Towards Non-technological Innovation:
Communicating Environmental Science to the Tourism Workforce

by Karmen Lužar

Dedicated to Prof Lynne Eagle

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet the requirements for an award at this or any other higher education institution. To the best of our knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Acknowledgements

They say life is about the journey itself and the person you become in the process. This is very much the case with a PhD as well… sometimes we do it to discover new frontiers, and sometimes to find new perspectives on the existing. Like a crooked wheel that cannot go quite straight, we wobble left and right from our intended path. If we are lucky enough, we find the courage and strength to persevere, and eventually reach a goal. Before we set a new one to chase. But it is a given that on the path, whichever one we choose, we will encounter others who will influence us with their own agenda, with their own attitudes. And so, this section is about the people and situations that shaped my performance and myself during my PhD project.

My advisory team. None of my supervisors is an expert primarily in the area that I have researched. However, they were an invaluable asset to me during the past few years and I have come to know them in certain aspects quite well. In the next few paragraphs, I will outline features that stood out to me as a student in these relationships. Perhaps this will provide a useful guidance to other future PhD candidates of what to consider and perhaps look for when they are choosing their advisory panel.

I would like to acknowledge David for his unexpected humanness and sticking with me from beginning to the end of this journey. I say *unexpected* humanness because despite his demanding and complex responsibilities in the executive positions he held, he always remembered that we are human. A number of times, when trouble arose, he would call me to check in with me. Just to see how I was managing stress. He would provide advice on how not to take things personally when dealing with various aspects of the PhD journey, including journal feedback, frustrating administration, etc. I do not think this task was on the list of supervisory responsibilities, but I cannot stress enough what a difference it made. Placing this into a wider context, many leaders at different scales in the world today are recognised for their fierceness and conquering disposition. My primary supervisor is professionally successful by common standards. However, he is also an example of a leader who gives me hope for a more benevolent future. The future that we - the human species - and the nature around us desperately need if we are to survive in a long run. I feel privileged and inspired to have worked with such a man.

Lynne for her incredibly quick responsiveness and determination. Lynne always responded to my drafts in a matter of hours or days. And if I did not send out anything to my advisory panel every couple of weeks, it was certain that her email would find its way

to my inbox, her asking if everything is ok. I appreciated her approach. Not because I would not be self-driven, rather because I know how rare this quality is. Many PhD students that I have meet during my candidature were dealing with the advisor non-responsiveness issue. And when one is bound to finish in a certain period of time because of financial and visa restrictions, believe me, it is an issue! Looking from the supervisory perspective, PhD guidance is only one of their tasks. Understandably, finding the time for quality supervision is not always easy. I, therefore, consider myself so incredibly lucky to have had a supervisor who always responded in a timely manner.

Sadly, Lynne passed away before my PhD completion. It all came as a bit of surprise, which made me realise why Lynne was always "so switched on". She probably knew about her condition all along but did not want it to interfere with my progress, and she kept quiet about it. I will always remember her as an incredible mentor, who taught me a lesson in determination too. Anytime I would come to her a bit deflated from obstacles on this PhD journey, she would simply say: "Keep going, keep going". Boy, she was right.

Liz for her dedication to her expertise and relatability. Scientific communication not only fits well within my topic, but it was also priceless to have such skilled academic editor on my team. Having a communication background myself, it was honestly an enjoyable learning process in improving my writing through her linguistic and stylistic suggestions throughout this project. In general, having excellent writing and communication skills in one of the key advantages in securing an academic or non-academic research-related job. In fact, *any* job, nowadays. One would be hard pressed to find a job vacancy that does not require it. Thus, I feel very, very grateful to have such skilled teacher in this area by my side these past few years.

Denis joined my advisory panel almost accidentally. Or maybe it was destiny. He first reached out to me when one of my survey respondents alerted him to my research. Following the initial contact, I proposed a Zoom conversation during which I got an impression of his genuine interest in my research as well as willingness to help despite him not being my supervisor. A few months later, after the tragic passing of Lynne, I needed a new advisor on my team. This time I reached out to him, and he willingly accepted my request to join the team. Apart from his aforementioned qualities, I appreciated his expertise in tourism research, which was really needed in this cross-disciplinary project.

Finally, a sincere thank you to my advisory panel as a whole for giving me such freedom in the development of the project and allowing me to express my ideas. They continuously trusted in my project management skills. I did not need to prove myself in that aspect, which made my progress much faster. I was able to channel energy into knowledge advancement. To conclude this part, when one is embarking on a PhD journey, all too often, the main objective is to find a topic-experienced researcher who is willing to take you on. Forget about the human qualities. And yet, one is about to spend three or more years of their life with these people. Knowledge can be found in libraries and online, whereas kindness, encouragement, understanding, etc. cannot. And that is why I would especially like to acknowledge my advisory team for the human qualities they have consistently shown.

Next, I would like to acknowledge Prof Franc Mali. Prof Mali was my Honour's project mentor and I have not heard much from him since. However, when I was in the middle of finding a topic, I, strangely enough, searched his name online. The result that came out first was an interview, in which Prof Mali mentioned the triple helix model. Not being familiar with this model, I was compelled to seek the insight online again. Sure enough, that was exactly the model on which I later based my project. Funny how sometimes just the right information comes to you at the right moment. So, my gratitude goes to Prof Mali for continuing to be my academic mentor even so many years past the obligation expiry date.

Further, I also want to acknowledge statisticians Rhondda Jones, Daniel Lindsay and Simon Moss for their willingness to discuss my statistics plans for this project. I had a decent knowledge of statistics before embarking on this PhD journey. However, when one collects one's own data, especially in the midst of COVID-19 pandemic, they are not perfect. Bouncing off ideas with them about how to work with "what we've got" was not only a relief, but inspiring. The same sentiment goes to my fellow researchers. Those with who I shared an office in the earlier days of PhD, those who I met in the hallways, at kitchen discussions, at Friday seminars or conferences. Thank you for continuously reminding me of the value of curiosity and that research is a worthwhile calling.

Finally, a sincere heartfelt thank you to my loved and treasured ones. First, to the family overseas, who accepted that due to my endeavour we would have to live an "online life together". To my partner for his love and unwavering support. To friends - those far and close, young and old - that "stayed out of it" and simply added to my journey with a nice conversation, a laugh, even a cry. You served as an anchor and a reminder that life is

not just about work and that in fact this PhD is not my life's work. And whilst I can honestly say that I have done my best, there is more to be done.

Karmen Lužar

Statement of the Contribution of Others

Nature of Assistance	Contribution	Titles, Names, and Affiliations
Supervision	Academic guidance in the development of this research project, its execution and the thesis writeup	Prof David Low (Charles Darwin University) Prof Lynne Eagle (James Cook University) Assoc Prof Liz Tynan (James Cook University) Dr Denis Tolkach (James Cook University)
Industry support	Project endorsement and online distribution of the research survey via their communication channels	Aimee Cameron (Tourism Whitsundays) Emily Ellis (Queensland Tourism Industry Council) Gemma Haskings (Brisbane Marketing) Hannah Walker (Fraser Coast Tourism & Events) Juanita Bloomfield (Tourism Noosa) Katherine Reid, Maddison Clerke (Bundaberg Tourism) Lina Cronin (Ecotourism Australia) Pip Close, Kahlia Pepper (Tourism Tropical North Queensland) Rosemary Allan (Townsville Enterprise)
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Statistical support	Statistical advice regarding the data analyses	Emeritus Prof Rhondda Jones (James Cook University) Dr Daniel Lindsay (James Cook University)
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Abstract

Building effective communication across sectors is central to this thesis, specifically between environmental science and the tourism industry. Scholars have noted that communication plays a key role in fostering or impeding cross-sectoral collaborations (Bernstein et al., 2018; Keyton et al., 2008; Romano et al., 2014), and these collaborations are essential for regional development (Chen, 2017; Organisation for Economic Co-operation and Development, 2009). Innovation does not occur in a vacuum; more often than not, it arises from a system of innovation that fosters capacity building and development (Lundvall, 2010). Innovation systems consist of actors, e.g., academia, industry and the government, and the relationships between them (Etzkowitz & Leydesdorff, 1995).

One element often largely overlooked, however, is that different professional groups - effectively different communication audiences - have different requirements (Leal Filho, 2019). In other words, to communicate effectively, one needs to know the audience and adjust communication to that audience. While environmental science has various stakeholders, this thesis focuses on the tourism industry. Tourism in Australia is largely nature-based. However, the effectiveness of communication between environmental sciences, which provide invaluable information for both interpretation of natural attractions and management of environmental resources, and tourism personnel is largely unknown. Thus, based on in-depth empirical research, this thesis investigates how to effectively communicate environmental science to the tourism workforce. Tourism marketing and communication studies have long-focused on visitors (see e.g., reviews by Beane & Ennis, 1987; Dolničar, 2020; Penagos-Londoño et al., 2021; Quer & Peng, 2022; Torkzadeh et al., 2021), however, less is known about the tourism workforce. Yet, studying tourism professionals as the audience is important: they are the brokers/gatekeepers of environmental knowledge, and the managers and decision makers with the power to direct businesses and their clients towards a sustainable future.

Furthermore, this thesis builds a case for cross-sectoral communication as a non-technological innovation. More specifically, through tourism workforce segmentation and reflective thematic analysis, it answers questions about "who, what, where and how" when it comes to communicating environmental information to the tourism sector. Data were collected via survey (quantitative) and focus group (qualitative). Analysis methods included descriptive statistics, ordinal regression, chi-square tests for association and

near tables. Apart from the latter, which was undertaken using ArcGIS, the analyses were conducted using SPSS software.

As this thesis adopts an interdisciplinary approach to address the problem in the intersection of systems of innovation, environmental science communication and tourism, the contribution of this thesis pertains to these three areas as well. In terms of theoretical contributions, this thesis addresses an important gap in triple helix scholarship by providing the first non-technological application example. Further, it consolidates communication scholarship within triple helix and applies marketing and communication concepts. Next, it proposes a triple helix communication model. Its contribution to communication theory includes applying encoding/decoding concepts to the cross-sectoral setting. Finally, this thesis provides an empirical example of stakeholder communication, specifically on how to communicate environmental science to the tourism workforce, which is a novelty from both angles. Practically, by addressing the research questions, it provides marketing/communication guidelines for environmental scientists. Second, this research has exposed the tourism workforce to the idea of using environmental science information as part of destination marketing strategies. Third, it provides evidence that can guide innovation policy change.

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Motivation of the Candidate

I am a communication and environmental strategist. I hold a Bachelor of Social Sciences with Honours (majoring in journalism) from the University of Ljubljana. I also hold a Master of Applied Science in Natural Resource Management from James Cook University. After completing my postgraduate studies, I founded and managed a consultancy focusing on science communication and planning for sustainable development with an international outreach to Europe, Australia and the Pacific. I have collaborated with Australian and international environmental institutions, including different levels of the Australian government, NGOs, research institutions and the private sector. Some of the major organisations include the United Nations Environment Programme – Regional Activity Centre in Split, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Brisbane, the Department of Environment and Conservation in Western Australia, the Sunshine Coast Regional Council, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH – Vanuatu Climate Change Office, James Cook University, and the ARC Centre of Excellence for Coral Reef Studies.

This work provided me with extensive experience in project development and management, stakeholder engagement and communication, as well as research including conducting interviews and surveys, qualitative and quantitative data analyses, and the production of outreach materials. Through my environmental consultancy work I have identified, and taken an interest in, the importance of effective communication. I worked with a variety of environmental science stakeholders, including the tourism industry. With my extensive training in linguistics, stylistics, and work experience in managing public relations, marketing and multimedia production, I was able to observe patterns that hinder effective dissemination of environmental knowledge and information within and across different environmental stakeholder groups. More recently, I was employed as a university lecturer. In that role, I developed a unit on sustainable innovation strategies and systems.

This previous work experience led me to undertaking a PhD, with strategic research focused on improving academia–industry relations by optimising cross-sectoral communication. Specifically, I link environmental science and the tourism industry in Queensland and investigate the feasibility of environmental science communication becoming an innovative destination marketing strategy (non-technological innovation) to contribute to regional sustainable development.

1. Introduction

"Learning and innovation go hand in hand. The arrogance of success is to think that what you did yesterday will be sufficient for tomorrow."
(William Pollard)

1.1. Background to the Research

A great number of environmental issues have grown in scale and complexity, threatening the survival of humankind on Earth (Bondar et al., 2019). It is well established that environmental issues like climate change, pollution, resource diminishment, food insecurity and biodiversity loss are global challenges and hence must be tackled with joint effort and cooperation (Barua, 2020; Ferronato & Torretta, 2019; Salvia et al., 2019; Scherer et al., 2020; Sheppard, 2018;). Sustainable development seems to be an ever-elusive goal in the face of increasing pressures from urbanisation, technological growth, transportation systems, agriculture, property development, etc. Developed countries, to protect their own environment, have moved 'dirty' factories to the developing parts of the world (Singh, 2006). However, moving problems out of sight does not make them disappear. With the additional issue of a rapidly growing global population, the environment struggles to cope (Pimentel & Pimentel, 2006). Human pressure on natural resources is unprecedented. Alternative solutions are needed, and promoting service-led structural changes is one of them (Ibrahim et al., 2022).

The shift from a manufacturing to a service economy requires innovative thinking. Tourism, as an example of a service sector industry, is one of the most prospective and dynamic businesses in the world and planning and developing tourism purposefully and sustainably is an urgent priority (Streimikiene et al., 2021). In future, the need to adapt to changes in natural environments driven by the aforementioned issues is likely to have profound impacts not only on how we market the regions for tourism, but how we can protect them and use them as tourism resources (Lew at al., 2020). Meeting the challenges of changing patterns of demand for tourism experiences and the impact of externalities that may affect the tourism sector requires an ongoing process of regular re-evaluation of key attractions and experiences, partnerships (domestic and international), competitors, potential new markets and planning to deal with the unexpected. Failure to adopt a strategy that incorporates these elements and recognises the needs for regional, inter-regional, state and national cooperation of this type can lead to reduced competitiveness, loss of opportunities and, possibly, long-term decline

(Dwyer et al., 2009). In the Australian context, Dwyer et al. (2009) suggested strategies for the tourism industry in the face of ongoing global changes, with one of them being innovation in product and service development. However, a few years later, a report that examined the views of industry, government and academic respondents about the long-term environmental and economic issues facing the tourism industry found that, with few exceptions, innovation has largely stalled and that, overall, there was a limited vision of the future (Prideaux et al., 2013). Even more recently, re-imagining and transforming tourism are still underway (Austrade, 2022; Queensland Government, 2022c).

Visions of the future commonly lean on innovation. According to Kuczmarski (1996), innovation is a mindset, i.e., a new way to think about business strategies and practice and the single most important factor in the future growth of any business. For example, a study of 330 firms in United Kingdom found that innovation pertains to enhancement of a company's core competence, and improvement in its output/product characteristics (Seddighi & Mathew, 2020). Furthermore, innovation is an integral part of regional development strategies that seek to foster competitiveness in the market (Chen, 2017; Organisation for Economic Co-operation and Development, 2009).

Innovations can often be seen through the restricted view of technological advancements (e.g., Etzkowitz, 2004; Ganda, 2019; Kennedy & Lim, 2018; Lemke & Press, 2010; McClements et al., 2021; Sundbo 1998;). However, emphasis on technology excludes a whole range of industries that sell products and services that are not technological in nature. A good example of such an industry is tourism. As Schumpeter[1] noted: "It might be thought that innovation can never be anything else but an effort to cope with a given economic situation." (Schumpeter, 1939, p. 81). While recommendations related to enhancement of competitive advantage through innovation strategy for tourism continue (Kuang-Chin, 2018), less is known about how to achieve that.

Non-technological innovation might be a possible solution. Non-technological innovation refers to novel organisational strategies and communication improvements in areas such as marketing, communication, organisation, management and design (OECD & Eurostat, 2005). Since these measures are not primarily driven by a technological invention or improvement, they are referred to as non-technological innovations. However, as information and communication technology (ICT) is commonly used as an enabler of most modern innovations, the tendency is to understand all innovations as

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[1] Schumpeter is considered by many to be a father of innovation theory (Sandal, 2021).

technological advancements (OECD & Eurostat, 2005). Jakob et al., (2003) found that non-technological innovations are more frequent in services than in manufacturing. The key purposes of non-technological innovation are to help create productive business partnerships and influence market development.

Raisi et al. (2020) postulate that efficient transfer of knowledge between academia and industry is the prerequisite for innovation and competitiveness of tourism destinations. The authors refer to the importance of communication networks rather than technological knowledge transfer. Developing this idea further, this project examines the notion of communication as a non-technological innovation. The purpose of this thesis is, therefore, to bring to light the possibilities of non-technological innovation by providing a plausible example where communication could serve to foster organisational and beyond-organisational change[2]. The next section will explain in more detail how communication relates to innovation and define the research problem.

1.2. Research Problem

Innovation is not born on its own; nowadays, more often than not, it arises from a system of innovation that fosters innovation capacity and development (Lundvall, 2010). Innovation systems consist of actors and the relationships between them. Existing research, however, rarely empirically deconstructs a system of innovation and examines its structure (Sant et al., 2020). This is especially true in non-technological innovation, including communication studies within the system of innovation scholarship.

Scholars have noted that communication plays a key role in fostering or impeding cross-sectoral collaborations (Bernstein et al., 2018; Keyton et al., 2008; Romano et al., 2014). The emergence of collaboration is facilitated by the sharing of knowledge across organisational boundaries, which promotes the formation of trusted relationships and builds social capital for further cooperation (Carayannis et al., 2000). However, this constructive process can only occur if communication barriers are acknowledged and overcome. The barriers may include differences in organisational cultures causing difficulties in establishing common practices, methods, and tools; different languages (jargons, vocabulary and corporate terminology), which make communication difficult in terms of categorising information; different regulations, norms and standards, which

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[2] The term refers to a change within a system of innovation, where the cross-sectoral communication process is one of the key functions and an agent of change.

make leadership difficult to be accepted by all; different locations, whereby the distance may impede trust building; and different skillsets, which may lead to refusal of others' ideas and fear of losing competitiveness by sharing expertise (Dalkir et al., 2019). Essentially, in cross sectoral communication, we are dealing with different professional cultures, each with its own mental framework and long-established priorities that differentiate them from others (Leal Filho, 2019). To communicate effectively, a communication strategy requires identifying and understanding target audiences for tailored communication (Leiserowitz et al., 2021). Further, the best means to reach various groups also differ. Providing information via mediums that specific groups (as audiences) normally use and trust is an efficient way to reach them (Leal Filho, 2019).

The research problem, therefore, pertains to effective communication in the cross-sectoral space. One element often largely overlooked is that different audiences have different requirements (Leal Filho, 2019). This notion requires scaling communication to one type of audience. While environmental science has various stakeholders, this thesis focuses on the tourism industry. The key question guiding this thesis will be how to effectively communicate environmental science to the tourism workforce. Detailed aim and objectives are developed in the next chapter, after the literature review (see section 2.6. Aims and Objectives).

1.3. Definitions

TRIPLE HELIX: Core model from the theory of system of innovation, consisting of three main spheres: academia, industry and government (Etzkowitz & Leydesdorff, 1995). For the purpose of this project, the model illustrates the key sectors and relationships between them; communication being the central function.

CROSS-SECTORAL COMMUNICATION: Communication processes between two or more sectors, characterised by interactions between different professional cultures, including norms, language, references of knowledge, etc. Cross-sectoral communication is a key focus in this project.

KNOWLEDGE TRANSFER: Within the context of cross-sectoral communication, a new concept of non-technological innovation. For the purpose of this project, knowledge transfer activity that occurs via communication between two sectors is seen as an innovation itself: more precisely, a process innovation.

NON-TECHNOLOGICAL INNOVATION: Non-technological innovation refers to novel organisational strategies and communication improvements in areas such as marketing, organisation, management and design (OECD & Eurostat, 2005). For the purpose of this project, non-technological innovation refers to the ideas/strategies pertaining to cross-sectoral communication and knowledge transfer between academia and industry.

ENVIRONMENTAL SCIENCE: Multi-disciplinary field comprising various branches of studies including life science, agriculture, chemistry, physics, public health, medical science and pharmaceuticals, etc. It is the science of physical phenomena in the environment that studies sources, reactions, transport, effect and fate of physical and biological species in the air, water, and soil, and the impacts of human activities on these (Singh, 2006). For the purpose of this project, environmental sciences refer to those that deal with natural resources, i.e., the physical and biological elements of environment.

TOURISM: An economic sector comprising industries related to the movement of people to places outside their usual place of residence, pleasure being the usual motivation (WTO, 2008). Tourism related industries are defined as those industries that would cease to exist without tourists. There must be a direct relationship between the provider of the product and the consumer. For the purpose of this project, the tourism industry is seen from the supply perspective, i.e., tourism workforce.

1.4. Delimitations of Scope and Key Assumptions

Every research project needs limits to its scope (Quinlan et al., 2015) and this section briefly outlines the key delimitations of this project. First, I explain why I chose the case of communicating environmental science to the tourism industry. Second, I explain the choice of scope, i.e., the Australian state of Queensland. The key assumptions are also explained.

1.4.1. Focus on Communicating Environmental Science to Tourism Industry

To empirically study cross-sectoral communication I needed to find two suitable sectors. The main criterion was to find sectors with the potential to foster non-technological innovation (as opposed to technological) and where collaborations would be meaningful (if not obviously needed). Furthermore, I also considered what case would be useful in

terms of transferability of lessons to other areas. I, therefore, chose environmental science as a representative of the academic sphere and the tourism workforce as a representative of the industry sphere. The Australian state of Queensland was chosen as the study area because it showcases the interdependence of these two sectors and the need for a meaningful engagement. Nature-based tourism is one of the key industries in this state (TEQ, 2021), dependent on pristine environments, and environmental science has direct relevance to the preservation of nature and sustainable use of resources. However, at present there are no systematic linkages between these two sectors, although they are both important for the country economically and socially.

In Australia, environmental science is one of the most funded research areas. The National Environmental Science Program (NESP) is a long-term Federal Government commitment to addressing emerging environmental research needs through an investment of $145 million from 2014–15 to 2020–21, and a further $149 million from 2020–21 to 2026–27 (Department of Climate Change, Energy, the Environment and Water, 2022). NESP hubs operate through regional facilities. The second phase of the program, currently underway, is enabling closer, more meaningful and efficient engagement between researchers and end-users (Department of Agriculture, Water and the Environment, 2021a). As the tourism industry is one of the key stakeholders of environmental science, this project is timely. In Queensland, more than 120 research facilities have the potential to provide environmental knowledge capital that could benefit the state's tourism industry (Queensland Government, 2022a).

The tourism industry contributes strongly to the Australian economy. Tourism was among the country's fastest growing sectors prior to COVID-19 (Deloitte Access Economics, 2017), with average annual growth of 5% per year in the decade preceding the pandemic (TRA, 2022a). Pre-COVID-19, the Australian tourism industry ranked as the 7th largest tourism market globally and 2nd for visitor spend per trip (Global Australia, 2020). In 2018-19, one in every eight businesses across the country was in tourism (Deloitte, 2022), and the Australian tourism industry directly employed nearly 665,000 people (TRA, 2022a). The Queensland tourism market is the second largest in Australia, and in 2018-19 accounted for 22.7% of national tourism output and directly employed 145,400 people (Queensland Government, 2020). The pandemic compounded the pre-existing challenges (e.g., limited available Australian workforce, increased consumer expectations and focus on climate change and environmental sustainability, etc. – for more details see Thrive2030) facing the tourism industry in Australia (Austrade, 2022); However, discussions are taking place on how to address the challenges and re-position

tourism globally (UNWTO, 2021) and nationally (Austrade, 2022). As part of responsible recovery from the pandemic, environmental considerations have a central role (UNWTO, 2021), positioning environmental knowledge as an important resource. The health of the natural environment is critically important to the stability and value of the nature-based tourism industry. Environmental scientists are needed more than ever to provide crucial information about the state of the environment and work collaboratively with government and the industry to overcome challenges, including climate change.

Environmental science can provide key information in several aspects of tourism business, including a) creating a destination image (marketing); b) developing/providing products (e.g., food) and services (e.g., interpretation); and c) implementing science-based environmental management practices (e.g., leadership). Interest in environmental science may not necessarily only be associated with nature-based tourism activities/experiences. Environmental accountability (Asadi et al., 2020; Kärnä et al., 2003; Melubo et al., 2019) or preserving livelihoods (Ioannides & Zampoukos, 2011) may also be among the motivating factors for the tourism industry's interest in environmental science. Increased environmental concerns on the part of customers, governments and nongovernmental organisations have placed pressure on the industry to implement a range of environmental responsibility measures in the forms of voluntary codes of conduct, manuals and green alliances (Honey, 2002). Many studies found that corporate social responsibility (CSR) programs help improve the attractiveness and popularity of a tourist destination (see e.g., Abaeian et al., 2019; Asadi et al., 2020; Blinova et al., 2021; Dodds & Joppe, 2005; Melubo et al., 2019). CSR programs include reporting on environmental performance. Sometimes it can be ethical beliefs that guide pro-environmental business decisions; however, they need to be coupled with commercial common sense (Buckley & Mossaz, 2018; Kasim, 2007). Overall, motivation will depend on organisational benefits, professionals' own initiative, response demand, and market trends (Chan & Tay, 2016; Fernández-Llamazares et al., 2020).

The tourism industry relies on and impacts natural resources in many other regions around the world. I therefore expect that the case examined in this thesis will provide valuable insights and lessons to other similar regions that might want to adopt a more sustainable, non-technologically driven approach to development.

1.4.2. Why Queensland

The reasons I chose Queensland as the study area are manifold. First, Queensland has some of the most diverse natural ecosystems on Earth, with more than 50% of total Australian biodiversity. 8.2% of Queensland's land is in protected areas and over 4.4 million hectares of land managed as private protected areas (Queensland Government, 2022a). Much of this natural beauty is leveraged by destination tourism companies that attract millions of international tourists annually. As it will be explained in the Literature Review chapter (next), the tourism industry in Australia and its destination marketing operates as a network on various sized geographies, including local, regional, state and national. The state level includes 13 regions managed by Regional Tourism Organisations (RTOs). At the regional level, the complexity of the tourism network increases and divergence in how these regional organisations are managed becomes more obvious. The variations can be attributed to substantial differences in the geographical size of the administrative regions, the number of participatory councils, systems of funding, different legal structures, and the number of members of each of the 13 RTOs (Destination Q, 2018). From the marketing and communication perspective, regions are at varying stages of market development and service vastly different marketplaces, ranging from mature resort destinations through to lesser developed and sparsely populated rural areas (Destination Q, 2018). Investigation of communication and cross-collaboration at Regional Tourism Organisations level is thus appropriate, and it was the geographical scale selected during the exploratory phase of the data collection process (described further below in the section 3.8.1.).

Furthermore, not scaling the project all the way up to a nation-wide level responded to a researchability criterion (Quinlan et al., 2015). Collecting data from different States and Territories of Australia would achieve greater variability in terms of diversity of respondents and natural destinations of interest, and potentially yield even more distinct results. However, that kind of scope would not fit the resources available to a PhD candidate. Key considerations included time, money and data requirements (Quinlan et al., 2015).

1.5. Outline of this Thesis

This thesis has five parts. Following this introduction is the Literature Review, a chapter that introduces key theories and concepts. The third chapter, Methodology, includes information on research philosophy, approach and design, sampling, the development of instruments and the data collection process. Following that is the Findings chapter that provides answers on the research questions. Finally, the concluding chapter

interprets the key findings of this project and provides recommendations for future research.

2. Literature Review

2.1. Introduction

This chapter presents a review of the literature that underpins the identification of research gaps that this thesis addresses. The opening theme of this review is the theory of systems of innovation[3]. This theory supports my general motivation to develop this project. The following section, therefore, sets the scene, and explains the main evolutionary waves of the innovation systems theory. Further, the triple helix model is selected to illustrate where cross-sectoral communication fits. The next section reviews literature on cross-sectoral communication within the context of triple helix to provide the landscape for this project and expose the gaps. To address these gaps, I borrow relevant models and concepts from communication and marketing theory. Finally, I zoom into audience studies and the tourism sector itself. Figure 1 outlines the literature review structure.
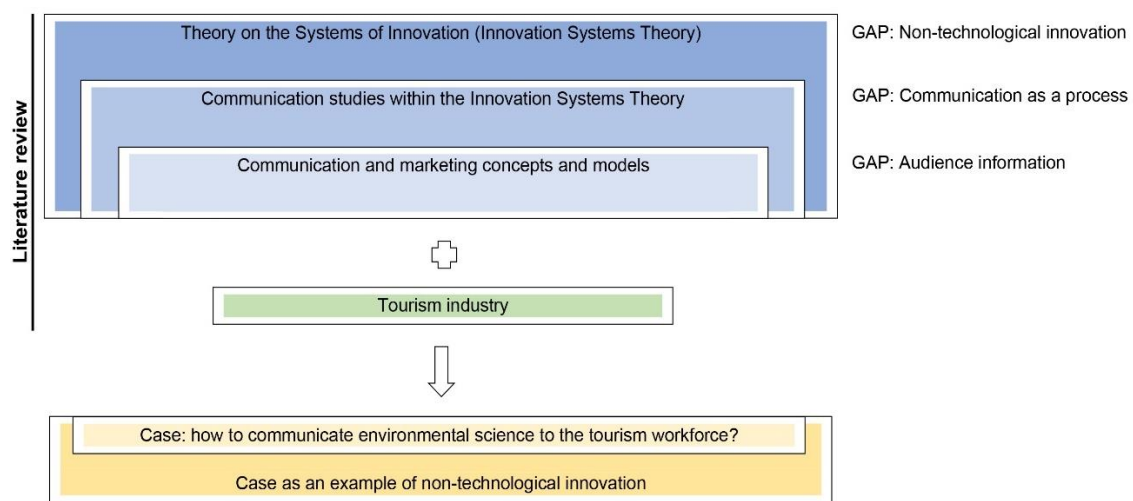
Figure 1: Literature review structure

2.2. System of Innovation Theory

Innovation is the key driver of economic growth in developed countries and is considered a crucial factor in national progress (Raghupathi & Raghupathi, 2017). Growth in the

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[3] The theory is also known as innovation systems theory, and in this thesis the names are used interchangeably.

world economy is increasingly dominated by knowledge-intensive goods and services (Kabir, 2019). A key element to competitiveness in the knowledge-based economy is interconnectedness between the key innovation actors. Infrastructure of linkages (networks) among firms, universities and governments, provides competitive advantage through quicker information diffusion and product deployment (Lundvall, 2010). The elements and relationships, which interact in the production, diffusion and use of new and economically useful knowledge, form a system of innovation (Lundvall, 1992). In other words, an innovation system is an environment in which innovation capabilities are fostered to promote economic performance (Acs et al., 2017).

Innovation systems have been studied since the 1970s. The Sábato Triangle model (1975) was one of earlier conceptualisations of linkages between science, industry and government, developed in the Latin American context (Althoff Philippi et al., 2015). The model recognised the necessity for the three sectors to be strongly linked together over the long term for technology transfer. The interrelatedness of the productive structure (industry), the state (government), and the scientific infrastructure (academia) was portrayed in the form of a triangle (Arocena & Sutz, 2021). The next wave of the innovation systems theory consists of national systems of innovation (Lundvall, 1992; Nelson, 1993), and their regional (Cooke at al., 1997) and sectoral variations (Malerba, 2005). Similar to Sabato's, these models consist of key actors and the relationships between them; however, the interorganisational structure of a system may be more complex than in Sabato's model. Another key difference compared to the previous wave is the focus on geography. National systems of innovation are studied within countries' borders (Roos et al., 2005), whereas regional systems scale down to smaller administrative or political regions (Cooke et al., 1997).

More recently, the triple helix model (Cai & Etzkowitz, 2020; Etzkowitz & Leydesdorff, 1995; Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2013), and its augmented quadruple (Afonso et al., 2012; Carayannis et al., 2018; Miller et al., 2018) and quintuple model (Carayannis & Campbell, 2010; Carayannis et al., 2012; Durán-Romero et al., 2020) have dominated innovation system theory. The triple helix model returns to observations of the innovation system via a simple triadic structure of government, industry and academic spheres (Etzkowitz & Leydesdorff, 2000). However, as opposed to previous models that stressed the leading role of government or industry for technology transfer, the triple helix model emphasises the role of universities in contributing to socio-economic development (Ranga & Etzkowitz, 2013).

In the triple helix model, higher education institutions (academia) are among the main actors in these dynamics, with their intellectual capital and as core generators of knowledge (Limones Meráz et al., 2021). Furthermore, the term entrepreneurial university was developed under this wave to describe universities' capacity to generate technology, which has changed their position from a traditional source of human resources and knowledge to a new source of technology generation and transfer (Etzkowitz, 2004). However, technology transfer has not really actualized in Australia[4] (ISA, 2016). The industry sector is the sphere where the knowledge is applied in innovation development, whereas government serves as an enabler and incentive provider.

The quadruple helix embeds the triple helix model by adding as the fourth helix the media-based and culture-based public, or civil society. The media-based public supports the diffusion of knowledge, while the culture-based public with its values, experience, traditions, and visions influences knowledge and knowledge production (Ranga & Etzkowitz, 2013). The goal and interest of proponents of the quintuple helix model are to include natural environment as a new subsystem for knowledge and innovation models, so that 'nature' becomes established as a central and equivalent component of and for knowledge production and innovation (Carayannis & Campbell, 2010). Under this model, natural environment becomes an informant of innovation, and sustainable development becomes underlying goal in knowledge production and innovation (Carayannis et al., 2017). Figure 2 shows the variation of helix innovation system models.

Quintuple Helix
(context of natural environment)

Quadruple Helix
(context of society)

Government

Academia

Industry

Triple Helix
(innovation core)

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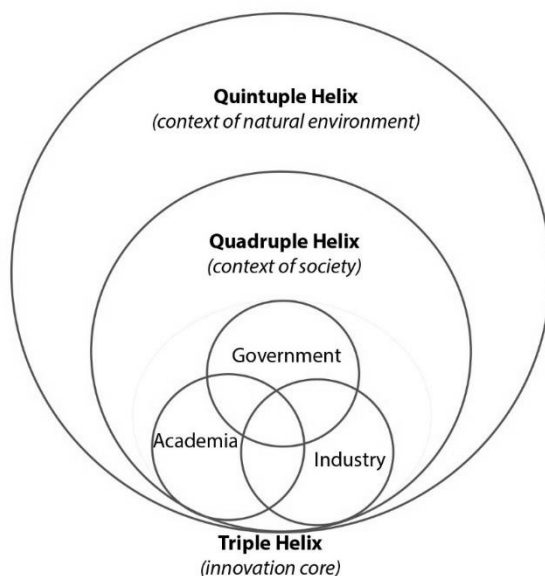
[4] With the exception of Monash University, which has been recognised as an entrepreneurial university (Bratianu & Stanciu, 2010; Clark, 2004).

Figure 2: Triple, quadruple and quintuple Helix models. Adapted from Carayannis et al. (2012)

To illustrate the relationship between academia and the industry, I chose to use the triple helix model[5]. The key advantage of this model, as opposed to the later models, is its simplicity; thus, less complex dynamics are at play in the innovation systems (Zheng, 2010). In essence, the triadic relationship of the core spheres is enough to illustrate where cross-sectoral communication fits in the model. Using the concept of Occam's razor (Walsh, 1979), there is no need for a more elaborate model. Braithwaite (2017, p. 2) explains: "If it is not absolutely necessary to introduce certain complexities or hypothetical constructs into a given explanation, then don't do it". Should my project be positioned in (social) media communication, the quadruple helix might be in order (Leydesdorff, 2012). But for the purpose of highlighting the communication process between any two sectors within the system of innovation, the triple helix is the best solution. Furthermore, unlike previous models (i.e., regional and national innovation system models), the triple helix model forms the scientific basis of numerous research and innovation strategies (Deakin, 2022). In this sense, it is more appropriate for this thesis than the previous models. In the next section, I therefore review the literature on communication within the triple helix context.

2.2.1. Communication Within Triple Helix: Consolidation of Existing Knowledge

Communication theory is not a single entity. It is rather a consortium of theories, initially developed from two distinct streams. The first is the mathematical theory of communication (also sometimes referred to as information theory), which is centred around technical properties of communication (see e.g. the seminal work of Shannon from 1948, and within the triple helix context particularly the works of Leydesdorff). The other direction relates to human dimensions of communication and has been further divided into rhetorical and relational aspects (Salwen & Stacks, 1996). While the first line studies influence and persuasion, the second relates to bonding/clustering traits. Both of these streams are relevant to the triple helix thesis.

Communication is at the core of triple helix relations: no collaboration can exist without communication in some shape or form (Dalkir et al., 2019). Acknowledging this idea,

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[5] Whilst the knowledge transfer model, i.e., US services extension model (see e.g., David et al., 2016), has been considered, it does not adequately cover the direction intended in this thesis, i.e., the communication within the system of innovation.

communication has been studied by triple helix scholars since the early development of the theory. The primary objective of the following review was to systematically and critically appraise existing studies related to communication scholarship within the triple helix context. I categorised studies into six thematically distinct groups (see Table 1). This systematic approach helped to uncover some important information about how communication theory and practice is developing within the triple helix context. The key observations are discussed with regard to the current state of knowledge and gaps.

The first category includes studies in which the focus is on elements related to network metrics, e.g., a network structure, interaction patterns, and geographic distribution of users involved in communication. Three specific factors can be identified among this group. They are a) information about the scale of collaborations; b) methods used to measure communication networks; and c) performance of specific channels/communication tools. The spatial element of scale of the interactions and patterns is represented as different geographic spreads of collaborations. For example, Leydesdorff et al. (2013) mapped collaborations globally, while Mejlgaard et al. (2012) focused on European clusters, and Murashova & Loginova (2017) and Virkkala & Mariussen (2021) on the Baltic Sea region. Choi et al. (2015) made a comparison of collaboration distinguishing between developed and developing countries. Further, in terms of spatial representations, interorganisational or interdisciplinary collaborations were also measured (see Kim, 2012; Kim & Park, 2014; Murashova & Loginova, 2017; Sugimoto et al., 2011).

Table 1: Categorisation of journal articles based on emerging themes (note: the terms are explained in detail in the sections following this table)

Category	Authors
1 Network metrics perspective	Cho & Park, 2012; Choi et al., 2015; do Amaral & Messias,2020; Giraldo et al., 2022; Heimeriks et al., 2003; Khan & Park, 2011; Kim & Park, 2012; Kim & Park, 2014; Kim, 2012; Leydesdorff et al., 2013; Li et al., 2018; Mejlgaard et al., 2012; Murashova & Loginova, 2017; Ontalba-Ruiperez et al., 2016; Park et al., 2015; Park, 2014; Pereira & Franco, 2022; Smorodinskaya & Katudov, 2019; Stuart et al., 2007; Sugimoto et al., 2011; Virkkala & Mariussen, 2021
2 Collaboration case studies (Triple Helix collaboration perspective)	Gao et al., 2014; Huang et al., 2013; Jekabsone, 2019; Leydesdorff & Deakin, 2011; Limonez Meráz et al., 2021; Marques et al., 2006; Scuotto et al., 2016; Sutriadi et al., 2022; Valderrama, 2019; Vesperi & Gagnidze, 2019; Williams & Woodson, 2012
3 Information and Communication Technology (ICT) studies	Chung et al., 2021; Heimeriks & Vasileiadou, 2008; Hutchings & Quinney, 2015; Nova & González, 2022; Nyamaka et al., 2020; Sanchez et al., 2017; Swar & Khan, 2014; Tsai et al., 2021
4 Scientometrics, knowledge infrastructure and flow	Dolfsma & Leydesdorff, 2008; Fujigaki & Leydesdorff, 2000; Ivanova & Leydesdorff, 2014; Leydesdorff 2011b; Leydesdorff et al., 2014; Leydesdorff et al., 2015; Leydesdorff et al., 2017; Leydesdorff, 2003; Leydesdorff, 2008; Lucio-Arias & Leydesdorff, 2009a; Lucio-Arias & Leydesdorff, 2009b; Megnigbeto, 2014; Petersen et al., 2016

5 Advancement of the triple helix theory	Deakin, 2022; Etzkowitz & Leydesdorff, 2000; Leydesdorff 2011a; Leydesdorff et al., 2018; Leydesdorff & Lawton-Smith, 2022; Leydesdorff, 1996; Leydesdorff, 2001; Leydesdorff, 2010; Leydesdorff, 2013
6 Factors, challenges and solutions related to triple helix collaborations	Anttonen et al., 2018; Beesley, 2005; Bjerregaard, 2010; Coutinho & Young, 2016; Dalkir et al., 2019; De Silva & Rossi, 2018; Estrada, 2017; Ibáñez et al., 2022; Jiménez et al., 2021; Kim & Jang, 2021; Ranga et al., 2008; Runiewicz-Wardyn, 2020; Ruuska & Teigland, 2009; Stemberkova et al., 2021; Thomas & Paul, 2019; Vick & Nagano, 2018; Yeh & Xing, 2010

Note: Studies were extracted from the Web of Science database with no date limit. The search criteria included words" triple helix" and "communication".

The second distinction can be made in the use of methods. Smorodinskaya & Katudov (2019) focused on cluster analysis. The majority of studies in this group, however, employed either a bibliometric (see Choi et al., 2015; do Amaral & Messias, 2020; Giraldo et al., 2022; Heimeriks et al., 2003; Leydesdorff et al., 2013; Mejlgaard et al., 2012; Murashova & Loginova, 2017; Ontalba-Ruiperez et al., 2016; Pereira & Franco, 2022; Sugimoto et al., 2011) or a webometric analysis (see Heimeriks et al., 2003; Khan & Park, 2011; Kim, 2012; Kim & Park, 2014; Li et al., 2018; Ontalba-Ruiperez et al., 2016; Stuart et al., 2007) to measure research collaborative productivity. While the first metric is based on the authors' institutional affiliations deriving from published papers, the latter uses institutional web domains (Aguillo, 2012). Three studies analysed joint projects - either in comparison with other network measurements or on their own - as a basis for measuring collaborations (see do Amaral & Messias, 2020; Heimeriks et al., 2003; Mejlgaard et al., 2012; Murashova & Loginova, 2017). Less commonly, scholars used a qualitative content analysis (see Khan & Park, 2011; Kim, 2012). Some authors studied a distinct role of social media platforms as channels of information diffusion, i.e., Twitter (see Cho & Park, 2012; Kim & Park, 2012) or comparing it to YouTube (see Park et al., 2015) or Google and Facebook (see Park, 2014).

The second category contains specific case studies that provide information about diverse applications of triple helix research. This category includes an investigation of regional collaborations, e.g., in less economically developed countries (Jekabsone, 2019; Williams & Woodson, 2012). A narrower approach has been taken by Marques et al. (2006) in a case study of the University of Coimbra, Portugal. Two studies focused on patents (knowledge application) as indicators for measuring technological competitiveness, technology impact and interaction (see Gao et al., 2014; Huang et al., 2013). Another two studies focused on smart cities as examples of innovation ecosystems (Leydesdorff & Deakin, 2011; Scuotto et al., 2016), while Vesperi & Gagnidze (2019) made the case of an entrepreneurial university in Italy, and Sutriadi et

al., (2022) explored the communicative city concept for the case of Gedebage Technopole area in Bandung, Indonesia. Of particular interest for this project is the study by Limonez Meraz et al. (2021) that reviewed the literature and analysed the current empirical evidence on the effectiveness of the relationships between academia and industry in Ciudad Juarez, Mexico. Stemberkova et al. (2021) studied an effective knowledge management model for technology transfer, while Ibáñez et al. (2022) provided insights on a new, Covid-19 instigated form of entrepreneurship, i.e., digital social entrepreneurship in the context of helix theory. These and other papers included in this review contribute to the argument about the wide applicability of the triple helix model. However, studies in this group also offer more detail insights into inter-spherical processes, including communication.

The third category includes studies that focused on Information Communication Technology (ICT) as a factor in competitiveness. They cover three relevant areas: developing regions (Heimeriks & Vasileiadou, 2008; Nyamaka et al., 2020; Tsai et al., 2021; Nova & González, 2022); education and sciences (Hutchings & Quinney, 2015; Sanchez et al., 2017); and small business entrepreneurs (Swar & Khan, 2014).

The fourth category, unlike other categories, appears to be driven almost entirely by a single source. The most active researcher in this group is Leydesdorff, who contributed to the majority of the studies. Another divergence observed is the considerably more abstract application of the triple helix concept compared to other categories. These studies are mostly conceptual papers, dealing with a variety of ideas mostly expressed as configurational information related to the dynamics of interactions/communications. Concepts discussed include 'flow of communication', 'synergy', 'probabilistic entropy', 'intellectual organisation', 'self-organisation', 'meaning', 'reduction of uncertainty', and indicators such as 'efficiency', 'unused capacity', 'transmission power' and 'interface quality control'.

The fifth category includes contributions to triple helix theory, expanding, for example, on sociological, communication-theoretical and cultural-technological perspectives (see Leydesdorff, 1996; Leydesdorff, 2001; Leydesdorff, 2013). In by far the most cited review by Etzkowitz & Leydesdorff (2000) - the founders of the triple helix model – this model is described in comparison to alternative models of innovation systems, while Leydesdorff (2010) in his review article summarised the state of understanding of the knowledge-based economy and the triple helix model. Within the sociological context Leydesdorff (2011a) differentiates between 'communication of knowledge' and 'communication of

meaning'. Further, Leydesdorff et al. (2018) considered a process of meaning generation within cultural evolution. Most recently, Deakin (2022) discussed organised knowledge production as the next-order system. He draws out how communication is associated with the structure of knowledge production, explaining further Leydesdorff & Lawton-Smith's (2022) social networks and cultural codes in communication overlay.

The sixth category contains studies that explore the dynamics of the collaborative research setting through human factors that either hinder or foster triple helix collaborations. For example, quite broadly, Jiménez et al., (2021) studied collaboration in the context of triple helix. In the Nordic context, Bjerregaard (2010) discusses the impacts of organisational culture on collaborative research projects (Danish context), while Ruuska & Teigland (2009) examine challenges and solutions to collective competence in public-private partnerships (Swedish context). Further, Beesley (2005) studied the key factors that influence research outcomes in tourism settings, while Ranga et al. (2008) looked at causes for already identified poor knowledge transfer related to weaker capacity of small firms in economically disadvantaged regions in the Netherlands. More broadly, Estrada (2017) investigated tensions in knowledge networks related to the global south, expanding on hierarchy production, restrictions to the access of production, spatialisation of networks, and different ways of understanding power. Anttonen et al. (2018) explored cross-sectoral conceptualisations of the circular economy. Vick & Nagano (2018) studied preconditions for successful knowledge creation in the context of academic innovation projects. Relevant to this project, Dalkir et al. (2019) analysed the reasons why cross-sectoral collaborations fail, and the role of communication in such failure. Thomas & Paul (2019) looked at communication as the medium for building trust and strong social ties to aid knowledge transfer, and, in similar context, De Silva & Rossi (2018) examined relational capabilities, and Runiewicz-Wardyn, (2020) the factor of proximity for successful collaborations. Lastly, this category includes a case study by Yeh & Xing (2016), who identified the 15 most influential factors among triple helix spheres specific to the Taiwanese digital content industry. While these papers present diverse sectors and geographies, the common thread is the focus on human attributes and skills. The acts of communicating, promoting and sharing, as well as interpersonal skills and leadership, are frequently mentioned concepts in these studies.

2.2.2. Critical Appraisal of the Thematic Groups

The thematic categorisation of communication studies within triple helix scholarship sets a platform for a critical appraisal. I would like to emphasise that critical appraisal is applied to thematic groups as a whole, rather than to individual studies. The subheadings in this section are set based on emerging themes outlined in Table 1. The overall relevance of communication studies within the triple helix context is discussed after that.

2.2.2.1. The First Emerging Theme: Network Metrics Perspective. The initial perceived strength of these studies is identification of shared intellectual contributions. New knowledge is developed based on extension of, or deviation from, the existing body of knowledge (Gibbons et al., 2010). Unlike in the past, when intellectual contributions were predominantly single-authored, today they are increasingly written by multiple authors (Kim, 2012). With the relational perspective of networks it is becoming possible to gain a clearer understanding of the knowledge-claims landscape and its longitudinal shifts (Heimeriks et al., 2003). Bibliometric and webometric analyses make important contributions that in a sense make knowledge claims visible. As studies show, this process is taking them out of historically localised geographic or intra-disciplinary contexts (Gibbons et al., 2010). For example, Mejlgaard et al. (2012) found a substantial heterogeneity when mapping the idea of an European model of science. Despite the common agenda of building collective science capacity and research priorities across the European Union, the authors observed significant differences among countries with regard to science communication, science links to policy, and citizens' participation in science related decision-making (Mejlgaard et al., 2012). Following the same principles but with a different focus, Leydesdorff et al. (2013) were able to show science centrality through clusters of knowledge on a global scale.

In relation to my project, however, this group offers limited assistance. First, poor distinctions are made between collaboration and communication. Although these studies came up in my search for articles on communication, the prevailing sense in these studies is communication as a synonym for collaboration. No distinction is made between different meanings of communication, nor an explicit connection made with communication theory. When the keyword in the search is "communication", the reader expects to receive information linked to communication theory. Second, these studies focus on communication as a product (outputs, e.g., journal papers, etc.) rather than a process of communicating (especially across sectors), which my project aspires to do. Third, the majority of methods employed in this group of studies are web-based (i.e., bibliometrics, webometrics) and therefore not helpful for an in-depth study of the process of communicating. On the other hand, the network perspective is useful in terms of

observed geographical variations of science communication. Several studies conducted at a large scale have pointed this out. In other words, I can hypothesise that environmental science communication would be location specific and conditioned by a variety of factors. This helps to inform my research design.

2.2.2.2. The Second Emerging Theme: Collaboration Case Studies. These studies show that diverse measurements of networks produce diverse results, which indicates diverse purposes and, in terms of communication as an activity, a service to different audiences. Depending on the measurement strategy, i.e., project collaboration, publications, or web links, triple helix networks differ in their structure and outreach complexity (Heimeriks et al., 2003). For example, Park et al. (2015) observed distinct roles of social media platforms in organising collective actions. In the case of the 'Occupy Wall Street' movement, dissemination of information on Twitter was organised and coordinated by a few opinion leaders, who successfully facilitated exchange of ideas between different groups. On the other hand, the exchange of ideas and information on YouTube was much more democratic and thus reinforced solidarity within the network (Park et al., 2015). A positive contribution of these studies therefore lies in providing information about how different tools/channels perform, highlighting the need for purposeful assignment in the process of disseminating information, including scientific knowledge. However, consideration of audience, which needs to play a deliberate part in the communication design (Moser, 2010), is not reflected in the current studies. For example, a researcher's audience may be segmented into different stakeholder groups, including the academic community, government, industry representatives, non-governmental organisations, and the general public. These groups differ in their capacity to understand the researcher's findings. According to the Australian Bureau of Statistics, most members of the general public have literacy levels of approximately grade 9, whereas academic scientists would have more than 15 years of formal education and thus a considerably higher level of scientific literacy (Australian Bureau of Statistics, 2006). This considerable difference needs to be accounted for in cross-sectoral communication, otherwise it is not likely that the communicator will be successful in his/her outreach.

Further, a variety of selected applications in the second group shows the dynamic and complexity of academia – industry interactions while measuring innovation performance in diverse settings. However, what these studies fail to recognise is the significance of cross-sectoral context of communication in those settings. A relationship between the academic sector and the industry sector represents an interaction between two different

professional cultures (Dalkir et al., 2019). Different professional cultures essentially operate under different semantic codes and conventions (Howarth, 2011). Such differentiation in the social communication context was first observed by Stuart Hall in the case of television producers and their audience. Hall postulated that the members of the television audience make meanings and understand reality through their use of cultural symbols in visual media, which may essentially differ from those of the producers (Hall, 1973). His encoding – decoding model highlighted that the sender's encoding and the receiver's decoding processes may not be the same, which may cause mis-readings. Knowing audience characteristics is, therefore, important to minimise communication failures.

2.2.2.3. The Third Emerging Theme: Information and Communication Technology. These studies are placed in a separate category because they provide a significantly different aspect of communication, i.e., with a technical meaning. The common rationale for these studies is the fast-spreading adoption of ICTs. For example, Yeh & Xing (2016) refer to ICTs as the "leading industry of the new century" (p. 699). Similarly, Heimeriks et al. (2003) explained that computer mediated communication technologies play an increasing role in fostering innovation. However, what is missing in these studies is clarity in terms of how this development occurs, essentially making a distinction between ICT supporting innovation vs ICT as innovation. Innovation by definition is not limited to technological advancements. Many innovations are of a non-technological nature, for example in areas such as marketing, organisation, management and design (European Commission, 2014). Since they are not primarily driven by a technological invention or improvement they are referred to as non-technological innovations. However, as ICT is commonly used as an enabler of most of today's innovations (Mothe & Thi, 2010), the tendency is to understand all innovations unseparated from technological advancements. While theory on innovation has evolved to include this notion, the theory on innovation systems has not. This third group of studies makes the overall technological innovation focus of the triple helix scholarship (and communication studies within) obvious. As discussed in the introduction, this notion is problematic, as it excludes a whole range of sciences where technology is not the main focus or driver for improvement. This range covers so called 'soft sciences', including environmental and social sciences that are addressing some of the most significant problems of today's world (Singh, 2006). To balance out the technological dominance of innovation systems theory, more emphasis on non-technological examinations within this space is needed.

2.2.2.4. The Fourth Emerging Theme: Advancement of the Mathematical (Information) Theory of Communication. The fourth group of studies is the most explicit in its theoretical contributions to communication theory, offering relevant and timely developments/advancements to the mathematical (information) theory of communication. For example, alongside the progression of triple helix theory from three to four, five and n-helices, Leydesdorff et al. (2014) developed a tool to cope with the emergence of the next-order 'systemness' to enable analysis of data in different dimensions, using large webometric and bibliometric data sets (Leydesdorff et al. 2014). However, the theory cannot stand alone without practical applications, which are limited in this group. Empirical testing for validation or falsification is an important component of theory refining (Popper, 1963). This testing highlights potential imbalances in research methodologies for theory-building (Wacker, 1998). More empirical studies on communication and knowledge flows would strengthen these theoretical contributions.

Furthermore, the articles in this category are written in highly specialised language. The following is an example of the first paragraph in the Introduction of one of the articles from this group:

> "When variation is considered as a relative frequency or probability distribution (Σ_i p_i), the Shannon- type information or the uncertainty contained in the distribution (H) is defined[6, 7] as follows: $H_i = - \Sigma_i p_i \log_2 (p_i)$. Equivalently, for a two-dimensional distribution (e.g., a matrix), H_{ij} is: $H_{ij} = - \Sigma_i \Sigma_j p_{ij} \log_2 (p_{ij})$. This uncertainty is the sum of the uncertainty in the two dimensions of the probabilistic entropy diminished by their mutual information. In other words, the two variations overlap in their co-variation, and condition each other asymmetrically in the remaining variations." (Leydesdorff, 2008, p. 391)

Such 'ivory tower' language coupled with the lack of a key to the symbols used in the formulas perpetuates the inability of a reader to understand the concepts. Readers outside of the narrow expertise of scientometrics/infometrics may have a hard time envisioning how the offered information could be applied. This notion supports the aforementioned recommendation to consider the audience when communicating research.

2.2.2.5. The Fifth Emerging Theme: Advancement of Triple Helix Theory. The fifth category contains advances in triple helix theory. This category includes some seminal works of the theory, including Etzkowitz & Leydesdorff (2000) and Leydesdorff (2010), that explain the triple helix model and place it within the broader context of

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[6] Shannon, C.E. A Mathematical Theory of Communication. Bell Sys. Tech. J. 1948, 27, 379-423.
[7] Shannon, C.E.; Weaver, W. The Mathematical Theory of Communication; University of Illinois Press: Urbana, IL., USA, 1949.

systems of innovation theory and knowledge-based economy. However, in terms of contributions to communication theory, this category does not provide a holistic and structurally sound view. In fact, the studies offer little to no identification of the gaps relative to communication theory within triple helix research. The theoretical reference in relation to communication is best - yet still to a limited extent - described in Leydesdorff's (1996) paper. In this article, Leydesdorff outlined the conceptual landscape of communication theory through the contributions of Luhmann, Pearson, Weber, and several other authors. However, his purpose was clearly to position his own work, rather than to provide a review. Leydesdorff's contributions are related to the mathematical theory of communication, with limited reference to others' work. Most recent work by Deakin (2022) and Leydesdorff & Lawton-Smith's (2022) recognises the importance of communication within the structure of knowledge production, and the influence of social networks and cultural codes in communication overlay. This is relevant for our project and provides an opportunity for empirical contribution. Overall, this group of articles draws upon the trajectory of the communication topic within the triple helix. It appears that the recognition of its importance is growing, indicating good timing for this project.

2.2.2.6. The Sixth Emerging Theme: Factors, Challenges and Solutions. The last category faces another epistemological issue. Differing to the preceding group, these studies make contributions towards improving understanding of cross-sectoral communication by investigating the human dimensions. This category includes studies that focus on social and psychological factors that either enable or disable triple helix collaborations. However, little distinction is made between knowledge transfer and communication (the act vs the process). An exception is the recent work of Dalkir et al., (2019), who specifically looked at communication in this cross-sectoral domain from a practical perspective – a complementary approach to Leydesdorff's conceptual work. They studied communication between three private companies and three universities funded by government. Their key contribution (as I see it) is a distinct differentiation between collaboration and communication, where the latter is in servitude to the former. To illustrate, they placed communication within collaboration models (Dalkir et al., 2019). They built on the framework of Keyton et al. (2008) to understand communication in interorganisational collaboration. My research provides complementary work by further examining cross-sectoral communication discourse and co-orientation (Koschmann, 2016). Furthermore, studies in this group predominantly remained at the phenomenological level. What is missing in these studies is a direct link to communication theory. Considering that these studies are classified as communication studies on Web of Science, one would expect their contributions to be made accordingly.

Instead, each of these studies is linked to a different theory (additional to the triple helix). This multiplicity indicates a lack of cohesion and missed opportunities in terms of theory building. Acknowledging the fact that no collaboration can come into existence without communication (Dalkir et al., 2019), it is necessary for communication theory to find more explicit recognition amid triple helix research.

2.2.3. Summary and Gaps

This literature review consolidated knowledge about communication related to triple helix research. Triple helix scholarship studies cross-sectoral collaboration between academia, industry and government for the purpose of innovating (Ranga & Etzkowitz, 2013). Communication is a critical aspect in such interactions as no collaboration can exist without it (Dalkir et al., 2019). This review has exposed a variety of triple helix situations, indicating a wide applicability. However, although these studies were returned during a search for 'triple helix communication' papers, the majority of them made little or no explicit reference to communication theory (with the notable exception of Leydesdorff, who significantly contributed to the mathematical theory of communication). As a result, the mapping of communication contributions is patchy. In some parts, contributions are strong theoretically, and in other parts one finds plenty of empirical evidence, but without a link to actual communication theory. Stronger emphasis needs to be put on the actual process of communicating and differentiating it from other concepts (e.g., collaboration, interaction and knowledge transfer). Complementary to that, studies contributing to the mathematical theory of communication could benefit from further empirical testing to strengthen the theory.

The nature of communication overall has changed dramatically over the past few decades, especially with the invention of the internet and fast emerging novel technologies (Heimeriks et al., 2003). These developments make studies of interactions and communication ever more complex, which was also observed in the literature on communication within the triple helix theory. Social and technological changes are reflected in a wider variety of research outputs, changes in boundaries of collaborative systems, patterns and increased heterogeneity in communication, including a growing number of different media (Heimeriks et al., 2003).

What we can learn from these studies related to communication is that context (e.g., location, network) matters and so does the medium. However, where these studies have

fallen short is in the notion that communication is not just the enabler of collaboration but a process that deserves attention in itself. Leeuwis & Aarts (2011) have started this work by examining the role of communication within complex systems of innovation, whereby they see communication as playing a role in innovation development and design. They noted the need for communication to be seen beyond the intermediary role of technology dissemination; however, they also acknowledged that this research domain remains largely unexplored. From here, I propose to examine communication as an innovation itself. Relative to the triple helix theory, this requires expansion to the non-technological domain (OECD & Eurostat, 2005). "Communication can still be regarded as an intermediary process, but we need to broaden our perspective on the types of intermediations that an innovation process includes and requires" (Leeuwis & Aarts, 2011, p. 22)

Finally, different recipients of information perceive information differently. Cross-sectoral communication inevitably deals with exchange of different professional codes and conventions that are rooted in different fields of experience and different references of knowledge. To make communication, as a precursor to collaboration (Dalkir et al., 2019) effective, we need to know more about those with whom we intend to communicate. The predominantly used methods of measuring collaboration within the triple helix scholarship, i.e., webometrics/bibliometrics, are not suitable for that. However, the notion of careful deliberation of the nature of the audience has long been recognised in marketing and communication texts. The next section will, therefore, look at suitable models and concepts from these disciplines to aid the objective of this research.

2.3. Cross-sectoral Communication

Cross-sectoral communication refers to communication between sectors. Applied to the triple helix model, it can be communication between academia and industry, industry and government, academia and government or all three spheres. One of the key characteristics of cross-sectoral communication is interaction among different organisational cultures, which are expressed in different mindsets (Leal Filho, 2019). These mindsets are based on differences in practices and skillsets, methods, tools, languages (jargons, vocabulary and corporate terminology), norms and regulations, and even locations (Dalkir et al., 2019). Knowledge about these differences (especially knowing the audience to whom communication is directed) is important, since it allows a better understanding of the potentials as well as the limitations of their commitments and actions related to collaborations (Leal Filho, 2019). Further, the best means to reach the

various audiences also differ. Providing information via mediums, which specific audiences normally use and trust, is an efficient way to reach them (Leal Filho, 2019). Following this premise, I propose a simple modification of the triple helix model to account for communication aspects. Through use of different shapes and colours the modified framework highlights the different mindsets and practices of each of the three sectors, creating complexity for cross-sectoral communication. See Figure 3.
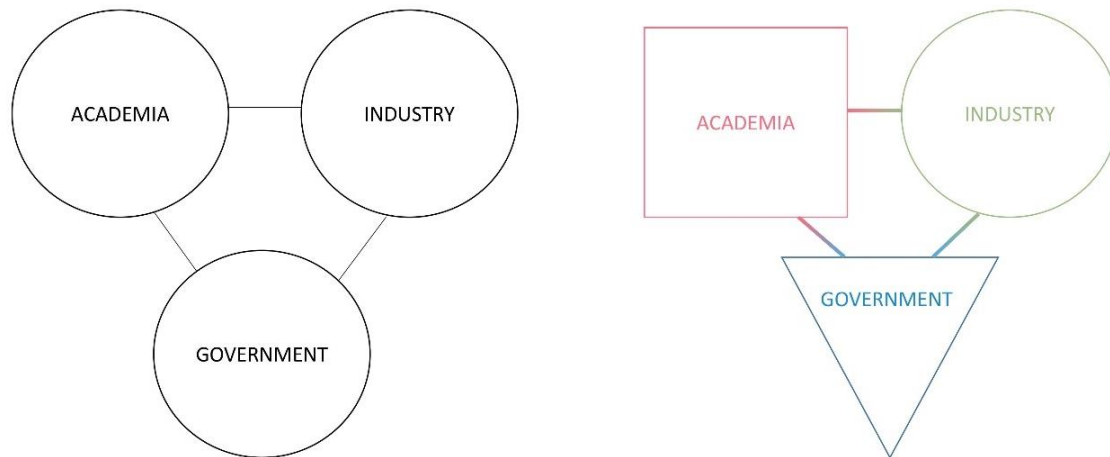
Figure 3: Left: Triple helix model (Etzkowitz & Leydesdorff, 2000); Right: Proposed triple helix communication model (Author)

Scaling down to communication between academia and industry, we can now look for the relevant communication models. A variety of communication models have stood the test of time and retain validity. The Shannon-Weaver technical model of communication (1948) paved the way, describing the chain of events that occurs between the stimulus and response (Shannon, 1948). This model was designed to develop effective communication between sender and receiver. The model identified that the stimulus is provided by a source who encodes the message according to some systematic means and their own perceptions and behavioural patterns. The message is sent via a channel and decoded by a receiver through their own perceptions and behaviours. See Figure 4. This unidirectional communication model predominantly focused on message transmission; however, it has been widely applied in the field of communication and is still relevant today, especially for online communication.
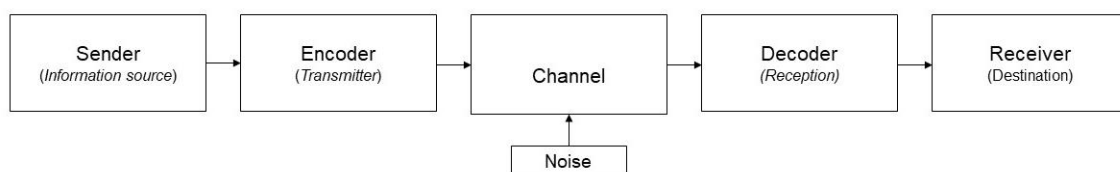
Figure 4: Shannon-Weaver model of communication (1948). Adapted from McQuail and Windahl (2015)

Later models, such as Schramm's communication model (1954), focused on communication as an interactive process, where both the sender and receiver interact by encoding, sending, interpreting, re-coding and receiving information. He also formulated the idea that the conceptual worlds of the sender and receiver may not be the same, although the model itself does not illustrate this notion (see Figure 5). The differences are attributed to different fields of experience (Schramm, 1960).
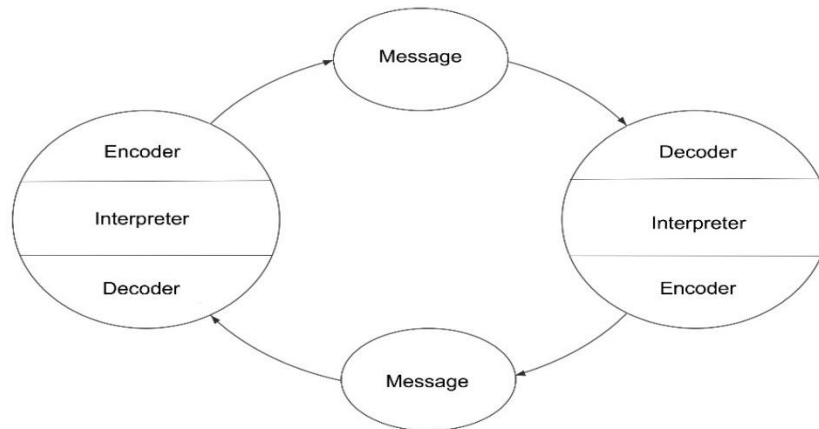
Figure 5: Schramm's communication model (1954). Adapted from McQuail and Windahl (2015)

In the 1970s Stuart Hall applied this principle to television audiences. He studied the role of social positioning in reading media texts through their production, dissemination, and interpretation (Hall, 1973). In doing so, Hall examined how audience members make meanings and understand reality using their own cultural references in visual media. He found that TV producers and TV audiences do not belong to the same culture and demonstrated that the intention of the originator of the message does not match the perception of its receiver (Hall, 1973). He called the model encoding/decoding model. The model is highly relevant to cross-sectoral communication as it explains that the meaning is not fixed and determined by the sender of the message. Therefore, audience characteristics must be known to communicate effectively. In triple helix theory this has not yet been applied.

While Schramm's two-way communication model illustrates the cyclical nature of communication among triple helix spheres more realistically, this next order complexity is not needed for this project. What is relevant is the notion of encoding and decoding, which Hall's model illustrates for the audience. However, since encoding and decoding has also been depicted in the Shannon-Weaver model, I will again, based on Occam's razor, employ the simplest relevant model approach. What can be taken from Schramm's model is the concept of different fields of experiences and knowledge references. Figure 6 illustrates the cross-sectoral communication model I propose for this project. This figure

illustrates dyadic communication between academia and industry; however, the model is also relevant for communication between other spheres.
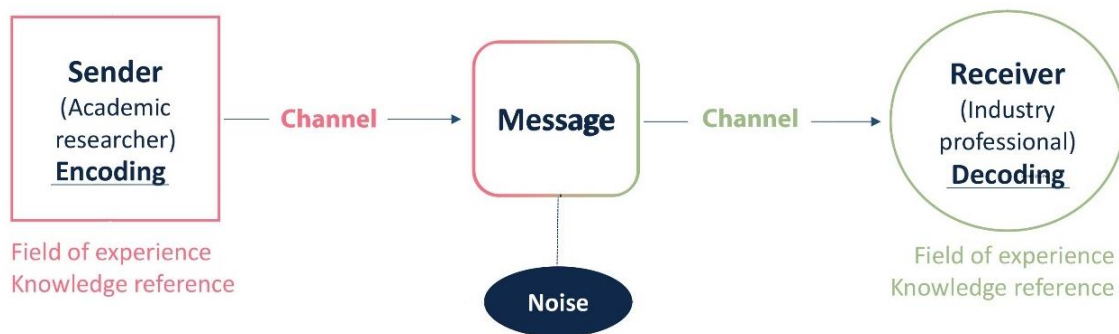
Figure 6: Proposed cross-sectoral communication model (Author)

In this model, the sender, i.e., the information source, is the environmental scientist/institution representing the academic sphere and the receiver, i.e., the destination is the tourism workforce (business or individual) representing the industry sphere. The information source starts the process by choosing a message to send, someone to send the message to, and a channel through which to send the message. Channel refers to the preferred communication medium of either sphere (hence the different colours). Message refers to the information conveyed. Noise refers to factors distorting the message, which can be internal (misunderstanding of the message) or external (channel issues, e.g., wifi not working, if the message is sent electronically).

The model suggests a tailored approach for targeted communication (Brotspies & Weinstein, 2019). Just as all consumers cannot be treated alike, as they differ in their tastes, preferences and buying behaviour (Kotler & Keller, 2016), neither can the tourism workforce be treated as a uniform environmental science audience. Market segmentation is the first and key strategic approach for defining a set of key consumer segments (Ottman, 2011). The next section, therefore, explores marketing segmentation theory.

2.4. Marketing Segmentation Theory

The concept of market segmentation is well established in marketing theory and is applied by organisations across all industry sectors (Dibb & Simpkin, 2010). Market segmentation is the process of dividing an undifferentiated market of potential customers into groups or segments based on common characteristics important to the organisation to make meaningful divisions within the total market demand (Tynan & Drayton, 1987).

Essentially, segmentation helps organisations to manage diverse customer needs and interests by identifying homogenous market segments (Kotler & Keller, 2016). The individuals grouped into segments share characteristics and respond similarly to messages the organisation sends to them.

Acknowledged outcomes of market segmentation include an improved understanding of customers (e.g., their reaction to a particular stimulus, their needs and wants), more efficient and effective resource allocation, better-tailored marketing and communication programs and consequently improved competitiveness (Albert, 2003; Beane & Ennis, 1987). The overall aim of segmentation is to identify high yield segment(s), i.e., those that are likely to be the most responsive, profitable and provide the highest growth potential. These segments are then targeted first, which is called a differentiated approach. Segmentation allows for individualised and customised communication, including medium and messaging (Brennan et al., 2020; Quinn, 2009; Verna, 2017). Tailored communication has the potential to change consumers' perceived benefits, preferences, and attitudes (Endrejat et al., 2020; Sleboda & Lagerkvist, 2022). The messages are potentially more relatable and in line with what customers want.

Generally, there are two main approaches to market segmentation (Dolničar, 2004; Torkzadeh et al., 2021). First is the *a priori* approach, which divides the market according to prior knowledge or pre-defined criteria associated with customers, services, or products, such as demographic or geographic variables. The second, the *a posteriori* approach, though, segments the market by analysing existing customer data (Torkzadeh et al., 2021). Since this project is explorative in nature (i.e., no actual data on the tourism workforce as a consumer of environmental science information yet exists), segmentation based on workforce characteristics will be applied. Of major importance here is the selection of suitable variables to achieve similarity within the segments (internal homogeneity), and differences between segments (external heterogeneity) (Sarin, 2010). To assist in this process marketers most commonly use the following segmentations: demographic, geographic, psychographic and behavioural (Clow & Baack, 2017).

Demographic segmentation is the simplest and the most widely utilised type of market segmentation (Beane & Ennis, 1987). Demographic segmentation is an important segmentation base to understand each market and its needs (Jaiswal et al., 2020). It is used to create broad groupings of the population based on demographic characteristics such as age, gender, education, occupation, income, social/marital status, location,

religion, household/business size, etc. An example of demographic variables database is a national census. While demographic segmentation can be a great starting point in explorative project, it also has its limitations. Demographic variables need to be a) appropriately selected relative to the product/service in question; and b) sometimes supplemented with other types of segmentation to give it enough predictive power (Smit & Neijens, 2000, Wells et al., 2010). For example, geographic segmentation can be useful in identifying where the prospects may be (Brennan et al, 2020a) as well as determining location specific segments that account for local factors and local bias (Ellis & Underwood, 2018). Apart from location, aspects of geographic segmentation also relate to distance/proximity and scale. Psychographic segmentation focuses on lifestyle, social or personality characteristics. It measures the activities, interests, values and opinions of customers to determine/deepen their identity through their motivations and influences (Smit & Neijens, 2000). Similarly, in providing further insights, behavioural segmentation aims to uncover potential customer habits and behaviours, e.g., purchase, usage, engagement, benefits sought, or actions taken (Gartlan, 2020; Mialk, 2021; Sgaier et al., 2018).

The subjects of segmentation (i.e., potential customers) can be individuals (B2C) or businesses (B2B) (Freytag & Clarke, 2001). Businesses may be segmented according to industry sector, business size, business location, turnover, number of employees, company technology, purchasing approach, number of years in business, or any other relevant variables (Bonoma & Shapiro, 1984). The set of characteristics by which to segment prospect businesses is called firmographics or emporographics (Brennan et al., 2020; Willan, 2015). Wind & Cardozo (1974), Chéron & Kleinschmidt (1985), Plank (1985), Abratt (1993), Freytag & Clarke (2001) provide a historical review of industrial market segmentation. However, even in those earlier studies, the authors have pointed out that individual segmentation is more common. This may be due to the personal characteristics of individuals managing/owning a business influencing the way the business is run (Kodama & Li, 2018). Further, studies on industrial segmentation noted the preference for a priori or cluster-based designs with varying descriptors. Bonoma and Shapiro (1984) identified location, sector and business size to be good initial determinants. The expectation is that companies of the same sector with a similar size and location will have similar service/product needs and usage patterns (Brennan et al., 2020).

To conclude, there is no standard method to segment a market (Dolničar, 2008) and different segmentation approaches and criteria lead to different extracted segments

(Dolničar et al., 2018). While psychographic- and behavioural- are more recent approaches to market segmentation (Metag & Schäfer, 2018), geo-demographic segmentation is the best fit for the purpose of this research. The geo-demographic characteristics of individuals and businesses are easy to identify as they are more tangible and serve as a useful starting point (Jaiswal et al., 2020). For example, it is easy to identify how long the business has existed in the market by searching on the internet for when it was established. Likewise, it is easy to identify individuals according to their gender or age. Then, psychographic and behavioural segmentation, which are purpose-specific, would be advisable once the basis for a communication strategy between the two sectors in question has been established.

2.5. The Tourism Industry – What Do We Know?

The tourism workforce, unlike tourists, is an under researched field (Baum, 2015; Baum et al., 2016; Ladkin, 2011; Solnet et al., 2014). As the main reasons for that Ladkin (2011) identified a lack of reliable employment data, problems of definition and the cost of empirical data collection. Baggio et al. (2010), however, noted that one reason is the complexity and heterogeneity of the tourism industry. Baum (2018) found that the tourism workforce (including its capacity, capability and social responsibility) has not been properly included in consideration and research related to planning for sustainable tourism neither by academics nor policy makers in the past 25 years.

This review (consisting of tourism publications and websites as well as an academic research review) summarises the information that I was able to gather pertaining the tourism workforce in Australia and Queensland specifically. The next section introduces the Australian tourism industry network, which broadly introduces the complexity of the tourism industry. Following that is a closer examination of tourism businesses in Queensland. After that I review how the tourism industry is involved with the natural environment, and finally some gaps derived from this review are outlined.

2.5.1. Tourism Industry Network in Australia and Queensland

In Australia, the tourism network structure consists of four levels of governance, with different actors, roles and responsibilities at each level. At the national level, Tourism Australia (TA) is the Australian government agency responsible for promoting travel to and throughout Australia, increasing the economic benefits to Australia from tourism and

helping foster a sustainable tourism industry in Australia (Destination Q, 2018). At the federal level, tourism-related activities are within the portfolio of the Minister for Trade, Tourism and Investment. In addition, the Australian Trade and Investment Commission (Austrade) is responsible for the strategy of tourism development (Austrade, 2022). Under Austrade, Tourism Research Australia provides tourism related statistics and research to assist the government, tourism industry and Australian businesses (Tourism Research Australia, 2022d). Australian Regional Tourism (ART) is the peak national body representing regional tourism organisations (Tourism Australia, 2022). On behalf of its members, ART advocates for sustainable regional development and amplifies key messages to government, other industries and industry sectors, researchers, educators and the public (ART, n.d.). Some Australian tourism industry associations, e.g., Ecotourism Australia, the Accommodation Association of Australia and the Australian Hotels Association, also operate at this level (Tourism Australia, 2022).

At the state level, the structure includes governmental departments and industry bodies. In Queensland (the study area for this research) this level includes the Department of Tourism, Innovation and Sport (DTIS), Tourism and Events Queensland (TEQ), and Queensland Tourism Industry Council (QTIC). The Department is responsible for tourism industry development and innovation (Destination Q, 2018), while TEQ is Queensland's lead tourism marketing, destination and experience development and major events agency (TEQ, n.d.-a). QTIC is a not-for-profit, private sector, membership-based organisation recognised as the peak industry body for tourism in Queensland, representing the interests of Queensland's tourism industry in all relevant policy forums (QTIC, 2022). Some tourism industry associations, e.g., Caravanning Queensland and Queensland Hotels Association (QHA), operate at a state level (Business Queensland, 2022).

At the regional level, Queensland's tourism industry is structured around 13 Regional Tourism Organisations (RTOs) that geographically cover the entire state. There is a wide divergence between the RTOs in terms of the size of their region, the number of local government areas they serve and legal structures. They are mostly membership-based organisations with some funding provided from the state and/or local government, who are typically also the members. The responsibilities of these bodies include the development, marketing and operations priorities related to their regional destinations (Destination Q, 2018). According to the Queensland government, the Queensland RTO network is widely regarded as one of the most influential in Australia (Business Queensland, 2022).

At the local level, Queensland has 77 local government areas, run by councils. These councils provide local infrastructure and community services, drive local public investment requirements and facilitate private sector investment within their geographic area. Additionally, Queensland's Local Tourism Organisations (LTOs) have been established to nurture and strengthen local tourism businesses and foster economic development. Locally, tourism groups were established out of a need to extend the efforts of individual businesses in promoting destinations. The network operates in a collaborative manner within and between different levels towards the development and growth of the tourism industry (Business Queensland, 2022).

Tourism is not a homogenous industry group. In fact, tourism is not even formally identified as an industry, but rather an economic sector. In the Australian and New Zealand Standard Industrial Classification (ANZSIC), industries are defined on the basis of the goods and services they produce. However, the tourism industry is defined according to the status of its consumers: tourists (Australian Bureau of Statistics, 2019). The word "tourism" is defined as "a social, cultural and economic phenomenon related to the movement of people to places outside their usual place of residence, pleasure being the usual motivation." (WTO, 2008, p. 1).

Tourism related industries are defined as those industries that would either cease to exist in their present form or would be significantly affected if tourism were to cease (Australian Bureau of Statistics, 2019). For an industry to be tourism-related it must serve the visitors themselves; that is, there must be a direct relationship between the provider of the product/service and the consumer.

2.5.2. Tourism Businesses in Australia and Queensland

In June 2020[8], Australia had 317,653 registered tourism businesses, which made up around 13% of Australia's 2.4 million businesses. The number of tourism businesses during 2019-20 increased by 1.2% despite the COVID-19 pandemic (Tourism Research Australia, 2022a). On a state level, Queensland-registered businesses in 2020 numbered 59,543 (Tourism Research Australia, 2022b), representing around 19% of

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[8] Latest available statistic when writing this thesis.

Australian tourism businesses, an increase from 58,738 the previous year (Tourism Research Australia, 2022c).

However, employment numbers did not increase during the COVID-19 pandemic. On the contrary, Australian tourism businesses in June 2020 had fewer employees on average and lower turnovers compared to a year earlier (Tourism Research Australia, 2022a). Tourism in Queensland employed 135,900 persons in the period 2019-20, a decrease of 11.8% compared with the 2018–19 period (Tourism Research Australia, 2022b). These changes mainly reflect layoffs due to lack of work, whereas businesses managed to stay open due to governmental support i.e., grants and JobSeeker payment (Australian government, n.d.; Australian Government, 2022).

According to the most recent statistic available (i.e., June 2020), Queensland registered businesses have the following employment size composition:

- Non-employing businesses: 29,626

- Micro and small businesses (1-19 employees): 26,724

- Medium and large size businesses (20-200+ employees): 3,193

(Tourism Research Australia, 2022c)

Location-wise, Queensland tourism businesses are divided among the 13 regions. See Table 2 and Figure 7 for details.

Table 2: Queensland tourism regions

ID	Region's name	Area (km²)
1	Gold Coast	1333.39
2	Brisbane	15624.81
3	Sunshine Coast	10061.15
4	Fraser Coast	7004.51
5	Southern Queensland Country	87960.56
6	Bundaberg	26100.94
7	Mackay	66321.22
8	Whitsundays	23818.97
9	Townsville	80036.10
10	Tropical North Queensland	386659.12
11	Outback Queensland	936212.65
12	Capricorn	78553.53
13	Gladstone	10484.29

QUEENSLAND TOURISM REGIONS
- Brisbane
- Bundaberg
- Capricorn
- Fraser Coast
- Gladstone
- Gold Coast
- Mackay
- Outback Queensland
- Southern Queensland Country
- Sunshine Coast
- Townsville
- Tropical North Queensland
- Whitsundays

Source: Australian Bureau of Statistics (2021)
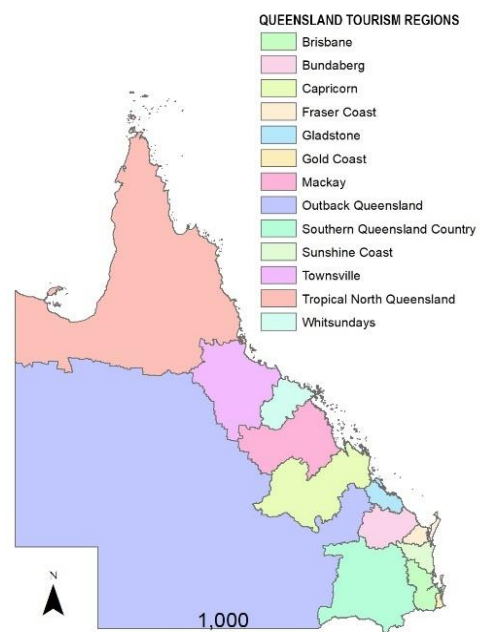
Figure 7: Map of Queensland tourism regions

Sector-wise, hospitality is the largest sector (employing 24% of the tourism workforce), retail (16%), accommodation (11%), transport (8%), travel agencies/tour operators (7%), sports and recreation services (5%), all other services (27%) (Tourism Research Australia, 2021).

2.5.3. Tourism Sector Level of Involvement with Natural Environment

Australian tourism businesses rely to a large extent on Australian environments and biodiversity (Buckley, 1999). Climate and natural resources are the main tourist attractions and tourism products in Queensland, consequently forming an important base for regional economies (Becken & Hay, 2007). Tourism-dependent communities understand the link between the climate change and their livelihoods. Changes in the environment or the climate may create threats and opportunities for the region's core activities, including tourism. The tourism industry, particularly nature-based tourism, is seen as being vulnerable to climate change impacts (Arabadzhyan et al., 2021; Jones & Scott, 2006; Saarinen & Tervo, 2006; Scott et al., 2008). Four broad categories of climate change impacts affect tourism destinations, their competitiveness and sustainability (UNWTO et al., 2008). First, direct climatic impacts, such as more droughts and increased severity of storms, are predicted and will influence tourists who select destinations on the basis of attractive weather conditions, thus likely affecting destination loyalty. Such changes will affect the tourism industry also through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses and business interruptions. Second, indirect environmental change impacts, such as biodiversity loss, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases such as Ross River fever will all impact tourism to varying degrees. Third, indirect societal change impacts, e.g., national and international security risks, are also expected to increase. Lastly, impacts of mitigation policies on tourist mobility - national or international mitigation policies seeking to reduce greenhouse gas emissions are likely to lead to an increase in transport costs and consequently have an impact on tourist flows (e.g., shift in transport mode or destination choices) (Gössling, 2008; UNWTO et al., 2008). In a more recent review, Arabadzhyan et al. (2021) highlighted the climate change impact on tourism under the premise that supply of as well as demand for tourism services depend on the quality and the management of a set of environmental attributes. Similarly, they listed among the reasons for the loss of attractiveness of marine and coastal environments biodiversity loss, increased exotic invasive species, degradation of landscape including loss of beach, increased danger of forest fires in tourism areas, emergent infectious

diseases, loss of tourist experience value in the destination due to changes in human comfort (heat stress) and change in the quality of infrastructures and facilities, including transport.

In Queensland, social and political circumstances have meant that tourism professionals are actively engaged in addressing issues related to major environmental themes such as climate change, sustainability, and conservation. This is consistent with findings from other studies that acknowledged meaningful engagements of the tourism sector in mitigation, vulnerability assessment and adaptation at all scales (Becken & Hay, 2007; Prideaux et al, 2021; Scott et al., 2008; Scott & Becken, 2010). The following section highlights some major nature-based settings in Queensland and associated environmental programs and projects in which tourism professionals in Queensland are involved.

Visiting national parks is one of the most popular activities for domestic and international visitors to Queensland, attracting more than five million visits from domestic travellers each year (Business Queensland, 2020). Queensland has over 1,300 national parks, marine parks, state forests and other protected areas (Business Queensland, 2020). The Great Barrier Reef (GBR) is a key natural icon to attract visitors in Queensland (See Figure 8). Marine tourism is the largest economic contributor to the Australian economy from reef-dependent activities in the Great Barrier Reef Marine Park (Lužar, 2016). It supports more than 60,000 jobs and provides access for more than two million tourists each year (GBRMPA, 2022). According to the latest assessment, the total Australia-wide value-added economic contribution generated in the Reef catchment is AUD 6.4 billion in national economic contribution, or 64,000 jobs and AUD 56 billion in total economic, social and icon asset value (Deloitte Access Economics, 2017). This is more than the previous assessment in 2012, which was AUD 5.7 billion, with employment (as measured in full-time equivalent workers (FTEs)) of just below 69,000. Over 90% of value added and employment generated emanated from tourism activity (AUD 5.2 billion in value added and about 64,000 FTEs).
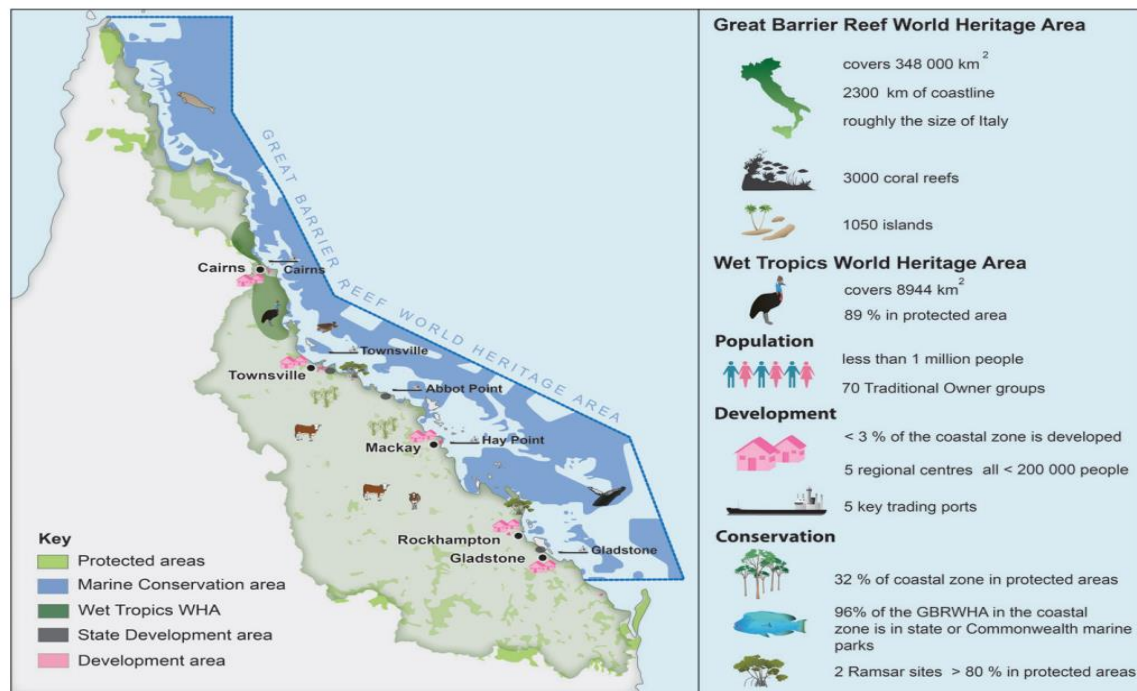
Figure 8: Great Barrier Reef as a natural asset (Source: Department of the Environment, Australian Government, 2013)

The GBR is considered a major driver or incentive for international travellers to visit Australia (Prideaux et al., 2013). Its biodiversity, aesthetic beauty, and world heritage status, as well as its scientific, educational and lifestyle values, are strongly recognised (Curnock et al., 2014). People's experience of visiting the Reef, combined with programs of information, education and interpretation, serve to maintain its significance (GBRMPA, 2014). Many operations are small-scale and carry only small numbers of tourists (fewer than 10) or operate infrequently (fewer than 50 days a year) (GBRMPA, 2013). Tourist satisfaction is closely aligned to the attributes of their visit that are most important to them. In a survey among 2743 visitors of the GBR (domestic and international, of whom the majority came from Europe) Stoeckl et al. (2013) found that visitors most value time on the beach, healthy coral reefs, healthy reef fish, iconic marine animals, no rubbish, and sunshine and warmth (Stoeckl et al., 2013). Over 20% of those surveyed indicated that they would not come to the area if there was half as much live coral. Related to attitudes towards preservation of the GBR World Heritage Area, the report found a feeling of collective responsibility. Most people (residents and tourists) disagreed with the statement that only people who live near or visit the GBRWHA have a responsibility to care for it. However, most also agreed with the statement that they are not prepared to pay unless people throughout Australia pay too. Evidently, respondents care about the GBRWHA, but do not want to be the only ones who 'pay' to protect it. Under the Great Barrier Reef Marine Park Zoning Plan 2003, commercial marine tourism is

permitted in almost all zones and localities of the Park. More than 85% of tourism visits, however, are concentrated around Cairns and the Whitsundays region, which represents only 7% of the whole GBR protected area (GBRMPA, 2022). Such uneven distribution of visitation calls for more detailed and sustainable tourism management arrangements in these two regions, including limitations on the size and number of vessels at a particular location (GBRMPA, 2014). Apart from visiting the Reef with a licenced operator, tourists can choose to visit the GBR with an ECO certified operator[9], or those who have obtained Climate Action Certification[10], to support sustainable conduct on the Reef (Ecotourism Australia, 2013).

Scientists working on the GBR have long been avid advocates for the Reef and have been warning about the negative effects of climate change. While climate change awareness has increased, it also brought the need to understand human vulnerabilities to it as well as how to prepare and adapt to its effects (Hein et al., 2009; Marshall et al., 2010). However, the impacts of climate change for the tourism industry are difficult to assess as they are manifold (Hein et al., 2009). According to the latest GBR Outlook Report, climate change is the most serious threat to the Great Barrier Reef (GBRMPA, 2019). The impacts include heat waves, and ocean acidification that is gradually restricting growth and survival of organisms that build calcium carbonate structures (e.g., corals). Impacts are also related to extreme weather events, in particular cyclones and floods. The severe damage caused by severe tropical cyclones Hamish in 2009 and Yasi in 2011 highlighted the risks of increased frequency of severe storms that is predicted for this area because of climate change (GBRMPA, 2014). As many tourist activities depend on climatic conditions (Jones & Scott, 2006; Scott et al., 2008), the severe weather is likely to have negative impacts on visitor numbers to Queensland.

Ecosystems already under pressure from natural events are further threatened by the accumulation of anthropogenic impacts such as those caused by excess nutrient run-off, coastal developments, and fishing, as well as tourism. All these activities have the potential to further weaken the resilience of the Reef and its ability to recover from serious disturbances (Hughes et al., 2003; Sura, 2021). These changed environmental conditions affect other ecological processes in the ecosystem, including reduced

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[9] The ECO Certification program identifies genuine nature and ecotourism operators (for details, see Ecotourism Australia, 2023a).

[10] The Climate Action Certification program is dedicated to reducing carbon emissions and assuring visitors that certified products are supported by sustainable practices related to addressing climate change (for details, see Ecotourism Australia, 2023).

recruitment for many key species such as some fish, dugongs, marine turtles and seabirds. Some degree of habitat loss and reduced biodiversity is inevitable. This is likely to have further social and economic implications for communities and industries that rely on the natural resources in the region, especially those that depend on a pristine, healthy and resilient ecosystem, such as marine tourism.

Understanding the importance of the health of the GBR, the tourism industry in Queensland is strongly involved in adapting to and mitigating climate change impacts in the region. In 2009, the Tourism Climate Change Action Group was formed, comprising the Queensland Tourism Industry Council, the Association of Marine Park Tourism Operators, the Whitsunday Charter Boat Industry Association, Tourism Queensland, the Queensland Parks and Wildlife Service and the GBRMPA. The group developed the Great Barrier Reef Tourism Climate Change Action Strategy (2009–2012), the first of its kind in the world. The strategy has guided a range of real-world adaptation actions among tourism operators, including emissions-reduction programs, tests of renewable energy options, implementation of site-based management strategies that support reef resilience, and new awareness and education campaigns (GBRMPA, 2009; GBRMPA, 2012b).

In addition, tourism operators also contribute to Reef Health and Impact Surveys (RHIS), the Sightings Network, the Rapid Monitoring survey program, and the High Standard Tourism program. RHIS is an impact assessment tool for reef hotspots to effectively allocate management resources and can also be used to assess the effectiveness of implemented management strategies (Marine Discoveries, n.d.). The Eye on the Reef Sightings Network is a community-based program developed in partnership between the tourism industry and GBRMPA to capture wildlife sightings and strandings as well as incidents (e.g., oil spills, pollution) on the Great Barrier Reef. The Sightings Network helps build knowledge about species diversity, abundance, habitat and range (GBRMPA, 2022a). The Rapid Monitoring survey program is another community-based program, designed for reef users to record what they see on the Reef and report that data to the Great Barrier Reef Marine Park Authority for the purpose of monitoring reef health (GBRMPA, 2022b). The High Standard Tourism Operator program requirements are geared to produce operators who provide ecologically sustainably and high-quality reef experiences (GBRMPA, 2022c).

Another program involving tourism operators is targeted control of crown-of-thorns starfish, one of the main predators of corals. Being aware of the key role in fulfilling

Australia's obligation to present this UNESCO World Heritage Area to visitors, most tourism packages include education and interpretation activities, aimed at increasing appreciation and understanding of the natural environment as well as sustainable practices that support the Reef (GBRMPA, 2012).

Another science-based initiative, released in 2013, is Queensland Eco and Sustainable Tourism (QuEST), developed in close consultation with the industry and supported by the Queensland Tourism Industry Council and the Australian Marine Park Tourism Association. As well as providing economic benefits, QuEST provides a framework ensuring sustainable management of national parks while safeguarding business certainty for existing tourism operators in offering long-term agreements (Department of Environment and Science, n.d.).

Further, Eye on the Reef Tourism Weekly Monitoring Surveys is a successful partnership between the tourism industry, Marine Park managers and researchers. Operators taking part in Tourism Weekly Monitoring are trained to supply data that allows for effective management of the GBR, help improve the local management of their site, update reef interpretation tours and tailor products for their visitors (GBRMPA, 2022b).

More recently, the United Nations World Tourism Organisation (UNWTO) identified the role that tourism has in contributing to the 17 Sustainable Development Goals (SDGs) (UNWTO, 2018). Tourism has been included as a major potential contributor to goals eight, 12 and 14 on inclusive and sustainable economic growth, sustainable consumption and production and the sustainable use of oceans and marine resources (QTIC, 2022). In Queensland, Towards Tourism 2032 framework sets a strategic direction for the tourism industry in Queensland in the next 10 years (Queensland Government, 2022c). Additionally, the Building a resilient tourism industry: Queensland climate change response plan represents an industry-led climate adaptation and mitigation plan for the tourism industry sector in alignment with the Queensland Climate Adaptation Strategy (QCAS) (Becken et al., 2018). Recognising the urgency of addressing climate change, this plan considers both a short- and mid-term time frame, with a long-term view towards the 2050 target of net zero emissions and sustainable water management. Specific tools, such as a carbon calculator, have also been developed in collaboration with Australian universities and international research institutions, e.g., EcoLab, to help tourism businesses improve their sustainability (QTIC, 2022).

Furthermore, the GBR also has its own sustainability plan: Reef 2050 Long-Term Sustainability Plan 2021-2025 (Department of Agriculture, Water and the Environment, 2021b). As the GBR is a World Heritage declared area (UNESCO World Heritage Convention, 2011), the World Heritage Committee requested a comprehensive strategic assessment of planned and potential future development that could impact the outstanding universal value of the GBR. With a joint investment of AUD 4 billion from the Australian and Queensland governments, the plan fosters scientific research and monitoring in collaboration between academia and the tourism industry (Department of Agriculture, Water and the Environment, 2021b).

Apart from the marine environment, the state of Queensland includes a variety of land based natural environments in which tourism occurs, including other four declared World Heritage Areas (K'gari (Fraser Island), Riversleigh, The Gondwana Rainforests and The Wet Tropics – for details on these WHAs see Queensland Government, 2022d). The advantage of WHA declarations is that they attract allocation of resources to consolidate and protect these areas (Department of Agriculture, Water and the Environment, 2017). The listings also help in destination promotion. Here too, the quality of visitor experience must start with concern for caring for the site (Garrod et al., 2002). Environmental science contributes by informing the establishment or maintenance of protected areas, use of private land for conservation, wildlife impacts and management as well as tourism experiences. The health of the natural environment is critically important to the stability and value of the nature-based tourism industry. For example, wildlife encounters are not only desired but expected (Arango et al., 2020). A survey of visitors to Mon Repos Conservation Park, Queensland found that 40% of respondents would not have visited the Bundaberg region in the absence of sea turtles and 19% would have reduced their length of stay. A survey of visitors to the O'Reillys/Green Mountains Section of Lamington National Park, Queensland revealed that in the absence of birds, 30 to 40% of respondents would not have visited this site (Ecotourism Australia, 2017).

Pre-COVID, nearly 70% of all international visitors engaged in some form of nature-based activity in Australia (Ecotourism Australia, 2017). An analysis of the domestic wildlife tourism market in Australia showed that Queensland was the most common destination in Australia for wildlife trips. The majority of encounters with wildlife were in natural habitats, i.e., national parks (44.3%) or in other natural settings (12.9%). Smaller proportions of visitors encountering wildlife included captive exhibits such as zoos (17.1%), wildlife parks (12.4%), theme parks (3.3%) and aquariums (2.4%) (Fredline, 2007).

Wildlife tourism is an important division of nature-based tourism, which in turn has been an increasingly important component of global tourism products since the 1990s (Newsome et al., 2002; Roe et al., 1997). Wildlife tourism is defined as: tourism undertaken to view and/or encounter flora and fauna in various natural environments. It can take place in a range of settings, from captive, semi-captive, to in the wild, and it encompasses a variety of interactions from passive observation to feeding and/or touching the species viewed (Newsome et al., 2005). It is in the interests of wildlife tourism operators and tourists to invest in protection of the wildlife resource on which their business is based (Higginbottom et al., 2001). Furthermore, many wildlife and nature-based tourism operators in Queensland incorporate environmental interpretation and education components. This decision is partially a response to visitors' expectations to learn and partially a strategic decision as wildlife viewing/interaction cannot be guaranteed (Arango et al. 2020). While the impacts of environmental education/interpretation have been extensively studied in relation to tourists (see e.g., reviews by Ardoin et al., 2015; Munro et al., 2011; Orams, 1996; Zeppel & Muloin, 2008), less is known about the tourism workforce perspective. More research on the supply side of tourism is needed.

Overall, tourism falls into non-extractive dependence on natural resources (Frey & George, 2010; Mueller, 2022). Some tourism businesses completely rely on natural resources (e.g., Reef cruises), while others may have much less direct reliance (e.g., accommodation providers). The sector they operate in may play an important role in their approach. Other than that, environmental characteristics of a destination may be conditioned by location.

2.5.4. Summary and Gaps

The literature review above uncovered what is known and unknown about the tourism industry in Australia and, more specifically, Queensland. With a focus on the tourism workforce, I first introduced the Australian tourism industry network, which illustrated the complexity of the tourism industry. Four main levels were outlined, including national, state, regional and local. This examination guided considerations about study design, as is explained in the next chapter. Following this broad review, I examined the characteristics of tourism businesses in Queensland. In Queensland, 99% of businesses are small (> 19 employees), with 50% of these being non-employing businesses. Geographically they are dispersed among 13 regions, with Tropical North Queensland

and Outback being the two largest by area size. Sector-wise, hospitality leads in terms of employment, followed by accommodation, retail, transport and tours. Demographic characteristics of businesses demonstrate diversity within the tourism industry. Next, I reviewed the involvement of the tourism industry with the natural environment. It became apparent that awareness of natural resource dependence in the tourism industry in Queensland is omnipresent. Tourism businesses are involved in a number of government led/science supported environmental projects. The environment is also a crucial component of Queensland's destination image. These reasons suggest that interest in environmental science information by the tourism workforce can be expected. However, research is needed to confirm this assumption. Plenty of research focusing on visitors' experience is available, however research on the tourism workforce is lacking. Studying tourism professionals as the audience is important. After all, they are the environmental knowledge brokers/gatekeepers, managers and decision makers with the power of influence to direct businesses towards a sustainable future.

2.6. Aim and Objectives

The literature review in previous sections has exposed the complexities of the intended project. Innovation is most commonly fostered in a system, which consists of actors and relationships among them. Communication is an important activity in the process of innovating, yet still poorly examined empirically. This thesis showcases the issues of cross-sectoral communication. In pursuit of this aim I assume that to communicate effectively, we need to know the audience. A specific case of communicating environmental science to the tourism workforce will be constructed to demonstrate this principle. This case was selected due to its relevance to Queensland as well as its potential for transferability, as explained in section 1.4. Delimitations of Scope and Key Assumptions. To achieve this aim, the following objectives were set:

A) To segment the tourism workforce to identify the best target group with whom to communicate environmental science information.

B) To examine the interest of the tourism workforce in major environmental science themes to identify the most relevant content for this audience.

C) To geographically segment the tourism workforce to determine the best targeting locations.

D) To qualitatively examine how video as a medium performs with the tourism workforce to guide the development of future video-making by environmental scientists for the tourism workforce.

2.7. Chapter Summary

This chapter presented the disciplinary and theoretical contexts of the thesis. First, the background theory of triple helix systems of innovation was explained. Second, the focus theories from the discipline of communication were discussed and their relevance to effective cross-sectoral communication of environmental science to tourism industry demonstrated. Third, characteristics of the tourism industry in Queensland were presented and key issues discussed. An overview of relevant theories was provided, together with the rationale for their selection. Key concepts were illuminated in each section along with research gaps. Finally, the aim and objectives for this research were set.

The next chapter presents the methodological approach that directs this thesis, including philosophy, approach and design, how the data collection instruments were developed and applied, ethical considerations and unforeseen limitations to this methodology.

3. Methodology

3.1. Introduction

As noted in the previous chapter, this thesis considers factors that aid effective communication of environmental science to the tourism industry. This will advance knowledge about cross-sectoral communication not only between these two sectors, but also more broadly. The principle of understanding the audience to which we wish to communicate is essential to this research project. To do so, the research questions refer to tourism professionals as recipients and audiences of environmental science communication. The extent to which the results can be generalised is important. Therefore, this thesis takes a pragmatic research stance, and applies an abductive approach in advancing knowledge about how environmental science can be communicated to the tourism industry. These two are described in the next two sections. Then I provide justification for the research design, which is a case study. Following that I describe the unit of analysis for each of four studies. Section 3.6 explains the development of data collection instruments, including an original video production and questionnaires for qualitative and quantitative data collection. Next, I describe the sampling strategy, including the sample size and purposive sampling that I utilised in this research. Data collection procedures included three phases, including the exploratory phase, survey and focus group, which are described in section 3.8. Covid-19 pandemic seriously impacted the development of data collection instruments and the gathering itself. These limitations to the methodology are explained at the end of this chapter.

3.2. Research Philosophy: Pragmatism

Pragmatism has been extensively applied in research about social and environmental topics including stakeholder engagement (for an overview see e.g., Baker & Schaltegger, 2015; Wills & Lake, 2021). Pragmatism is a philosophical tradition that sees the world as inseparable from agency within it (Legg & Hookway, 2021). Pragmatism is concerned with the process of 'sensemaking' by which individuals come to understand truth when engaging with the world (Weick, 1995). Originally, pragmatism was developed based on the notion of anti-foundationalism, which is the belief that ideas do not exist as timeless and pre-existing perfect forms, but instead are formed contingently and experimentally in response to particular needs as people live out their lives in a given place and time (Barnes, 2008). Pragmatism favours experience over fixed principles. Thus, pragmatists

share the epistemological position that meaning and truth are inferential rather than representational (Baker & Schaltegger, 2015). In other words, the truth is to be found in the process of verifying ideas (Thayer & Rosenthal, 2022).

According to pragmatism pioneer Dewey (2018), the conceptualisation of inquiry begins with understanding the problem through describing its elements and relationships between them. From there, we identify a concrete question that needs to be answered (Legg & Hookway, 2021). In this thesis, the problem is positioned within a system of innovation, and the main question concerns cross-sectoral communication. The understanding and development of standards of procedures come from the application of concepts to directly experienced subject matters (Thayer & Rosenthal, 2022). Theories are used as tools rather than answers to questions (James, 2000).

Theoretical concepts and frameworks (i.e., a predefined lexicon to a social inquiry) are utilised to help us reduce the complexity to a manageable size (Wills & Lake, 2021). From thereon - as pragmatists believe - ideas have functional character (Thayer & Rosenthal, 2022). They are being tested for being workable, valuable and useful suggestions of possible behaviour, or not. While the Greek meaning of the word "pragmatic" relates to "instructive", the German meaning refers to experimental, empirical, and purposive thought "based on and applying to experience." (Thayer & Rosenthal, 2022, para. 3). A methodology that follows pragmatism would thus involve exploring how individual tourism professionals derive meaning from an uptake or engagement with environmental science findings and in what ways they find it useful. In this process, key theoretical concepts from cross-sectoral communication discipline would be applied to the tourism research. Pragmatism has been utilised in tourism research before (for an overview see Ritchie et al., 2013).

Generally, pragmatists work at the micro level (Elder-Vass, 2022) and ideas hold truth within a particular context (Thayer & Rosenthal, 2022). With that in mind, I want to be cautious when declaring the contribution of this research. Rather than generalising, this research provides theoretical and methodological pathways that are transferable to other fields of inquiries. However, with the pragmatic "commitment to problem solving and perspective that extends beyond the academia" (Wills & Lake, 2021, p. 5), this thesis strives for that contribution to be original and substantial.

3.3. Research Approach: Abductive

An epistemological stance can be defined as the researcher's way of discovering knowledge i.e., how data is collected, analysed and used (Saunders et al., 2019). Pragmatic inquiry reorients the focus of research from academic debate to working with a particular social or stakeholder group (Wills & Lake, 2021). However, this does not mean that theory is neglected; rather, the key theoretical concepts are applied in a specific context to carry out abductive reasoning.

The abductive approach allows for the systematic combining of theory and reality, whereby theory provides the context rather than an inductive fit (Dubois & Gadde, 2002; Kovács & Spens, 2005). Inductive as well as deductive approaches both aim to establish relations between already known constructs. The abductive approach is set to transcend this limitation (Kirkeby, 1990). Instead, abductive reasoning offers inference to the best explanation (Mickelson, 2019). In other words, insights (i.e., new knowledge) are produced in a logically and methodologically ordered way (Reichertz, 2004) through the theory – reality learning loop or as identified by Dubois & Gadde (2002, p. 554) "systematic combining".

A good example of an abductive approach is a recent study by Hurley et al. (2021) that applied it to a social marketing program design. The authors argued that this approach to co-design allowed for incorporation of theory (i.e., expert knowledge), while investigating user views and ideas to extend understanding beyond known effective approaches (Hurley et al., 2021). In my case, the triple helix model served as the general initial framework. The search for useful theories, complementary to the general framework, was ongoing and guided by the fact that the empirical observations and the framework alone did not match (Debois & Gadde, 2002). Concepts from cross-sectoral communication theory and marketing segmentation theory were used to empirically test and explain the phenomena within the triple helix framework.

The abductive approach has previously been applied in the context of marketing (e.g., Davey & Grönroos, 2019; Mehmet & Simmons, 2019), consumer psychology (e.g., Kardes et al., 2022) and tourism (e.g., Okumus et al., 2022; Ritchie et al., 2013). Kolko (2010) contended that of the three types of reasoning, abduction is the best suited to uncover novel insights. Labroo (2022) argues that abduction is most useful for largely understudied domains and populations with problem specific context as well as to address complex social issues (such as cross-sectoral communication). This is relevant

also for my case, where deduction alone would be impractical because not enough knowledge exists about how to communicate to tourism professionals and generalisation about cross-sectoral communication of environmental science from other domains may not be meaningful. Furthermore, abductive reasoning involves the reimagining of existing knowledge to envision and explain a new concept (Roozenburg, 1993), i.e., knowledge transfer as non-technological innovation. Finally, the abductive approach is recommended especially when dealing with single case research aimed at theory development (Dubois & Gadde, 2002), which will be explained in the next section.

3.4. Design and Justification for the Methodology

This thesis uses a single case study design. A case study provides a unique means of developing theory by utilising in-depth insights of empirical phenomena and their contexts (Dubois & Gadde, 2002). Case studies are best used for answering the question about "how some social phenomenon works" (Yin, 2009, p. 4), which is exactly what I am trying to achieve with this research. A case study methodology has wide-reaching applications (for overviews, see e.g., Brock-Utne, 2015; Silliman, 2018; Yin, 2003), including in *business* (Benbasat et al., 1987; Dul & Hak, 2007; Farquhar, 2012; Ghauri, 2004; Ghauri et al., 2020; Gibbert et al., 2008; Rashid et al, 2019; Reddy, 2017), *marketing and communication* (Bonoma, 1985; Chen & Ko, 2015; Easton, 2010; Herndl & Nahrwold, 2000; Perry, 1998; Pousttchi & Wiedemann, 2006; Riege, 2003; Sengul, 2019; Taylor &Every, 2011; Tumele, 2015) and *innovation* related studies (Gao et al., 2021; Goffin et al., 2019; Seyr, 2020; Wang et al., 2022). For researching emerging concepts (i.e., non-technological innovation, cross-sectoral communication), exploratory studies are needed, and case study research is most suitable for the construction and expansion of new research paradigms (Gao et al., 2021; Goffin et al., 2019). Furthermore, it is also the main research method of innovation systems research overall (Gao et al., 2021).

Case study research can be built on single (Dubois & Gadde, 2002; e.g., Gaya & Smith, 2016) or multiple cases (e.g., Ćwiklicki, & Pilch, 2021; Vavrus & Bartlett, 2022). Choosing between these two variants is the primary consideration of designing a case study, before any data collection occurs (Yin, 2003). One rationale for selecting a single case rather than a multiple-case design is that the single case can represent a critical case of a significant theory (Yin, 2003). Prior to this research, cross-sectoral collaboration studies have mostly been focused on barriers and incentives to collaboration (as the Literature Review chapter discussed in detail). However, little attention has been paid to

processes that enable collaboration in the first place, i.e., communication. In this sense, this project represents a significant addition to the existing research on the systems of innovation. Another consideration is the maturity of the new direction. Multiple case study design is comparative in nature (Vavrus & Bartlett, 2022) and would, therefore, be more suitable once a few cases of communicating environmental science to different stakeholders have been developed.

Case study research typically relies on multiple sources of data (Silliman, 2018; Yin, 2003), which can all be qualitative (Ellinger & McWhorter, 2016; Eriksson & Kovalainen, 2008; Stake, 2000) or a combination of qualitative and quantitative. As opposed to mixed methods design, where multiple methods are joined to deliver insights, a case study design uses a combination or sequence of methods to build a case (Plano Clark et al., 2018). For my project, a survey and a focus group were used to build a case. The survey method was chosen due to previous applications in similar projects. For example, Hine et al. (2014) conducted a review on conceptual and methodological considerations in the context of audience segmentation for climate change communication. Their study concluded that most climate change segmentation studies have been conducted using surveys and large samples (Hine et al., 2014). Tolkes's (2018) review of sustainability communication in tourism also concluded that the majority of the investigated studies used quantitative research design and observed a predominance of survey-based studies. Using the survey, I gathered data for the first three analyses that provided insights on what to communicate, and to whom, in the context of my case.

However, it was important that the perception of the recipients was also explored. The qualitative approach enables collection of richer data about the phenomenon (Quinlan et al., 2015).). This was necessary for my project due to the lack of existing literature related to tourism professionals as recipients of environmental research information. The focus group method proved suitable to achieve this objective. An online focus group method was used because of the vast geographic dispersion of tourism professionals across Queensland, financial constraints and COVID-19 restrictions. Compared to an in-person focus group, the advantages of an online version include easy access and convenience, as participants can be located anywhere as long as they have the access to technology, and it is an inexpensive method compared to in-person focus group (Quinlan et al., 2015).

Sections 3.8.2. and 3.8.3. explain in detail how the survey and focus group methods were carried out to collect the data. The Findings chapter then explains the analysis

methods performed on the data. Finally, the Discussion and Conclusion chapter (based on the results presented in Chapter 4) deals with the construction of the case.

3.5. Unit of Analysis

The unit of analysis is the entity being examined and ultimately analysed to provide a conclusion that explains the outcome and addresses the research problem (Casteel & Bridier, 2021). Defining the unit of analysis is essential to empirically measure or observe concepts, and analyse data (Neuman, 2013). In social sciences, the unit of analysis is commonly an *individual* and investigations are oriented toward individual characteristics (Casteel & Bridier, 2021). In the business discipline, however, it is frequently the *business* unit that is analysed (Kumar, 2018). For this project, the individual unit of analysis would apply to tourism professionals employed in any tourism sector in Queensland and the business unit of analysis to tourism organisations (mainly businesses and associations) operating in the State of Queensland. In this research, I used both types, as necessary (See Figure 9).

In the first analysis, when constructing a typical target profile with whom to communicate environmental science information, segmentation was applied to demographics of individual respondents. This was done as the business level would not give fine enough resolution; organisational structure and hierarchy also needed to be taken into consideration. For that, the individual unit of analysis was employed to gather and analyse the data. The second analysis deals with the themes of interest. Since the research question explores whether interest is conditioned by the type of business, the organisational unit of analysis sufficed. The same is true for the third analysis that focuses on business location and their proximity to natural features. The final analysis again employed the individual unit of analysis. This was a qualitative study dealing with perceptions and therefore this unit of analysis was appropriate to use (Casteel & Bridier, 2021).

Unit of Analysis	Individuals	Businesses
Who is interested		
Themes of Interest		
Location: Scale and Proximity		
How to Communicate Environmental Science via Video		

Figure 9: Units of analysis applied in this research

3.6. Data Collection Instruments

The quantitative data collection instruments originally consisted of a survey questionnaire and a video, which was used to elicit responses. These two instruments were embedded in the WordPress website *https://karmensphdresearc.wordpress.com/*, which was developed for this research purpose only. The video was hosted on an unlisted YouTube page *Linking environmental science and the tourism industry - YouTube*. However, after modifying the data collection procedure (see further explanation under 3.9. Limitations), the video was used to elicit responses via focus group.

The online survey questionnaire was developed using the Qualtrics platform (www.qualtrics.com). First, the survey questionnaire provided information about the project, the research team and ethics committee, and also asked for consent from respondents. From here on, development was guided by the literature review. The question sections included demographic information of individual respondents and business they represented, themes of interest, scale of interest, and questions about the video. Response options included single- and multi-choice answers. At the end of the questionnaire, an option to enter into a voluntary prize raffle was given to respondents who completed the questionnaire. The reward offered was a voucher for a major Australian supermarket. The voucher was intended as a small incentive, as well as a token of appreciation for donating their time, which was during the COVID-19 pandemic, a challenging period for the survey respondents. To secure the anonymity of the data collected through the survey questionnaire, the raffle entry was handled separately (Qualtrics, 2020). A focus group questionnaire was developed for the final study to gather information on audience preferences. This questionnaire included seven open-ended questions about various documentary attributes. This method replaced the originally intended inquiry via the survey (For details regarding the change, see the section 3.8. Data Collection Procedures and 3.9. Limitations). Both questionnaires can be viewed in Appendix A.

Videos were a necessary instrument for this data collection to examine audience perception of and preferences for video elements. Recently, video has received increasing scholarly attention due to its rising popularity (see e.g., Chang et al., 2019; Haixiang & Nan, 2022; Milliken et al., 2021; Tan et al., 2020; Zhou et al., 2020;); however, how tourism professionals "see it" has not yet been explored. Pauwels and Mannay

(2020) argue for the need to understand the perception of the intended audience. This is precisely the gap that this research addresses.

To test viewer preferences, it was important to create examples with contrasting elements. For this purpose, I produced an original video. The video production was guided by the literature and largely was executed by me due to previous multimedia production experiences and limited resources available (For details on the production of this video see Appendix B). In general, video making varies depending on the nature of scientific inquiry and how the creative process is carried out (Pauwels & Mannay, 2020). In my case, both video examples portrayed recent environmental research conducted in Queensland. The first example showed a scientist describing 'live' to the camera her study on whale breathing behaviour. The scale of the study was the entire Queensland coast. Her communication was cut with moving pictures of whales underwater, the sounds of whales singing and background music. The second example was a narrative. The video portrayed the discovery of fossils in a small town in Queensland. The audio was narrated by a professional communicator and accompanied by photographs supplied by the researchers. This video also featured background music. An Integrated Framework for Visual Research was adopted to aid consistency of future studies of similar kind (See Appendix C).

This video production was validated by the most recent "directions towards more effective audio-visual communication" of Ferreira et al. (2021, p. 10). Their study of 171 video abstracts (as a new format to journal article abstracts) looked at different aspects of video production, including length of the video, format model, professional production and required training. According to the authors, the optimal length of a video is two to three minutes (Ferreira et al., 2021). Both my examples were planned to be around 2 minutes and 30 seconds in length. The postproduction required some adjustments, however the videos remained within/close to the optimal length.

Second, Ferreira et al.'s (2021) favoured format was a documentary, which can be understood as a "movie about a real life" (Aufderheide, 2008, p. 23). My videos followed the same format. In this format, the audience expects to be told information about the real world, honestly. Documentary conventions arise from the need to convince viewers of the authenticity and trustworthiness of the message (Aufderheide, 2008). This, however, cannot be understood as an objective endeavour. Manipulations, such as e.g., content selection, editing, mixing sound, are a necessary part of the creative process of film making.

Finally, Ferreira et al.'s (2021) findings show preference for professional compared to amateur production (sometimes also called user generated videos). They emphasise that specific knowledge is required for science video production, including knowledge about the subject/content as well as technical knowledge of video making (Ferreira et al. 2021). Similar has been established by the latest recommendations of the Visual Research Methods textbook. "Competent visual researchers need to achieve a sufficient degree of technical knowledge, which enables them to produce images or other types of visual representations with the required amount of visual detail (data richness)" (Pauwels & Mannay, 2020, p. 24). My education and professional experience in multimedia production responds to this criterion. Additionally, other professional staff were recruited as needed (See Appendix B) to produce the highest quality instrument for this project.

3.7. Sampling Strategy

This section describes how the sampling strategy was developed and executed. First, the sample is described, followed by the selected sampling methods. Sampling for this research evolved from the originally intended stratified sampling method to purposive sampling. The reasons for modification are described in section 3.9. Limitations.

3.7.1. Sample Size

When the population of a research interest is too big to fall within the scope of a project, research is carried out on a sample from that population. A sample is the set of units selected to represent the population of interest (Gravetter & Wallnau, 2017). The analysis is carried out on the sample data, and the results are then inferred or transferred to the population of interest, depending on whether the analysis is qualitative or quantitative (Casteel & Bridier, 2021).

For this project, the defined population consisted of tourism industry professionals in Queensland. In 2019-20, total tourism employment (both direct and indirect) accounted for 135,900 employees (Tourism Research Australia, n.d.). For a survey, the ideal sample size was determined using the 95% confidence level and the margin error 5%[11].

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[11] A *confidence level* describes the extent to which the selected sample probabilistically represents the population of interest, whereas *sampling error* describes variation between random samples from the same population of interest (Quinlan et al., 2015).

This method (as opposed to the power analysis) was best to use for my quantitative studies, as I was interested in describing the characteristics of the population of interest (Casteel & Bridier, 2021). The ideal sample size of Queensland tourism professionals consisted of 384 respondents. The actual sample size consisted of 403 respondents.

The nature of qualitative data requires a different sample size. Discrepancies exist among scholars regarding determining the size *a priori* (Blaikie, 2018; Byrne, 2015; Emmel, 2015; Fugard & Potts, 2015) as the characteristics of studies may significantly influence and cause variations in the sample sizes (Hennink et al., 2019). Some find this approach to be inherently problematic (Sim et al., 2018) and the consensus is that rather than having a prescribed sample size, the size of a sample should be determined based on the nature of research and adapted to the themes emerging from the study (Casteel & Bridier, 2021). The data saturation point (Fusch & Ness, 2015) varies depending on the method employed (Casteel & Bridier, 2021). A focus group method (which was also employed in my data collection) leans towards smaller samples due to the abundance of data it can supply (Kim et al., 2017). While aiming to finish data collection at the saturation point, it is advisable to determine an approximate sample size as a guide. For this study I aimed to recruit eight to ten participants. The actual sample size for this study consisted of five respondents (see section 3.9. Limitations for details). This sample size, however, still falls within current guidelines for thematic analysis (applied in my last study), which start from two cases (Fugard & Potts, 2015). The quality of the results was not compromised due to the richness of data obtained (Kim et al., 2017).

3.7.2. Sampling

Tourism professionals in Queensland are a known and finite population, however not every member had an equal chance of being selected due to the limited options to reach them. For example, not all tourism professionals are members of RTOs and contactable via their communication channels, and not all are located in easily accessible areas due to the geographic size of our study area. Thus, non-probability sampling was employed (Quinlan et al., 2015). Non-probability sampling is also useful when a population is very large (Etikan et al. 2016), which was also the case for the tourism workforce in Queensland. A combination of sampling methods was used to achieve the required number of responses and sample representativeness of the population. This included purposive sampling and snowball sampling, via online means and face-to-face. Having multiple sampling methods is not unheard of. For example, Chan & Lopez (2014) used convenience and snowball sampling while Asemani et al. (2014) used three methods,

including convenience, snowball, and maximum variation sampling. Soulé (2014) also used the combination of three: purposive, maximum variation, and network sampling.

Purposive sampling is the most used strategy in qualitative research (Kim et al., 2017). For this project, purposive sampling was utilised based on judgements regarding its capacity to inform the research (Quinlan et al., 2015). The key quality of purposive sampling is its intentional focus on those potential respondents who have the required information and are willing to share it (Etikan & Bala, 2017). As this was exploratory research, all tourism professionals could meaningfully contribute with their participation. Purposive sampling was utilised in online as well as in face-to-face data collection procedures, which are further explained in the next section (see 3.8. Data Collection Procedures).

As a secondary online sampling strategy, snowball- or respondents driven sampling (RDS) was also tried to improve the response rate. Originally introduced by Heckathorn (1997), this is a commonly utilised method in sociological research. A snowballing method is recommended for hard-to-reach populations (Handcock & Gile, 2011). My initial experience with sampling and the informants from the exploratory phase marked tourism professionals as such and thus this method was tried.

For the RDS method, a study sample is generally yielded through referrals made among people who know of others who possess characteristics that are of research interest (Biernacki & Waldorf, 1981). Many tourism professionals in Queensland are connected via their network, and thus this method was deemed appropriate for this project. The initial sample (consisting of so-called egos or seeds) was selected semi-randomly based on a spatial sampling frame (Handcock & Gile, 2011). More precisely, one business from each of the 13 RTOs in Queensland was randomly selected as an ego/seed. The actual respondent representing that seed business might have been an employee, manager or owner: the level of employment did not matter. The respondents were then encouraged to share the invitation to the survey in any level direction within the tourism industry network (e.g., with their colleagues, business partners, employees, bosses, etc.).

This method aimed to achieve the representative sample over time (Handcock & Gile, 2011). However, the research literature has identified five key problems related to this method. The first two, i.e., finding respondents and starting referral chains (a) and verifying the eligibility of potential respondents (b) (Biernacki & Waldorf, 1981) were not problematic in our sampling. The social visibility of our target population was not an

issue. Tourism professionals know they work within tourism industry and, unlike deviant groups, there is no stigma connected to this identification. Most tourism professionals know, communicate and interact with other tourism professionals. The tourism industry in Queensland directly employs over 130,000 people and therefore finding respondents and starting referral chains was not difficult. However, actually engaging respondents as research assistants (c), controlling the types of chains and number of cases in any chain (d), and pacing and monitoring referral chains (e) proved ineffective and difficult to achieve (Biernacki & Waldorf, 1981). Overall, this method did not yield good results in reaching the set sample size. Most of my data were collected using purposive sampling.

3.8. Data Collection Procedures

Data collection was carried out in two stages, with the preceding exploratory stage. The exploratory stage provided the background information for this research project. I deepened knowledge of the scholarship and the tourism industry to better design the project (i.e., refinement of the original research idea, development of data collection instruments and processes). Furthermore, the exploratory stage was also an opportunity to introduce this project to members of the tourism industry and the prospective research participants. The intent was to gauge their interest in being involved in the project. The data collection process itself started with a quantitative approach, where a survey method was employed. Finally, qualitative data were collected using the focus group method.

3.8.1. Exploratory Phase

The exploratory phase included a literature review and structured interviews with representatives of RTOs. The literature review included a review of scholarship on triple helix theory, cross-sectoral communication, marketing segmentation, and video audiences. Additionally, I gathered background information on the tourism industry in Queensland by examining online secondary sources, including key tourism industry websites (on a state and regional level), reports, and online mass media articles.

Conversations with the Chief Executive Officers (CEOs) of RTOs across Queensland occurred between October and December 2018. Of the 13 invited subjects, 11 chose to participate. The meetings were conducted in person at RTO headquarters, or where accessibility proved difficult due to large geographical distances between the

interviewees and me, on the phone. The conversations took on average one hour. Questions were standardised to allow for comparison between RTOs. Questions included information about an individual RTO, communication processes and channels within an individual RTO, with other RTOs and with RTO members to identify key communication elements from the regional level of the network down. In addition, an inventory was made of key natural assets as determined by the CEOs. Finally, to determine existing and potential linkages between academia and the industry, questions related to collaboration with universities concluded the meetings. I took notes about the answers provided during the meetings. The notes were transcribed into an Excel document after each meeting for easier observation of commonalities and differences between RTOs. Finally, the information gathered online and in person was triangulated with printed materials given to the primary investigator by the interviewees during the meetings.

3.8.2. Quantitative Data Collection Process

Data collection began at the end of October 2020. The survey questionnaire (along with the video) was distributed via the RTO's preferred communication channels, specifically e-newsletters and websites. This approach was decided based on the information gathered during the exploratory stage. I negotiated the format and launch date with each RTO individually, depending on their schedules and capacity. Formats varied. For example, Tourism Tropical North Queensland, Townsville Enterprise and Bundaberg RTOs built a webpage, where they hosted a survey, and shared a link to the website in their e-newsletter to their members. Bundaberg additionally posted the link on their corporate Facebook page (See Appendix D for some illustrations.). Where a website was built by an RTO, I supplied the material, including the introductory text, video and the link to the survey. Within a month following the launch, which based on a rough estimation reached more than 10,000 tourism professionals, only 19 responses were received.

After consultation with an industry expert, I decided on distribution via tourism associations. For this purpose, I built a website (as described under the 3.6 Data Collection Instruments section). The website included information about the project, the documentary video and a link to the survey. On 1 December 2020, the website link was then shared via email with tourism industry state-based and national associations (See Queensland Government (2013) for the list). The email included a request to disseminate the link via the associations' communication channels to tourism businesses and professionals working in the Queensland tourism industry. The response was negligible.

Data collection was stopped until the end of January 2021, when the holidays - the expectedly busiest time for the tourism professionals - were mostly over.

At the end of January 2021, I sent an email directly to selected tourism professionals utilising a snowballing sampling strategy (described under the section 3.7.2. Sampling). A database of businesses' email addresses was compiled from publicly available sources on the internet. It included over 1000 email addresses. An email invitation included a request to fill in the survey and distribute it to three other Queensland tourism professionals of their choice. By the virtue of exponential function, the intended sample size of 384 respondents would be reached in five cascading steps, provided that every respondent forwarded the survey to three contacts. However, this did not occur. On the contrary, the response rate employing the direct email distribution method was extremely low (approximately one respondent per 100 emails sent).

To promote the data collection process, I launched a media campaign in mid-April 2021 (following consultation with the advisory panel). A press release about the research and request to participate in the survey was sent to 40 regional newspapers across Queensland. Morning Bulletin (covering the Capricorn region) and Kuranda News (covering parts of the Tropical Tourism North Queensland region) responded and published the press release. Additionally, the board of the Noosa Biosphere Reserve promoted the survey via their networks. Ecotourism Australia and Tourism Queensland (government) were also approached with the request for endorsement via their social media and other communication channels. Ecotourism Australia offered to share the news in its newsletter and to promote the survey on social media. By mid-April 2021 the project obtained 60 responses. In the second half of April 2021 a second email was sent to all already targeted email addresses of tourism businesses in Queensland. By mid-year the project had 99 valid responses. As the required number of responses was not achieved through online means, and as soon as travel restrictions eased, face-to-face data collection was undertaken.

In person data collection is more resource intensive, which prompted strategic decisions regarding the data collection points. Queensland covers 1,727,000 square kilometres (Queensland Government, 2017). Surveying the entire area was unrealistic. The four most visited tourist regions were selected instead: Whitsundays RTO, Tourism Tropical North Queensland RTO (Cairns area), Fraser Coast RTO and Sunshine Coast RTO. The first two represented Northern Queensland and the latter two Southern Queensland. See Figure 10 for the chosen locations. Testing face-to-face data collection in the

Whitsundays area yielded promising results, with 27 entries over six days. I continued to collect data in the Fraser Coast and Sunshine Coast areas, and for Tropical North Queensland a research assistant was recruited. I trained the assistant in the data collection protocol prior to the field work. In-person data collection at all four locations was administered with iPads using the original website. The survey questionnaire remained consistent with the rest of the data collection minus the video questions (see section 3.9. Limitations for details). Some of the online methods were repeated alongside the face-to-face data collection.
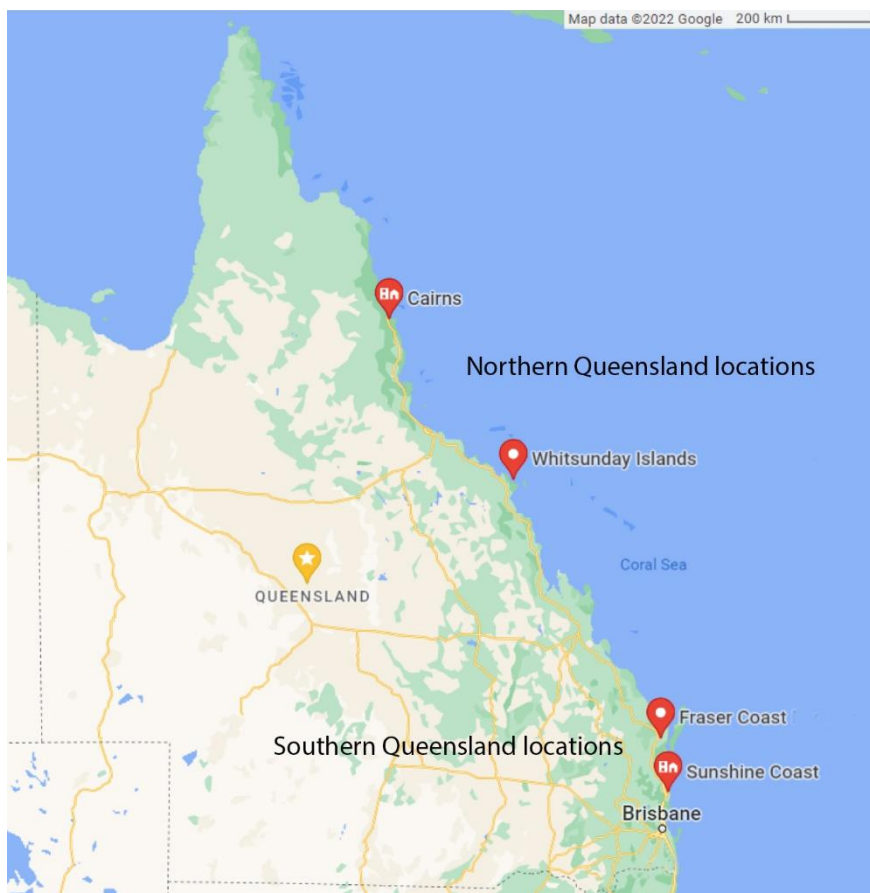
Figure 10: Data collection areas. In person data collection areas are marked in red, online data collection areas include the red marked areas and the yellow marked areas

The ideal sample size for this project was exceeded within a month. The survey collected approximately 478 responses, of which 403 were completed 100% and therefore suitable for the analysis. After the collection was complete, the data stored in the Qualtrics database was converted into SPSS and Excel formats for further processing and analysis. The analyses are described in detail in the next chapter.

3.8.3. Qualitative Data Collection Process

The process followed the guidelines for conducting a focus group developed by Krueger (2014). The invitation to participate in an online focus group was sent to the same email database as for the quantitative data collection. The email included an information sheet describing the project and the intended focus group session. Several date/time options were also proposed with a request to respond with two preferences. Of approximately 1000 invitations, seven recruits responded positively with five actually participating (two withdrew). Richardson (2018) suggests four to six participants per focus group. We therefore ran one focus group, with the intention of collecting sufficiently rich data for the analysis.

The focus group was facilitated online via Zoom (zoom.us) and recorded for data transcription purpose only. The focus group was conducted at the end of August 2022. I facilitated the focus group according to the following protocol: my introduction and a brief description of the project was followed by a statement of the focus group purpose. Then verbal consent was collected from all participants. Third, the participants were shown the first example of recent environmental science research from Queensland (for details, see the section 3.6 Data Collection Instruments). Fourth, I facilitated discussion about video elements through a series of five questions (see Appendix A for details). Fifth, the participants were shown the second example of recent environmental science research from Queensland (for details, see the section 3.6 Data Collection Instruments). Sixth, I facilitated discussion about video elements through a series of same five questions as for the first example. This part was followed by a more general question about example preferences and what the participants deemed important that had not been addressed. The focus group took a good hour from start to finish. I took notes during the session. However, the final data used for the study was transcribed from the Zoom recording.

3.9. Limitations

The COVID-19 pandemic severely impacted the data collection. Required modifications included changing the research instruments, sampling strategy, and data collection process.

First, changes in research instruments relate to questions about the video attributes (final study). Originally, 29 attribute questions were included in the survey questionnaire, with a 7-point Likert scale answer choice. After modifying the data collection procedure, these

questions were eliminated from the survey questionnaire. This decision was made for the purpose of shortening the time required to complete the survey. Instead, the focus group questionnaire was developed to collect qualitative data on preferences regarding video attributes. Furthermore, as part of this process, the original video was shortened to only include the two examples of environmental science research. Finally, data analysis for the fourth study needed to be changed from factor analysis to reflective thematic analysis.

Second, the modification to the sampling strategy came in response to a very low response rate. Originally, stratified sampling was intended, with representative percentages of respondents coming from all 13 RTOs. This strategy could work with online sampling. However, after the data collection procedure moved to in-person, the stratified sampling strategy was no longer possible due to limited time and funds to complete the project. Purposive sampling was employed instead. Consequently, quantitative data analysis had to be amended to account for reduced geographic variability. Also, for the qualitative study, the intended sample size was between eight and 10 people; however, only five (out of approximately 1000 invited) responded. However, due to the richness of data obtained through one focus group (Hennink et al., 2019; Kim et al., 2017), I do not believe that the quality of results was compromised by the lower number of respondents.

Third, the data collection procedure was originally intended to be carried out online. However, the low response rate prompted consideration of how to improve it. Initially, the data collection launch was conducted via RTO communication channels, predominantly e-newsletters. Then invitations with a link to the survey website were sent via email. Neither of these yielded a satisfactory response rate (despite a repeat). After consultation with the advisory panel, a decision was made to change data collection to in-person. After further discussion with a statistician, a strategic decision was made to collect data from areas of Queensland that had higher concentrations of tourism. The decision took into account my limited resources, while aiming to reach the required sample size.

None of the changes above were made in isolation; rather, one prompted another and so forth. While the process of data collection was cumbersome, lengthy and exhausting, it provided my with a unique opportunity to experience and really understand a variety of the data collection methods. This "advanced research training", hopefully, has made a better researcher.

The scope and methodology remained the same. A strategic debate around these two points was carried out with the advisory panel in the early stages of the pandemic. However, it was impossible to predict how long the pandemic was going to last and what the governmental restrictions will be. A decision was made to keep the scope to the state level. A consideration was also made whether to change the subject, i.e., diversify from tourism professionals and include other stakeholder groups or entirely replace the population. However, that would trigger changes of the case and likely also of research aims and objectives. Surrounded by lot of uncertainty, a pragmatic decision was made to stick with the original scope and case. Later on, when government-imposed travel restrictions and paid quarantine came into force, adhering to this decision proved to be a real challenge that needed to be continuously accounted for. Ultimately, it was a character-building endeavour, which taught me that decisions carry consequences, and that research is not always carried out in ideal circumstances.

3.10. Data Analyses

The analyses of data consisted of descriptive statistics, logistic regression, chi-square tests for association and near tables. These methods are explained in detail in the next chapter.

3.11. Chapter Summary

This chapter outlined the overall research plan, philosophical stance and approach, which informed the data collection for the studies contained in this thesis. The sampling strategy, development of the data collection instruments, and execution procedures were explained along with the justification of the selected options. Finally, COVID-19 pandemic related limitations were outlined as part of the data collection experience. The next chapter will present results. Descriptions of analyses proceed presentations of results. The first three analyses are based on quantitative (survey) data and the fourth is based on qualitative (focus group) data.

4. Findings

4.1. Introduction

The previous section explained the methodology for this project. The philosophical stance of pragmatism and abductive approach guided the development of instruments and data collection. Purposive sampling and snowball sampling were applied in data gathering procedures, which were also explained separately for quantitative and qualitative stage. Finally, some limitations related to COVID-19 were outlined.

This chapter summarises and analyses the data for their relevance to the research objectives/questions. First, for quantitative data, descriptive statistics of the sample are presented. For qualitative data, the sample is described through key selection criteria. Second, survey analyses and results are presented sequentially for three quantitative studies. Finally, we describe the analysis and results of the focus group.

4.2. Sample Description

The survey sample consisted of 403 entries. The sample was made up of 40% males, 59.5% females and 0.5% of other gender. The median age of respondents was 41 years old. The majority of respondents had post-secondary (e.g., VET, certificate, diploma) education (34.7%) or a bachelor's degree (25.6%). A quarter had finished secondary school (25.3%). There were also 1.7% respondents with a doctoral degree in the sample. All levels of occupation were represented, with more than half being managers and/or owners (52.9%). Respondents came from all regions, with the majority from where we conducted in-person data collection. See Table 3 for details.

Table 2: Survey sample characteristics

Demographics	Count	Percentage
Gender		
Male	162	40.2
Female	239	59.3
Other	2	0.5
Age		
<20	29	7.2
20s	88	21.8
30s	71	17.6
40s	76	18.9
50s	75	18.6
60s	52	12.9
70s	8	2.0
>80	1	0.2
Missing age	3	0.7

Education		
Primary school	27	6.7
Secondary school	102	25.3
Post-secondary	140	34.7
Bachelor's degree	103	25.6
Master's degree	24	6.0
Doctorate and further	7	1.7
Occupation		
Manager and/or Owner	213	52.9
Professional	70	17.4
Technician/Trades Worker	5	1.2
Clerical or Administrative Worker	36	8.9
Sales Worker	66	16.4
Machinery Operator or Driver	2	0.5
Labourer	5	1.2
Community and Personal Service Worker	6	1.5
Location (RTO region)		
Brisbane Marketing	12	3.0
Bundaberg Tourism	3	0.7
Capricorn Enterprise	15	3.7
Destination Gold Coast	3	0.7
Fraser Coast Tourism and Events	42	10.4
Gladstone Tourism	1	0.2
Mackay Tourism	5	1.2
Outback Queensland Tourism Association	8	2
Southern Queensland Country Tourism	13	3.2
Tourism Tropical North Queensland	88	21.9
Tourism Whitsundays	44	11.0
Townsville Enterprise	11	2.7
Visit Sunshine Coast	174	43.3
Missing region	1	0.2

The focus group sample consisted of five individual tourism professionals, three females and two males. They ranged in age from 20s to 50s. One participant represented the Southern Queensland Country Tourism RTO, one was from Fraser Coast RTO, one from Capricorn RTO, one from Gold Coast RTO, and one from Townsville Enterprise RTO. Their positions were: regional tourism and events officer, tour agent, tour operator, marine transport, and tour guide and promotor. The levels of employment were owner/manager (two), employee (two), and volunteer (one).

Methodological challenges (described in the 3.9 Limitations section) impacted the sample structure. However, overall, both samples achieved diversity in all characteristics' categories and were therefore deemed suitable for the purpose of this research. The analyses were adjusted where needed (further described in the next sections).

4.3. Analyses and Results

The survey data served to perform three quantitative analyses. In the first analysis, I explored who among tourism professionals is more inclined towards receiving environmental science information. In other words, if environmental science information

were communicated to the tourism workforce, who would be the best to target? Through ordinal regression a profile of the best target group was determined. The second quantitative analysis investigated correlations between the type of business (i.e., tourism sectors) and possible interest in different environmental themes. The third analysis spatially examined two geographic factors, i.e., scale of environmental studies and proximity from business operations to natural features, in relation to possible interest in the uptake of environmental science information. The last analysis was qualitative in nature and examined how video as a medium works in the delivery of environmental science information to the tourism workforce. Through reflective thematic analysis guidelines for the production of such videos were determined. The following subsections describe in detail the analyses undertaken and results for each study.

4.3.1. Who Is Interested

The audience needs to be considered prior to determining all other aspects of the communication process (Moser, 2010). Intentional science communication means that the needs, abilities, perspectives and constraints of the audience are incorporated during the planning process (Langan et al., 2019). This involves identifying groups that may differ in their attentiveness or response to scientific information, distinguished by demographic and other tangible characteristics. Most commonly, segmentation is developed based on a topic and applied to national populations. For example, Chryst et al. (2018) segmented Americans into Global Warming's Six Americas based on their climate change beliefs, attitudes, and behaviours. The six audiences were first identified in 2008 using a large nationally representative survey of American adults. Since then, the survey has been applied annually, and over the years the change in proportions of six categories was observed. Overall, Americans are becoming more worried about global warming, more engaged with the issue, and more supportive of climate solutions (Yale Program on Climate Change Communication, 2022). Recommendations for communication strategy and tactics were then developed for each of these segments (Leiserowitz et al., 2021). Similar climate change-inspired audience segmentation was also applied in other countries. For example, Morrison et al. (2018) studied attitudes towards climate change among Australians, while Douenne and Fabre (2020) examined French attitudes towards climate change, carbon taxation and other climate policies. Environmental pollution (Bian et al., 2019), sustainable energy use (Roser-Renouf et al., 2020), transport (Anable, 2005), and sustainable lifestyle choices (Poortinga & Darnton, 2016) are some other subjects of national segmentation studies.

Scarcer are studies that applied segmentation to specific environmental science stakeholder group. Li (2016), for example, looked at communicating scientific information to fisheries stakeholders in Australia. He segmented the audience according to their role into fisheries managers, researchers, and commercial and recreational fishers. Jones et al. (2019), in the context of conservation efforts focused on hunters in Liberia. Zabala et al. (2017), applied segmentation to farmers in Mexico to guide the introduction of conservation-friendly farming practices. As shown in the Literature Review (Chapter 2), the tourism industry workforce is diverse, and the nuances have not yet been explored in terms of interest in environmental science information. While tourism segmentation of visitors is a long-standing practice (see e.g., reviews by Beane & Ennis, 1987; Dolničar, 2020; Penagos-Londoño et al., 2021; Quer & Peng, 2022; Torkzadeh et al., 2021), less is known about the tourism workforce as segmentation foci. As this was exploratory research into tourism workforce's interest in the uptake of environmental research, establishing a typical profile of those most interested provided the most practical solution for the purpose of communicating.

The objective of this study is therefore to identify the best target profile to whom to communicate environmental science. In this study, the concepts from market segmentation theory are applied. More specifically, demographic characteristics and employment roles were examined for their power as predictors of the interest for the sample. The results provide guidance on who to target with environmental science information in this workforce.

4.3.1.1. Analysis. A logistic regression model was selected as the most suitable method after careful consideration of the dataset. Logistic regression is a generalised linear model (GLM) which is useful when analysing proportions calculated from a binary categorical outcome – in this case, the binary outcome is whether or not a member of the tourism workforce is interested in environmental research information. GLMs are generalised variants of ordinary linear regression, which is used to assess the impact of one or more predictor variables on an outcome.

To perform the analysis the demographic variables (i.e., predictors) were reclassified as follows:

Education: 1 = up to the high school graduate level; 2 = some college, including diploma, certificate etc.; 3 = bachelor's degree or higher.

Occupation: 1 = manager/owner; 2 = employee.

Age: 1 = young (≤ 29 years); 2 = medium age (30 to 59 years), 3 = older (≥ 60 years).

Gender: 1 = male; 2 = female.

Cases with missing values (N=3) were omitted from the analysis and respondents specifying the gender category 'Other' (N=2) were also omitted to satisfy the model requirements.

Each respondent was asked whether or not they were interested in receiving environmental research information about each of seven different habitat types. The response variable for each respondent was then the proportion of positive responses they provided, derived from a sample size of seven for each respondent.

All the predictors listed above were included in the logistic regression as potential explanatory variables. Interaction terms were not included in the model.

Logistic regression applies a logit transform (log(odds) = log(픽/ (1 − 픽)) to its estimates of average proportions (p) and the effects of explanatory variables are therefore expressed as the log of odds ratios.

4.3.1.2. Results. The model identified several significant effects among the explanatory variables: the omnibus test gave a highly significant result (LR $\chi^2(6)$ = 48.627, p <<0.0001). Test of individual explanatory variables found that education, age and gender are significant predictors, whereas occupation is not (see Table 4).

Table 3: Test of model effects (N=398, 100%)

Predictors	*LR χ^2*	*df*	*p*
Education	34.100	2	0.000
Age	13.722	2	0.001
Gender	5.612	1	0.018
Occupation	0.633	1	0.426

Parameter estimates (Table 5) show that those with education below the high school graduation are significantly less likely to be interested in environmental research compared to those with college education or a degree. The odds ratio decreases for 0.614 times compared to those with bachelor's degree or more and increases for 1.004 times with those who have some college education.

Younger tourism professionals (<30 years old) are significantly more interested in environmental research than older (>59 years old). The medium aged (30 to 59) are significantly less likely to be interested in environmental research than older. The odds

ratio for young is 1.111 greater compared to older, and 0.798 less for medium aged than older.

Males are significantly less interested in environmental research than females. The odds ratio is 0.829 less for males that females.

Although the occupation parameter was not statistically significant, managers tended to have somewhat higher interest in environmental research than employees.

Table 4: Generalised Linear Model parameter estimates

Parameter	Estimate (logit)	Odds Ratios
Education=1	-0.487	0.614
Education=2	0.004	1.004
Education=3	0a	
Age=1	0.105	1.111
Age=2	-0.226	0.798
Age=3	0a	
Gender=1	-0.188	0.829
Gender=2	0a	
Occupation=1	0.068	1.070
Occupation=2	0a	

Note: The odds ratio represents the multiplier by which the odds for the category is greater or less than the reference level, so a value of 1 means it is the same, 1.5 means that it is 50% greater, and 0.5 means that it is 50% less.

For the purpose of communicating environmental research findings to the tourism workforce, the results suggest that the most receptive profile would be females, less than 30 years old, who have at least post-secondary education, although preferably a bachelor's degree or higher. This result is not surprising. In Australia, females are more likely to seek education in general, especially at university level (Australian Bureau of Statistics, 2022). Furthermore, in Australia, the majority of people would have completed their education before the age of 30 (Australian Bureau of Statistics, 2022). This is not to say though that interest in environmental science is not fostered outside of academia. At that age, it is difficult to expect or predict whether the best target group would be in managerial positions, although if they are, their interest in environmental research findings is likely to be higher.

4.3.2. Themes of Interest

The previous study examined whom best to target within the tourism workforce with environmental science communication. A profile of the key target group was established. The main goal of that segmentation was to inform the targeting and tailoring of messages to the specific segment (Hine et al., 2014; Moser, 2010). The next question arising, therefore, relates to content. Specifically, what kind of environmental science messages

can be communicated to the tourism workforce? Environmental science includes a broad field of disciplines, and not all environmental science research is relevant to the tourism industry.

This study delved deeper into potential messaging themes. The objective of the second study was to explore whether environmental science messaging to the tourism workforce could be tailored based on firmographics. For example, based on the sector, would nature and wildlife operators be more interested in conservation research, and accommodation providers in sustainability? The next section describes the analysis applied to quantitative data, which is followed by the results.

4.3.2.1. Analysis. The dataset for this study was collected via survey (described in detail in the third chapter Methodology). In summary, data were collected electronically using the Qualtrics platform. From there, the dataset was downloaded into SPSS for the analysis and visualisation. This analysis used 403 entries.

To gather information regarding the themes of interest, the respondents were asked about the kind of research findings they would be most interested in receiving. The themes were set as broad fields of interest within which the topics/studies of interest may lie. The question had multiple choice answers based on key environmental science themes. We asked respondents to mark all that applied.

Choices included: 1 = Species; 2 = Habitats; 3 = Geo-physical resources, e.g. rocks, soil, water, air,...; 4 = Environmental management practices; 5 = Climate change; 6 = Sustainability; 7 = Conservation; 8 = Other (please describe); 9 = None. The Other option was ticked by 6 respondents only. Upon examining responses under the 'Other' option, this category was eliminated, because the answers were already included in other categories, the answers did not relate to environmental topics, or the respondents did not provide further explanation. To identify the preference for theme overall, frequency analysis was performed on the entire sample dataset of themes.

The independent variables used for this study were the 'Business Sector', 'Business size', 'RTO regions' for location, and 'Decade of establishment', which were all recorded as categorical variables. The business sector featured the following options: 1 = Accommodation; 2 = Activities, Tours & Attractions; 3 = Associations and Agencies; 4 = Business event services; 5 = Hospitality (e.g., restaurant, bar, etc.) 6 = Transport services; 7 = Professional, Shopping & Other services (TTNQ, 2018). Business size was

measured using the following options: 1 = Nil/self-employed; 2 = 1-19 employees, 3 = 20 and more. The options for RTO regions included all 13 RTOs. Postcodes were also recorded to allow for post-allocation to the appropriate region. The Decade of establishment was calculated based on the entry of the year the business was established according to the following pattern 1950 to 1959 = 1950s, 1960 to 1969 = 1960s etc.

For the analysis, dummy variables were created first from the multiple-choice themes of interest question. Eight binary variables were created, one for each choice listed above, minus the 'Other' option. These variables were then associated with the firmographic variables using chi-square test for independence. The missing values (for business sector N=57, 14.1%, and for location N=2, 0.5%) were omitted from the analysis.

Finally, to explore the association among different themes of interests, a tetrachoric correlation was performed between themes. To explore diversity of interest, the responses to the themes of interest question were first summed up into a new variable: for this "tick all that apply" question, those who ticked more responses scored higher. The higher the score, the more diverse (or broad) an interest in environmental themes a respondent had. The new variable was then box plotted against the business sector, using the four most common business sector categories, i.e., accommodation, tours, hospitality and retail.

      4.3.2.2. Results. Frequency analysis was performed on the dataset of themes. See Figure 11. Overall, the preferred theme of the sample was Conservation, with nearly two-thirds of respondents choosing this option (65.3%), followed by Sustainability (64.3%) and Species (55.1%). Over half of the sample also chose themes of Climate Change (53.3%), Environmental Management Practices (53.3%) and Habitats (53.1%). The results indicate keen awareness that the Queensland tourism industry relies on tourists experiencing natural features and wildlife. The theme of Geophysical resources was chosen only by a quarter of the sample (27.3%). This is a bit surprising, considering that scarcity of some natural resources, for example water, are obvious and continues issues in Queensland (Bradfield & McKenna, 2020).
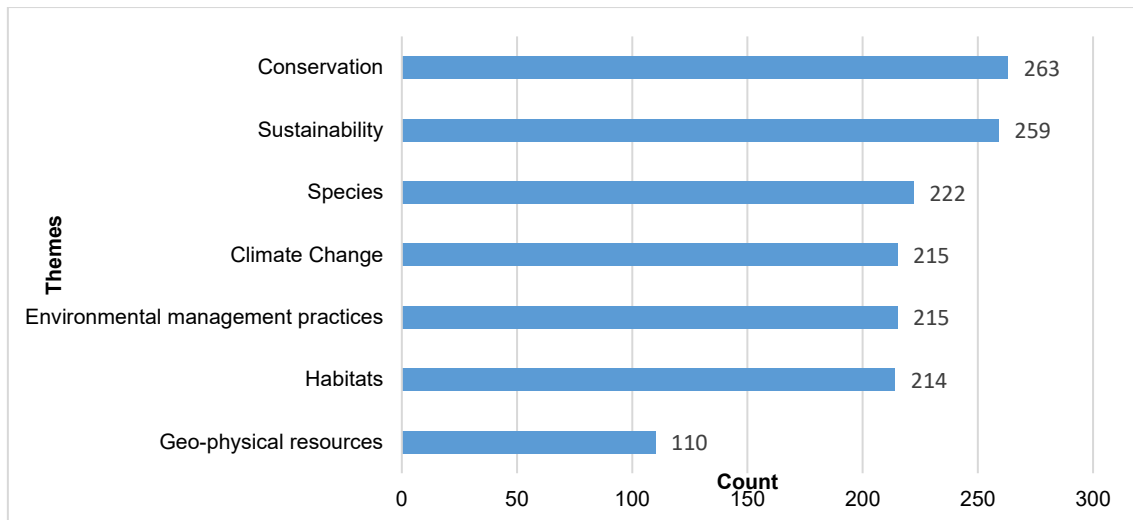
Figure 11: Frequency of themes (N=403)

To test whether a business sector conditions interest in a specific theme, chi-square test was applied for each theme. No significant association was found between any business sector and any theme (see the summary in Table 6). Overall, the business sector is not a good determinant for targeted messaging.

Table 5: Associations between themes of interest and business sector (N=346, 85.9%)

Themes of interest	χ^2	df	P
Species	6.951	6	.325
Habitats	8.534	6	.202
Geo-physical resources, e.g. rocks, soil, water, air,…	5.827	6	.443
Environmental management practices	11.915	6	.064
Climate Change	6.695	6	.350
Sustainability	4.871	6	.560
Conservation	9.834	6	.132
None	1.326	6	.970

To test whether a business size conditions interest in a specific theme, Chi-square test was applied for each theme. No significant association was found between any business size and any theme (see the summary in Table 7). Overall, the business size is not a good determinant for targeted messaging.

Table 6: Associations between themes of interest and business size (N=403, 100%)

Themes of interest	χ^2	df	P
Species	3.031	2	.220
Habitats	.983	2	.612
Geo-physical resources, e.g., rocks, soil, water, air,…	.779	2	.677
Environmental management practices	.051	2	.975
Climate Change	.234	2	.890
Sustainability	1.690	2	.430

Conservation	3.856	2	.145
None	4.384	2	.112

To test whether the decade in which a business was established affects interest in a specific theme, chi-square test was applied for each theme. See the summary in Table 8. A significant association was found only for the theme of habitats (p=.041), which is likely linked to tourism development including infrastructure, i.e., roads and airports, accommodation and camping grounds, etc. (Green, 2020; Kelly, 2003). The results suggest heightened interest among tourism businesses established in 1980s and 1990s but falls for those established after that. Most habitat destruction in Queensland occurred before 1997 (Queensland Government, 2022b). Some of the earliest environmental legislation that was introduced in Queensland dates to the 1990s, including the Nature Conservation Act 1992, the Environmental Protection Act 1994, the Coastal Protection and Management Act 1995 and the Environment Protection and Biodiversity Conservation Act 1999 (Australian Government, 2022; Department of Environment and Science, 2022). These are the key legislative tools to protect Queensland environment, including habitats[12], for example, through environmental impact assessments for major development projects that may impact them. The businesses established pre-protection may have witnessed greater habitat loss and are thus more interested in this topic. However, overall, the decade of the business establishment is not a good determinant for targeted messaging as its significance covers a limited range of businesses.

Table 7: Associations between themes of interest and decade of the business establishment (N=403, 100%)

Themes of interest	χ^2	df	P
Species	17.566	10	.063
Habitats	18.978	10	.041
Geo-physical resources, e.g. rocks, soil, water, air,…	13.954	10	.175
Environmental management practices	18.032	10	.054
Climate Change	6.441	10	.777
Sustainability	7.598	10	.668
Conservation	9.560	10	.480
None	10.768	10	.376

We also tested whether location conditions interest in a specific theme. A chi-square test was applied for each theme. Significant associations were found between several RTOs and different themes. Table 9 summarises the significant scores.

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[12] The research, however, shows that the habitat protection is still ineffective and inadequate (Ward et al., 2019).

Table 8: Associations between themes of interest and location (Queensland tourism regions) (N=401, 99.5%)

Themes of interest	χ^2	df	P
Species – Whitsundays RTO	4.703	1	.030
Species – Tourism Tropical North Queensland RTO	16.019	1	<.001
Habitats – Tourism Tropical North Queensland RTO	12.707	1	<.001
Habitats – Brisbane RTO	4.501	1	.034
Geo-physical resources – Outback RTO	9.319	1	.002
Geo-physical resources – Bundaberg RTO	8.024	1	.005
Environmental management practices – Tourism Tropical North Queensland RTO	11.405	1	<.001
Environmental management practices – Brisbane RTO	4.430	1	.035
Climate Change – Tourism Tropical North Queensland RTO	11.405	1	<.001
Climate Change – Visit Sunshine Coast RTO	5.807	1	.016
None – Capricorn RTO	5.079	1	.024

Overall, location proved to be the best firmographic determinant for targeted messaging. Significant scores have been achieved between a number of locations and interest in specific themes. For example, the Whitsundays RTO is most renowned for whale and dolphin watching tours. Thus, not surprisingly, the species theme is significantly associated with this area. Similarly, the Tourism Tropical North Queensland RTO is associated with the species and habitat themes. The region serves as the main access area to the Great Barrier Reef and The Wet Tropics WHA. Further, Brisbane RTO is significantly associated with habitats and environmental management practices. Brisbane – Queensland's capital city - is the main urban area. The results indicate that it matters to the tourism workforce how the natural environment is managed and maintained. The theme of natural resources, i.e., water, air, soil, etc. was significantly associated with the Outback region and Bundaberg RTO. The first is obvious given that the region is characterised by strong seasonal variations and harsh weather conditions (Phelps & Kelly, 2019). Water is a scarce resource as rainfall in the arid interior of Australia is highly variable in timing, duration and intensity (Northfield et al., 2021; Stafford et al., 1990). The Diamantina and Georgina catchment is a major tributary of the Lake Eyre Basin. However, the rivers of the Lake Eyre Basin have some of the most variable hydrological regimes in the world and are typically ephemeral, subject to an alternating flood and dry cycle (Puckridge, 1998). Several industries, including tourism, agriculture and mining, compete for the limited natural resources in the region, which

may condition interest in the geophysical resources theme among the tourism workforce. Furthermore, water shortages in these areas impact on biodiversity loss (Conradie et al., 2020). This is different to the existing tourism marketing of this region to tourists, which promotes the area as authentic Australia, unspoiled landscape, real wilderness, red and rugged place, projecting images of vastness, expansive grandeur, and adventure in unbounded spaces (Fyall et al., 2011). Contrary to the Outback, the Bundaberg region is known as the access point to some of the best Queensland tourist islands including Lady Musgrave and Lady Elliot eco island resorts. Mon Repos turtle rookery also lies in this region (Bundaberg Tourism, 2022). Issues of water quality leaving the agricultural lands, pesticide drift, water use efficiency, soil health and water quality entering the farms have been identified as future environmental risks (Campbell et al., 2005; Inman-Bamber et al., 2003). The quality of natural resources, rather than their availability (as is the case for the Outback region), is likely to condition interest in the geo-physical resources theme in the Bundaberg region.

Interestingly, the Capricorn RTO was significantly associated with no interest in environmental themes. This indicates that this region's tourism workforce may not be interested in building capacity in this sense. Therefore, this may not be the best region for targeted environmental science communication. This has further implications for regional development. Biggs (2011) emphasised the importance of human capital and capacity building in strengthening tourism enterprise resilience in the face of global changes. The region is currently promoted to tourists as a nature destination (Visit Capricorn, 2022) and therefore has the potential to complement destination marketing with environmental research information. However, from the perspective of innovation systems, the lack of interest shown by the tourism workforce may be a hindrance in fostering such innovation. A well-functioning system by definition requires willing cooperation and collaboration between the core spheres (Etzkowitz & Leydesdorff, 2000), i.e., academia and the industry. The existence of and/or ability to create a knowledge base with commercialisation potential provides the innovation capacity as the necessary condition of triple helix interactions (Cai & Etzkowitz, 2020).

Finally, to uncover more information about interest in different environmental themes I explored associations among the themes using the Spearman bivariate correlation. Associations describe the effect when two or more phenomena occur together and are therefore linked, without implying causation. Almost all associations were positive (See Table 10).

Table 9: Associations among common environmental science themes

Sp	W	H	W	GR	W	EM	W	CC	W	Su	W	C	W
H** r=.571	12	Sp** r=.571	12	EM ** r=.294	12	Su** r=.351	12	Su** r=.351	12	sEM** r=.351	12	Su** r=.272	12
GR** r=.228	10	GR** r=.286	10	H** r=.286	10	GR** r=.294	10	EM** r=.292	10	sCC** r=.351	12	EM** r=.237	10
CC** r=.206	8	CC** r=.257	8	CC** r=.238	8	CC** r=.292	8	H** r=.257	8	C** r=.272	8	GR** r=.166	8
C* r=.117	3	EM** r=.158	6	Sp** r=.228	6	C** r=.237	6	GR** r=.238	6	GR** r=.178	6	CC** r=.164	6
EM* r=.116	2	C* r=.118	2	Su** r=.178	4	H** r=.158	4	Sp** r=.206	4	H* r=.109	2	H* r=.118	2
Su r=.066	0	Su* r=.109	1	C** r=.166	2	Sp* r=.116	1	C** r=.164	2	Sp r=.066	0	Sp* r=.117	1

Note: The first row represents the theme. In each column, associating themes are presented in descending strength of association. Sp = theme of species; H = theme of habitats; GR = theme of geophysical resources, e.g., soil, air, water, etc.; EM = theme of environmental management practices; CC = theme of climate change; Su = theme of sustainability; Co = theme of conservation; W = weighting.** represents confidence level at 99%, * represents confidence level at 95%, and no star means there is no significant association between that and the first-row theme in that column. 's' in front of the name means same score.

The *strongest* positive association between two themes was found between the themes Species and Habitats (r=.571, p=0.01). See Table 10. This suggests that those who are interested in the theme of species are more likely to be also interested in the theme of habitats and vice versa. From an environmental science perspective this association is not surprising as species do not exist outside of their environment. However, from a communication perspective, the association is not obvious or immediate. While the researcher would commonly record environmental conditions while studying a particular species, this would not necessarily be a focus of the research outputs. Thus, when it comes to communication strategy in practical terms, this would imply complexity of a message. For example, a message about a study on whale breeding behaviour would be joined with a study on their migration route environment. Furthermore, most other themes also showed significant association scores. These could be added as sub-themes, should the messaging be longer and/or more elaborate.

Sustainability ranks as the first association across the set of themes, with a score of 50% (three out of six themes). This means that an audience would most *likely* link the theme in which the study is placed with the theme of sustainability. The themes of environmental management, geophysical resources and climate change scored the highest in terms of the most *common* associations, with 52, 50 and 50 points respectively. The most frequent/common association is based on the following weighting: *position level (6->1) x confidence level (2->0).* Position level was assigned one point for each rank with six

points for the highest rank. For confidence level two points were assigned for 99% confidence level, one point for 95% confidence level, zero for no significant association. The weighting for each theme was then added up. From a communication perspective, this means that the themes of environmental management, geophysical resources and climate change may not be the first ones that tourism professionals recall, but rather the ones that they would on average recall most commonly.

The themes of climate change and geophysical resources had consistent associations with all other themes at 99% confidence level. This indicates that they may be "safe" themes to include in the messaging as associations are more likely to be made from these to themes that the audience already knows. This, again, relates to the idea of cognitive mapping. On the same note, low association between the conservation theme and the themes of habitats (r=.118, p=.05) and species (r=.117, p=.05) were found. This is a surprising, yet useful, result, as it indicates that tourism professionals may not be associating conservation with species or habitats (as environmental scientists would). The result illustrates that cognitive mapping differs among different professional cultures and cannot be assumed.

Finally, I explored how broad the interest in environmental science might be among various sectors. The box plot allowed for comparison among different sample sizes for different types of business within this variable (See Figure 12).
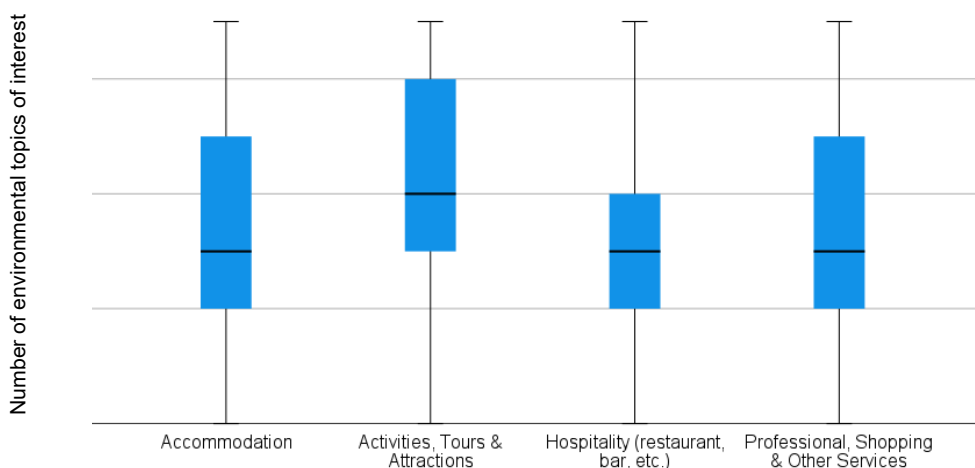

Figure 12: Diversity of interest in different environmental topics per business sector (N=332)

The results show that all selected industries had respondents who were interested in all seven themes and those who were not interested in any. The inter quartile range tells us that at least half of the surveyed tourism professionals are interested in at least two topics,

with a median of three. The exception are tour operators, who had interest in between three and six topics, and a median of four. This means that this industry sector has the widest interest in environmental topics. Hospitality, on the other hand, had the narrowest interest among the selected industry sectors. Hospitality's overall spread is identical to other industries, but more responses were closer to the median. This result also suggests that tourism businesses in activities, tours and attractions sector may be the easiest to target because their "window of interest" is the widest. The opposite may be true for the hospitality sector.

Combined with the previous analyses above, the results suggest that rather than a single theme, a set of themes could be of interest. Three would be a standard rule, four for tour operators, and two for the hospitality sector. The study topic should be linked to themes based on associations that may elicit interest due to preference or recall/familiarity. However, it also should be noted that themes are broad suggested categories, within which a particular research topic might fall. In other words, a theme provides a field within a topic of interest may be, rather than being the topic itself. Other factors need to be explored to determine tailoring of the messages. The next study examines the location factor as a possible determinant.

4.3.3. Location: Scale and Proximity

Tourism destinations in Queensland are often set in a specific attractive natural environment. The previous study showed that location plays significant role in determining interest in environmental science themes. The objective of the third study was therefore to further explore geographic factors. Due to challenges associated with the sampling (see section 3.9. Limitations), I used two proxies to geographically segment the tourism workforce to determine best locations for targeted communication. The first proxy used was proximity of tourism operations to the natural features. The second proxy was scale of environmental studies. The following section presents how the location proxies of proximity and scale were applied in the analysis.

4.3.3.1. Analysis. The dataset for this analysis was collected via survey (described in detail in the Methodology chapter). In summary, data were collected electronically using the Qualtrics platform. From there, the dataset was downloaded into SPSS and ArcGIS for analysis and visualisation.

Due to difficulties with stratified sampling, proxies were used to geographically segment the tourism workforce. The first proxy is proximity, which relates to the nearness of tourism operations to natural features. Proximity can be associated with familiarity with or reliance on the environment in which tourism professionals operate. The second proxy is scale of environmental studies. Environmental studies cover various geographic areas. They can be focused locally, such as a specific site like the second example from our video that focused on Makowata, Queensland (see Figure 13 for the visuals and Chapter 3 for details). Alternatively, they can also cover larger areas, for example the Great Barrier Reef, which encompasses most of the length of the Queensland coast.

Figure 13: Environmental studies are conducted at different scales

To gather information related to proximity, the respondents were asked two questions. The first question concerned the natural features situated near to their operations, and the second was on environmental research findings about natural features that they would be most interested in receiving. The response options were similar for both questions. Both questions were multiple choice and asked respondents to mark all answers that applied. For nearby natural features choices included: 1 = Beach/Dunes; 2 = Marine; 3 = Estuaries; 4 = Lakes; 5 = Rivers; 6 = Wetlands; 7 = Forests; 8 = Caves/Rock formations; 9 = Hot springs; 10 = Other (please describe). For interest in natural features choices included: 1 = Beach/Dunes; 2 = Marine; 3 = Estuaries; 4 = Lakes; 5 = Rivers; 6 = Wetlands; 7 = Forests; 8 = Caves/Rock formations; 9 = Hot

springs; 10 = Fauna (Animals); 11 = Flora (Plants), 12 = Other (please describe), 13 = None. The Other responses were examined. Irrelevant responses were eliminated, and some answers were placed in the appropriate categories, e.g., Fish in Fauna. The remaining relevant answers in the Other category for natural features nearby included: Historic Mine Sites (one response), Gardens/Parklands (two responses), Islands (four responses), Mountain Ranges (one response), Coral Reefs (four responses), Vineyards (one response). The remaining relevant answers in the Other category of interest included: Desert (one response), Mountain environment (one response), Coral reefs as a separate topic from Marine (two responses), Night sky (one response), Soil (one response). Location of the respondents was also recorded automatically as longitude/latitude.

To gather information related to scale, respondents were asked about the preferred size of environmental studies the respondents would be interested in. The question was multiple choice and asked respondents to mark all that apply. Choices included: 1 = Environmental studies conducted within my council area; 2 = Environmental studies conducted within my RTO boundaries; 3 = Queensland-wide environmental studies; 4 = None.

For the analysis, first, dummy variables were created, then the descriptive statistics were performed to identify the most and least common answers. Results are presented in Figure 14 and 15.

Second, a chi-square test for independence was performed to examine the association between the identified nearby features and interest in environmental research about natural features. Results are presented in Table 11. Statistics for associations are summarised in Table 12.

Third, percentile distances were calculated for those features where proximity proved most important. Near tables were generated using geodetic method in ArcGIS then converted into SPSS files to calculate descriptive statistics. Findings are presented in Figure 16.

Finally, to identify the preferences for scale, dummy variables were created for that question and then descriptive statistics were performed. Results are presented in Figure 17.

4.3.3.2. Results. An interest (or lack of) in environmental research findings about different natural features was expressed by 403 respondents. Ninety-seven per cent of respondents were interested in at least one natural feature. The features for which there is the most interest in knowledge about them are Marine (74.4%) and Beach/Dunes (62%). The least interest among the sample was expressed in Hot springs, where over 80% of respondents did not choose this category. Similar results, also expressing lack of interest, were found for Caves/Rock formations (74.4% not interested), Lakes (68.5% not interested), Wetlands (67.5% not interested) and Estuaries (62.3%). For the ratio between interested and not interested in each category, see Figure 14.
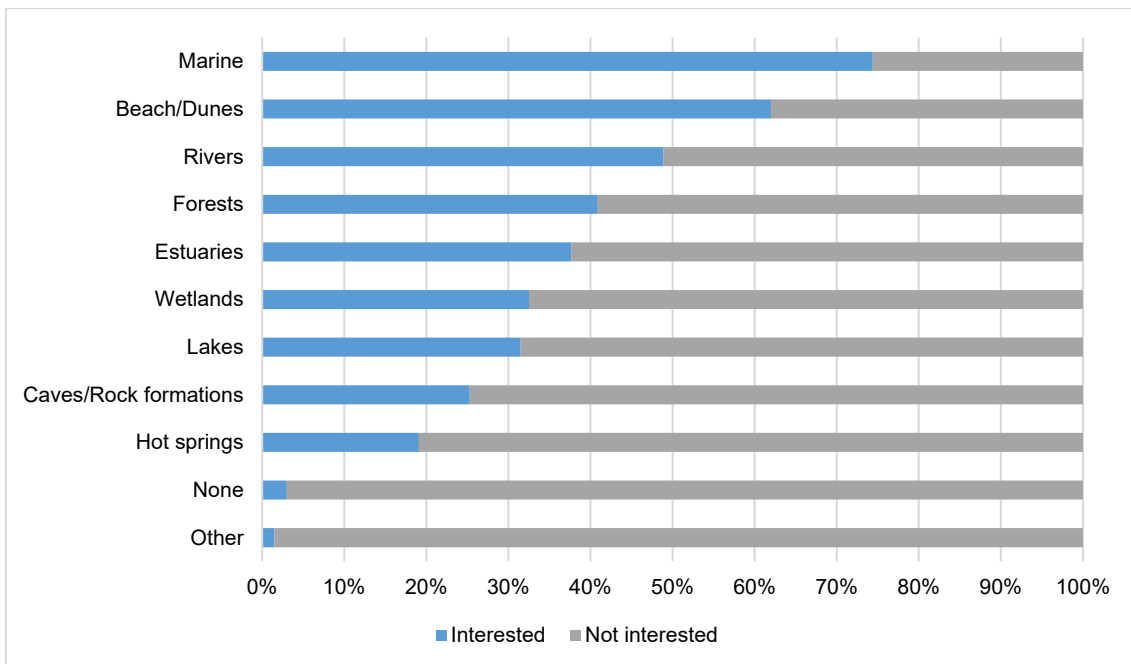
Figure 14: Ratio of interest in environmental science findings about natural features

Considering fauna (animals) and flora (plants), the respondents were more interested to learn about the former than the latter, with 61% of the sample expressing interest in scientific information about animals, and only 37% about plants. For the ratio between interested and not interested in each category, see Figure 15.
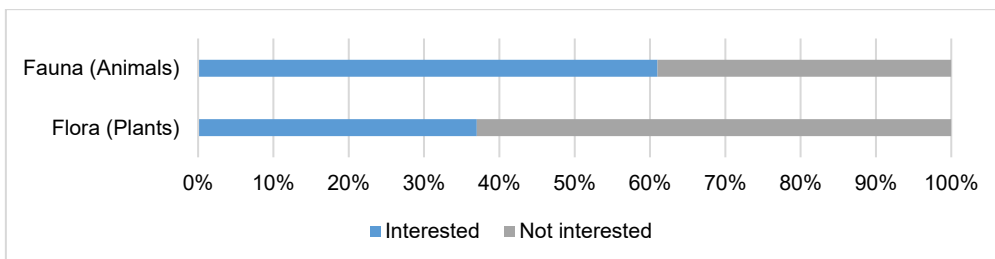
Figure 15: Ratio of interest in environmental science findings about fauna and flora

I tested whether proximity to the natural features influences interest in learning/knowing more about them. A significant association was found for all categories. The results are presented in Table 11.

Table 10: Association between the natural features nearby and interest in environmental research findings about natural features

Category: Natural Feature	χ^2	df	p
Beach/Dunes	54.657	1	.000
Marine	104.279	1	.000
Estuaries	87.276	1	.000
Lakes	37.036	1	.000
Rivers	49.421	1	.000
Wetlands	60.093	1	.000
Forests	67.550	1	.000
Caves/Rock formations	36.367	1	.000
Hot springs	20.448	1	.000

The proximity measure works both ways: those who are near a particular feature are likely to be interested and those not near are likely not to be interested. The following paragraphs describe these ratios for each natural feature separately. See the summary in Table 12 below.

Table 11: Proximity associations for each natural feature category

		Interested in beach/dunes		
		No	Yes	Total
Operating near beach/dunes	No	71 (68.3%)	33 (31.7%)	104 (25.8%)
	Yes	82 (27.4%)	217 (72.6%)	299 (74.2%)
	Total	153 (38%)	250 (62%)	403 (100%)
		Interested in marine environment		
		No	Yes	Total
Operating near marine environment	No	74 (58.3%)	53 (42.4%)	127 (31.5%)
	Yes	29 (10.5%)	247 (89.5%)	276 (68.5%)
	Total	103 (25.6%)	300 (74.5%)	403 (100%)
		Interested in estuaries		
		No	Yes	Total
Operating near estuaries	No	226 (75.6%)	73 (24.4%)	299 (74.2%)
	Yes	25 (24%)	79 (76%)	104 (25.8%)
	Total	251 (62.3%)	152 (37.7%)	403 (100%)
		Interested in lakes		
		No	Yes	Total
Operating near lakes	No	238 (76%)	75 (24%)	313
	Yes	38 (42.2%)	52 (57.8%)	90
	Total	276	127	403
		Interested in rivers		
		No	Yes	Total
Operating near rivers	No	152 (66.4%)	77 (33.6%)	229 (56.8%)
	Yes	54 (31%)	120 (69%)	174 (43.2%)
	Total	206 (51.1%)	197 (48.9%)	403 (100%)
		Interested in wetlands		
		No	Yes	Total
Operating near wetlands	No	246 (76.6%)	75 (23.4%)	321 (79.7%)
	Yes	26 (31.7%)	56 (68.3%)	82 (20.3%)
	Total	272 (67.5%)	131 (32.5%)	403 (100%)
		Interested in forests		
		No	Yes	Total
Operating near forests	No	195 (73.6%)	70 (26.4%)	265 (65.8%)
	Yes	43 (31.2%)	95 (68.8%)	138 (34.2%)
	Total	238 (59.1%)	165 (40.9%)	403 (100%)
		Interested in caves/rock formations		
		No	Yes	Total
Operating near caves/rock formations	No	288 (78.9%)	77 (21.1%)	365 (90.6%)
	Yes	13 (34.2%)	25 (65.8%)	38 (9.4%)
	Total	301 (74.7%)	102 (25.3%)	403 (100%)
		Interested in hot springs		
		No	Yes	Total
Operating near hot springs	No	325 (82.1%)	71 (17.9%)	396 (98.3%)
	Yes	1 (14.3%)	6 (85.7%)	7 (1.7%)
	Total	326 (80.9%)	77 (19.1%)	403 (100%)

Table 11: Proximity associations for each natural feature category

Overall, the results show a strong link between operating location and interest in research about the natural features nearby. Tourism professionals who operate near or within a specific natural feature are significantly more likely to take an interest in learning more about it, and vice versa: those that do not are significantly less likely to be interested in it. Proximity to natural features is therefore an important factor to take into consideration when selecting the environmental research content to be communicated to tourism professionals in different locations.

The strongest positive associations between proximity and interest were identified for the categories *beach* and *marine* environments. I then calculated how far from these environments the interested tourism service providers operate. Separate analysis was performed for *marine* and *beach* category. The results were similar. While the range of interested tourism professionals for both categories spanned between two metres and 132 kilometres, the frequency distribution graph shows that the majority of respondents interested in learning more about marine environments operate in the immediate proximity (See Figure 17). The percentile analysis revealed that 50% of interested tourism professionals operate within two kilometres of the beach, and 85% within 4.7km. For marine environments 50% of interested tourism professionals operate within 2.3 kilometres, and 75% within 4.7km. This result provides guidance for communication strategy. Specifically, it indicates the distance band (i.e., 2-4.7km) from these environments in which to find tourism businesses that are most likely to be interested in beach or/and marine research.
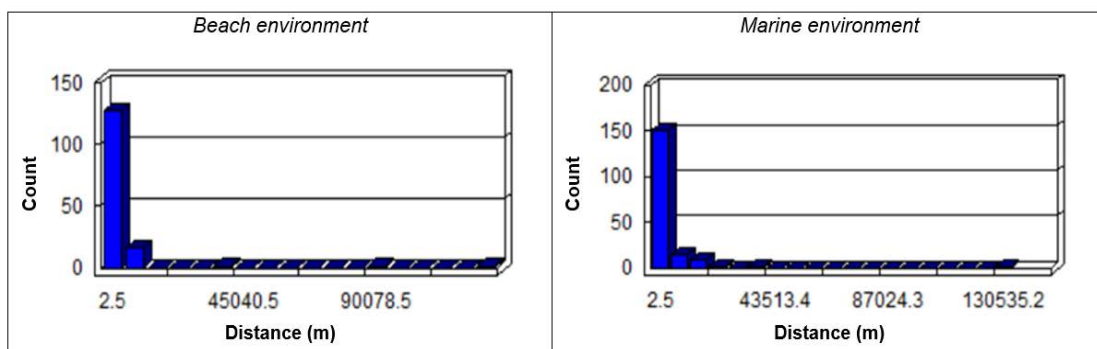
Figure 16: Frequency distribution of those interested in beach- and marine-related science based on the distance from beach and marine environment respectively

For the scale factor (the size of the area on which studies are conducted) no significant preference was found. Ninety-five per cent of the sample responded that they were interested in some research. Two-thirds of respondents (n = 269, 66.7%) selected one answer, followed by responses with all three available scales (n = 62, 15.4%) and then two scales (n = 54, 13.4%). See Figure 18 for the preference count for each size of

studies. Testing for associations between preferences, the analysis showed a weak negative association at the 95% confidence level between interest in studies conducted in the council area and those conducted across the entire Queensland state as the study area (r_s = -.107, p = .031). This indicates that those interested in local research are slightly less likely to be interested in state-wide environmental research and vice versa.
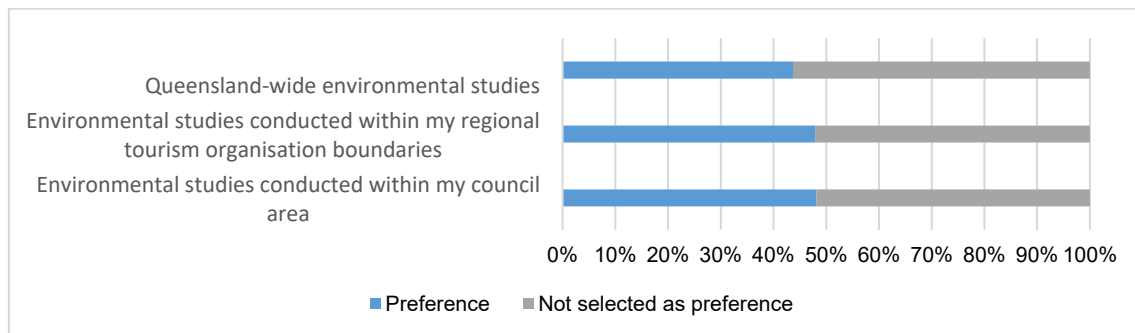
Figure 17: Preference in the area size of the environmental studies

Overall, the scale factor does not seem to be a good factor upon which to determine communication strategy, with no particular study size significantly favoured.

4.3.4. How to Communicate Environmental Science via Video

Environmental science can be communicated through a variety of media, although video and film are increasingly used for evidence-informed advocacy and persuasion (Davis et al., 2018). Research shows that video generally performs better than any other medium in terms of engagement with target audiences (Vorbau et al., 2007). However, how this works for the tourism workforce is still unknown. As discussed in the thesis introduction, perception is subjective and differs depending on who is in the audience (Leal Filho, 2019).

Generally, in communication processes, the communicator's intention is to be understood, while the audience cares about relevance (Forceville, 2020). This means that the utterance of the message must be compatible with audience's abilities and preferences, and the message must be sufficiently relevant to be worth the audience's processing effort (Wilson & Sperber, 2002). Therefore, to design, optimise and deliver multimedia products for tourism professionals, performance must be matched to the capabilities of users. Weichselgartner and Kasperson (2010) refer to this as access to knowledge, which may be influenced by various factors, including language and format. Furthermore, in relation to ecotourism interpretation, Tsang et al. (2011) determined that

the focus on a medium is crucial because the medium influences the level of audience attention and the cognitive involvement necessary for learning. The medium influences how the story material is created, presented and consumed (Bongshin et al., 2015). However, the challenge for science communicators is how to communicate for the video medium and resonate with the audience (Finkler & León-Anguiano, 2019). This notion provided direction for this study to examine video as a medium to convey environmental science findings to the tourism workforce.

This study aimed to qualitatively examine how video as a medium performs with the tourism workforce to guide the development of future video-making by environmental scientists for the tourism workforce. The data collection for this study was described in section 3.8.3. Qualitative Data Collection Process. The next section describes the analysis of data. The results are described after that. They aim to provide guidelines for environmental scientists on how to design environmental science videos for the tourism workforce.

4.3.4.1. Analysis. Audience perception refers to the process by which individuals collectively receive, select, organise and interpret information (Kačániová, 2013). A video represents a multisensory way of communicating. The word 'multisensory' pertains to the integration of information from different sensory modalities. For example, a multisensory process would be the integration of visual and auditory information in the perception of a scientist explaining their study in a video. In contrast, reading a journal paper involves information perceived through the sense of sight only and is therefore considered to be a different process. In a video, different senses are stimulated by different elements or attributes of the film. The attributes broadly relate to visual aspects, audio and content. These aspects can be analysed to depicts specific audience's perception.

The dataset for this study was collected through a focus group (see details in the Methodology chapter). The data were analysed using reflective thematic analysis. Thematic analysis is a widely cited method for analysing qualitative data from many disciplines, including social and business sciences. Reflexive thematic analysis, developed by Braun and Clarke (2006) as an interpretive method situated within a qualitative paradigm, proved to be the most suitable for exploring themes around how to communicate environmental research to the tourism industry. In contrast to other approaches to qualitative data analysis, such as grounded theory (Glaser & Strauss, 1967) or interpretative phenomenological analysis (Smith & Fieldsend, 2021) - used

predominantly in psychology - reflexive thematic analysis is described as more flexible in terms of theoretical and epistemological applications (Campbell et al., 2021). This means that the researcher is responsible for selecting theory and epistemology and ensuring that reflexive thematic analysis fits within the selected philosophical approach (Braun & Clarke, 2021).

The method is used to develop, analyse and interpret patterns across a qualitative dataset, however, the difference between classic thematic analysis and reflective thematic analysis is that the researcher's position and contribution are necessary and integral ingredients in the process. This contribution is particularly expressed through the researcher's experiences and pre-existing knowledge (Devine, 2021). In other words, the subjectivity of the researcher is recognised and viewed not as problematic, but as integral to the analysis process (Campbell et al., 2021). I prior knowledge/experiences in not only environmental sciences but also multimedia production seemed particularly suitable and useful for this kind of analysis. Tsai & Chen (2018) found that an environmental science background alone is not enough to master the skill of environmental video production and persuasive messaging. In their study, environmental scientists would not notice or be able to comment on the quality or performance of shooting methods and techniques, music, sound effects or communication skills. Their focus was, rather, on content and learning new knowledge (Tsai & Chen, 2018). Therefore, having a multimedia background allowed for necessary reflections about production.

The second reason for choosing this method is the lack of literature on perceptual aspects. Video analysis is most commonly employed as a basis for researching social phenomena in sociology, social psychology, and criminology (Nassauer & Legewie, 2021). However, if we aim to design effective videos, we need to know how our audience perceives them. I therefore chose to utilise reflexive thematic analysis and advance my analytic skills in applied qualitative multimedia research, to provide direction and guidance for environmental scientists interested in developing research videos for the tourism workforce. A critical approach was applied to how these experiences and prior knowledge influence and contribute to the research process and potential insights into our qualitative data (Devine, 2021).

Reflective thematic analysis can be used for research questions related to people's experiences, or people's views and perceptions (e.g., how tourism professionals relate to the information from the video); understanding and representation (e.g., how do lay

people understand environmental science theory); people's practices or behaviours (e.g., video watching habits of tourism professionals), and the construction of meaning (University of Auckland, 2022a). These aspects were explored in the original research undertaken in the spirit of curiosity and reflexivity (Clarke et al., 2015), with the intention of contributing to the pre-existing body of knowledge with rich, contextualised and creative insights. The orientations are not fixed. In this study, inductive and deductive, semantic and constructionist approaches have been used. However, generalisability should be approached with caution and with acknowledgment of the ways the researcher, the research design, the participants, and the context may shape the findings.

4.3.4.1.1. The Process. The method was conducted in accordance with the guidance for a reflexive thematic analysis set by Braun and Clarke (University of Auckland, 2022b). In the first step – familiarising with the data - I listened again to and transcribed the focus group recordings and re-read the answers given by the participants. This provided a good overview of the entire dataset. In the second stage important parts of the data were identified in relation to the questions asked during the focus group. The questions related to visual, audio and content of the two videos shown (for details, see the section 3.6 Data Collection Instruments and 3.8.3. Qualitative Data Collection Process). In the third step, the key themes were fleshed out based on my practical and theoretical knowledge about multimedia production and environmental science in accordance with the analysis guidelines. These themes represent the broad patterns of meanings or central organising concepts (Braun et al., 2014). In the fourth step, the data were reviewed in connection to these themes and mind-maps were made manually around the key themes, combining information pertaining to both examples. In the fifth phase, the themes were elaborated to ensure the complete story of the data. The sixth stage included describing each theme by weaving together the analysis, evidence and context. This final phase also involved selecting extracts from the coded and collated data to illustrate various aspects of the themes to convince the reader of the analytic points we make about the data (Braun & Clarke, 2019). The results are presented in the next section.

A reflective process was included in all stages of the analysis. In re-listening to the recordings, I reflected on the development of the questions and whether these questions captured the information this study intended to gather. The material revealed that questions were broad enough to allow respondents to express themselves freely without bias. With a degree in journalism and my supervisor's additional expertise in science

communication, much needed skills were applied to formulating the questions before data collection began. During the focus group, when needed, follow-up questions were asked to obtain greater depth in an answer. Here, my previous journalism experience, particularly in conducting interviews, aided the smooth communication process and ensured the quality of data. When reflecting on the data content, it helped that we already had knowledge of the key concepts pertaining to multimedia production. This knowledge made it easier to guide the discussion around these concepts, while leaving room for respondents to introduce their own concepts and associations. The organising, mind-mapping and narrative development around the key themes was a back-and-forth process utilising tourism, multimedia and environmental science perspectives.

4.3.4.2. Results. Video composition is a complex, recursive process that allows for sequential multimodal representation of thoughts and ideas (Bruce, 2009). This process can be adjusted to the target audience. The main aspects of video making that this study examined included visual, audio and content. The following results provide information on these aspects as the key themes in the context of tourism professionals as the audience for environmental research videos.

4.3.4.2.1. The Visual Aspects of a Video as a Medium. The visual aspects of a video relate to elements that audience can see. They can include motion pictures, still images and graphics (i.e., written text such as titles, signatures and subtitles, logos, etc. added to the baseline material). The main function of visual communication design is to convey information, which is conveyed by visual symbols, unlike abstract concepts conveyed by language (Liu, 2021). "Humans are visual creatures", and therefore seeing something is more likely to establish interest and connection with the subject (Farah, 2003, p.152). My study confirms this idea. When respondents were asked what they liked about the video examples in general, and what stood out the most to them, their first recall was the visual material. This was an open-ended question, and the respondents could have preferred any aspect. The responses suggest that this audience is primarily visual and hence great attention should be placed on this aspect of video production.

P4: "Whale footage!" was the clear and concise answer of one of the respondents. Answering the same question, another respondent commented on the visuals of the first example: "I liked the images, I found them absolutely fascinating to be that close to humpback whales. /…/ The calf and mum and the size, and the fish that were hanging off…and things like seeing a tag on a whale was useful [to understand] how it works. /…/

You never really see those pictures so close up and when you go for whale watching you see nothing really, so I was quite hooked, actually." (P2)

One respondent expressed his preference for this element quite explicitly by commenting on the visuals as the main point of focus while placing the content in the background: "The visuals were nice, inviting, and also information running in the background gave you connection to the images and vice versa." (P3)

Different visuals were purposely used in the two examples shown to the audience. The first example featured moving images of whales underwater interchanged with the scientist talking, whereas the second example used still images with slight directional movements and narration in the background, no scientist visible. When asked about preferences for visuals between the first and the second example, respondents in unison leaned towards the first example. In summary: "Moving images are better than still…" (P1)

Another respondent commented: "I did not notice until now [after watching the second example], how I did enjoy the video of whales being cut with someone talking. Maybe it would have helped this video if it was cutting between some nice imagery and then made it a bit more personable to have someone there talking about it as well." She later returned to this comment to explain further… "I think that might have been the difference, maybe not so much the cutting. The first video was all videos [moving pictures] and cutting between them, whereas this one was just lots of photos stacked on top of photos. Maybe that is the difference that I have noticed…" (P3)

The reasons for moving images preference included that the first example "seemed smoother", "more interesting to watch", "engaging". Videos, unlike still images, contain a wealth of detailed information about the physical world (Goyal et al., 2017). However, both processes still require a common sense understanding of the depicted situation. In the case of the fossil story, my non-expert audience found it difficult to connect the story through the images, despite them being taken at the research site at the time of discovery.

P4: "I really liked the photos of fossils, they were cool, not so much other stuff that I didn't get, but the actual pictures of the fossils were cool."

The second video example proved how important the visuals are to help understand the story. To create the visuals for this video in support of the narrated voiceover, photos were supplied by the research team. They included images of the location, campsite, scientist, plant fossils, and life plants. However, as the responses suggest, the connection between the story and visuals was not successfully established by the video. It appears the complexity got in the way: "It had pictures of creek and gullies but did not really put that in context." (P1) And "I think the photos were good, but there were some slides that were irrelevant, like the camp site and maybe of the people." (P2) This is consistent with Tsai & Chen (2018), who noted that their non-science background audience not understanding the topic focused more on the production aspects (compared to the science background audience). Furthermore, this points to important considerations to be made in the selection of the visual material: how to connect the dots. The supporting material needs to aid in the understanding of the story, not distract from it. However, the story also needs to work with the visuals, which will be further examined under the last two topics below. When the audience has low involvement (i.e., familiarity with the content), the impact is more on perceptions. However, repeated exposure to the content helps with its acceptance as the truth (Hawkins & Hoch, 1992). Examining the moving pictures in the first example more deeply, comparisons can be made between the whale footage and the scientist talking. Interestingly, what the audience predominantly recalled first in the first example was the footage of the subject of the research (i.e., whales), not the scientist, although the total duration of both was approximately the same.

4.3.4.2.2. The Audio Aspects of a Video as a Medium. The audio aspects of a video relate to elements that audience can hear. In the examples used in this study the audio elements included a scientist talking, voiceover/narration, background music, and story enhancing sounds (whale sounds). In the first example, clarity is what stood out the most: "Audio was clear and easy to understand." (P3) From the production perspective, this is important information as clear audio is not easy to achieve. Especially when filming occurs in an outside environment, a lot of ambient noise can be recorded along with the scientist talking. For example, to film the scientist on the top of the hill for the whale video, the filming had to be postponed for several days due to strong winds. On the filming day, additional equipment (i.e., so called dead cat microphone cover) had to be used to muffle the wind and avoid the wind cutting through the audio. Experienced videographers often note that audio is the most neglected aspect of filming, yet the most important. In production, images are commonly obtained more easily than good audio.

Another respondent commented: "I think the audio was clear, concise, you weren't struggling that much to listen and there was not too much happening that would be distracting people. Her [scientist's] accent was where the clarity got lost a bit…/…/ it made it a bit hard to understand what she was saying." (P2) The accent distraction was not an isolated remark. Another respondent elaborated on the comment: "…the thing with the accent, it is just that breathing and breeding sounded very similar, which was a bit confusing. But otherwise, it was good." (P3) Nodding her head, the third respondent remarked: "…what detracted [from the content] for me was the accent. Breathing and breeding… that is kind of crazy because she is the scientist and all of us in Australia are used to hearing foreign language spoken, but I picked up on it." (P1) This is the second important piece of information. On reflection, many scientists work outside their countries of origin. While speaking English is usually not a problem, accent is something that is difficult to eliminate even after years of living in another country. It would therefore be difficult for the researcher to convey the story without an accent. On the other hand, there is a push across the research institutions for scientists to communicate their findings. While the accent issue can be eliminated through a written message, doing so for a video might require a different solution.

The second example for this study included a story narrated by a professional communicator. The neutral delivery seemed to resonate well with the audience: "He spoke well, his voice was beautiful." (P5) Another two respondents agreed with the sentiment from the first response: "His voice was quite lovely and at the end it got exciting." (P1)

"I agree, the gentleman's voice was nice, clear and concise, but he was too slow to the point that he could become monotonous. Just towards the end, with a lot of explanation of the big words it started to slow down and could start to lose the audience." (P2)

These comments also indicate that the audience perceived the narration's pace differently; for one the excitement built, while others became less interested as the story progressed. Perhaps stronger attention to the audio was due to the visuals in this example being still images and thus the narration became more prominent.

"I actually liked the voiceover, I liked that different style, he had such a beautiful voice, I think he must have been a voice actor or something, so it sounded lovely. I didn't mind the idea of explanation with some good images, but the context was certainly missing." (P4)

Like for video aspects, the supporting audio material is an important component of the video production. The responses suggest that the supporting audio material can make a significant impact on the audience. The respondents bounced off one another to comment on the supporting material. One of the respondents put it: "The whale noises, is probably what stood out to me the most." (P5) Another respondent added: "There was nice, gentle music in the background, and even whale sounds…that is a nice thing, just gentle, atmospheric, but also did not distract from her speaking." (P4) Another respondent further commented on the role of background music: "…it kind of engages you more, because you feel like you are underwater with whales." (P5) Some responses summed up: "If it would be just her speaking, it would get boring." (P2) And: "…I have noticed by the end of the film there were some things that added; there was some spiritual music in the background plus the noises that they [whales] make and that added to it [the story]. (P1)

4.3.4.2.3. Video Content. The respondents' comments were most elaborate when discussing the video content. In the first example the scientist conveyed the content herself. She was asked to prepare a simpler version of research summary for the general public. A respondent noticed that she had pre-prepared and noted that it came across "clear and thought through". (P2) However, the complexity still pushed through and was noticed at times. Complexity was especially noted in the language: "Describing a research piece that always involves complex and long sentences, and you have to pay attention, because there are concepts you are not familiar with. I say that because by the end of it, my thoughts wondered off." (P1) Another respondent commented: "I can see it was carefully done and thought through, but maybe a bit more [information is needed]. Because you are talking to general public, and they are not used to research." Another respondent added: "…yes, probably the phrase "dumb it down" even more, because it is talking to the general public and possibly what would help is shortening it, and not so much in the detail of research." (P4) The research actually argues against "dumbing it down". Rather, scholarship advises to make it clearer and simpler in the sense of prioritisation and finding the core of the idea (Finkler & León-Anguiano, 2019; SBUJournalism, 2010).

Comparing the two examples, one respondent noted: "…the language that was used, I think that one was more understandable, whereas there was a lot of science jargon used in the second one. I got a degree in science, and I did not know what he was talking about." The second example deliberately used the journal paper abstract section for the narration. Simplification is one of the key principles of video science communication

(Leon, 2007). This can be achieved through "concretising" the messages rather than using abstract information (Shimp & Andrews, 2013). Concrete language refers to tangible qualities or characteristics, which we can perceive through senses (Finkler & León-Anguiano, 2019).

Scientists often struggle with translating their abstract concepts into concrete descriptions that a lay audience can more readily understand (Finkler & León-Anguiano, 2019). One of the respondents said: "Honestly, it was full of jargon, it was full of words I have no idea about, I would say it was a 100% fail, there was very little I understood." (P1) Another respondent commented: "…It was just a lot of jargon; a lot of jargon that only people who enjoy ancient plants are going to enjoy." (P2) The comments clearly confirm that communication needs to be adjusted to the target audience. Language suitable for academics usually does not have meaning for general audiences, which this case confirmed. This includes the volume of detail that the message contains. Even in the whale example, which was the simpler of the two, one of the respondents commented: "Probably by the end of it I started to lose track, because it was quite detailed." And another: "All the information was quite easy to follow but when she started talking about the breathing rates, I found that this is where I got lost a little bit. I started wondering How is this relevant to me?" As suggested by Finkler & León-Anguiano (2019) the visuals can make a positive difference is explaining complex topics. The provided imagery, which is better remembered and recalled than words alone, needs to evoke familiar images in audience's mind (Shimp & Andrews, 2013). Effective video communication will include affective imagery that evokes associations and relevance to audience's lives, i.e., information that people can relate to (Leiserowitz et al., 2005). For example, as found by Finkler & León-Anguiano (2019) on whale watching impacts, audiences can associate whales' primary functions, i.e., feeding, breathing and resting with similar human functions, and thus relate more closely to the subject, relevance and even emotions. Staying too technical may lose the effect. Effective science communication is communication that stays true to the facts while tapping into something more human (Olson, 2018).

This notion also emerged when discussing the way information is conveyed. One of the respondents commented: "Maybe another way to present it is more like…I think what people are getting excited about is authentic personal stories "I'm a researcher and I had these the most amazing whale experiences when I was a kid…" /…/ Not planned and rehearsed, but that there is something really exciting and engaging about it… This was totally fine and well done, but that may be a different way of communicating…like sharing

"I am a human being, I have a story to tell and as such I connect with you." Less, static, more emotional." (P1) The existing literature is divided on this topic. Scientists sometimes resist storytelling, fearing that stories are manipulative, less trustworthy or oversimplified (Dahlstrom & Scheufele, 2018). Others argue that science is not about entertainment, but rather about gathering evidence, reaching new understandings and informing (Leon & Bourk, 2018). Similarly, Dahlstrom & Scheufele (2018) posit that if the goal of communicating science is to help an audience engage or develop scientific reasoning and orient discourse around evidence, there is no intrinsic advantage in creating captivating stories for mass audiences for science. The authors discuss the paradox of science storytelling, emphasising that such tools create a narrative way of thinking, which is anecdotal. This is because humans often interpret new information through integrating it with the existing cognitive maps that we already use to understand the world, rather than on its own merit (Schank & Abelson, 1995).

However, in tourism, for example, storytelling is emphasised as a valuable promotion tool (Moscardo, 2020). Stories can be highly persuasive and audience-engaging (Braddock & Dillard, 2016). They help to build bridges between rational scientific facts and human emotions. Thus, storytelling can be useful for developing trust with an audience and increasing knowledge retention as well as the ability and willingness of audiences to learn and take action (Sundin et al., 2018). Storytelling could be used to encourage greater sustainability in tourism through explaining and encouraging more sustainable action on site and beyond (Moscardo, 2017), and by presenting alternative stories of tourism itself (Moscardo, 2020). Video would therefore work well as a medium as its multimodal characteristic allows for effective storytelling (Pearce et al., 2020).

The focus group session was designed for the conversation to flow freely, and one respondent asked me: "Can we ask, is this meant to be related to tourism?" I responded that the video was purposively made for any audience to depict what resonates and what is missing for a tourism audience. The follow-up questions concerned their ideas about purpose and relevance. Some explicit suggestions came through: "Communicate with the tourism professionals for a purpose, whatever that is. Then relate it to their interest. So, if I am a tourism business owner I am on the coast and I am very conscious that whales come to my region at a certain time of the year, then relate it to that. I am based on Toowoomba, there is no whales here, it is not relevant to me." (P3) This sentiment links with the findings from my quantitative study about the importance of considering location when communicating environmental science to the tourism workforce.

The other members of the group agreed with the notion of relevance. The strategy of engaging audiences in discussing solutions to increase relevance proved fruitful, with several useful suggestions provided. For example: "The focus of the video was a bit too general and not specific to whale tourism or fishing tourism of the area; this is where she could have refined it to point out what effect it might have on these tourism groups. /…/ I might elaborate a bit more…the whole breathing talk that she was doing doesn't feel connected to the tourism industry. But if she could turn this around and say with the whale boats being around whales that might require them to dive more and use more energy, which might be detrimental to them…also for example the tourism fishing industry, with the competition over their food, again, would that be something that affects their rate or anything like that. So, therefore, giving more insight to those tourism industries so they know whether they need to back off. Or if there is no impact and the animals are becoming more placid around humans and are not being stressed out and the tourism industry can bring more tourists out to them. Something like that, that is more connected to the tourism industry of that area." (P2)

Ideas about the purpose were developed also for the fossils example: "From the tourism perspective, the fossil video could have been super exciting, for someone like me that could just go out there and go on a fossil hunt. That could be something really interesting to me and other tourists if it was made a little bit more doable from the video or you knew how you would have more of a reference point." (P3)

Environmental impacts seem to be an important consideration for the tourism workforce. For example: "Tell them what is the impact that is going to have. For example, with whales, if it is negative, no more whales, no more tour boats. Same with archaeology, if these environments start to break down because we are doing too much tramping through the bush and destroying artefacts or plants, what is the impact. Put it down, step by step, digestible information that the tourism industry can understand." This is consistent with other science communication studies nestled in the theory of changed behaviour (see e.g., Nabi et al., 2018; van Valkengoed & Steg, 2019; Yuriev at el., 2020). Another respondent considered relevance more in terms of a business impact: "My thoughts would be how can I as a tourism business make more money, e.g., how can I attract more visitors, make them stay longer, what can I do to make them spend more money in my business. /…/ It is more about expenditure on the business, developing a new product or adjusting their practices." (P1)

Finally, some suggestions were made on how to make the video a coherent whole: "The connection between what she [the scientist] was saying and the relevance for the tourism industry.... Probably just a few more sentences, just to connect the two ideas together would be really great." And: "Put it at the end or the start of the video, so they know why they are watching it." (P3)

"There has got to be purpose around it; people want to feel engaged. /…/ How do we translate research into action that is meaningful? It is a massive challenge for all of us, so you have to be hyper focused on what is the outcome that you are trying to achieve." (P5)

Consistent with Francés and Peris (2018), the feedback on the content suggested that education alone is not enough: "The other thing is, there is no call for action in this video. In marketing terms, what do you want the viewer to do?" (P5) Another respondent added: "I agree with the whole call to action thing. If there was a way the audience you are trying to reach can do something, like help collect data on breathing rates or something like that, that would make it more interesting to watch."(P3) The ideas started rolling and this is where the focus group setting proved successful in terms of engagement: "A call for action could be…visitors can adopt a whale or opt in to pay additional dollar on the ticket to sponsor research…give them ideas." (P1) Another one noted: "When you try to convey it to the tourism audience, you need to either connect with them or inspire them. And make call for action, because it gives audience more incentive to pay attention and take action from it. /…/ I am thinking more in terms of connecting with the visitors. But you could also make it for the businesses, how can they make their customers excited, or how can they get their guests engaged in projects, research or something like that… or how can they use this information to drive in more customers. You can use it both ways." (P3)

The conversation about the call for action continued to move between action calls related to visitors and business owners, so I asked for clarification: "I was initially thinking record action for the tourism business owners, but there could also be a call to action for tourists. For example, if you are in a whale watching tourism, you [i.e., tourism business] could be encouraging tourists to donate to whale migration research or teach them how to stop buying plastic, because plastic has detrimental effect on food chain of these marine animals, etc." Reflecting on that, as a scientist, I started thinking about the practicalities of this advice. Environmental research projects commonly have limited scope, to achieve a focus and account for as many associated factors as possible (Quinlan, 2015). Apart

from expertise, it is the choice based on available resources for that particular project (e.g., time, money, access to data). Quinlan (2015, p. 19) describes this as a "researchable project" that refers to a project that "the researcher could possibly undertake and complete." Keeping these parameters in mind, it is difficult to expect that the scientist alone would be able to spend resources outside of their narrow research scope, as these comments suggested. Furthermore, such an endeavour would be more likely for those environmental scientists whose area of expertise extends to the tourism discipline. However, that would discount many other environmental scientists.

Like the complexity of content + visuals in the fossils example (already discussed under the visuals theme), it appears that the complexity of the information conveyed through the narration also caused some audio information to become lost. For example, both videos explained the location and scale of the study; however, some members of the audience heard one but not the other, and vice versa. One of the respondents said: "Maybe the other reason why maybe I did not like the second example as much is… if at the start of the video it said "It's here in Central Queensland [which it did, but the respondent did not notice] I would be like "oh, cool, because I am in Central Queensland, I'm going to go find some fossils. For the first video she did say it is on Sunshine Coast, so it gave you that connection. The second one did not interest me as much, not because I am at the water and I love water, but because for the second example I had no idea where it was." (P3) Another respondent counteracted: "That is so funny, in the first video I did not hear that she is on Sunshine Coast, I did not hear any location, and in the second video I heard them say it is in Central Queensland. It is funny that we hear different things." (P1)

Contemplation of the concept of location prompted a sub-question, i.e., whether a location was a factor in their interest. "The location of the videos and the tourism businesses that they are trying to affect is very important. Like the first one obviously is for coastal region and those [industries] that are close to that area. And the other one is more for the bushlands, bushwalking tourism industry in country areas. That will probably more appeal to the inland areas of Queensland." (P2) Another respondent added: "Can you have one video that is relevant to all tourism professionals in Queensland…? Probably not. You probably need to go to RTOs and ask them what would be relevant to their local industry…what is relevant to accommodation is different to tour operators is different to hospitality industry…It is a tricky one. Make a video that is interesting just for that relevant audience." (P1). These remarks are consistent with the findings of quantitative study where location proved important determinant of the interest in different

environmental science themes. However, in terms of the tourism sector factor, more research is needed as these suggestions are inconsistent with the results from the second study on environmental science themes.

4.3.4.2.4. Montage[13]. Interestingly, during the focus group session, there was no explicit question asked about the montage, although the respondents frequently commented on it. This interest is consistent with the finding of Tsai & Chen (2018) that non-science background audiences focus more on the production quality than the content. As the interaction elicited that montage is an important aspect to consider in such video making, I therefore set it as a separate theme. Montage refers to editing the material (i.e., determining what from the raw materials is included and excluded in the output video) as well as connecting visuals, audio and content into a meaningful whole (i.e., how the transitions are made).

Some of the comments in the previous sections reflect the advice that different elements need to work together to create a meaningful whole. In essence, the producer secures the raw material, but it is the story editor who selects the "rough cuts", and the technical editor who works on the final product. Sometimes one person takes on more than one role. The importance of selecting the right material is shown through the following comments: "…if it would be just her [the scientist] speaking, it would have been boring even that it was interesting, but to have this dispersed with the whale images that was good." (P3) Contrasting with the second, less successful example, one respondent commented: "They were probably bouncing too much between too many subjects. Compared to whales, this one was not quite as smooth. It does not mean that it distracted, but it just made you more concentrating on what is happening around." (P2)

Transitions are another important aspect of the post-production process. Feedback on transitions included: "…I have seen videos where they jump a lot; this one was very nice and had very smooth transitions between the whale footage and the researcher talking rather than skip jumps that can disorientate people. I found that very good." (P2) A few respondents nodded their head to this comment, and another added: "Along the same lines, I think it was really nice to keep the things simple between the person talking and what she was talking about made it really easy to follow." (P5)

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[13] The term montage differs from the term editing. Montage refers to a composition work produced by combining smaller parts, or the process of making such a work, as opposed to the term editing, which refers to the process of making changes to a text or film, deciding what will be removed and what will be kept in, to prepare it for being printed or shown (University of Cambridge, 2020).

One respondent touched on the complexity of perception, which related to the importance of a good montage. The editing needs to be relational and done in a way that the elements seamlessly complement one another. In the first example: "The visuals were working with the audio, so you did not need to bounce between the listening and seeing.", whereas in the second the perception was different: "They were probably bouncing a bit too much between too many things compared to the whale example. /…/ It is probably not the quantity that they put into, but the quality. That could make a big difference." (P2)

On reflection, obtaining high-quality moving pictures is not always possible. For example, in the fossil discovery photos, the only existing visual material were the still photos. However, montage can still assist in improving the connection with the audience. One of the respondents noticed: "Weren't photos zoomed slowly into them and out? That felt nice, it brought them to life, it wasn't just static". (P5) A skilled editor will know of the importance/preference for moving images, and work with the material to create this kind of effect. This emphasises the importance of working with multimedia skilled professionals.

Another important aspect related to getting the raw material is the cost of production. For example: "…seeing whales so up close, that was quite captivating, because you never see this in real life." (P4) As the producer on this project, I was aware that the footage of whales was made with an expensive camera, which is rarely possible with a scientific project's budget. The alternatives are raw footage depositories, however relevant footage of the subject in question may not always be available. As with the second example for this study, sometimes the visual raw material consists only of what scientists made at the time of discovery. However, in this situation I was lucky to have been supplied with high resolution images of sufficient quality to be used in a 4K video; often this may not be the case. While striving to obtain the best quality material should always be part of a production project, the availability of resources is inevitably a consideration in such endeavours. A balance needs to be found between maintaining scientific integrity while attracting the audience. Video science producers need to maintain an awareness of the risks associated with sacrificing rigour in an attempt to make the message more intelligible to the public (Francés & Peris, 2018).

4.4. Chapter Summary

This chapter focused on the analysis of the data obtained for this research project. The first three analyses were quantitative in nature, while the last one was quantitative. Analysis 1 employed ordinal regression to identify a profile of tourism professionals that would be best to target with environmental science communication. Analysis 2 correlated themes and firmographics to explore the most suitable content. Analysis 3 focused on geographic segmentation as location proved an important determinant in the previous study. Further insights were gained in terms of where to apply targeted communication as well as in terms of content related interests. Analysis 4 examined the tourism workforce preferences in video production and provided guidelines for environmental scientists making them. Results for each study were presented in their respective sub-sections and will be further discussed in the next chapter.

The next chapter aims to provide a bigger picture. First, I build a case of how to communicate environmental science to the tourism workforce. Following that we position this cross-sectoral communication case as a non-technological innovation. Third the thesis contribution is discussed. Finally, limitations and recommendations for future research are outlined.

5. Discussion and Conclusion

"Knowledge can then be constructed as a meaning which makes a difference."
(Loet Leydesdorff)

5.1. Introduction

Effective communication requires knowing the audience (Chambers, 2018; Leal Filho, 2019; Moser, 2010). When communication occurs across different sectors, the recipient(s) are likely to come from different professional culture(s) and with different frames of reference (Dalkir et al., 2019). Acknowledging this principle, this thesis has sought to understand the conditions and activities needed to systematically develop communication between environmental scientists and tourism professionals in aid of improving academia – industry relations. These relations, along with government involvement, are known to be drivers of innovation and as such can contribute to sustainable development of the Queensland region. The overall aim of this thesis was to position environmental science communication as a non-technological innovation by constructing a case. Non-technological innovation is under researched, yet it might be a necessary missing piece in the service economy. The case: how to communicate environmental science to the tourism workforce is built based on the four studies that have been presented in the previous chapter.

In this chapter, I conclude the research by discussing the key findings in relation to the research aim and objectives, and position cross-sectoral communication as a non-technological innovation. Following that, the original contribution of this thesis is discussed. Lastly, I will review the limitations of this research project and propose opportunities for future research.

5.2. Building the Case

The four studies in the previous chapter in sequence responded to the questions "who?", "what?", "where?" and "how?". Simultaneously, they relate to the four objectives set in the Introduction to this thesis. This case is, therefore, built on an overview of how the objectives of this thesis, contributing to the overall aim, have been achieved.

Objective 1: Identify the best target group to communicate environmental science information to responding to a research question: *Who among the tourism professionals*

would be the most receptive and therefore the best to target with environmental science information?

Segmentation is a commonly used marketing technique to fragment the total available market into more manageable groups (Tynan & Drayton, 1987). The groups (also called segments) are set based on the principle of homogeneity (Kotler & Keller, 2016). However, this research project was exploratory in nature as the literature review exposed a knowledge gap concerning information available to the tourism workforce (as opposed to tourists) as an audience (see Literature Review chapter for details). Therefore, profiling the group that is likely to be most responsive and therefore best to target with environmental research information seemed a better way to provide a meaningful contribution than identifying segments across the entire population. This objective was achieved through the first study, which employed a generalised linear model with demographic characteristics of tourism professionals as predictors. The results indicate that the most receptive group in the tourism workforce would be females younger than 30 years with at least post-secondary education, although preferably university level. The results present a tangible way of identifying those who would be best to target with environmental research information. These individuals represent a primary target group for communication strategies. However, as this is exploratory research, the likelihood that this is not the only interested group must be considered; there may be other latent groups of tourism professionals who are interested. This research finding should therefore be taken as a starting point for applied communication and/or further empirical research to determine how to most effectively reach this target group (medium) and frame the messages.

Defining the profile based on demographic characteristics provides a tangible way of identifying the members of the target group in a practical sense (Beane & Ennis, 1987). Furthermore, this segmentation also provides information for individualised and customised communication, including medium and messaging (Brennan et al., 2020; Moser, 2010; Quinn, 2009; Verna, 2017). How is it possible to reach this target group? is the primary question that follows identification. Or, more specifically, which channels can be used to reach this target group? What language and framing would be the most effective to use? These are some of the questions that practitioners should take into consideration when developing communication strategies. Further empirical research to confirm effectiveness is also advised.

Objective 2: Examine the interest of the tourism workforce in major environmental science themes to identify the most relevant content for this audience responding to the question: *What kind of content would be best received among the tourism workforce?*

This research project started with an assumption that the tourism sector will inform the content. However, the second study disproved this assumption. The results revealed the opposite: that the business sector is not significantly correlated with any of the major environmental themes. This challenges insights on specific content. Moreover, the results showed strong correlation among themes, three on average. Some themes, e.g., sustainability and climate change, were identified as more interesting due to familiarity and relevance. The theme of species is also interesting to them when communicating about habitats and vice versa. The theme of geophysical resources would work as an additional theme, although the least preferred on its own. Without clear answers on what to communicate, I also examined other firmographics, i.e., size of a business, decade of business establishment and location of their operation. Only the latter proved important, with different themes achieving significance in different locations.

The role of location is well supported by the literature related to the development and management of tourism. The location factor is known to be a key determinant of destination success, along with attractive products and service offerings and quality visitor experiences (Bornhorst et al., 2010). Santos et al. (2022) found that perception that destination is sustainable is related to destination success. Location aspects are therefore crucial part of destination marketing as tourism destinations primarily compete on the basis of perceived image (Michaelidou et al., 2013). Literature referring to the relationship between climate- and human-induced impacts, and the effect on the destination image is almost non-existent (Almeida & Machado, 2019; Salvatierra & Walters, 2017). This relationship, however, is important, as changes in destination image are good predictors of destination choice, and of tourists' satisfaction and expenditure while at the destination. The cascading effects trickle down to the tourism workforce, potentially affecting their livelihoods.

The state of Queensland (our study area) as a destination has a large number of natural and protected areas, and the demand for nature-based and ecotourism activities is strong and expected to grow in the future (Business Queensland, 2020). Therefore, for many locations across Queensland, geography forms a crucial component of destination image. My respondents are interested in information about natural environment that is directly relevant to their operations. However, location-specific aspects, such as natural

attractions and climate, are not static. They change over time, and environmental science can monitor these changes. Furthermore, environmental science can provide important data in terms of species abundance, migration patterns, weather seasonality, etc. that are based on a specific geographic location. For nature-based tourism, biodiversity is a significant factor in a wide range of tourism product purchasing decisions. Indeed, biodiversity is a critical product component for tourists who travel to look at scenic landscapes due to particular flora, fauna and/or underlying terrain. Examples of nature-based tourism include visits to national parks and wildlife reserves, diving, fishing and hunting tours, and wildlife watching, e.g., bird or whale watching. However, all of these are location specific. Environmental research is important, not only for conservation planning, but also for the development of tourism services and products. The location aspect of tourism products is emphasised especially when it comes to iconic wildlife and landscapes. Some Queensland-based examples include Mon Repos Conservation Park as an important marine turtle rookery involved in ecotourism (see e.g., Tisdell & Wilson, 2005), Wet Tropics rainforest (see e.g., McNamara & Prideaux, 2011) or the Great Barrier Reef (see e.g., Howlett et al., 2022; Ritchie et al., 2022; Rolfe & De Valck, 2021).

When the tourism industry relies heavily on biodiversity and healthy ecosystems - such as the case of Queensland - changes in the environment can induce economic pressures. For example, the Tropical Tourism North Queensland region and other coral reef-dependent destinations may experience a significant and sustained decline in international arrivals if further coral bleaching events occur in the near future (Prideaux et al., 2021). Nature-based tourism operators might be interested in knowing more about environmental research as their products rely on the quality of the natural environment (Huybers & Bennett, 2003). As environmental resources are essential inputs to tourism and hospitality operations, environmentally aware stakeholders are more likely to protect them and invest in measures to enhance their sustainability (Öztüren et al., 2021). To do so, they are likely to be interested in environmental research that addresses issues linked to the natural resources they are directly utilising for their tourism products and services.

Seen from a broader perspective, location also dictates possibilities in the development of tourism to varying degrees, which in turn plays an important role in driving economic and employment growth (Baum et al., 2016, Harvood & Christie-Johnston, 2021). In remote regions, the tourism industry sometimes emerges as one of the few, if not the only, options to foster economic growth and diversification (Ioannides & Zampoukos, 2019). The potential to provide economic benefits to isolated communities is particularly pronounced with nature-based tourism (Balmford et al., 2015; Cheer & Lew, 2018).

However, limited options also bring many challenges, including concerns about ecological impacts on sensitive ecosystems (Sisneros-Kidd et al., 2019). This has been confirmed in my study through the Outback region example. In highly populated areas, on the other hand, attractiveness hinders tourism businesses' access to the same natural resources (Aragón-Correa et al., 2022), which is consistent with my example of Brisbane region. If people's environmental views depend partly on where they are (Hamilton et al., 2010), it is not surprising that interest in environmental science will align with the place of operations too. Location was further explored as part of reaching the next objective.

Objective 3: Geographically segment the tourism workforce to determine the best targeting locations responding to a research question: *Where are businesses interested in environmental research located?*

This objective was achieved by applying proximity analysis to interest in nearby features. Proximity to natural features proved to be a significant predictor of the interest in research about the nearby features. Further analysis of the data relevant to marine and beach environments showed that 50 per cent of those interested operated at a distance of less than 2.5 kilometres and at least three-quarters within 5 kilometres of these natural features. These results provide useful measures to map out the communication area in which interested businesses are located.

Tourism service providers play a crucial role in the quality of visitor experience through interactions with them (Johnson et al., 2019; Moon & Han, 2019; Prakash et al., 2019). Familiarity with the environment in which tourism service providers operate adds to the quality of experience. Similar to some forms of cultural tourism, where a performance may be staged by traditional dancers who are trained to enact roles that fit with the setting (Crang, 1997; Viviana Moscoso, 2021), the environmental performance of tourism workers can be inspired by their environment. My study confirms that the interest in scientific information about natural features is greater when they operate in close proximity to them.

Environmental interpretation is often described as a critical element in nature-based tourism, and tourism service providers, especially tour guides, are often viewed as an important part of the sustainable tourism framework (Ormsby & Mannle, 2006; Randall & Rollins, 2009). Aspects of environmental interpretation include enhancing visitor experience, managing on-site behaviour and encouraging positive conservation attitudes (Moscardo & Ballantyne, 2008). Staff expertise plays an important role (Walker &

Moscardo, 2014). Guided interpretive tours are considered the most effective means of conveying educational and conservation messages according to their users, although they are not as common as static tools such as experiential facilities, interpretive signs, and exhibition materials (Tsang et al., 2011). Guides conducting interpretative tours require knowledge to provide the service. To meet the needs and expectations of twenty-first century tourists and the challenges of the global communication environment, tour guides need to become more highly skilled experience-brokers (Dybsand, 2020; Weiler & Black, 2015). It is therefore in the tourism industry's interest to form strategic alliances with environmental scientists. Such alliances have great potential for mutual benefit, both for sustained growth and prosperity in the tourism sector and for conservation of biodiversity and other components of the natural environment (Buckley, 1999).

An important indicator of successful destination marketing is place attachment (Jiang et al., 2016). Place attachment is a strong emotional bond with a specific location, resulting in customer loyalty and ambassadorship (Debenedetti et al., 2014; Yuksel et al., 2010) Place attachment has also been recognised as a key factor contributing to the sustainable development of destinations (Zou et al., 2022). However, place attachment studies have predominantly focused on visitors and their experiences at tourist destinations. When it comes to the tourism workforce, spatial dimension research has so far been largely neglected (Baum et al., 2016; Ladkin, 2011). However, my study addressed this gap. Those near particular natural features are significantly more interested in them. My study confirms that for beach and marine environments, but more data are needed to examine other features. At least for these two natural features I can posit that due to the interdependence of tourism service providers and the environment at nature-based destinations, the tourism workforce has developed a place attachment for the environment they operate in. This is consistent with Andersen (2022) who found that tour guides in the Arctic region also developed strong emotional connections and caregiving responsibility to the natural environment.

Objective 4: Examine how video as a medium performs with the tourism workforce to guide the development of future video-making responding to a question: *How to make environmental research videos for the tourism workforce?*

A reflective thematic analysis of the qualitative data collected via the focus group provided insights related to the key aspects of video production. Two originally produced short examples demonstrating contrasting film elements were shown to the audience to depict their preferences and perception signature. The following section provides

recommendations for environmental scientists to communicate their research to the tourism professionals via video.

First, most people are primarily visual in their perception (Farah, 2003), and tourism professionals are no exception. Their initial recall mostly related to visuals, emphasising the importance of making them well. The guidelines for visualising environmental research for tourism professionals include a) using moving pictures rather than still images; b) placing greater attention on the subject rather than the researcher, although the researcher's active presentation of the research can be valuable; c) choosing visuals that elicit emotions/connection; and d) ensuring that the visuals support the content and vice versa.

Second, the responses suggest that the voice audio needs to be clear and concise, and preferably without a strong accent. Engaging a professional communicator may be preferable, especially when the scientist's accent is strong and when research is presented in a non-native language. This may sometimes be difficult to achieve due to resource constraints. Another aspect of the voice audio is pacing and tone; avoiding a monotone voice is essential to ensure that audiences stay engaged. Supporting audio material adds to the story and these elements should be skilfully interwoven throughout the video to enhance the viewing experience and audience connection to the story.

Third, gathering and selecting the right visual and audio material relate to the pre- and post-production process of the video making. The footage needs to be high-quality and simple, and the transitions must be seamless and smooth. The study showed that this is not easily achieved without the help of multimedia skilled professionals. This relates to findings of Hautz et al. (2014) who studied video making for tourism videos, comparing user and agency generated videos. Their study suggests that audience perception is most influenced by the technical quality of a video. My non-science background audience also showed a significant interest in the technical aspects of the video, including quality and montage.

Further to the previous point, another issue may be that environmental scientists are rarely trained in video communication (Eise, 2019). Video making and presenting requires a set of technical skills, acting/public speaking skills, and branding and marketing skills (Tolkach & Pratt, 2021). Some studies suggest mixed teams of multimedia professionals, scientists and industry experts (Eise, 2019; Tsai & Chen, 2018). This work can also be time-consuming and potentially uncomfortable due to public

scrutiny (Tolkach & Pratt, 2021). However, including scientists in the production process would add to the credibility and trustworthiness of a video (Hautz et al., 2014).

Finally, the content of the two video examples was examined at length to establish how the audience were able to connect with it. Communication principles were explored through language. In relation to language, this study found that academic jargon does not resonate with tourism professionals. The feedback to the narration based on a journal article abstract revealed confusion and lack of interest. Although the other example of a whale breathing research used simplified language, it did not sufficiently resolve the complexity of the conveyed research. Simple language must be used to communicate environmental research to the tourism industry, as this and previous research has confirmed (Finkler & León-Anguiano, 2019).

Further, cognitive principles were explored under the content topic. Despite the video neutrally developed for any audience, the respondents clearly indicated what is needed when communicating with tourism professionals. First, a video needs to relate to a relevant location, a finding that is consistent with the quantitative study (see the second and third analysis). For example, those who are on the coast would be interested in marine/beach research. Others would be more interested to what is near their business operations. The responses of this study also indicated linking studies with the relevant business sector, which is not what my previous study found. Further, research information needs to be accompanied by a clear statement of purpose and a call to action. The call to action may apply to tourism businesses or the tourists themselves. Delving further into expectations about the purpose, it became clear that these expectations were set very high. From the environmental scientist perspective, research usually has a limited focus; however, the response suggests providing information beyond that focus, which can also be linked to the results from the second analysis. Resource availability (including time, money and access to data) may pose a challenge to achieve that. Other studies suggest working in a multidisciplinary team (Eise, 2019; Tsai & Chen, 2018) or engaging professional media science services, such as Cinematic Science, for example (Cinematic Science, 2022).

On reflection, the collaborative push would most likely need to come from the organisational level (i.e., universities, industry or the government), with incentives to motivate scientists' engagement (Eise, 2019). Developing a culture of cross-discipline collaboration would likely help. Considering that most universities do have both environmental science as well as media departments, facilitating such endeavours is

feasible, although the question of motivation arises. Societal norms are changing and bringing science to various publics is becoming more common (National Academies of Sciences, Engineering, and Medicine, 2017). Most existing literature on environmental science communication via video focuses on examining impact, e.g., change in attitudes, behaviours and beliefs. This empirical study, on the other hand, contributes by providing concrete guidelines for environmental scientists on how to develop research videos for tourism professionals (See the case summary in Appendix E). The democratisation of video-making through inexpensive technology and easier distribution methods has not made such endeavours intrinsically effective. Rather, democratisation has increased competition for audiences' attention (Finkler & León-Anguiano, 2019), which makes capturing the attention of the targeted audience an ever more important and challenging task. Understanding how to capture attention is paramount to having one's message heard. The insights from this study have the potential to aid in that.

In addressing these four objectives, this thesis enhances understanding of how to communicate environmental research to the tourism workforce. The next section will discuss how the case that was built in this section fits in the cross-sectoral space, as a non-technological innovation.

5.3. Cross-Sectoral Communication as a Non-Technological Innovation

The Background to the Research (section 1.1.) identified the need to foster the service economy, which requires innovative thinking. To address this, this thesis postulated expanding the current predominant association of innovation with technology to also include non-technological innovations. These pertain to areas such as marketing, communication, organisational management and design. Through the previous chapters of this thesis, I have systematically addressed the problem of cross-sectoral communication. In the previous section, the case for how to communicate environmental science to the tourism workforce was created as an example to illustrate the required understandings of conditions and activities needed to improve communication between environmental scientists and tourism professionals in aid of improving academia – industry relations. This section will now discuss the implications for organisational and beyond organisational change.

First, the implications for organisational change pertain to knowledge transfer. For some time, the tourism industry has struggled to innovate. This may be attributed to the fact that as a service sector, it does not fit the model of industries that can easily innovate

through products. Or can it? We live in exciting times of the so-called *knowledge society*, where knowledge, in successful applications, has become cognitive capital (Castelfranchi, 2007). Compared to the preceding *information society*, the main principle of this new era is based on transforming information into resources instead of just disseminating information. In other words, in a knowledge society, the ability to effectively apply existing knowledge in a novel way creates the basis for achieving competitive advantage from knowledge-based assets (Alavi & Leidner, 2001). This leads me to proposing the development of a novel destination marketing strategy, one that includes the latest environmental research information. To provide an illustrative example: Australia's biggest competitive advantage in terms of its global tourism offering is its world class natural environment (Tourism Australia, 2017). Major sites include the Great Barrier Reef, Uluru, The Great Ocean Road, Barossa Valley, Kakadu National Park, The Kimberley, Kangaroo Island, Tasmanian Wilderness, Australian Alps, Ningaloo, and many more. Some of these tourism assets are listed under UNESCO's natural heritage and other protection conventions, which helps promotion to a large number of domestic and international visitors. Focusing on aquatic and coastal environments, in 2010 Tourism Australia's launched a global consumer marketing campaign "*There's Nothing like Australia*" (Tourism Australia, 2017, p. 1). The campaign was designed to promote sense-enriching experiences, including static and immersive creative delivery (Tourism Australia, 2017). Due to the success of this campaign, in 2020 Tourism Australia launched its *There's Still Nothing Like Australia* campaign film reinforcing the message that this destination abounds in natural assets (Tourism Australia, 2020).

From a strategic perspective, nature-based tourism tactics are progressively advancing from merely selling the viewing of natural sites towards selling 'experiences', to attract clientele longing for authentic and unique holiday experiences. Gastronomy, adventure and cultural tours are just some examples (see e.g., Kane, 2012; Meler, 2015; Smed, 2015). However, I could not find any scholarly evidence of differentiation made from a longitudinal perspective. In other words, it seems that natural tourism attractions and experiences are sold as static elements in time and place, e.g., something uniquely Australian and as something that is assumed will always be there. Yet, nature is continuously changing and transforming under anthropogenic and natural influences. The unique feature of environmental monuments (compared to human-made monuments) is their dynamic, living nature.

For example, in relation to the recurrent bleaching on the Great Barrier Reef in 1998, 2002 and 2016, environmental scientists found distinctive geographic footprints created

by different spatial patterns of sea temperatures (Hughes et al., 2017). This means that each coral bleaching event was in itself unique, as were the periods of recovery in between. These and other changes in natural environments are recorded by environmental scientists. Yet, the application of such information in destination marketing rarely occurs. Should environmental knowledge be applied in this way, it would become a form of innovation. Innovation is "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)." (OECD & Eurostat, 2005, p. 46).

Knowledge transfer not only leads to innovation but, according to this definition, could be an innovation itself when utilised in alternative ways from its original purpose. To illustrate, if the primary purpose of environmental science is saving the natural world from destruction by providing rigorously obtained evidence for conservation policies and awareness raising, then the secondary purpose could be using the latest scientific findings to inform visitors to a particular destination about the changing state of the environment, e.g., conveying scientific findings about coral bleaching to visitors of the Great Barrier Reef. In this alternative use, however, environmental knowledge would become an outcome, i.e., an innovative product itself. Promoting the changing state of the natural environment would be a potential strategy to add knowledge-intensive value to the destination. This strategy would give visitors an opportunity to learn about a natural wonder at a certain point in time rather than merely as a timeless feature. Equally importantly, non-scientists may come to better understand the nature of science: that is it is not a belief system but based on a robust appreciation of the real world (Low & Eagle, 2017).

This is only one example where environmental science information could aid tourism innovation. Others, a lot better studied and known, are eco-innovations in the accommodation and hospitality sectors: "innovation that results in a reduction of environmental impact, and/or optimises the use of resources throughout the lifecycle of related activities" (Jakob et al., 2003; OECD, 2012, p. 29). Different sectors may utilise different applications of environmental science in their innovative endeavours.

However, this communication strategy also responds to innovation as a process. For the knowledge transfer to be continuous as the aforementioned envisaged products would require, *systematic* relations between academia and industry need to be established. This requires changes beyond the organisational level. Collaboration is one of the key

drivers of innovation in tourism (Carlsen et al., 2010, Divisekera & Nguyen, 2018). This thesis has focused on collaboration between environmental science as the domain where knowledge is generated, and the tourism industry where it will be applied to serve as a public good in an innovative way. At first glance it may appear that the case of how to communicate environmental research to tourism workforce has little to do with innovation systems. However, cross-sectoral communication is one of the key functions in such a system. Therefore, this case has served as an example to illustrate the bigger picture. The dyadic relations within the system are expected to lead to co-evolutions in processes of mutual shaping (Leydesdorff & Etzkowitz, 1998). However, the principle of needing to know the audience, which was the guiding predisposition of this thesis, can, and should be, applied between all helices of an innovation system, i.e., industry and the government, and academia and the government. This, of course, renders the innovation system a lot more complex than originally presented. However, as the pioneers of the triple helix, Leydesdorff and Etzkowitz (1998), suggest, the triple helix model is not formulated at the level of the phenomena to be explained, but serves as a methodological and discursive tool to help with explaining and integrating the contributions by trying to organise them in terms of the expected sub dynamics of the complex system. Approaching communication with the intention of acknowledging its multifaceted complexities not only provides a path towards effective cross-sectoral communication, but can also lead to increased public engagement, and funding (Langan et al., 2019).

Scaling down was necessary for this project to depict and illustrate required considerations. In addition to 'knowing the audience', cross-sectoral communication triggers other organisational and beyond-organisational changes. These may include the way cross-sectoral communication is in practical terms managed, organised, designed and delivered. All these areas are pillars of non-technological innovation, at present sitting as potential. However, hopefully this thesis inspires consideration in this direction. The theoretical and practical contributions of this thesis are further described in the next section.

5.4. Thesis Contribution

The communication of environmental science to its stakeholders benefits from an interdisciplinary approach (Li, 2016). This thesis adopted an interdisciplinary approach to address the research problem at the intersection of the areas: systems of innovation, environmental science communication and tourism. The original contribution of this thesis pertains to these three areas as well: systems of innovation, environmental

science communication and tourism. This section will describe the contributions to these three areas (For the graphic summary of thesis contribution, see Appendix F).

In terms of theoretical contributions, this thesis addresses an important gap in triple helix scholarship by providing a first non-technological application example. As the Literature Review (Chapter 2) of this thesis described, triple helix scholarship has thus far kept its focus on technology transfer, neglecting the non-technological aspects of innovation. This thesis expanded existing scholarship to bridge this gap. This expansion is necessary to include a range of industries that sell products and particularly services that are not technological in nature. Tourism is a prime example of a service economy and was used as an example in this thesis to expand the current paradigm of innovation systems scholarship.

This thesis has contributed to novel and under researched field. Non-technological innovation has a potential to foster regional development by redirecting the focus from intense natural resource utilisation to knowledge as a resource. This not only aligns with the philosophy of knowledge society but is also greatly needed if we are to move towards sustainable development. The quintuple helix theory partially leans on this aspect by positioning natural environment as the fifth helix informing innovation. However, quintuple helix scholarship does not make the redirection to the non-technological domain, which this thesis has done. The term non-technological innovation was coined nearly 20 years ago, but innovation systems scholarship has not caught up with it yet. This thesis offers a new way of thinking that includes the concept of non-technological innovation. A whole range of avenues open up with that, be it marketing innovations, management innovation, innovations pertaining communication or those focusing on design. The key notion to keep in mind is that they need to be positioned to help create productive business partnerships, influence market development and aid sustainable development, as did our example of cross-sectoral communication between environmental science and the tourism industry (The practical contribution of this example will be discussed further below.).

The next original contribution of this thesis relates to consolidation of communication scholarship within triple helix, which had not yet been done when this research project began. This allowed me to examine the development of the theory over time and identify the clusters of studies around the most common themes. The review exposed poor differentiation between the concepts of communication and cooperation, collaboration, knowledge transfer and interaction. To make this distinction, this thesis contributed by

focusing on the actual process of communicating. This required zooming into a dyadic relation between academia and industry. However, the triple helix model is adequate to be used for various underlying dynamics, including those between two helices (Leydesdorff & Etzkowitz, 1998). Applying the principle of *knowing thy audience* (as every audience has different communication requirements (Leal Filho, 2019), I proved that communication is not just an enabler of collaboration but a process that deserves attention in itself. Audience characteristics and particularities must be known to communicate effectively (Moser, 2010). Using the example of cross-sectoral communication between environmental science and the tourism industry, I demonstrated that communication within innovation systems should be viewed beyond the intermediary role of technology dissemination (Leeuwis & Aarts, 2011).

Furthermore, the review of triple helix communication scholarship also exposed the lack of referencing in studies to communication theory, with the notable exception of Leydesdorff, who extensively contributed to the mathematical theory of communication. My thesis has made a third contribution in this sense, by adding to this research marketing and communication scholarly traditions. The triple helix as a scholarly enterprise itself builds reflexively on these disciplines in terms of what they contribute to the research focus (Leydesdorff & Etzkowitz, 1998). As a result, the thesis proposed a triple helix communication model (see Chapter 2, Figure 3).

Contribution to communication theory includes applying encoding/decoding concepts to the cross-sectoral setting and developing a cross-sectoral communication model (see Chapter 2, Figure 6). The concept has been acknowledged in the seminal Shannon-Weaver (1948) transmission model of communication, Schramm's interactive communication model (1954) and Hall's research on mass media communication (1973). However, to my knowledge this is the first application of the concept in a cross-sectoral setting, and specifically to relations within a system of innovation. The model illustrates communicating relationships between two different professional cultures (in my case academia and industry); however, this dyadic dynamic can be replicated to any other cross-sectoral setting and even their combinations.

Finally, a theoretical contribution has also been made to tourism research. The existing marketing and communication segmentation studies related to the tourism industry have predominantly focused on tourists (see e.g., reviews by Beane & Ellis, 1987; Dolničar, 2020; Penagos-Londoño et al., 2021; Quer & Peng, 2022; Torkzadeh et al., 2021), and less is known about the tourism workforce as a focus of segmentation. Yet, studying

tourism professionals as the audience is important: they are the brokers/gatekeepers of environmental knowledge, the managers and decision makers with the power to direct businesses and their clients towards a sustainable future. This thesis, therefore, found a new and relevant audience of environmental science within the tourism research and extended segmentation principles to it.

In a practical sense, this thesis contributes by providing communication guidelines for environmental scientists. The case constructed in the section 5.2. Building the Case answered questions about whom to primarily communicate environmental science among the tourism workforce, what content to focus on, where to find the target audience and how to produce videos for such communication. At the university level, the need to better communicate science with the industry has long been recognised, yet existing activities remain uncoordinated, internally and externally (B. Smith, personal communication, October 14, 2017). Universities in regions that lack governmental facilitation towards innovation can serve as regional innovation organisers, encouraging the creation of connections between academic research and local industry (Gebhardt & Etzkowitz, 1996). This thesis aids in understanding the conditions and required activities for a more coordinated approach in the future. If these findings can be verified by future studies, there are positive implications for those designing communication strategies aimed at a diverse range of environmental science stakeholders. While other environmental communication studies have focused on stakeholder audiences (e.g., Finkler & Higham, 2020; Jones et al. 2019, Li, 2016; Zabala, 2017), this is the first one focusing on cross-sectoral communication for the purpose of innovating.

At the other end of the spectrum, this research project exposed the tourism workforce to the idea of using environmental science information as part of destination marketing strategies. Environmental problems, such as climate change, pollution, overpopulation, and resource diminishment, are going to affect tourism destinations that predominantly rely on natural resources. This is likely to have deep impact on how regions are marketed while at the same time protecting them as tourism resources (Lew et al., 2020). As an example that highlights the importance of communication, Finkler and Higham (2020) argued that the failure of sustainability of whale watching tourism is, in part, due to poor implementation of recommendations from scientific impact assessments, ineffective science communication about the negative impacts of whale watching on whale populations, and limited collaboration between whale watching operators, organisations that promote whale watching, and the scientists who measure the impacts of whale watching. This thesis contributes information on how to overcome this gap. Furthermore,

adoption of innovation is suggested as the optimal coping mechanism to counter intense competition as well as an efficient response to ever-changing demands to achieve sustainable growth for tourism businesses (OECD, 2008; Jacob et al., 2010). However, the tourism industry has been struggling to innovate for a long time (Prideaux, 2013; Lew et al., 2020). This may be attributed to the lack of acknowledgement that service industries innovate differently compared to primary and secondary industries that are focused on manufacturing and production (Miles, 2008). For innovations in service industries, new strategic value can be created when experience is seen as an important new attribute (Stamboulis & Skayannis, 2003). In relation to marketing of environmentally focused destinations, this translates into preserving the quality of the natural environment (Jacob et al., 2003). This thesis provides further rationale for this perspective by clarifying how environmental knowledge can be innovatively applied in tourism as a resource. Tapping into this as-yet unrecognised potential would create consequences for the growth of not only destination strategies and policies (Stamboulis & Skayannis, 2003), but also those related to innovation.

Lastly, this thesis provides evidence for innovation policy change. The limited empirical knowledge of the innovation process and its determinants in the tourism sector is a major obstacle to the development of appropriate policy measures that enhance and facilitate innovation (Divisekera & Nguyen, 2018). Service industries display different innovation patterns to primary and secondary industries; however, in relation to innovation policies, a service-dominant logic is rare (Miles, 2008). In Australia, specifically, the federal government currently supports science and industry through the Industry Transformational Research Hubs (also called Growth Centres initiative) (Australian Research Council, 2017). These are designed to accelerate commercialisation of scientific research by fostering innovation, productivity and competitiveness by concentrating investment on identified key industry sectors. These sectors are: Advanced Manufacturing, Cyber Security, Food and Agribusiness, Medical Technologies and Pharmaceuticals, Mining Equipment, Technology and Services, and Oil, Gas and Energy Resources (Australian Government, 2023). The tourism industry as well as environmental science are currently both excluded from this initiative, despite the significant (and growing) contribution of this industry to the national economy (see sections 1.4.1. and 2.5 for details). This thesis provides a viable example from a service sector towards consideration of innovation policy change to be more inclusive of service industries and soft sciences that can contribute to non-technological innovations.

5.4. Limitations and Recommendations for Future Research

This section outlines some of the issues I experienced during the research, including Covid-19 related restrictions and limitations, and geographical limitations. The 3.9. Limitations section under the Methodology chapter has already outlined some of the key challenges faced during the data collection process and adjustments that had to be made to successfully complete that stage during the pandemic. Here I reflect on Covid-19 related aspects that prompted those changes.

5.4.1. Limitations Related to Covid-19

Covid-19 played a significant role in the development of this thesis as it severely impacted the tourism industry itself and my research plan. The key issues included:

a) Border closures that prevented travel between states to collect data in person. To deal with the pandemic, Australia arguably imposed one of the strictest movement restrictions worldwide. The rapidly changing rules and restrictions, unforeseen lockdowns and border openings and closings (including the risk of mandatory paid quarantine with every border crossing), increased the difficulties in terms of travelling to the study area of this project. This impacted my access to tourism professionals in Queensland, while living and working in the Northern Territory.

b) Low response rate with online data collection techniques, which was – according to an expert opinion – a consequence of tourism professionals dealing with Covid-related issues.

c) Limited availability of tourism professionals to fill in the survey questionnaire during the key tourist season, which coincided with the data collection time (work commitments at a university prevented me getting leave at any other time).

Related to point b) and c), it must be noted that Covid-19 caused significant structural and employment changes in the industry. Before the pandemic, the Queensland state tourism industry heavily relied on interstate and international visitors and workers. Without these, tourism businesses (large and small) were struggling to survive. In 2020 alone, employment was reduced for more than 10,000 tourism professionals (Munawar et al., 2021). In 2022, the recorded loss was over 20 per cent compared to pre-pandemic

(Australian Bureau of Statistics, 2022). For example, in Tourism Tropical North Queensland region, the loss of more than 9,000 jobs was attributed to the Covid-19 pandemic (Sexton-McGrath, 2022). At the same time, the government marketing campaigns redirected millions of domestic visitors to Queensland (Vickers, 2020)[14]. The mental state of the tourism professionals (due to industry instability and being overworked) and their availability to participate in this research (due to shortage of workforce) were significantly compromised due to the pandemic (Robinson & Jiang, 2021). "Too busy just trying to survive" and comments along similar lines were received several times during the data collection.

d) Covid-19 spread posing health risks while collecting data on the field. While all advised precautionary measures were taken to prevent falling ill while collecting the data, medical statistics showed that it could happen regardless. It was not so much the fear of physically getting ill, but the mental stress due to fear of being stranded in another state, should this happen, that I had to combat.

No one could predict and plan for such circumstances that I had to face to bring this PhD to completion. However, having previous fieldwork and project management experiences really helped with adjusting when necessary and continuing to progress towards the goal. In retrospect I can also say that mental agility and strength are good (if not necessary) qualities for a researcher to have.

5.4.2. Geographical Limitations

Queensland state spreads over 1,730,648 square kilometres, almost a quarter of the entire Australian continent. Online data collection is recommended for large study areas

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[14] Alongside the Queensland Government's roadmap for easing restrictions, the state launched a major tourism campaign titled *Queensland is good to go* to attract domestic and interstate visitors (The Queensland Cabinet and Ministerial Directory, 2020). The campaign especially targeted so-called overnight visiting friends and relatives' travellers and Australians who planned to travel overseas this year (TEQ, 2020). Every year, 3.2 million Australians spend nearly $10 billion holidaying interstate and overseas (Mirage News, 2020). Redirecting this revenue to the Queensland market was the goal of this campaign. The advertisements, featuring key tourism attractions, reached an expected 8.3 million people in New South Wales and Victoria with the aim to inspire Australians to take a Queensland holiday (Personal communication, TEQ e-newsletter, 3 December 2020). Recognising the tourism workforce shortage, the government also launched a campaign called Give It a Go to attract workers to tourism regions (Personal communication, TEQ e-newsletter, 10 December 2020), however that campaign was not successful as the issue persists (Australian Bureau of Statistics, 2022; Department of Tourism, Innovation and Sport, 2022).

(Quinlan, 2015). While lower response rates compared to in-person data collection was expected, the COVID-19 circumstances made it impossible to collect enough data online. Even involvement of and project endorsement by tourism bodies at all levels did not make a significant difference. Neither did the voucher incentive for completing the survey. Hence the data collection had to be conducted in person.

However, for the offline data collection the large size of the study area posed a limitation. Stratified sampling, as originally planned, was beyond the allocated budged and hence replaced with purposive sampling. This strategy enabled me to collect a representative sample of the population. The analysis of collected data, however, revealed the importance of the location factor (analyses 2, 3, and 4). Therefore, it is recommended that future similar projects keep the stratified sampling. Stratified sampling would allow for comparisons between the RTOs and other possible comparisons, i.e., coastal vs inland or urban vs rural areas.

Further, related to this project specifically, another location related point needs to be made. The results of the third study revealed that it is not only the region that matters when it comes to interest in environmental research. The proximity of the tourism operation to the natural features was linked to the interest about these features. A distance of less than five kilometres from the features was calculated for beach and marine environment. It is recommended that future researchers also test this distance for other natural features.

One strategy that would assist with stratified sampling and worked well in this project was the recruitment of a field work assistant in one of the data collection regions. Local research assistants are usually already well acquainted with the area. But they must be trained in the data collection procedure, which, in my case, they were. For future similar projects, rather than researchers travelling to all regions themselves, local assistants should be recruited in the various data collection regions. While this is a common practice for research in developing countries, implementing this strategy in developed countries such as Australia is much more difficult because salary expenses are much higher. These expenses need to be covered by the available budget. A PhD project budget is typically small and poses a constraint in itself; however, I obtained some additional funding and quadrupled the original budget. This enabled successful completion of the project despite the methodological changes that I had to make.

5.5. Conclusion

To conclude, innovation systems can play a critical part in globally coordinated efforts towards creating a sustainable future (Fernandez et al., 2022). However, the roles and functions within the system need to be better understood. This thesis has focused on cross-sectoral communication as one of the key functions in fostering collaboration, which is a prerequisite for innovation. The Introduction chapter of this thesis provided the background and outlined the research problem to be addressed, i.e., effective communication in a cross-sectoral space. Specifically, this thesis focused on how to communicate environmental science to the tourism industry. In the second chapter (Literature Review) the key theories and concepts were outlined. They included innovation systems theory, in particular triple helix, and communication studies within that scholarship. Communication and marketing models and concepts relevant to cross-sectoral communication were also explained and applied in the development of new relevant models. Finally, the review examined literature related to the tourism industry. Based on that, four objectives were set. These objectives responded to four guiding questions that aided in the construction of a case study. The Methodology chapter provided justification for this design, along with philosophical and epistemological orientations. Information about the sampling strategy for this project, which consisted primarily of purposive and snowball sampling were also provided. Further, this chapter described the development of data collection instruments (i.e., original video production, and two questionnaires) and data collection procedures (i.e., survey and focus group). Some Covid-19 related limitations pertaining to methodology were also outlined. Four studies were developed from the quantitative and qualitative datasets obtained. Each study responded to one of the research objectives/guiding questions for the case construction, namely: who, what, where and how. The analyses and results were presented in Chapter 4. The last chapter provided the discussion to illustrate the bigger picture. First, the case of how to communicate environmental science to the tourism industry was built. This case then also served to position cross-sectoral communication as a non-technological innovation in the broader context of innovation systems.

This thesis provides original theoretical and practical contributions in the areas of systems of innovation, environmental science communication and tourism. It is my hope that this thesis, and other work coming from it, help in understanding conditions and required activities to improve communication between environmental scientists and tourism professionals in aid of improving academia – industry relations and contributing to sustainable development of the Queensland region. Furthermore, my intention was to

stimulate awareness, interest and further explorations of non-technological innovation and systems of innovation as important and under-studied topics.

6. References

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Appendices

Appendix A: Questionnaires

<u>Survey Questions:</u>

1. Environmental studies are conducted over various geographical scales. Which scale of studies would be most interesting/relevant for your organisation? (Multiple-choice question)

2. Research findings about which natural features would you be most interested in receiving? (Multiple-choice question)

3. What kind of research themes findings would you be most interested in receiving? Studies related to... (Multiple-choice question)

4. Please tell us a little about yourself so that we can compare our respondents to the overall population. What is your age? (Open-ended question)

5. Gender (Single-choice question)

6. What is your organisation's post code? (Open-ended question)

7. In which tourism region is your organisation based in? (Single-choice question)

8. What is your highest educational qualification? (Single-choice question)

9. Type of business your organisation is in: (Single-choice question)

10. Size of the organisation – number of employees (Single-choice question)

11. What year was the organisation/business established? (Open-ended question)

12. What is your primary occupation? (Single-choice question)

13. What are the most prominent natural features nearby your organisation's establishment? (Multiple-choice question)

14. Thank you for completing this survey. Would like to participate in a raffle for a gift voucher from Woolworths? (This information is gathered separately from the rest of the answers) (Single-choice question)

<u>Focus Group Questions</u>

1) What did you like about this video and why?

2) What did you not like about this video and why?

3) What can you tell me about the visual aspects of this video?

4) What can you tell me about the audio aspects of this video?

5) What can you tell me about the understanding of the content?

(1-5 repeated for the second video)

6) Overall, which did you prefer, the video or the narrative. Sub-question: Why?

7) Is there anything else you would like to comment on?

Appendix B: Video Production

In general, the production process has three stages: pre-production, production and post-production. For this project, all stages were planned to be completed within the three-month time period. The intended output of this process was to be a video between five and ten minutes in length, showcasing some examples of environmental science research.

This small production team included three people: myself as the principal investigator, videographer/editor and one additional producer brought on to the project due to Covid-19. The team worked jointly and interchangeably on different stages of the process. I have international contacts in the screen industry due to my professional experience in multimedia production. However, sourcing collaborators locally for logistical as well as financial reasons was a strategic decision.

The recruitment process for the editor/videographer involved joining a local screen production association Sunshine Coast Screen Collective (SCSC). A couple of meetings were organised with the president and a well-known producer to inquire about local talent that might be available for this project. Additionally, I attended two SCSC networking events. A number of contacts with potential collaborators were made with requests for portfolios and description of relevant experiences. Upon examining these, I (in the producer role) organised meetings with three candidates. Each meeting took approximately two hours. During the meetings, the production process and intended outcome was discussed in detail to gauge candidates' technical and creative skills, as well as the equipment available. Because of a limited budget, it was important not to run into additional costs if needing to hire professional filming equipment. Request for a quote was also made during this meeting, while explaining that this was a low-budget project intended for educational purposes only. The final choice for who got the videographer/editor's job was made based on skills, equipment, a quote and availability to work within set timeframe.

The other aspects of pre-production included script development, recruitment of environmental scientists, location scouting and schedule development. A script for the documentary was developed utilising my professional experience as a story editor. This format was the best for this project due to perceived credibility (Lužar, 2006). The original script included the following sequence: Intro, Interview 1, Narrative, Interview 2, Outro (See Table 13). The storyline, technical specifications and required resources were

described for each part, along with content texts. The script served as a working document and was shared with the videographer/editor.

Table 12: Summary outline for the documentary script (Source: Author)

INTRO	INTRVIEW 1	NARATIVE	INTERVIEW 2	OUTRO	
text (K)	interview shots (V, K)	scripted narration (K, V)	interview shots (V, K)	invite to survey (K, V)	V=Videographer
music (V)	music (V)	music (V)	music (V)	music (V)	K=Karmen
drone shots (V, K)	work shots (R1, S)	supportive shots (K, S)	work shots (R1, S)	credits (K, V)	R1=Scientist 1
	whale shots (K)		surf shots (K, S)	work shots (J, K)	R2= Scientist 2
					S=Shutterstock
1	2.5	2.5	2.5	1	minutes

As per the original script idea, environmental scientists provided a statement about the relevance of their work to the tourism industry. Having a master's degree and working experience in environmental science helped me in understanding the featured studies and forming questions for the featured researchers and guiding the narrative. Having a bachelor's degree in journalism and working experience helped me in conducting interviews in a professional manner. While the initial idea was that the number of the recruited scientists would depend on the budget (as would the length of the final product), the final choice was made based on an unforeseen factor – Covid-19 – as is explained in the production section below.

To select the relevant research to be included in this documentary I extracted from the Web of Science all environmental research related articles published in 2019 by Queensland-based universities. The initial search yielded 1050 articles. Abstracts of all these studies were read and based on the information gathered the pool was reduced to 187 papers. From these, one study was chosen to be featured in the documentary as a narrative example.

For the interviews, environmental scientists were selected based on geographic proximity to keep production costs to a minimum. Scientists from two local universities were contacted. The requirement of having recently conducted environmental study in Queensland remained a pre-requisite for the selection. The scientists were also asked to provide published or unpublished articles so that I could identify filming requirements. The scientist for Interview 2 was selected through this process.

Additionally, I attended an Environmental Forum hosted in Noosa shire, where an environmental scientist from the University of Queensland gave a presentation on her PhD research. During the presentation I learned about the recent study and concluded the content would be relevant for the documentary. Apart from her study content, this

particular scientist seemed suitable because of the contrasting elements to the other featured scientist. These elements included gender (male vs female), different University (metropolitan vs regional), different scale of studies (local vs state-wide). The scientist agreed to be interviewed in the documentary, however, the final confirmation of participation depended on the agreement by the scientist's affiliated institution. I prepared a two-page document with a short outline of this PhD research, the documentary project and information about our background. Once the agreement was obtained, I worked with the scientist on developing a script for the Interview 1.

The last two tasks of the pre-production process were location scouting and scheduling. The script included outdoor locations and indoor locations (e.g., scientists' offices). The budget (i.e., keeping the transport costs low) and the scientists' residences were considered. Living in the area where the documentary would be filmed, I already knew potential filming sites. Together with the videographer we visited several coastal sites in the Sunshine Coast area prior to filming to determine environmental conditions (e.g., light at different hours of the day, which would determine filming in the morning or afternoon, wind which affects the recorded sound, etc.) to select the most appropriate sites and equipment.

The output of the pre-production stage was a production plan, with scheduled dates/times and locations of the filming, participants' contacts and a script of the intended footage.

Production stage

Weather conditions and the availability of the environmental scientists and videographer influenced the documentary production. Additional complications arose with Covid-19.

In the production stage, I took on the role of a film director. Initially, two filming days were scheduled: the first to record the two interviews, and the second to record the additional/supporting footage. Covid-19 emerged around the time of the scheduled filming. Increased uncertainty and fear about virus transmission permeated this period. Governmental restrictions were changing/strengthening unpredictably.

Due to these reasons, and the scientists' working commitments, it proved to be impossible to schedule both scientists on the same filming day. Focusing on the first interview only, it was easier to make arrangements with the scientist and the crew.

However, a day prior filming the scientist informed that she had recently felt unwell, suspecting she had caught a virus a couple of weeks previously while travelling. She advised she has not been tested and was feeling better, but felt it was her duty to declare her situation. Out of precaution we postponed the filming to a virus-transmission safe time. Additionally, we continued with the social distancing rule.

The filming took place on the top of Emu Mountain near Peregian Beach (Figure 18), which required all the filming equipment to be carried up. This location was chosen as it was also one of the observation points of the scientist's environmental study. During location scouting, the site was deemed particularly suitable for the visuals and wind protection (bush acting as a natural barrier). The videographer recruited an assistant to help with the lighting equipment. Several takes of the interview were recorded to secure enough footage. The total filming took approximately two hours.

Figure 18: Shooting the interview

To keep production costs within the budget, I requested supporting images or videos that the scientist had from her field work. Three images were supplied by the scientist: data collection tag, whale with a tag, and statistical graphs, which were not used in the final version of the documentary. Additionally, I sourced archival video footage of whales underwater and their sounds from a local photographer. It was important that footage from different sources and footages were compatible and of sufficient quality for the documentary to be produced in 4K. The camera used for this footage was Sony a7iii.

In the meantime, the scientist for Interview 2 decided to limit his social exposure and opted out of participating. Under these circumstances, the decision was made not to look

for another environmental scientist to be featured in a second interview. Instead, the second interview was excluded from the script and the outro was changed.

In the original script the outro would have been shorter and consisting of a written text. The new outro script we featured explained the research behind the documentary (its purpose) and invited the audience to participate in the survey. The changed script required additional resources (e.g., appropriate indoor space), which would be difficult to obtain considering the Covid-19 situation and the limited budget. To solve this problem, an experienced local producer was recruited to the project.

A local office was negotiated to film the outro footage (Figure 19). Local traffic noise proved to be a problem, as the office was located next to a bus stop. Several takes of the interview were recorded to secure enough footage. The total filming took approximately two hours. The camera used for this footage was Sony a7iii.

Figure 19: Shooting the outro

The introduction part of the video included drone shoots. The filming of these did not go according to schedule due to weather. Too much wind several days in a row prevented filming in the coastal area. Once the conditions were right, the videographer and the other producer went on site. I selected the sites in discussion with the other producer. Due to Covid-19 restrictions, I did not attend this filming. However, I supplied a detailed map of the selected areas to film within a designated location. See Figure 20.
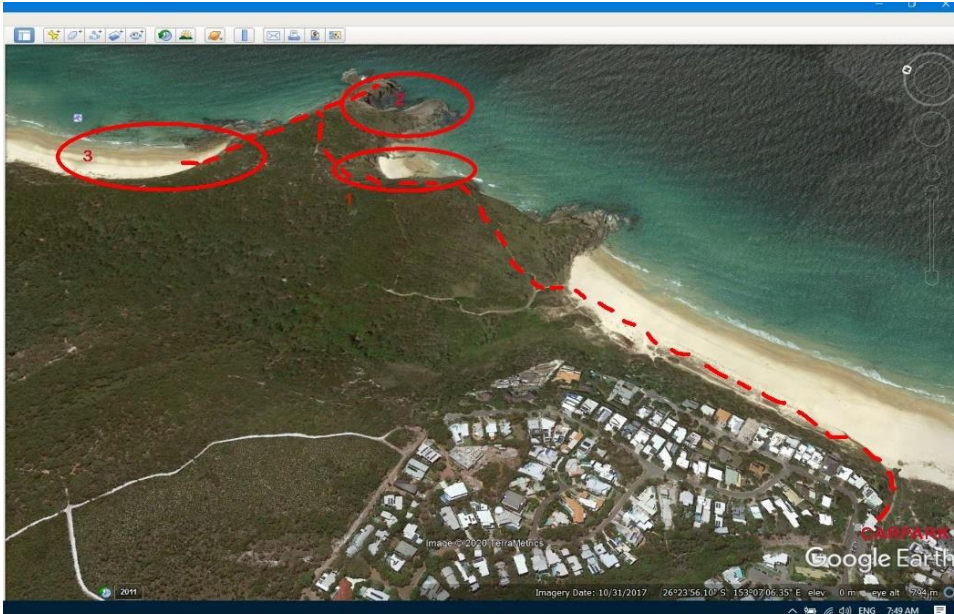
Figure 20: An illustration for the drone shooting location

This location was specifically chosen due to its wilderness (lack of built environment and beach-walkers). This meant that there was no car access to this area and the equipment needed to be carried to the location. The equipment used for this footage was Mavic 2 Pro 4K. The filming took approximately two hours.

The narrative production

After reading the paper to be used for the narrative we got in contact with the first author, explained the documentary project and requested permission for the abstract to be used and any relevant visual material to accompany the story. The study was about the discovery of a new species of horsetail, and due to this novelty, no material was available to be purchased from Shutterstock data bases[15].

The author approved and advised that the permission was also needed from the publisher. After I obtained the permission from the editor of Australian Systematic Botany and CSIRO publishing, a written request for the visuals was made to the Queensland Museum, which held the rights to the high-resolution images taken in the field during their research. After explaining that the required material was for non-commercial purposes, written permission (contract) was given to obtain the photos free of charge.

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[15] Shutterstock data bases are repositories of stock photos, videos, and illustrations, where royalty-free material can be purchased. The material is supplied by photographers and videographers worldwide. These data bases are commonly utilised to obtain footage that would support the main story/recordings.

The documentary gained interest among the authors as well as the Queensland Museum (QM), which saw the narrative as great promotion of the research. I received a request to share the documentary and participate in the World Science Festival Brisbane 2021. Because the documentary was a research instrument, sharing it publicly for promotional purposes did not seem appropriate. However, including the documentary as part of a presentation at the festival seemed suitable. The plan did not proceed due to the Covid-19 pandemic restrictions.

I had several conversations with the primary author (researcher) as well as the photographer to better understand the study and behind the scenes environment. Additional to the QM copyrighted images, a few high-resolution photos relevant to the narrative were supplied by the first author of the study and the photographer from their private collections. Due to Covid-19 restrictions I was not able to travel to Brisbane for face-to-face conversations and to collect the material. Instead, transmission via Dropbox was arranged. The geologic timeline was created using Adobe Photoshop 2020.

The recording of the narrative was led by the videographer, who recruited local talent to narrate the story. Several takes were recorded, as it was important that the entire text is spoken in "one go". The narrator was a native English speaker.

Postproduction

The post-production was a joint effort shared between me, the videographer and the other producer. I took on the role of a director/story editor and the videographer of a technical editor. The original idea was for the director/story editor to create 'items'[16] from the entire footage and providing instructions/suggestions to the technical editor about the transitions, design, etc. However, due to Covid-19 restrictions, the items had to be done by the videographer himself. Material from QM was delivered to the videographer via Dropbox. However, detailed editing instructions and examples of similar work examples were provided to help visualise the expected outcome. Background music examples were also provided, and the videographer purchased a song in a similar style from a music database. I wrote the text to be used in each section of the documentary. The videographer then edited visuals and audios and montaged them into a final product. This stage took much longer than expected. Due to social distancing rules, all contact

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[16] Items are smaller sections of the raw footage without precise cuts.

had to be carried out online. Because large files were involved, it was not possible to simply send them via emails. Each version had to be exported from the Adobe Premiere software (which was used for editing) and be placed unlisted on YouTube, which took eight hours or more. In normal circumstances, the director and technical editor would sit together at a computer and would be able to make changes immediately. In this editing process, each change took days. Despite the best efforts from the post-production team, two "emergency" face-to-face meetings still had to be held to complete this project.

The entire project took approximately five months to complete. The finished product was a video of 6.55 minutes in length. For comparison, Finkler and León-Anguiano (2019) created a 2 minute and 20 second video for the purpose of their research on science communication videos for sustainable whale watching. Their production took one year (Finkler & León-Anguiano, 2019).

My final video included the introduction, an interview with a scientist, a narrative, and the outro. For an easier distribution, I created a YouTube channel, where the documentary was uploaded as an Unlisted video[17]. This allowed for sharing only the link to the documentary rather than the entire file.

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[17] Unlisted videos and playlists can be seen and shared by anyone with the link, but they will not show in the YouTube search results (Google, 2023)

Appendix C: Framework for Documentary Development (adapted from Pauwels, 2019)

INTEGRATED FRAMEWORK FOR VISUAL RESEARCH (VERSION 2.0)

1. PROVENANCE & NATURE OF VISUALS	2. RESEARCH DESIGN & PROCEDURAL ASPECTS / ISSUES		3. FORMATS, PURPOSES & AUDIENCES

1.1 Source & Production Context

- **Pre-Existing/'Found' Visual Materials**
- Societal/'found' visuals (from a variety of private, institutional, public sources)
- Secondary visual research material (produced by other researchers or for other research purposes)
- **Researcher-Instigated New Materials**
- Researcher-produced 'in-situ' transcriptions of direct visual observations (no permanent intersubjective visuals)
- Researcher-produced visual materials (possibly in collaboration with professionals)
- Respondent-generated visual/multimodal output (prompted by researcher)

1.2 Referent / Subject of Research

- **Material Nature and Culture**
- Actual artifacts, objects and structures (and signs of use: e.g. erosion measures)
- Reconstructed artifacts, objects and structures
- **Human Behavior**
- Naturally occurring behavior
- Prescribed/ritualistic behavior
- Elicited behavior (experiments)
- Staged/re-enacted behavior
- **Non-visual/Non-material Referent**
- Non-visual phenomena
- Abstractions/concepts/relations
- Quantitative data

1.3 Visual Medium / Recording Technique

- **Transcription Modes**
- (Written transcription of direct observation, e.g. counting/measuring = no permanent visual recording)
- Non-algorithmic/intentional recording or visualization techniques (drawings, sand paintings, …)
- Algorithmic/non-intentional or (semi) 'automated' recording/visualization techniques (photographs, film, medical imaging techniques, …)
- **Some Core Traits**
- Static versus moving (audio) visual representations
- Spatial dimensions: 2D or 3D representations
- Multimedia capabilities: image, sound, spoken & written word, lay-out & design/ forms of interactivity
- Scopic range & mobility (fixed, movable, wearable, remote control, aerial devices)

2.1 Analytical Focus

- The Visual Artefact ('found', respondent- or researcher-generated)
  - The level of the depicted or the content (the 'what')
  - The level of the depiction or the formal qualities (the 'how')
- The Production Process (who, how, why)
- Respondents' Verbal (and visible) Reactions to visual prompts (visual elicitation)
- Visual Practices/Uses (what people do with the visual artefacts)

2.2 Theoretical Grounding

- Theories and frameworks related to visual production & analysis
- Theories and frameworks related to the specific subject matter/theme

2.3 Visual Competencies

- Operationalization and visual translation of theory and research interest
- Choice of recording devices and techniques with respect to their epistemological consequences
- Active knowledge of the dynamic visual language and conventions of media in their cultural context
- Productive collaboration: integration of expertise/skills: technical, normative, creative aspects

2.4 Sampling & Data Production Strategies

- **Collecting & Sampling of Found Visuals**
- Choosing appropriate search and sampling strategy (physical or algorithmic selection parameters: e.g. time, place, content, form)
- **Visual Data Production & Sampling**
- Explorative/opportunistic/systematic approaches
- Sampling and shooting techniques (before and during data production: what and how): random, spatial (grid or X-steps), shooting script.
- Temporal dimension: time-slice, interval, or longitudinal (repeat) approach
- Instructing/briefing respondents (respondent-generated visuals)
- Expressive/creative visual production (with communicative end)

2.5 Monitoring Interventions

- **Preliminary investigation** of the specific demands of the field and the chances of using visual media ('prior ethnography').
- **Diminish undesirable external influences** (e.g. censorship before, during or after the shooting) to an acceptable minimum
- **Reduce 'reactivity'** via information, gradual introduction of visual media and crew, behavioral leeway of situation.
- **Assess 'obtrusiveness'** of the research set up and the resulting 'reactivity'/self-monitoring (during and after the study)
- **Recognize and justify intentional interventions** (reenactments, material modifications)
- **Special production measures** (framing, lighting, camera position) or post-production interventions (digital erasure, cropping, black strip), e.g. for ethical reasons

2.6 Nature & Degree of Field Involvement

- No awareness/no involvement
- (Slightly) aware but unacknowledged
- Reactive behavior (e.g. before camera)
- Interactive behavior (exchanges with researchers and crew)
- Participatory (taking active part in production)
- Joint production (shared responsibilities and benefits)

2.7 Context & Reflexivity

- Provision of **image-internal context** (visually and possible auditory/verbally)
- Provision of **image-external context** (other sources of information: e.g., study guide or related data)
- **Reflexivity issues:** personal and cultural position of researchers/producers; explication of 'choices' and set-backs along the way; specifics of what is shown and not shown

2.8 Ethical & Legal Aspects

- Maintain **integrity of visual materials** (communicate process and any alterations)
- Avoid **harm to research subjects** and related parties (often but not only through securing anonymity)
- Apply appropriate forms of **'informed consent'** (if and when possible)
- Ensure **ongoing preservation** of subjects' rights
- Adhere to culturally sensitive and discipline specific **ethical charters** and practices
- **Acknowledge ownership** (copyrights holder/authorship (maker)/portrait right (subject)
- Encourage **'fair use'** (USA)/'fair dealings' (UK) in scholarly publishing

3.1 Presentational Form & Standards

- **Output Options**
- Article/chapter without visuals
- Article with graphical or conceptual representations
- Pictures/visuals and words (illustrated article; poster; lecture; visual essay)
- Self-contained linear film/video
- Interactive multimedia product
- Exhibition/performance, …
- **Standards of Acceptance and Weight of Each Format**

3.2 Status & Role of the Visual

- Distinct **status and role:** illustration/ example/exception/synthesis/projection/ conceptual construct,…
- Requirement to unequivocally **communicate** the distinct ontological status and role
- Use and recognition as both **mimetic** (documentary) and **expressive** (argumentative) tools
- Clarify **relations/interplay** with other expressive systems and codes (multimodality)

3.3 Aims & Audiences

- **Selected Purposes and Audiences**
- Contribute to fundamental research (peers)
- Support applied research (commissioners, peers)
- Educate novices in the field (students)
- Inform general audiences (press, authorities, citizens)
- Sell projects to approving bodies and funding agencies (scientific organizations, institutions and corporations)
- Entertain broader audiences (vulgarization in magazines or TV programs, game shows)
- Activism: help to induce changes in society (communities, pressure groups, political parties,…)
- **Evaluate 'match'** between provenance, process, end-format, purpose and audience
- **Re-evaluate appropriateness** of visual artefact when changing purpose and/or audience

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Appendix D: Examples of Online Survey Distribution via RTOs Communication Channels
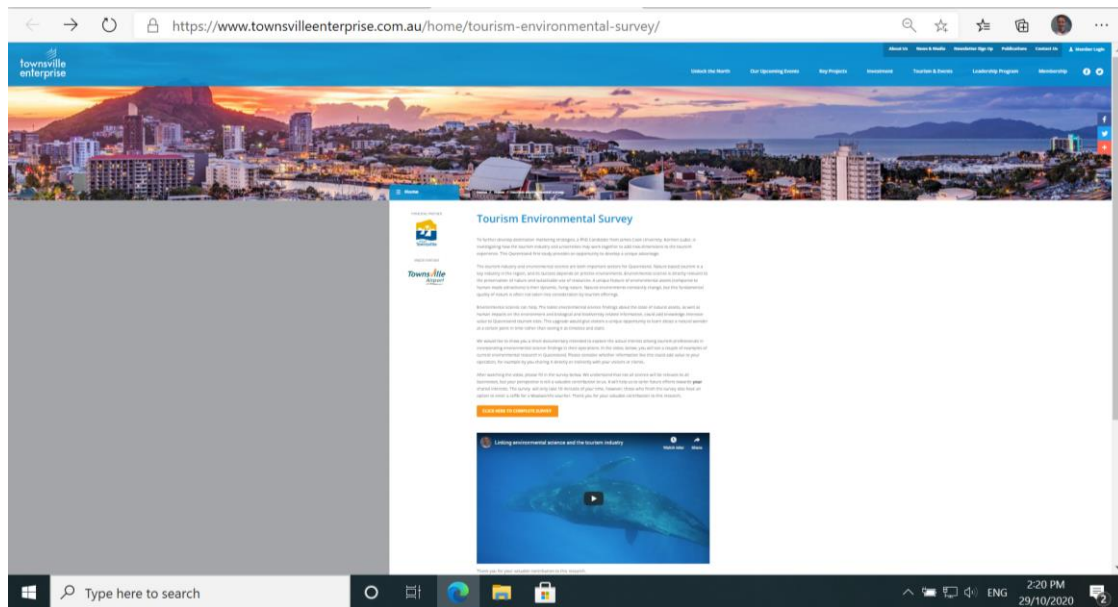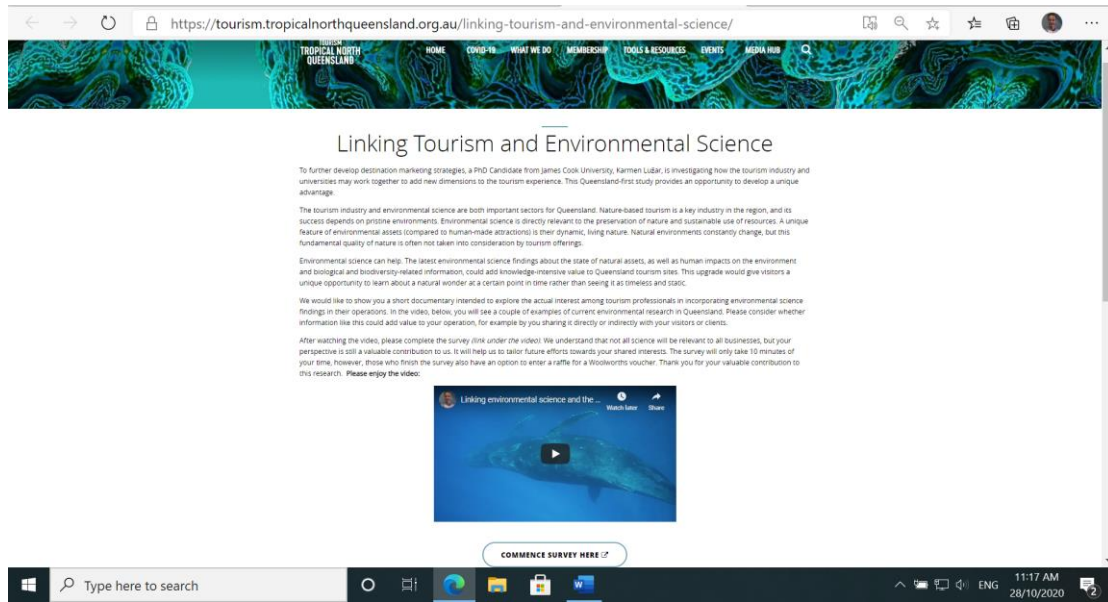
Tourism and Events Alert - Brisbane Business Hub launches

Research survey

To further develop destination marketing strategies, a PhD Candidate from James Cook University, Karmen Lužar, is investigating how the tourism industry and universities may work together to add new dimensions to the tourism experience. This Queensland-first study provides an opportunity to develop a unique advantage.

Please click here to watch a short documentary first, which is intended to explore the interest among tourism operators in incorporating environmental science findings. After watching the video, please complete the survey below, which should take approximately 10 minutes. All submitted responses will have an option to enter a raffle for a Woolworths voucher.

Complete survey here

Latest industry news and updates from FCTE 🌳

FCTE - QTIC Survey

FCTE and QTIC are working together to identify tourism and hospitality job needs in the region. With a survey conducted by QTIC to help identify the key workforce challenges that the Tourism and Hospitality Industry is currently facing. The data collected will allow QTIC to better align government-funded employment and training initiatives under the 'Tourism Training Skills Support Strategy' funded by the Department of Employment, Small Business and Training. Workforce issues are likely to feature prominently as QTIC work towards a strong recovery for tourism. Tourism businesses in all states are raising growing concerns about workforce issues.

It is a quick five-minute survey with all answers remaining confidential. Complete the survey and go into the draw to win two tickets to our Tourism Village Celebration (valued at $300), or a $200 gift voucher.

James Cook University Survey for Tourism Businesses

Amidst these COVID-19 times we need to look at innovative ways to market Queensland destination more than ever. Is it feasible for the tourism industry and universities to work together to add new dimensions to the tourism experience? Karmen Lužar, a PhD Candidate from James Cook University, is investigating whether latest environmental science findings can become part of destination marketing strategies to aid sustainable development of the region. This Queensland-first study provides an opportunity to develop a unique advantage.

We understand that not all science will be relevant to all tourism businesses, but your perspective is still a valuable contribution to us. It will help us understand what tourism professionals at a local level collectively think so we can make future efforts in that direction.

Please view the following seven-minute documentary before answering the survey.

James Cook University
Destination Marketing Research

To further develop destination marketing strategies, a PhD Candidate from James Cook University, Karmen Lužar, is investigating how the tourism industry and universities may work together to add new dimensions to the tourism experience. This Queensland-first study provides an opportunity to develop a unique advantage.

The tourism industry and environmental science are both important sectors for Queensland. Nature-based tourism is a key industry in the region, and its success depends on pristine environments.

The latest environmental science findings of the state of natural assets, as well as human impacts on the environment and biological and biodiversity-related information, could add knowledge-intensive value to Queensland tourism sites.

See below a short documentary intended to explore the actual interest among tourism professionals in incorporating environmental science findings in their operations. In the video, you will see a couple of examples of current environmental research in Queensland.

After watching the video, please complete the survey, link provided below. The survey will only take 10 minutes of your time; however, those who finish the survey also have an option to enter a raffle for a Woolworths voucher. Thank you for your valuable contribution to this research.

Please enjoy the video:

Take the Survey

Please refer all questions to Karmen Lužar at karmen.luzar@my.jcu.edu.au

APPENDIX E: Case Summary: Communicating Environmental Science to the Tourism Workforce

Who is interested?	Females
	< 30 years old
	Postsecondary education or higher
	+ Managerial position preferred
What kind of content would be best received?	• Location specific • Strong association between multiple environmental themes of interest • Activities, tours and attractions sector has widest interest
Where are they located?	• Strong interest in natural features when they are operating near them • Low interest in natural features when they are not operating near them • For research related to beach and marine environments seek within 2 to 4,7 kilometres from these environments
How to make environmental research videos for the tourism workforce?	Visual Aspects of a Video as a Medium: • Visuals are the first recall • Moving pictures before still images • Visuals need to support the content (story) • Subject over object • Affective imagery Audio Aspects of a Video as a Medium: • Importance of clear audio • Accent matters • Pace and tone preferences differ withing audience • Supporting audio sounds improve emotional engagement Content: • Mind the complexity of topic • Mind the language • Support the content with affective imagery that evoke associations • Alternative: Personal stories • Include clear purpose (needs to be relevant to the tourism workforce or tourists, e.g., impact) • Include call for action • Location as reference for relevance

	Montage: • Tourism workforce focuses on production aspects more than content • Different elements need to work together to create a meaningful whole • Transitions matter: aim for seamless and smooth • Consider high-quality reel vs cost of production (potentially seek professional production assistance)

Communicating Environmental Science to the Tourism Workforce

Appendix F: Summary of Thesis Contribution

Towards Non-technological Innovation:
Communicating Environmental Science to the Tourism Workforce

OVERALL AIM: To understand conditions and required activities to improve communication between environmental scientists and tourism professionals in aid of improving academia – industry relations and contributing to sustainable development of the Queensland region.

CASE:

Communicating environmental science to the tourism workforce

Cross-sectoral communication as a non-technological innovation

THEORETICAL CONTRIBUTION:

Innovation Systems Theory – Triple Helix
- Non-technological application
- Consolidation of communication scholarship
- Application of communication and marketing segmentation concepts
- Proposed Triple Helix Communication model

Communication Theory
- Application of the encoding/decoding communication model in a cross-sectoral setting

Tourism Theory
- Stakeholder communication: empirical example on how to communicate environmental science to the tourism workforce

PRACTICAL CONTRIBUTION:

- Provide how-to communication guidelines for environmental scientists
- Expose the idea of using environmental science communication for a unique selling proposition in tourism
- Provide evidence towards innovation policies change