An investigation of the influence of knowledge-production and learning processes on complex practices in a community-driven citizen science initiative: A nature conservation case study

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ABSTRACT

Community-driven citizen science initiatives have become an increasingly popular tool for combating social-ecological challenges that arise within communities. Scientific protocols have been designed to strengthen and support the accuracy and reliability of data collection and information sharing; however, little is understood of the *dynamic social processes* that reinforce and co-ordinate such community-driven action. This qualitative case study was undertaken to identify and understand complex organisational, political and socio-cultural processes (in particular knowledge-production and learning processes) that have guided, sustained and informed complex practices in a community-driven citizen science initiative. The study aimed to inform the development of a social protocol that might be transferable to other citizen science contexts.

The study drew on the theory of 'Landscapes of Practice', which highlights how multiple communities of practice overlap, interrelate, share knowledge and cross boundaries to create potential learning across a landscape. Additionally, ideas and typologies in recent citizen science literature offered perspective on the community-driven citizen science practices.

This qualitative case study focused on the bounded case of the Western Leopard Toad Conservation Committee. Specific data generation tools (interviews, observations, document analysis and diagrams) were used from multiple perspectives over time to provide rigor and depth to the data.

The study demonstrated how multiple 'nexes of practice' co-engaged in collective knowledge creation practices, which helped to enhance 'knowledgeability' across the landscape. This coordinated effort, however, was sporadic and inconsistent. Recommendations are made for the development of social protocols that could assist collaborators in citizen science initiatives to scrutinise and rethink their practices and to examine both their successes and shortfalls towards their shared interest.

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LIST OF ACRONYMS	
AC	Area Coordinator
BMP	Biodiversity Management Plan
CTEET	Cape Town Environmental Education Trust
EIA	Environmental Impact Assessments
EMB	Environmental Management Branch
EWT	Endangered Wildlife Trust
IUCN	International Union for Conservation of Nature
KirMiTS	Kirstenhof to Muizenberg Toad Savers
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NGO	Non-Governmental Organisation
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SPOTS	South Peninsular Toad Savers
ToadNUTS	Toad Noordhoek Unpaid Toad Savers.
WESSA	Wildlife and Environmental Society of South Africa
WLT-CC	Western Leopard Toad Conservation Committee

CHAPTER ONE: INTRODUCTION AND CONTEXT

1.1 Introduction

Although the Western Cape province of South Africa offers natural beauty for visitors and residents alike, the juxtaposition of land-use increases the likelihood of human-wildlife conflict in residential areas. While people who reside in such areas are often aware of such problems, they cannot always resolve them alone and seek assistance from various stakeholders such as local government, provisional agencies, national conservation agencies, non-governmental organisations (NGOs) and conservation scientists (Rebelo, Measey, de Villiers & Dorse, 2011). The research reported here explores the educational dimension of a community-driven citizen science initiative in which participants worked and learned together to identify and respond to the complex social-ecological challenges that the endangered western leopard toad (*Amietophrynus pantherinus)* faces.

In Chapter One, the study is introduced. It begins with an overview of the endangered western leopard toad (section 1.2) and presents a rationale for the case study that follows (section 1.3). Key concepts (section 1.4) relevant to this educational study (community-driven citizen science, co-engaged learning and co-produced knowledge and 'Landscapes of Practice') are then introduced – noting that these concepts will be further elaborated on in Chapter Two. The research questions and sub-questions are presented in section 1.5 and the concluding section (1.6) then provides a brief outline of the six chapters comprising this research report.

1.2 The Broader Context of the Western Leopard Toad as a Social-Ecological Issue

1.2.1 Western Leopard Toad habitat

The Western Cape is one of the most bio-diverse areas in South Africa encompassing diverse and endemic flora and fauna species, including the protected Cape Floristic Region. This unique habitat is where the western leopard toad species resides (Rebelo, Holmes, Dorse, & Wood, 2011). In this area, the greatest threat to amphibians is the loss of habitat due to land use change through urbanisation (Measey

& Tolley, 2011).

The ongoing threat of the quality and quantity of suitable environmental habitat for local flora and fauna is associated with urbanisation. Built-up areas are concentrated in the sandy coastal lowlands or flats of the Cape. Conservation issues of the lowlands were only identified and highlighted as recently as 1982, after decades of development in the Cape. The earliest conservation plan for the City of Cape Town (CoCT) was the proposed 'Greening the City' report in 1982 (Rebelo, Holmes, et al., 2011). During that time, Jarman (1986) developed conservation priorities in the lowlands of the Fynbos biome. However, multiple sites were excluded and not prioritized by City planning such as the proposal for a large park – to be known as the False Bay Coastal Park – that would provide a corridor linking the Peninsula with the Hottentots Hollands mountain range, via the Kuilsriver wetlands. However, in 1984 "it was decided by national politicians to develop the majority of this area as the Khayelitsha Township to cope with a rapid increase in people translocating to Cape Town" (Rebelo, Holmes, et al., 2011, p. 28). In 1997, a study was commissioned by the Botanical Society to identify the vital remaining 'Core Flora Sites' which contained species that were reliant on the habitat and required adequate and immediate conservation measures (Rebelo, Holmes, et al., 2011). The first report identified 20 of 47 sites investigated (McKenzie & Rebelo, 1997) and in 1999 a follow-up report identified a further 37 of 118 sites investigated for conservation coordination (Maze & Rebelo, 1999). Although the reports were formally accepted by the City Council, no action resulted: no conservation locations were declared nor were conservation measures put in place (Rebelo, Holmes, et al., 2011).

In 2002 and again in 2008, systematic conservation planning studies were conducted in order to identify a Cape Town biodiversity network (Rebelo, Holmes, et al., 2011). Due to the lack of previous conservation efforts in the City, results showed that in order to have adequate representation of indigenous species "97% of the remaining natural areas would have to be protected" (Rebelo, Holmes, et al., 2011).

Currently, most conservation areas in the Cape Peninsula are located in the higher montane areas. The focus species of this study, the western leopard toad, is indigenous to the Western Cape region with 62% of its breeding habitat and 57% of its foraging habitat (based on a 1km range) occurring at lower altitudes in unprotected Sand Fynbos (of which less than 1% is conserved) and Strandveld (of which 13% is

conserved) (Rebelo, Measey, et al., 2011). These areas of the Cape Peninsula and Cape Flats have encountered increased development and road traffic, which threaten the survival of indigenous flora and fauna. However, there are areas that provide sanctuaries for the toads, such as public open spaces, greenbelts and, often, private residential gardens.

Due to an annual migration of the western leopard toad during its breeding season (June to September), a high number of toads move between breeding sites (wetlands, ponds, rivers, dams etc.) and residential sites. Subsequently, toads must negotiate multiple barriers (roads, walls, embankments and piped waterways) and threats (electric fences, domestic animals and humans) along their journey, which leads to multiple deaths and negatively impacts species growth (Rebelo, Measey, et al., 2011).

In order to stop the loss of irreplaceable biodiversity areas in the Cape "spatial urban planning design must change from one of urban sprawl to densification" (Rebelo, Holmes, et al., 2011, p. 30). This transformation has slowly begun through redevelopment projects. The CoCT has been working with local initiatives through formal stewardship agreements and Memorandum of Agreement (MOA) documents and with landowners and communities in conservation vulnerable areas on maintaining local sanctuaries for vulnerable flora and fauna species, such as the western leopard toad.

1.2.2 The Western Leopard Toad (*Amietophrynus pantherinus*)

The Western Cape has a wealth of different animal species, with amphibians being particularly diverse, especially in the context of the total number of species in South Africa (Rebelo, Holmes, et al., 2011). The western leopard toad is a large bufonid that is typically between 90 and 110mm in size. As alluded to by its name, once metamorphosed, the toad boasts a striking dorsal pattern of chocolate to reddish-brown patches, much like the spots of a leopard, on a bright yellow background (Fig.1) and can have a striking yellow strip running down the middle of its back (Cape Nature, 2013). The western leopard toad is indigenous to the Western Cape and has two disjunct coastal distributions in the south-western tip of South Africa, spanning a range of 140km from the Cape Town Peninsula in the west and as far east as Gansbaai (Measey & Tolley, 2011; Rebelo, Measey, et al., 2011). It has been listed as a globally and regionally endangered species on the International Union for

Conservation of Nature Red List and is legally protected under Schedule 2 of the Nature Conservation Ordinance 19 of 1974 in South Africa (Rebelo, Measey, et al., 2011). The western leopard toad is a flagship species for conservation and has a small distribution in pockets of wetland areas in the Cape. Little is known about its population biology as each of the habitat areas offer differing statistics due to unpredictable external variables (Measey & Tolley, 2011).

Adults are prolific breeders and are most active during the rainy winter months in the Cape. During this time, large numbers of adults move towards and congregate at water bodies to breed (Cape Nature, 2013). This movement can last between one and three days, "but the actual dates, durations and intensity vary unpredictably between years and are determined mainly by climate" (Rebelo, Measey, et al., 2011). Males attract females with their calling (sounds like snoring) and while in amplexus (mating) the females lay thousands of eggs in clutches of gelatinous spawn (Measey & Tolley, 2011). The development from egg to tadpole (metamorphosis) takes approximately three months. After that, thousands of toadlets, no bigger than 11mm in size, leave the water between October and December. However, over the course of their lifecycle, from migration to dispersal, many fall victim to a variety of threats such as busy roads and predators and therefore, due to a fragmented habitat, very few reach adulthood. The western leopard toad, like all toads, provides an ecosystem service in controlling many insects and pests (Cape Nature, 2013).

Figure 1.1: The western leopard toad, *Amietophrynus pantherinus* (Cape Nature, 2013).

1.2.3 The Formation of the Western Leopard Toad Conservation Committee

To fully understand and resolve the threats to this flagship species, action by multiple stakeholders is required, including regional co-ordination, local and national conservation authority support and volunteer involvement from property owners and community members (Rebelo, Measey, et al., 2011). The Western Leopard Toad Conservation Committee (WLT-CC) was established in 2007. It aimed to combine ideas and scientific knowledge to present reliable information to the public and media as well as to coordinate research, monitoring, fundraising and volunteer work to monitor and understand the species and its social-ecological context (Day, 2014). A preliminary meeting of invited stakeholders was convened to discuss the western leopard toad distribution and potential breeding sites. Forty-two participants representing six NGOs, two national conservation agencies (South African National Biodiversity Institute (SANBI), South African National Parks (SANParks)), two provisional agencies (Department of Environmental Affairs and Development Planning and Cape Nature), two local agencies (CoCT, Overstrand Municipality) and eight conservation scientists attended (Rebelo, Measey, et al., 2011). During the meeting, social-ecological threats were recognised, prioritised and discussed and a steering committee was appointed. Funding applications were prepared and a Biodiversity Action Plan was developed and circulated for comment (Rebelo, Measey, et al., 2011). The aim of this newly established community-driven committee of interested stakeholders was to survey, secure and legally protect all major breeding sites of the western leopard toad by 2012. This included contacting private landowners with breeding sites on their properties and promoting toad-friendly practices and corridors as well as awareness campaigns for all residents (Rebelo, Measey, et al., 2011).

The WLT-CC consisted of individuals who represent various areas of practice, either through their occupations or personal interests; as such, it brought together a diversity of skills, backgrounds and experiences centred on protecting a shared interest. Upon initiation, the public was called into action and people were encouraged to join toad rescue groups as volunteers to assist in toad saving measures, such as helping the toads cross roads, canals and barriers and counting or documenting toad numbers to monitor population sizes in specific areas. The public was additionally encouraged to put up ‘Beware Frogs Crossing’ signs on roads around active breeding sites and to

ensure gardens with toad activity had safe passageways for toads to and from breeding ponds. Lastly, the public was discouraged from using pesticides, for example snail bait or insect poisons, in their gardens (Rebelo, Measey, et al., 2011).

Area Coordinators (ACs) were approached and positions were established where toads were prolific and breeding areas were vulnerable, needing volunteers to assist with the protection of the toads on the roads and in gardens. For example, one AC founded a volunteer group called ToadNUTS (Noordhoek Unpaid Toad Savers) (Day, 2014). This volunteer group falls under the WLT-CC and is an example of a community-driven citizen science initiative that engages with locals and works with multiple stakeholders around a shared issue, creating space for shared learning and action (Van Wyk, 2015). Valuable data was collected by the volunteers for both long-term species monitoring and specific short-term research outcomes. Each AC and location had its own procedures, however all areas monitored the same general scientific data gathered by the committee each season. The following steps were taken in each area:

- Scout for calling and moving toads in roads, gutters, gardens and drains
- Assist toads moving across the road in the direction that they are moving
- Collect data such as male/female, eggs/no eggs, size, location, time, date, man-hours etc.
- Collect road kill data
- Take a photograph of the toad or road kill where possible

In conjunction with public participation, the WLT-CC consisted of various authoritative entities from different areas of expertise. These authorities were called to act where they could within their line functions. For example, The CoCT and City Parks were called upon to keep urban recreational areas and greenbelts un-mowed during the western leopard toad breeding season so that toadlets could emerge in a protected habitat. Additionally, authorities were called upon to assist in protecting breeding sites from development, installing safe storm water drains and safeguarding water catchments at breeding sites (Rebelo, Measey, et al., 2011).

Upon creation, the WLT-CC aimed to diagnose challenges, design possible solutions, take action and/or evaluate progress – with the overall aim of contributing to the sustainable future of the species. Through this initiative, the Western Cape western

leopard toad population became carefully monitored. Statistical trends and the species' distribution and conservation status was supervised and supported by multiple stakeholders, community members and interested parties (Rebelo, Measey, et al., 2011).

1.2.4 The WLT-CC Conservation Measures

At the 2007 preliminary WLT-CC meeting, invited stakeholders discussed the initiation of a Biodiversity Management Plan (BMP) and, after a steering committee was selected, with a diverse range of representatives from multiple areas of practice, they began compiling and editing the first draft that would be circulated for comment among all interested and affected parties (Rebelo, Measey, et al., 2011). The BMP was configured in compliance with the 2004 National Environmental Management Biodiversity Act principles, which stated that:

> … 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. (Republic of South Africa, DEA, 2004, p. 40)

The BMP identified that ecosystem disturbance and loss of a species should be avoided and the risks of this mitigated as best as possible. Further, specific attention of management and planning actions from government, formal institutions and citizens should be taken into account (Rebelo, Measey, et al., 2011). The BMP set out actions that would require the consideration of multiple factors and areas of practice. For example, the WLT-CC was immediately tasked with identifying all known breeding sites so that volunteers could begin their work (by December 2008). Volunteers, researchers and conservation authorities began to "map the known and projected foraging area of leopard toads" and aimed to "survey, secure and legally protect all major breeding sites by 2012" (Rebelo, Measey, et al., 2011, p. 22). This entailed involvement of multiple entities in the initiative, including: local property owners signing 'stewardship' agreements; conservation authorities assisting with making road verges, storm water systems, open spaces and drains toad-friendly; and volunteers creating public awareness for the plight of a prolific, local flagship species (Rebelo, Measey, et al., 2011). Lastly, the SANBI was called into action to

amalgamate crucial data into an accessible database for use in various research studies (Rebelo, Measey, et al., 2011). This was the beginning of the conservation measures set out by the committee involving multiple stakeholders and 'nexes of practice' in order to understand and protect a local and regional shared conservation interest.

1.3 Research Rationale

As is evident in the abovementioned introduction to the WLT-CC, community-driven citizen science initiatives appear to be effective in combating ever-increasing social-ecological challenges that arise from within a community. Where the use of scientific protocols can assist in supporting accuracy and standard practice of data collection and information sharing towards a shared goal, it is equally important to identify and understand the complex organisational, political and socio-cultural processes that guide, sustain and inform practices. The development of scientific protocols has received a great deal of attention and provided valuable processes to guide citizen science projects while the *dynamic social processes* that strengthen and co-ordinate such action are less developed and largely under-theorised (Vallabh, Lotz-Sisitka, O'Donoghue & Schudel, 2016).

This study sought to identify and understand the social processes associated with knowledge production and learning processes within and between the multiple practices of the WLT-CC. The research focused on the various structures and processes that encouraged learning, knowledge creation and co-engagement within and between the multiple areas of practice and understanding how these informed practice and negotiated challenges. It aimed, ultimately, to inform the development of a set of recommendations for social protocols that are transferable between multiple citizen science contexts. These concepts will be further explored in Chapter Two.

My interest in this work stems from my experience in working with communities and environments around South Africa that have faced social-ecological challenges and how they have had to overcome challenges in order to protect and care for a shared interest. Citizen science is one of the best ways to involve people and communities directly with the environment around them. The WLT-CC is one of the most well-known and established community-driven initiatives in Cape Town. Therefore, I used the WLT-CC as a case study to better understand the complex social practices and processes that occur within a community-driven citizen science initiative that

ultimately aims to understand their local environments in order to assist fragile eco-systems. This will further be discussed in section 3.9.2.3.

After observing and reflecting on the past decade of the WLT-CC's work through interviewing key informants on the committee, analysing meeting minutes and understanding how individuals operate 'on the ground' and in authoritative positions, I was able to identify how the WLT-CC has diagnosed problems, designed solutions, acted together and evaluated their progress with multiple participants. This enabled my understanding of what social processes (learning or knowledge creating and sharing) occur between or within each area of practice and gave insight into how challenges can be negotiated, collaborative efforts strengthened and practices informed around a shared interest. This research methodology will be further explored in Chapter Three.

1.4 Key Concepts of the Study

Key concepts relevant to this study are further explored in Chapter Two. However, for the reader to understand some of the terminology and ideas within the research question and sub-questions, the following concepts are briefly outlined here:

Community-driven citizen science refers to the specific collaborative efforts and practices of local, non-qualified community members who take part in the collection, analysis and assimilation of research results (Díez, Gullón, Sandín Vázquez, Álvarez, Martín, Urtasun...Franco, 2018) around a specific local challenge or issue.

The concepts of *co-engaged learning* and *co-produced knowledge* refer to the social processes occurring between multiple people taking part in practices around a shared interest and how information and understanding is created and shared among various stakeholders. This research sought to identify how these processes occur between various members and groups of the WLT-CC and how they assist in informing day-to-day practice and negotiating challenges the committee may face.

The theory of *Landscapes of Practice* informs this research and is developed by Wenger-Trayner, Fenten-O'Creevy, Hutchinson, Kubiak & Wenger-Trayner (2015). This theory recognises, firstly, that people participate in different 'communities of practice' and, secondly, that those communities of practice overlap and interact in a wider landscape of practice. This research explored the interrelations as well as the

boundaries that people encountered within the WLT-CC landscape of practice, focusing on how knowledge was co-produced and shared to support learning that enabled boundaries to be negotiated.

1.5 Research Questions and Sub Questions

The study was designed to answer the educational research question: how do knowledge-production and learning processes influence the way participants in a community-driven citizen science initiative negotiate boundaries and inform complex practices in their 'Landscape of Practice'?

Sub-questions:

1. What is the 'Landscape of Practice' of the WLT-CC?
2. What form do knowledge-production and learning processes take in this 'Landscape of Practice'?
3. What is the role of these knowledge-production and learning processes in establishing the WLT-CC's 'social body of knowledge'?
4. How are the WLT-CC's boundaries negotiated and mediated in relation to knowledge-production and learning processes?

1.6 Overview of the Research Report

This thesis consists of six chapters that respond to the research question and sub-questions presented in section 1.5. This first chapter has provided an overview of the context, giving perspective on the case study and its participants in relation to the socio-ecological challenge that the WLT-CC has worked on over time. This chapter has explained the purpose of the study, its research questions and rationale and has identified my position in and motivations for working with the WLT-CC.

Chapter Two reviews literature relevant to this study's contextual, conceptual and theoretical framing. Concepts such as citizen science and community-driven citizen science are critically presented and educational concepts and perspectives such as co-engaged learning and co-produced knowledge are clarified in relation to the study's contribution to the development of social protocols. The chapter also introduces 'Landscapes of Practice' as the main theoretical framework that informs this research, including concepts such as system boundaries, system conveners, learning

mechanisms at the boundary and boundary crossing competence.

Chapter Three describes the study's research methodology. The data generation methods, two-phase data analysis process and data management measures are explained and an account of how the research was conducted in a way that prioritised research ethics, validity and trustworthiness is given.

Chapter Four presents the case study data in response to the research sub-questions set out in section 1.5. The landscape of practice of the WLT-CC is illustrated and the complex practices within the landscape are described. Evidence of the social processes that occur within and between each 'nexus of activity' is presented and an indication of what learning and knowledge production may be occurring in the WLT-CC is explored.

Chapter Five provides a more in-depth discussion of the data presented in Chapter Four by drawing on the conceptual and theoretical framework highlighted in Chapter Two. This discussion looks at the interrelations, processes and dynamics that inform and shape practices in a landscape. This discussion addresses the research questions stated in Chapter One by exploring the learning and knowledge production that occurs between various 'nexes of practice' in order to negotiate boundaries.

Following the informed discussion in Chapter Five, Chapter Six makes recommendations based on the research findings towards potential social protocols that can inform practices and negotiate boundaries. Chapter Six concludes the research findings; the research process is reviewed and research gaps and opportunities for further research are suggested.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This literature review introduces concepts and theories to explore forms of knowledge-production and learning processes that can assist in negotiating boundaries and informing complex practices within Landscapes of Practice. Firstly, I highlight the concept of citizen science (2.2), exploring the multiple typologies and classifications that help mobilise citizen engagement in large-scale information gathering initiatives. I progress to highlight more specifically the concept of 'community-driven citizen science' (2.2.1), which explains how community members identify local issues as they arise and how they collaborate to create tangible solutions from a local level. The challenges within citizen science approaches to research, such as validity, accuracy and scientific literacy, are further highlighted (2.2.2). The social processes (2.3) that enhance co-engagement and collaboration within citizen science practices are explained, such as co-engaged learning (2.3.1) and co-produced knowledge (2.3.2). The development of social protocols (2.4) towards co-ordinating research efforts around a shared interest and promoting co-engagement across multiple components of an initiative is argued. I highlight the theoretical concept of 'Community of Practice' (2.5) and how social learning, knowledge and responsiveness can help cultivate collaborative knowledge production. Finally, I explain the theoretical framework of Wenger-Trayner et al., (2015), 'Landscapes of Practice' (2.6), that informs this research. I describe the nature of boundaries and boundary crossing and the potential learning possibilities that can occur through the use of learning mechanisms at the boundary. The concepts of boundary crossing competence along with boundary objects are explained, as well as how people at the boundary (system convenors) are essential in assisting connectivity and relations across the landscape of practice. Lastly, I highlight the concept of co-configuration (2.7) that involves building a responsive sustained system where boundaries can be negotiated.

2.2. Citizen Science

Citizen science is a broad concept with constantly evolving definitions and aims due to the rapid expansion of the field and diversification of participants (Eitzel et

al., 2017). It is a field that is "mobilizing people's involvement in information development, social action and justice and large-scale information gathering" (Eitzel et al., 2017, p. 1). Therefore, no classification is appropriate for all contexts, as projects differ in size, duration, research types and outcomes (Davies, Fradera, Riesch, & Lakeman-Fraser, 2016). Citizen science projects can be characterised by drawing on the efforts and knowledge provided by a wide and diverse set of contributors who look to either solve a common problem, collect data for a particular cause or assist with broadening knowledge around a particular object (Franzoni & Sauermann, 2014). Terms such as 'democratic' citizen science and 'participatory' citizen science have developed to emphasise the emergent partnerships between science and society and between amateur data collectors and professional researchers (Eitzel et al., 2017) in this growing field.

Social scientist, Irwin (1995), a pioneer in citizen science literature, identified and explored two significant relationships between citizens and science. Firstly, science addresses the needs and interests of citizens and what they are inquiring about; and secondly, science is developed, designed and implemented by citizens themselves. At a similar time, Bonney (1996) independently worked on multiple scientist-driven public research projects. His use of citizen science as a research technique, which enlisted the public in gathering scientific data, became influential in shaping the field of citizen science. The majority of literature on early citizen science initiatives was heavily focused on projects, which observed, gathered, recorded, analysed and reported on samples and data from the field, led by scientists. This positivist approach emphasises gaining predominantly scientific knowledge through standardised scientific protocols for initiatives designed to gain answers to specific questions. However, it lacks citizen scientific literacy and community members' development of their own tools and methods, features which Irwin (1995) had originally highlighted as significant in the relationship between citizens and science.

Several typologies have been suggested that identify complex activities and levels of participation by citizens in scientific processes. There are multiple levels of involvement of both scientists and citizens at different stages of a citizen science initiative depending on the needs, objectives and aims of the initiative. Citizen science projects can be described as either 'contributory' (citizens contributing to or

supporting the work of scientists), 'collaborative' (citizens and scientists working alongside one another) or 'co-created' (citizens taking the lead with the support of scientists or researchers) (Bonney et al., 2009). Vallabh et al. (2016) map out 56 citizen science projects in southern Africa that represent a "range of knowledge-production purposes…from laboratory science to social learning" (p. 540). Other typologies include: geographic species mapping (e.g. bird atlases); management of natural resources; applied conservation action; landscape-wide ecosystems monitoring; community action, activism and learning; and situated and wider social learning (Vallabh et al., 2016). All such levels of engagement and participation depend on the motivations, interests and skills of various stakeholders toward the shared social-ecological interest. Although many documented projects fall into the contributory project category wherein citizens can contribute at any time and from any location towards an existing project, co-created community-driven projects have become pivotal in addressing local challenges on the ground and have also been termed 'community science' or 'participatory action research' (Wilderman, Barron, & Imgrund, 2004; Fernandez-Gimenez, Ballard, & Sturtevant, 2008).

While awareness raising and public participatory initiatives are helpful, "they often lack an engagement with key issues and risks" (Graham et al., 2014, p. 3) and are predominantly top-down in their approaches. They can lead to greater awareness around a socio-economic issue but may not enable sustainable change in practices that can bring about greater care for our environment. The focus of this study is community-driven citizen science**,** initially described by Irwin (1995) as local people developing and enacting science in order to create contextual knowledge and combat a local challenge that people have a vested interest in.

2.2.1 Community-driven Citizen Science

Community-driven citizen science requires no qualification, experience or age specification and participants can engage at the level of their choice. Through such projects, local community members can engage in the collection, analysis and assimilation of research results (Díez et al., 2018). This co-created process allows the community to identify their own problems from the ground up and create tangible, relevant solutions for their contexts. Hulbert (2016) describes community-driven citizen science as "whole community cooperation and engagement to answer

scientific questions" (p. 18), with mutualism at its core, and suggests that a single cause supported by an entire community (interested individuals and groups) can create a movement towards solutions to community specific challenges. Hulbert (2016) explains that the citizen science movement in South Africa is robust and, given the lack of education in many rural areas, allows for community engagement and education that "teaches individuals to be cautious, rigorous, unbiased and thorough, ultimately benefiting society" (p. 19). There are many citizen science projects in South Africa with different levels of individual and community involvement. These projects differ in structure, scale, purpose and citizen engagement but in some way "contribute toward the simultaneous advancement of knowledge and scientific literacy" (Hubert, 2016, p. 18).

An example of a local community-driven citizen science initiative, *Cape Citizen Science* in South Africa, incorporates 'many eyes' from the community to survey plant diseases in the fynbos biome (Hulbert, 2016). Having multiple contributors from the community improves the integrity of the research and if any new developments arise, they will likely be detected quickly so that a response can be determined. For example, each local is encouraged to realise their 'inner scientist' while hiking (Hubert, 2016) by surveying microorganisms called *Phytophthora* or 'plant destroyers' that can affect endemic fynbos species, submitting physical samples or learning laboratory skills. A heightened awareness of invasive species is created, which helps in the monitoring and management of indigenous plant species. Participating in community-driven citizen science can help "communities develop skills for data collection to make scientifically informed decisions, further benefiting society and South Africa as a whole" (Hulbert, 2016, p. 19).

Graham et al. (2014) provided a report to the Water Research Commission that explores literature on how different "social change models of learning and educational change" (p. ii) can impact water resource management. This report was in association with GroundTruth and the Wildlife and Environmental Society of South Africa (WESSA) and explored the conceptual and practical links between social learning, citizen science and natural resource management. They share specific citizen science tools, interventions and resources that support community-based monitoring and water resource management. One example is the involvement of citizens in measuring stream and river characteristics through scientific protocols that were co-created, such

as a Stream Assessment Scoring System (miniSASS).[1] Involvement in this initiative allows citizens to gain scientific literacy in various areas such as nutrient enrichment, microbiology, water quality monitoring tools and geomorphological characteristics (Graham et al., 2014).

Díez et al. (2018) examine how community-driven citizen science approaches can contribute towards policy recommendations through incorporating the research participants in the process. Although this literature predominantly looks at creating environmental recommendations for obesity prevention within communities, the authors highlight the beneficial community-driven process, which is relevant to this study. Díez et al. (2018) targeted interventions at the neighbourhood level with a sustained impact, which would require the participation of a diverse set of stakeholders within a community. The authors found that to build community support for environmental change, participants or residents should be a part of the research process at multiple levels as they can provide essential insight into contextual social and environmental conditions. Díez et al. (2018) initiated learning between researchers, public health professionals, political advisors and locals. Coburn (2003) agrees that including local voices in community issues contributes to 'knowledge democracy', where knowledge becomes freely accessible to all and not restricted to the academic elite. Community-driven citizen science fosters co-learning between residents and researchers; both parties learn from one another. Such collaboration and co-creation can contribute towards adapting existing activities and even policies to suit real needs of the community (Díez et al., 2018). The local participants at ground level become the actual experts on their environment and "guide the actions needed to foster policy change at the community level" (Díez et al., 2018, p. 10).

It is important to bear in mind that the process of community-driven action only makes sense and works if it is supported by the community living in the area. It is a complex process and Díez et al. (2018) highlight the importance of participants' sustained involvement to maintain success. This may include, for example, disseminating results to the public, maintaining citizen science meetings, creating awareness campaigns and presenting on-going findings.

[1]*MiniSASS is a tool used by citizens to monitor the health of a river. One collects a sample of macroinvertebrates from a body of water indicative of the general river health and water quality.*

2.2.2 Challenges within Citizen Science Approaches to Research

Davies et al. (2016) highlight that citizen science has its challenges, specifically related to validity of knowledge production, data collection and analysis, especially if these are insufficient in terms of scientific standards. Previously, traditional methods of data collection and analysis in scientific research were predominantly a solo researcher's pursuit, generally involving data collection over a long time span, focusing on validity and usability and seeking to answer a predetermined research question. Where some argue that questioning the validity of citizen science data is a barrier for citizens to enter the field, others believe that if projects are collaborative and create working relationships between scientists, vested societies, government agencies and other stakeholders, it should be possible to identify and create mechanisms "to minimize error and help validate records" (Dickinson & Bonney, 2012).

Citizen science challenges the competitive traditional scientific field that credits individual researchers for their achievements, applauds their academic publications and secures recognition in a community of peers by pioneering new research results. Due to the vastness of citizen science initiatives, traditional scientific methods alone are no longer adequate for collecting large data sets in a short period over a vast landscape (Franzoni & Sauermann, 2014). Today, due to the public collecting large quantities of information "vast data-storage warehouses, accessible to many researchers, are going up in several scholarly fields to keep track of the wealth of information" (Young, 2010), thereby giving a variety of researchers and organisations from several fields access to substantial bodies of knowledge. According to Young (2010), this sharing of knowledge and information between multiple interested parties in citizen science has assisted the field of scientific research.

Díez et al. (2018) identify limitations of community-driven citizen science. Firstly, research findings may only reflect the activities of a particular group of participants or community, which can limit representativeness and generalisability of results. To combat such a limitation, the community-driven approach should be transferable in design so that it can be used in other communities and contexts. Secondly, local voices and recommendations are derived from present participants only, which can exclude historical evidence and endeavours. Thirdly, a community-driven approach is time consuming and participation often depends on the most motivated individuals in

the community, which can create a selection bias or create vulnerability of participant involvement over time.

However, the benefits of collaborative information production are that scientific questions and challenges "can be addressed at relatively low cost, while also increasing the speed at which they can be solved" (Franzoni & Sauermann, 2014) and a greater amount of knowledge can be produced by civilians who are local experts within an area, regardless of their training. As data rapidly continues to accumulate, more resourceful ways to store and process information will be required (Young, 2010). Projects need to be designed to mitigate various shortfalls, such as validity, lack of training and methodology. As our world rapidly changes, it is important to alleviate various social-ecological challenges by up-skilling citizens in their local areas to incorporate multiple views and expertise into important local decision-making (Haywood & Besley, 2014) and provide opportunities to answer pertinent questions.

2.3 Social Processes in Citizen Science Practices

Bela et al. (2016) highlight that scientific protocols are utilised to easily validate, evaluate and measure data. However, the organisational, social and political processes and impacts are far less researched and far more difficult to identify and evaluate. By exploring various social processes (such as knowledge-production, social learning processes and co-engagement) occurring between various 'nexes of practice' alongside scientific protocols, one can begin to identify where public participation, local knowledge, science-society-policy interrelations and innovation can occur and be extended (Bela et al., 2016). These processes can occur through engaging in citizen science practices, gaining scientific literacy and interacting between diverse stakeholders. This highlights an urgent need to give careful descriptive accounts of the multidimensional character of citizen science and complex practice initiatives and to seek ways of assessing its possible dynamic outcomes. It is therefore essential to enhance understandings of the social processes and interrelations in multidimensional initiatives that work with citizen science.

This study investigated such social processes and the impact of complex practices around the shared interest of protecting the endangered western leopard toad. The complex areas of practice are termed 'nexes' in this study. 'Nexes' refers to the

multiple connected project components and systems of activity that make up the core of the WLT-CC, including education, research, conservation, governance and citizen science work. To give a fuller account of what is meant by social processes, the terms ‘co-engaged learning’ and ‘co-produced knowledge’ will now be discussed.

2.3.1 Co-engaged Learning

There is currently limited literature on co-engaged learning. To analyse the term, I considered both ‘engaged learning’ and ‘co-learning’, combining the most effective and relevant elements of each term, and reconstituted the term, ‘co-engaged learning’. Co-engaged learning refers to how people engage and learn with and from one another and become adaptable in their problem solving of an object of interest in the context of their residence or work. Importantly, co-engaged learning looks at how people communicate through a shared language, their commitment to a specific cause and their valuing of collectively achieving resolutions (Barge et al., 2008). Co-engaged learning aims to create spaces with a sense of community through learning, initiating, sustaining and extending partnerships (Bovill, Felten, & Cook-Sather, 2014).

Lave and Wenger (1991) theorise learning as a social process which occurs through social engagement, participation and potential learning in a community of practice. A community of practice (further discussed in section 2.5), is defined as a group of people who share a common interest and who interact, learn together and improve their knowledge and skills by doing, belonging and participating in meaning-making experiences. A community of practice reflects shared experiences around which participation is organised (Lave & Wenger, 1991) through utilising physical and conceptual artefacts.

Armstrong (2013) highlights various forms of co-engagement that can assist in improving capacity development, encouraging a wealth of interrelations between multiple entity initiatives or organisations and the learning that occurs between them. Armstrong (2013) argues that in order to address complex problems (which can be messy, ambiguous, social and political) and complex interrelationships (between issues and multiple stakeholders), an adaptive system is required that is “constantly adjusting to environmental changes” (p. 19). The author shares that typically organisations have “deeply engrained behaviours, entrenched interests, [and] unique

contexts" (p. 62) which are bound in a tangled web of relations. Co-engaged practices between multiple participants should, therefore, be non-linear in structure. Armstrong (2013) argues that collaborative effort is the most effective strategy in diagnosing problems, learning together, agreeing on solutions and understanding others' interests and perspectives through adaptive practices. Armstrong (2013) highlights the following forms of co-engaged practice:

2.3.1.1 Co-diagnosing

Diagnosis, especially when "carried out conjointly, can contribute significantly to improving the quality of analysis" of issues within a specific context (Armstrong, 2013, p. 110). It stimulates discussion and works on critical and relevant issues. Effective and lasting changes can be made collaboratively if the process of co-diagnosis is supported by multiple participants within the organisation. Armstrong (2013) shares that the process of co-diagnosis is the first step of 'co-learning', where members "learn new ways of thinking, assimilating and using knowledge" (p. 110).

2.3.1.2 Co-learning

Armstrong (2013) highlights that learning and knowledge, although closely related, are different in their verb form: "to know and to learn" (p. 111). Learning is "the act or process of acquiring that knowledge or changing behaviour" (p. 111). Armstrong (2013) identifies that shared knowledge is gained through local context and practice, where expertise, understanding and information is created and shared.

Armstrong (2013) terms this process of gaining shared knowledge through engaging in practice 'co-learning' and believes it is the foundation of capacity building. Through co-learning, which places emphasis on action, reflection and experimentation, Armstrong (2013) believes that current and future complex issues can be addressed. Armstrong (2013) identifies that an integral part of co-learning is the co-diagnosis process, where participants question, reflect and implement practices according to their local context. Individuals can gain skills by being a part of practices that encourage "introspection, retrospection and reflection" (Armstrong, 2013, p. 113*).*

2.3.1.3 Evaluation Through Co-learning

Armstrong (2013) highlights that evaluation is central to learning. Where most evaluative processes only check results against predicted outputs when a project is

finished, co-learning occurs in real-time. Therefore "continuous adjustments and improvements" need to be made and "a more dynamic, non-traditional approach to evaluation is required" (Armstrong, 2013, p. 126). Traditional forms of evaluation focus on goals and results that can be easily and narrowly assessed and are separable from other activities. However, the evaluation of multi-faceted initiatives needed to assess a variety of complex problems and practices can be more complicated (Armstrong, 2013). Armstrong and Think Tank Initiative[2] discuss the benefits of alternative traditional evaluation processes (such as 'Outcome mapping'*)* that enable stakeholders to track four important social processes in real time (Armstrong, 2013, p. 134):

1. *'*Interdependence' – monitoring the interconnectedness of a vast network of complex relationships;
2. 'Relationships and collaboration' – shifting from evaluating the parts to the whole perspective and from individual performance to broader patterns of behaviour;
3. 'Feedback loops' – cyclical real-time feedback from multiple avenues providing flexibility and adaption;
4. 'Partnerships' – establishing and monitoring links and associations between multiple entities.

This evaluative process of monitoring co-learning and reflecting on experience is an on-going process.

2.3.1.4 Co-designing

Armstrong (2013) explains that co-designing is a social process that identifies what learning is needed in order to grow and what planning is required to reach targets and expectations. It is important to highlight, however, that this cannot be specifically designed and is not brought about by following a grand master design but by continually understanding, engaging with and readjusting direction towards achieving particular goals (Armstrong, 2013). It is an iterative process and participants within the initiative should have the operating space to experiment rather than following a

[2]*The Think Tank Initiative - a multi-donor project with a vision to 'ensure policymakers in participating countries consistently use objective, high-quality research to develop and implement policies that lead to more equitable and prosperous societies' (Armstrong, 2013, p.216).*

linear, cause-and-effect plan. Co-designing is a reflexive problem-solving process through which "flexibility for learning-based adjustment" (Armstrong, 2013, p. 151) is enhanced. Armstrong (2013) shares that "people support what they help create" (p. 159). Areas of co-design allow people to collaborate and create assets or methods that they will build upon themselves. For example, volunteers within the WLT-CC designing effective ways to collect data and then building upon these methods to create important and valuable information for the WLT-CC as a whole. The process of co-designing can build various capabilities, such as collaborative skills, problem solving for contextual challenges, development of practices and self-confidence (Armstrong, 2013).

2.3.1.5 Co-acting

Armstrong (2013) highlights that once participants have engaged in elements of learning and experience to collaborate efforts and action, practices should be continuously monitored and altered as challenges and opportunities arise. As participants take action, the process of co-diagnosis, co-design and co-acting is repeated with differing emphasis at different times depending on what they are trying to achieve. Armstrong (2013) argues that co-acting is the set of practices through which participants act together, learn and grow and is a process "without which learning would be impossible" (p. 166). During the process of co-acting, the focus remains on learning and applying that learning to improve the design and the diagnosis of the issue as well as achieve a focal objective. As Armstrong highlights, "co-acting is learning by doing" (2013, p. 169). Applicable to the case of the WLT-CC is that the focus of co-acting is through "coherent action [and] not the final solution" (p. 166). Participants are constantly encouraged to understand shared meaning of the social-ecological problem that they face and act to resolve this.

Putting "the collective at the [centre] of learning" (Curry & Cunningham, 2000, p. 78), the process of co-engaged learning allows participants to gain newly-shared knowledge through real-world practice and can assist in community capacity building for sustainability. Through co-engagement, partnerships are formed between diverse stakeholders and citizens can democratically become members of a thriving multidisciplinary programme. Through this research, I aimed to explore such co-engaged learning in the WLT-CC and identify how their multiple 'nexes of practice' collected information, shared findings, gained insights and, ultimately, developed

capacity through engagement with multiple participants within their community.

2.3.2 Co-produced Knowledge

In citizen science, learning activities are situated around knowledge production and, sometimes, the creation of a shared meaning within a particular context in relation to a shared interest. The co-production of knowledge involves varying levels of participation, multiple types of knowledge-production and meaning-making from several viewpoints within a community. As the WLT-CC is a multi-faceted initiative, it is important that participants from across the landscape share their different expertise, perspectives and skills that can encourage historical and social knowledge being brought forward into the context (Udall, Forrest & Stewart, 2015). According to Armstrong, knowledge creation "is deeply embedded in local context and practice" (2013, p. 112). This is evident in the WLT-CC initiative, where 'locals' or 'experts' with specified backgrounds in a multidisciplinary context work to bring about transformative agency and resolutions around a shared interest (Bowen, 2005).

To understand how co-produced knowledge is created and shared among multiple stakeholders, I drew on Wenger-Trayner et al.'s (2015) concept of "knowledgeability in a Landscape of Practice" (p. 19). The authors highlight that people engage in, visit, encounter and even avoid practices throughout their lifetimes and that this shapes who they are and their experiences of themselves. Wenger-Trayner et al. (2015) state that people cannot be competent in all practices within a landscape but can have knowledge about them, understand the relevance of specific practices and situate them within a larger landscape or context. "Learning is not merely the acquisition of knowledge" (Wenger-Trayner, 2015, p. 19) but rather the act of becoming a person who inhabits a dynamic identity and who reflects a trajectory through a landscape of practice that includes gaining memories, competencies, key formative events, stories and relationships with others.

Co-produced knowledge occurs when participants across a landscape of practice with multiple areas of 'knowledgeability' come together to share "a culture of open communication, in which members of an organisation collaborate in 'organisational enquiries' to discover better ways of achieving the organisation's purposes" (Boreham & Morgan, 2004, p. 308–309). This can occur through active listening, shared ideas, managing conflict and delegation, which essentially encourages

organisational learning and collaboration (Boreham & Morgan, 2004). Edwards (2005) similarly explains that we shape and are shaped by our worlds by outwardly sharing information with others and problem solving in various contexts. Through this research, I aimed to identify how co-produced knowledge occurs within the multiple 'nexes of practice' and how participants together "recognise, question and replace the hidden assumptions…that underpin their current practice" (Boreham & Morgan, 2004, p. 309) to negotiate project boundaries and create commonalities towards their shared interest, in this case, the conservation of the western leopard toad. Co-produced knowledge occurs through meaningful and mutually beneficial collaborations between multiple contributors who work towards building ideas, theories or solutions to assist in "building democracy and civil society" (Udall et al., 2015, p. 158).

2.4 Towards the Development of Social Protocols

The development of scientific protocols has received much attention and have become valuable processes in guiding the collection of data and advancing scientific knowledge in citizen science projects (Bonney et al., 2009). However, the *dynamic social processes* that strengthen and co-ordinate such action, such as organisational, social and political processes of multi-agency initiatives, are less developed and largely under theorized (Vallabh et al., 2016). In citizen science, scientists and citizens utilise clear, robust scientific tools, methods and resources to support practices that strengthen the rigor of scientific data collection. These scientific protocols are step-by-step practical tools created and designed to direct and monitor efficient and valid information creation and transferability so that scientists and researchers can work with useful and robust data for analysis (Beguin et al., 2013). Such tools and resources inform participants of what, how, when and why actions should be taken in order to contribute valid data to a project. They embody the scientific method, the foundation on which valid scientific knowledge is built. They are specific and scheduled and aim to train, prepare and formulate data through observing, measuring and recording (Beguin et al., 2013). Although scientific protocols are effective and essential in the collection of accurate data and can provide relevant guidelines for citizens, they don't necessarily support the required underlying *social* processes. Furthermore, they can create limitations due to their empirical,

structured and quantifiable mechanisms, which often focus on very specific outcomes (Berg, 1997).

Community-driven citizen science goes beyond simply collecting data for research because it incorporates and is heavily reliant on social engagement, action, intervention and collaborative effort from multiple 'nexes of practice' in addressing a particular concern (Tweddle, Robinson, Pocock, & Roy, 2012). The development of social protocols, therefore, can co-ordinate research efforts around a shared interest and promote co-engagement across multiple components of an initiative. Social processes such as the co-diagnosis of issues, co-learning through understanding practice, co-design of strategies and co-acting to intervene (Armstrong, 2013) can be valuable and complementary to scientific protocols. Social practices and processes utilised to advance a shared community interest, such as group problem solving, active listening, shared ideas, managing conflict, delegation and peer leadership, can enhance community-driven citizen science and essentially close the gap between science and society (Boreham & Morgan, 2004). It is therefore important to explore the collaborative social processes that occur within community initiatives that (i) involve local members investing their time and effort by collectively taking action, recording data and sharing information with multiple entities and (ii) have coordinated practice around a shared ecological interest.

2.5 Community of Practice

Society is constantly involved in multiple complex practices because humans are social beings and we collaborate, participate, engage in relationships and share vested interests (Wenger, 2009). Citizen science and volunteer practices within the WLT-CC constitute a community of practice that contributes towards the macro initiative of protecting a flagship species and conservation as a whole. A community of practice is a group "informally bound by what people do together" (such as engaging in volunteer activities to save toads or collating research to answer a research question) "and by what they have learned through their mutual engagement in these activities" (Wenger, 1998a, p. 2). Communities of practice are self-organising systems that develop around a shared interest that has meaning to people. Community-driven initiatives such as the WLT-CC are organised in response to a social-ecological need and locals looking to create change.

Wenger (1998a) defines a community of practice as having three dimensions. Firstly, it is defined by its *joint enterprise*, in this case, the need, which is continuously changing and being understood by its members, to protect the western leopard toad species. Secondly, a community of practice is defined by its relationships and *mutual engagement* between its members when engaging in practice. Lastly, it is defined by the *shared repertoire* that members develop over time through routines and the use of knowledge and vocabulary (Wenger, 1998a).

Wenger (1998a) highlights how communities of practice assist in the "creation, accumulation and diffusion of knowledge in an organization" (p. 5), which is essential for social learning and the groups' identity. Firstly, members of a community of practice understand their objectives and cause; they communicate through various channels, "such as best practices, tips, or feedback" (Wenger, 1998a, p. 6), between each entity. For example, the WLT-CC share information with one another pre- and post-breeding season at meetings as well as via email and WhatsApp groups, all of which help to inform practice and encourage future participation. They are the connectors for the 'exchange and interpretation of information' (Wenger, 1998a). Secondly, Wenger (1998a) emphasises that communities of practice *retain knowledge* in holistic ways rather than just on a database or a regimented platform. Even if tasks and processes are routine, they remain adaptable in responding to local challenges and contexts. Thirdly, communities of practice *steward competencies* in order to maintain current trends and remain at the forefront of their field. This involves collaborative inquiry and responsibility where members "invest their professional identities in being part of a dynamic, forward-looking community" (Wenger, 1998a, p. 6). The WLT-CC is constantly working to improve their data collection strategies through new solutions and technologies to be at the forefront of citizen science and to keep up with ever-changing policies and bureaucracies around local and regional conservation. Lastly, Wenger (1998a) describes that communities of practice offer *homes for identities.* The WLT-CC has members who volunteer in local areas and call themselves ToadNUTS or KirMiTS (Kirstenhof to Muizenberg Toad Savers): names that offer identity within an area and within the cause under the umbrella initiative of saving toads. These displays of identity, Wenger (1998a) believes "help us sort out what we pay attention to, what we participate in and what we stay away from" (p. 6).

People can belong to several communities of practice simultaneously; they can belong to single organisational structures, smaller sets of people or larger institutions. A community of practice can be made up of separate teams, networks and units that take care of various tasks and form various relationships (Wenger, 1998a). For example, the WLT-CC is a steering committee representing various communities of practice within a landscape of practice (See 2.7). It has a representative from the CoCT who manages separate teams within different line functions that engage in various conservation practices that directly and indirectly protect the western leopard toad. It is through these communities of practice that actions take place, knowledge is developed and learning occurs, allowing each member to engage in tasks or practices. It is the social learning between multiple communities of practice that makes such an initiative effective (Wenger, 1998a).

2.5.1 Social Learning in Communities of Practice

As mentioned above, communities of practice are bound by what they do, how they learn and by a shared interest that occurs through mutual engagement. Wenger (2009) argues that learning is contextual and occurs through engaging in experiences and participating in the world around us; it is "a fundamentally social phenomenon, reflecting our own deeply social nature as human beings capable of knowing" (p. 210). Wenger (2010) argues further that communities of practice are social learning systems, which exhibit characteristics that arise out of learning, such as "complex relationships, self-organization, dynamic boundaries, on-going negotiation and cultural meaning" (p. 1).

Wenger (2009) discusses learning as an activity that is not separate from daily life nor an independent activity that we engage in. It is not something that we suddenly do and then stop doing when we move from one context to the next. Sometimes learning intensifies when we are encouraged or required to focus on a particular phenomenon, challenged beyond our abilities or seeking to engage in a new practice. At other times, learning occurs informally and fluidly when we gain insight or if we become a fully recognised member of a community of practice.

Graham et al. (2014) explore why social learning constitutes an appropriate approach to learning within community-driven initiatives and citizen science practices. Social learning can assist with social-ecological change, as there is an on-going interest by

sustainability practitioners to "bridge the divide between learning, knowledge and change" (p. 9). Within the literature on social learning, Wals (2011) proposes that learning requires 'hybridity', where multiple actors within society assist in integrating formal and informal education. This 'hybrid' space can bridge the gap between having knowledge and taking action. Sterling (2011) uses the term 'transformative learning' that looks to transform current frames of reference, such as people's perspectives, habits and mind-sets, and make them more inclusive. This resonates with the environmental democracy, scientific literacy and community inclusion that Irwin (1995) claimed citizen science could achieve.

Social learning literature indicates that reflexivity is important to "cultivate a culture conducive to collaborative knowledge production" (Graham et al., 2016, p. 10). This recognises that each entity involved needs to understand itself in relation to the other, be respectful of and accommodate new perspectives and practices in order to promote adaptive ways of thinking. This aligns with Irwin's "pursuit to democratize knowledge production" (Graham et al., 2016, p. 10) through citizen science. By including the publics' local knowledge and contextual perspectives that can assist in the design, development and application in contextually-bound initiatives (Graham et al., 2016), real-world concerns can be addressed through the creation of purpose-driven, community-produced knowledge. This form of reflexive activity is best described as the 'co-created projects' that Bonney et al., (2009) previously identified and what Wals (2011) describes as offering the greatest potential in becoming a 'hybrid social learning space'. As such, social learning can elevate citizen science through the inclusion of diverse stakeholders within a specific context and can create a space in which learning and knowledge production can thrive (Graham et al., 2014).

In the literature there are multiple conceptual and practical links between citizen science, social learning and natural resource protection (Graham et al., 2014). Johnson et al. (2012) state that there are no straightforward answers and actions to address multifaceted challenges that emerge from complex and unpredictable social-ecological systems; these require not only scientific capabilities but also adaptive learning through well-mediated participatory learning platforms. Such learning coordination, however, is scarce and therefore this study fills an important gap through the development of recommendations for potential social protocols that can

assist scientific and learning capabilities to enhance "social learning for collaborative sustainable development" (Johnson et al., 2012 p. 1).

Social learning can equip society with various tools and skills to engage across multiple practices and boundaries. Boundaries (section 2.7) are social constructs that arise when people assume professional or expert positions in society. However, people in such positions are often alienated as they do not exchange information with one another and sectors within society are left lacking the capability to answer multifaceted, dynamic questions about social-ecological challenges in their separate fields of interest (Graham et al., 2014). The authors describe this separation of society and science as 'silos of practice' (Graham et al., 2014). It is therefore important to identify what boundaries are, how they can be overcome and how social learning can provide "citizen science processes with meaning making and a structure to plan and act, from an informed standpoint to build socio-ecological resilience" (Graham et al., 2014, p. 11).

2.6 Landscape of Practice

The theoretical framework that informs this research is what Wenger-Trayner et al. (2015) identify as a 'Landscape of Practice'. The authors describe this as "a complex system of communities of practice and the boundaries between them" (Wenger-Trayner, 2015, p. 2). A variety of communities of practice need to overlap and interact across their differing disciplinary boundaries for a landscape of practice to form, knowledge to be shared and created and unexpected learning to occur (Wenger-Trayner, 2015). As described in Chapter Three, this framework informed the research design of this study and influenced my understanding of how knowledge and 'knowledgeability' contribute to the application, vitality and sustainability of practices in a community-driven citizen science project (Wenger-Trayner et al., 2015). The authors highlight that "knowledgeability manifests in a person's relations to a multiplicity of practices across the landscape" (Wenger-Trayner et al., 2015, p. 13). They suggest that it is the level of connection and engagement as well as legitimacy within that community that makes a person a competent contributor. Competence and knowledge are not static but social and become recognisable through co-engagement with members in a community of practice, which is shared and dynamic (Wenger-Trayner, 2015).

Wenger-Trayner et al. (2015) highlight that no single component of the project can claim to represent the landscape of practice; rather, each community of practice within the different 'nexes of practice' influences and supports the project's overall practice. landscape of practices are complex as multiple stakeholders have diverse perspectives, backgrounds, skills, affiliations, regulations, aspirations, relationships and contributions toward the shared interest as a community of practice. Each of the components of the organisation convene and interact in different ways to create working relationships encouraging new learning, innovation and progress towards their shared interest: in this case, the western leopard toad. Wenger (2010) argues that "learning gives rise to a multiplicity of interrelated practices, it shares the human world as a complex landscape of practice" (p. 4). All these 'nexes of practice', with their various overlapping communities of practice "share an enterprise, an understanding of what matters, relationships as well as the resources that their history has produced" (Wenger, 2010, p. 3). As Wenger-Trayner et al. (2015) suggest, by understanding how 'knowledgeability' and learning between and across the separate 'nexes of practice' is created through social engagement, one can begin to understand the range of social processes needed to negotiate project boundaries and create commonalities and how a collective body of knowledge in a landscape of practice is created.

2.6.1 Boundaries and Boundary Crossing

Wenger-Trayner et al. (2015) state that "boundaries are inherent in landscapes of practice" (p. 101) and are unavoidable. Boundaries reflect the natural restrictions of human engagement in complex landscapes. Boundaries exist when there is a shared history of learning in a landscape of practice with complex practices, power dynamics, locations, times and institutional practices, which can arise between and within each nexus, affecting all interactions.

Wenger (1998a) highlights that communities of practice structure learning potential in two ways: "through their knowledge they develop at their 'core' and through interactions at their 'boundaries'" (p. 6). Wenger-Trayner et al. (2015) identify five overarching 'boundaries' that communities of practice may need to negotiate for successful interrelations and commonalities to be reached. These complex boundaries may be hidden or open and involve dynamics related to: 1) practices; 2) institutions;

3) scale; 4) power relations; and 5) time. Each of these complex boundaries is discussed below in relation to the WLT-CC.

Firstly, landscapes are characterised by 'complex practices'. Stakeholders across the landscape identify with often "unrelated, overlapping, and competing practices" (Wenger-Trayner et al., 2015, p. 101). For example, the different nexes of the WLT-CC do not necessarily engage in similar practices toward their shared interest but have differing objectives, histories, work ethics and dynamics. Secondly, landscapes have 'complex institutions' that have specific policies, structures and politics, which manifest as boundaries that need to be traversed (Wenger-Trayner et al., 2015). In the case of the WLT-CC, the volunteer and research nexes may have differing pressures to meet the demands of stakeholder groups or funders due to their different objectives and roles. The involvement of each institution may vary at different levels, locations and times. Thirdly, landscapes of practice have 'complexity of scale'. Stakeholders may be involved locally (the volunteers/citizen scientists) or at a regional or national scale (national conservation agencies like Cape Nature and SANBI). The investment of each stakeholder may differ and could cause disassociation; however, such boundaries, if traversed, allow for co-engaged learning processes to cross multiple levels of scale (Wenger-Trayner et al., 2015). Fourthly, landscapes of practice have 'complex power relations' among groups, sub-groups and individuals. Power dynamics within and between the nexes need to be understood and negotiated to forge learning relations and commonalities (Wenger-Trayner et al., 2015). Lastly, landscapes have 'complexity of time'; the *status quo* is constantly restructuring over time. However, if there is coherence and continuity towards the shared interest, the project can remain focused and sustainable (Wenger-Trayner et al., 2015).

Akkerman & Bakker (2011) define a boundary as a "sociocultural difference leading to discontinuity in action or interaction" (p. 133) and are interested in the ways in which continuity can be established despite these sociocultural differences. They believe that "all learning involves boundaries" (Akkerman & Bakker, 2011, p. 132) through allowing participation and collaboration to occur across a "diversity of sites, both within and across institutions" (p. 133) involving multiple actors in numerous professional cultures. However, the literature on boundaries and boundary crossing does not effectively explicate how or what kind of learning can take place when such complexities are negotiated.

Boundaries have the potential for unexpected learning possibilities. If participants in the WLT-CC negotiate their existing boundaries, through co-engagement and co-production of knowledge, they, as a community of practice have the potential to expand what they see as the core of their practice (Wenger-Trayner et al., 2015). As discussed in detail in Chapter Three, guided by the theory of 'Landscapes of Practice', I needed to design this study so that I could observe the macro and micro view of the WLT-CC initiative and understand the cross-cutting social processes of knowledge production and co-engaged learning that affected the project's relevance and efficacy.

2.6.2 The Nature of Boundaries and Potential Learning Possibilities

The potential learning possibility of boundaries has become a large part of the learning theories developed by Wenger (1998a & 1998b), Wenger-Trayner et al., (2015) and Engeström, Engeström and Kärkkäinen (1995). Wenger (1998b) explicitly argues that learning resulting from boundary crossing is essential if communities of practice wish to maintain their dynamism. Akkerman and Bakker (2011) investigate two valuable questions central to this discussion: 1) what is the nature of boundaries? and 2) what learning takes place at boundaries? In addressing these questions, firstly, one needs to distinguish between the term 'transfer' and 'boundary crossing' from the available literature. Boundary crossing is not a one-time transfer or one-sided transition from one context to another but rather an on-going interaction between different contexts affecting "not only the individual but also the different social practices at large" (Akkerman & Bakker, 2011, p. 136). Literature that discusses the idea of once off transfers argues that sociocultural differences are problematic. However, literature that discusses boundaries values sociocultural differences and encourages "a need for interdisciplinary and cross-sectional work" (2011, p. 138) in and between different domains.

According to Akkerman and Bakkers' (2011) review that analysed over 181 studies referring to boundaries, the nature of boundaries can be conceptualised between two or more sites (what I have explained in this study as 'communities of practice' or 'nexes of practice'). These two or more sites will maintain a similar shared interest (the wellbeing of the western leopard toad) but have potentially differing cultures or practices. The differing culture or practice thus represents the boundary, indicating their "potential difficulty of action and interaction across these systems but also

represent[ing] the potential value of establishing communication and collaboration" (Akkerman & Bakker, 2011, p. 139).

The nature of boundaries is ambiguous. They can be identified as the middle ground that belongs to "*both* one world *and* another" (Akkerman & Bakker, 2011, p. 141) or can be explained as both connecting and dividing 'nexes of practice'. This ambiguity causes people or objects to either cross over or stand between sites. This explains educators' interest in the boundary and crossing boundaries as the 'multi-voicedness' and the 'unspecified quality' of boundaries initiates a need for communication through which "meanings have to be negotiated and from which something new may emerge" (Akkerman & Bakker, 2011, p. 142). Carlile (2004) argues that knowledge can be both a source and a barrier to innovation, therefore it is important to understand how knowledge and learning is managed and created across boundaries where innovation and collaboration is desired. This research is interested in what Carlile (2004) highlights as the "different processes required at each type of boundary to effectively manage knowledge" (p. 555).

2.6.3 Learning Mechanisms at the Boundary

The learning potential of crossing boundaries is broad and can include stakeholders in the landscape gaining new understandings, developing new identities, changing practices and leading to possible institutional development (Akkerman & Bakker, 2011). According to Akkerman and Bakker (2011), four mechanisms of learning at the boundary have been identified: 'identification', 'coordination', 'reflection' and 'transformation'.

2.6.3.1 Identification

'Identification' entails people's simultaneous participation in multiple 'Nexes of Practice' in the landscape of practice, being involved in multiple intersecting sites and identifying with more than one aspect of the initiative; for example, western leopard toad volunteers both collect toad data and uphold the rules and regulations of the city or conservation area. Tensions can emerge and a variety of individual and social identities can be encountered and reconstructed, creating learning opportunities through overcoming discontinuities (Akkerman & Bakker, 2011).

2.6.3.2 Coordination

'Coordination' entails four processes that assist in actual and intended coordination and learning across boundaries (Akkerman & Bakker, 2011). (a) Coordination creates 'a communicative connection' that looks to enhance dialogue between diverse stakeholders who practice differently and hold various perspectives. (b) Coordination enhances 'efforts of translation' between different 'nexes of practice', for example, researchers translating various research findings into common understanding for the public to assimilate. (c) Coordination helps with 'enhancing boundary permeability', which creates practices that runs effortlessly by repeatedly crossing boundaries through continuous interaction. (d) The process of coordination across boundaries is 'routinisation'. This entails coordination that automatically becomes a part of practice, enhancing standardisation and certainty across boundaries. Learning may not occur through the reconstruction of the boundary but rather in overcoming it. Learning at the boundary potentially resides in continuity being established, which "facilitates future and effortless movement between different sites" (Akkerman & Bakker, 2011, p. 144).

2.6.3.3 Reflection

There is learning potential in terms of 'reflection', where boundary crossing assists in "coming to realize and explicate differences between practices and thus [learning] something new about [one's] own and others' practices" (Akkerman & Bakker, 2011, p. 144). The 'reflection' mechanism emphasises comprehension and promotes learning through looking at oneself through the perspective of other 'nexes of practice'. A lack of perspective can create misunderstandings and miscommunication between stakeholders in the landscape of practice that can negatively impact how negotiation and collaboration is perceived and proceeds. Taking a Bakhtinian point of view, Akkerman and Bakker (2011) explain that "both perspective making and perspective taking are dialogical and creative in nature" (p. 145) and can enrich one's identity beyond its present position. Reflection therefore results in expanded perspectives and new identity formation that informs practice for the future.

Smith (2011) explains that critical reflection is often needed to "consolidate and assess…learning of a discipline and its practices" (p. 211). There are multiple models of reflection that serve various purposes, including critically reflecting through

thinking, learning and "assessment of self and social systems" (p. 211), which can help identify and negotiate complex practices and issues. Critical reflection has become an important approach in "assessing and overcoming biases in knowledge construction" (Smith, 2011, p. 214) and the issues around why knowledge is created and who says it is 'knowledgeable'. Smith (2011) highlights four forms of reflection: 1) 'personal reflection', 2) 'interpersonal reflection', 3) 'contextual reflection', and 4) 'critical reflection'. 'Personal reflection' involves reflecting on one's own thoughts and actions, which 'filters' one's past experiences, beliefs and motivations. It acknowledges one's individual influence on specific responses and subjectivity. 'Interpersonal reflection' aims to address the influence of interactions with others and acknowledges how group interactions may influence the ways of working. 'Contextual reflection' identifies how concepts, theories and methods are established and "involves questioning the knowledge structures we operate within" (Smith, 2011, p. 217). Lastly, 'critical reflection' aims to address the role of political, ethical and social contexts and highlights the influence of powerful groups' agendas. Reflection is an important process in identifying personal, professional and social influences on practices and challenging how knowledge is created and learning occurs.

2.6.3.4 Transformation

'Transformation' can lead to substantial "changes in practice, potentially even the creation of a new, in-between practice" (Akkerman & Bakker, 2011, p. 145). 'Confrontation' has been described as a process through which learning can occur. Through confrontation at the boundary, intersecting 'Nexes of Practice' are forced to reconsider their relationships and current practices. If confrontations don't occur (through exploration and discussion), there cannot be movement toward transformation, which tackles current issues and engages with differences of perspective. Akkerman and Bakker (2011) state, "only when cultural differences lead to discontinuities can these generate negotiation of meaning" (145).

Another process through which transformation can occur is 'recognising a shared problem space' between 'nexes of practice' in the landscape of practice, which is often a direct response to the previously mentioned 'confrontation'. Learning can occur when a deliberate target for change can be identified, which is "motivated by and directed toward the problem space that binds the intersecting practices together" (Akkerman & Bakker, 2011, p. 148). This can stimulate another process of

transformation, ‘hybridization’, where elements from multiple contexts are brought together to form something unfamiliar and new, such as a new concept, practice or interdisciplinary field. Finally, the literature highlights the importance of ‘maintaining uniqueness of the intersecting sites’. Where this slightly contradicts the ‘hybridization’ process previously discussed, interdisciplinary work requires a balance between pushing for new practices and knowledge and core disciplinary concentrations. It is vital to work continuously and jointly at the boundary in order to maintain the productivity of boundary crossing and find sustainable transformations.

2.6.4 Boundary-Crossing Competence

Authors Walker & Nocon (2007) speak of ‘boundary-crossing competence’, which is the “ability to function competently in multiple contexts” (p. 178). They highlight that a network of related communities of practice can develop boundary-crossing competencies through “participation in expanded, horizontal – rather than hierarchical – systems” (p. 178). Considerable literature supports the notion that competence is constructed within social practices. However, less attention is given to the actual social processes in which members of the various communities of practice cross contextual boundaries and function competently across multiple contexts. The authors highlight that a cognitive-behaviourist model of competence prevails in educational research. The term competence has historically been vaguely defined and focuses heavily on measurable individual achievement related to competition and performance outcomes. Walker and Nocon (2007), however, critique this model and highlight that the socio-cultural approach (of which ‘Community of Practice’ is an example) explores “individual development within the context of the specific social and cultural processes” (p. 180). Their research has highlighted that boundary-crossing competence is defined by the ability to recognise and negotiate meaning through engaging with others and the practices of the group, as well as managing and integrating “multiple, diverse discourses and practices across social boundaries” (Walker & Nocon, 2007, p. 181). In order to achieve such boundary-crossing competence, the authors suggest the use of ‘transcontextual mentors’ and multifaceted artefacts that connect “related practices across boundaries” (Walker & Nocon, 2007, p. 139) in order to connect related ‘nexes of practice’ and create opportunities to expand horizontal systems.

2.6.5 Boundary Objects

In order to create sustainable practices, mutual engagement across boundaries where realignment can occur across the entire landscape, is needed. Graham et al., (2014) suggest that social learning can equip organisations with the tools to engage and connect across knowledge, practice and complexities and boundaries. The authors mention the role of boundary objects in assisting the process of building trust and alignment among various stakeholders. Boundary objects can assist in learning across a landscape of practice and are "artefacts that articulate meaning and address multiple perspectives" (Akkerman & Bakker, 2011, p. 140), such as minutes from a committee meeting involving multiple 'nexes of practice'. Daniels et al. (2007) suggest that boundary objects can build knowledge around a shared interest and are "tools such as meetings, referral processes and information sharing databases" (p. 533) that are instrumental in interpreting, negotiating and synthesising information and for boundary-crossing to occur. Social learning platforms, such as the WLT-CC, its volunteer groups and ACs, provide a space for co-engaged learning to create transparency for multiple members of society to engage in science and combat social-ecological challenges. As mentioned previously, a range of social processes and recommendations toward social protocols are needed to negotiate project boundaries and create commonalities within a landscape of practice. As such, this research aimed to explore what boundaries the 'nexes of practice' were encountering and how they could overcome various complexities in order to inform transformative practice, action and community identity (Wenger-Trayner et al., 2015).

2.6.6 People at the Boundary (System Conveners)

Both Wenger-Trayner et al. (2015) and Akkerman and Bakker (2011) focus on the socio-cultural aspects of boundary crossing and the people who cultivate communities of practice and learning within the landscape. Groups and individuals who engage in boundary crossing have the ability to bridge two worlds that "simultaneously represent the very division of related worlds" and "introduce elements of one practice into the other" (Akkerman & Bakker, 2011, p. 140). Akkerman and Bakker (2011) refer to such individuals tasked with "building bridges" between the sites as "brokers, boundary crossers and boundary workers*"* (p. 140). Wenger-Trayner et al. (2015), however, refer to the role of a 'system convener' who assists in gathering and

facilitating events and various collaborations that address common challenges, which can create lasting changes across both institutional and social systems. A complex landscape of practice therefore has the potential to create relationships that explore "mutual learning needs, possible synergies, various kinds of relationships and common goals across traditional boundaries" (Wenger-Trayner et al., 2015, p.100). This research seeks to understand what social processes (knowledge production and learning processes) occur or are needed to negotiate boundaries and inform practices.

When conveners cultivate communities of practice as interventions in the landscape, they then begin to forge "new learning partnerships, create new capabilities, and enable new identities in the landscape" (Wenger-Trayner et al., p. 97). Their role is to bring people from various locations together in order to transform practice. Such diverse partnerships are not always obvious and may even come from conflicting perspectives. For example, the CoCT representative on the WLT-CC is responsible both for development applications for the city and assisting with protecting areas where the flagship toad species resides. This can lead to conflicting narratives and such individuals run the risk of not being accepted by either 'nexus of practice' (Akkerman & Bakker, 2011). At the same time, however, conveners have the capacity to be appreciated for their innovative role in maintaining professional practices over time and can assist in creating partnerships that can rearrange social systems through collaboration.

The challenges and risks for system conveners reconfiguring such partnerships and social systems is that contexts and people are unpredictable, and situations constantly change. System conveners assist in managing factors that are often in conflict with one another and therefore require skill and expertise to achieve buy-in from stakeholders from various perspectives across boundaries (Wenger-Trayner et al., 2015). This is a sensitive endeavour as there are multiple power dynamics, voices to be heard (including the traditionally silent ones) and various demands from multiple sectors that all have different motivations, interests and expectations. This role therefore requires respect for all areas of involvement and expertise in the landscape. It is not realistic to intervene in new practices and influence new actions without creating common ground and respecting existing stakeholders and their competencies, agendas and expectations in their individual contexts and the landscape of practice (Wenger-Trayner et al. 2015).

Another challenge faced by conveners when negotiating boundaries and discovering commonalities is that they must hold multiple parties accountable to structures in their own contexts and simultaneously organise collaboration and action around a shared interest and outcome as sustainably as possible (Wenger-Trayner et al., 2015). Stakeholders across the landscape have varying demands, practices and institutional commitments that can overshadow the enthusiasm for "engaging in cross-boundary endeavours" (Wenger-Trayner et al., 2015, p. 103). Therefore, it is not enough to merely encourage conversations around a shared interest; rather, conveners must ensure that decision-makers in effective positions in the landscape are involved at multiple levels and must "stand accountable to organizational structures and political hierarchies" (Wenger-Trayner et al., 2015, p. 103). This similarly highlights what Akkerman and Bakker (2011) described regarding the learning mechanisms at the boundary of 'identification' and 'reflection', where multiple actors in a landscape need to be involved in more than one integral part of the initiative to understand the multiple practices and individual perspectives towards the shared interest.

Stakeholders can become impatient for short-term results; for example, researchers may want immediate collection of data about the western leopard toad by volunteers in the field. However, building a foundation of learning and knowledge between multiple 'nexes of practice' cannot be hurried. Therefore, conveners are tasked with balancing long-term sustainable change with short-term learning to result in the landscape of practice working collaboratively so that people from different 'nexes of activity' in the landscape can move beyond their familiar spaces and be effective together (Wenger-Trayner et al., 2015). They can achieve this by designing boundary activities that can expand and motivate participants' understanding of the macro- and micro-contexts (Wenger-Trayner et al., 2015). Conveners visualise potential with the whole endeavour in mind, whereas each community of practice within the different 'nexes of practice' may only see their area of expertise, accessing only a small part of the vision. It is, therefore, up to the convener to assist with the co-creation or co-configuration of the vision by getting people to identify with the narrative so that different stakeholders can recognise their role and aspirations in it (Wenger-Trayner et al., 2015).

2.7 Co-configuration

'Co-configuration' is a term used by Daniels et al., (2007) when referring to multi-agency organisational work and how to negotiate boundaries across local systems to meet complex and diverse needs. 'Co-configuration' was identified by Victor and Boynton (1998) to understand historical forms of work, which highlights that "the work of co-configuration involves building and sustaining a fully integrated system that can sense, respond and adapt" (p. 195). The authors suggest that co-configuration can generate a type of learning and knowledge where progress can occur to new and more effective forms of work in complex multi-agency settings.

Organisational climates operate in "highly responsive, highly personalized case work and customised relationships" that emphasise "participation in planning and decision making" (Daniels et al., 2007, p. 535). Therefore, in the case of the WLT-CC, it is important to explore and understand the relational ways in which learning and practice unfold. Co-configuration work does not specifically focus on a 'finished' product, but instead it is "a living, growing network" that constantly develops and evolves between people and activity (Daniels et al., 2007, p. 526). Co-configuration is embedded in "fluid social and cultural contexts" (Daniels et al., 2007, p. 533) and looks to create "new knowledge and new practices for newly emerging activity" (p. 523).

Daniels et al. (2007) refer to learning for and learning in co-configuration within and between activity entities. Co-configuration occurs in multi-activity fields through "the renegotiation and reorganization of collaborative relations and practices" through the creation of new "corresponding concepts, tools, rules and entire infrastructures" (Daniels et al., 2007, p. 527). Learning in co-configuration refers to learning from on-going interactions over time through interpretations, reflections, disruptions and responses within and between activity systems, which represent diverse traditions, areas of expertise and social languages. "These two aspects – learning for and learning in – merge in practice" (Daniels et al., 2007, p. 527). Like in the case of the WLT-CC, co-configuration often occurs between 'nexes of practice' that may not always share common professional backgrounds, physical locations and can meet at different times in a variety of configurations. This aligns with what Wenger-Trayner

et al. (2015) refer to in their account of complex practices and boundaries in landscapes of practice.

Through co-configuration, traditional boundaries can be renegotiated. Engeström et al. (1995) propose the concept of boundary-crossing: how collaboration can occur between people with different professional backgrounds 'horizontally' across sectors and can assist in creating new professional practices and knowledge. According to Daniels et al. (2007), multi-agency work and organisations should be driven by results in relation to the whole and the shared interest rather than a "rigid adherence to the process" (p. 535). In this study, for example, each 'nexus of practice' should be driven in relation to the endemic species of the western leopard toad as a landscape of practice as opposed to each of their individual adherences.

Engeström (1999) argues for the importance of 'knotworking': a "rapidly changing, distributed and partially improvised orchestration of collaborative performance which takes place between otherwise loosely connected actors and their work systems" (as cited in Daniels et al., 2007, p. 526). The analogy refers to the tying and untying of various flexible, interconnecting threads of activity, depending on their relationships, purposes and goals. This argument states that no specific person or entity (like a systems convener) is solely responsible for collaboration and partnership building. Therefore, working with a multi-agency organisation such as the western leopard toad initiative, this research investigates "*with* whom practices are developed, where current practices lead *to*, where practices have emerged *from* and *around"* (Daniels et al., 2007, p. 533, emphases in original) and what new practices and activities emerge through social processes and collaboration.

As previously stated, the role of a systems convener is of utmost importance in order to step back, observe the landscape and define what matters, what is successful and what action is required across the landscape of practice. However, it is also important to consider that one person's perspective or position is not more important than another. Conveners need to pay attention to voices, differences and power. Whether this means "differences in perspectives, goals, languages, or approaches" (Wenger-Trayner et al., 2015, p. 108), conveners should aim to work with multiple parties within the landscape in order to be inclusive as well as "discover true mutual interest" (p. 108). The difficulty arises when stakeholders don't see what is possible or have a narrow vision of the broader picture. A convener's role, therefore, is "not to displace

people's agendas; on the contrary it embraces these agendas to make them more ambitious, more connected and in the end more likely to be effective" (Wenger-Trayner et al., 2015, p. 109). This can be done through supporting communication and activities of individuals within the communities of practice at a micro-level but also through achieving alignment and interconnectedness of the relationships of the landscape as a whole (Wenger-Trayner et al., 2015).

Wenger-Trayner et al. (2015) identify various ways conveners can assist in enabling "productive cross-boundary encounters" (p. 107) to create learning opportunities and reconfigure partnerships within the landscape. Firstly, learning can occur when boundary crossing is facilitated. This can occur when various stakeholders share and negotiate information and create new, or refine existing, boundary objects (such as documents) that link people from different 'nexes of practice' and engage in practical contexts that negotiate a common aim or shared interest. Secondly, for learning to take place, it is important to design and develop different types of learning spaces. Such spaces can support different kinds of interaction between stakeholders, from informal to formal spaces and from being "introspective to observing the practice of others" (Wenger-Trayner et al., 2015, p. 108). Lastly, boundary-crossing activities should focus on practical and concrete issues of relevance to all stakeholders, which should be treated as opportunities rather than challenges. These cross-boundary learning opportunities connect people in multiple ways by creating "imaginative use of physical space" to connect people "across geographies, time and differences" (Wenger-Trayner et al., 2015, p. 108).

2.8 Concluding Summary

This chapter outlined the socio-ecological context and problem that this research aims to further understand. The research rationale regarding the lack of social processes or protocols that strengthen action was outlined. The concept of citizen science was described and a further glance at what community-driven citizen science is gave insight into the importance of communities working towards a shared interest and the challenges that such an approach can yield for research. The concept of social processes was highlighted through understanding the terms 'co-engaged learning' and 'co-produced knowledge' in relation to this research context and how such social processes can assist towards the development of potential social protocols.

‘Community of Practice’ theory gave insight into how social learning and knowledge production can occur between and within the ‘nexes of practice’ of the WLT-CC. The related theory of ‘Landscapes of Practice’ establishes an understanding of what boundaries are, how boundary crossing can create learning possibilities and what learning mechanisms are needed in order to negotiate boundaries. Concepts of boundary crossing competence, boundary objects and system conveners were illustrated and explained. Lastly, the term ‘co-configuration’ was considered as a way of understanding how an initiative or organisation may require sustainable collaborative practices that are adaptable and assist in creating cohesive mutual interest and workings around a shared interest.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the study's research methodology. I begin by describing the study site before providing a rationale for the critical transformative research orientation and qualitative case study approach. I then describe the data generation methods and instruments, showing how they were designed in response to the research questions and goals and to produce robust, trustworthy data. The chapter then describes how the data was recorded, arranged, managed and analysed and concludes by giving an account of how validity and ethical considerations were addressed throughout the research process. As described in Chapter One, the study was designed to address the main research question: "How do knowledge-production and learning processes influence how participants in a community-driven citizen science initiative negotiate boundaries and inform complex practices in their 'landscape of practice'?" The study sought to make recommendations towards the development of social protocols that can potentially assist in strengthening collaborative effort around a shared interest.

3.2 Research Orientation

Due to my research focus being civic action, sustainable development and the interconnectivity between people and the environment, I took a critical transformative approach. Lotz-Sisitka, Wals, Kronlid and McGarry (2015) argue that in order to "deal with accelerating change, increasing complexity, contested knowledge claims and inevitable certainty" (p. 73) a transformative, transgressive learning approach is needed to address and respond to the various social-ecological challenges we currently face. They argue that the "boundary-crossing nature of sustainability issues" (Lotz-Sisitka et al., 2015, p. 73) and the complexity and uncertainty of practices required to create change makes for a "volatile environment in governance, policy, education and research" (p. 73) and therefore calls for new approaches in rethinking higher education, learning and pedagogy. This aligns with the need to address the social-ecological challenges of the western leopard toad species and understand new potential learning possibilities to effectively combat these issues.

Knowledge and what we do with it as researchers is important. My aim was to use this study to critique and transform learning and praxis in a community-driven citizen science initiative towards making informed decisions. Due to our ever-changing and challenging environment, Sterling (2004) argues that we need to rethink the foundations of how we do things and re-design the system towards transformation so that we can potentially overcome unsustainable practices and routines. To achieve this transformative research, issues need to be engaged with across disciplinary boundaries by including "transdisciplinary perspectives across multiple systems involving multiple actors" (Lotz-Sisitka et al., 2015, p. 74). I aimed to achieve this by engaging with multiple 'nexes of practice' within the particular landscape of practice of the WLT-CC. I aimed to engage with individuals who share an interest in the well-being of the western leopard toad but who engage in different practices, work in different institutions and have different perspectives of the WLT-CC and its operations. It is important to hear everyone's voice in order to understand both the micro and macro views of the committee's role and functionality in protecting the western leopard toad species.

The research was designed to be responsive to ontology, that is, how reality is understood. Bhaskar (2008) argues that the "central paradox of science" (p. 11) is that there are two sides to knowledge. Firstly, he highlights that humans produce knowledge as a social product through the engagement of social activity, similarly to how craftsman and technicians produce books or motor cars; secondly, he acknowledges that knowledge is 'of' things that are not produced by humans at all and do not depend on social activity (Bhaskar, 2008). This study takes a realist position that some things exist regardless of human knowledge and experience of them (for instance, the existence of the western leopard toad as a species adapted to a specific habitat is not dependent on people knowing about or observing them) but that this is conditioned by the actions of human agents according to their knowledge, experiences, values and motivations (for instance, local residents encounter western leopard toads – they hear their calls and see them crossing the road – and this creates possibilities for people to respond in certain ways to the toads). I was therefore interested in understanding the mechanisms that have caused things to be the way they are. Mechanisms are "the ways of acting of things" (Bhaskar, 1978, p.14) that are connected and combined to cause various events to occur. Easton (2010) explains

how mechanisms "are at the heart of causal explanation" (p. 122) and when activated they can produce various causal effects. Within the critical realist approach, mechanisms can "offer a rich source of explanatory devices" (Easton, 2010, p. 122) for what is occurring in reality.

O'Donoghue, Lotz-Sisitka, Asafo-Adjei, Kota and Hanisi (2007) argue that current sustainability perspectives should recognise a more diverse socio-cultural worldview and that certain social constructivist notions of learning do not account for robust learning, praxis and "reflexive human agency" (p. 436). The authors argue that transformative learning is created through situated processes of reflexive learning around various tensions, discontinuities and risk with and between local multi-actor groups (O'Donoghue et al., 2007). Examples of such reflexive processes of social change include: becoming aware of a local concern or problem; and seeking responsive learning interactions and social processes needed for such an emerging concern (O'Donoghue et al., 2007).

Through this research, I aimed to identify and explore a range of "social processes of reflexive learning interaction" (O'Donoghue et al., 2007, p. 437) by looking at contextual praxis (interactions between practice and theory) within the case of the WLT-CC. Transformative critical research requires historical, contextual depth. Therefore, as a researcher, I had to consider what type of data to gather and engage with. O'Donoghue et al. (2007) utilise a contextual praxis framework to gain insights into people's practices and activities. Firstly, they look to engage with the 'socio-historical context', which gives insight into the 'who' and the 'where'. Secondly, they look at 'emergent local imperatives', which highlight 'why' things are done and the motivations behind them. Thirdly, they look to explore the learning activities which give insights into 'what' is currently being done and 'how'. Lastly, they consider a stage of "reflexive consideration of possible change" (O'Donoghue et al., 2007, p. 437), which explores the 'for what' aspect. These 'emergent and intermeshed processes' informed the processes of data generation, analysis and reporting in this particular case study.

This research aimed to be praxis-orientated by collecting data that highlights how the WLT-CC has operated over time (exploring the socio-historical context) and identifying who is engaged in what aspect of the landscape of practice. It identified why people take certain actions and participate in particular practices around the

shared interest (understanding local motivations) and how they negotiate boundaries through knowledge production and learning processes. Identifying these "co-engaged forms of knowledge production and pedagogy" (Lotz-Sisitka et al., 2015, p. 75) can assist in re-thinking learning approaches and potentially decolonising environmental pedagogy. For this study, I was therefore interested in transformative, transdisciplinary and praxis-orientated learning shaped by reflexive social learning between multiple 'nexes of practice' in the WLT-CC landscape of practice.

3.3 Qualitative Case Study

A case study methodology provides appropriate tools to study complex phenomena to "enhance understanding of contexts, communities and individuals" (Hamilton & Corbett-Whittier, 2012, p. 3). According to Yin (2003), if the aim of a study is to answer 'how' and 'why' questions of a specific phenomenon and the researcher wishes to understand a specific contextual condition that is relevant to the phenomenon being explored, then a case study approach is an appropriate method (as cited in Baxter & Jack, 2008). Using a case study is beneficial if you are seeking to answer a question that looks to explain links in real-life that are too complex for survey or experimental strategies (Baxter & Jack, 2008). When looking to explore, describe or explain findings, a case study with multiple data sources ensures that the issue under investigation is not explored narrowly but rather a variety of lenses, which highlight multiple facets of the addressed issue (Baxter & Jack, 2008).

This study sought to explore 'how' social processes occurred within and between multiple 'nexes of practice' in the specific case of the WLT-CC and whether they enhanced collaboration and learning, which has not yet been fully understood in the context of a community-driven citizen science initiative. My aim was to understand the committee and their work at both a macro and micro level over time, obtaining rich, in-depth detail from participants who are involved in multiple areas of the cause so that I could fully capture "the complexity of case" (Hamilton & Corbett-Whittier, 2012, p. 11). I used a variety of data collection tools (interviews, observations and document analysis) from different perspectives (educator, volunteer/citizen scientist, researcher and conservationist) to provide rigor and depth of data collection to ensure the topic of interest was well explored (Hamilton & Corbett-Whittier, 2012).

It is important to note, however, that case study research can be lengthy and requires

exploratory work over time. In this case study, qualitative data was generated over a ten-month period to provide scope and depth. Due to the specificity of case study research, findings are not usually generalisable; however, I do anticipate that the insights from this study and the recommendations for social protocols for the WLT-CC may stimulate reflections and innovations in other citizen science initiatives as well as projects that have multiple entities working around a shared interest. This is argued by Hamilton & Corbett-Whittier (2012) who suggest that the case study, although bounded, "involves interactions, communications, relationships and practices between the case and the wider world and visa-versa" (p. 11).

3.4 Research Context and Data Generation Sites

As explained in Chapter One, the western leopard toad is an endangered species that resides in sporadic breeding sites around the Cape Town Metropolis. Due to the nature of its habitat, members of the WLT-CC operate from vastly spread out areas and convene at least twice a year (once before the western leopard toad breeding season and once afterwards) in a location that is convenient for all.

The research was conducted (between 15 November 2017 and 5 October 2018) with a group of individuals who voluntarily represent different professional sectors but sit on the same committee that aims to monitor and protect the western leopard toad. These individuals joined the committee at different times since 2007 and have varying levels of participation. Due to the complex nature of the landscape of practice, data was collected from the various sites indicated in the figure below (Figure 3.1). The image represents the Cape Town Metropolis and where each data source was collected in relation to the western leopard toad breeding sites (the black circles). The red numbers (1–3) and the purple numbers (1–5) indicate where the observations and interviews were conducted, respectively. Each committee member who was interviewed or observed and each data generation method utilised and analysed will be explained in Section 3.5.

3.5 Data Generation Schedule and Methods

In this study, a range of data methods and accounts from multiple sources was used for generating a multifaceted dataset to address the research questions. According to Ryan (2006), using a "range of explanatory devices" (p. 104) maintains the reliability

of the data but also allows researchers to explore more than just one person's perspective and their 'facts' or view on the situation. Ryan (2006) highlights that using various illustrative strategies allows a researcher to "draw on generalised conclusions rather than conclusions pertaining to individuals" (p. 104). This assists researchers to attend to the issues at hand "without passing judgment on the individual who offers the account" (Ryan, 2006, p. 104).

A data generation schedule (see Appendix A) was created that spanned from November 2017 (the end of the western leopard toad's 2017 breeding season) to October 2018 (the end of the western leopard toad's 2018 breeding season). Over the year, I scheduled five semi-structured interviews with multiple members from the

Key	
Black circles	Breeding sites
Red numbers (1–3)	Observations conducted (number 3, occurred over 3 months)
Purple numbers (1–5)	Interviews conducted

Figure 3.1: Map of the Southern Cape Peninsula indicating data collection sites. The western leopard toad breeding areas are spread across the Southern Cape Peninsula (indicated by black circles). Interviews (purple numbers 1−5) and observations (red numbers 1−3) were conducted at various geographical positions within this Landscape of Practice. (Adapted from Google, n.d).

WLT-CC, conducted three observations and viewed multiple documents for analysis. The data generation schedule highlights what methods were used, when they were used, who was involved and their position related to the WLT-CC, the place the data was collected, how the data was recorded and saved and the reason for the interview or observation.

As mentioned above, the methods I chose to generate data within this case study were semi-structured interviews and observations. I also gained valuable insights from documents (meeting minutes of the WLT-CC) to gain socio-historical information as well as information about current social processes occurring. Through these chosen methods, I aimed to gain a broad understanding of the landscape of practice through personal, professional, local and national accounts within the case study.

3.5.1 Semi-structured Interviews

An interview is a conversation or a means of collecting dynamic talk, which provides a way of measuring what people know according to a specific context or situation (Euvrard, 2017). I chose semi-structured interviews as a method in this case study because it enabled participants to give an in-depth idea of their context as well as to "bring a plurality of experiences and perspectives into learning interactions around the focal concern being addressed" (O'Donoghue et al., 2007, p. 445). I interviewed five members of the WLT-CC between 15 November 2017 and 1 May 2018. These were: 1) two ACs/local experts: 2) the committee head/SANBI researcher; 3) a CoCT representative for nature conservation; and 4) an intern who coordinated practice during the set up and development of the WLT-CC. These interviews assisted me to contextualise and map out the social structure of the WLT-CC, guided me on who to interview next, and identified if and how the various 'nexes of practice' co-engage. The five semi-structured interviews took place in various locations around Cape Town. As highlighted in Figure 3.1, the purple numbers 1–5 represent the order in which I interviewed each committee member and where they were based in relation to one another and the western leopard toad breeding sites. This is an interesting visual representation of how individuals in this landscape of practice were geographically spread out. This unique scale and location of participants provides both scope and far reaching possibilities for the protection of the western leopard toad species but can also create various boundaries that the participants are required to negotiate.

Table 3.1 provides insight into how the interviews were conducted and the contributions they provided to the study. A clear interview schedule was drawn up and used, with semi-structured questions prepared in advance to assist in answering the research questions (see Appendix B). The questions remained the same for all the interviews in order to distinguish any similarities or differences across the landscape of practice. Due to the semi-structured method, as the researcher, I could rephrase, repeat or reorder questions where appropriate, according to the dynamics of the interview process (Euvrard, 2017). It is important to mention that all conversations inevitably have bias, which must be recognised and controlled for (Euvrard, 2017), as each person's perspective is unique, subjective and offers slightly differing accounts of reality. Therefore, in order to mitigate bias and provide a variety of perspectives in the interview conversations, I organised interviews with multiple members of the WLT-CC representing different positions on the committee in relation to the western leopard toad species to provide a multifaceted reflection of all the 'nexes of practice' within the landscape.

At the end of each interview, each interviewee was asked to sketch a visual representation of the landscape of practice on a piece of paper, indicating the various members of the WLT-CC, the multiple roles and stakeholders involved and any links or interrelations they have within or between one another. Each interviewee created a different organogram that represented their perspective of the landscape and discussed it in detail throughout the processes.

3.5.2 Observations

I conducted three observations in various locations around Cape Town (see Figure 3.1). The red numbers 1–3 represent the order in which the observations were conducted, noting that observation three was conducted over a three-month period. Again, Figure 3.1 demonstrates where each observation occurred in Cape Town in relation to the others and in relation to the western leopard toad breeding sites.

The observations were unstructured, non-participatory observations (Hannan, 2006). Each observation aimed to understand how knowledge is produced and shared as well as what social processes were informing practices and negotiating boundaries. Table 3.2 provides insight into how the observations were conducted and the contributions they provided to the study.

Table 3.1: Summary of interview data collection. Interviewee details and the purpose of each interview are given. Interview number corresponds to a geographical location given in Figure 3.1.[3]

Interview number	Position/title of interviewee	Purpose/contribution to the study	Index used
1	Area coordinator and a founding member of ToadNUTS and SPOTS volunteer group	This interview provided a micro understanding within the specific volunteer 'nexus of practice', informed other valuable interviews and provided a macro understanding of the WLT-CC work as a whole.	INT_1; (AC1)
2	Area coordinator and founding member of KirMiTS volunteer group, researcher and WLT-CC secretary	This interview provided insight into another perspective from volunteer practices but also an overall understanding of how research and volunteer practices overlap, intersect or lack connectivity.	INT_2; (AC2)
3	WLT-CC chairman, botanist and researcher at SANBI	This interview helped explore ideas of research practices and how they relate to the WLT-CC and the western leopard toad species. It also aimed to understand if and how information was reported, shared and fed back to the WLT-CC for decision-making.	INT_3; (CC1)
4	Senior Environmental Professional from Biodiversity Management Branch representing the City of Cape Town Environmental Management Branch	Highlighted various conservation practices that are involved from the City's perspective and what line functions are involved on a micro and macro level both locally and regionally in order to protect the western leopard toad species.	INT_4; (CT1)
5	Intern with the WLT-CC (2008 & 2009); WLT-CC volunteer and coordinator (until 2014)	Illustrated what engagement occurred on the WLT-CC and what a convening role provides in terms of coordination and convening at a macro level.	INT_5; (CO1)

[3]*The designated index is used for later reference to each interview. SPOTS: South Peninsular Toad Savers; ToadNUTS: Toad Noordhoek Unpaid Toad Savers; AC: Area Co-ordinator; WLT-CC: Western Leopard Toad Conservation Committee; SANBI: South African National Biodiversity Institute; KirMiTS: Kirstenhof to Muizenberg Toad Savers; CC: Committee Chairman; CT: Cape Town representative; CO: Co-ordinator.*

Table 3.2: Observation schedule. Details of the observation data collected are given. Observation number corresponds to a geographical location given in Figure 3.1.[4]

Observation number	Observation, site and date	Participants	Contribution of observation	Index
1	WLT-CC post breeding season meeting, Tokai conservation centre, Cape Town. (08 December 2017)	WLT-CC members (Chairman, area coordinators, researchers and conservationist representatives)	This observation provided insight into how the WLT-CC shared information, what forms of co-engagement occur and what boundaries they come across and negotiate.	OBS_1
2	ToadNUTS information session and recruitment presentation, Noordhoek, Cape Town. (25 July 2018)	AC1 conducted the presentation with the help of AC3 to new and seasoned locals/volunteers	This observation highlighted how information was shared with locals, how the transfer of knowledge occurred within volunteer practices and what social processes were needed to engage and motivate locals to be involved.	OBS_2
3	KirMiTS volunteer WhatsApp group. (July−September 2018)	AC2 manages this platform with volunteers from Kirstenhof to Muizenberg during the breeding season	This observation offered insight into the workings of a specific volunteer group on the ground saving toads, collecting data and taking action to protect the species. This provided evidence of what social processes and knowledge sharing were occurring between volunteers, their actions and how the AC managed the group.	OBS_3

[4]*The designated index is used for later reference to each observation.* ***T****oadNUTS: Toad Noordhoek Unpaid Toad Savers; AC: area co-ordinator; WLT-CC: Western Leopard Toad Conservation Committee; KirMiTS: Kirstenhof to Muizenberg Toad Savers; OBS: Observation.*

3.5.3 Document Analysis

Document analysis is a systematic procedure for examining data from both printed and electronic material. When reviewing and examining documents, I aimed to understand, elicit meaning and find out more information about the object of my study (Bowen, 2009). The official WLT-CC minutes were used as a primary source of data and were carefully analysed in relation to the research questions. The WLT-CC committee meeting minutes were gathered from 2009 to 2018. These provided evidence of changes in practice, communications and methods of co-engagement over time. Document analysis was further used to examine and triangulate the interview and observation data to corroborate findings across data sets and create credibility for the study (Bowen, 2009).

As mentioned in 3.5.1, the visual maps created by each interviewee provided documentation of the landscape of practice from multiple perspectives in order to understand who does what and who the main role players were and provided a foundation on which a macro comparative analysis was conducted (see Appendix C).

As mentioned in 3.5.2, the WhatsApp group observations (see Table 3.2) provided valuable documentation of how one specific volunteer group operated in various capacities. I printed out transcript documents from the group chat form the beginning to the end of the volunteer season and analysed these documents with various theoretical lenses to provide multiple insights into what social processes, boundaries and practices occurred between the volunteers in the specific local context.

3.6 Data Management

To effectively manage and safely store the case study data, I backed up all the work electronically on multiple hard drives and created a specific Google Mail account in order to send myself data that I collected and archive important readings, documents and draft chapters. I scanned all hard copy data and saved these electronically. Additionally, I printed and filed hard copies of electronic documents. All interviews and observations were recorded with two devices (a digital audio-recorder and a cellular phone) and all the recordings were stored digitally and transcribed for a hard copy paper trail and subsequent data coding. This is to ensure that all material was safe, secure and confidential for up to five years in case it is required.

The use of multiple data generation tools, such as two audio-recording devices, note taking and interview and observation schedules as well as data generation methods, such as drawings of landscape of practice maps and minutes sent to me after each meeting, improved the accuracy and rigor of the data from which I developed my conclusions (Hannan, 2006). Additionally, I maintained a reflexive research journal through the data generation and analysis processes. This enabled me to record information about the data, the importance of each piece of data and the reasoning behind each interview and observation. It allowed me to brainstorm the data arrangement and explore evidence that was not apparent at first, which became valuable during the analysis of the data.

I indexed the data to provide accessible links to it when presenting the discussion in Chapters Four and Five. An inventory of data indexing and a description of the data source are highlighted in Appendix D. This provides a data trail of where the data evidence was sourced. The index code, which appears in-text, is given in Appendix D. The index reflects the data source first and secondly, the page number or the speaking turn from which the data was extracted.

3.7 Data Analysis

3.7.1 Phase One: Initial Contextual Profiling and Social Mapping of the WLT-CC

I aimed to interview a key figure from within each 'nexus of practice' (see Appendix C): education, research, conservation and volunteering/citizen science. However, through my initial social mapping exercise (asking each interviewee to sketch their perspective of the landscape/WLT-CC), I realised that defined 'nexes of practice' are not as clear-cut and separate as I thought. Rather, there are multiple perspectives *within* each 'nexus of practice' that overlap different professions, interests, skills and expertise. The implications of this insight for understanding the landscape of practice and the social processes and knowledge production between each nexus are discussed further in Chapters Four and Five. I analysed the landscape of practice maps to gain a broader perspective of roles and interrelations within the landscape. I looked at similarities and differences between the maps and, guided additionally by the interviews, observations and documents, I was able to construct a comprehensive

contextual profile, locate key informants within the landscape of practice and identify evident social processes.

3.7.2 Phase Two: Thematic Analysis Using Analytic Memos

After achieving a rigorous contextual profile and having identified general social processes within and between the 'nexes of practice' from the landscape of practice maps, I needed to analyse each data source from a theoretical perspective. Therefore, in the second phase of analysis, I drew on concepts and perspectives from the study's context and the theoretical and conceptual framework (as described in Chapter Two) to provide a thematic analysis and address the research questions. I collected various narratives from the participant's experiences and viewpoints through interviews and created thematic descriptions according to theoretically derived categories and codes that emerged from the data. Maxwell (2012) explains that coding and categorising themes from the data are strategies that can help identify similarities and differences in perspectives across multiple sources.

I was able to collect, collate and code my data by labelling and grouping the interviews, observations and documents into segments, which were then "examined and compared, both within and between categories" (Maxwell, 2012, p. 110). For example, I examined what social processes and boundaries were evident in the WLT-CC as well as what knowledge was being created and shared within and between each entity. Maxwell (2012) highlights that this process helps reorganise the original structure of the data and recontextualises it according to the context of the research topic. At the same time, I made sure not to isolate the data into predetermined categories and reflexively created new categories as they emerged out of the data to prevent a narrow perspective.

While transcribing the interviews and observational audio data and reading through the minutes, I began to identify themes and broad ideas in the data. I listened to what was being said, considered what was *not* being said, identified key points (recording the time it was said in the audio file to identify where I heard it) and highlighted why it was important to my study. I then recorded what key category it may fall under and what research question it gave insight into. Each data source provided slightly different insights and perspectives, some providing a macro-perspective, a broad observation across the whole landscape of practice, taking into account all areas of

practice (like M1-9 and OBS_1), and others a micro-perspective, a more specific observation within the landscape of practice, looking particularly at one area of practice (like OBS_3 and INT_1-5).

To understand each data source, the perspective that it gave and its contribution to the research questions, I analysed each data source with a separate analytical memo. An analytic memo is a tool that assists in the analysis and reduction of data and is used to connect analytic strategies across data sources (Maxwell, 2012). For example, an analytic memo identifies "key relationships that tie the data together into a narrative or sequence, and eliminat[es] information that is not germane to these relationships" (Maxwell, 2012, p. 115). An example of this analytical strategy is how I compared the data across the analytic tools from different data sources. Appendix E is a portion of a memo created to analyse two different observations through the same theoretical lens. Appendix F is one of three analytic memos used to help reduce, compare and analyse the WLT-CC minutes and focus the information through the theoretical framework needed to answer the research questions. Appendix F specifically looks at examples of boundaries and potential learning emerging from the data.

As Bazeley (2009) argues, there can be problems with merely naming and presenting broad themes that emerge from the data and suggests rather that researchers describe, compare and relate when working through and recording results in data analysis. I aimed to achieve this by firstly describing what I observed from each source of data, outlining context and providing details such as interrelations between identified features, background and other characteristics that were important to the study. Secondly, I used my analytic memos to compare differences across the multiple data sources and relate important emerging themes or categories. I asked, for example: Where are boundaries emerging between practices? Are there similar social processes in different areas of the landscape of practice? Where are there meaningful associations? Lastly, Bazeley (2009) recommends that the theme or category must be related to other themes that have already been written about. Once questions such as "What actions/interactions/strategies are involved?" are asked, the structure of the data develops and the analysis converges on an "integrating idea, with arguments to support it drawn from across your completed (interim) analyses" (Bazeley, 2009, p. 10).

The data was analysed differently depending on each data source, using the above-mentioned categories, concepts and theories. Some of the categories emerged from the data, while others were guided by the theoretical and conceptual framework highlighted in Chapter Two. For example:

Categories emerging from the case-specific data

- Context identification (the WLT-CC landscape of practice)
- Practices involved in the WLT-CC landscape of practice (Educational, Volunteer/Citizen Science, Research and Conservation)
- Social processes such as forms of knowledge, knowledge-sharing, co-produced knowledge and learning.

Categories guided by theoretical and conceptual framework

- Areas of co-engagement namely co-diagnosis, co-design, co-act and co-evaluate (Armstrong, 2013)
- Boundaries in the landscape of practice such as complex practices, power dynamics, scale, time and complex institutions (Wenger-Trayner et al., 2015)
- System convenors such as coordinating committee members, the WLT-CC as well as information platforms (Wenger-Trayner et al., 2015)
- Areas of potential learning such as identification, coordination, reflection and transformation (Wenger-Trayner et al., 2015)

3.7.2.1 Analysis of Interviews

Due to the length, complexity and depth of discussion of each interview, five separate memos with the same structure covering the abovementioned categories were used to provide valuable insights across all perspectives. I analysed each interview using an analytic tool that I developed (see Appendix G). The identified categories that each of the interviewees spoke about introduced not only the landscape of practice but the interconnections between the categories, the challenges they face and how they have achieved co-engagement over the years. Using the same analytic tool for each interview allowed me to explore the variation of each interview. I then worked across all five interviews, focusing on one analytical category at a time, to find evidence of what was occurring across the multiple 'nexes of practice'. Evidence of the data from the interviews is clear in the narrative presented in Chapter 4, referenced by the use of interview number (INT_1−5) and speaking turns.

3.7.2.2 Analysis of Observations

Due to a similar organisational structure (many participants being observed and recorded from an outsider's perspective), one memo was used to analyse both OBS_1 and OBS_2 (see Appendix E). This provided a simultaneous analysis from a macro perspective (the WLT-CC meeting with all participants) and a micro perspective (one specific volunteer group's information and recruitment session) within the same analytic memo that identified the following categories:

- complex 'nexes of practices' within the landscape of practice;
- forms of co-engagement;
- knowledge and information being discussed;
- boundaries or challenges experienced and sites of potential learning.

3.7.2.3 Analysis of WhatsApp Group Transcript and WLT-CC Meeting Minutes

The third observation (OBS_3) was conducted over a three-month period (June to September 2018) with the KirMiTS volunteer group by 'observing' the everyday interactions as the practices were unfolding over their WhatsApp group. However, the main analysis was of the transcript of the WhatsApp group communications. Therefore, OBS_3 is a combination of an observation and document analysis as both forms of analysis were beneficial in contributing towards the WhatsApp data analysis and narrative. The analysis of this document highlighted speaking turns of each person's comments as it was posted on the cellular phone application and included attachments for viewing (such as images, emojis and videos). The transcript was analysed in three stages using three different lenses, with a separate analytical memo for each (see Appendix H).

Similar to the WhatsApp data, the nine WLT-CC meeting minutes (collected between 2009 and 2018) were analysed three times with three lenses and summarised in different memos. The minutes were analysed in three stages using three different lenses, with a separate analytical memo for each (see Appendix F). The categories identified in each analytical memo for both the WhatsApp transcript and the WLT-CC meeting minutes are highlighted in Table 3.3.

3.8 Ensuring Validity and Trustworthiness

Brinberg and McGrath (1985) highlight that, in qualitative research, "validity is like

Table 3.3: Description of categories analysed from document data sources.[5]

Memo	Data source	Index	Categories identified
1	WhatsApp transcript	OBS_3 M1	Identified multiple 'nexes of practice', the roles they play in protecting the shared interest and the interconnectivity between them, for example, volunteer/citizen science practices, research practices, conservation practices, educational practices and private/institutional practices.
1	Minute documents	M1-9 M1	
2	WhatsApp transcript	OBS_3 M2	Identified social processes, such as forms of knowledge, knowledge sharing, co-production of knowledge and areas of co-engagement.
2	Minute documents	M1-9 M2	
3	WhatsApp transcript	OBS_3 M3	Identified boundaries faced by the WLT-CC, such as miscommunication, lack of knowledge, lack of scientific protocols, capacity issues and complex institutional practices.
3	Minute documents	M1-9 M3	

integrity, character, and quality, to be assessed relative to purposes and circumstances" (p. 13). In this section, I describe the measures taken during the study to ensure that data and subsequent findings are as rigorous and trustworthy as possible. This involved attending to issues and strategies, such as accounting for multiple perspectives within a bounded case, triangulation of data, researcher positionality and highlighting the various validity checks that Maxwell (2008) encourages researchers to examine.

3.8.1 Multiple Perspectives in a Bounded Case Study

Considering multiple perspectives within a bounded case study was critical for my understanding of the multiple 'nexes of practice' in various locations in the landscape of practice. It was important to acknowledge the macro and micro socio-cultural and social-ecological contexts to create a valid picture through accurately providing scope and focus. I therefore ensured that all aspects of the WLT-CC were equally and accurately explored by involving participants from all areas of the landscape of

[5]*The designated index is used for later reference to the analysis process. M: minutes; OBS: observation; WLT-CC: Western Leopard Toad Conservation Committee.*

practice, taking heed of Wenger-Trayner et al.'s (2015) insight that no single component of the project can claim to represent the entire landscape. By using a bounded case study, I understand that not all accounts of an individual activity, the institution or programme can be "equally useful, credible, or legitimate" (Maxwell, 1992), but rather that there are multiple accounts and perspectives within the case study I observed.

3.8.2 Validity Checks

Maxwell (2008) explores strategies that can be used in qualitative studies that aim to address validity threats and increase the credibility of data collection, analysis and conclusions. Here, I examine the validity checks that are applicable to my research study. Firstly, Maxwell (2008) writes about the role 'rich' data plays in increasing credibility. He states that data that are varied and detailed can provide a "full and revealing picture of what is going on" (Maxwell, 2008, p. 244). For example, the use of notes, audio and detailed transcription in my interviews and observations can create a 'rich' data product "of the specific, concrete events that you observe" (Maxwell, 2008, p. 244) across the context. This is similar to what Maxwell (1992) explains as 'descriptive validity', which aims to increase credibility of data through creating accurate recordings and descriptions of what is occurring. I achieved this through my data collection phase (audio recordings, landscape of practice map drawings, observations, taking notes, email correspondence) and by keeping records of everything I did in a research journal.

Secondly, Maxwell (2008) writes about 'respondent validation', which is similar to what Lincoln & Guba (1985) refer to as 'member checking'. This is valuable in combating validity threats as gaining feedback from the study participants can assist in "ruling out the possibility of misinterpreting the meaning of what participants say and do" (Maxwell, 2008, p. 244). This is what Maxwell (1992) describes as 'interpretive validity', which suggests that research should reflect not only the researcher's point of view but also the language, words and perceptions of the research participants. These could include conscious and unconscious "intention, cognition, affect, belief, evaluation and anything else that could be encompassed" (Maxwell, 1992, p. 288). To this end, I used direct quotations from the interviews to represent the participants' voices as accurately as possible. I also requested each

participant to draw their own representation of the WLT-CC landscape of practice in an organogram (see Appendix C), which illustrated and reflected what they had explained to me in the interview. In October 2018, I presented my research goals to the WLT-CC and allowed the people representing the different 'nexes of practice' in attendance to ask questions, make comments and give insights into the research process and rationale. I created the opportunity in order to be transparent about the study's aims and to allow participants to review the process, comment on whether they regard it to be accurate or a misinterpretation and to identify gaps or inaccuracies in representing their initiative and committee.

Thirdly, Maxwell (1992) writes about 'theoretical validity' and how data analysis "goes beyond [the] concrete description and interpretation and explicitly addresses the theoretical constructions that the researcher brings to, or develops during, the study" (p. 291) to provide an explanation of the phenomenon. It is important to consider that analysed data is not "independent of the researcher's perspectives, purposes, and theoretical framework" (Maxwell, 1992, p. 292). This encourages researchers to be aware of their own positionality and biases during the research process.

Maxwell (2008) similarly explains that it is important to understand the ways in which "data collection or analysis are distorted by researchers' theory, values or preconceptions" (p. 243). Prior to and during the research process, I made my experience and vested interest in the project and WLT-CC explicitly clear to the participants. I explained the reasoning behind the study's aims and my intentions for working with the WLT-CC. I took each of the interviewees through a consent form (see Appendix I) prior to the interview that explained my research objectives and, at each observation and committee meeting I attended, I was introduced by a member of the committee and consent was given for me to observe the practice. In order to maintain rigor and reliability, it was important for me to understand my own positionality, biases and assumptions that could compromise the accuracy and validity of the data and the overall findings. I acknowledged that I have been guided by theories and concepts, as well as values that I have advanced through my experiences in community-based conservation and project management, having worked before with multiple stakeholder groups.

In order to plan for rigorous and fair research that encompasses multiple viewpoints as well as my own as the researcher, Diefenbach (2009) recommends the processes of

'triangulation', which is the collection of accounts from multiple sources (different people, places and times) using different methods (interviews, observations and document analysis). Leech and Onwuegbuzie (2008) suggest that triangulation goes beyond the use of multiple data generation methods and tools, using multiple data 'analysis' tools too. In this study, I applied 12 analytical memos to multiple data sources, allowing me to interpret the data using different lenses and at different scales.

Maxwell (1992) highlights the validity issue of 'generalisability', or what Guba and Lincoln (1989) refer to as 'transferability'. Maxwell (1992) suggests that there is a limit to which "one can extend the account of a particular situation or population to other persons, times, or settings than those directly studied" (p. 293) and explains "qualitative studies are usually not designed to allow systematic generalizations to some wider population" (p. 293). However, representativeness and generalisability can be beneficial whenever one "wants to draw inferences from the actual persons, events or activities to other persons, events, or situations" (Maxwell, 1992, p. 293) in a similar context or social structure. For example, comparison in multi-site contexts like the WLT-CC can assist in identifying similarities and differences in practices and challenges that occur for different stakeholders across the landscape of practice. Maxwell (2008) argues that "single case studies often incorporate implicit comparisons that contribute to the interpretability of the case" (Maxwell, 2008, p. 245) and can give insight as to how other contexts similarly operate.

3.9 Research Ethics

In this final section, I reflect on the values and ethical considerations of relevance to this case study and report on the steps I took to ensure that the research was conducted ethically. Where possible, I narrate these steps chronologically from the point of negotiating access to the study sites to representing the research findings and sharing them with the wider field. Key influences in my thinking were McGarry's (2017) 'Morally Intuitive Ethical Guide', the Rhodes University Ethics Handbook (RUESC, 2014) and authors Wiles (2012), Oliver (2010) and Israel & Hay (2006). I consider the values that guide research behaviours and examine what ethical considerations need to be reflected upon during the research process. As Oliver (2010) suggests, research is not sequential or linear; therefore, researchers are required to consider a diverse set of issues, such as ethics, which "arise at different

stages of the research process" (p. 26) and must be dealt with prior to, during and after the data has been collected.

3.9.1 Ethical Considerations Prior to Research Commencing

3.9.1.1 Research Design

I designed my study in such a way that ethical decisions would be made "on the basis of care, compassion and a desire to act in ways that benefit the individual or group who are the focus of research" (Wiles, 2013, p. 5). An example of this was communicating with each participant via email prior to the interviews and observations and inviting each of them to engage in the research processes (see Appendix J). This invitation explained the study in detail and allowed each participant to accept or decline from a position of knowing what the study involved and required. This document also explained that each participant had the right to withdraw from the study at any point. This research design was intended to highlight my integrity as a researcher from the start of communications and motivate professional behaviour that would help to build a "climate of trust" (Israel & Hay, 2006, p. 3) in which I would continue the research process.

3.9.1.2 Procedures for Identifying and Recruiting Potential Participants

Ethics is important when deliberating research questions, research design, data collection methods and sampling strategies of participants who provide data (Oliver, 2010). There was no linear structure to selecting participants as I was initially unsure of all the role players in the landscape of practice. Therefore, to let the landscape of practice 'speak for itself', the selection criteria for the data collection process occurred organically. I started with one AC and committee member and then, using a snowball sampling technique, I was guided by each individual to identify other key individuals and components of the initiative to include. Concurrently, I spent time in the WLT-CC meetings and observed who the role players were and what insight they were able to give me towards understanding the landscape of practice and its processes. Depending on who the WLT-CC members guided me to speak to, I arranged further interviews and listened to their perspectives on their specific nexus of practice as well as their view of the landscape of practice. This was a flexible process that enabled me to identify and recruit participants in a more informal

manner. This process allowed me to listen and understand the landscape without a prescribed structure or schedule.

3.9.1.3 Informed Consent and Anonymity

Once the participants were identified, it was important to provide them with clear information regarding what participation in the study would involve and give them the opportunity to decide whether they wanted to participate or not (Wiles, 2013). It is important to always consider and be sensitive to the complexities and diversities of the social context and respect the participants' involvement (McGarry, 2017). To allow participants to fully comprehend the nature of the study and voluntarily agree to the role they would play (Israel & Hay, 2006), I provided each interviewee with a consent form (Appendix I) prior to them partaking in the research. This was to provide participants with relevant "information about the purpose, methods, demands, risks, inconveniences, discomforts and possible outcomes of the research" (Israel & Hay, 2006). Once this document was explained, and the participants agreed with the parameters of the study, they were encouraged to sign it to assure that all parties were content with the agreed terms before proceeding with the study.

Researchers can protect participants' confidentiality through anonymisation, "which occurs through the use of pseudonyms applied to research participants, organisations and locations" (Wiles, 2013, p. 7). The consent form highlighted that participants were to be offered anonymity and confidentiality; however, the research would be shared within the university department and published publicly. I explained that I would remove their names from the research; however, it was not entirely possible to remove the roles people played and their functions related to the WLT-CC, which were important to include. For example, the chairman of the WLT-CC is also a researcher at a well-known organisation who many people know of. Therefore, I extracted all members' names but kept their roles and gave each participant a code, such as CC1, CO1 and AC2 (see Table 3.1 and 3.2). Each participant was aware that their anonymity could be compromised if people encountering the research knew the identities of people holding the relevant public positions. Nonetheless, each research participant voluntarily agreed to participate.

3.9.2 Ethical Considerations During the Research Process

3.9.2.1 Creating the Space to Share

The data generation phase of research inevitably brings about complex interactions between researchers and participants, which can involve predicted or spontaneous ethical issues and decision making (Oliver, 2010). Therefore, it is important to create a "reflexive, empathetic, imaginative and caring space" (McGarry, 2017, p. 4) from which the research can develop further, by including the participants in the process. I tried to achieve this by meeting each of the interviewees in a space that they chose and informally conversing with them through semi-structured questions. The questions were designed to allow the participants to share their viewpoints and let them lead the description of their context and experience. After conducting the interviews and observations, I made a presentation to the WLT-CC on the research progress. This opportunity to share information, solicit feedback and invite questions created a reflexive space within the WLT-CC.

3.9.2.2 Fair Representation

McGarry (2017) speaks of the "ethical obligation and 'response-ability' to share and transform the narrative democratically" (p. 4). It is the responsibility of the researcher to ensure that the process of gathering and sharing the information gained serves the common good and represents the participants fairly. For the participants to feel comfortable with an 'outsider' sitting in on their meetings, recording their conversations and taking notes of the dynamics between each component, it was important that the study and myself as the researcher were carefully introduced so that the participants felt at ease with my intentions. Before each observation, I was introduced by the member who invited me to join: CC1 welcomed me at the WLT-CC meeting (OBS_1); AC1 explained my research objectives at the information and recruitment session (OBS_2); and AC2 added me to the WhatsApp group (OBS_3).

There were various cultural, religious and gendered dynamics and power gradients within and between the multiple 'nexes of practice'. Therefore, as I collected and analysed the data, it became important to ensure fair representation by allowing multiple voices and perspectives to be heard and allow all aspects of the initiative to be reflected evenly and fairly. As mentioned previously, no one component of the WLT-CC reflects the entire initiative. Through the method of triangulation and understanding the scope and dynamics of the project through thorough social mapping, I was able to anticipate and respond to the multiple and sometimes conflicting perspectives. Due to participants expressing their personal opinions and

concerns regarding practices within the landscape of practice, various insights were gained into some of the boundaries that the WLT-CC face. Some of these issues contradicted one another and shed light onto what could be done better or what was not being done. Wiles (2013) explains that researchers are frequently required to balance out "the quality of their research with the ethical treatment of their research participants" (p. 80) and must make various ethical decisions accordingly. Representing each participant and their viewpoint fairly without implicating another member due to their comments was challenging and I had to make careful considerations in resolving this ethical issue. The actions I took were to stay present with the 'trouble', remaining "devoted to what [I was] hearing, seeing and feeling" (McGarry, 2017, p. 5) in order to reflect on what was occurring in the landscape of practice. If the comments didn't directly relate to the study's aims and research question, although they were valuable points, I did not include them in the analysed data set. In the case where they did assist in giving evidence towards the study, I paraphrased the evidence without using the participant's role or pseudonym directly.

3.9.2.3 Researcher Positionality

My role as a researcher and my positionality in this study was motivated by a combination of factors. My objectives were to learn more about the field of environmental education, add to knowledge in an area of community-driven citizen science initiatives and better understand the social processes that occur in multi-entity organisations. After studying environmental education through the WESSA and leading high school and university students on multiple volunteer projects, I began working as a project manager of various community and environmental projects around South Africa and helped set up and manage programmes that work with social-ecological challenges, data collection and citizen science. This work inspired me to become more involved in combatting local issues at the human-wildlife conflict interface. I became interested in how multiple stakeholders are involved in protecting natural resources and what social processes and learning can assist in the sustainable management of such projects. I have worked with diverse 'host organisation' teams who run on-the-ground programmes across South Africa. We have worked together to set up, develop and monitor scientific and social protocols for projects to run successfully. My intentions for this study, therefore, were to observe and understand how an initiative, which has been in operation for over a decade, has managed to

function with multiple ‘nexes of practice’ around a shared interest and goal and what learning and social processes assist this functionality. I aim to take my research experience and findings back into my field of interest where I can have a greater awareness of how multi-agency organisations and initiatives function and what support structures and processes need to be nurtured to overcome boundaries that the landscape of practice may face.

My positionality and work interest needed to be clarified to the WLT-CC for my intentions for the study to be clear and for expectations to be accurately set. I explained to each interviewee and member of the WLT-CC through email and an invitation to participate in the research that my study was purely observational and that my intention was not to change or transform their practice but rather to describe what was occurring in the landscape of practice. However, the findings that would come from the study would be shared with them and could potentially be used to inform their future practice.

3.9.3 **Ethical Considerations After Data Collection**

3.9.3.1 Avoiding Harm and Doing Good

In the social sciences, harm more than likely involves “psychological distress, discomfort, social disadvantage, invasion of privacy or infringement of rights” (Israel & Hay, 2006, p. 96) rather than actual physical injury. In order to avoid any harm to the WLT-CC while collecting data and disseminating findings, I aimed to reduce any risk of misrepresentation or distortion of research results that may have been to the detriment of the participants. This was done by using quotations from interviews, direct extracts from observations and allowing the participants themselves to draw their own representation of the landscape of practice. This allowed each individual’s voice to be heard and concerns were shared for the benefit of both the study’s aims and to create potential recommendations and findings for the WLT-CC to use.

3.9.3.2 Describing, Narrating and the Publication of Research

As I wrote up my research findings, I was aware of and acknowledged that I was using my own authority and privileges to narrate the story. I was able to observe the landscape of practice from a uniquely macro and micro perspective with prior understandings and experiences from my personal work experience and environment.

As Ryan (2006) argues, we as writers of research "are narrators, with our own points of view, and our own situated knowledges" (p. 107). As I worked through and analysed the data from this study, I recognised that I am a product of my society and culture (Ryan, 2006) and therefore was writing from a standpoint, extracting pieces of information from the data according to the research questions. In order to objectively narrate what was emerging from the data, I constantly reminded myself of the context that I was working with at a micro and macro level. I used a research journal alongside my memos to reflexively stand back, observe and narrate what was occurring and let the valuable data emerge organically rather than prescribe what needed to emerge.

Upon dissemination of information, McGarry (2017) suggests that the research "should present both academic and practical value" (p. 5), with attention paid to the "beneficiation and…value of the research" (p.5) not only to the field but also to the participants with whom the study was conducted. The data I generated and analysed aimed to respond to knowledge gaps in the academic field as well as provide social processes and recommendations that the WLT-CC could pursue or adopt, should they wish.

3.10 Concluding Summary

This chapter has explained the research design and structure and given a clear account of how the research was conducted. I discussed why a qualitative case study approach was chosen and explained the various data generation methods including semi-structured interviews, landscape of practice social maps, observations and documents. I highlighted how the analysis process used a two-phased approach to address the specific research questions highlighted in Chapter One. I discussed the management and indexing of the data, used as data trails for evidence. Lastly, I explained the steps taken throughout the research process to ensure and maintain ethical standards as well as how I upheld the validity and trustworthiness of the study.

CHAPTER FOUR: DATA PRESENTATION

4.1. Introduction

In this chapter, I present a thick description of the data: an in-depth contextual description of the data generation and analysis from Phases one and two. I begin the chapter by evidencing the various 'nexes of practice' within the landscape of practice of the WLT-CC. Next, evidence of the interrelations between each of the 'nexes of practice' and the work being achieved around the shared interest is presented, including various social learning interactions and processes regarding knowledge production and sharing, as well as forms of co-engagement. Lastly, the boundaries between the multiple 'nexes of practice' and the WLT-CC are described. This discussion provides a foundation for the analysis provided in Chapter Five.

4.2 Understanding the 'Landscape of Practice' of the WLT-CC

The WLT-CC 'Landscape of Practice' comprises multiple 'nexes of practice' that engage a shared interest including volunteering, conservation, education and research. They are not bounded but interact, interrelate and overlap to monitor and manage the protection of the western leopard toad. The WLT-CC comprises individuals who represent various areas of practice, either through their occupations, personal interests or residential location, bringing together a diversity of skills, backgrounds, and experience. As highlighted in Chapter One, the WLT-CC was created as a platform that brings these multiple stakeholders together to focus their attention, work and passions around the same objectives and goals.

In the sections that follow, evidence of each and their workings within the landscape of practice is provided and their interrelation across the landscape in achieving their shared interests is discussed.

4.2.1 *NIMBY (Not in my Back Yard) Initiative: The Beginnings of the WLT-CC*

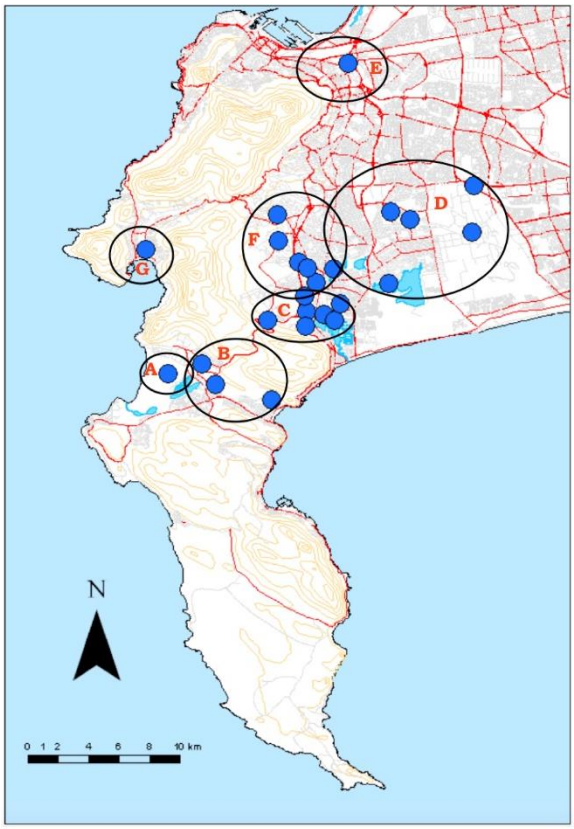
"We're saying, 'not in our backyard'; we do not want this animal to go extinct and that's the positive of that mindset" (INT_1, 8).

This particular initiative began with the volunteer action of two individuals in Noordhoek and then later formalised into the WLT-CC in 2007. The AC (AC1) of the South Peninsula Toad Savers (SPOTS) — one of the most established western

leopard toad volunteer groups — explains that she received a phone call from a fellow community member who said there were multiple toads on the road: "*I actually think there might be leopard toads and now all been killed and I couldn't allow that to happen, do you want to come out with me tonight?"* (INT_1, 3). This initiated local community members going out, encouraging friends to join and recording information about the toads. The data demonstrates that present-day volunteers are active annually during the breeding season, led by ACs, and participate in multiple practices outside of the season to maintain momentum and motivation and encourage participation.

One the founding toad savers, AC1, explains that they have a sense of pride in being pioneers of the cause, initiating action, "*working it out and trying to come up with ways to do things in a credible way, but also in a way that inspires volunteers"* (INT_1, 3) to continue taking action. Volunteers are unpaid; however, they are knowledgeable and experienced in their local areas and have been *"watching [the toads] and working with them for 11 years*" (INT_1, 44). The chairman (CC1) of the WLT-CC explains that these local 'champions' drive the action on the ground, while the WLT-CC endorses volunteer action and development with letters and official backing (INT_3, 4). Community members live with the species daily and have first-hand experience with the charismatic animals. For example, a volunteer explains via the KirMiTS WhatsApp group to their fellow community members, "*I've had 2 [toads] emerging from hibernating somewhere in my house this past week — 2am this morning out of a cupboard much to my cats delight! Definitely a sign they are on the move*" (WA, 23).

Currently, there are seven coordinated volunteer groups across Cape Town that manage and monitor multiple breeding areas. As shown in Figure 4.1, A–G represent the general groupings of volunteer communities that occur around western leopard toad breeding sites. A previous intern and member of the WLT-CC who assisted in convening multiple 'nexes of practice' (CO1) explained that the initial idea was to gather groups of volunteers in various locations to try to "*legitimise and formalise the processes*" (INT_5, 4) through ACs, who were promising, driven volunteers and who would connect everyone and represent each group on the WLT-CC (M1, 2).



Key	Volunteer groups and breeding areas
A	**ToadNUTS** (Noordhoek Unpaid Toad Savers) Noordhoek
B	**SPOTS** (South Peninsula Toad Savers) incl. Capri, Clovelly, Fish Hoek, Glencairn, Kommetjie & Sun Valley.
C	**KirMiTS** (Kirstenhof to Muizenberg Toad Savers) incl. Frogmore Estate, Kirstenhof, Lakeside & Marina Da Gama.
D	**Grassy Park** incl. Lotus River, Phillipi & Zeekoeivlei & **Bergvliet** incl. Die Oog, Meadowridge, Plumstead and Retreat.
E	**Observatory** incl. Ottery & Pinelands.
F	**Tokai** incl. Blue Route, Constantia, Nova Constantia, Steenberg, Sweet Valley, Westlake & Zwaanswyk.
G	**Hout Bay** (No Area Coordinator)

Figure 4.1: Volunteer groups and monitoring areas of the western leopard toad (Day, 2009 amended).

4.2.2 Volunteer/Citizen Science Practices

The volunteer and citizen science 'nexus of practice' within the landscape started through collaborative effort in areas where threats to the western leopard toad species were identified. This nexus represents people who are 'on the ground' in breeding areas where western leopard toads are living and moving during the breeding season. As residents in these areas, they have vested interest in the western leopard toad species stemming from their exposure and proximity to this social-ecological issue. Members of the public were catalysed to participate in the monitoring and management of western leopard toads when it became evident that these endangered toads were being killed by motor vehicles. Multiple volunteer groups have been set up around the Cape Peninsula over the past decade and are managed by an AC who recruits and educates their group to assist in their neighbourhoods during the breeding season. Volunteers are organised via rosters and WhatsApp groups and engage in various citizen science practices such as saving toads crossing roads and collecting

data (toad numbers, location, gender and behaviours). The ACs collect and share this information with their volunteer group and the WLT-CC at the end of each breeding season. The volunteer/citizen science nexus not only engages in on-the-ground practices but also overlaps and interrelates with conservation, research and educational practices before, during and after each breeding season.

4.2.2.1 Coordinating Volunteer Practice

ACs are individuals representing different regional areas; they help to recruit, inform and manage volunteers before and during the western leopard toad breeding seasons (INT_3, 12). Before the season begins, it is up to each AC to initiate and organise action in their area through information and recruitment sessions, as AC1 expresses, "*We need people who will rescue toads and record the data and we also need people who will get other people excited, to spread the word. This is something that we are doing for ourselves. We can save this species. It doesn't have to go extinct on our watch*" (OBS_2, 6:28). Yearly minutes from the WLT-CC indicate that ACs: a) schedule volunteer meetings prior to the breeding seasons, b) coordinate on-the-job training when patrolling and c) establish WhatsApp groups and other social media avenues to coordinate practice (M9, 3).

Volunteer groups go through numerous standby and action periods throughout the breeding season as the toads move in waves according to weather patterns and other external factors, often making volunteer practice sporadic and unpredictable. As such, WhatsApp groups and rosters are important tools to coordinate action. AC1 highlights that "*as the coordinator, [he/she] need to know what's happening all the time*" (OBS_2, 29.15) so the use of a WhatsApp group to coordinate action when the toads begin to move in a particular area, is essential.

To support instant communication around unpredictable toad movement, the ACs put together rosters with volunteer availability in the area and, when the toads begin to move, the WhatsApp group allows for delivery of messages to the entire volunteer community instantaneously. For example, on the KirMiTS WhatsApp group, AC2 explains, "*toads are moving so please let me know if you can help any time starting tonight for at least the next 5–7 days. Please check current roster for duties this week and all standby people will be welcome*" (WA, 5). Community members await contact from the AC or toad scouts. For example, one KirMiTS volunteer shared on the

WhatsApp group: "*Thanks so much, we are on standby with torches at the ready if there is movement and you need back up*" (WA, 15). As the toads begin to move, AC2 sends out a simple message to trigger the schedule: "*We are in action and the roster kicks in*" (WA, 5).

ACs utilise the rosters as flexible tools that the group comments on constantly in a collaborative manner and can make changes to according to availability and capacity constraints. The AC tries to partner experienced and novice volunteers to assist with on-the-job training (WA, 26). This combination of coordination strategies supports the ACs in bringing about effective responsive action in areas that most require it when toad movement occurs.

4.2.2.2 'Toading'

"You need a big heart, because you've gotta, you gotta feel empathy for the species" (OBS_2, 17,40).

ACs and volunteers have termed toad-monitoring and toad-saving practices 'toading' and in active, heavy traffic areas such as Noordhoek 'extreme toading' (OBS_2, 15.06). A typical night of 'toading' gives insight into the practices that volunteers engage in daily during a breeding season. At an information session to recruit volunteers, AC3 explains that volunteers are trained to go out in pairs to save toads along the roads by driving slowly at 40km per hour: "*If we go at a steady pace and we're quick, if we stop the car, get the toad, take a photograph, pull it off the road and carry on, it's almost like a sweeper*" (OBS_2, 27.02). This indicates how volunteers operate as a team to prevent toad mortalities and increase volunteer safety on the roads. AC3 goes on to explain that through this method of practice, "*hopefully we gonna get to the toad before the other cars do, and we have a really good success rate like that*" (OBS_2, 27.15). A KirMiTS volunteer's account of 'toading' at hotspot areas demonstrates how volunteers are at risk when working on the roads: "… *saw 3 on the road immediately we arrived. Cars were speeding down there. I had to pick 2 up at once to rescue them from fast car*" (WA, 33). This also provides evidence that volunteers will prioritise rescuing toads before documenting information. AC3 confirms this by indicating (to new recruits when informing them of what 'toading' entails), "*our secondary goal is data collection*" (OBS_2; 19.16). When there is time

and no threat to the volunteers' safety, data collection is important. The volunteers take part in citizen science practices as far as is possible while saving the toads.

AC1 explains the scientific protocols that volunteers are encouraged to follow when documenting information: "*You actually want a picture of the toad with some form of measurement, so either a ruler or else one of these very high tech devices called an ice cream tub with a ruler inside it and that prevents the toad from jumping out so you can take a photo*" (OBS_2, 19.38). After a night of 'toading', the AC reminds the volunteers to share the statistics they have recorded: "*Please keep all your stats guys and send to me: numbers, sex, road kill and man hours*" (WA, 27). The data collected by the volunteers through citizen science practices is then used within the volunteer group to identify trends in toad hotspots. AC1 explains, "*So this is what we use the data for; it doesn't just go away, we use it for hot spot identification so knowing where the biggest road kill is happening*" (OBS_2, 22:12).

4.2.2.3 Volunteer Practices Informing Research, Conservation and Education

ACs and volunteers' primary strategy to save toads is road patrols. However, there are multiple practices that they take part in throughout the year that indirectly assist in the protection of the species. AC1 gives insight into such practices, noting that "*We talk; we are sometimes on radio; we've done a few television things, ah various bits and pieces, and awareness. We do a lot of that. We also do a lot of advocacy for the toads now, as development is ramping up. We are using the toads as a way of trying to, um, slow things down a little bit*" (OBS_2, 15. 25). The data indicates that volunteer practices overlap, contributing towards other 'nexes of practice' including (a) conservation, (b) research and (c) educational practices.

(a) Volunteer practices assist in conservation efforts. Volunteer practices inform and assist in conservation efforts through advocacy work, rehabilitation of injured animals, governance (i.e. through Environmental Impact Assessment (EIA) and opposition to development proposals) and connecting valuable partnerships around a shared objective. An example of biodiversity advocacy is the AC's assistance not only with western leopard toad protection but also with greater biodiversity issues in their local areas. For example, volunteers on the KirMiTS group identify animals other than toads while out 'toading': "*porcupine on green belt after crossing bridge at top of Altenberg; has dug hole under fence where there is a small strip of land between*

fence and a tall wall" (WA, 12). In the WLT-CC minutes from 2012, AC2 suggested that the WLT-CC could act as a type of advocacy group in instances where other small faunal species, such as porcupines, were being threatened. Similarly, CO1 noted, "*by showing support of other species, it may benefit the toad cause, in being seen as a flagship species for conservation*" (M5, 4). While volunteers are 'toading', they collect road kill data (whether amphibian, bird, mammal or reptile) that is gathered and reported not only to the volunteer group and the WLT-CC but also to the Endangered Wildlife Trust's (EWT) Wildlife and Roads Project. This valuable partnership supports the EWT work in minimising wildlife road mortalities, which has been conducted since 2010. The collection of data helps to better understand mitigation measures needed to reduce the impact of road infrastructure on wildlife and inform the emerging scientific discipline of road ecology (Collinson, 2013).

Similarly, volunteers aim to collaborate with multiple organisations that share similar goals to maintain support. Continuous partnership work with conservation entities can provide solutions to minimise threats and reduce human-wildlife conflict, which enables volunteers to take part in actions beyond saving toads off the roads. Volunteers additionally work with SANParks to educate and share information with rangers in areas in which western leopard toad species are monitored. As expressed in the WLT-CC minutes, "*ToadNUTS and SANParks reps to meet with SANParks Honorary Rangers to discuss collaboration and partnerships*" (M5, 4) to strengthen conservation, volunteering and educational ties.

Another example of advocacy work is ACs' involvement in the opposition to development proposals in various areas of Cape Town. AC1 explains that they utilise their collated data about endangered species in their areas to try to halt developments: "*The moment we have the leopard toads, certain things get triggered and [developers] have to go through certain law procedures, public participation processes*" (OBS_2, 22.50). Volunteers, together with conservation entities, identify challenges on the ground and processes to put in place to prevent further developments. Following the rejection of a development proposal, AC1 explained in a WLT-CC meeting that an "*inadequate faunal assessment was undertaken with inadequate mitigation measures proposed*" (M9, 4) and that a specific western leopard toad specialist report would be required. She explained that ToadNUTS had submitted a formal objection with a letter of support from the WLT-CC and that

formal comment was required from all conservation entities (M9, 4). Another example of volunteer advocacy practice is ACs' prevention, with assistance from EIA specialists, of potentially damaging development proposals. As seen in the WLT-CC minutes, AC2 shares that they had personally "*met with the consultant for the EIA/scoping*" in 2016 (M7, 3) to halt development near a breeding site in Silvermine Road, Noordhoek. This advocacy practice was further highlighted the following year when ACs motivated for funding from the local community (who also provided resistance) for an initial objection document to be compiled to oppose developments in the area (M8, 4; OBS_1, 1:29:26). Similarly, volunteers found western leopard toad tadpoles and collected DNA samples in the River Club area, Observatory, which was due for development by the CoCT. This flagged the area as an important endangered species breeding site, which had not been considered, and helped halt the development (M9, 3). Although this is important work arising from community-driven efforts, AC1 explains that the community cannot sustainably self-fund these objection documents or respond to calls for "*assistance from the committee in the form of expertise and input on the objection*" (M8, 4).

An additional volunteer practice that aids in conservation efforts is the assistance in rehabilitation efforts for injured toads and other animals in peril. One volunteer on the KirMiTS WhatsApp group shared, "*Injured toad in drain outside [address]. Cannot reach it as car parked on drain. Perhaps someone passing could check if drain accessible later?*" (WA, 9). An hour later a message on the group stated, "*Injured toad rescued and taken to [medical support volunteer]*" (WA, 9). Members from rehabilitation and medical support programs, like the Two Oceans Exotic Animal Hospital, work with volunteers to save and rehabilitate toads and other animals and release them back into conservation areas. Feedback, such as, "*We have had a terrible day in rescue, but the one positive is that the latest injured toad from Zandvlei was operated on today and flew through the surgery with flying colours*" (WA, 18), is given to the volunteer group, which motivates volunteers to participate, feeling that their efforts make a difference. The efforts of volunteers to protect the endangered species goes beyond saving them from roads — every animal counts and multiple practices are put in place by numerous volunteers with diverse expertise to lower mortalities. As highlighted by a medically trained volunteer, "*The injured toad from last night is in the hospital tank. Sadly doing very elaborate laboured breathing. Have him on painkillers and antibiotics. If makes it through the next week also will send*

him to Cape Exotic Animal Hospital to have the leg set or more likely amputated" (WA, 36/37).

ACs are responsible for their own areas and must adhere to various conservation policies. For example, each breeding season they are required to erect signage as a traffic calming measure and to inform community members of the presence of toads in the area. As one volunteer shares, "*I'm putting up posters for the Tokai area today (and yesterday). The orange permit stickers are valid from 1 July to the end of October (the green permits of 2017 are no longer valid. Each poster must have one permit attached*" (WA, 4). Local municipalities and conservation bodies issue permits so that policies are adhered to. Volunteers and ACs are required to take down signage at the end of the breeding season, otherwise they are fined personally, increasing accountability. The above volunteer and conservation practices either directly or indirectly contribute towards the protection of the western leopard toad.

(b) ***Volunteer practices assist in research efforts***. Volunteers gather information while out 'toading' according to the scientific protocols or methods shared by the ACs. This information (generally size, gender, with or without eggs and location) is instant messaged via WhatsApp to the ACs or uploaded to citizen science data platforms, such as iNaturalist or iSpot. This practice is highlighted on the KirMiTS WhatsApp group where volunteers try to upload their information: "*Would you mind WhatsApping*[6] *me a photo of our stats for this evening? So I can add the sizes to my iNaturalist postings, 'cause it says my sightings are incomplete*" (WA, 7). The AC collates this data and then generates a report for the season, which is usually communicated back to both the volunteer groups and the WLT-CC. CT1 explains the data collection process: "*People go out, they take photographs of the individuals and they then at the end of the breeding season or during the breeding season, log it all onto iSpot, so there's a central database then that, that has all of this information*" (INT_4, 61). iSpot is a data collection platform that is used by the public (citizen scientists) and multiple conservation entities, such as SANBI, towards national biodiversity monitoring. These collaborative efforts contribute towards the country's red data list and inform conservation efforts and policies. CT1 mentions that although

[6]*WhatsApping –When a message is sent to (someone) through the WhatsApp. When you send a message through the WhatsApp, you can say "I am whatsapping him" (Urban Dictionary, 2016).*

there are capacity constraints and issues with information sharing platforms (for example, the WLT-CC no longer uses iSpot as their data uploading platform due to usability challenges) regarding collation and analysis of information, the aim for volunteers and the WLT-CC is "*to identify individuals based on the back markings and then get an understanding of where they move and how long they live*" (INT_4, 61).

Researchers often attend WLT-CC meetings and share their research goals with the committee, requesting assistance from the volunteers on the ground. Some researchers require genetic testing for their studies and have requested that volunteers collect road kill while out 'toading'. For example, in 2017, volunteers were asked to freeze samples of road kill while they await collection by the researcher. This researcher needed specific genetic samples for her study and asked the volunteer teams, "*just inform us as to what things are happening so we can, we can be ready and be there to gather samples*" (OBS_1, 7.55). Similarly, reminders to collect samples are shared through WhatsApp communication between volunteers: "*Please either freeze and keep road kill until she is home or drop them at [house number] and we can stockpile if families object to frozen toads next to the peas*" (WA, 16).

(c) ***Volunteer practices assist in educational practices***. Due to their experience and knowledge regarding the western leopard toads and local issues, ACs and volunteers have become involved with numerous educational practices, communicating information about toads, biodiversity and conservation to the public. AC2 shares, "*I've been asked to talk on toads at a lot of old age retirement complexes, been to rotary meetings, I've been to wherever, wherever. So the volunteers also do a lot of education, as well as the on the ground toad saving and running around taking people's toads*" (INT_2, 58). AC3 explains that she initiated an environmental education project for children "*through which they [could] voice their concerns surrounding issues they find important, such as recycling, litter, toads, etc. The group exhibited at the Long Beach Mall and conducted neighbourhood awareness work*" (M5, 4). Another example of educating children and the public about toads is through encouraging them to look after ponds, wetlands and breeding sites on their properties; for example, "*Fish Hoek Primary School has a pond; there has been training of 190 children with bumper stickers distributed*" (M4, 2). Another example is the Clovelly Country Club, which engaged in training to "*educate them[selves] about the WLT and*

the breeding season so that any clearing of pond weed etc. is done before the time" (M4, 2).

A large part of volunteers' engagement in educational practices is recruiting potential volunteers. A volunteer from the KirMiTS group described the process: "*A notice will go into Marina Weekly Newsletter so hopefully get more volunteers*" (WA, 8). The newsletter shares information regarding volunteer practices but also information about the toads. The public is informed about species identification and how the toads migrate to breed; for example, at an information and recruitment session AC1 speaks about how "*migrations happen from our suburban gardens from July through to September. Every year is, is slightly different, they never clue us in, they keep us on our toes. We never really know when exactly the migration's gonna happen*" (OBS_2, 3:07). Volunteers also take part in 'eco' fun days, for example, "*1 October – AC1 manned the stall with the assistance of some volunteers*" (M7, 3), which educate the public and help gain support, awareness and recruitment.

Recently, volunteers have used their expertise to develop new platforms to share information and educate the public about toads and volunteer opportunities using an updated website platform. A volunteer on the KirMiTS group highlights this new development: "*hey guys, I just wanted to let you know that our Save the Toads website and video went live yesterday :) http://saveourtoads.co.za* 💔*. We wanted to get it up sooner but hopefully it will still help and educate people* :)" (WA, 38). This platform not only educates people about toads but also informs them about the importance of volunteering, how to fundraise and who to contact if toads are identified in an area and need rehabilitation. This website is an important link between volunteer, research, conservation and education practices.

As the evidence indicates, the volunteer 'nexus of practice' highlights how local individuals and groups can collaboratively engage in practices that identify local issues, create meaningful partnerships and take action to continuously monitor and manage efforts around the protection of an endangered species. Through coordinated effort between ACs, volunteers, the WLT-CC and conservation entities, volunteers take part in citizen science practices on the ground and contribute towards other conservation, research and educational efforts around a shared interest. The evidence highlights that the role of ACs is an important driving force for this as they

communicate action plans, mitigate local risks and assist with problem-solving during evening volunteering sessions.

4.2.3 Conservation Practices

The conservation 'nexus of practice' within the landscape has had numerous representatives on the WLT-CC over the years — various conservation entities, such as Cape Nature, SANParks, Table Mountain National Parks, CoCT and City Parks and local nature reserves, such as Rondevlei, Zandvlei and Zeekoeivlei (M1-M9). These entities either have western leopard toad breeding sites within their reserves, jurisdiction or are concerned with species protection and conservation of biodiversity. These conservation entities operate independently from one another but overlap across various issues of concern and work collaboratively towards shared goals, such as conserving species and mitigating risks that threaten biodiversity. As CO1 highlights, the natural areas within a city that are monitored "*aren't wild areas, they're intensely managed by public works and like, the whole space is a managed system*" (INT_5, 30).

4.2.3.1 Conservation Practices Directly Protecting the Western Leopard Toad

Each breeding season, local volunteers act within their different communities, however "*the day to day on-the-ground decisions [are] all done by the local municipalities*" (INT_3, 64). A WLT-CC member (CT1), who is also a Senior Environmental Professional from the Biodiversity Management Branch representing the CoCT in the Environmental Management Branch (EMB), highlights that there are multiple entities and line functions within the city, including five or six individuals that need to be involved in various conservation practices before they can be implemented (INT_4, 10). For example, City Parks is mandated to maintain recreational spaces: "[They] *mow the lawn, they neaten up, they pick up the litter, they, they prune the trees, you know, they maintain public open space. So very straightforward things that have been in place for decades and on a schedule*" (INT_4, 37). These practices can directly affect the western leopard toad in breeding sensitive areas and therefore need to be monitored in order to promote the conservation of the endangered species. Therefore, the multiple line functions of public works and the EMB collaborate to manage such practices and protect the species, complying with the issued mandate. An example of this is controlling the

mowing schedule of recreational spaces during the time the toadlets are emerging because, as CO1 highlights, "*one mowing event can completely wipe out the emergence of a whole year of spawn*" (INT_5, 16). CC1 further highlights that due to the unpredictable western leopard toad movements each season, the WLT-CC assists in mapping toadlet emerging areas, noting, "*We give them maps showing where mowing isn't allowed*" (INT_3, 18). CT1 explains that one City Parks representative steers her line function towards an operational schedule that is sensitive to the western leopard toad toadlet emergence during December and January but also tries to halt any practices "*that could jeopardise the adults migrating towards the breeding sites or cause mortality*" (INT_4, 37) such as the use of pesticides or insecticides at inappropriate times of the year, especially when toads are moving and are susceptible to exposure. CT1 explains that these practices have been developed and scheduled over time and happen daily as a part of pre-defined jobs. One tension is that conservation officials sit in the WLT-CC meetings but sometimes don't communicate exactly what practices they are involved in behind the scenes; this can make other members feel that nothing is being achieved. However, CT1 explains that "*it just gets done whether the committee exists or not, this work will get done*" (INT_4, 33). Therefore, these entities constantly contribute to the protection of the western leopard toad as part of their day-to-day line functions.

Another example of how conservation practices directly protect the western leopard toad is conservation entities giving official backing to volunteers on the ground and assisting in high impact areas. For example, CT1 explains that there were roadworks taking place in an area that the CoCT was not aware of (not all city projects are communicated through the extensive organisation) and she became concerned about the construction activities impacting the western leopard toad. She describes that she met with the local AC and contractors on site and eventually they "*came to some conclusion where everyone was happy, that the toads were looked after, their work was still getting done within the timeframes and the scope of what they needed to have done and ultimately it came to quite like a cooperative solution*" (INT_4, 63). CC1 reiterates this point by explaining that when key conservation issues come up, it is articulated to the City representative and they can assist by negotiating, mediating and communicating: "*Hey, this is going to impact on toads, you need to do this…"* (INT_3, 62).

Another aspect of this work is wetland management. Wetlands are essential to the protection of the western leopard toad species and conservation organisations assist in identifying, rehabilitating and protecting these valuable western leopard toad breeding sites. For example, CC1 explains that data regarding the western leopard toad population from breeding ponds are uploaded to Geographic Information Systems, which the City accesses and uses for management decisions regarding conservation practices, such as canal dredging, maintenance of canals and monitoring water systems. These conservation efforts are practices that directly respond to the data collected (INT_3, 58). Over the years, volunteers have identified and shared new breeding sites with the committee, as AC2 shared in 2018: "*Great, thanks team. New breeding site in Sea Breeze Park canal. Yay*" (WA, 31). These have then been mapped and acknowledged by the CoCT. Damage to wetland sites is also identified and communicated with the WLT-CC and City, catalysing conservation action. As seen in WLT-CC minutes, CT1 reported on damage to a wetland in an area and an action and restoration plan from the CoCT was put into place (M6, 2).

4.2.3.2 Conservation Practices Indirectly Protecting the Western Leopard Toad

Conservation entities are extremely important in directly protecting the western leopard toad species through scheduled practices throughout the year; however, there are equally important conservation practices that indirectly impact the protection of the toads through legislative requirements, policies, MOAs, objection documents and public awareness. CT1 explains the importance of having multiple conservation organisations involved and represented on the WLT-CC when initiating conservation practices and management decisions: "*Different organisations might implement different initiatives and not know about one another. So it was very important to have a representative from each of these bodies on there to make sure we're always on the same page*" (INT_4, 10). AC2 of KirMiTS highlights that a biodiversity protocol has been written for the western leopard toad that was legislatively required and involves multiple conservation stakeholders' input and expertise (INT_2, 22) so that conservation practices are consistent upon implementation.

Another example of a conservation practice indirectly impacting the western leopard toad species is the negotiation of urban development proposals. The CoCT is pivotal in circulating and commenting on construction guidelines, development proposals and objections to urban developments that impose on conservation sensitive areas. This is

evident in the WLT-CC minutes, which indicate how members of the committee observe such documents: "*The revised version [of the construction guidelines document] will be circulated around the committee one more time for outstanding comments*" (M1, 4). Having multiple 'eyes' on developmental activities close to western leopard toad breeding sites such as canals, rivers, wetlands and ponds is essential in holding larger corporations and companies accountable for their actions.

Lastly, as the western leopard toad resides in urban areas with high traffic volumes, conservation practices are needed to enforce traffic calming measures to reduce toad mortalities. Signage by-laws implemented in the CoCT to manage signage clutter required that signage approval be dealt with internally by the city (M3, 4) and new application forms and permit stickers on posters were required (M9, 4). CT1, the CoCT representative on the WLT-CC, shared that to achieve this she had to go through the correct city channels and collaborate with the committee: "*We designed the official thing, it went through the committee as well. Everyone bought into the final and gave comment on the final designs,*" which, she expresses, "*effectively represent everything, everyone*" (INT_4, 43). CT1 also shares that she communicated with a CoCT roads engineer to collaborate on installing permanent wildlife warning signs or the "*use of temporary flashing speed-indicator signs during hotspot movements in the breeding season*" (M9, 2). This is an example of how conservation entities, the CoCT and local communities can collaboratively monitor traffic through signage in order to conserve the western leopard toad and biodiversity.

4.2.3.3 Conclusive Point

The conservation 'nexus of practice' engages in multiple efforts, which directly and indirectly impact the wellbeing of the western leopard toad species. Coordinated effort between the CoCT, citizens, the WLT-CC and independent conservation entities contribute greatly towards convening and implementing strategies that share similar objectives and goals. This includes valuable day-to-day monitoring and management of recreational spaces (such as mowing, dredging and clearing), protecting various breeding sites, wetland management and implementation of MOAs, development proposals and construction guideline documents. These efforts enable conservation decisions to be made and allow a diverse platform for concerns to be shared around the protection of biodiversity in the cape, including the flagship western leopard toad species.

4.2.4 Research Practices

Although informal 'toading' and research was already in motion through local volunteer practice, formal research efforts specifically focused on the western leopard toad species only commenced when the WLT-CC was initiated in 2007. The original chairman appointed to oversee the WLT-CC was working at the SANBI and therefore was heavily involved with research and had many students take part in initial research projects. SANBI is a national organisation that contributes towards South Africa's sustainable development through facilitating access to biodiversity data, generating information, building capacity and conserving biodiversity. The previous chairman also had a strong connection with the University of Stellenbosch and the University of Cape Town "*so could effectively ensure that research entities [were] well aware of any initiatives, and they provide[d] guidance towards that too*" (INT_4, 10). A new chairman was appointed in 2012 (CC1) who also represented a SANBI research focus and, along with the WLT-CC, was pro-active in using technological tools to map out initial observations "*[to] try and build a picture as to where toads [were] and where they [were] migrating to*" (INT_5, 16).

Over the years, students from various educational institutions have conducted research studies. For example, to understand toads' home ranges in relation to their breeding sites, a research student "*put tracking devices on some leopard toads in Kirstenhof area and they obviously monitored the movement*" (INT_4, 51). Research projects often require multiple collaborations between funders, volunteers and conservation bodies and can inform practice depending on the actions that are required. For example, a researcher sent a message on the KirMiTS WhatsApp group informing them of the research being conducted and to request assistance and participation from all the volunteers. The researcher proposed:

> *With the WLT season upon us, I would like to ask any and all volunteers in the Kirstenhof/Tokai areas for some assistance. I am a researcher at the South African National Biodiversity Institute (SANBI) conducting a genetic monitoring study on Western Leopard Toads. We have data from 2007 and now need to compare samples from this breeding season. I am therefore in need of samples from the Kirstenhof/Tokai areas and would appreciate it if anyone helping out in those areas would mind keeping any road kills that I*

> *will collect ASAP. If you'd like any further information about my study and credentials, do not hesitate to contact me.* (WA, 2)

This is an example of how research required collaborative effort and citizen science practice to collect multiple sources of data over a vast landscape and short time period.

Researchers contribute to specific areas of expertise that are shared among the multiple 'nexes of practice'. The researchers involved in the WLT-CC have knowledge on, and an interest in, the local flora and fauna of the Cape and this interest motivates questions about the species and its behaviour. For example, CC1 describes how the western leopard toad's markings can assist in understanding population census research:

> *The back of the toad is unique. So it's a fingerprint. So we can track individual turns and from that we can look at how far they move, how long they live for, whether they stay at a pond, or do they move between ponds and whether they go back to the same garden every time or whether they just move around. Um, and also from that, we could work out the population*. (INT_3, 4).

Another example of researchers sharing their expertise is the provision of insight into certain issues; a researcher proposed that a lack of emergence of toadlets, toads and birds at Die Oog breeding site was due to submerged vegetation that nitrified the water, depleting the oxygen, and therefore negatively affected the fauna. The chairman at the time issued a research mandate to look at tadpole growth in accordance with the water quality parameters to identify factors that would promote/stunt developments of toadlets and relevant professionals were brought in (M2, 2). This form of research practice provided the volunteers on the ground with knowledge to resolve an arising environmental issue.

4.2.4.1 Research Informing Conservation Measures

Research can inform various conservation practices and assist in implementing measures that positively impact biodiversity. CC1 describes how conservation measures were put in place due to data being generated, collated and shared with conservation entities. Road maps were compiled indicating high mortality hotspots that could be used by the WLT-CC "*as leverage to go to the city saying we needed, we need areas, we need signage, we need um, traffic calming measures*" (INT_3, 4).

Therefore, the WLT-CC "*got the volunteers to actually map where they were when they found the dead ones [toads]"* (INT_3, 4) and compiled a report that encouraged traffic calming measures and signage in high impact areas. Likewise, this data assisted ACs in organising 'toading' traffic reports in collaboration with Cape Talk Radio in 2011. Researchers encouraged volunteers to use the 'upload your toad' platform and expressed that "*during the breeding season, daily records will be entered onto the website during the next day, so that data is available for evening traffic reports*" (M4, 3). These evening reports were shared with the public and, along with signage and volunteers on the road, aimed to reduce toad mortalities.

Research efforts have the capacity to affect local governance and practice. CT1 notes that to effectively manage operational activities from the city's perspective, monitor development applications and for volunteers to more effectively manage people's driving action, researchers were needed to find out how far toads moved from their breeding site over a period of time (INT_4, 51). CT1 explains that after tracking the western leopard toad's movement over a season, research concluded that many individuals moved within a mere 200m radius from the breeding site for up to two or three months. CT1 highlights that,

> *for that immediate period after the breeding event, they were actually in close proximity to the breeding site, so that's incredibly valuable information for us because what we did immediately is we remade that two kilometre radius, a 500 meter radius and we started managing very intensively in that radius from a city line function.* (INT_4, 51)

The city began to produce maps supplied to multiple line functions that informed their operational obligations, along with an operationally binding MOA stating that,

> *within a 500 meter radius from a breeding area, you cannot, unless you've discussed this with us and we've cleared it with the rest of the committee and with the specialist, you cannot mow like in December; you cannot do river maintenance inside the water body in June, July, August, whatever. Actually that whole period from July to December, while the toads are moving to the water, breeding and the toadlets, or the eggs are developing and the toadlets are emerging. So that streamlined that quite a bit for us*. (INT_4, 51)

This is an example of how research creates awareness and can accordingly intensify practice and efforts, providing guidance and resolutions that can be implemented on an operational level.

4.2.4.2 Conclusive point

The research 'nexus of practice' is essential in contributing towards biodiversity management and the protection of the western leopard toad species. Collaboration between volunteers, the WLT-CC and research initiatives driven by SANBI and various universities has helped build a valuable picture of the western leopard toad species and its behaviour. Not only has research identified specific phenomena regarding the species, but ongoing data collection has informed pivotal conservation efforts, such as road-calming measures in specific areas. Ongoing research has not only provided all 'nexes' with a greater understanding of toad behaviour and breeding patterns but has also provided leverage to the CoCT and independent organisations for requesting the protection of breeding sites.

4.2.5 Educational Practices

The educational 'nexus of practice' within the landscape is not represented by one group of individuals; rather all members of the WLT-CC engage in educational practices throughout the year in varying capacities. Ongoing learning and education occur across all 'nexes of practice' via presentations to new recruits in volunteer groups, awareness drives in public areas, guest speakers at the WLT-CC and researchers sharing knowledge regarding new research findings. Each nexus has the capacity to inform and educate one another regarding their area of expertise.

4.2.5.1 Knowledge and Information Sharing

The WLT-CC not only educates communities about the endangered species and the work that they do but also organises information sessions to deliver information at committee meetings through guest speakers and researchers. For example, the committee has been informed about eco-friendly initiatives to promote western leopard toad breeding areas through green initiatives such as eco-pools. A company, Natural Swimming Pools, delivered a presentation to the committee explaining that "*the pools typically have sloping banks and vegetation growing along the embankments. This allows for the potential for pools to act as breeding grounds for the WLT and other species*" (M3, 2). Such approaches educate the multiple 'nexes of

practice' (researchers, conservationists and volunteers) about new initiatives to protect the species and encourage the committee to share the information on public platforms. For example, the guest speaker "*suggested that a page be generated on the WLT website providing information on natural pools and that he would create a page on his website with facts about the WLT*" (M3, 2). Similarly, CT1 suggested that the CoCT could get involved through another platform and "*could promote green initiatives such as printing flyers on natural pools as awareness for pool owners*" (M3, 2). CC1 noted in the same meeting minutes that: "*such an awareness drive would encourage residents who dislike toads to consider them more as part of an ecosystem*" (M3, 2).

The WLT-CC delivers information to the public through various platforms, such as the western leopard toad website, pamphlets, newsletters and local media outlets such as radio and television. This is illustrated by information dissemination through letters, blogs and Facebook pages to schools and local communities regarding western leopard toad breeding seasons and volunteer recruitment (M5, 2). Information was similarly shared on a television programme to create awareness and motivate community involvement. The programme, called '50/50', aired across South Africa and emphasised "*the fact that we all have species that are threatened and the community can make a difference*" (M4, 2). This is an example of an educational platform that not only encouraged the participation of volunteers and motivated accurate data collection but also highlighted the importance of conservation efforts and educating the public about the work being done and how they can contribute towards protecting the western leopard toad.

4.2.5.2 Educational Activities

Human knowledge of reptiles including amphibians often contains engrained bias from a young age that negatively impacts the human-species interaction throughout their lives. CO1 explains that "*people are brought up to dislike reptiles because they don't know. They think they're slippery, slimy or gross or something*" (INT_5, 12). The WLT-CC aims to combat such biases, for example, through delivering important educational information and messages about the species and its eco-system services to society. The ACs of volunteer groups have especially engaged children through presentations and educational activities to combat such predetermined ideas. ToadNUTs AC, AC1, has engaged with a group of young Brownies who learnt about

toads in their area and discussed ways to reduce the risks for toads in their neighbourhood (see Figure 4.2). AC1 and AC2 have also exposed the SANParks junior honorary rangers (12−18 years of age) to 'toading' by getting them to assist in moving toads off the roads and experiencing the species first hand (see Figure 4.3).

Figure 4.2: A screen grab from the ToadNUTs Facebook page. Examples of youth engaging in educational activities.

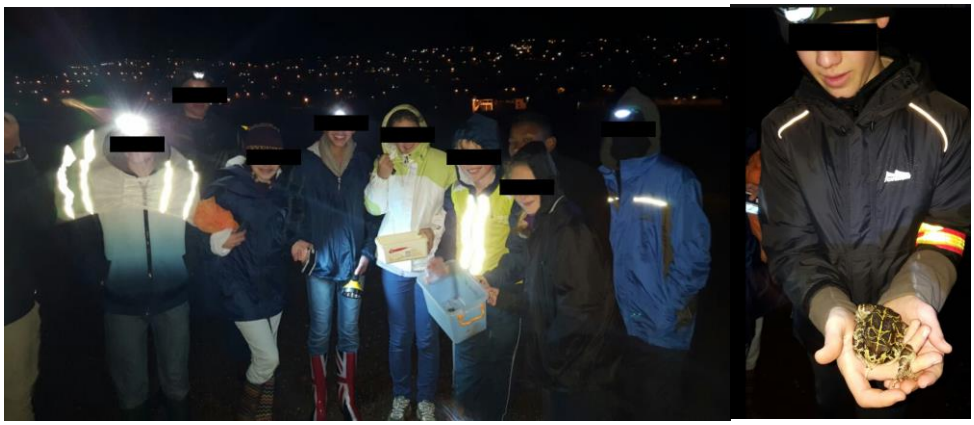


Figure 4.3: SANParks junior honorary rangers out 'toading' with western leopard toad ACs and volunteers.

4.2.5.3 Conclusive point

The education ‘nexus of practice’ is not bounded to one specific area of activity in the landscape of practice. Learning can occur across all areas of the landscape and often stems from educational practices overlapping and interrelating with other ‘nexes’. Such educational practices are how participants engage in knowledge and information sharing practices (WLT-CC learning how to promote green initiatives), share their individual and group expertise with one another (researchers involving volunteer action in their research projects) and engage in diverse educational activities to help promote and nurture environmental awareness and action (youth experiencing ‘toading’ first hand). These educational activities and knowledge sharing practices have encouraged young people and civilians to become involved in local conservation issues and have helped instil and nurture a passion for the environment.

4.2.6 Interrelations Between Identified ‘Nexes of Practice’

As indicated above, the ‘nexes of practice’ do not function solely within their own fields; they overlap, interconnect and contribute to on-going or once-off collaboration. Illustrated in Figure 4.4, the WLT-CC has complex practices engaging at various levels around the same shared interest. While some ‘nexes of practice’ are hands-on in collecting and disseminating information and saving toads on the ground, others provide expertise, fundraising and official support at a macro level. There are multiple roles across all practices; for example, a “*city representative on the leopard toad committee would be a conservator in the midst of people that are not conservators by training*” (INT_4, 37). Therefore, the city representative would address conservation and education issues with the city as they have the most experience and access within that practice.

Each ‘nexus of practice’ contributes towards the conservation of the western leopard toad species in different ways. Likewise, every ‘nexus of practice’ representative within the landscape of practice has a unique perspective of how the ‘nexes of practice’ connect. However, they all share the same overarching objective, which is the monitoring and protection of the western leopard toad. As AC2 expresses, "*every single individual from the volunteers to the top guys at SANBI or whatever, it’s the passion and interest in that actual animal and the fact that they, we know its endangered; we see what happens to it every year. Um, we marvel at the fact that it's*

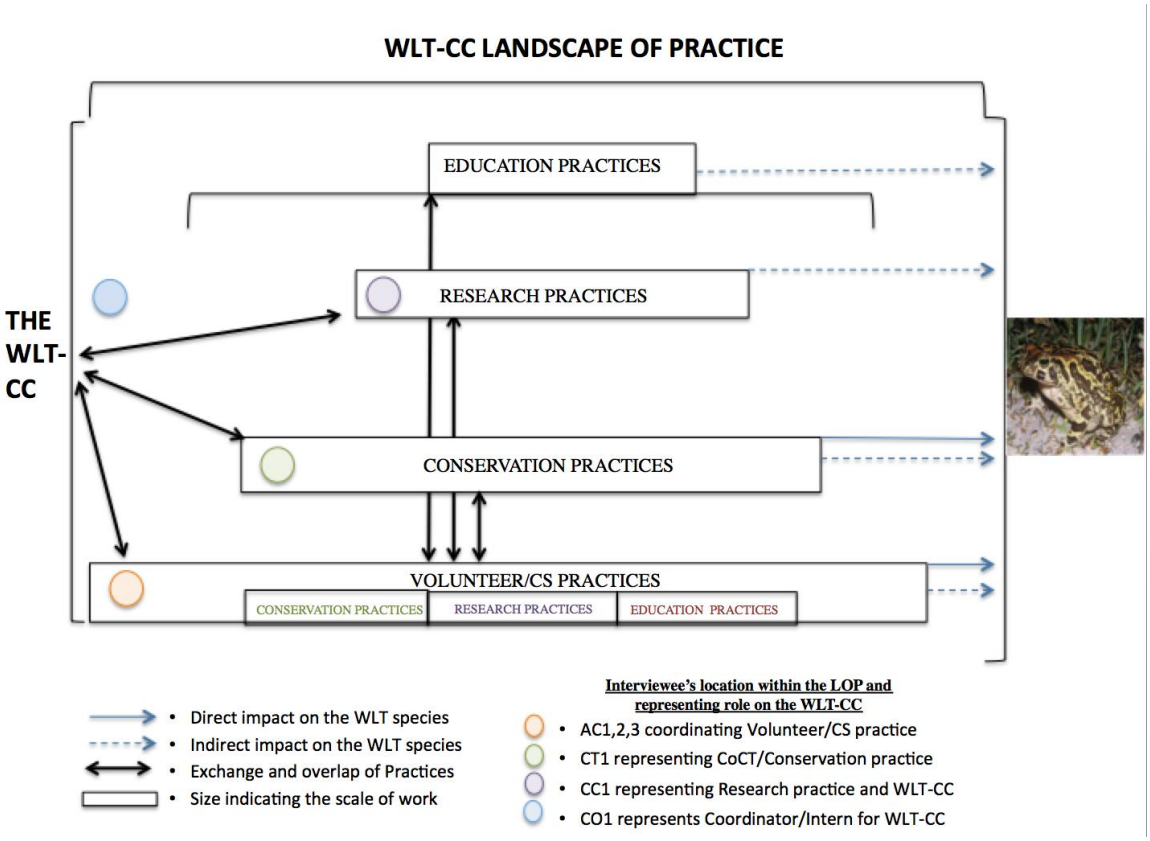


Figure 4.4: The researcher's representation of the WLT-CC's 'Landscape of Practice'.[7]

such a resilient little thing" (INT_2, 52). The landscape of practice maps that were created by each interviewee (who represented a different 'nexus of practice') are evidence of these different perspectives around the same shared interest. These maps (Appendix C) indicate how the 'nexes of practice' link with one another in the landscape at a macro level and how each perspective is an indication of the complex practices within a landscape of practice. To visualise these complexities within the landscape of practice from evidence given in 4.2, Figure 4.4 highlights examples of the interrelations between all 'nexes of practice' in relation to the shared interest. This illustration encapsulates the foundational understanding upon which the rest of the study will build.

Figure 4.4 illustrates the WLT-CC landscape of practice, the four loosely defined 'nexes of practice', and their relationship with the western leopard toad species. The

[7]*The designated index is used for later reference* to the WLT-CC landscape of practice. *CS: Citizen Science, AC: Area Coordinator, CT: Cape Town, WLT: Western Leopard Toad, WLT-CC: Western Leopard Toad Conservation Committee.*

volunteer ‘nexus of practice’, as explained in section 4.2.2.2 (‘Toading’), not only has direct impact on the toads in the field by reducing mortalities but also engages in volunteer/citizen science practices that inform areas of research, conservation and education within the ‘nexus’, impacting the toads indirectly (section 4.2.2.3). As illustrated in Figure 4.4, the volunteer ‘nexus’ with the help of ACs, engages in conservation practices within their own nexus through advocacy work, rehabilitation of toads, governance and initiation of partnerships. They engage in research practices within their own ‘nexus’ through data collection methods and monitoring of local trends to identify road kill hotspots. Lastly, the volunteer ‘nexus’ constantly engages in various educational practices within their own nexus by delivering talks, presentations, recruiting volunteers through information sessions and nurturing children’s passion for the environment through environmental activities. The volunteer ‘nexus of practice’ operates relatively independently from the WLT-CC; however, it does overlap and interrelate with the other ‘nexes of practice’ to share diverse expertise and gain official backing that is pivotal in navigating boundaries to the protection of the western leopard toad species across the landscape of practice. The volunteer/citizen science practices both directly and indirectly impact the wellbeing of the toads (Figure 4.4).

The conservation ‘nexus of practice’ (section 4.2.3) involves multiple independent conservation entities that overlap to support a similar goal around the shared interest of the western leopard toad species. These entities assist in the management of public and recreational spaces, which include multiple breeding sites of the western leopard toad species, and assist in development proposals, EIAs and construction guidelines for activities occurring within their areas. Coordinated effort, assisted by CT1 (a representative from the CoCT), occurs between these conservation entities, the CoCT, citizens and the WLT-CC to implement solutions to protect the western leopard toad and its breeding sites.

The research ‘nexus of practice’ (section 4.2.4) involves collaborative effort between citizens, the WLT-CC and research entities such as private students, various universities and SANBI. CC1 (a SANBI researcher and the chairman of the WLT-CC) assists the WLT-CC in collecting information about the western leopard toad species through coordinating research projects that address direct questions relating to a phenomenon regarding the species or through continuous data collection to identify

trends. This collected information is used as leverage to gain various tools, resources or permissions from the CoCT to implement conservation measures to monitor and protect the western leopard toad species. The impact of research practices is specific to answering questions as they arise and indirectly impacts the wellbeing of the toads (Figure 4.4).

The educational 'nexus of practice' (section 4.2.5) overlaps and interconnects all 'nexes of practice' across the landscape and has an indirect impact on the western leopard toad species through multiple participants constantly engaging in educational activities and sharing knowledge within and between each entity.

There is a constant exchange between all 'nexes of practice' depending on the context and requirements. CT1 explains that each element of the landscape of practice is important and that no one aspect outweighs another: "*What my take on it is, is that everyone is critically important*" (INT_4, 33). Various forms of interaction are evidenced below:

a) The interrelations between research and volunteer practices are beneficial to the collection and dissemination of real time information from ACs to volunteers while out toading. AC1 explains that in 2015 and 2016 a volunteer developed an App (mobile application) that assisted in collecting vital data used to protect toads with accurate resources. She explains that during that time the App allowed them to collect information "*in real time. Um, if the volunteers were uploading the data immediately, I could sit on my couch and see where the road kill was happening. Now, and literally deploy more volunteers now to that space. Phenomenal, phenomenal. I mean how useful is that*?" (INT_1, 42).

(b) The interrelations between volunteers and conservation practice assists in the CoCT's response to the needs of the toads and community members on the ground during breeding seasons. For example, CT1 requested that the volunteers and ACs inform the CoCT when the toad emergence occurs so that management decisions about conservation practices around the western leopard toad species is prioritised (M7, 4). This is indicated in the WLT-CC minutes that highlight, "*going forward: please notify CT1 when your breeding season is underway – this is useful for response to queries*" (M7, 4). Collaborative efforts between conservation and volunteers can be seen between the Muizenberg East Conservation Area and the

KirMiTS volunteer group, where conservation teams, such as the Cape Town Environmental Education Trust (CTEET), and their students assist with monitoring breeding site areas that cannot be accessed by the community members on the ground. AC2 mentions that the conservation team "*stepped on board to help us out which was fantastic, so they do Marina de Gamma, Muizenberg and they can get into the breeding site, the main breeding site in Muizenberg is in the business park, which we not allowed into at night, civilians*" (OBS_1, 56.32).

Community resistance in collaboration with invested conservation entities and the CoCT has been essential in halting developments and motivating alternative conservation orientated projects instead. For example, in Kommetjie, there was interest in a hotel development in the area; however, locals resisted this expansion and involved a local herpetologist along with the CoCT and the AC to propose a wetland development instead. AC1 explains, "*they had money available [from the CoCT]. They had like R200,000 and they work[ed] together to rehabilitate Skilpadsvlei, now it's a major success*" (INT_1, 5). AC1 explained that during the 2018 season "Kommetjie was an absolute revelation" (OBS_1, 1:15:57). She shared that there were toads everywhere: "*they were all around Skilpadsvlei, I have never seen so many satellite males in my life".* The population numbers were the highest ever recorded which was a direct result of collaborating with multiple entities: "*we counted on one night a hundred in the pond so that was really good if you think back to 2010 when Wally Peterson counted one toad*" (OBS_1; 1:15: 57).

(c) The interrelations between education and conservation practices assist in creating public awareness and inform the multiple 'nexes of practice' on the committee. For example, NCC Environmental Services have identified an alien species, the Guttural toad, which could negatively impact the western leopard toad species. They shared with the committee that they are monitoring the possible threat of hybridisation between the species but that their breeding seasons don't overlap. The minutes indicate that the "*NCC can provide training for the volunteer coordinators or join in the pre-season training sessions*" (M6, 2) to get everyone (the public, volunteers, reserve managers and committee) on the same page with regards to species identification and information.

4.2.6.1 Important Roles Working Together Across the Landscape of Practice

As illustrated in Figure 4.4, the role of CO1 was a vital convening factor in coordinating the 'nexes of practice' across the WLT-CC. The importance of this dynamic role is highlighted through the multiple tasks CO1 was involved in within the WLT-CC landscape of practice. Analysis of committee minutes documented over the formative years identified some of the foundational tasks of this role, including: drafting press releases together with the chairman regarding the breeding season results (M1, 2); communicating with conservation specialists regarding monitoring operations (M2, 2); assisting with fundraising proposals (M2, 2); meeting with volunteer groups and ACs to set up monitoring programs in breeding sensitive areas (M1, 2); and assisting with MOA developments between the city and the committee: "*[CO1] met with each manager to identify the buffer zones which would constitute a 'no-mow' zone and the MOA is to be signed within the month*" (M2, 3). CO1 was pivotal in involving the committee in this MOA process and was responsible for drafting letters on the committee's behalf: "*the contents hereof will remind CoCT managers of the MOA agreements with City Parks and Catchment Management. This should stipulate the periods during which mowing and dredging of watercourses must be avoided*" (M5, 3). As the WLT-CC became more established, CO1's role in recruiting volunteers through awareness days, markets and engagement with schools became more important to motivate participation, awareness and local attention (M5, 2). CO1 helped arrange committee meetings and on the odd occasion when the chairman was absent, chaired the multiple 'nexes of practice' (M5, 2). Lastly, CO1 established the roles of the ACs with the aim to formalise volunteer coordination and training in specific areas and engage local community members in the monitoring process. The roles of ACs have since become pivotal in facilitating their own volunteer groups before (information sessions, meetings, fundraising and training), during (creating rosters, delegating, training, establishing partnerships and answering questions) and after breeding seasons (collating information, reporting back to the WLT-CC and identifying hotspots). The AC's efforts have ultimately informed volunteer practice as well as research, conservation and education practices.

4.3 Identifying the Social Learning Interactions and Processes Within and Between the 'Nexes of Practice' Within the Landscape of Practice

The following section highlights the role of knowledge — the form it takes, how it is

produced and disseminated and how social learning occurs in the landscape of practice. The social learning interactions that this study focuses on are forms of co-engagement between the 'nexes of practice' and this, as well as individual learning and effort, contributes towards building a 'social body of knowledge' in the landscape of practice.

4.3.1 Strategies to Capture and Share Knowledge

The WLT-CC 'nexes of practice' utilise various knowledge-sharing strategies, such as communicating via WhatsApp groups, uploading information on Facebook, western leopard toad focused websites, interaction between ACs and data sharing platforms. These knowledge-sharing and data capture strategies assist the WLT-CC in disseminating information across practices. The following strategies have contributed towards the assimilation and dissemination of information to the public and the WLT-CC to help inform practice.

4.3.1.1 Community Learning Processes

In the WLT-CC landscape of practice, learning and knowledge production occur through engagement in different practices over time individually or collaboratively. This can be observed in the accumulated knowledge of the ACs over a decade of volunteering. They understand the general patterns of behaviour of the species and know approximately when toads will begin or cease moving in a season. For example, AC2 shares on the WhatsApp group, "*if you have been wanting to see toads this year, this is going to be the last opportunity,*" (WA, 25) and a few days later, "*seems to be quietening down but let's keep going until we see no toads for 2 nights in a row*" (WA, 36). Volunteers learn how to monitor and manage challenges that occur within their context by constantly being out in their local area season after season. AC2 expresses how they manage independent companies coming into the area posing a threat to the toads: "*the trenching for fibre*[8] *is starting in all the roads, which we patrol. Not good for the toads*" (WA, 3). A volunteer responded, stating that, after speaking with the engineers on their street, they "*promised me they have to close up trenches and holes at night in case of injury. If you see that not happening please complain*" (WA, 3).

[8]*Trenching for fibre –Installing fibre optic cables for internet connectivity by digging into pavements to lay cables.*

Another form of shared knowledge within the WLT-CC community is through researchers sharing their findings across the landscape. After experimenting with different resources in the field to trial factors that toads may favour when moving through tunnels, researchers learnt that toads would use "*all tunnels, no preference. Went straight through all the tunnels relatively quickly (square is better than round – prevents slipping)"* (OBS_1, 18.30). This informs decision-making with regards to conservation measures needed to install tunnels for the protection of the western leopard toad species and allows everyone, from volunteers on the ground to conservationists, knowledge of what research is being conducted and what is resulting from the joint work.

4.3.1.2 Volunteer WhatsApp Group Platforms

Volunteer WhatsApp groups are important tools to encourage instant information sharing among community participants and the continuous organisation of multiple members. These groups are closed groups that consist of recruited and trained volunteers from a specific area. The WhatsApp groups' efficiency depends on the capability of the AC in that community as they organise the communications. As seen in Figure 4.5, the WhatsApp group helps with the day-to-day coordination of the volunteer group and is a platform to share interesting photographs, data, roster information and voice recordings to motivate, practice or ask questions.

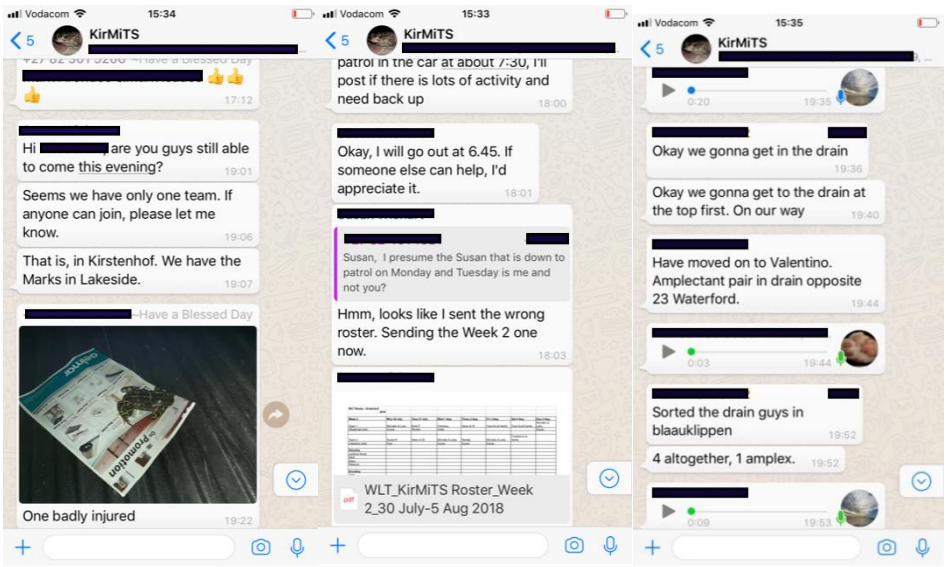


Figure 4.5: Examples of images from the KirMiTS WhatsApp platform

4.3.1.3 Website and Facebook Platforms

Another platform that has been used to share information in the past, is the western leopard toad website. In 2009, the WLT-CC developed the platform (http://www.leopardtoad.co.za) with members stating that the "*success of this website is dependent on upkeep of site. To remain interesting there must be feedback and activity*" (M1, 1). The purpose of the website was to share information about the species, volunteer work being done, actions taking place in the communities and general facts and advice on dealing with the endangered species. Due to a lack of upkeep and no one overseeing this role, the website platform is now out of date and the information no longer accurate. Minutes from a 2018 meeting highlight that the "*website should be updated. Existing website perhaps to be replaced. In the meantime [AC3] will explore setting up a Facebook Page. Areas to continue with existing social media resources but an official, electronic WLT-CC awareness and information source is needed*" (M9, 3). In 2018, a volunteer shared a new website platform link via the KirMiTS WhatsApp group: "http://saveourtoads.co.za 💔"" (WA, 38). The website 'Save our Toads' (see Figure 4.6) was designed and developed by a volunteer with the purpose of sharing information in video format about traffic and toad tunnels and providing a platform to recruit volunteers, motivate the need for volunteers, contact someone if a toad is found, donate to the cause and link to more information via publications or websites for Cape Nature, the Two Oceans Aquarium, ToadNUTS volunteer group (FB) and the CoCT.

Figure 4.6: Home page of the 'Save our Toads' website.

The benefit of website and Facebook platforms is that they are open to the public and anyone can join the conversation, whether they are an active volunteer, a researcher, journalist or just an interested community member. For example, there is a Facebook page entitled The Endangered Western Leopard Toad (see Figure 4.7) with over 650 members, which was set up in 2008 by three WLT-CC ACs and CO1 and has provided a platform to share interesting stories, photographs, statistics and relevant information regarding the species. The public has access to this platform and can contribute through sharing their opinions and insights.

The challenge with platforms being set up on social media is that there can be multiple Facebook pages representing different elements of the initiative maintained by different members or multiple ACs, which can be confusing for participants trying to locate relevant, centralised information and up to date contact details. For example, there is a ToadNUTS group, a ToadNUTs page and the Endangered Western Leopard Toad page on Facebook, which are different platforms with slightly different purposes that can cause usability issues for the public. Each community is independent and has their own platform and some areas do not have a Facebook page.

Figure 4.7: A Facebook platform enables the public to share motivational stories, awareness and information.

4.3.1.4 Data Collection Platforms

To assimilate data into one platform so that it can be stored and accessed by the public and researchers, the WLT-CC have utilised various citizen science platforms over the years, such as iSpot and iNaturalist (Figure 4.8). In 2011, CC1 shared with the committee that the "*new upload your toad interface is available for use and that images can be sent to http://za.ispot.org.uk/node/137767*" (M3, 5). However, this platform took a large amount of time to upload images one by one and was therefore not user-friendly. As AC1 explains, "*iSpot is a fantastic tool for…identification and [CC1] wants to use it as a record of all the toads every year. The difficulty with iSpot, is that it takes seven minutes to upload one toad, now if you're picking up 100 toads in a night, which we are, who is going to do that?"* (INT_1 42). In 2017 and 2018, CC1 changed the collection portal to iNaturalist, asking volunteers to test it and report back on whether it was more user-friendly (M9, 4) explaining that "*the tools are far more versatile on iNaturalist than on iSpot*" because, ultimately, the platform needed to provide graphs of the deaths versus lives (INT_3, 110). The volunteers share their data with the ACs and either upload the information to the data platform themselves or the ACs collate all the data at the end of the night, week and season and share it with the WLT-CC, uploading it onto the platform themselves.

Although there are many platforms that assist in collating and disseminating information, there is no overall database that the WLT-CC uses that provides safety and longevity as well as feedback with regards to important information. For example, AC2 shares, "*if I should move to England tomorrow, you know who all my people are, so you don't lose 30, 40 volunteers, 10 years' worth of [sic] smirking [sic] and begging people to be volunteers*" (INT_2, 94). ACs and volunteers often request feedback from their data collection "*because, if [they] know what they have discovered about the toads, then they can inform how we operate*" (INT_2, 94). If there is no central platform where all the data is stored, not all the information is evident and therefore trends, patterns and decisions cannot be inferred with certainty.

CT1 explains that there is a "*huge amount of information that needs to be looked at by someone and there isn't always the capacity within organisations to do so*" (INT_4, 61). It is not only the lack of a platform to share information but the lack of a role to manage the high volume of information that is generated annually. Data generation and knowledge production assists in keeping the initiative going as it motivates

volunteers, informs the public and assists in management of monitoring efforts. The data collection, storage and feedback are essential in unifying the 'nexes of practice' around the shared interest.

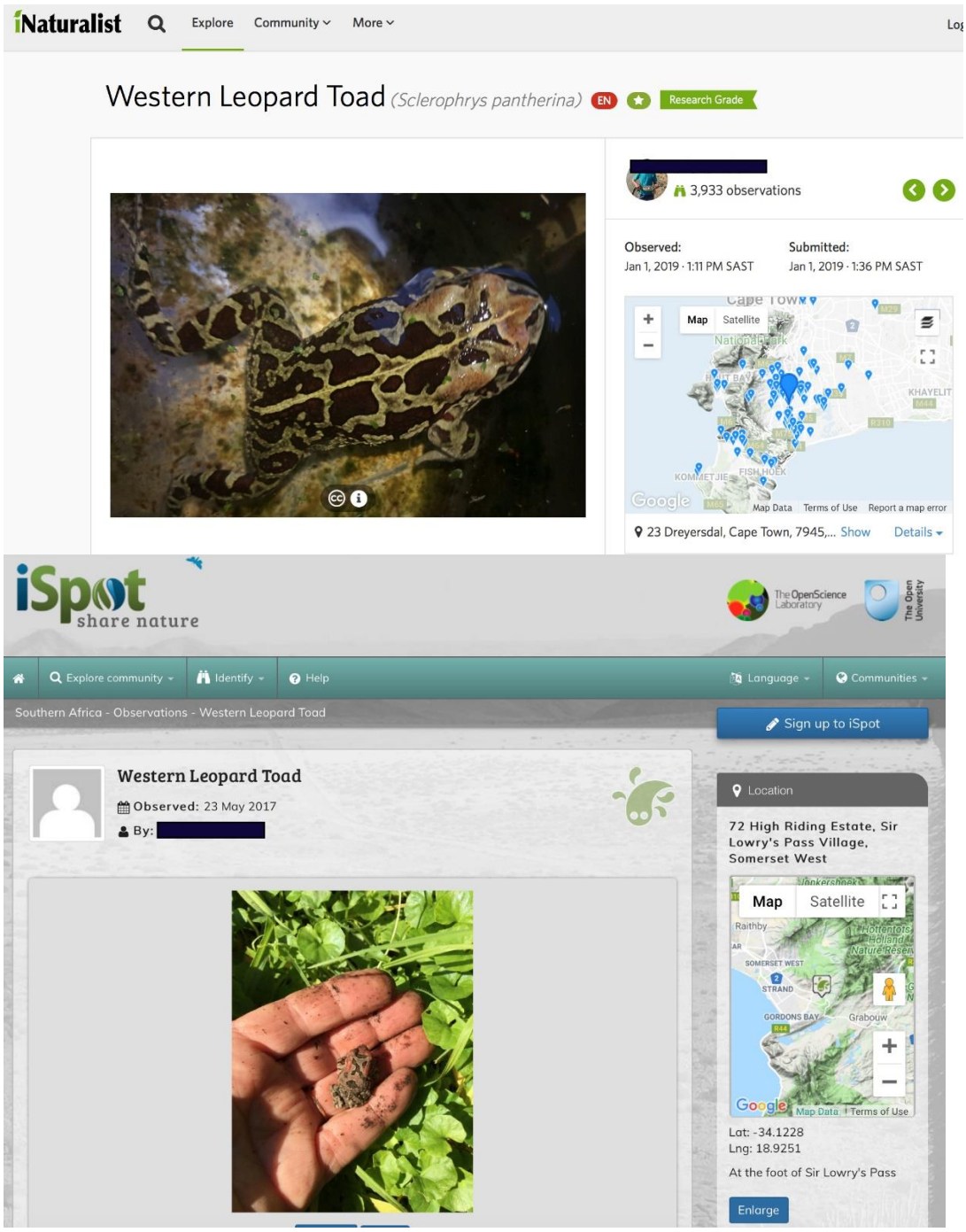


Figure 4.8: Examples of data being recorded on iNaturalist and iSpot.

4.3.1.5 Area Coordinators

Another form of knowledge-sharing is the AC role. As depicted in Figure 4.9 the ACs deliver information within their volunteer groups, on various platforms as well as back to the committee and serve as an important link in the communications chain in the WLT-CC landscape of practice. As CT1 describes, ACs take information that is sourced through the committee to members of the public in various residential areas. As CT1 shares, ACs not only represent the people and the issues that come up within their areas but also feed information back to their communities (INT_4, 10). CO1 similarly explains that the ACs are involved in multiple avenues of communication; they collect data with their volunteers and "*everyone would share their data at the end of the night and then that coordinator would feedback generally at the end of the breeding season*" (INT_5, 42) to both the committee and the volunteers. ACs not only communicate within and between multiple 'nexes of practice' (see Figure 4.9), they also assist in sharing information across the different volunteer groups, which helps inform their practice during the season. For example, AC2 explains to her volunteer

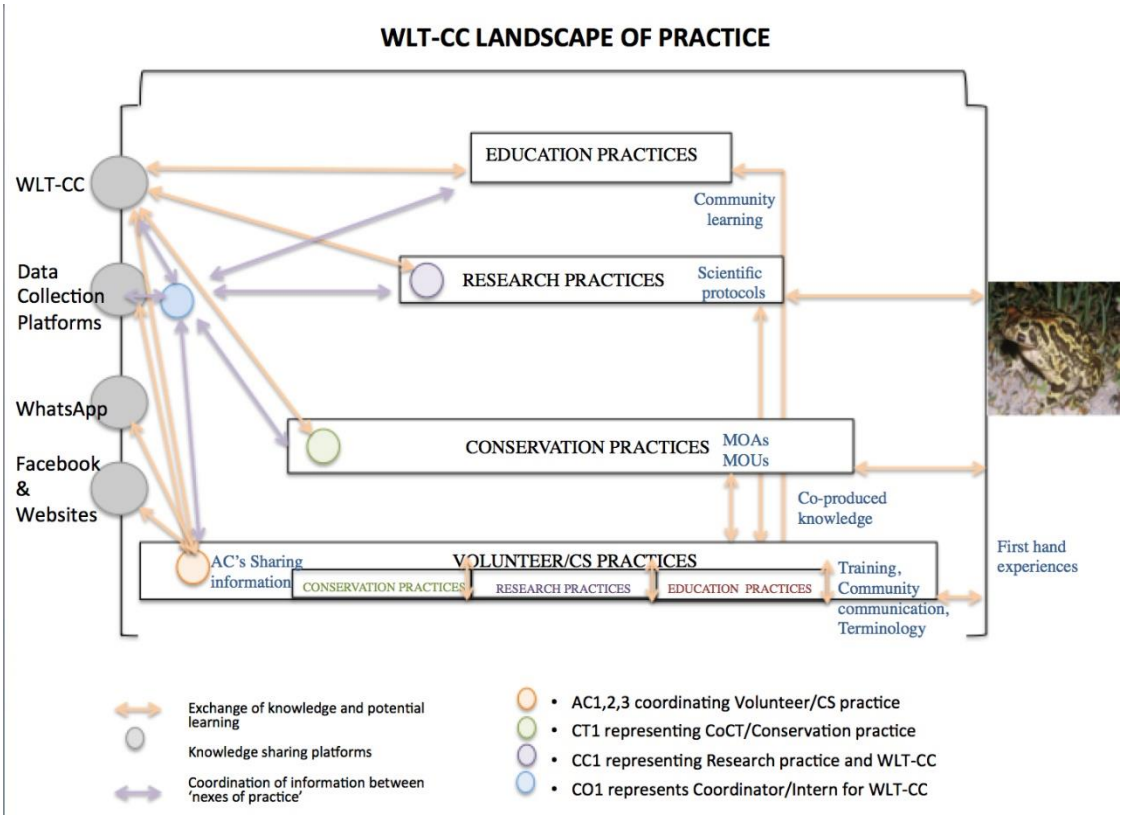


Figure 4.9: Social learning interactions and knowledge production in the landscape of practice.

group (KirMiTS) that "*ToadNUTS did have a little bit of movement last night,*" (WA, 21) indicating that their volunteer roster may kick in soon as the toading season had started in other areas. Similarly, volunteers communicate and share information about which areas have seen toad activity before and during the breeding season. On the KirMiTS WhatsApp group locals communicate toad movements in multiple areas; a volunteer asks, "*good afternoon can anyone let me know if the toads moving?*" To which AC2 replies, "*I will ask on the Bergvliet group*." After asking the Tokai volunteer group she responds, "*answer is no*". The volunteer then shares, "*neither has Tokai guys, very strange"* (WA, 17). This conversation is an example of how various WhatsApp groups can assist with knowledge-sharing and local insight into toad movement, which ultimately informs volunteer practice.

4.3.1.6 Training and Education

Additional methods of knowledge sharing are training and education. As explained in 4.2.5, volunteers learn through engaging in 'toading' activities and through annual volunteer information sessions. Practical knowledge and learning occur best when ACs create partnerships between experienced and novice volunteers who can go out 'toading' together. As AC2 explains to a novice 'toader', "*I will meet you the first time you come or pair you up with an experienced KirMiT, you will become experienced yourself within one day*" (WA, 5). The WLT-CC also utilises researchers, guest speakers as well as independent contractors to inform the committee and assist with the protection of the toad; as discussed in the WLT-CC meetings, the committee helps address "*the need to train contractors annually on identifying toads and what not to do"* (M2, 3).

4.3.1.7 The Western Leopard Toad Conservation Committee

The WLT-CC evolved into a coordinating platform assisting with knowledge sharing across practices. As CT1 expresses, during its foundation years,

> *there [were] a lot of little bits and pieces happening, but the idea was that this committee would then coordinate all of that and form basis of support for all the organisations primarily but also just kind of make sure that the initiatives are coordinated and moving in the same direction and actually moving forward*. (INT_4, 6)

In terms of legislation, CC1 explains that the WLT-CC is an informal organisation and steering committee: "*So it's our job to make sure that all the management recommendations are carried out and, and the monitoring is done*" (INT_3, 14). AC2 shares that the WLT-CC tries to "*coordinate efforts to understand where everybody's at, what developments there have been. What we need to be thinking about, alerting one another to issues that we may not have had an opportunity to alert one another to prior to that*" (INT_2, 60) through meetings and communications. CT1 adds that the meetings function as a place "*where everyone can talk face-to-face to each of these entities*" (INT_4, 85) to identify challenges. The meetings allow different 'nexes' to discuss their field observations of what is or is not working: "*which is always the best platform where everyone is around the same table and can brainstorm*" (INT_4, 63). CT1 continues that the "*relevant committee member that has probably the best scope to deal with the issue takes it on*" (INT_4, 63).

4.3.1.8 Conclusive point

As highlighted above and illustrated in Figure 4.9, there are various knowledge sharing and data capturing strategies that enable the flow of information to extend to multiple participants between and within the multiple 'nexes of practice' in the WLT-CC landscape of practice. Various platforms (Volunteer WhatsApp groups, Websites, Facebook and data collection platforms) allow for instant communication so that members of the public feel involved in the production and sharing of information. These platforms provide communicative coordination, organisation of volunteer action, recruitment avenues and awareness campaigns and encourage multiple participants with diverse expertise to engage in conversations regarding the monitoring and protection of the western leopard toad species. The role of ACs has become pivotal in linking information and knowledge between the WLT-CC, the volunteer groups and the public. Various training and education strategies, such as information sessions, practical 'toading' through partnership work and training independent contractors, have become important in sharing valuable findings through research projects and knowledge regarding the species and its behaviour over time. These strategies help generate and circulate various forms of knowledge across the WLT-CC landscape.

4.3.2 Forms of Knowledge Circulating in the WLT-CC Landscape

4.3.2.1 Field Based 'Real-time' Knowledge

During the breeding season volunteers from different areas share stories and events with one another and communicate as a team. This community engagement allows for the sharing of individuals' learnt experiences but also encourages collaboration, participation, support and cohesiveness. Participants feel that they can share both negative and positive stories with their communities of practice. For example, AC1 calls for participation before heading 'toading' one evening: "*Seems we have only one team. If anyone can join, please let me know*" (WA, 11). Afterwards, she shares how disappointed she was having lost toads due to low volunteer numbers: "*It would have been good to have one more team. Feeling very deflated with my two dead toads*" (WA, 12). She shares this to motivate and encourage volunteers to participate and to prove that low volunteer numbers can directly affect toad mortality.

Positive communications occur between volunteers and independent institutions through feedback, which lets volunteers know that they are having an impact on toad rescues. Volunteers share good news about the status of an injured toad: "*healing well, stitches are holding, and should be due for release soon. Anyone know where it was picked up?*" Another volunteer and the AC responded to this, "wow wonderful," and, "thanks for the update" (WA, 20). This shared information encourages participation and motivation for volunteers and builds a sense of community effort. Similarly, positive feedback is given to the WLT-CC through AC report back information. For example, AC2 shares in a committee meeting:

> *The one other thing which is really cool is that we had the lowest death rate which was 10%, 10% might sound high, but for Noordhoek it's very, very low, it used to be like 30%, so I put that towards the volunteers*. (OBS_1; 1:02:24).

Another example of community communication is sharing information about first-hand experience regarding safety on the roads. AC2 shares information with the volunteer group regarding which roads to use and avoid: "*It's that busy section of road from Stonehurst to Steenberg Road. Please look after yourselves*" (WA, 26). Similarly, ToadNUTS founder, AC1 commented at a WLT-CC meeting "*on the dangerous conditions on Noordhoek Main Road caused by speeding motorists,*

highlighting the area for having a 29% road kill to live ratio and as being a human safety hazard" (M3, 3).

Lastly, ACs make use of a WhatsApp group that joins all members together on the same communication platform, which encourages day-to-day communication on rostering, data collection and questions the volunteers may have regarding 'toading' practices and can also be used to answer pressing questions while out in the field. For example, (see Figure 4.10) volunteers capture images on their smart phones while out moving toads; they collect the relevant data (location, size, gender etc.) and can immediately share not only the image of the toad but also the attached statistics. The volunteer group can see what work is being done and the AC can save the images and statistics more efficiently. The WhatsApp group is a responsive, reflexive tool that encourages communicative coordination and helps inform multiple people about the context of their work. For example, a volunteer shares with the entire group information regarding a busy event that would bring heightened traffic to a western leopard toad breeding area: "*KPS have their annual concert on again tonight so more traffic in that area to be expected. Hope the toads keep off the roads tonight* " (WA, 38).

4.3.2.2 Terminology, Species Identification and Behaviour

The WLT-CC landscape of practice involves multiple areas of expertise, from local first-hand experiences to researchers' understandings of phenomena. The first form of knowledge evident in the WLT-CC landscape of practice is the committee members and volunteer groups' acquired knowledge of species identification, behavioural patterns during the breeding season and terminology to use when sharing information with each other, so that there is mutual understanding. For example, at an information and recruitment session, AC2 speaks of 'amplex pairs' and toads being 'in amplexus', which is the mating position of toads where the male clasps onto the back of the female. This terminology is used by volunteers when identifying this phenomenon out in the field: "*first amplex pair reported alive in [address] Kirstenhof this am" (WA, 3).* Such information is important in understanding breeding sites, patterns and timing. Another example of terminology used and understood by the volunteers, researchers and conservationists is the term 'percentage dead'. AC2 explains,

> *percentage dead is, of all the toads we observed, what percentage were dead, so that's a very important point to compare against because it tells us, that's*

really the more accurate of all our numbers, it tells us how successful we are at our road patrols. (OBS_2, 13.45)

Accurate information regarding the identification of the species has been shared over the years, which has informed the practice of protecting the species. CC1 describes how the unique markings of the toad as well as its shape can assist in better identifying the species out in the field. Through the WhatsApp group, the KirMiTS volunteer group have been able to assist volunteers in the field who are uncertain as to distinguishing between female and male toads as well as whether the females have eggs or not. For example, a volunteer asks via WhatsApp, "*how does one tell if the female has eggs? 2 enlarged areas, 1 on each side when turned over?"* AC2, who has more experience in western leopard toad identification responds to this, "*they have fat sides, you will get used to telling, and will know especially once you have seen the little flabby sides of a female who has released eggs,*" (WA, 8). This learning occurs through sharing images and information while in the field and, with experience, volunteers become better at identification.

Even though over a decade of work has informed the WLT-CC of typical western leopard toad breeding behaviour, AC2 shares that, due to social (lack of volunteer capacity and platform changes) and ecological (weather) variables, every year is slightly different. Volunteer practice needs to be responsive when the toads emerge: "*The males go down to the ponds first and then sometimes a few hours later or sometimes a few days or even weeks later the females follow*" (OBS_2, 3.50). The ability to identify this this difference between hours, days and weeks is an important form of knowledge to minimise toad mortality. Therefore, becoming more knowledgeable about toad movements and behaviour equips volunteers to identify hotspot areas and record accurate information, ultimately allowing for effective monitoring despite the unpredictability of the species. Accuracy and reliability come from the methods through which the information is collected, shared and understood.

4.3.2.3 Scientific Protocols

The second form of knowledge is related to how participants create knowledge and learn through using scientific protocols or collection methods while gathering data. Here, researchers advise that specific scientific protocols should be followed when collecting and uploading data to maintain standard practice across various contexts.

This is highlighted from the WLT-CC minutes where sample forms of scientific protocols were discussed. CC1 expresses that the only numbers required for data analysis are "*male, live; female (gravid), live; female (empty), live; amplexus pairs, live; juvenile, live; unknown, live; male, dead; female (gravid), dead; female (empty), dead; amplexus pairs, dead; juvenile, dead; unknown, dead*" (M4, 2).

In practice, information that is collected from 'toading' is documented by the volunteers through citizen science protocols so that the information can be shared and used for hotspot identification in breeding areas. This in turn affects the future practice of volunteer efforts. An example of this data collection in the field according to specific requirements is expressed by a volunteer: "*1 x female post eggs - location [address]. Female post eggs location – [address]" (WA, 33).* Another volunteer shares*, "total for the night (mainly Oranje & Altenberg) - 4 Amplex Pairs (one a drain rescue) 11 Males, 2 Females and unfortunately 2 dead*" (WA, 34).

A conversation on WhatsApp between a volunteer and AC2 highlights how ACs assist in strengthening scientific protocols and the collection of data by responding immediately to questions when volunteers are in the field. A volunteer asks, "*Do we need to measure the length of both male and female in an amplexus pair? So on I-Naturalist it would be 100mm and 80mm for example?"* The AC responds, *"Don't worry to measure. Just put the ruler in the photo and the computer software will do the rest*" (WA, 8).

Sometimes the volunteers are taught about the various projects their collected data has contributed towards and are informed of any specific scientific protocols required to support scientists and researchers accurately. For example, a researcher studying genetic diversity in toads noted that they need to decipher optimal sampling periods to assist with population size estimates and habitat use; she noted that a key aspect of genetic modelling to monitor genetic diversity was to collect "*50−60 samples (toe clips or road kill) from 2017 or 2018*" (M8, 3).

In the case of the WLT-CC, accurate scientific data is valuable when it contributes towards conservation measures that monitor and manage the western leopard toad species. CC1 explains,

> *The city won't just allow us to come along and say we need a road calming measure here, they want to see the data saying where there're kills. How many*

got killed, is it? Um, so that's where the data becomes crucial. (INT_3, 48)

As seen in Figure 4.10, data is attached to images that volunteers capture in the field indicating the toad size (in cm), the time the photo was taken, the gender of the toad and, depending on the groups' scientific protocol, the location or coordinates. The ACs collect this information and collate the data at the end of the season and it is then reported back to the WLT-CC to provide knowledge regarding the breeding behaviour and population. CT1 explains that the volunteers "*effectively take photographs with coordinates of individuals and obviously the photographs are quite nicely described and also take it from straight up, give a size reference, you know, those things that could make them comparable*" (INT_4, 61).

Members of the WLT-CC believe that the use of standardised scientific protocols needs more consistency across volunteer groups and breeding areas as collection methods vary by location due to differing resources, volunteer participation, safety and other external variables. AC1 argues that, due to methods evolving from circumstances in different areas, the data collection is slightly different across the board, which subsequently affects results (INT_1, 86). AC1 points out, for example, that Kirstenhof has street lights and shorter roads so the volunteers can walk and collect data; however, in Noordhoek, the roads are traffic heavy and busy with toads therefore volunteers must drive and often don't have time to collect all the data but instead save the toads (INT_1, 86). These protocols differ from researchers'

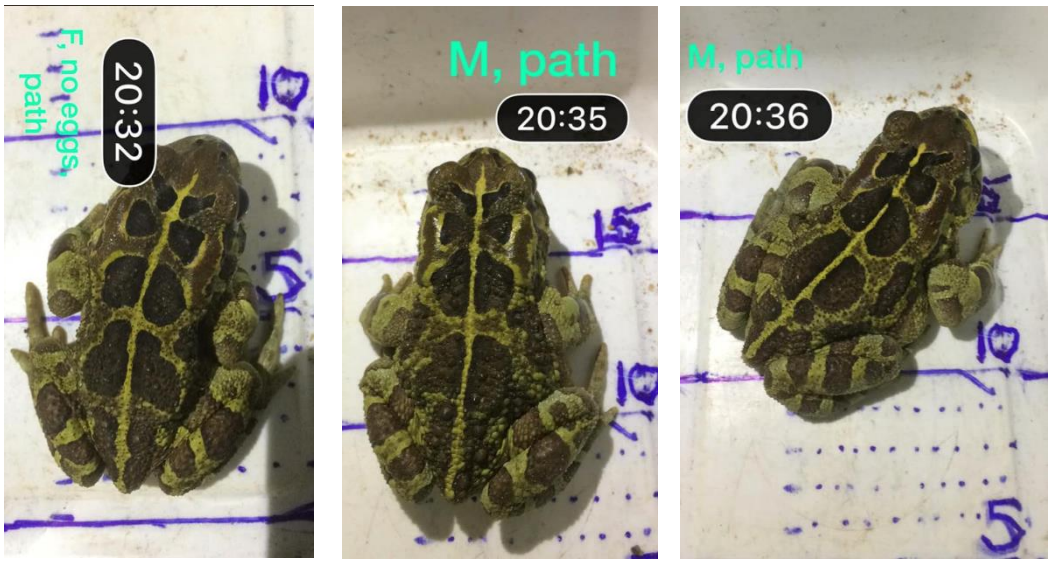


Figure 4.10. Examples of shared images of western leopard toad data from the field on WhatsApp groups and Facebook

expectations and these complex practices affect how knowledge is produced in the WLT-CC landscape of practice.

4.3.2.4 Conclusive point

WLT-CC participants' engagement through various strategies has generated diverse forms of knowledge, such as first-hand experiences shared through story-telling, disheartening accounts, positive feedback or warnings about road safety via valuable WhatsApp groups. This useful tool has assisted in information sharing and immediate feedback. Likewise, scientific protocols have enhanced standard data collection practices across the landscape of practice. However, although volunteers have designed methods to assist their work in the field (photographs of data shared via WhatsApp), improved consistency across the landscape is required. Lastly, participants have learnt about the conditions and behaviours of toads and accumulated knowledge by engaging in multiple practices over time. This has informed joint decision-making and cohesive information sharing and has helped build a foundation towards a 'social body of knowledge' around the western leopard toad species.

4.3.3 Co-production of Knowledge

Knowledge is generated in multiple ways within the WLT-CC landscape of practice. As highlighted in section 4.3.1 and 4.3.2, diverse forms of knowledge have been produced and shared via collaborative knowledge-sharing and data capture strategies. This knowledge has significantly contributed towards the WLT-CC's 'social body of knowledge'. Volunteer monitoring efforts (through species identification, community communications and data collection) along with researchers' expertise (through scientific protocols and sharing findings) and conservation entities (implementing collaborative MOAs and memorandums of understanding (MOUs)) generate knowledge either for short-term results or towards a long-term body of knowledge. In other words, since its formation, the WLT-CC landscape of practice has generated knowledge that has answered specific questions, addressed knowledge gaps or explored the need for an intervention. They have also generated knowledge through a constant collection of information to identify themes, patterns or trends for historical comparison. An example of knowledge creation in response to short-term questions is researchers' investigation of tadpole growth and water quality in western leopard toad breeding ponds: "*tadpole length and growth can then be measured from photos using*

software, and this linked to various water parameters can assist in identifying factors influencing the developments of tadpoles" (M2, 2).

4.3.3.1 Building a Collective Body of Knowledge: Some Examples in Practice

Example 1: Data revealed how volunteers and researchers used their unique areas of expertise to collect and create valuable information together. A researcher conducted a comparative genetic analysis with the help of volunteer data collection between leopard toads in the Cape Metro area and the Overberg area. Historical data as well as current data compared across areas and over time contributed significantly towards a collective body of knowledge as the information was collated to identify similarities, differences and trends that could ultimately assist with potential management decisions (M2, 2).

Example 2: Over time the WLT-CC has distinguished between pertinent threats to the western leopard toad species and those that are no longer an issue. CC1 explains that the committee's initial task was to better understand what negatively affected the western leopard toad population growth, such as "*electric fences, ducks, alien ducks, alien fish, um, filling in of the wetlands, damage to the wetlands and then [the toads] getting ridden over on the roads*" (INT_3, 4). After engaging with multiple stakeholders in the various 'nexes of practice', they began to learn about what caused the most mortalities, which ended up being fatalities on the roads. WLT-CC representatives could then make management and monitoring decisions together according to the shared information. Through joint research objectives and shared expertise, a greater understanding of the species and its behaviour was built over time with contributions from multiple individual efforts collaborating to form a 'social body of knowledge'. This finding focused collective activity within the landscape of practice over subsequent years and provided a knowledge base for new members joining the community.

Example 3: The WLT-CC helps organise information from all the 'nexes' and shares knowledge regarding the western leopard toad species across the landscape and to the public. In 2009, CO1 and the previous chairman collated resources and information from all 'nexes' and produced press releases of breeding season results to be shared with volunteer groups and groups of reserve friends (M1, 2). Similarly, in 2016, the CoCT, ACs and volunteer groups convened their areas of expertise and

local knowledge to co-create migration maps to assist the CoCT in highlighting breeding sites and areas scheduled for mowing, clearing and dredging to prevent impacting the toads (M7, 3). AC2 expresses that sharing information across the landscape of practice and back to the volunteers is essential in keeping everyone invested in the same cause: "*Instead of like just me or just [AC1] keeping the information to themselves, now that it's on the group, everybody knows and everybody becomes an AC, because the information is shared. So it's very powerful like that*" (OBS_2, 29.47).

Example 4: Collective research initiatives build over time. In 2016, a researcher shared a 'Tunnel of Love' presentation to the WLT-CC to create awareness regarding toad road kill prevention and proposed a possible road kill mitigation measure (M7, 4). In 2017, an underpass project researcher "*reported back on the prototype developed in this past season*" (M8, 3) for a tunnel and provided advice on the developments moving forward. It was suggested that experiments on tunnels were required to test the strength of suitable materials and the design needed to be approved by CoCT (M8, 3). AC2 reported that she was "*working with CTEET to identify areas in which tunnels could be installed and this [would] contribute to the quotation need by the funders*" (M8, 3). The research conducted in 2017 helped inform the decisions and practice in similar initiatives in 2018. For example, in 2018, a proposal, which "*entail[ed] the actual construction of a working toad tunnel concept*" (M9, 2), was used to inform how effective tunnels could be in reducing toad mortalities during breeding seasons. This example provides evidence that multiple individual efforts and joint expertise is needed to co-produce knowledge over time and that multiple efforts from various 'nexes of practice' are required to build a 'social body of knowledge'.

Example 5: The co-production of MOAs and MOUs between multiple 'nexes', institutions and organisations. In 2009, the WLT-CC along with CoCT considered documenting and agreeing upon catchment management and mitigation of public mowing to protect the toads (M1, 2). CO1 drafted a letter for circulation to the committee: "*the contents hereof [would] remind CoCT managers of the MOA agreements with City Parks and Catchment Management. This should stipulate the periods during which mowing and dredging of watercourses must be avoided*" (M5, 3). Community members also participated in preparing individual and combined

letters that voiced concerns for the species (M5, 3) and a co-produced representation of all ‘nexes of practice’ was voiced. This collaborative effort and understanding have been the foundation upon which monitoring and management of specific areas and species has been established to protect not only the western leopard toad species but also biodiversity as a whole moving forwards.

Example 6: ACs together with volunteers produce important information from the field each season to be shared with the WLT-CC landscape of practice. ACs and volunteers collect data throughout the breeding season from each night out ‘toading’. Their statistics and numbers of toads are shared via WhatsApp; the ACs then create a report with regards to the scientific protocols discussed at the WLT-CC meetings prior to the season including total numbers (alive, dead, gender, amplexus pairs, dates, location) and they report these final statistics to their individual volunteer groups and the WLT-CC at the end of each season. Volunteers have been collecting ‘toading’ data for years and have saved their individual volunteer group data over time, building their own separate ‘social body of knowledge’ within their ‘nexus’. Most of the ACs have their own individual data collected, collated and saved, but it is not all convened with other volunteer groups on one public platform that can be accessed by those requiring the information, which could be problematic for analysis, understanding and feedback for decision making. ACs collate the information from their area and report a total number and summary to the WLT-CC. AC2 shares, "*I've got like reports from, I think my reports started in 2010/2009, when I became a volunteer and not just running around with [CO1]. And so I've got nearly 10 years' worth of data*” (INT_2, 68).

Although there is no WLT-CC convening platform for all ACs to utilise, the end-of-season data is collected by the chairman, saved for the year and, depending on what platform is being used at the time, uploaded onto a public data-sharing platform or saved in multiple formats on the chairman’s computer. The data that is shared with the committee at the end of the season reflects breeding area total numbers. For example, AC1 shares, “*the final count from Noordhoek for 2009 was 140 alive & 43 dead,”* (M1, 2) and CC1 similarly reports from another area, “*overall result of 868 alive toads and 195 road kills. A total of 27 new breeding sites were added to the breeding site list,*” (M1, 2). This knowledge helps build a greater understanding of the toads in the local area and keeps each ‘nexus of practice’ on the same page with

feedback from the season from different areas. It also provides a story about toad numbers over time, enabling researchers and volunteers to track trends and sudden shifts in numbers and toad movements.

4.3.3.2 A Managed Platform is Pivotal in Helping Build a Collective Body of Knowledge

A managed platform can increase access to data moving forwards as it is vital to understand how information has, for over a decade, contributed towards the WLT-CC's 'social body of knowledge'. Knowledge of the western leopard toad species and its behaviour has been continuously built through individual effort, volunteer work on the ground, research projects, conservation monitoring and management.

Example 1: ACs wish to feel more connected and central to the knowledge and feedback. The AC for the ToadNUTs volunteer group expressed,

> *my whole goal is to create longevity for ToadNUTS. I don't want this all, all the work we've done to collapse… I wanted my volunteers to feel plugged-in. I don't want us to be this outlier kind of maverick. I want us to somehow be more centralised exactly into something*. (INT_1, 28)

A suggestion on how to strengthen this connection to the information is to create a secure space or platform for this 'social body of knowledge'. CT1 expresses that what would "*be incredibly valuable, which we tried to do,* is *to get a library built up for all the information, all the research that has been done on western leopard toad specifically and keep that in…general locality*" (INT_4, 55). If one could get all the knowledge that has been produced saved into a central place, it would secure it for educational activities, research and conservation initiatives and for future decision making.

Example 2: A safe and sustainable platform is needed for information to be saved and monitored over time. Previously, the chairperson stored this information for the WLT-CC and, along with the help of an intern, was able to manage all the data. However, "*his computer crashed and he lost everything*" (INT_2, 68). Therefore, to create a central accessible space for the WLT-CC's collective body of knowledge, CT1 recommended that all research, papers, articles, journals and specialist assessments that have been created for the western leopard toad over the past decade be "*sent to her in order to start a western leopard toad database. [CT1] will*

coordinate this for all to have access" (M9, 5). AC2 recommended that the WLT-CC ask a conservation entity like EWT, "*can we put it on your website? Can we put it on your database? Because then you can provide database to any authority*" (INT_2, 70), any individual or group of people wanting access to that information or feedback on what their actions have achieved.

4.3.3.3 Conclusive point

Figure 4.9 illustrates the pivotal social learning interactions that occur across the WLT-CC landscape of practice which have contributed towards the collective 'social body of knowledge' over the past decade. This body of knowledge has become an important foundation upon which multiple decisions have been made and it has helped inform current practice. Figure 4.9 indicates how volunteers and researchers co-produce information through engaging with the western leopard toad species by utilising scientific protocols and sharing the data collection with the WLT-CC and onto various platforms. Another example is how volunteers, together with conservation entities, produce MOA and MOU documents that are shared with the WLT-CC to receive comment from all the representatives on the committee before being shared publicly. As illustrated in Figure 4.9, the position of the WLT-CC is a valuable platform in organising and sharing information from all the 'nexes of practice' across the landscape of practice and to the public.

4.4 Boundaries Experienced in the Landscape of Practice

Wenger-Trayner et al. (2015) argue that boundaries are unavoidable in 'Landscapes of Practice' as they reflect the natural restrictions of human engagement and practice in society. The authors identify five overarching boundaries that affect practice and potentially limit engagement in landscapes of practice and require negotiation to successfully reach commonalities and "renew learning" (Wenger, 1998b). These boundaries involve dynamics related to: 1) practices; 2) institutions; 3) scale; 4) power relations; and 5) time. In the following section, I discuss the boundaries identified in the WLT-CC and their relevance for practice.

4.4.1 Engaging in Complex Practices

As Wenger-Trayner et al. (2015) note, practices can often overlap and interrelate or are unrelated and can compete with one another. An example of this in the WLT-CC

landscape of practice, is how research and volunteer practices engage differently in relation to a shared interest. People in each 'nexus of practice' have different expectations of data collection methods and objectives based on the primary interest in that nexus.

4.4.1.1 Differing Practice Expectations

Volunteers on the ground believe that "*rescue comes first, recording the data, comes second*"; AC1 explains, "*data collection is really important to us, but saving lives is more important*" (INT_1, 58). Volunteers make this a priority as they witness the roadkill first hand and are at the urban-wildlife interface. AC1 describes how volunteers are often in a situation where there are toads about to be run over and volunteers have a decision to make: "*are you now going to slow down, take the photograph of that toad and potentially allow that toad to be run over. My answer to that is no, data is second*" (INT_1, 58). ACs have created a protocol around this and they train their volunteers accordingly. Researchers on the other hand, require the data to make informed conservation decisions towards protecting the species. As CC1 explains, "*it's difficult, getting people motivated to make them think that, make them realise that the data is so useful*" (INT_3, 48). He shares that volunteers are "*contributing to citizen science, but that's not their focus, ya, their focus is saving toads. Yeah. You know if they were short of time, or anything they would give up on the science then, they would just rescue more toads*" (INT_3, 44). Both areas of practice contribute significantly to the protection of the toads; however, the difference in methodology and objectives affects and limits the practices that contribute towards collaborative knowledge-production and learning.

4.4.1.2 Lack of a Standard Scientific Protocol

Another example of this complex practice interaction is how researchers follow particular scientific protocols and expect a standardised sample quality from the field, whereas volunteers who are civilians and not trained in this area of expertise are not aware of the processes researchers require. For example, the AC of Observatory shares that although the researcher required genetic material samples from 60 toads, she didn't want her toads to be toeless from the extraction. The researcher replied, "*it's just, its only taking a portion of it*" (OBS_1, 11.13). Volunteers advocate for the toads' well-being and believe that researchers should use best practice when

collecting their data. For example, AC2 recalls how one year a university student "*freaked [the] volunteers out because she was taking blood samples and they felt that she wasn't doing it very nicely, so they refused to work with her. So that was very interesting*" (INT_2, 54). This boundary comes from a lack of identification with and reflection on each practice causing a lack of collaboration as well as differing understandings of ethical practice while working on joint enterprise.

ACs explain that they don't feel they have the scientific knowledge, literacy or backing to support the researchers. One claims, for example, *"[we don't] have the science to be able to prevent double counting, so we call them observations*" (OBS_2, 7.43). The researchers believe that the volunteers don't have standard methodology or protocol to deliver accurate statistics: "*How did they collect it? How accurate were they, how many streets away did lots of them get killed, and nobody knew?*" (INT_3, 50). Due to there being separate volunteer groups in different areas, each AC operates differently and therefore produces different reports in different formats. CC1 explains how incompatibilities occur due to how the data comes in: "*Some of it's paper and some of it's electronic and some of it's on excel and some of it's on databases. So it's very difficult to collate that*" (INT_3, 84). CO1 similarly shares how volunteer groups don't follow the same methods due to contextual or external factors:

> *On a busy night there lots of toads, you just move them and you say, okay, those are seven toads, there four males, three females roughly this size; versus putting each toad on a page and measuring them with, uh, with like a grid behind them so you can get exact size, which is probably really important for the science.* (INT_5, 52)

He shares that if accurate science is required for a population census, to understand an average toad's lifespan or to contribute to a long-term study, one would need to have greater resources (INT_5, 52). Volunteers have requested assistance from the WLT-CC on how to achieve better accuracy as they have useful and valuable data to share. AC1 explains,

> *we never yet been able to get anybody to help us with putting together a prediction model. We have 11 years of data, but we don't have a prediction model and that would be so helpful to us to know something like there's an 80 percent chance tonight that if there is rain that the toads would walk. Because*

historically we have these patterns. (INT_1, 10)

Due to the lack of standard protocols, varying methods as well as the lack of a platform to share the various collected data, there is no clear idea of whether the populations are increasing or decreasing. As expressed in WLT-CC minutes, in 2016, "*This year was difficult for some groups, statistics-wise as there were several options available for reporting and the data collation became complex*" (M7, 4). AC1 shares that this is the volunteers' primary predicament. She expresses, "*that's always our dilemma, we don't know if the work that we are doing is making a difference because our observations are just observations,*" (OBS_1, 14.31). This complexity of practice across the landscape can cause a limitation in knowledge-sharing, learning and accurate feedback, as well as sustainable data use for decision-making.

4.4.2 Complex Institutional Practices

Wenger-Trayner et al. (2015) highlight that landscapes of practice must negotiate complex institutional practices, which have specific policies, structures and politics that need to be navigated to collaborate and progress. Each 'nexus of practice', which represents various institutions, may be involved in the WLT-CC landscape of practice at different levels, locations and times.

4.4.2.1 Differing Time Schedules

The WLT-CC works with representatives from City Parks and the CoCT who represent much larger institutional entities with multiple line functions and job specifications. CT1 explains that working with these larger governing bodies and making decisions is like steering a "*massive ship, like a cruise liner, and you don't do just a 90-degree turn within three seconds. It's a massive thing and your little individual efforts is like a tiny little thing*" (INT_4, 37). She explains that people work in accordance to predetermined schedules, which are established by many other factors, so things take time and must go through the correct channels (INT_4, 37). An example of how bureaucracy can affect practice was evident when community members wanted to establish a monitored breeding pond in the Noordhoek area, but CT1, who represents the CoCT, advised that they "*would require an entire EIA process*" (M6, 3) before the development could be considered. Volunteers become frustrated as they wish to alleviate issues within their local areas but require expensive paperwork and reporting as well as multiple members' input and comment to be

granted permission. Another example of this was a researchers' design for a toad tunnel that was developed and approved by engineers; however, they "*went to [their] funders, and they said no, before we build it, so before we build it, they um, want a quote on how much its gonna cost to put in tunnels across the whole of Cape Town*" (OBS_1, 40.53), which is difficult and time consuming to calculate. The project came to a halt due to the red tape needed to move forwards with the initiative.

4.4.2.2 Differing Institutional Priorities

The CoCT's representatives, who look after environmental assets, have other priorities besides the monitoring and management of one endangered species — for example, rehabilitating wetlands or rectifying sewage spills, which have a larger impact socially and environmentally and therefore require immediate attention. AC2 explains how various institutional organisations deal with issues at a macro level, noting that "*unfortunately in South Africa the authorities are so stretched and these kind of things seem so luxurious when you're trying to put toilets in for human beings and somebody says please can you look after the toads??"* (INT_2, 24). CT1 similarly states that the CoCT is impacted by social and political needs and therefore many posts are vacant; even though they are priorities, capacity hinders institutional practice (INT_4, 43). This can impact communications between the various sectors and reduce important engagement and interrelations between the 'nexes of practice'. For example, while the City usually adheres to scheduling and MOAs, operations in various areas can be miscommunicated and have various consequences. AC3 noted in 2009 that a drainage operation was conducted in a breeding area "*resulting in the water sitting at an exceptionally low level"* and as a result *"no toads were heard calling at the dam*" that year (M1, 4).

4.4.3 Scale and Location Challenges

Wenger-Trayner et al., (2015) speak of the complexity of scale, where members within the landscape participate at different levels and in different locations.

4.4.3.1 Differing Methods and Structure Across the Landscape

Volunteers on the ground operate locally when saving the toads, whereas national agencies such CoCT and SANBI operate at local, regional and sometimes national levels and must adhere to multiple policies. The level of investment of each member

may differ which can cause dissociation and lack of co-engagement across the landscape. CO1 identifies that different 'nexes of practice' flourish more than others depending on the ACs or leaders that drive practice. He highlights that there would be "*people that were quite passionate and wanted to build a local community of volunteers. Um, in other areas we didn't manage to build that structure*" (INT_5, 4); there would be no monitoring of that particular breeding area. Similarly, having various locations of practice (multiple volunteer groups spread around the city) can cause alienation or division between each group and 'nexus of practice' if they don't engage directly with one another. For example, AC1 shares that "*each of these volunteer groups is run completely differently. There's no control over it. There's no monitoring of it really, um, because it's been organic*" in formation over time (INT_1, 24). CO1 previously assisted with the coordination of this (M1-5); however, this role was vacant between 2012 and 2018. The impact of the lack of a coordinating role during this time is addressed further in section 4.4.6.

Due to each context and external factors (such as traffic, street lights, location of breeding ponds, private versus public land and funding) each of the volunteer groups have different ways of operating and organising themselves. In 2009, the WLT-CC minutes reflected that the locations of some breeding sites "*endanger toads more than others*" (M1, 2) making some sites more challenging than others to monitor and manage. A volunteer highlighted this on the KirMiTS WhatsApp group: *"just been brought an amplex pair found on main road Lakeside hit by a car."* The AC responds, "*Damn. Hard to save them on that road. [Volunteer on call] please check, but look after yourselves*" (WA, 4). This subsequently affects the efficiency and sustainability of practice and ultimately can affect results.

4.4.3.2 Differing Support Structures and Access

CO1 explains how some communities have better support, funding and involvement than others, which causes a large contrast in information sharing and data collection results. He asks, "*how do you engage different communities that are coming from different social strata but also have different needs?*" (INT_5, 60). For example, volunteer groups in Noordhoek compared to Retreat, both of which are areas where the western leopard toad breeds and resides, may have different obstacles, such as safety, to overcome while 'toading' at night, resulting in less people invested in the cause and differing fundraising capabilities (INT_5, 95). In Zeekoeivlei, although

they have had increased toad activity and calling in 2018, they are "*operating with very little capacity support. WhatsApp group [is] operational and effective, [but] serious decline of western leopard toad numbers observed over years. Population estimates needed*" (M9, 3). Another complexity of scale is that due to volunteers operating at a local level in their neighbourhoods, it is "*difficult to get all landowners to provide access to their properties*" (M6, 2) and get permission to access areas that are bound within business parks and reserves. AC1 shares that due to the nature of the dispersed locations, each entity can feel detached from the collaborative effort towards the shared interest. She expresses her concern for being on the outside and how this can affect learning and sustainability:

> *As volunteers we are kind of isolated, isolated. I don't like that. I want us to be plugged-in some way. I want us to have a home. I want us to belong somewhere where we can benefit as well from the increased scientific knowledge*. (INT_1, 100)

4.4.4 Complex Power Dynamics Limit Co-engagement

Various interactions among individuals, sub-groups and groups constantly emerge within landscapes of practice. In order to create learning relations and commonalities among the multiple 'nexes of practice', interrelations and power dynamics need to be understood and negotiated (Wenger-Trayner et al., 2015).

4.4.4.1 Complex Relationships

Within the WLT-CC, the differences identified between people and groups were due to varying expectations, methodologies, complex practices and diverse motivations. CO1 explains how the landscape has "*volunteer citizen scientists and then the official people with slight[ly] different needs and urgencies*" (INT_5, 50), which can cause disagreements and affect practice and outcomes. An example of this is one discussion regarding researcher samples and volunteer practices at a western leopard toad committee meeting:

> AC3: *I think at the beginning of the season we just need to know if people want dead toads or not.*
>
> AC2: *Ya, [Researchers name].*
>
> CC1: *There is no harm in collecting dead toads.*
>
> AC3: *No, it's not fun to do and it's very difficult to motivate…*

CC1: *No, we need them frozen for the DNA, that was decided already.*

AC3: *Somebody must keep it because I don't want to keep it in my freezer*. (OBS_1, 1:03:08)

This conversation indicates how the chairman (who is research-driven) and the volunteers (who are driven to save toads from the roads) have different expectations for the data collection process. There is an evident lack of identification of the multiple needs and urgencies of each practice. AC2 shares that some members can be more straightforward and abrupt than others, requesting immediate action that sometimes not all members can get to in the desired time frame (INT_2, 60). Complex practices of different 'nexes of practice' can conflict with one another; for example, the difference between researchers and volunteers' expectations regarding the data collection process has never really been addressed or resolved (INT_5, 52).

4.4.4.2 The Role of the Western Leopard Toad Conservation Committee

Another difference in perspective has been the varying expectation and understanding of the role that the WLT-CC itself plays in the landscape. CC1 believes that the committee serves to get together prior to breeding seasons: "*We get all the volunteers together and we tell them what they're allowed to do and what they're not allowed to do and how best to*" (INT_3, 36). This wording indicates one entity instructing another one on practices that need to be adhered to, rather than a collaborative effort. In the earlier years, the minutes reflect quarterly meetings were held, bringing multiple entities together frequently; however, in more recent years, it has been limited to one or two meetings a year and is only prior to and post breeding season for checking in and reporting back. AC1 explains that the committee sees themselves as an umbrella overseeing all elements of the initiative: "*[The] committee is supposed to be centralised. It's supposed to coordinate. It's supposed to, to hold the data. It's supposed to, um, have an overall plan of how we're moving forward. It's supposed to evaluate what we're doing now*" (INT_1, 48). However, volunteer groups feel like they have been somewhat let down by the overarching committee on a few occasions; for example, the volunteer groups in recent years have requested numerous letter heads and coordination from the committee supporting their work and motivating partnerships. An example of this was evident while fighting a development proposal that would potentially threaten the western leopard toads in their area; the AC requested official backing from the WLT-CC: "*We said, now's your time, step up.*

This is where you can help us put together a covering letter" (INT_1, 36). Upon writing the letter, the choice of wording was very interesting to the AC: "*It came out as more, we report to the committee*", as opposed to "*the Western Leopard Toad Conservation Committee works to enable and empower the volunteer groups*" (INT_1, 36), as the ACs see it.

In 2007, the formation of the WLT-CC coincided with the South African government initiating various environmental management action plans, *"which [were] an initiative whereby the minister could sign a group of interested and affected parties…and provide support for management of that problem, whatever the problem was, and specifically…dealt with animals or plants"* (INT_3, 4). According to the terms of reference of the environmental management plan, the WLT-CC chairman had to be a representative from SANBI, regardless of whether they were an animal conservationist or not, due to their research focus. CT1 shares that it is "*very effective if the chairperson is from a formal institute because that gives them [backing] authority to sit, to do certain things and also to act in a certain capacity which might be more tricky coming from a completely public [person]"* (INT_4, 89). However, CC1 explains that he doesn't really have time for it and shares, *"it's very much on the side for me. I'm not an animal ecologist, but they need someone from SANBI on the committee*" (INT_3, 4). This indicates that although a chairman has the official backing, there may be capacity constraints leading to optimal leadership and coordination of the WLT-CC.

4.4.4.3 Differences in Volunteer and Paid Commitment

There were conflicting opinions regarding the western leopard toad species being the focus for each member on the committee and a lack of understanding and identification of roles and contributions in the landscape of practice. AC2 expressed that volunteer groups have the toad as their main priority, whereas other 'nexes of practice', for various reasons, have the toad as one of many concerns (INT_2, 18). Alternatively, CT1 who works for the CoCT with many other line functions to worry about, shares that committee members "*need to realise no one would be there, if they weren't crazy passionate about it, it's completely extra*" (INT_4, 39). The lack of awareness and knowledge of what each member does may be due to people not always openly sharing during meetings what they are doing to practically save the toads. For example, CT1 continues,

> *people need to just realise that there [are] a lot of things happening from official side behind the scenes that's not always depicted clearly. And I think a mutual respect is essential for committees such as this to function optimally because people get tired, they get overwhelmed, they, it's an emotive issue and there can be scope for a lot of animosity*. (INT_4, 39)

CO1 adds that volunteers are not employed and therefore coming to meetings and 'toading' at night is use of their personal time whereas the officials care, but "*part of it is that they're actually being paid*" (INT_5, 56). In response, CT1 argues that being a part of the WLT-CC is completely extra and often officials must "*work overtime to make up for the time that you've spent sitting in this community meeting*" (INT_4, 16).

4.4.4.4 The Challenge of Feedback Across the 'Nexes of Practice'

There are conflicting ideas regarding reporting and feedback within the WLT-CC landscape of practice. For example, volunteer groups compile their reports at the end of each season and share their data with the WLT-CC; however, AC1 shares that the reverse is not true, noting that "*there is no feedback on initial reporting from the volunteers, the ACs don't know where their reports have gone? How have they been used?"* (INT_1, 58). CC1 shares that reports and documents are important but then says he himself is not sure what happens to them (OBS_1, 1:30: 51). AC1 explains that it would be highly beneficial to gain feedback and be told that "*this has been used in this way, this is for this*" (INT_1, 58). Due to changes in the committee over time, reports have not been tracked and compiled and data has been lost. CC1 argues that "*in theory the secretary's got them, but I don't think, I don't think that's being looked after properly*" (INT_3, 74). This indicates a lack of communication and coordination between 'nexes' and highlights the need for a coordinating role to convene these practices into something useful that can have a positive impact.

4.4.5 Complexity of Time and Capacity

Lastly, Wenger-Trayner et al., (2015) speak of landscapes as having complexity of time and that over time, things can change and restructure. This boundary highlights a need for coherence and continuity in relation to the shared interest for the landscape of practice to remain focused and sustainable. In the context of the WLT-CC, practices change each year due to the unpredictability of toad behaviour, toad emergence and volunteer involvement. As CC1 highlights, "*the biggest challenge of*

course, we don't know when it's going to happen," (INT_3, 116) and when it does, "*you got to mobilise hundreds of people quickly. That's the biggest, that's the biggest challenge*" (INT_3, 116).

4.4.5.1 Volunteer Participation is Unpredictable

Practice is also affected by the limited time that various stakeholders can allocate to the shared interest; for example, during the breeding season of the western leopard toad, volunteer participation is unpredictable. AC1 highlights,

> *volunteer groups by their very nature can be vulnerable to change because people are not earning a salary. They're doing it out of a kind of emotional or social awareness and people's lives change and shift and move on, so it relies heavily on recruitment and motivation*. (INT_1, 3)

Although there are rosters in place designed to share the work load, unpredictability of volunteers during the season continues to occur and can affect practice and put strain on the success of the season as well as the quality of the data collected and information produced and shared. Examples of unpredictable behaviour are anything from illness, work commitments, moving house, injury and car punctures. One volunteer shares, "*I have to look after a two-month-old baby, I haven't got any time for this*" (OBS_#1; 1:22:21); another volunteer apologises, "*sorry guys, wife is sick so I'm taking care of her. Can't come out to help*" (WA, 12); and, "*work crisis, is there anyone who can take my shift this eve please?*" (WA, 13). AC2 highlights that people are willing "*but if you don't organise them it doesn't happen*" (INT_2, 52).

4.4.5.2 Capacity Constraints

Capacity constraints have affected and inhibited practices across the WLT-CC landscape of practice. For example, AC1 shares that the information and data collected on the ground is a product of how many volunteers they have (OBS_2, 8:49). She questions if the data collected is a true reflection of what is happening with the toads each year if there are not enough volunteers on all the roads collecting data. Likewise, most of the members who sit on the committee representing various 'nexes of practice' have some capacity constraints. CT1 explains that "*either you, you are a member of the public that has a very unrelated job function that you're already fulfilling*" (INT_4, 20) or you're an official who is already stretched beyond capacity due to lack of staff and resources. CT1 explains further that there is a lack of

communication and feedback from various 'nexes of practice' "*purely because there's just a huge amount of information that needs to be looked at by someone and there isn't always the capacity within organisations to do so*" (INT_4, 61). This is an indication of how time and capacity can affect practice, and further points to the need for a convening role to coordinate efficiency of practice.

4.4.6 Lack of Coordination

Aside from the identified boundaries that Wenger-Trayner et al. (2015) recognise, another boundary became evident from the data: the lack of a coordinating entity or role that joins all the separate 'nexes of practice' around the shared interest and helps to compile valuable information and facilitate engagement. Wenger-Trayner et al. (2015) describe this role as a 'system convener', someone with the ability to simultaneously bridge two contexts through addressing common challenges and exploring "mutual learning needs, possible synergies, various kinds of relationships, and common goals across traditional boundaries" (p.100). Upon formation, the WLT-CC provided a platform to share and encourage interaction; however, more recently, the boundaries highlighted above have limited co-engagement and overlap between 'nexes', preventing continuous effective collaboration. Previously, the CoCT appointed an extension officer over a two-year contract to assist with the facilitation and communication between multiple 'nexes of practice'. This person acted as a liaison between volunteer groups as well as officials on the WLT-CC. The previous intern (CO1) reflects, "*I was sort of the interface between the node coordinators in their volunteer capacity. Um, and then the kind of official people that actually did this as part of the job*" (INT_5, 32). CT1 explains this coordinating position:

> *An official coordinator or an assistant to…the volunteer groups, but also the committee as a whole. So he would set up the committee meetings. He would take the minutes…organise a venue. And in cases like this, like where there's a development application, he would actually coordinate the comments from everyone*. (INT_4, 28)

As AC2 highlights, the current problem is that "*there isn't anybody to actually do it - the coordination*" (INT_2, 60).

As illustrated in Figure 4.4 and CT1's landscape of practice map (LOP5; see Appendix C), as well as explained in 4.2.6.1, CO1 was involved in the coordination

and organisation of multiple practices across the WLT-CC. Additionally, in Figure 4.10 and LOP5, one can see how CO1 was involved with convening information, knowledge production and learning between each 'nexus of practice'. This official role ended in 2012 and since, there have been various boundaries limiting practice and a lack of co-ordination, identification and reflection within the WLT-CC landscape of practice. AC1, AC2 and CT1 share in their maps (LOP1, 2 and 4) that there is a need for a convening or coordinating role in the WLT-CC (see section 4.4.4.) This position is highlighted as either an exterior independent position to oversee the macro initiative (LOP1), a bridge between the committee and the volunteer groups (LOP2) or a position within the WLT-CC to assist where need be (LOP4). AC2 adds that this position along with a shared platform could manage a database of valuable information, operate social media, coordinate feedback between students and volunteers, work through protocols with research bodies, collaborate on development proposals alongside the CoCT and engage with conservation entities such as SANParks and Cape Nature to issue permits and permissions (LOP2).

CT1 expresses that due to various current capacity constraints, even "*having someone that takes charge and champions just the admin, that's invaluable*" (INT_4, 31). This is illustrated in LOP4 (Appendix C); a coordinator would be helpful in fundraising, training volunteers pre-season and debriefing post-season. CT1 similarly adds that a coordinator would be able to see "*stuff coming up and manage it accordingly with more information to all the relevant bodies, would probably help manage that*" (INT_4, 41). The "*need to secure a person to act as WLT-CC coordinator [as previously done by CO1] was expressed*" and flagged as an area of importance at one of the 2018 committee meetings with opportunities to be explored further (M9, 5). AC2 shares that if someone would take on that role, where people could,

> *dump all the tasks [regarding] leopard toads onto someone and that person was just doing it all the time, we would be so much further along the road than we are. We always ask the question are like, are we really making any difference? So do, how do we know if the population is less, more, stabilised?* (INT_2, 78)

AC1 adds that people want to contribute in different ways, but "*they just need to be facilitated into doing that*" (INT_1, 88). As highlighted above, multiple members of the WLT-CC believe that a coordinating platform and role can assist with this

boundary that limits practice.

Wenger-Trayner et al. (2015) explain that 'system conveners' assist in identifying "where new forms of engagement across boundaries are likely to be productive" (p. 26) in encouraging lasting change across social systems. Due to the complexity of the landscape, the WLT-CC has multiple convening roles and platforms, which occur sporadically or when needed, and include the following:

4.4.6.1 WLT-CC Coordinator (CO1)

As explained in 4.2.6.1 and illustrated in Figure 4.4 and Figure 4.9, CO1 was pivotal in coordinating co-engagement across the multiple 'nexes of practice' in relation to the WLT-CC's shared interest. Examples of CO1 engaging across practices encouraging co-engagement are given in 4.2.6.1, where CO1 would not only set up committee meetings with all 'nexes' and take the minutes but would coordinate and monitor practices between ACs and conservation operations, such as mowing and dredging in specific locations (LOP5; Appendix C). CO1 would also assist with managing the implementation of MOAs (see 4.2.3.1), volunteer on the ground with ACs (section 4.3.1.5) and collect and collate data for researchers (see 4.2.4). This multifaceted convening role demonstrates the important attribute of strategic thinking and designing for co-engagement, which highlights what Wenger-Trayner et al., (2015) believe a 'system convener' should have in order to make new partnerships work.

As explained in 4.3.3 and illustrated in Figure 4.9, CO1 played an extremely important role in convening information and building knowledge across all 'nexes of practice' as well as distributing it via various platforms. CO1 demonstrates how a convener can build 'knowledgeability' and co-produce knowledge across the landscape through coordinating breeding season results from ACs at WLT-CC meetings and drafting this into press releases with the WLT-CC chairman to be distributed to volunteer groups, reserve friends, the CoCT and the public (see 4.3.3). This feedback, which CO1 helped assemble, was a valuable process and a beneficial tool to evaluate the season and motivate future volunteers to protect the species. CO1 compiled data results from the season, important terminology, identifications and behaviour information of the species in addition to general experiential learning from the field (see 4.3.2) and distributed the co-produced knowledge through standard

presentations, which CO1 and ACs delivered to schools and the public to teach about the protection of the endangered western leopard toad species (see 4.2.5). CO1's role began as an intern and progressed to an AC, eventually becoming a WLT-CC coordinating role. This role demonstrates that a convener is not only competent in one 'nexus' but rather builds "enough of a history in the landscape to have cross-boundary perspective" (Wenger-Trayner, 2015, p. 33), between all practices.

4.4.6.2 Multiple Areas of Convening

The WLT-CC has various forms of convening configurations occurring at different times, which often serve different purposes. Such configurations can cause conflicting narratives and a convener can run the risk of not being accepted by either 'nexus of practice' (Akkerman & Bakker, 2011). An example of this is highlighted in 4.2.3.2, illustrating that CT1 (the representative from CoCT on the WLT-CC) is responsible for managing development applications for the city and assisting with protecting areas where the flagship toad species resides — activities which can conflict with one another. CT1's role is therefore pivotal in coordinating across practices between the city, locals and the committee by managing AC expectations and involvement in opposing the development proposals (section 4.2.2.3a) and circulating objection documents to the WLT-CC for comment to monitor urban developments that impose on conservation sensitive areas (section 4.2.3.2). This highlights how convening across the landscape is challenging due to varying demands, practices and institutional commitments (Wenger-Trayner et al., 2015). At the same time, however, conveners have the capacity to be appreciated for their innovative role in maintaining professional practices across boundaries over time and can assist in creating partnerships that can rearrange social systems through collaboration. This is demonstrated in the case of Skilpadsvlei, Kommetjie (section 4.2.6) where coordinated diagnosis, design and action of locals, funding and support from the city and involvement of a herpetologist facilitated collaboration across various boundaries to rehabilitate and develop a western leopard toad breeding site. This has since become one of the most successful breeding areas in the Southern Suburbs with population numbers being the highest recorded, which is in stark contrast to almost no signs of breeding in 2010.

Since its formation, the WLT-CC itself has evolved into a coordinating platform assisting with knowledge-sharing across practices. As explained in Chapter One and

section 4.3.1, during the foundational years, there were many practices occurring in different areas around the protection of the western leopard toad species. These multiple efforts required coordination to focus the work of the multiple stakeholders and organisations via one platform to ensure that the initiatives were moving in the same direction and sustainably monitoring the protection of the species (INT_4, 6). Today, the WLT-CC is a steering committee which monitors how management recommendations are carried out (see 4.3.1.7) and a gathering place where the 'nexes of practice' can communicate face-to-face, discuss field observations, identify what is or isn't working and which 'nexes' or committee member has the best scope to deal with the issue. However, members of the WLT-CC point to the shortfalls of the committee as a convening structure; the chairman shares that currently the biggest contributors are the volunteers and ACs and the committee serves as an informal place to discuss problems and iron out issues (see 4.3.1.5 and 4.3.1.7). There is no convener who initiates collaboration and there is no social protocol, structure or platform to catapult the WLT-CC further than its current communicative connection. The lack of an effective convening role is evident in section 4.4, where complex practices (see 4.4.1), institutional practices (see 4.4.2), scale and location challenges (see 4.4.3), power dynamics (see 4.4.4), time and capacity challenges (see 4.4.5) and lack of coordination are shown to be preventing valuable co-engagement between practices, ongoing 'knowledgeability' and potential learning to provide longevity to the cause.

4.5. Concluding Summary

In this chapter, I presented evidence to address the research questions described in Chapter One (section 1.4). I presented data to map out and contextualise the WLT-CC landscape of practice and provide a greater understanding of the 'nexes of practice' and the interrelations between them. Firstly, I highlighted the diverse practices community members are involved in and what they have managed to achieve within their 'nexus' in response to the local social-ecological challenge. I presented data to demonstrate the pivotal role ACs play within their various areas in coordinating practice. Secondly, I shared evidence highlighting the multiple efforts conservation entities have been involved in that have directly and indirectly affected the western leopard toad species. These have included important, daily management decisions as

well as implementing MOA and MOU documents that have protected biodiversity, including the western leopard toad. Thirdly, I explained how the research 'nexus of practice' along with multiple collaborations has helped build a valuable information picture of the western leopard toad species and its behaviour. This research has been essential in informing practices across the WLT-CC and providing valuable leverage to achieve protection of sensitive breeding areas. Fourthly, I described how educational practices are not bound by a particular 'nexus' but rather constantly occur within and between 'nexes'. Through sharing and creating information and engaging in educational activities, participants have become motivated to continue the work that has been conducted over the years. Lastly, I highlighted various examples of overlapping and interrelated work between the 'nexes' and the important roles that helped facilitate and enhance the coordination of information sharing, collaborative projects and co-engagement. These roles included CO1, the coordinator/intern; CT1, the CoCT representative and the ACs of the volunteer groups.

I then presented data that highlighted the important social learning interactions and processes that have helped establish the WLT-CC's 'social collective body of knowledge' around the western leopard toad species. Firstly, I explained the diverse forms of knowledge that have been generated across the landscape. The creation and transfer of information through real life experiences, sharing stories and taking part in training events has helped enhance community communication, forms of co-engagement and informed decision-making. Tools such as WhatsApp, websites, Facebook and data collection platforms as well as the role of ACs have assisted in linking information production to sharing across the WLT-CC. This flow of information is essential in keeping participants plugged into the process and helps nurture effective collaboration to involve the relevant 'nexes'. The identified knowledge-sharing strategies motivate participants by sharing how they are making a difference and contributing to the initiative. I continued to discuss how knowledge has been co-produced through social learning interactions between multiple 'nexes' over time, contributing towards a collective 'social body of knowledge'. This body of knowledge has formed the foundation upon which multiple practices within the WLT-CC landscape of practice have been informed. The data highlighted the need for a coordinating platform or role to facilitate and link knowledge to practice more effectively in future.

Although the data presented various forms of social learning interactions that contributed towards co-engagement and collaborative efforts around a shared interest, numerous boundaries were highlighted that indicated limitations to practice within the WLT-CC landscape of practice. A lack of identification between the 'nexes of practice' was identified, which limited practice due to a lack of standardised, shared practice for the 'nexes' to work towards across the landscape. I identified examples of how complex institutional practices can inhibit practice due to differing priorities, schedules and policies. Scale and location challenges highlighted the need for collaboration across areas with shared resources and support systems. Complex landscapes of practice involve participants who operate in multiple ways with varying perspectives, methodologies and expertise levels. This can cause identification challenges between practices and create tension. Dynamic power relations can affect practice, especially when specific differences are not resolved. Due to the unpredictability of toad movements and volunteer capacity from season to season, the monitoring of toads is vulnerable to change, and the accuracy of the information being collected can reduce depending on external factors. The role of a coordinator or convening structure is required to provide a more effective platform for regular engagement for all participants across the landscape of practice to feel connected. This coordinating role can increase the connectivity between 'nexes' to improve the ways of informing practice and negotiating boundaries. Along with this coordinating role, the development of a social protocol would help provide focus and attention to specific areas of practice where it is needed and enhance efficiency.

The following chapter discusses how knowledge-production and learning processes influenced and informed the 'nexes of practice' within the landscape of practice and identifies where social learning processes and co-engagement can assist the WLT-CC members in informing complex practices and negotiating identified boundaries. This chapter will seek to identify the role of learning mechanisms at the boundaries and how this could potentially help transform practice.

CHAPTER FIVE: FINDINGS

5.1 Introduction

This case study aimed to answer the research question and sub-questions highlighted in Chapter One (section 1.6). In this chapter, I respond to each sub-question by reflecting on the data that was presented in Chapter Four and propose my findings drawing on the theoretical perspectives, concepts and perspectives outlined in Chapter Two. I will explore where potential learning can occur through the negotiation of boundaries by using learning mechanisms, co-engagement and convening entities. This leads to the conclusion of the study in Chapter Six by proposing a social protocol to assist the WLT-CC in strengthening this community-driven initiative.

5.2 What is the 'Landscape of Practice' of the WLT-CC?

Finding 1: As a community-driven citizen science initiative, the WLT-CC landscape of practice is predominantly driven by the volunteer 'nexus of practice', relying on the other WLT-CC representatives across the landscape of practice for guidance, support and permission.

As explained in Chapter Two, Wenger-Trayner et al. (2015) describe a 'Landscape of Practice' as a multifaceted system of interrelating and overlapping communities of practice and the complex boundaries between them. As highlighted extensively in Chapter Four, the four loosely defined 'nexes of practice' within the WLT-CC are examples of such communities of practice; they engage in multiple practices across ongoing boundaries of the dynamic WLT-CC landscape of practice. This community-driven citizen science initiative became informally self-organised as it sought to resolve a social-ecological need through multiple participants who were looking to create change. The WLT-CC landscape of practice brought together like-minded, driven participants within complex communities of practice who have shared interests and motivations around a common goal.

Wenger-Trayner et al. (2015) highlight that one community of practice or network cannot represent a whole landscape of practice alone. As the evidence illustrates, this is true in the case of the WLT-CC landscape of practice. Although each 'nexus of practice' within the WLT-CC landscape operates independently of the steering

committee, they each represent specific tasks, roles and expertise that the others do not and ultimately each contributes, influences and supports the WLT-CC's overall practice and objective through different practices. This highlights what Díez et al., (2018) refer to as 'building community support for environmental change', which requires the participation of diverse stakeholders within a community to target interventions with sustained impact.

This similarly relates to the citizen science field (specifically community-driven citizen science) as it too involves 'whole community' participation for greater cooperation and engagement (Hulbert, 2016). It is important to note, however, that an entire community of interested parties does not always need to be involved in every practice on-the-ground, but rather all need to be *invested in* the single cause and objective of the initiative. The WLT-CC demonstrates this idea of participants being a part of the 'whole' initiative; multiple contributions from citizens as well as representatives within conservation entities and research institutions improve the integrity of the work. If any new developments and discoveries arise, they are more likely to be detected, enabling a quicker response by those in the landscape of practice who are best able to deal with the issue at hand.

This being said, not all contributions across the landscape are equal or consistent towards the shared interest. In the case of the WLT-CC, the volunteer/citizen science nexus (perhaps due to it being a community-driven initiative) is the dominant driver of action and co-engagement (see 4.2.1.4) as it not only co-engages within its own context but its practices also influence and inform research, conservation and education and operate relatively independently of the WLT-CC's involvement. The volunteer/citizen science 'nexus' is an example of a community of practice participating collaboratively through various levels of co-engagement to monitor and manage a local social-ecological challenge. Their individual 'nexus of practice' highlights what Díez et al. (2018) describe as successful, community-driven action due to local participants being involved at multiple levels of the process.

Figure 5.1 illustrates the volunteer/citizen science 'nexus of practice' and its rich processes of co-engagement within its own community of practice as well as the complex relations across the greater WLT-CC landscape of practice. I was able to produce this schematic overview at the end of the data generation stage, drawing on Armstrong's (2013) ideas regarding co-engagement. Figure 5.1 demonstrates not only

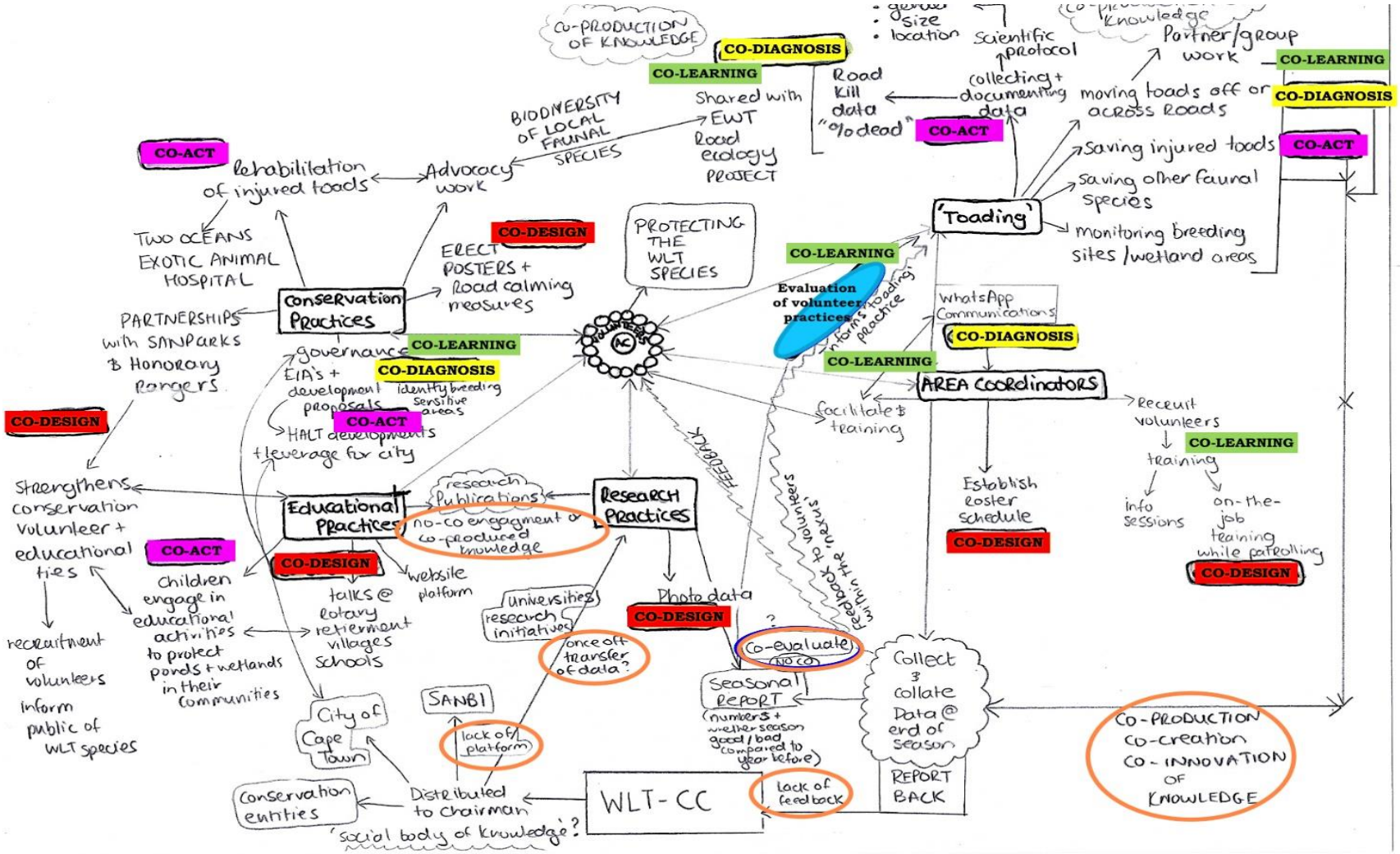


Figure 5.1: A schematic of the rich processes of co-engagement, specifically identifying areas where participants co-diagnose, co-design, co-act and co-learn together within and across the volunteer 'nexus of practice'.

the independence of the volunteer/citizen science practices but also how potential learning and collaboration can occur when participants co-engage across communities of practice. For example, in the case of Skilpadsvlei in Kommetjie, AC1 (from the volunteer/citizen science 'nexus of practice') and CT1 (from the conservation 'nexus of practice') overlapped to combine networks, expertise and access, forming a collective effort to bring about a sustainable solution towards the protection of the western leopard toad species. This demonstrates Wenger's (1998b) idea that, if communities of practice mutually engage in 'joint enterprise' and 'share repertoire', they can form pivotal partnerships that encourage new learning, innovation and progress towards the shared interest and goal.

Figure 5.1 also illustrates how, through co-engagement processes, community members are able to diagnose, design, act and evaluate specific social-ecological issues within their areas as they arise and have become successful in their specific areas in managing and monitoring the WLT-CC species. However, this level of co-engagement does not occur effectively across the entire landscape of practice, which limits interrelations across all 'nexes of practice'. The volunteer 'nexes' can be limited by the requirement for official backing, access and permission from other 'nexes' in their efforts to protect the western leopard toad species and its habitat. Another co-engagement shortfall that emerged from the data was the lack of effective evaluation and feedback processes that, if implemented as a 'co-evaluation' process between multiple entities across the WLT-CC, could enhance participation, inform practice and potentially motivate sustained vested interest in the initiative. These valuable insights about knowledge production and social learning processes are further explored when answering the next research sub-question (section 5.3).

5.3. What Forms do Knowledge-production and Learning Processes Take in this Landscape of Practice?

Finding 2: When participants are involved in multiple practices learning is stimulated, and knowledge can be created and distributed across the WLT-CC Landscape of Practice.

Due to the nature of the WLT-CC landscape of practice, participants learn through engaging in multiple practices across various contexts with different people and at different times. Volunteer practices align with daily life, such as toads crossing

participants' neighbourhood roads and conservation representatives engaging in decision-making according to both their daily jobs and their aim to protect the western leopard toad species. Through the process of engaging across numerous practices, participants are able to learn through being in the field by producing 'real time' knowledge and through engaging in educational activities and new experiences (see 4.3.2.1). This is evidence of what Wenger (2009) explains as learning being fluid throughout everyday life. Wenger (2009) shares that learning can intensify when we want to answer a specific phenomenon (like volunteers engaging in data collection to build knowledge for research initiatives) or if we are challenged to understand new ideas, methods, perspectives and practices (such as the way that all 'nexes' roles were discussed at WLT-CC meetings). Engaging in everyday practices across a variety of activities and interacting with participants with varying levels of expertise and perspective across the landscape of practice facilitates a greater understanding and flow of information to various areas of the landscape.

During each breeding season, participants within the WLT-CC landscape of practice were able to co-produce knowledge and learn from one another due to a range of social processes, including but not limited to:

- Field based 'real-time' communications
- Scientific protocols
- Community learning processes
- Knowledge-sharing strategies
- Various platforms (such as data sharing through WhatsApp photos)
- Coordination, training and education by ACs

These social processes and forms of knowledge have informed practice and assisted the 'nexes of practice' with effective methods of co-engagement. As illustrated in Figure 5.1 and explained in section 4.2.2, these processes are more prevalent within the volunteer/citizen science 'nexus of practice' than the other nexes. This is highlighted in the way that community members diagnose, approach and evaluate arising social-ecological issues to successfully manage and monitor the western leopard toad species in their contexts. This level of co-engagement, however, does not transfer to the entire WLT-CC landscape of practice and overlapping collaborations often only occur when needed or to address a particular challenge, as opposed to continuous connectivity. It would be beneficial to adopt such processes across the

entire landscape to promote continued learning from the different 'nexes' and to effectively co-produce diverse knowledge, which could ultimately transform the WLT-CC practice.

Finding 3: Participants' co-engagement within and across 'nexes of practice' (such as co-diagnosing, co-designing, co-acting and co-learning) was found to strengthen knowledge-production and learning processes in the WLT-CC.

Armstrong (2013) highlights that a complex adaptive system is required in order to address complex challenges, such as the social-ecological challenge faced by the WLT-CC. The WLT-CC is an example of a system that has "deeply engrained behaviours, entrenched interests, [and] unique contexts" bounded in a tangled, complex web of relations (Armstrong, 2013, p. 62). Figure 5.1 maps out the non-linear connections and the complex forms of co-engagement evident in the volunteer 'nexus of practice' and how it overlaps across the landscape of practice to highlight how collaborative effort and learning can inform practice and enhance capacity.

Participants' co-engagement within and across 'nexes of practice' was found to strengthen knowledge-production and learning processes in the WLT-CC through the following areas of co-diagnosis, co-design, co-acting and co-learning.

Areas of Co-diagnosis (highlighted in yellow in Figure 5.1)

Co-diagnosis stimulates discussion between participants around relevant issues that arise within a particular context through embracing new ways of thinking and producing knowledge. Figure 5.1 illustrates areas where participants jointly contributed to the analysis of an issue in their specific context, which in turn assisted in either knowledge-production or learning. This is similarly highlighted in section 4.2.1; volunteers sought to initiate credible action that inspired local community members to live sustainably with and simultaneously protect the species. Participants involved in the WLT-CC are invested in the process of "diagnosing their own change context" (Armstrong, 2013, p. 89). These forms of knowledge and learning processes occur through participants learning new ways of thinking (how to address day-to-day challenges while 'toading'), informing new practices (new ways to minimize human-wildlife conflicts) and creating collective knowledge (sharing individual areas of expertise to address challenges). These social processes are the building blocks of participants' engagement in co-learning practices.

Areas of Co-learning (highlighted in green in Figure 5.1)

Figure 5.1 illustrates areas where learning was fostered within and across multiple areas of the WLT-CC. It highlights where participants learnt with and from one another and how they acquired forms of knowledge resulting in behaviour changes as well as logistical and policy decision-making. For example, it is evident that co-learning between residents and representatives within the CoCT (see 4.2.1.4a), as well as residents and researchers (see 4.2.1.4b), contributed towards adaptation of existing activities, such as mowing and dredging schedules, and implementation of conservation measures. Each season multiple areas within the landscape of practice collaborate and learn from one another by communicating from the ground as action is needed to inform practices moving forward. In the case of the WLT-CC, local participants at ground level have become experts within their environments and have collaborated with other areas of the landscape of practice to "guide the actions needed to foster policy change at the community level" (Díez et al., 2018, p. 10). This form of co-learning (shared knowledge gained through engaging in practice) is what Armstrong (2013) refers to as 'the foundation of building capacity.'

When participants addressed issues together, greater collaboration and understanding developed in relation to complexities. For example, participants learnt to question and reflect on local practices within their contexts (volunteers inquired and questioned through WhatsApp) and engaged in practices that contributed towards shared knowledge across practices (volunteers learnt best practices through on-the-job, partnership training). Armstrong (2013) argues that learning by gaining context-specific skills and expertise occurs through linking participants' multiple forms of knowledge. This can be by working across existing forms of knowledge (weather variables affect toad emergence) or newly-gained forms of knowledge (new breeding area sites), which inform practice (such as when to go out 'toading' or in the development of MOAs to protect breeding sites).

Areas of Co-design (highlighted in red in Figure 5.1)

Figure 5.1 illustrates areas where participants identified what strategies, planning and learning were needed to reach specific objectives. For example, volunteers co-designed a roster to increase efficiency during the western leopard toad breeding season. The co-design of tools and structures (such as data collection using WhatsApp

groups and photographs) assisted volunteers in collecting valuable, accurate information in the field. Armstrong (2013) highlights that co-designing is not about creating a master plan to establish structure and rigidity for people to follow but rather about constantly engaging in processes that give direction towards achieving goals. For example, rather than creating specific rules and regulations to follow, participants created partnerships to strengthen conservation and volunteer and educational ties so that there would be a greater understanding between areas of practice (see section 4.2.1.4 a–c).

Armstrong (2013) argues that "people support what they help create" (p. 159). For example, ACs have, over time, co-designed methods to effectively involve and motivate their volunteers through on-the-job training while patrolling. The participants learn collaboratively through experiencing the human-toad conflict. Armstrong (2013) explains that areas of co-design allow people to collaborate and create assets or methods that they will build upon themselves, such as the way that volunteers in the WLT-CC designed effective method to collect data and then built upon these methods to create important and valuable information for the WLT-CC as a whole. This form of knowledge-production and learning enhances problem solving for context-specific challenges and at the same time, builds the skills and capacities of the individuals who take part.

Areas of Co-acting (highlighted in pink in Figure 5.1)

Figure 5.1 illustrates areas where multiple participants acted, learned and established practices together. Armstrong (2013) highlights that participants learn through co-acting, improving the design and the diagnosis of the issue at hand (such as community members learning about development proposals and providing 'kick back' to the city). Co-diagnosis, co-design and co-acting occur fluidly and are repeated with different foci as and when needed. For example, volunteers co-diagnosed the issue of toad road kill, co-designed partnerships with EWT's road ecology project and acted together to collect 'percentage dead' numbers, highlight hotspot areas and implement road calming measures where these numbers were highest. This form of knowledge-production and learning corroborates Armstrong's claim that "co-acting is learning by doing" (2013, p. 169). Participants are constantly learning through engaging in numerous practices at multiple levels.

Finding 4: Limited feedback and evaluation within the WLT-CC Landscape of Practice hinders knowledge-production and learning processes.

Armstrong (2013) highlights that a combination of efforts (co-diagnosing, co-designing, co-acting and co-learning) are needed between multiple entities in order to provide sustainable, long lasting improvements towards a shared goal (identifying and negotiating boundaries). In the case of the WLT-CC landscape of practice, the data revealed a lack of knowledge-production and learning processes occurring through the use of feedback and evaluation mechanisms. The few areas where evaluative processes were identified that were successful in informing practices and negotiating boundaries within the WLT-CC landscape of practice were found predominantly within the volunteer 'nexus of practice'. This suggests that if evaluation and feedback was generated and constantly shared across the entire landscape, it could initiate valuable future knowledge-production and learning processes.

As Akkerman and Bakker (2011) explain, potential learning can occur by evaluating and discovering the development of new ideas, understandings and changes in practice. Through an evaluation of practice across the landscape of practice, greater mechanisms of learning such as *identification*, *coordination*, *reflection* and *transformation* can occur (Akkerman & Bakker, 2011). For example, transformation in practice can occur when a shared problem is recognised and a target for change is identified, which can bind intersecting practices. If there was co-evaluation within the WLT-CC landscape of practice, participants across different 'nexes of practice' would be equipped to tackle relevant issues and differences in practice and perspective that constantly arise across the landscape through knowledge-production and learning. Through gaining new knowledge regarding practice, participants within a landscape of practice can recognise the unavoidable boundaries that limit practice and learn new competencies to overcome them (Wenger-Trayner et al., 2015).

Co-evaluating processes can assist in reflecting on what worked and what did not and nurture the community of practice to ensure sustainability. As emphasised in section 4.3.1, knowledge-sharing strategies such as WhatsApp and Facebook platforms, assisted in evaluating the season's progress; however, there was limited feedback on how the volunteers' data transferred into meaningful, usable information for conservation management decisions and research initiatives. Volunteers were

unaware of how the data they generated was collated, stored and used. This in turn affects the volunteer groups as they don't feel connected to the process and lose opportunities to gain scientific literacy and knowledge.

Figure 5.1 illustrates the limitations of a lack of evaluation and feedback *(circled in orange),* such as the lack of interdependence between various nexes (lack of co-production of knowledge between research and volunteer 'nexes'). There is no monitoring of the vast network of these complex relationships, interrelations and collaborations. There is a lack of real time feedback loops from multiple areas of practice, which hinders reflexive practice. Armstrong (2013) advises that a dynamic initiative (such as the WLT-CC) should move away from traditional evaluation methods, which have traditionally focused on end results, towards evaluation that helps generate knowledge and learning through making "continuous adjustments and improvements" *as issues arise*, or if and when practices require further co-diagnosis, co-design and co-acting (p. 126).

5.4 What is the Role of these Knowledge-production and Learning Processes in Establishing the WLT-CC's 'Social Body of Knowledge'?

Finding 5: Knowledge-production and learning processes within and between nexes of practice assist with the accumulation and dissemination of knowledge across the whole landscape of practice.

According to Wenger (1998b), communities of practice not only assist with the accumulation and dissemination of knowledge within an initiative, like the WLT-CC, but also contribute greatly towards its identity and the social learning that occurs between practices. It is through co-engagement processes between diverse participants within and between each 'nexus of practice' that actions take place, social learning occurs and knowledge is produced.

As the evidence indicates in Chapter Four, participants gained greater understanding of their shared objective and interest by communicating through various channels between each nexus. For example, the WLT-CC share advice and best practice information between themselves on how to mitigate challenges pre- and post-breeding season. This is done at meetings as well as via email and WhatsApp groups and helps to inform practice and encourage future participation. Through co-engagement

processes, participants within the WLT-CC landscape of practice have become what Wenger (1998b) describes as pivotal connectors of "exchange and interpretations of information" *(*p.6). These complex interactions and relations exemplify the WLT-CC landscape of practice as a complex social learning system that accumulates knowledge through engaging across dynamic boundaries and through "on-going negotiation and cultural meaning" (Wenger, 2010, p. 1).

Knowledge-production and learning processes further assist with the accumulation and dissemination of knowledge across the landscape of practice by retaining knowledge holistically across the entire WLT-CC landscape through information sessions, engaging in on-the-job training and continuous WhatsApp communications. Wenger (1998b) explains that this method of accumulation and distribution of knowledge can be more effective than a regimented platform or database. However, in the case of the WLT-CC landscape of practice, evidence has highlighted that a combination of both is essential. As this landscape of practice is characterised by scale and location challenges, power dynamics, capacity constraints and complex institutions, convening structures and platforms have been essential in providing consistency in knowledge accumulation and distribution. Such holistic and regimented areas of knowledge production and learning (such as Facebook and WhatsApp groups, the 'Save our Toads' website and scientific data collection platforms) have contributed to a dynamic collaboration of information regarding the western leopard toad species. Graham et al. (2014) highlight that this form of social learning can benefit citizen science initiatives, such as by building citizen scientific literacy. As in the case of the WLT-CC, the 'nexes of practice' are able to address tasks and processes with routine (WLT-CC meetings, scientific protocols and reporting back) but have remained adaptable in responding to local challenges and contexts.

Participants in the WLT-CC landscape of practice have learnt and created knowledge within their own context as well as overlapping with the contexts of others and the surrounding environment. Through the accumulation and distribution of knowledge over the past decade, the WLT-CC landscape of practice has maintained relevant contextual information to help researchers answer engaging questions, develop trends and stay at the forefront of the citizen science and conservation field that it represents. Through their collaborative inquiry, invested participants in the WLT-CC landscape

of practice take part in practices that constantly identify structures, technologies and methods for solutions. This type of learning, Wenger (1998b) explains, helps to steward competencies within the communities of practice, which in the case of the WLT-CC landscape of practice, builds capacity to address the ever-changing policies, complex practices and bureaucracies around local and regional conservation. These processes exemplify the method proposed by Johnson et al., (2012) to address multifaceted challenges that emerge from complex and unpredictable social-ecological systems. Systems such as these require such competencies and adaptive social learning. The continuous need for updated knowledge *produced by* each nexus (such as current standardised data collection, hot spot identification, or informing volunteers and the public), which is then *shared between* the multiple 'nexes of practice', has promoted co-engagement and constantly equipped participants within the landscape of practice with the tools and skills to engage across complex practices and inherent boundaries.

Finding 6: Knowledge-production and learning processes establish greater 'knowledgeability' across the landscape of practice.

Learning multiple skills, methods and content from participants with various areas of expertise between each 'nexus of practice' is evidently invaluable. Knowledge produced in this way builds over time and is organic, practical, useful and applicable. In this case, it was used to address current social-ecological challenges. It brings a social awareness to important environmental needs and gears society up to take care of their planet. It is therefore important that knowledge and 'knowledgeability' are produced through co-engaged processes so that everyone has the ability to contribute, which is important for environmental democracy and equality. In the case of the WLT-CC, important knowledge-production and learning processes occurred when WLT-CC participants engaged in practices in varying capacities as they encountered various forms of knowledge (see 4.3.2), learnt in different ways by engaging different information sharing strategies (see 4.3.1) and produced knowledge together over time (see 4.3.3).

The term 'knowledgeability', articulated by Wenger-Trayner et al., (2015), indicates that while participants need not be competent in all practices, they can still have knowledge about them and an understanding of the relevance of specific practices and

information in the landscape of practice regarding the shared interest. This was evident in how the volunteer 'nexus' had knowledge of their own individual practices and additionally had an understanding of when the CoCT initiated mowing and dredging within their areas. This occurred through co-engagement with multiple participants across the landscape of practice when communication of information was shared and dynamic (Wenger-Trayner et al., 2015).

In the WLT-CC, 'knowledgeability' occurred through the creation and accumulation of information (volunteer groups collecting data when 'toading') and through the diffusion of knowledge (sharing photographs and uploading data to I-Naturalist and Facebook pages). 'Knowledgeability' across the landscape of practice was also evident when participants shared information collaboratively to produce short-term results (such as identifying hot spots for seasonal monitoring in a specific area) or to build a long-term body of knowledge (such as understanding the radius of movement around the breeding ponds over time). When participants engaged in a knowledge sharing process, whether short-term or over longer periods of time, a greater understanding of their joint cause was established.

Areas of co-engagement and social learning within the WLT-CC landscape of practice facilitated the learning, knowledge and change that occurred (Graham et al., 2014) and assisted in building a body of knowledge around a social-ecological issue. Volunteer groups have contributed greatly to the 'social body of knowledge' of the western leopard toad species for over a decade. Wenger-Trayner et al., (2015) highlight that "learning is not merely an acquisition of knowledge" (p. 19) but encompasses the gaining of memories and building of capacities through rebuilding relationships and contextual skills. This has been achieved through multifaceted contributions and sharing of historical and social knowledge (Udall et al., 2015) brought into the WLT-CC landscape of practice. Knowledge-production and learning enhancing 'knowledgeability' is evident in how ACs have learnt to question, initiate and educate; they collect data, assimilate information, disseminate knowledge and coordinate their areas relatively independently from other practices' input in the WLT-CC.

When volunteer groups, researchers and conservationists within the WLT-CC landscape of practice combined their multiple levels of 'knowledgeability' across the landscape and shared "a culture of open communication" (Boreham & Morgan, 2004,

p. 308-309), co-produced knowledge was cultivated and the committee collaboratively discovered the most effective ways of addressing a particular need. An example of this is how participants from different 'nexes of practice' on the WLT-CC, which included representatives from the CoCT, City Parks, ACs, and SANBI, contributed towards a letter stipulating the appropriate times to mow, dredge or maintain recreational areas that may affect the wellbeing of the western leopard toad. Each member's perspective, as well as specific experiential, historical, social and professional knowledge, was considered to create the document, which was implemented to protect, monitor and manage the western leopard toad species.

Co-engagement processes across the WLT-CC landscape of practice have increased 'knowledgeability' of multiple practices and assisted with negotiation of boundaries, such as understanding complex practices. This social process is most effective when engagement and interrelations are constantly nurtured and coordinated across the landscape of practice. Significantly, despite evidence of 'knowledgeability' building across various practices over time, there was evidence of a lack of on-going coordinated co-engagement across the entire WLT-CC landscape. Due to the WLT-CC landscape of practice being a complex social learning system, it requires constant coordination between all its 'nexes of practice', which is highlighted in the following section.

5.5 How are the WLT-CC's Boundaries Negotiated and Mediated in Relation to Knowledge-production and Learning Processes?

Finding 7: Learning mechanisms such as coordination, identification and reflection enhance collaborative effort across boundaries.

Disciplinary boundaries reflect the restrictions of human engagements in complex landscapes, such as complex practices, power dynamics, location, time and capacity differences and institutional practices. Such boundaries occur constantly between and within each 'nexus of practice' and can affect interactions. As explained in section 2.3.2, Dickinson and Bonney (2012) suggest that mechanisms are needed to overcome such boundaries to connect society, scientists and a variety of stakeholders in multi-agency initiatives.

It is evident that boundaries can be crossed and new unexpected learning can occur when areas of learning and knowledge-production arise through processes of co-engagement across a landscape. Currently, as the 'nexes of practice' interact across the WLT-CC landscape of practice, there are multiple boundaries that limit various practices and in turn restrict the full potential for learning and knowledge sharing within and across the landscape. Examples of such boundaries are: engaging across complex practices (4.4.1), institutional practices (4.4.2), scale and location challenges (4.4.3), power dynamics (4.4.4), time and capacity constraints (4.4.5) and the lack of coordination (4.4.6). As illustrated in Figure 4.4, all practices involve independent tasks and projects in relation to the western leopard toad species. However, multiple boundaries restrict full collaboration and connectivity between all the 'nexes of practice'. Carlile (2004) suggests that various social processes are required at boundaries to manage knowledge and learning. If such processes are implemented across disciplinary boundaries, they can help facilitate new understandings, identities and changes in practice.

Akkerman and Bakker (2011) explain how areas of coordination, identification and reflection are important learning mechanisms that facilitate and enhance co-engagement, shared knowledge and potential learning across boundaries within landscapes of practice. These learning mechanisms along with areas of co-engagement have assisted in the negotiation of boundaries within the WLT-CC landscape of practice:

Identification

According to Akkerman and Bakker (2011), simultaneous participation across different practices can assist participants to identify with more than one aspect of the initiative and create new understandings, perspectives and learning across boundaries. ACs within the volunteer 'nexus of practice' were seen to be effective in achieving cross-landscape identification by engaging in multiple complex practices simultaneously. Over time, volunteers learnt about governance strategies, how to train community members to be effective 'toaders' in the field and how to successfully build awareness for the protection of the western leopard toad species. In the case of the Skilpadsvlei western leopard toad breeding site, identification across intersecting sites along with areas of co-engagement between volunteers and the CoCT helped to alleviate discontinuities between complex institutional practices. Representatives

from conservation entities, the City and local volunteers co-diagnosed the issue of development in the area of a vulnerable breeding site, co-designed strategies and structures to advocate against this development and acted together to rehabilitate and build a new wetland. The City understood the local on-the-ground challenges and connected with the vulnerable species; the volunteers fully realised the effort and time needed to gain permissions, funding and line functions for an effective project.

Coordination

The learning mechanism of coordination creates a 'communicative connection' (Akkerman & Bakker, 2011, p. 144) that enhances dialogue between multiple participants who practice differently. This communicative connection aids in the negotiation of scale and location limitations by ACs communicating information between WLT-CC meetings and the volunteers on-the-ground. By sharing achievements and the progress of other 'nexes of practice', issues that arise can be addressed, and any emergent challenges can be diagnosed and discussed effectively. This encourages shared knowledge across different practices and designs strategies such as scientific protocols to facilitate "future and effortless movement between different sites" (Akkerman & Bakker, 2011, p. 144). Coordination through communicative connection allows participants from different 'nexes' to co-engage and take joint action across complex practices, such as negotiating difficulties between community members protecting breeding areas and the Public Road Works employees fulfilling their mandate to lay internet cables. Two representatives from different 'nexes' co-engaged through dialogue to resolve the issue of road construction occurring in a sensitive western leopard toad breeding area. Through collaborative communication a cooperative solution satisfying all entities was reached.

Reflection

Akkerman and Bakker (2011) discuss the process of reflection as a learning mechanism wherein participants acknowledge and understand differing practices and learn by looking at themselves through the perspective of the other. Section 4.4.4 presented an example of limited reflection on a boundary in the WLT-CC where misunderstandings arose due to a lack of perspective and acknowledgement of the work being done within different 'nexes of practice'. This lack of reflection was

evident when participants expressed their frustrations with the pace at which permissions were granted, policy briefs were organised and decisions were made.

With the introduction of areas of co-engagement across the WLT-CC and through careful reflection, misunderstandings and miscommunications experienced when engaging across complex power dynamics and practices could be resolved. Problematic situations can be remedied; for example, the evident disconnect between the research and volunteer 'nexes of practice' around the issue of data collection and saving toads could be resolved if each 'nexus' reflected on the others' practice to create a mutual understanding of the complexities that each 'nexus' may face. Through acknowledging and assessing differences in practice, new knowledge and learning can occur during future engagement. Only then can participants begin co-designing strategies and structures, such as a standard practice protocol on how best to record data accurately and simultaneously save toads off the roads. Through reflection and forms of co-engagement, volunteers would better understand the pivotal role of accurate data and researchers would see first-hand how toads are affected on the roads. This would ultimately affect and inform the varying practices and assist in the development of a plan to negotiate the boundaries that arise.

At the time of reporting, there was an evident lack of ongoing identification, coordination and reflection across the entire WLT-CC landscape of practice that has led to limited feedback, connectivity and co-production of knowledge and learning between all the 'nexes of practice'. Subsequently, various 'nexes' have become alienated as they are not engaging constantly in the creation or exchange of information. This can limit how participants and 'nexes' contribute towards a joint 'social body of knowledge' or the way 'knowledgeability' is nurtured across all practices.

5.6 Conclusion

This chapter highlighted findings according to the research questions. These findings illustrated the following points:

- The WLT-CC landscape of practice is a complex social system that requires participants to engage in multiple practices through coordinated co-engagement in order to respond to their contextual challenges.

- When participants co-engage (co-diagnosis, co-design, co-act and co-learn) across multiple practices within the landscape of practice, knowledge-production and learning is strengthened. The 'knowledgeability' that is built informs further practice and assists in negotiating inherent boundaries as they arise.
- A 'social body of knowledge' is created through assimilating and disseminating such knowledge across the WLT-CC landscape of practice, which reinforces the WLT-CC's identity around their shared interest and enhances their capacity to address ever-changing and complex practices.
- There is a need for a regimented platform or database as well as learning mechanisms that will constantly generate feedback and evaluative monitoring to maintain this complex social system.

Such findings can assist community-driven citizen science initiatives to understand how they generate knowledge, how they learn together and how to become more effective and efficient in using their shared knowledge, resources and diverse set of competencies.

A social protocol could assist such a complex social system to collaboratively answer pertinent questions or generate knowledge of long-term trends regarding a citizen science issue in order to stay at the forefront of citizen science research within the conservation field.

Chapter Six, to follow, highlights how a social protocol could help strengthen, coordinate and monitor knowledge-production and learning across all of the 'nexes of practice' in the WLT-CC landscape of practice to more effectively inform complex practices and negotiate boundaries as they arise.

CHAPTER SIX: RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This research was designed to respond to the overarching research question: How do knowledge-production and learning processes influence the way participants in a community-driven citizen science initiative negotiate boundaries and inform complex practices in their 'landscape of practice'?

The case study has identified and explored the social processes (knowledge production, co-engagement and learning) that occur within and between the 'nexes of practice' in a multidimensional community-driven initiative (the WLT-CC). This was done with a view to understanding how people participate in and learn through local knowledge, engage democratically in 'science-society-policy' interrelations (Bela et al., 2016, p. 991) and learn to strengthen social protocols to inform practices which respond to social-ecological challenges.

This chapter concludes the research report by summarising Figures 4.2, 4.4, 4.5 and 5.2 along with the findings from Chapter Five in relation to the research question. Based on the insights and conclusions gained from this case study, I propose guidelines for a social protocol that the WLT-CC or similar community-driven citizen science initiatives or organisations can utilise to enhance their convening potential and create further 'knowledgeability' and co-engagement across their landscape of practice.

6.2 Answering the Research Questions

This section answers the research questions highlighted in Chapter One with reference to the figures and findings shared in Chapters Four and Five.

Firstly, as illustrated in Figure 4.4, Figure 5.1 and explained in Finding one, the complex WLT-CC landscape of practice was identified and the volunteer 'nexus of practice' was highlighted as being the dominant driver of co-engaged practice within the WLT-CC landscape. Areas of knowledge production and experiential learning occurred through volunteers and area coordinators co-engaging in multiple areas of practice including research, citizen science, conservation and education; these co-engagements helped inform their day-to-day practice and assisted in negotiating

boundaries that surfaced.

Secondly, as illustrated in Figure 5.1 and explained in Findings two, three and four, when WLT-CC participants co-engaged in and across multiple practices towards a shared interest, learning was stimulated, and knowledge was created and distributed across the landscape of practice. Where limited feedback and evaluative methods may have hindered knowledge-production and learning processes, co-engagement processes across multiple 'nexes of practice' strengthened collaborative knowledge-production and learning processes.

Thirdly, as explained in Findings five and six, knowledge-production and learning processes assisted in the assimilation and dissemination of knowledge across the WLT-CC landscape of practice, which established greater 'knowledgeability' across multiple practices towards a recognised and shared 'social body of knowledge'.

Lastly, as illustrated in Figure 5.1, and explained in Finding seven, boundaries across the WLT-CC landscape of practice can be negotiated and mediated through the introduction of learning mechanisms, which can enhance collaborative effort and learning through practices that encourage and nurture co-ordination, identification and reflection.

6.3 Towards a Social Protocol

As highlighted in Chapter Two, Johnson et al. (2012) state that there are no straightforward answers and actions to address multifaceted challenges that emerge from complex and unpredictable social-ecological systems. With the exception of sporadic instances, there was generally no joint effort to convene information and practice across the WLT-CC landscape of practice. This appeared to constrain opportunities for short-term learning and long-term sustainable change around the shared interest of toad conservation. Although there was some evidence of knowledge production and learning processes in the WLT-CC landscape of practice informing practice and assisting in the negotiation of boundaries, this study highlights the need for a social protocol or a convening structure to be applied alongside the existing scientific protocols to strengthen the work that the organisation does to monitor, manage and protect the western leopard toad species.

If there were structures in place coordinated by social processes and learning

mechanisms to bridge practices, not only would the landscape of practice build social-ecological resilience (Graham et al., 2014), but there would be a greater push towards the environmental democracy, scientific literacy and community inclusion that Irwin (1995) originally claimed citizen science could achieve. Due to the WLT-CC being heavily reliant on social engagement, action, intervention and collaborative effort, it requires not only scientific capabilities but also what Tweddle et al. (2012) identify as well-mediated participatory learning platforms which can enhance adaptive learning. This study enabled me to identify the social processes that were successful in the WLT-CC, what was lacking across the landscape of practice (in terms of knowledge co-production and sharing) and the support structures that were effective in enhancing collaborative effort towards the shared interest within a multi-agency organisation. The theoretical framework explained in Chapter Two provided additional perspectives and conceptual tools to reflect on knowledge-production and learning processes. From this vantage point, I have proposed guidelines towards a social protocol with the potential to assist in further knowledge-production and learning processes to enhance "social learning for collaborative sustainable development" (Johnson et al., 2012, p. 1).

6.4 Social Protocol Recommendation

As highlighted in Chapter Two, a social protocol is a tool that can inform participants in a complex social landscape of what, how, when and why actions should take place for effective collaboration to occur. Due to community-driven citizen science initiatives extending beyond data collection according to a scientific protocol, each initiative would benefit from a resource that supports them to co-ordinate and monitor collaboration in its specific context towards its specific goals. Boreham and Morgan (2004) argue that valuable social processes and practices can guide and advance shared ideas, problem solving and delegation around a shared interest and help close the gap between society and science.

A social protocol within a community-driven citizen science initiative should aim to help participants maintain the emergent unique qualities of their practices and support the complex and evolving collaborative work that arises surrounding their shared interest. Where a social protocol should enhance and work with this emerging diversity of activity and not merely standardise it, it is also valuable in providing

systems of standardisation to share effective collaboration methods in other community-driven citizen science initiatives.

Edwards (2011) argues that building common knowledge is important for "working across the practice boundaries on complex tasks" (p. 33) and that collaborative engagement is vital for negotiating boundary spaces. Guiding the development of a social protocol therefore requires building common knowledge or 'knowledgeability' from inter-professional work across multiple practices that are "both substantive and relational" (ibid., 2011, p. 35), which can mediate and coordinate successful co-engagement and collaboration in the field.

6.4.1 Principles to Guide and Enhance Areas of Common Knowledge, Collaboration and Co-engagement

Drawing on insights from the literature and the WLT-CC case study, I recommend the following guiding principles to assist effective, collaborative social practice in community-driven social science initiatives. To guide the development of a social protocol towards building common knowledge, I have contextualised Edwards' (2011) principles regarding ways collaborators can identify areas where long-term sustainable engagement can be created (Table 6.1).

These guiding principles can be used by collaborators to stimulate the development of a more specific, contextualised social protocol for greater common knowledge, co-engagement and collaboration around their shared interest. This is demonstrated below with the introduction of section 6.4.2, where I applied the above principles to the case of the WLT-CC. Within this bounded case study, I worked with the above principles to identify specific practices and processes that can help the WLT-CC navigate complex activity and strengthen common knowledge, collaboration and co-engagement around the protection of the western leopard toad species.

The development of a social protocol involves the identification and establishment of collaborative processes rather than an end result. It requires role players to implement the principles above to open valuable spaces where community-driven citizen science initiatives can strengthen activity across their multiple entities through informing practice and negotiating boundaries that arise.

Table 6.1: Eight principles to guide community-driven citizen science initiatives in building common knowledge and strengthening collaboration and co-engagement

	Guiding principles	**Ways community-driven citizen science initiatives can build common knowledge**	**Social process benefits**
1	Manage practice around the shared interest	Clarify the shared interest across the diverse groups involved and maintain the purpose of the collective work around both short- and long-term goals.	Allows for multiple agendas, perspectives and goals to be sustained around the same central driving force of the initiative.
2	Maintain joint goals of the initiative	Take into account the micro and macro context of the shared interest to understand the complex challenges as a whole.	Allows all aspects and members of the initiative to be included, involved and to contribute.
3	Engage in and across multiple practices	Learn through co-engaging with a variety of participants across multiple practices: both professionals and volunteers.	Enhances contextually relevant, ground-up collaboration and co-engagement.
4	Engage in reflexivity of practice and reflection	Maintain open communicative channels between all members through which questions can be asked, answers shared and multiple understandings consolidated.	Encourages discussion and evaluative practice. Creates space where boundaries can be acknowledged and future practices informed. This will encourage a greater understanding across diverse values, perspectives and motivations regarding the

			shared interest.
5	Engage in shared knowledge production	Create on-going collaborative work through collective educational activities around the shared interest. Constantly share collective information between all entities of the initiative.	Enhances open communication and varied methods of knowledge-production and encourages learning across the landscape of practice where all areas contribute.
6	Establish methods to build cohesiveness	Collectively create and develop applicable tools and platforms to encourage collaboration and connectivity (i.e. website, scientific protocol, communicative channels).	Creates standard protocols across the initiative and supporting guidelines that help standardise practice around the shared interest.
7	Establish joint learning processes	Create and maintain areas of co-engagement (co-diagnosis, co-design, co-learning and co-evaluation) to inform joint practice and negotiate boundaries that arise.	Allows for the initiative to be responsive and flexible in practice and receptive to change. Encourages multiple entities to work together to bring about change where needed.
8	Maintain awareness of boundaries that limit practice	Constantly identify challenges that arise through communicating individual and collective issues around the shared interest. Maintain areas of co-engagement across boundaries.	Encourages reflexive engagement across boundaries, creating new learning potential wherein participants engage across complex practices, institutions, power dynamics and capacity constraints.

6.4.2 The Application of the Above Social Protocol to the Bounded Case, Providing a Set of Recommendations to the WLT-CC

In order to demonstrate its usefulness to citizen science initiatives, I applied the eight principles of the social protocol to the bounded case study of the WLT-CC as a reflection tool. The principles presented in Table 6.1 are used as recommendations to examine, rethink and orientate practices towards effective knowledge-production, learning and collaborative practice across the landscape of practice.

6.4.2.1 Principle 1: Manage Practice Around the Shared Interest

Currently, the WLT-CC has biannual meetings which allow multiple entities across the landscape of practice to check-in and report back on challenges and/or achievements around the western leopard toad species before and after the breeding season. Feedback is given regarding the status of the toad in each area (i.e. inclining or declining numbers or issues within the habitats). However, there is limited discussion on how all this sporadic information benefits or inhibits the wellbeing, monitoring and protection of the western leopard toad species.

6.4.2.1.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Plan set times and locations for meetings that a minimum number of members are able to attend. At least one representative from each entity should attend. More than two meetings should be scheduled per year.
- Prepare and share relevant information regarding the western leopard toad species. Design a feedback resource aimed to collect feedback from each entity to be shared collectively. For example, what does the WLT-CC want to know from each area/entity of the initiative? What is important to find out for species monitoring and protection?
- Ensure that every stakeholder and entity is represented and prepared to share feedback.

6.4.2.1.2 How would this inform practice, negotiate boundaries and support the initiative?

- Every entity across the landscape would remain in agreement regarding the status of the western leopard toad species and therefore decisions made around

the species would remain democratic, with everyone's voice being heard.

- Each member would have a clearer idea of what to prepare for, how this would be used for the protection of the western leopard toad species and what actions to take in response to questions that arise regarding practice.
- Each area would learn about other areas, habitats and toad populations and collectively gather information around the shared interest.
- The western leopard toad species would remain central to the decisions and practice of the WLT-CC.

6.4.2.2 Principle 2: Maintain Joint Goals of the Initiative

Currently, the WLT-CC utilises its meetings and email communication to maintain connectivity and provide joint goals of the initiative. Various entities overlap and connect when required. It is up to specific members to drive communication. However, there is no shared platform where all entities can co-engage and communicate immediately to maintain joint goals.

6.4.2.2.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Collectively structure an annual agenda around the western leopard toad species that the committee jointly designs, follows and amends accordingly.
- Collectively identify and commit to short- and long-term goals for each entity and as a committee.
- Design a collective platform to follow up on information and tasks from meetings (i.e. email chain or WhatsApp group with each entity represented).

6.4.2.2.2 How would this inform practice, negotiate boundaries and support the initiative?

- All elements of the WLT-CC would be brought together under one umbrella through joint aspirations for the species.
- A shared on-going platform convening collective practice would allow questions to arise, delegation to occur and new developments (research, logistics) to be introduced without having to coordinate a separate meeting to bring all elements together.
- All collective work around the species monitoring and protection would remain

central to current and future practice.

6.4.2.3 Principle 3: Engage in and across Multiple Practices

Currently, the WLT-CC co-engages in multiple practices across various entities during breeding season (see section 4.2.6). Specifically, the volunteer 'nexus' informs research conservation and educational practices through recording data, saving toads, educating the public, communicating with conservation entities and monitoring habitats. However, the WLT-CC does very limited monitoring of how all 'nexes' co-engage across practices to harness information for it to be effectively used. This appears to limit collaboration and cohesive effort.

6.4.2.3.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Set up practice protocols together with the volunteers on the ground regarding the effective collection, storage and sharing of data.
- Once the data is successfully collected, discuss how information would be accessed and used, and how this would ultimately help protect the shared interest.
- Orientate committee members to all elements of the initiative, especially their inter-relatedness and unique contributions to the shared interest.
- Arrange that each committee member take part in volunteer practices to understand the on-the-ground work being done.
- Provide a workshop, presentation or training for volunteers alongside researchers to standardise practice protocols and data collection methods.
- Establish a convening role within the WLT-CC to assist with co-engagement across practices where needed.

6.4.2.3.2 How would this inform practice, negotiate boundaries and support the initiative?

- Collaboration and participation across all areas of the initiative would be enhanced.
- Multiple contributions from all 'nexes of practice' from the ground up would be encouraged.
- Inclusivity would be promoted and common knowledge of what is occurring

in various areas of the initiative would be built.

- Awareness and understanding of all activities would be increased towards the shared interest.
- Cumulatively, the convening of differing practices would harness all individual efforts towards the collective monitoring and protection of the western leopard toad species.

6.4.2.4 Principle 4: Engage in Reflexivity of Practice and Reflection

Currently, all 'nexes' of practice lean on one another for expertise sharing and a diversity of skills and efforts. Through reporting back at meetings, entities understand that all practices are necessary in the overall protection of the western leopard toad species. By being reflexive in practice, each entity better understands the diverse perspectives and work ethics of the other 'nexes'. This is valuable when convening over challenges, such as when volunteers, the CoCT and researchers worked collaboratively on Skilpadsvlei, or how they collectively combat various development proposals (see section 4.2.6.1).

However, most entities across the WLT-CC still operate within their own silos of practice with little co-ordinated interaction, which ultimately limits opportunities for growth, idea sharing and knowledge-production among all areas of the initiative. In this regard, the potential of the WLT-CC has not been fully realised.

6.4.2.4.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Become more reflexive by being open to sharing opinions and concerns from within and across 'nexes' at meetings without fear of power dynamics.
- Engage in constant interaction and equal partnerships through honest reflections and evaluations.
- Collectively design an evaluation method (forms, questionnaires, report back templates) to assist with reflection on the season.
- Create a position in the WLT-CC for a system convener who can help democratise the evaluative process and bring forward concerns from all areas of the landscape of practice.

6.4.2.4.2 How would this inform practice, negotiate boundaries and support the initiative?

- Effective collaborative effort would occur when multiple participants engage in and reflect across professional and expertise boundaries.
- The landscape of practice would ultimately diagnose issues together and provide solutions collectively – delegating the most appropriate person, activity or practice to combat issues that arise.
- Gaps in perspective and understanding would be articulated and consistent mutual understanding would be created.
- All practices would be enabled to exchange views and information, collectively address challenges and answer multifaceted, dynamic questions from their unique positions.
- Equal engagement would be enhanced through reconfiguration of relations and learning.
- A respectful, accommodating space to share would be created that promotes adaptive ways of thinking.

6.4.2.5 Principle 5: Engage in Shared Knowledge Production

The WLT-CC over time has built 'real time' knowledge in the field, co-created terminology and species identification and identified behavioural patterns. Volunteers have collectively designed scientific protocols that inform their specific field practices. Currently, ACs share toad numbers at each meeting (whether they have increased or decreased from the previous season) as well as any achievements or challenges they have encountered. Toad numbers are reported and documented and pertinent short-term and long-term questions are answered regarding the shared interest (see section 4.3.3). However, there is no central place to store this information that is accessible to all participants and no feedback is generated as to how the numbers are used according to the shared interest and WLT-CC goals.

Volunteers and ACs use WhatsApp to share information while in the field 'toading'. However, there is no communication across 'nexes' to share information and inform all areas of the initiative if and when instances or challenges occur. The WLT-CC utilises multiple platforms to share information such as a variety of websites, Facebook and citizen science platforms. However, various contributors each have their own portals. There is no collective site or space for shared information from all areas of the landscape of practice. Hence, there is no unified knowledge-sharing

platform.

6.4.2.5.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Create one shared online portal for collaborative knowledge of the shared interest. For example, an updated Wiki account can build a collective body of knowledge that can be jointly managed with updated contributions as information surfaces or varies (see section 4.3.3.2.).
- Select one accessible citizen science platform that can store data. All members should be trained on how to use it and upload their data using an agreed protocol.
- Communicate clearly and openly regarding knowledge production and sharing. A WLT-CC WhatsApp group for all committee members can assist with sharing purpose-driven knowledge around the shared interest.
- Engage in annual or seasonal workshops that bring all 'nexes' together to share information gathered, rather than a quantitative report back session only.
- Discuss what each 'nexus' has learnt, what they collectively know and what they wish to find out, regarding the shared interest within their contexts.

6.4.2.5.2 How would this inform practice, negotiate boundaries and support the initiative?

- Knowledge production, creation and use would be democratised.
- All knowledge, local and professional, would be included. All 'nexes' would contribute to the contextual concerns.
- A space for collaborative knowledge production would be cultivated that can inform future activity and help navigate challenges that arise.

6.4.2.6 Principle 6: Establish Structures and Methods to Build cohesiveness

Currently, the WLT-CC organises itself around answering pertinent questions and challenges that require diverse sets of expertise across multiple contexts. The WLT-CC has developed various scientific protocols or structures to assist volunteers in the field to inform their practice. They help standardize information so that it can be collated, stored and potentially used (i.e. WhatsApp group pictures of toads with data attached). However, there is a need for greater consistency of practice and

collaboration across the landscape. Protocols that explicitly encourage inclusivity, co-creation and responsiveness of diverse stakeholders are needed.

6.4.2.6.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Establish co-created protocols that inform practice in the field and between committee members. For example, each 'nexus' could set their own expectations regarding their aims, targets and goals independently and share them collectively each year.
- Create and maintain a platform such as a WLT-CC WhatsApp group to assist with collaboratively convening information across differing locations, resources, practices and other external variables keeping the shared interest central to practice.
- Establish a convener position that can maintain cohesion across all practices and assist with identifying and negotiating boundaries as they arise.

6.4.2.6.2 How would this inform practice, negotiate boundaries and support the initiative?

- The development of collective concepts, tools, rules and infrastructures would be encouraged that nurture the landscape of practice and assist with on-going interactions.
- A single position or entity would not be solely responsible for collaboration or partnership building.
- A variety of interpretations, perspectives, areas of expertise and social languages would be consolidated.
- Joint decision-making and information sharing would be enabled, which would build a foundation for a common WLT-CC body of knowledge.
- Collaboration would become more effective when 'nexes' cohesively convene around a shared goal, such as protecting a habitat under threat.

6.4.2.7 Principle 7: Establish Joint Learning Processes

Currently, the WLT-CC engages in community learning processes such as local citizens learning within their contexts, enhancing their own scientific literacy alongside other members of the landscape of practice and learning about the shared

interest. Honorary rangers, scouts and other youth engage in real life tasks out ‘toading’ and other educational activities around the shared interest. This encourages new ways of thinking and behaving with acquired knowledge.

The volunteer ‘nexus’ is effective in co-engaging across multiple ‘nexes of practice’ to stimulate critical and relevant problem solving around local issues. However, this form of co-engagement does not occur as effectively between all ‘nexes’ within the landscape of practice.

6.4.2.7.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Encourage participants to actively take part in co-diagnosis of issues, co-design of solutions, co-acting to create changes and co-learning and co-evaluating to maintain sustainability of practice.
- Establish a system convener or chairman position that encourages such engagement during workshops or frequent meetings by advocating for:
    - Interconnectedness
    - Collaboration
    - Feedback
    - Partnership work
- Generate co-evaluation and feedback methods to open discussion regarding shortfalls and achievements.
- Develop and nurture a learning space that focuses on taking action and sharing information together, where co-engagement and knowledge-production can thrive.

6.4.2.7.2 How would this inform practice, negotiate boundaries and support the initiative?

- Citizen science work would be elevated through social learning processes by creating the space for co-engagement.
- Joint analysis would be improved, discussion would be stimulated and new ways of operating would be encouraged.
- Continuous adjustments and improvements would be encouraged across the landscape of practice when addressing boundaries and informing practice.
- Environmental democracy, scientific literacy and inclusion of both scientists

and locals in the process would be inspired, which is one of the aims of citizen science.

6.4.2.8 Principle 8: Maintain Awareness of Boundaries that Limit Practice

Currently, members of the WLT-CC are aware of the different practice protocols of various 'nexes' (such as researchers' and volunteers' differing expectations around data collection). This can affect how they each operate and in turn, affect the common knowledge that is generated between them. These complex practices and differing perspectives have introduced multifaceted power dynamics across the landscape of practice, which can limit collaboration. Researchers and volunteers believe that their respective methods are the most effective and applicable, when both are equally important towards the shared interest.

6.4.2.8.1 What can be introduced to enhance and nurture common knowledge, collaboration and co-engagement?

- Address boundary issues as they arise. Co-diagnose both internal and external boundary factors in the landscape of practice.
- Work together to create potential learning and collaboration through bridging the gaps between differing backgrounds, areas of expertise, locations and practices rather than allowing these to inhibit practice.
- Co-create bridging activities and methods to:
    - Coordinate practice around the shared interest.
    - Generate relevant and accessible scientific and practice protocols for all 'nexes' to follow.
    - Generate both individual and collective time schedules and priorities that overlap and work together effectively towards the shared interest.
- Introduce a convener position that can assist with coordinating the multiple methods and structures used and equalise support structures and access to resources across the landscape of practice towards the shared goals.
- Engage in reflexive practice and reflection, guided by a convener or coordinator, in WLT-CC meetings.
- Engage in feedback methods (i.e. forms, structured report backs) and discuss how data is generated, used and applied in conservation efforts.

6.4.2.8.2 How would this inform practice, negotiate boundaries and support the

initiative?

- Co-engagement across evident boundary spaces would be improved, which would generate new learning potential where participants engage across complex practices, institutions, power dynamics and capacity constraints.
- The multiple 'nexes of practice' would be encouraged to come together and co-engage around the shared interest in a variety of configurations, interconnecting in practice to collaborate around boundaries that arise.
- Responsiveness by multiple stakeholders around the unpredictability of boundaries would be increased.
- Sustainable development would be maintained around the shared interest and adaptable practice protocols would be supported. This would assist in transforming practice.

6.5 Conclusion

The abovementioned principles illustrate how a social protocol can assist the WLT-CC in scrutinising their practice protocols and examining where they are effective and where there are gaps in their efforts towards their shared interest. Through identifying the processes required for the WLT-CC to build common knowledge through collaboration and co-engagement, they can begin to collectively inform their practices and negotiate boundaries as they arise. These processes take time and require flexibility and a genuine understanding amongst multiple entities that the shared interest should remain at the centre of all practice. If the WLT-CC is prepared to reflect on, explore and reconsider relationships, practices and shared problem spaces collectively, they can identify sites for change and increase productivity at boundaries, which can provide sustainable transformation.

The above social protocol and principles were developed through the experiences of this case study. However, they have the potential to be transferred to other community-based citizen science initiatives as a reflection tool to examine, rethink and orientate practices towards effective knowledge-production, learning and collaborative practice across their unique landscape of practice.

This case study of the WLT-CC set out to understand how knowledge-production and learning processes influence the way participants in a community-driven citizen

science initiative negotiate boundaries and inform complex practices within their local context around a shared interest. It has concluded that a complex social initiative such as the WLT-CC requires participants to engage in multiple practices through coordinated co-engagement to respond to their contextual challenges. In doing so, knowledge-production and learning is strengthened, which ultimately informs practice and assists in negotiating boundaries as they arise. Knowledge-production and learning reinforces the identity of the WLT-CC around their shared interest and enhances their capacity to participate in complex practices to combat local social-ecological challenges.

From these insights, I developed a social protocol aimed at assisting a complex social system in strengthening, co-ordinating and maintaining knowledge-production and learning across the WLT-CC landscape of practice to collaboratively answer pertinent questions or generate knowledge towards a local shared problem, which ultimately informs complex practices and negotiates boundaries as they arise.

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APPENDICES

APPENDIX A – Data Generation Schedule

Date	Interview or observation	Time	Location	Consent form signed	Length of interview/observation	Position in relation to the WLT
2017						
15-Nov	Interview	12.00	Noordhoek	Yes	**1:22:50**	Founder of ToadNUTS, volunteer action based initiative
	semi-structured				saved on phone, emailed	
					and on dropbox	
08-Dec	Obseravtion and introduction of my	2.30	Tokai	No, but an email was sent t	**1:45:46**	A selection of committee members
			conservation centre	asking for permission for m	Saved on phone and emailed	Committee head, volunteer heads from various areas in
				to take notes and observe.	saved in masters folder	CT, researchers (genetics and barrier crossing), conservationists
2018						
14th Jan	Interview	11.30	Michaels	Sent	**1:09:40**	Volunteer/local expert/ minutes taker at the committee meeting
Sunday	semi-structured		coffee shop	Take hard copy to sign at m	saved on phone and emailed	local co-ordinator - began in 2008
				Read and signed	saved in masters folder	
17th Jan	Interview	2pm	SANBI offices	Sent	**46:35:00**	Committee head/SANBI
Wed	semi-structured		Kirstenbosch	Take hard copy to sign at m	saved on phone and emailed	
					saved in masters folder	
26th April	Interview	11.30	City of Cape Town	Sent	**1:06:53**	Development applications for the City, protection of the species
	semi-structured			Take hard copy to sign at m	saved on phone and emailed	from the city and nature conservation
01-May	Interview	6pm	UK	Sent via email and explaine	**39:47:00**	Original intern who worked at the beginning of the WLT set up
	semi-structured		Previous coorindato	Waiting for scanned signed	saved on phone and emailed	coordinated multiple components of the WLT-CC
			WLT-CC			
June	Preliminary analysis of diagrams from interviews					
25-Jul	Observation of volunteer training (N	7pm	Noordhoek	Was asked by the volunteer	**0:34:00**	Education regarding scientific protocols, communication etc.
				I will make sure that my pre	saved on my phone and emailed	
22-Jul	Observation of the KIRMITS Whatsap	Ongoi	Toaki/lakeside/muiz	Emailed the AC to ask perm	**Ongoingly - Added on the 22 July**	Area Corordinator/volunteer; WLT-CC secretary
		July-S	area	Asked her to inform the group that I may be using some of the conversations as a part		
				of my data collected - and either she or I could introduce me on the group.		

APPENDIX B - Semi-structured Interview Questions

Development of semi-structured interview questions for '<u>key informant' participants (INT_1, INT_2, INT_3, INT_4, INT_5)</u>

Open up the discussion with a more general conversation about the western leopard toad and how it came to be and why and who the key players were in the beginning.

Opening questions:

- Can you start by letting me know more about the western leopard toad project?
  - How did it start, who started it and why, and how has it developed into the organization it is up until now?
  - Originally the aim was to survey, secure and legally protect all major breeding sites by 2012 – has this happened? If not – why?
  - **How is the project made up** – for example what are the key central aspects of the project (The research? The volunteering? Conservation? Education/awareness?)
  - What are the **different components** that you would say keep the programme going?
  - What or who are the **biggest contributions of this project**, would you say? / Why do you believe this is an important project?
  - **Who brings all these elements together**?

Secondary questions:

- **What is your involvement in the project?** Are you a key figure who understands all the elements of the project? Are there other role players like yourself?
- **What is the role of the western leopard toad committee**?
- **How is everyone 'kept on the same page' with regards to information sharing, decision making, creating solutions and acting on particular decisions?**

Further questions:

- **How is the flow of information communicated?**

- **What structures are in place to check the validity of information, facts, data that makes up the knowledge of the western leopard toad?**
- What is the **flow of knowledge production** – i.e. volunteers/CS help inform the research, and this informs education and conservation? i.e. how is the 'social body of knowledge' – what is known to the community of the western leopard toad created, shared and validated?
- **How do you link information collected – to research – to decision making?**
- **How does the project identify problems/challenges**?
- Who is involved in identifying these and then mitigating them?

Addressing challenges: - introduce with my mind map – what I consider a boundary or complexity in the projects:

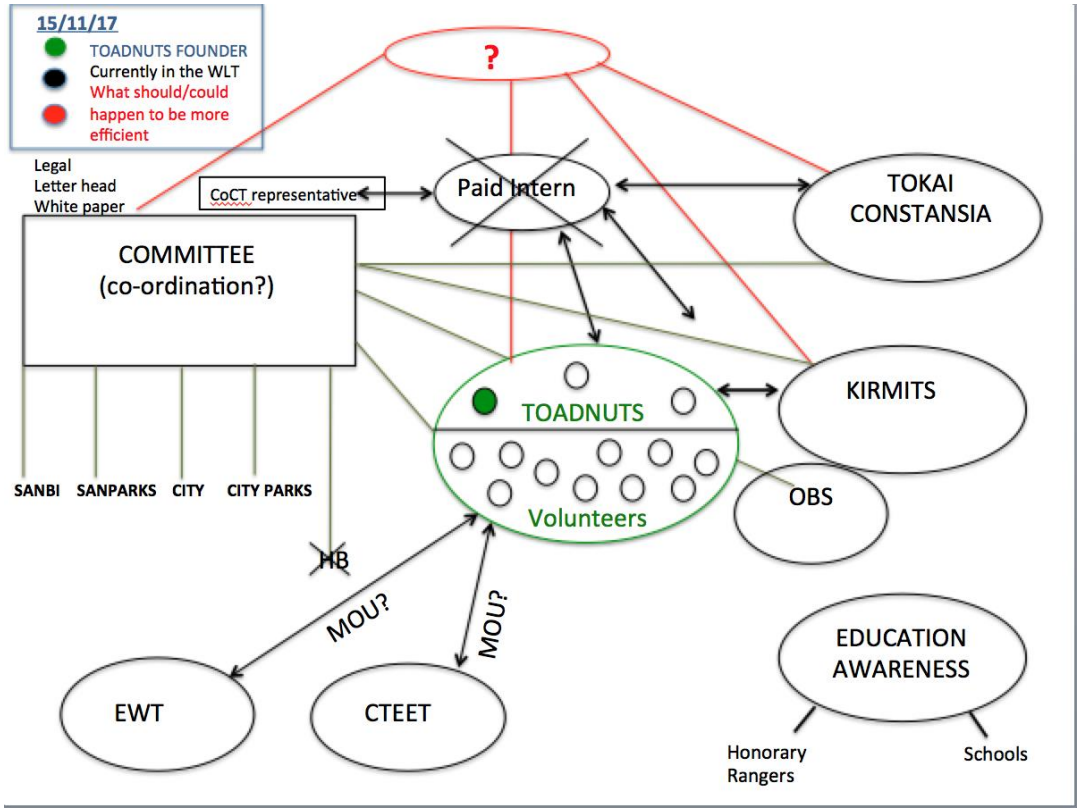
- **What challenges or boundaries does the western leopard toad face**?
- **How are all the focus groups of the project able to adapt and work together across challenges? (i.e. timing, funding, power dynamics, institutional demands, practices, scale, location etc.)**

  Can you tell about the processes that have been put in place to support different focus groups to work together and manage differences?

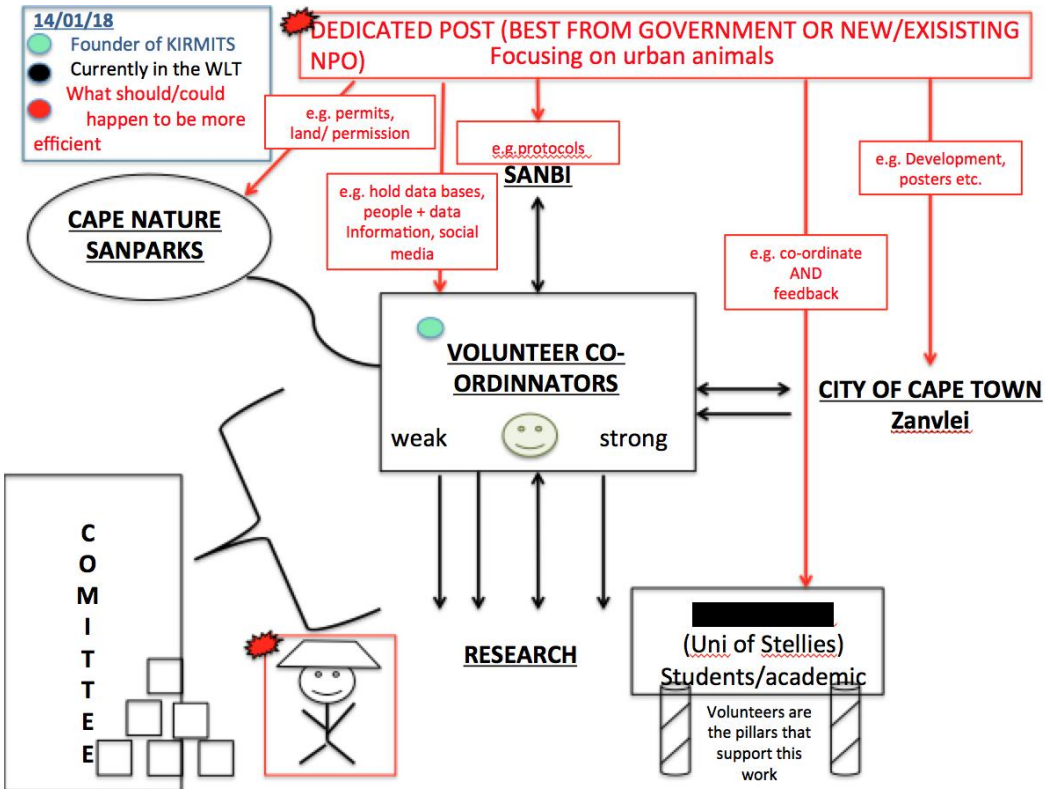
  - Please can you draw out how you see the western leopard toad initiative/project with all its role players and contributors including the committee? (BLACK/BLUE)
  - Please can you add in how you see it working differently to achieve more cohesion and social connectivity to being about better and more effective results? (RED)

APPENDIX C – WLT-CC Landscape of Practice Social Maps (LOP1–5)

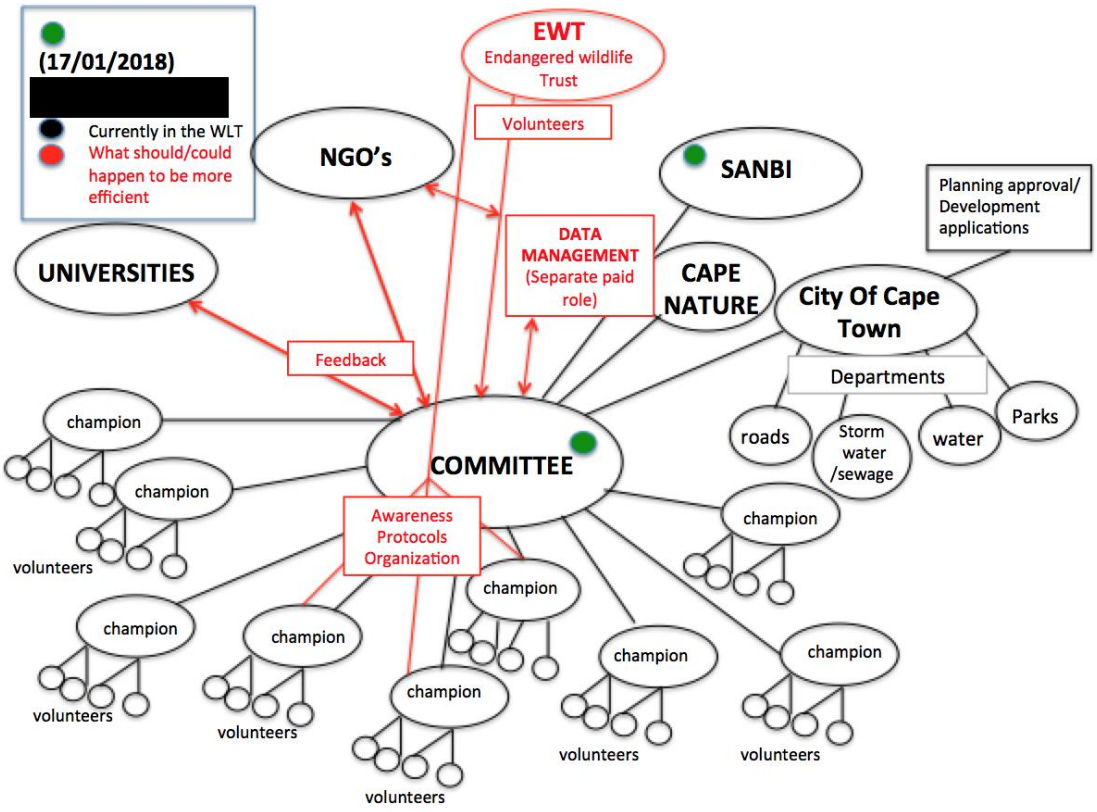
Landscapes of Practice 1 (LOP1) = Area Coordinator 1 (AC1)



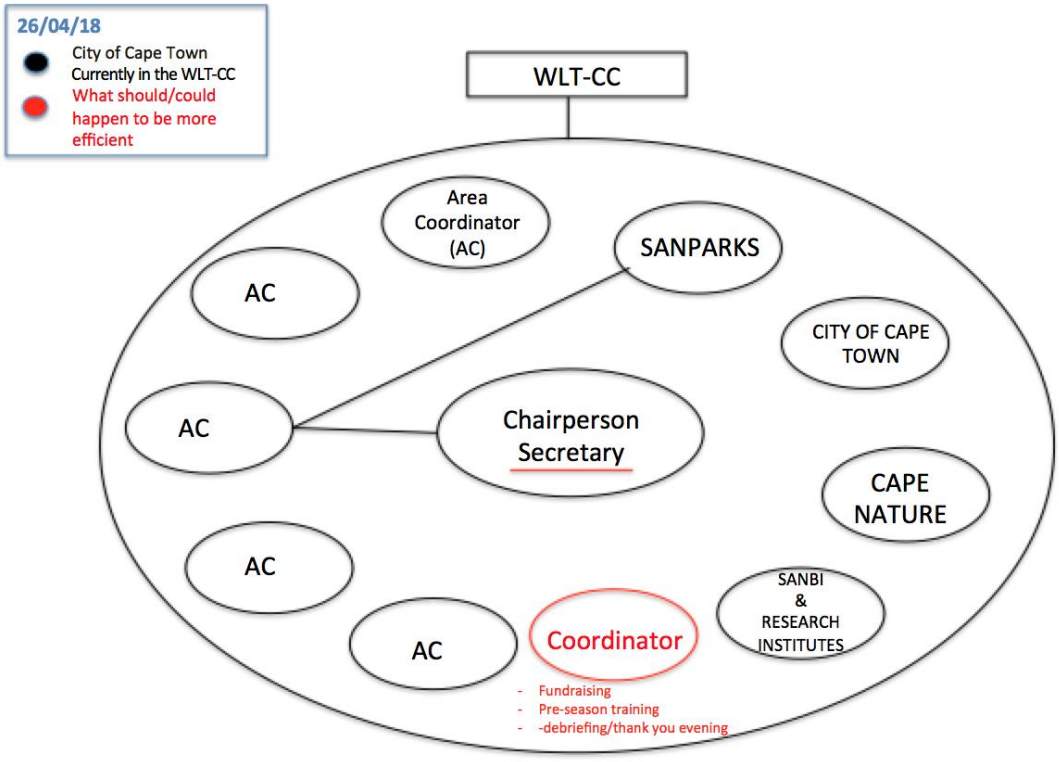
Landscapes of Practice 2 (LOP2) = Area Coordinator 2 (AC2)



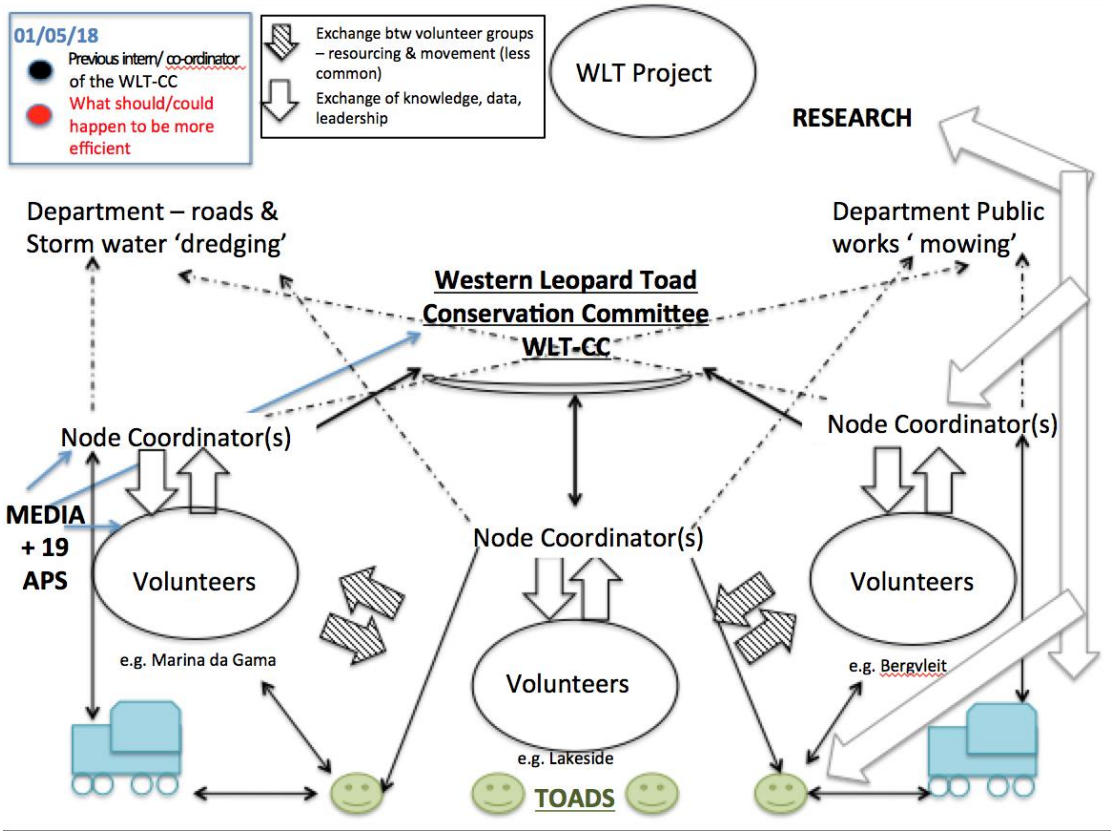
Landscapes of Practice 3 (LOP3) = Committee Chairman 1 (CC1)



Landscapes of Practice 4 (LOP4) = Cape Town 1 (CT1)



Landscapes of Practice 5 (LOP5) = Coordinator 1 (CO1)



APPENDIX D: Data index given to each data source

Data type	Index	Description of data	Date generated
Interview	INT_1	Interview transcript with ToadNUTS and SPOTS founder and WLT-CC member	15 November 2017
Interview	INT_2	Interview transcript with KirMiTS founder and WLT-CC secretary	14 January 2018
Interview	INT_3	Interview transcript with SANBI researcher and WLT-CC chairman	17 January 2018
Interview	INT_4	Interview transcript with Senior Environmental Professional from Biodiversity Management Branch representing the City of Cape Town Environmental Management Branch and a WLT-CC member	26 April 2018
Interview	INT_5	Interview transcript with previous WLT-CC intern and coordinator	01 May 2018
Drawings, organograms	LOP1-5	Landscape of Practice drawings of WLT-CC	(same dates as interviews)
Observation	OBS_1	Observation of a western leopard toad committee meeting	08 December 2017
Observation	OBS_2	Observation of a volunteer information and recruitment session	25 July 2018
Observation/ Document	OBS_3WA p. 1–39	WhatsApp group observation of KirMiTS (3 month observation)	June 2017– September 2018
Document	M1	WLT-CC meeting minutes	2009_1
Document	M2	WLT-CC meeting minutes	2009_2
Document	M3	WLT-CC meeting minutes	2011_1
Document	M4	WLT-CC meeting minutes	2011_2
Document	M5	WLT-CC meeting minutes	2012_1
Document	M6	WLT-CC meeting minutes	2015_1
Document	M7	WLT-CC meeting minutes	2016_1
Document	M8	WLT-CC meeting minutes	2017_1
Document	M9	WLT-CC meeting minutes	2018_1

APPENDIX E – Analytic memo – Observation 1 & 2 (OBS_1 & OBS_2) identifying the WLT-CC's landscape of practice context and practices

Observation #1 and #2:

Analysing OBS_#1& #2 audio with OBS schedule: observing the multiple 'nexes of practice' across the WLT-CC landscape of practice

OBS_#1: Group being observed: **Western Leopard Toad Committee meeting**	OBS_#2: Group being observed: **Western leopard toad Volunteer training/information evening**
Date and time being observed: **08 December, 2.30pm, 2017**	Date and time being observed: **25 July, 7pm 2018**
Location: **Cape Research Node, Cape Town**	Location: **Noordhoek, Cape Town**
Contact details of group: **Chaired by [redacted], Invited by [redacted]**	Contact details of group: **[redacted] – leading annual Western leopard toad public recruitment evening/information evening**

Questions linked to RQs	Speaker:	Comment/quote	Why NB?	Audio time
Who is involved? Which **nexes of activity?** **What practices are being engaged in?** How is this linked to shared interest?		Outside/private/university researcher – from SANBI ([redacted]) and Project manager (toad underpasses) – understanding the toads and protecting the toads Volunteer coordinators/locals (Area Coordinators from different locations of breeding areas)	NB to see where the research is coming from and how the research questions come about	

		Coordinators from each location report on their seasons within their areas. (seasonal reports) **(OBS_#1)** ACs – ToadNUTS and SPOTs Volunteers Locals – people from the neighbourhood Education about knowledge, information, questions and answers about species, behaviour etc. **(OBS_#2)**		
Practices: Research	SPOTs AC1: SPOTs AC1:	"Our secondary goal is data collection" (OBS_#2; 19.16) "So this is what we use the data for, it doesn't just go away, we use it for hot spot identification so knowing where the biggest road kill is happening". (OBS_#2; 22:12) Uses the data for a range of things. Grade 8 projects to PhDs	Saving toads first, data collection second What the ACs use the data for…hot spots Volunteer practices inform research projects	(OBS_2; 19.16) (OBS_2; 22:12)

	Researcher:	**Research:** 2017 - Climate change affecting the genetic landscape of the toads. “And so the key findings that came from this were that within the cape metropolitan area Observatory had the lowest diversity, um so its showing signs of decline, um follow up well, compared to the other um sites and followed, by Hout Bay.” **Resistance Analysis:** what the obstacles/barriers are in preventing population (estuaries, elevations greater than sea level, residential areas, water features, roads, oceans) – path of least resistance – paths are used - toads are able to traverse the landscape **Research built on research –** one researcher found that the Cape area was susceptible to high loss in diversity due to locations– therefore the second researcher is looking at monitoring change. Need to look at now and future. Establishing a Base line –	NB to understand the **research practices** that are assisting the work that is done on the ground – negative impacts on the species and which areas to work hard on to protect the species.	(OBS_1; 2.02) 4mins+-

Practices: Volunteers		samples from 2007. Healthy pop, (Noordehoek/Kirstenhof), declining population (OBS) and a new pop. What need – 20 samples from past or next season.		
		Volunteer practices: What do you want from us, there are toads moving all the time. There is no season in OBS, but seasonal movement in Noordhoek.	**Volunteer and research practices differ** – and different priorities and knowledge's (**research knowledge and experiential/on the ground knowledge)**	
	OBS: AC Researcher:	"What do I do with them, do you freeze them?" "If they're dead, yes, just freeze them yeah that would be, that would be great and if you have live ones, just you can give me a call and I will go and take a clip."		(OBS_1; 11.32)
	SPOTs AC1:	"We rely totally on volunteers, we don't get paid for it, we don't get paid people to go out to do it, this is what I like to call the better side of NIMBY (Not In My Back Yard) we are saying, we are not going to let this animal extinct in our backyard, so that is what we tend to believe in"	Explanation of **volunteer practices –** what they stand for and how they go about things.	(OBS_2, 0:29)

	SPOTs AC1: SPOTs AC1:	"Our primary strategy is road patrols. We do a range of other things throughout the year. We do, we talk, we are sometimes on radio, we've done a few television things, ah various bits and pieces, and awareness. We do a lot of that. We also do a lot of advocacy for the toads now, as development is ramping up, we are using the toads as a way of trying to, um slow things down a little bit. "You actually want a picture of the toad with some form of measurement, so either a ruler or else one of these very high-tech devices called an ice cream tub with a ruler inside it and that prevents the toad from jumping out so you can take a photo".	All the activities the volunteers take part in throughout the year. Resources needed to collect data out in the field. Female or male or unknown Female – eggs or empty (Juvenile – anything less than 5cms Location – where did you see it Time (20-21m)	(OBS_2; 15. 25) (OBS_2; 19.38)
A day in the life of a volunteer	ToadNUTs AC3:	"I normally always do partners unless I'm really stuck."	Explains a night in Noordhoek 'toading' and what the	26 mins OBS_2

		• Sweep the roads - Slow and steady movement cleaning the roads • Success rate this method, but struggle in high impact roads – Noordhoek, Main Rd – high volume of quick traffic • Driving 40km, people have to drive slowly behind you • Some people race past – safety – 6.30 8.30pm (first shift), 8.30-10.30 and then later if need be) • Coordinator need to know what's happening all the time. Photography WhatsApp group goes to everyone. It's happening! Everyone GO! "As the coordinator I need to know what's happening all the time, and the new thing that we did 3 years ago was actually make a photograph WhatsApp group, so when you see a photograph you take a picture and then it goes to all of, everybody	volunteers do **WhatsApp photo group** - Assisting the coordinator in convening the volunteers	(OBS_2; 29.15)

		who's on that photo group and then they know, it's happening and then it's not a matter of me trying to make a phone call, because I don't have time for that, but it's like somebody sees all of these animals and then they just get out". • One person picks up toad, get into the car, take photo and then get out to place it back to which direction it was going in – SAFE – in and out as quick as possible –depends on the roads and how busy they are.		
Practices: Conservation	SPOTs AC1:	**"**We are trying to use the data of an endangered species, as soon as um a developer wants to develop something and there is an endangered species there, and at the moment what we have are the leopard toads certain things get triggered and they have to go through certain law procedures, public participation processes. So we need to know are there toads there, in order to make developers do the right things."	**Toad advocacy –** making sure there is information about the species and numbers so that **developments can be informed** about the area before developing (EIAs)	OBS_2, 22.50)

APPENDIX F – Analytic memo - boundaries and potential learning emerging from WLT-CC Minutes

Analytic Memo 5A: Boundaries (and potential learning)

Identifying the different boundaries and the potential learning that can occur when navigated, within the landscape of practice the WLT-CC.

What are they? What is the potential learning possibility? **From WLT-CC minutes (2009-2018)**

Category	Sub-category	Comment and indexing	Comments and why NB	Date
Boundaries	(Communication) Mis-Communication/lack of communication	**"Contact list:** [redacted] requested the attendees to update the contact list. Again!" (M7, 3) "Agreed to hold quarterly meetings – pre-set the meetings for the year so there can be more information sharing/ support" (M7, 4)	**Multiple times a request for updating contacts f**or the list so that there is effective comms – this has not been done in a few meetings. This has not occurred – only seems like maximum of **two meetings a year** (pre-and post-season)	2016_1
		"Coordinator details: Everyone was requested to send updated contact details to [redacted]." (M9, 2)	Still the **same request from two years previously** about updating contact details to (coordinator role?)	2018_1

	Lack of Knowledge of species, habitat and process	[Chairman] "[redacted] notes people must not kill any toads, but only alert authorities." (M1, 3)	**Guttural toads vs. WLT** toads and which species to **protect** and which one to **eradicate.**	**2009_1**
		"The committee discusses the need to train contractors annually on identifying toads and what not to do. The committee stressed that the wording of the MOA should ensure that this is a compulsory activity." (M2, 3)	Need for **educational/awareness** efforts for contractors/city officials – prevent them from removing/killing toads	**2009_2**
		"Challenge – have the barriers created the problem? [redacted] noted that she would like some technology to support the decision as to whether to carry on– e.g. camera traps/ trackers. [redacted] suggested that the project continue for the next 2 years into a wetter period (hopefully)." (M8, 4)	Volunteers need support and resources to make NB decisions – **lack of data and technology prevents from making informed decisions**. **NB** – interesting to note that Chairman says to vary on with monitoring it – and offers no assistance with regards to resources or	**2017_1**

			knowledge on how to best monitor it.	
	Scientific protocols lacking/scientific platforms	"[redacted] points out that the identification of toads from different photos has proven difficult." (M2, 3)	**Scientific protocol structure of taking photos** (identification) or process not adequately trained or implemented	**2009_2**
		"This year [2016] was difficult for some groups, statistics-wise as there were several options available for reporting and the data collation became complex." (M7, 4)	**Lack of platform for data = lack of data being recorded** and lack of knowledge/information being produced, created and shared – lack of accuracy of findings	**2016_1**
	Power dynamics	"ToadNUTS paid for the initial objection documentation – they will not be able to assist with the next round of objections. [redacted] hopes there will be assistance from the committee in the form of expertise and input on the objections." (M8,4)	**Volunteers require official lettering/permission** and backing from the WLT – which is something they don't always receive when asking.	**2017_1**

APPENDIX G – Analytic memo – Semi-Structured Interview memo (example: a portion of INT_1)

Key										
Co-engagement (co-diagnosis, co-design, co-act, co-evluate)										
Boundaries (complex practices, power dynamics, scale, time, institutions)										
Potential learning (Identification, coordination, reflection, transformation)										
Practices (Educational, research, conservation, volunteer/CS)										
System Convenors (intern, people, tech, WLT-CC)										
Context (the WLT-CC and the LOP)										
LINKS to other sources of data										
INFO/KNOWLEDGE										
Comments/notes about quotes										
AC1 = INT_#1: ToadNUTS/SPOTS WLT-CC										
Transcription time	**Theme/Major points**	**Co-engagement**	**Boundaries**	**Practices**	**Potential learning**	**System Convenors**	**Context**	**INFO/KNOWLEDGE**	**Comments/notes about quotes**	**LINKS to other aspects of the study/sources of data**
4.26<	**Context**						"I'm so ToadNUTS and then that's part is		Noordhoeks, Unpaid Toad Savers with the emphasis on the fact that we started off in Noordheok and we're a volunteer organization	
		"there were all these frogs on the road. I actually think there might be leopard toads and now all been kill					"there were all these frogs on the road. I		actually think there might be leopard toads and now all been killed and I couldn't allow that to happen, do you want to come out with	
		"that was 2007 in the season and we worked out quickly that the toads only seem to move on, on wet nig					"that was 2007 in the season and we w		They weren 100% sure what they were doing, but they knew there was something that they could do practically to prevent	
							"that was actually before the West Leo		They weren 100% sure what they were doing, but they knew there was something that they could do practically to prevent	
							"It was an initiative by SANBI and Dr Joh		Organisations approached the volunteer initaitives at the time to come to the meeting - and with those initial stakeholders,	
	Practices: Volunteers/CS; **Co**: codiagno	"We're going to do things our way. We used.		"We're going to do things our way. We used. I think we sort of felt quite a lot of pride of being kind of mavericks in a way, being the first pioneers and working it out and trying to come up with ways to do things in a credible way, but also						
11:00	**Co**: co-diagnosis, co-design, co-act	"initially one Rand from every bottle of wine sold would go to toad NUTS. So that felt fantastic because then we were able to, to have enough mon							Able to function as an entity that (**LINK** -(INT_#5) ans INT_#4 how different areas have different networks and affluency wh	
	Boundary: Institutions and practices		"Subsequently, that whole relationship with Cape Point vineyards collapsed...that's a whole other ethical, problematic dilemma'						This private wine farm is still selling wine that has a splattered toad emblem on the front of it, which is sold and none of the	
11.49	**Practices**: Volunteers/CS			"And I think the strength behind ToadNUTS is the fact that it's not relying on one person to do it. It's					NB to remember that alone it would be too difficult that there is a need to have multiple entities involved so that if somethi	
12.10	**Boundary**: practices		"volunteer groups by their very nature can be vulnerable to, to change because people are not earning a salary. They're doing it out of a kind of emotional or social av						The committee asked the Acs to role out their way of working to other areas that had toa	
13.41	**Practices**: Volunteers/CS; **Boundary**:scale/location; **Cont**	"So we decided to just focu		"So we decided to just focus our efforts on what we could re			"So we decided to just focus our efforts		Interviewee feels that it is far mor	Areas that they rolled out to was: Kom, FH, SV. Clov, Gl.C
15.18	**Practices**: Volunteers/CS; **Boundary**:scale/location/pract	"we're not replacing what		"we're not replacing what [you] do, we're building on it."					The most active ToadNUTS volunteers were asked to lead and start up new areas and recruit for those areas. At first there v	
16.00	**Practices**: Volunteers/CS, research; **Plearning**: Identification			"a trained hep	"a trained hepatologist was very excited about the whole idea and he was amazing an				Bringing in professionals who had an interest in the species helped motivate changes and developments	
16.58	**Practices**: Volunteers/CS;			"we were spread very thin. Um, but over the years what has come out of that is, is kind of small wins					saveing and picking up toads.	
One example Refering to Skilpadsvlei - mini case study/example										
18.00	**Practices**: Volunteers/CS, conservation;	"He then did a little, a little survey, photograp		"He then did a little, a little survey, photographic survey, asked all the KEAG members to please send					2010: Heptologist found that there was one toad when he examined the area in season over 12 nights (strange), but when t	
	Practices: Volunteers/CS, conservation;	"they had money available.[from the City of (		"they had mo	"they had money available.[from the City of Cape Town] They had like R200,000 and t				2017: together with the AC, the CoCT and a green warden team. They built Skilpadsvlei up. Now there are toads everywhere	
21.23	**Practices**: Volunteers/CS, conservation;	"what you need is good dedicated volunteers		"what you nee	"what you need is good dedicated volunteers. What you need, is people that live there"					
21.45	**Practices**: Volunteers/CS,			"We're saying not in our backyard, we do not want this animal to go extinct and that's the positive of					Locals establish a concern and then co-diagnosed and designed processes that have helped them act on NB matters and hel	
	Context						ToadNUTS model -1. June/July recruit, need for local vols, advertise in local n		**LINK** - OBS_#2 (information session)	
	Boundary: Practices and location		All areas have different practices due to locations. I.e. Noordhoek - higher rate of toads crossing due to roads and dynamic of po						That type of data analysis would b **LINK** - INT_#4 (capasity issues/volunteering members)	
24.20	**Boundary**: Practices, institutional; **Plearning**: coorindatic	"we never yet been able to get anybody t		"we never yet been able to get anybody to help us with putting together a prediction model. We have 11 years of data, but we don't have a prediction model and that would be so helpful to us to know something like there						
25.30/26	**Practices**: Volunteers/CS; **Co**: Co-design	"something might happen tonight and we ha		"something might happen tonight and we have whatsapp groups for all of this who can go out tonigh					Toading/scouting process explained: very difficult to call, therefore one needs to use local experience, weather, area and lo	
NOTE from attitude and words used.	**Boundary**: Power dynamic		Area coordinator (very active and founder of ToadNUTS) doesn't get on well with Chairman							
30.45	**Boundary**: Practices, location, time/capasity, scale		"each of these volunteer groups is run completely differently. There's no control over it. There's no monitoring of it really, um, b						If something happens to its founding member, it can affect the whole operation so its vulnerable	
33.30	**S C** role					"they had an actual paid intern here who's name was Mark Day			internal intern. And He, his job was **LINK** - to all interviews explaining M.Day and the role of the intern	
34.35	**Context**; institutional, role of the WLT						"we use the committee for anything that		involves any kind of legal letterhead kind of stuff. So if we need an official response, then we will use the committee. The committee	
Transcription time	**Theme/Major points**	**Co-engagement**	**Boundaries**	**Practices**	**Potential learning**	**System Convenors**	**Context**	**INFO/KNOWLEDGE**	**Comments/notes about quotes**	**LINKS to other aspects of the study/sources of data**
35.17	**Practices**: Volunteers/CS; **Co**: co-design	"My whole goal is to create longevity for tota		"My whole goal is to create longevity for total nuts. I don't want this all, all the work we've done to c					NB to have vision and for there to be connectedness. NB to have everyone feeling like they are contributing and are a part c	
36.29	**Boundary**: Power dynamic, practices, institutional		"I think the committee would see themselves as that umbrella. We don't. And the reason for that is we've been let down by them						numerous times, numerous times. **LINK** - Contraditions to what other people have said as the role of the committee	
37.38	**Boundary**: Power dynamic		"But I'm saying that we've had exactly one meeting this year, so we used to meet quarterly. So when, when John Measey was ru						The only thing that INT_#1 mentions that the WLT-CC do, is white letter head stuff and the offical work, as well as some coc	

APPENDIX H - Analytic memo – social processes emerging from KirMits WhatsApp group correspondence

Analytic Memo 1: Social processes (knowledge and co-engagement)

Identifying the different social processes of knowledge production, sharing, creating, storing and learning within the Volunteer/Citizen science Nexes of Practice within the landscape of practice.

Where does this happen? And how does this happen?

Category	Sub-category	Comment and indexing	Comments and why NB
Knowledge	Forms of knowledge	Volunteer: First amplex pair reported alive in melody road Kirstenhof this am (WA,3)	**Terminology** between volunteers – an understanding that has been learnt after training/experiencing toading
		Volunteer: Can we check this afternoon or must it be in the evening? AC: It needs to be in the evening when they move. As per roster. (WA,3) Volunteer: Can you let me know what happens in Klein Wassenaar area? Which roads and what direction the roads move? I am new to this area... Tks AC: We will hook you up with a partner once I have your availability via email. (WA,15)	Element of **training and educating** the process through the WA – an immediate response to a question

		Volunteer: We've had one live male, 1 live female, 1 dead male. Calling at the pond on [redacted] opposite [redacted]. (WA,5) Volunteer: "1 x Female post eggs - location [redacted]Lakeside Female post eggs location - [redacted] Female road kill [redacted] rd (looks like an old road kill) Went up to main Lakeside fire station seen none" (WA, 33) AC: "Doing one last circuit. About 25 tonight." (WA, 33) Volunteer: "Total for the night (mainly [redacted] & [redacted]) - 4 Ampl. Pairs (one a drain rescue) 11 Males, 2 Females and unfortunately 2 dead (does someone still need the bodies?)" (WA, 34)	Sharing **scientific protocol** details about the toads – sharing data platform **Sharing data and knowledge** about **how productive** the evening of scouting and moving toads was to the group. Able to ask questions regarding what to do with the dead toads
		Volunteer: "A notice will go into Marina weekly newsletter so hopefully give more volunteers. So sorry I'm unavailable but following all the action from very brown Gauteng" (WA, 8)	Sharing information about the toads in **publications – advertise volunteering**
		Volunteer: How does one tell if the female has eggs? 2 enlarged areas, 1 on each side when turned over? AC: They have fat sides, you will get used to telling and will know especially once you have seen the little flabby sides of a female who has released eggs. Not to worry too much, though, if unsure,	Sharing information about **toad identification**, and how to upload the information on to the research platform

		just say that on the app. (WA, 8) Volunteer: Do we need to measure the length of both male and female in an amplexus (?) pair? So on iNaturalist it would be 100mm and 80mm for example? AC: Don't worry to measure. Just put the ruler in the photo and the computer software will do the rest. (WA, 8)	
		AC: not many but it would have been good to have one more team. Feeling very deflated with my two dead toads. (WA, 12) Volunteer: "Thanks [redacted] - you have again been tireless & selfless in co-ordinating us again this year; thank you for all you do to strengthen the WLT population." (WA, 39)	Sharing information about **emotional feelings** about the situation – not enough people out, and dead toads. **Thanks to the AC** as the season comes to an end for all the work and organizing of the group.
		Volunteer: "More good news on the toad front is that the toad from Zandvlei with the [Sic] degloving [Sic] injuries is healing well, stitches are holding, and should be due for release soon. Anyone know where it was picked up?" Volunteer: "Wow wonderful Thanks for the update. Lakeside, Where the injured toad was found" (WA, 20)	**Sharing positive stories and good news** – motivates volunteers and brings community members together. **Feedback on toads** = validates that volunteers are doing a great job

		Volunteer: “The injured toad from last night is in the hospital tank. Sadly doing very elaborate laboured breathing. Have him on painkillers and antibiotics. If you make it through the next week also will send him to cape exotic animal hospital to have the leg set or more likely amputated.” (WA, 36/37) AC: “Great, thanks team. New breeding site in Sea Breeze Park canal. Yay.” (WA, 31) Volunteer: “Hey guys, I just wanted to let you know that our Save the toads website and video went live yesterday :) http://saveourtoads.co.za 💔” (WA, 38) (**<u>Very interesting platform to share knowledge</u>** – there is a link to an informative video about traffic and toad tunnels, as well as applications to volunteer, motivating people as to why volunteers are needed, how to contact someone if a toad is found, how to donate to the cause and links to more information via publications or websites of Cape Nature, Two oceans Aquarium, ToadNUTS volunteer group (FB)	Informing the group of medical information of a **toad that was saved** and the progress in the hospital. CS and Institutional practices coming together. **New breeding area** identified **New website** for SAVE OUR TOADS was launched and went live – NB for communication, awareness, education, how to volunteer, fundraising and WHY there is help needed etc.

APPENDIX I – Participant Consent Form

INFORMED CONSENT FORM FOR WESTERN LEOPARD TOAD PARTICIPANTS

Research Project Title:	Investigating the role of the knowledge production and learning processes which facilitate complex practices in a community-driven citizen science project: A case study of the Western Leopard Toad Project
Principal Investigator(s):	Jaclyn Alexander, G06s1069

Participation Information
• I understand the purpose of the research study and my involvement in it • I understand the risks and benefits of participating in this research study • I understand that I may withdraw from the research study at any stage without any penalty • I understand that participation in this research study is done on a voluntary basis • I understand that while information gained during the study may be published, I will remain anonymous and no reference will be made to me by name or student number • I understand that achievement reports, minutes from meetings, photographs and voice recordings may be used • I understand and agree that the interviews will be recorded electronically • I understand that I will be given the opportunity to read and comment on the transcribed interview notes • I confirm that I am not participating in this study for financial gain

Information Explanation
The above information was explained to me by:
The above information was explained to me in English and I am in command of this language:

Voluntary Consent

I, hereby voluntarily consent to participate in the above-mentioned research.	
Signature:	Date: / /

Investigator Declaration	
I, Jaclyn Stephenson, declare that I have explained all the participant information to the participant and have truthfully answered all questions ask me by the participant.	
Signature:	Date: / /

APPENDIX J – Invitation to participate in research process

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

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Environmental Education
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Tel: +27 (0) 46 603 8389
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02 November 2017

Dear XXX,

Re: Invitation to participate in a research study

You are invited to participate in a Rhodes University Environmental Education Masters research study. The aim of this research is to observe the western leopard toad project and understand how multiple stakeholders and contributors engage and work effectively together to bring about effective collaborative effort toward the protection of the endemic species. Your participation can provide valuable in-depth understanding of how the project components such as citizen science practices, educational practices, research practices and conservation practices work together to protect the western leopard toad.

The research will be undertaken through interviews with committee members, as well as participants in various aspects of the programme, through observations of different components of the project and how they operate around the western leopard toad; and through working with documents such as research achievement reports, and minutes from committee meetings etc. Your participation in the research will be anonymous and your identity will not be revealed. It will be beneficial if the collection of this data spans over a 2–3 month period so that an adequate, in-depth understanding of the programme as a whole can be captured.

If you agree to participate, we will explain in more detail what would be expected of you, and provide you with the information you need to understand the research, (e.g. at a meeting or telephonically). These guidelines would include potential risks, benefits, and your rights as a

participant. This study has been approved by the Ethics Committee of the Faculty of Education and if need be, I can send you the letter of ethical approval.

Participation in this research is voluntary and a positive response to this letter of invitation does not oblige you to take part in this research. To participate, you will be asked to sign a consent form to confirm that you understand and agree to the conditions, prior to any (interviews or observations) commencing. Please note that you have the right to withdraw at any given time during the study.

Thank you for your time and I hope that you will respond favourably to our request.

Yours sincerely,

Jaclyn Stephenson
Student number: G06s1069

Dr Lausanne Olvitt
Research supervisor
Education Department, Rhodes University