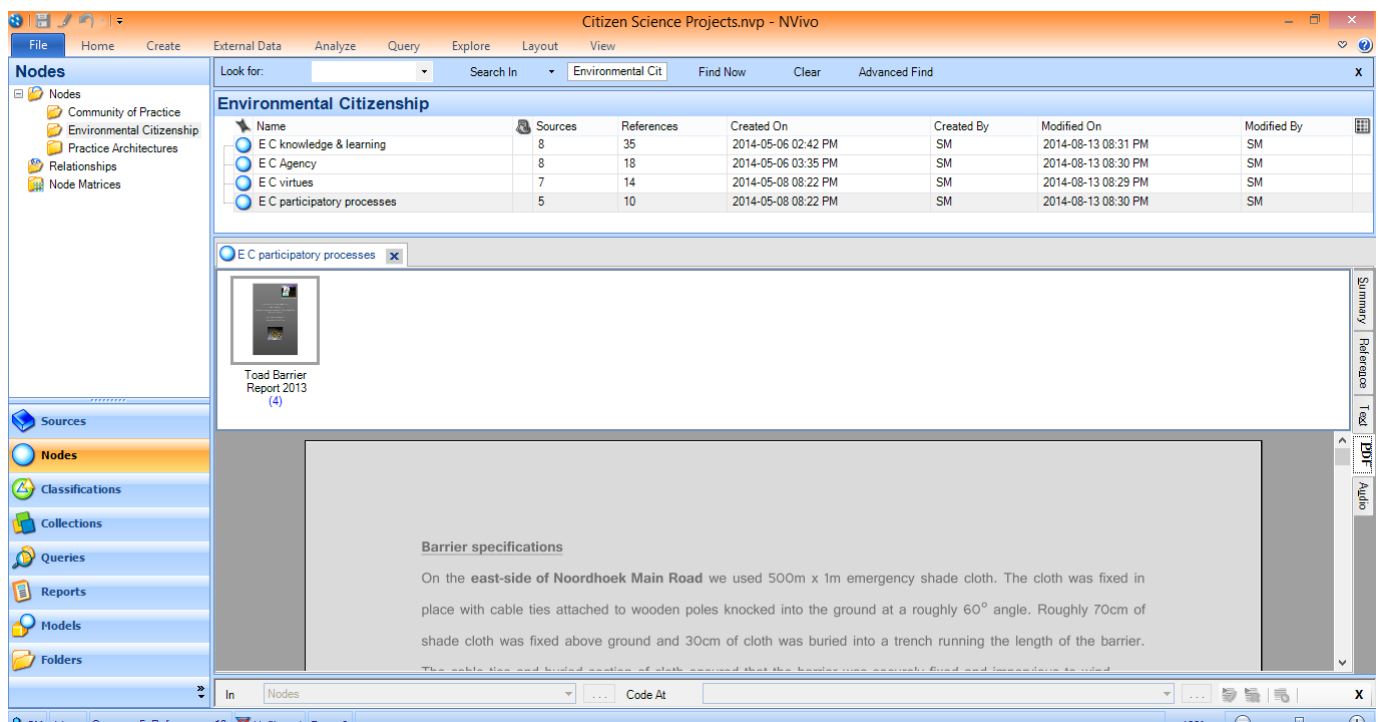


Figure 6: This shows the PDF document(s) used of which there is only one in this case.

Citizen Science Projects.nvp - NVivo

File Home Create External Data Analyze Query Explore Layout View Media

Look for: Search In Environmental Cit Find Now Clear Advanced Find

Environmental Citizenship

Name	Sources	References	Created On	Created By	Modified On	Modified By
E C knowledge & learning	8	35	2014-05-06 02:42 PM	SM	2014-08-13 08:31 PM	SM
E C Agency	8	18	2014-05-06 03:35 PM	SM	2014-08-13 08:30 PM	SM
E C virtues	7	14	2014-05-08 08:22 PM	SM	2014-08-13 08:29 PM	SM
E C participatory processes	5	10	2014-05-08 08:22 PM	SM	2014-08-13 08:30 PM	SM

E C participatory processes

Interview Alison Faraday (1) Interview recording M D... (1) Jeanne Tarrant EWT (1)

0:00.0 10:00.0 20:00.0 30:00.0 40:00.0 50:00.0 1:00:00.0 1:10:00.0 1:20:00.0 1:30:00.0 1:40:00.0 1:50:00.0

Timespan 1:22.0 - 1:25.0 Content

8 Would you consider the barrier as the most important achievement of the Toad NUTS group?
 A- definitely, it changed everything for us.
 S-What were the main obstacles with that?
 Main thing, lack of support or funding
 A- Lack of support. It took me months to get permission from the relevant authorities. I had to go through the environmental people and they took about 6 weeks to get back to me and then they let me know that because I am digging into the ground for the buckets, I will have to get permission from Telkom and Telkom. Then I had to meet Telkom and Telkom at the side of the road and they said "Oh please there are no cables there" It's 30cm deep, there are no cables

In Nodes Code At

SM 1 Item Sources: 5 References: 10 Unfiltered 0:00.0/1:51:06.1 1:51:06.1

Figure 7: This reveals the last tab that opens a list of all the interview transcripts from which data is extracted.

APPENDIX 10 - ACCESS LETTER



To: _____

2014-04-20

Agreement to participate in research towards a Masters Degree in Environmental Education Research

I am the Eco-learning manager at an NGO called Whale Coast Conservation which is based in Hermanus and active in the Overstrand area. My focus is community learning and I am interested in the effectiveness of appropriate educative instruments for this target group. I am presently registered at Rhodes University, completing a Masters Degree in Environmental Education Research.

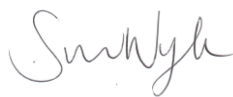
It is widely appreciated that human activity is generating fundamental changes to global ecological systems which is affecting the capacity of these systems to support life as we know it. Two challenges arise as a result. Firstly to understand the causes and effects of these changes and secondly to effect a transition to a more sustainable societal system. The second challenge is more difficult to address. In the whole humans have yet to learn how to manage itself in ways that do not threaten the ecological systems on which it depends. Social scientists are concerned with the challenge of societal change for sustainability from the perspective of knowledge and learning. There is a need for a deeper understanding of the interplay between knowledge and learning on the one hand and individual behavioural and societal changes on the other.

My interest lies in the analysis of how knowledge and learning can lead to action and changing behaviours in different learning spaces and the ways in which these learning spaces provide access to various people. I have chosen in this instance, to investigate one such learning space that is, citizen science, to probe how citizen science projects embrace learning and influences emergent environmental citizenship. (Environmental citizenship

embraces learning, action taking, values, agency, decision making and behavioural changes.) I have chosen to explore the practices of the Noordhoek Toad NUTS group as a case study of citizen science as it has a long and successful history of working effectively to protect the Western Leopard Toads. Detailed records have been kept of data collected and of the group's activities, which is very useful. The research proposal is available for your interest if you should wish to gain more information.

I would value the input of various stakeholders involved in or affected by this group's activities. I therefore ask for your participation in this research. Will you kindly indicate your willingness to do so by signing this letter in the appropriate space below? The information that you provide will be treated confidentially and your identity will be protected. Respondents will remain anonymous. Interviews are recorded and transcribed and this will be sent to the respondent to verify the content and adjust if necessary. Respondents are free to withdraw from the process at any time. Your participation in this research is greatly appreciated.

Yours sincerely



Sheraine van Wyk

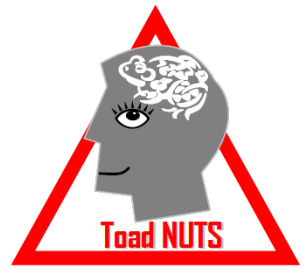
Please indicate your willingness to participate in this research here.

Name _____

Signature _____

APPENDIX 11 – FINAL TOAD BREEDING REPORT

**To: The Noodhoek Conservancy;
Noordhoek Environmental Action group;
Toad Friends;
Toad NUTS**



Final Report - Operation Toad off the Road 21 September 2008

1. To start with:

This report describes the strategy within Noodhoek to protect and conserve the Western Leopard Toad (*bufo pantherinus*) during the annual breeding migration period from July through to August. This strategy was developed and implemented by the Toad NUTS (*Noordhoek Unpaid Toad Savers*) for the breeding season of 2008.

The endangered toads have now completed their annual migration to and from the breeding ponds and have finally arrived back home – to our gardens. **The Toad NUTS moved a total of 243 toads off Silvermine and Noodhoek Main roads over this period, of which 62 had been killed by cars. The remaining 181 toads were moved off the roads to safety.** This means that 3 out of every 4 toads were saved.

2. Operation Toad-off the Road Strategy during 2008 breeding season:

Step 1: Find Volunteers

During the breeding season of 2007, only five passionate toad lovers went out to patrol the roads on the rainy nights. In order to ensure the long term survival in our valley of the Western Leopard Toad, a more comprehensive road patrol system needed to be put in place and 'manned'. Through the NEAG data base; attending the AGMs of NEAG and the Noodhoek Conservancy; and word of mouth, a list of 30 volunteers was created.

Step 2: Get sponsors for the necessary equipment

A list of essential equipment was drawn up with a corresponding list of potential sponsors. Many thanks to our sponsors NEAG and the Noodhoek Conservancy for the 1750 pamphlets, 3 car signs, 4 posters and bumper stickers. In addition, Permoseal provided marine glue and Alnet provided garden mesh, both used to make and install toadsavers. A local enviro-business, Wetland Solutions, donated 25 bags of reeds for the rehabilitation of local breeding ponds.

We would also like to thank the following businesses for proving discounts on their products
Jimmy's Sports - headlamps

Midas - rotating car-top lights
Lam-it-All – printing of pamphlets
Graphix-4-U - printing of signage and stickers

This year, the Toad NUTS took 'toading' into a new age by using satellite technology. A special thanks to Louis Liebenberg for the loan of 3 GPS Cybertracker units.

Step 3: Train volunteers

Before the start of the 2008 breeding season, **two training sessions** were held to equip 25 'toadally' enthusiastic volunteers to patrol Noodhoek Main and Silvermine Roads. Their job was to move toads away from oncoming traffic ensuring their arrival at the breeding ponds. As each female lays approximately 1000 eggs, we are hoping for a bumper 'crop' of toadlets this year!

Step 4: Inform the public

A **pamphlet** was designed and sent out to 1750 Noodhoek and Sun Valley post boxes in the third week of July to herald the start of the breeding season. The intention was to warn residents of what the Toad NUTS would be doing for the following 6 weeks as well as to alert them to the presence of toads on the roads.

In addition, four **posters** warning motorists of the presence of toads on roads on rainy nights, were placed strategically in Noodhoek and Sun Valley. The posters were sanctioned by SANParks.

An **article** describing the work of the Toad Nuts was featured in the Argus. The Full Circle Magazine will also be publishing an article.

Step 5: Patrol the roads and save those toads

For 6 weeks from 21st July to 31st August 2008, two cars with two Toad NUTS in each, patrolled Noodhoek Main and Silvermine Roads on every rainy night and also checked the roads on dry nights. Of the 42 nights patrolled, toads were found on 20 nights. Toads were measured, photographed and GPS'd before being released. This information will be used for research and data tracking purposes for SANBI (*South African National Biodiversity Institute*) and is known as 'citizen science'.

The Toad NUTS received a mostly positive response from other motorists, many of whom were extremely patient while driving slowly behind the 'amphibulance' on duty. Many thanks to residents for the encouragement and support – we needed it!



Step 6: Determine the Results

Louis Liebenberg was able to correlate the Cybertracker GPS data with photographs taken of every toad. This data was compared to the manual records kept by the Toad NUTS teams. Richard Faraday then identified 5 stages that occurred in the 2008 breeding season: 1) Early 'Birds'; 2) Waiting for the season to start; 3) Start of Main Season; 4) Peak Season and 5) End of Season. The results in the next section have been split into these stages.

3. The Results:

2008 BREEDING SEASON SUMMARY						
A. Comparison of LIVE and DEAD toads per stage						
STAGE OF SEASON	DATES	TOTAL NO OF NIGHTS IN PERIOD	NO. OF TOADS ALIVE	NO. OF TOADS ROADKILL	TOTAL NO. OF TOADS	% ALIVE
Early 'Birds'	19-Jun	1	15	0	15	100 %
Waiting for season to start	20 Jun to 26 Jul	37	0	0	0	n/a
Start of Main Season	27 Jul to 12 Aug	17	15	6	21	71 %
Peak Season	13 Aug to 21 Aug	9	143	39	182	79 %
End of Season	22 Aug to 3 Sept	13	8	17	25	32 %
TOTALS 2008 (all stages)	19 Jun to 3 Sept	77	181	62	243	75 %
TOTALS 2008 (main season)	27 Jul to 3 Sept	39	166	62	228	73 %
Comparison with 2007	23 Jul to 1 Sept	41	89	57	146	61 %

Interesting observations and conclusions:

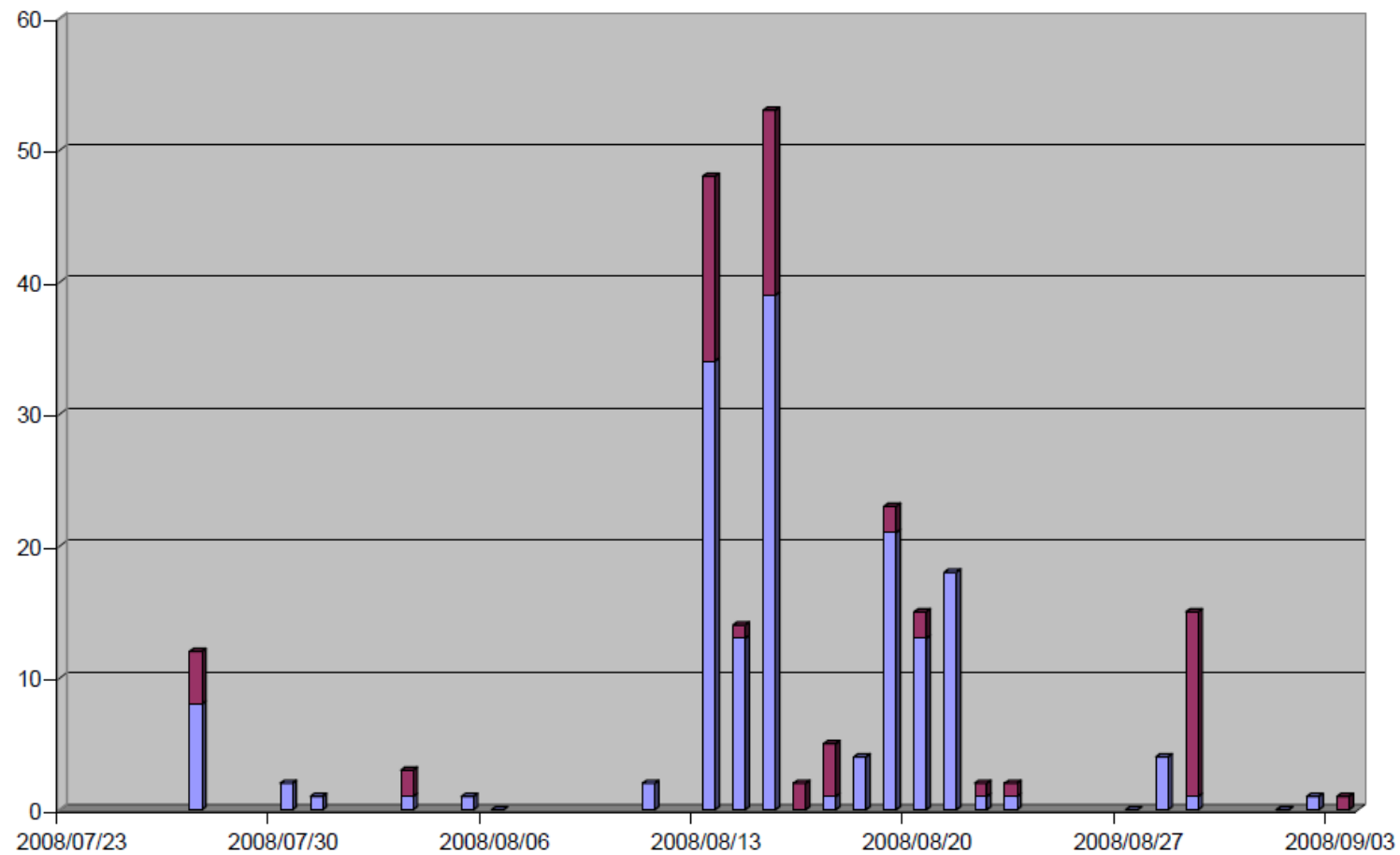
- This table shows the number of toads found alive and dead on the roads over the different stages of the season. In total 75% of all toads found were alive. This means 1 in every 4 were found dead, in all cases they had been squashed by cars on the road.
- This table also compares these statistics for 2008 with 2007, when the toad operation began on a much more informal basis. The 62 roadkill observed in 2008 was slightly higher than the 57 in 2007, which was for some a disappointing result, but in fact was to be expected given the fact that in 2008 there were about double the number of toads on the roads than in 2007. In fact, 2008 was more successful than 2007 in that the % of toads saved was 75% in 2008 compared with 61% in 2007. This was due to the fact that in 2008 patrols took place almost every night over 6 full weeks and involved about 25 volunteers, whereas in 2007 it was mainly limited to rainy nights with a handful of volunteers (who worked very hard). The conclusion is that although the number of roadkill observed in 2008 was higher, there was probably much higher roadkill in 2007 that was not observed, due to the fewer patrols.
- The % of alive toads that occurred over the 9-day peak season (79%) was significantly higher than the corresponding % over the 17-day early season (71%) and the 13-day late season (32%). This indicates the success of patrolling the roads. Over the peak season there was almost always at least 2 cars on the road until late in the evening due to the large numbers of toads on the road. Over the final period in particular, the fact that the toads had not appeared on four consecutive rainy nights meant that the season was thought to be over. Patrols were reduced, so when a late batch of toads left the De Villiers Farm, many were killed. We should watch out for these late leavers next year.
- The toad season in 2008 (excluding the early bird toads) was similar in length to the season in 2007 (39 v 41 days). The peak period in 2007 was of a similar duration to the peak period in 2008 (9 days).

B. Toad Activity vs Weather (Rain)					
STAGE OF SEASON	DATES	TOTAL NO OF NIGHTS IN PERIOD	NO OF TOAD NIGHTS	% OF NIGHTS WITH TOADS	NO OF RAINY DAYS/NIGHTS
Early 'Birds'	19-Jun	1	1	100 %	1
Waiting for season to start	20 Jun to 26 Jul	37	0	0 %	5
Start of Main Season	27 Jul to 12 Aug	17	6	35 %	6
Peak Period	13 Aug to 21 Aug	9	9	100 %	2
End of Season	22 Aug to 3 Sept	13	6	46 %	9
TOTALS 2008 (all stages)	19 Jun to 3 Sept	77	22	29 %	23
TOTALS 2008 (main season)	27 Jul to 3 Sept	39	21	54 %	17
Comparison with 2007	23 Jul to 1 September	41	9	22 %	not recorded

Interesting observations and conclusions:

- This table compares the number of toad nights with the total number of nights per period and shows the percentage of nights with toads. Over the peak period of 9 nights there were toads on the roads every night (100%), which is why this period was identified as the peak period. For the main season of 39 nights, toads were on the road on 21 nights (54%).
- This table also shows the number of rainy days/nights. Rain was a very important factor in the migration of toads (for example the 'early bird' start to the season on 19 June, the actual start of the season on 27 July, and the start of the peak period on 13 August, were all rainy nights). However, it was clearly not the only factor. (for example there was rain on only 2 of the nights over the peak period of 9 nights). This pattern appears to indicate that once the toads start the main migration they do not stop just because it is not raining.
- We also considered other factors, such as the moon phases, but no obvious pattern emerged. Over this period full moon occurred on 18 June, 18 July, and 16 August and the new moon occurred on 3 July, 1 August and 30 August. It is noted that the peak season from 13 to 21 August was centred around the full moon on 16 August but this was probably not meaningful. We can watch out for this next year.
- The % of toad nights over the main season was 54% in 2008 and was much higher than the 22% in 2007. This is unlikely to be due to an increase in toad activity but most certainly due to the greater number of patrols in 2008 than in 2007.

Number of Toads on the Road - 2008 Season



4. Plan for the Toadlets:

Toadlets leaving the ponds:

The Western Leopard Toad is an explosive breeder, using the strategy of numbers to overcome the odds of predation. As a result, all the baby toadlets leave the breeding ponds approximately 3 months after fertilization. We know that this occurs early (6am) on a wet late November or early December morning. Thousands of 5c piece-sized toadlets disperse from the ponds and into our gardens looking for shade and suitable foraging. (Damp areas, compost heaps and veggie gardens are particularly attractive to them.)

There, numerous hazards await them, including:

- Storm water drains along Silvermine and Noordhoek Main Roads
- Lawnmowers (and lawns on which they dehydrate and die)
- Swimming pools (drownings)
- Dog water bowls (drownings)
- Drains
- Predation (natural)
- Roads

Our concern for the toadlets is two-fold this season: 1) Getting them off the roads as they leave the ponds and 2) preventing unnecessary deaths in gardens and swimming pools.

For the former concern, Paul Hoffman has arranged to have 3 traffic officers on stand-by over the period in which the toadlets are most likely to leave the ponds. They will act to stop the traffic and to allow the Toad NUTS to work safely to move the toadlets off the roads. *(According to Mark Day of SANParks, this is ground-breaking work as no group has focussed on the toadlets before, limiting themselves to getting the adult toads to and from the ponds.)*

For the second concern – “domestic deaths” – we will be producing a DIY guide and pamphlet showing home-owners their proximity to the known breeding ponds, and how to ‘toad-proof’ their gardens and swimming pools. We are looking for sponsors for this pamphlet. This pamphlet will be developed in conjunction with the Western Leopard Toad education boards mentioned in (5) below.

5. Education and Awareness

The IUCN (*International Union for the conservation of Nature and Natural Resources*) Red List of International Species describes the situation for our Western Leopard Toad as follows:

“Listed as Endangered, in view of its extent of occurrence of less than 5,000 km² and area of occupancy of less than 500 km², with all individuals in fewer than five locations, and a continuing decline in the extent and quality of its habitat, area of occupancy, number of locations, and number of mature individuals.”

The IUCN classification ‘Endangered’ means:

ENDANGERED

‘Endangered’ is used when the best available evidence indicates that it ...is considered to be facing a very high risk of extinction in the wild.

For residents of Noodhoek this means that we cannot act fast enough or comprehensively enough to save the Western Leopard Toad. To encourage every Noodhoek and Sun Valley resident to assist in saving the leopard toad, a series of educational interventions are planned:

the kids:

- Suzie J'kul has designed a Montessori presentation teaching our children all about the leopard toad. This presentation has been given to 4 Montessori schools (3 in Noodhoek and 1 in Wynberg).
- Alison Faraday has tailored the presentation to suit children aged 8 and up and has presented it to 4 Sun Valley Primary School classes. Both sets of presentations have focused on what the children can do to help and have ended by selling WLT bumper stickers for a nominal fee to the children for their parents' cars.
- If you would like this presentation done at your child's school, please contact one of us.

For the adults:

- Belinda Ashton is currently preparing a proposal for the development of a WLT education board to be erected at the Farm Village initially, and hopefully rolled out to other Leopard Toad hotspots around the Cape Peninsular. The board will be in a style similar to that of the whale boards dotted along the coastline. We are hopeful that the City will consider funding for this project.
- The pamphlet described in (4) will direct homeowners to this education board as well as to the official Conservation Committee website.
- Suzie J'kul is frequently called out by home-owners wondering what "to do" about the toad living in their garden. Suzie then does on-the-spot education.
- *"Operation Toad Saver"* will be launched towards the end of November. Toad NUTS will install 'toad savers' in swimming pools adjacent to known breeding ponds and simultaneously conduct informal homeowner education.

6. Funding:

Through the generous support of NEAG and the Conservancy as well as local businesses, we have been able to get Operation Toad off the Road started. But we have a dream of being self-sufficient. We have been invited to host a Toad NUTS stall at the annual Noodhoek Fair on 2nd November. We plan to sell the following items amongst others:

Bumper stickers
Toad T-shirts
Toad cupcakes
Toad warning signs
Calendars
Toad games for children
Toad art raffle and items for sale



APPENDIX 12 - ANALYTIC MEMO – COMMUNICATION SYSTEM

[<Internals\\Observation SvanWyk>](#) - § 2 references coded [1,90% Coverage]

Reference 1 - 0,45% Coverage (OBS 1, 2, 2)

S1: M: Two females on the gravel road. Brigatine should be quiet – that's Sun Valley.

Reference 2 - 1,45% Coverage (OBS 1, 2, 4)

S says calling at Lake Michelle new entrance. So we can go there.

Why do people take pictures of all the squashed toads? Yuck, that's horrible. Especially A, she loves taking pictures of dead things.



Figure 4: Toad NUTS member checking WhatsApp group communication.

Interview SJ

Timespan		Content (INT 5, 1, 3)
3	11:00,0 - 12:00,0	Sh - Would you say that the digital platform for communication has helped? Su - It's been massive. Literally last year was the first time we used Whatsapp. Before that Alison & I, it was like a one person job. For every single night that we had to get people out, each of us would spend a whole afternoon phoning to try to get people out.
Timespan		Content (INT 5, 2, 5)
5	15:30,0 - 17:00,0	Before we struggled because it was really only myself and Alison. We were delegating but we had to do the work to delegate. So we had to phone 20 different people, have a whole conversation to get them into the loop to get people on the road. Now that everyone is on WhatsApp everyone is in the loop. Sometimes you get messages at 11 - 12pm but you can put the phone on silent so it's not a problem. So the news is current, keeps everyone in the loop and inspires us to go out. Then someone may say "guys I'm struggling can anyone come

and help". Now it is coming straight from the person and not Suzie all the time, and people are more likely to go and help. Then it's a one-on-group relationship rather than always just us.

Whatsapp group communication – whole document DOC 14 page 1

7/24/2014 2:40 PM: A: The barrier is open and ready for business! 41 buckets behind 1.5km of netting, which took about 200 man (and woman) hours to erect is fully operational before tonight's rain. K you have the privilege of doing the first bucket run for 2014.

7/24/2014 3:00 PM: +27 83 745 3060: Yay!! Looking fwd. will be there with bells!

7/24/2014 7:33 PM: A: Fair bit of movement in Noordhoek tonight. Some in SV too

7/24/2014 8:33 PM: A: photo of a large female WLT

7/24/2014 8:34 PM: A: Look at the size of this female in Noordhoek tonight!

7/24/2014 8:35 PM: +27 72 196 3755: WOW lucky:)

7/24/2014 8:54 PM: +27 83 745 3060: 2 fm, 1 m vet

7/24/2014 8:55 PM: My pet while at Rhodes: Amazing girl. What a beaut!

7/24/2014 8:56 PM: A: So hoping you find toads in buckets K!

7/24/2014 9:10 PM: +27 83 745 3060: photo showing toads in bucket

7/24/2014 9:11 PM: +27 72 196 3755: Yay😊

7/24/2014 9:11 PM: A: Great! Take a pic of toads in the bucket you found them with bucket number showing next time

7/24/2014 9:11 PM: A: I meant bucket number

7/24/2014 9:15 PM: +27 83 745 3060: photo of toads in bucket

7/24/2014 9:16 PM: A: Perfect!

7/24/2014 9:17 PM: A: That bucket looks flooded?

7/24/2014 9:18 PM: +27 83 745 3060: photo – toads in bucket

7/24/2014 9:22 PM: +27 73 295 3816: Excited for you and the team Alison! Beautiful female you got there!! She will provide a few thousand offspring for next season! We are looking forward to our visit!

7/24/2014 9:23 PM: A: Do you like our bucket numbering system?

7/24/2014 9:24 PM: +27 73 295 3816: Looks like it is working wonderfully!! You had a bright idea there!

7/24/2014 9:25 PM: +27 83 704 7049: All we need to do is note the gps...home in 2.Or do you need me to go anywhere A?

7/24/2014 9:26 PM: A: L had roadkill opp Common. There?

7/24/2014 9:27 PM: +27 83 704 7049: Took a drive round there already a few mins ago but saw nothing.

7/24/2014 9:29 PM: +27 83 704 7049: Also saw 3 cars flashing lights so think noordhoek is well covered.

Page 2

7/24/2014 9:30 PM: A: □

7/25/2014 7:41 AM: +27 83 745 3060: <image omitted>

7/25/2014 7:41 AM: +27 83 745 3060: <image omitted>

7/25/2014 7:43 AM: +27 83 745 3060: Sorry for bucket photo overload. Prob best to just record data rather. Was just so excited to find so many! Carried away.... 10 males in total. 7 in buckets, three on road near vet.

7/25/2014 7:44 AM: +27 83 261 0570: Wow it's almost as if they know we are there to help. Very exciting!

7/25/2014 7:50 AM: +27 83 704 7049: Well done K! Will just need a summary of last night and tonight including bucket numbers how many toads in each. Also totals per gender.

7/25/2014 7:52 AM: A: Wow - I am always relieved when the barrier and buckets do their job! ☺ Nothing at Caravan park barrier this morning when I checked

7/25/2014 10:00 AM: +27 78 740 3020: So great to see so many beautiful toads well done every one! I look forward to helping out next week □

7/25/2014 10:02 AM: A: No rains forecast for next week but we will still need scouts

7/25/2014 10:04 AM: +27 78 740 3020: Ok thanx A

7/25/2014 5:41 PM: +27 82 883 5911 left group

7/25/2014 7:32 PM: +27 82 876 9531: A are you covered for the bucket run tonight?

7/25/2014 7:34 PM: +27 82 476 1016: Yes

7/25/2014 7:36 PM: +27 82 876 9531: Thanks S

7/25/2014 7:36 PM: +27 71 198 7875: A I can do a bucket run tomorrow am if anyone wants to swop. Do we partner?

7/25/2014 9:36 PM: A: Hi L. I am showing S the bucket run tomorrow at 7am. Could you do Sunday morning rather?

7/25/2014 9:38 PM: A: Sorry for late reply S - was at the buckets! Nothing in any buckets.

7/25/2014 9:40 PM: +27 82 876 9531: Thanks A.

7/26/2014 9:26 AM: +27 71 198 7875: Can't do Sunday A. Will ring you later to go through it all. Is Capri on the map this year?

7/26/2014 11:47 AM: A: I would love you and Lauren to keep your eyes open on rainy nights in Capri. Note the roads on which toads were seen. We have very little idea if the toad situation there.

7/26/2014 11:48 AM: +27 71 198 7875: Ok cause there are 2 streams very full.

7/26/2014 11:53 AM: A: Fast flowing streams wash their eggs away. They need sluggish or still water.

Page 3

7/26/2014 11:55 AM: +27 71 198 7875: But there are reeds and still water on edges lots if tadpoles in there

7/26/2014 12:01 PM: A: Ok good to monitor. Can you take a drive round there tonight?

7/26/2014 12:05 PM: +27 83 704 7049: I would like to know if the toads breed in the pond in the far corner near kommetjie road so perhaps check those roads. If you see a few toads this season in Capri and if can

figure out where they are going to breed then I think Capri should be put back on the Map for regular patrols.

7/26/2014 12:05 PM: A: Agreed!

7/29/2014 1:57 PM: A: <audio omitted>

7/29/2014 1:59 PM: A: Just in case you need reminding. This is what a love-struck male toad sounds like□□. Listen out at your local ponds from tonight onwards.

7/30/2014 8:01 AM: +27 83 607 6706: Nothing in buckets this morning

7/30/2014 8:02 AM: A: □

7/30/2014 8:04 AM: A: While you are listening at the ponds you will hear this one: clicking stream frog

7/30/2014 8:04 AM: A: <audio omitted>

7/30/2014 8:05 AM: A: <audio omitted>

7/30/2014 8:05 AM: A: And these too

7/30/2014 8:06 AM: A: <audio omitted>

7/30/2014 8:07 AM: A: <audio omitted>

7/30/2014 8:08 AM: A: <audio omitted>

7/30/2014 8:09 AM: +27 82 659 0957 joined group

7/30/2014 8:59 AM: +27 72 196 3755: Brilliant. Now we can start identifying. 😊🐸

7/30/2014 10:17 AM: +27 73 295 3816: □□

7/30/2014 12:02 PM: +27 83 704 7049: At Skilpadsvlei in Kommetjie 10pm last night I saw 14 males in water and heard another 16 males calling in bushes on water edge. The chorus was louder than i can ever remember. Two gravid females also were spotted. This is a great success story as 3 seasons ago only 1 toad was spotted in the whole season and so wally of keag organised the wetland to be rehabilitated. Last year I think 4 toads arrived and now 32!

7/30/2014 12:03 PM: +27 83 704 7049: <image omitted>

7/30/2014 12:04 PM: +27 83 704 7049: If you wish to listen to this amazing chorus and see what we are all doing this for feel free to go along over the next few evenings. It is at the corner of Benning drive and Kelp Way. Please note the ground is still being rehabilitated so tread lightly when off the boardwalk and dont shine light too much onto the toads.

Page 4

8/8/2014 3:17 PM: A: With this very warm and dry weather we are not expecting movement this weekend. However if you do see any of our spotty friends on the roads let us know asap. Morning bucket runs will continue as planned. Have a hoppy weekend□

8/8/2014 4:16 PM: +27 83 607 6706: Yeah there was nothing in buckets this morning

8/10/2014 3:55 PM: A: <image omitted>

8/10/2014 3:57 PM: A: This is the pond in front of Noordhoek Chalets at the end of Houmoet by BP. Perfect toad breeding spot. S and M - no sign of our injured female. Let's hope she made it to the water.

8/10/2014 3:59 PM: +27 82 876 9531: I was just about to ask about her.

8/10/2014 4:01 PM: A: Thats her

8/10/2014 4:03 PM: A: <image omitted>

8/13/2014 2:09 PM: A: We are expecting rain tonight and tomorrow. M are you checking SV as usual? B you are scheduled to check FH. S can you go around Milkwood Park tonight and tomorrow please? L and A can I roster you for tomorrow night Milkwood Park?

8/13/2014 2:10 PM: +27 72 196 3755: Yes i am in

8/13/2014 2:11 PM: A: Great. Remember to send your stats and patrol times to R soonest. Enjoy!

4/8

Filming / videoing observations

This is very difficult. It is dark + rainy. I don't want to use my camera in these conditions. I have no light. It is not like the flash on a camera. You cannot video in the dark.

What should I do?

Audio recordings paired with photos?
Let's try that tonight.

10/8 Date Author, Title,

Analysided for Goal?

Categories

Observation mix historic video
photos
recording
personal observation

Drivers beware, mating leopard toads ahead

WEEKEND ARGUS July 7 2012

SARAH-JANE BOSCH

IT'S mid-winter and some of the peninsula's residents are in their element.

It won't be long before the Western Leopard Toads start heading to their local gathering places for the annual breeding season. But many will have to travel several kilometres and cross busy roads, and many won't make it back home.

The biggest recorded population of leopard toads (*Amietophrynus pantherinus*) are found in urban areas on the Cape Peninsula, but are increasingly being threatened by urbanisation.

Most of their known breed-

ing and foraging habitats are outside protected areas, and in Cape Town they breed in public open spaces, green belts and golf courses.

They are also often encountered in surrounding gardens, which are important foraging areas and sanctuaries.

But development, traffic and associated threats put the long-term survival of the local population at risk.

"The International Union for the Conservation of Nature Red List classifies the Western Leopard Toad as an endangered species.

"Busy roads are death traps and this animal needs all the help it can get to survive," says

Alison Faraday, one of the founders of Toad Nuts (Noordhoek Unpaid Toad Savers) and its subsidiary, Spots (South Peninsula Outstanding Toad Savers).

For years volunteers from Noordhoek, Muizenberg, Lakeside, Kirstenhof and Tokai, have regularly ventured out to help the toads reach their watery breeding sites and get back home safely once the breeding season is over.

The toads are "explosive breeders", which means that breeding is restricted to short, sporadic bursts of activity, lasting up to a week at a time.

Breeding usually takes place during August but has

also been recorded in late July and in September. The start of the season seems to depend on rainfall and temperature and sometimes occurs during warmer spells following periods of rain.

The first indication is when large numbers of adult toads appear after dark, particularly on rainy nights, and converge on breeding ponds. The same sites tend to be used year after year.

The males call in bouts and in choruses of up to 50, but as many as 200 males have been heard chorusing at a large breeding site such as De Oog in Bergvliet.

The tadpoles then develop

into 11mm long toadlets that leave the water from November to January in their thousands.

During last year's breeding season, thousands of toads reached the breeding grounds, and volunteers helped about 1 800 of them to reach their mates, a big improvement on previous years.

Susan Wishart of KirMITS (Kirstenhof to Muizenberg Toad Savers) asked that drivers drive more cautiously in these areas to avoid killing the toads.

Toad Nuts will present their annual volunteer training at Cape Point Vineyards in Noordhoek at 5.30pm on July 22. Call Alison on 082 771 6232. Visit www.LeopardToad.co.za.



BREEDING TIME: Mating pairs tend to use areas of open water for spawning.

Conservation of the Western Leopard Toad by a Dedicated Multi-Stakeholder Group in the City of Cape Town

By John Measey¹, Suretha Doron² & Alison Faraday³

Habitat change is still the biggest threat to amphibians globally. Of the different types of habitat change, urbanization is probably one of the most heterogeneous changes of an amphibians' environment. Although roads, paved areas and buildings represent amphibian free environments, parks and gardens have the opportunity of holding suitable breeding and foraging habitats for many anuran and urodele amphibians (e.g. 1, 2). In addition, these (often peri-urban) areas are the places where a majority of the human population have their encounters with amphibians, providing conservationists with a unique opportunity to engage in amphibian issues.

The City of Cape Town is situated at the south-westernmost tip of Africa with a population of 3.8 million people. It is a typical African city, with a rapidly increasing population (approximately 50,000 per annum), and going with that the intensification of urbanisation throughout its 2,460 km². However, it is situated in an extra-ordinary area, in the heart of the Cape floristic region: a mega-diverse area with 19 distinct vegetation types and an estimated 3,250 indigenous plants. Perhaps not surprisingly, 17 out of the 19 vegetation types are threatened (CR, EN & VU) in the latest national biodiversity assessment, mostly due to agriculture and the rapid expansion of the city since the 1940s, with little regard for conservation planning (3). The fynbos biome is also the centre of remarkable anuran diversity, and the peak of the endemic diversity happens to centre on the area encompassed by the City of Cape Town (Figure 1).

The Western leopard toad (*Amietophrynus partherinus*) was first assessed as threatened in 1988. In the City, this toad breeds in the "southern suburbs" coinciding with acid soils of the Sand Fynbos (see Measey & Tolley 2011). Within these areas, this species appears to depend on a level of disturbance to keep water bodies open and foraging areas productive. Like many large bufonids, it undergoes an annual migration to and from large open water-bodies, in which large congregations of adults form during the antipodan winter (typically August). Migrations became notorious as mass mortality events during the 1940s, when roads neighbouring large breeding sites became impassable due to the build-up of toad carcasses. This coincided with the on-going expansion of these peri-urban areas (3), so that over a number of years populations quickly dwindled. More recently, a new threat from a domestic exotic congener, the Guttural toad (*Amietophrynus gutturalis*), has begun to expand its distribution within the City of Cape Town (see Measey & Davies 2011).

The decline of the Western leopard toad did not go unnoticed, and several volunteer groups formed in different areas of its range to raise awareness of the plight of this species and to help avoid casualties during the mass migration events. Each volunteer group operated within discrete peri-urban areas, and there was little involvement from other conservation stakeholders. Despite long hours on wet nights by many individual volunteers, the toad populations continued to decline so that in 2004, this species was listed as Endangered (EN) with much the same set of increasing threats.

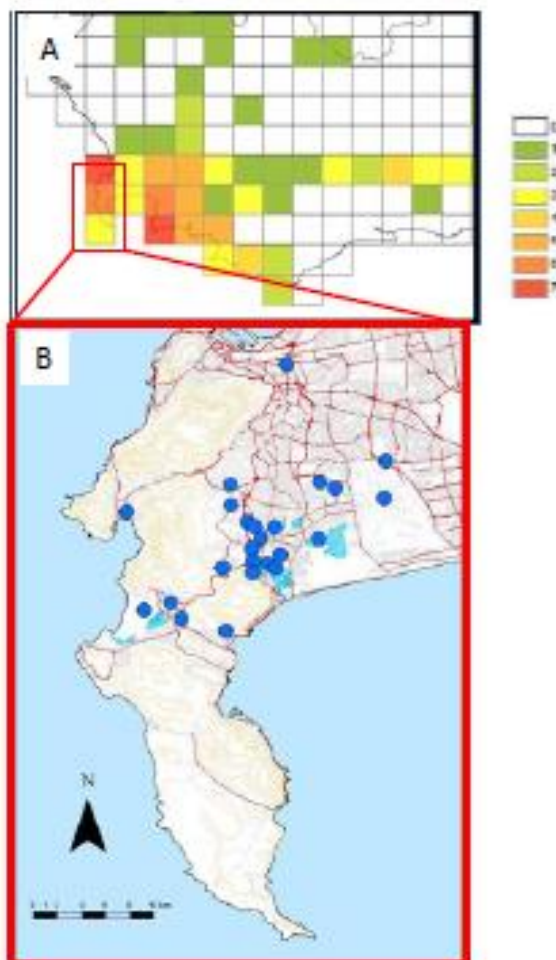


Fig. 1A: The southwestern Cape of South Africa has a remarkable assemblage of anurans demonstrated by the high level of endemism (>20 quarter degree grid squares). B: Despite the Cape Peninsula having a large area of protected land, the Western leopard toad breeds (blue points) in peri-urban areas.

¹ Department of Zoology, Nelson Mandela Metropolitan University, Port Elizabeth. ² Environmental Resource Management Department, City of Cape Town, Plumstead Office, 3 Victoria Road, Plumstead, Cape Town. ³ South Peninsula Outstanding Toad Savers, Leoparddoorn Hill Country Cottages, Noordhoek, Cape Town.