To What Extent Have the Mandates of Transportation Agencies Been Improved Regarding the Consideration of Biodiversity? An International Comparison

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ABSTRACT

To What Extent Have the Mandates of Transportation Agencies Been Improved Regarding the Consideration of Biodiversity? An International Comparison.

Sabrina Mruczek

Transportation infrastructure, particularly road networks, have significantly contributed to the social and economic development of many countries. However, roads also negatively impact biodiversity through habitat fragmentation, degradation, and wildlife-vehicle collisions. The project has two goals: to examine the global extent of biodiversity consideration in transportation agency mission statements and to identify barriers to integrating biodiversity, surveying Canadian and U.S. transport officials. Guided by the 'polluter pays principle', we ask: to what extent do agencies consider biodiversity, and what challenges or opportunities exist? We hypothesize that countries who signed the Convention on Biological Diversity (CBD) should show an increased openness to biodiversity consideration, 30 years after the agreement's 1992 signing by 196 nations. Methods include a dimensional cluster analysis of 77 mission statements from Canada and its provinces, the U.S. and its states, and 13 CBD signatory countries. Hierarchical dendrograms and four linkage methods ('Complete', 'Average', 'Single', and 'Ward.D2) were used to visualize similarities. France was the only country to explicitly mention 'biodiversity'. Most statements emphasized human focused priorities like safety, economy, and quality of life, often omitting or vaguely referencing the natural environment. Survey findings revealed general openness to biodiversity inclusion but barriers such as public or managerial backlash, political constraints, misuse of funds, and concerns over greenwashing were cited. The

mixed-methods approach aims to identify exemplary mission statements that can serve as biodiversity leadership models in the transport sector. It also seeks to provide strategies for overcoming identified barriers to biodiversity integration into agency mission statements worldwide.

Keywords: Biodiversity, Transportation infrastructure, Mission statements, Polluter pays principle, Convention on Biological Diversity (CBD), Dimensional cluster analysis, Barriers to biodiversity integration

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Contribution of Authors:

As first author, I was responsible for the conception, design, data collection, analysis and the writing of the two manuscripts related to this thesis. The manuscripts were co-authored by Dr. Jochen Jaeger, who advised on study design, statistics, editing, and overall revisions to the manuscripts as well as conceived the original idea for the project. The project emerged from several discussions during research projects between my supervisor and the Ministère des Transports du Québec (MTQ) about the frequencies of animal mortality on roads and the lack of road mitigation measures. When my supervisor suggested incorporating wildlife passages and wildlife fencing to better protect biodiversity along roads, the representatives of the MTQ always responded: “That is not in our mandate!” This dismissal led to a deeper question: What is preventing the consideration of biodiversity in road planning and road maintenance? The answer seemed to lie in their mission statements and mandates, sparking the idea for this research.

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1. Thesis Introduction

Road networks are important today for socio-economic reasons but they are also responsible for bringing about negative changes in the natural environment (Meijer et al., 2018, Barrientos et al., 2021). Not only does the construction and use of more roads lead to more greenhouse gas emissions but is also responsible for fragmenting wildlife habitats which has negative impacts on biodiversity. The negative impacts of roads have been well documented and include wildlife-vehicle collisions, habitat loss, and reduced habitat connectivity (Teixeira et al., 2020). Roads act as major barriers to animal movement for many species. Roads increase animal mortality and alters the spatial configuration of habitat (Jaeger et al., 2005).

Not all roads have the same level of ecological impact. Their effects on wildlife can vary depending on road type such as paved roads, gravel roads, two-lane rural highways, or four-lane expressways, and the type of landscape, e.g., ecologically sensitive areas. Larger, busier roads can pose greater risks due to higher traffic volumes and faster travelling speeds, whereas smaller or unpaved roads may have less severe but still significant ecological consequences (Coffin et al. 2021). This variation underscores the need for context-specific assessments when evaluating the impact of roads on biodiversity. Today's rate of biodiversity loss is occurring 10 times the pre-human background extinction rate (Betts et al., 2019) and the building of roads is one of the main drivers of global biodiversity decline (van der Ree et al., 2011) with roads now comprising the majority of transport infrastructure in most countries (Gibbons et al., 2019).

Currently, the Convention on Biological Diversity (CBD) has been one of the main leading global efforts, signed by 196 nations, with the aim to conserve biodiversity at the heart of the treaty (Chandra & Idrisova, 2011). It was signed in 1992 and officially enacted in 1993 which globally recognizes of the importance of biodiversity and preserve it.

This study aims to better understand how, globally, biodiversity is being considered within the transportation sector. Through the analysis of government transport agencies across countries presumed to support biodiversity protection through international agreements, the goal is to understand if there has been any improvement in the consideration of biodiversity, since 1992, or if it has made its way into mandates of transportation agencies. The additional use of a survey questionnaire will investigate how biodiversity is perceived within these agencies. For the project we are using the 'Polluter Pays Principle" (PPP) which is a principle in environmental economics that "renders the polluter responsible for the damage it causes to the environment" (Ambec & Ehlers, 2016, p.892). Using this principle, we want to understand how transportation agencies aim to better regulate biodiversity loss through policies implemented at several levels of government. The research aims to answer the following questions:

(1) Have there been significant changes to the mandates of transport agencies in regards to their consideration of biodiversity?

(2) How does Canada compare to a selection of other industrialized countries (e.g. U.S., France, Switzerland, Germany, and the Netherlands)?

(3) Are transport mandates today following an economy-centered paradigm or have they started using more ecologically centered schools of thought, since 1992?

(4) How much room is in these mandates for the consideration of biodiversity? How do agencies view biodiversity as a whole?

This thesis includes two manuscripts, each addressing complementary aspects of how biodiversity is considered within the mission statements of transportation agencies. The first manuscript focuses on assessing the extent to which biodiversity has been integrated in the

mission statements of transportation agencies of 77 regions including those at national and sub-national levels. This manuscript seeks to address the following research questions:

(1) What are the dimensions of the mandates of road agencies according to their mission statements? Which ones are more commonly used than others?

(2) How often and how detailed are environmental issues included in these mandates?

(3) How often and how detailed is biodiversity considered in these mandates?

(4) How often and how detailed is safety included within these mandates?

(5) How similar are the mandates of road agencies across sub-national regions (including Canadian provinces and territories, U.S. states, and other key player countries)?

(6) How many clusters of transport mandates can be distinguished based on their similarities and differences?

The second manuscript explores the perceived barriers to the integration of biodiversity, drawing on insights from officials within transportation agencies in Canada and the United States. It addresses the following questions:

(1) Do members of transport agencies believe that their mission statements are adequate regarding issues pertaining to biodiversity?

(2) What key factors within transport agencies could be hindering the inclusion of biodiversity in their mission statements?

(3) Do transport agency officials believe that the inclusion of biodiversity in their mandates would simply imply some level of greenwashing without real improvements?

(4) Do agents within the transport sector believe that biodiversity should be at least, in part, the responsibility of the transport sector?

Collectively, these two manuscripts aim to investigate the extent to which biodiversity has been formally and informally integrated into mandates in the transportation sector and to identify the institutional, ideological, and practical barriers that may be limiting its inclusion.

The following review of literature summarizes the impacts of road networks on wildlife in Section 2.1. Section 2.2 will discuss problems in policy design and implementation. Section 2.3 analyzes a political framework that can aid in guiding my research. Lastly, section 2.4 explores how and why we believe the study of these transportation mandates is necessary in our efforts in biodiversity conservation.

2. Literature Review

2.1 Brief Overview of the Effects of Roads on Wildlife

This section will primarily summarize the effects of roads on animals, excluding their impact on plants. Globally, roads dominate landscapes with both paved and unpaved roads totalling over 64 million kilometers. Projections suggest that an additional 25 million kilometers of road networks will be paved by 2050, a 60% increase since 2010 (Dulac, 2013; van der Ree et al., 2015). For the past three decades, road ecology, defined as "the study of how roads and traffic affect animals and plants, their abundance and distribution, and the conditions of long-term population persistence" (Jaeger, 2012, p. 344), has emphasized the repercussions of roads and road networks on landscapes, wildlife, and ecosystem stability (Bennett, 2017). The expansion of road networks in recent years has emerged as a key driver of habitat fragmentation contributing significantly to mortality rates due to vehicle collisions (van der Ree et al., 2015,

Barbosa et al., 2020). Some effects that we will be looking at briefly include; road mortality from wildlife-vehicle collisions, habitat fragmentation, and habitat loss.

2.1.1 Road Mortality: Wildlife-Vehicle Collisions

In Canada, from 2000-2014, 474 human fatalities were recorded on Canadian roads as a result of collisions between vehicles and wildlife (Vanlaar et al., 2019). This is largely due to Canada's vast rural expanses which increases the likelihood of encounters between motorists and wildlife on roadways. These encounters may involve large ungulates such as moose, elk, and deer, as well as smaller mammals including squirrels and turtles (Vanlaar et al., 2019). In Canada, the highest rate of human and animal mortality was found to be in Quebec because of roads built in the dense forests located in the province (which account for 45.6% of the total surface area). Although Canada has experienced a high rate of wildlife mortality, the rate of wildlife mortality was occurring at an alarmingly high rate in Europe (Gunson et al., 2011) and has additionally been on the rise as a result of three major changes including demographic expansion of ungulates, increased vehicle speed, and increasing length of roads (Bartonička et al., 2018). With large ungulates being the primary cause for human fatalities and damages to vehicles, the cost of an accident has significant economic impact and rates of wildlife-vehicle collisions are on the rise. The United States registers 725,000-1,500,000 wildlife collision cases with over 200 people dying annually. Canadian records show that the rate of roadkill on roads is between 4 and 8 animals per day in which the Canadian Ministry of Transportation (Transport Canada) spends upwards of $600,000 CAD annually tending to the cleaning of collision sites (Nandutu et al., 2022).

Though wildlife-vehicle collisions (WVCs) represent a relatively small portion of overall human road fatalities, they remain a significant and often overlooked contributor to deaths on roads. Mason et al. (2022) reported that, as of 2019, Canada's road traffic death rate was 4.69 per 100,000 people and, despite global efforts, the World Health Organization's Sustainable Development Target 3.6, which aimed to have reduced traffic deaths by half by 2030, will not be met at this rate (World Health Organization, 2018; Mason et al., 2022,). While many traffic-related fatalities are driven by human behaviours including impaired driving, speeding or not wearing seatbelts, factors that are difficult to control, WVCs represent a category of collisions that can be mitigated through targeted, evidence-based interventions. Roads can be designed to reduce the likelihood and severity of WVCs. Therefore, treating biodiversity on roads as a legitimate safety concern not only contributes to ecological preservation but also supports broader efforts to enhance road safety and reduce preventable fatalities.

2.1.2 Habitat Fragmentation, Reduced Movement, and Population Subdivision

Habitat fragmentation is defined as "a process in which a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original" (Fahrig, 2003, p. 490). Roads fragmenting habitats can have devastating effects on wildlife including genetic consequences, or the "barrier effect", as a result of the decrease in gene flow between the patches (Jaeger et al., 2005). For some species, roads act as complete barriers to animal movement (for example, they portray road avoidance behaviours including noise avoidance, road surface avoidance, and car avoidance). Therefore, mammal populations that are highly sensitive to roads and avoid them, access to mates, food, and breeding sites is impeded. These patches are less likely to receive an influx from other populations which can lead to inbreeding within specific patches and find a higher probability of

inbreeding in patches of smaller sizes (Jaeger et al., 2005). Additionally, if an inbreeding depression is formed, the genetic fitness of offspring can decrease to the point where the probability of local extinction can increase (Kardos et al., 2016). Therefore, roads can cause inbreeding and local extinction among mammals that show a higher level of road avoidance.

2.1.3 Habitat Loss and Habitat Changes

Habitat loss and changes in habitat composition can have additional negative consequences for mammal populations. This includes the direct change from a suitable habitat (forested habitat) and replacing it with a matrix such as an asphalt road (unsuitable habitat) (Eigenbrod et al., 2008). A new and unusable habitat is formed causing changes in mammal behaviour, migration patterns, and the use of the remaining habitat (Duffett et al., 2020). Roads also cause additional indirect consequences on biodiversity. Road construction increases the presence of artificial edge habitats within forested landscapes. These edges are subject to microclimates that differ from the original forested habitat (Alamgir et al., 2017). Forested areas situated within 50-100 meters of these edges experience variations in sunlight exposure, temperature, humidity, as well as altering the geochemical cycles within the habitat edges, all of which can affect the abundance of wildlife utilizing the edge habitats (Laurance et al., 2009; Alamgir et al., 2017).

2.2. The Problem: Roads and Other Linear Infrastructure

With road networks becoming increasingly prominent, it is up to the ministries of transportation to understand and mitigate these effects. While mitigation measures to prevent the loss of biodiversity exist in the form of signage, animal detection systems, wildlife fences, and wildlife passages, it is an economic decision that the cheaper mitigation measures are the ones

that will be used more frequently (Glista et al., 2009; Bond & Jones., 2013). While transportation agencies are aware of the issues pertaining to biodiversity, the question remains: Since 1992, when the Convention on Biological Diversity (CBD) was signed, what can, and what are they doing at the policy level to prevent biodiversity loss?

2.2.1. Why Care about the Effects on Biodiversity?

The well-being of humans is supported by the ecological systems surrounding us and the benefits that they provide. Changes to these systems, including the loss of biodiversity, has become an economic, social, and political concern (Jaureguiberry et al., 2022). Biodiversity and human wellbeing are inherently linked as biodiversity offers a wide range of benefits including the foundation and regulation of ecosystem processes and functions in which its decline would significantly alter human well-being (Naeem et al., 2016). Conserving biodiversity can have mutually beneficial outcomes by safeguarding the ecosystems that are essential to human well-being and economic development (Kilpatrick et al., 2017). Policies, however, tend to emphasize economic growth while the integration of biodiversity remains ambiguous. This disconnect has led to growing calls to shift biodiversity strategies to more effectively align biodiversity preservation with socio-economic objectives (Seddon et al., 2016).

2.2.2. Current Mitigation Measures to Lessen Biodiversity Loss on Roads

2.2.2.1 Road Signs

Transportation agencies have begun applying different mitigation measures which all have varying degrees of success. One of the most often used mitigation measures is road signs. This measure targets altering driver behaviour (Glista et al., 2009; Found & Boyce., 2011; Bond & Jones., 2013). However, it has been found that they are either ineffective or their effectiveness

is relatively unknown (Bond & Jones., 2013). Economic factors have been cited to be an important deciding factor regarding the implemented of mitigation measures, such as signage, which is the cheapest of all the mitigation options (Bond & Jones., 2013). A meta-analysis conducted by Rytwinski et al. (2016) also found that "economic considerations strongly influence the chosen mitigation measure" and many state transportation agencies in the U.S. have reported that little is known about the effectiveness of this mitigation measure.

2.2.2.2 Wildlife Fencing

Wildlife fencing has been deemed effective if used in combination with other mitigation measures such as wildlife passages which has the added benefit of increasing connectivity to other patches (Huijser et al., 2016). The best outcomes of fencing have been observed when they are coupled with other mitigation measures (Rytwinski et al. 2016) yet single retrofitted fencing may be suitable in certain cases. Van der Ree et al. (2015) stated that retrofitted fences may be acceptable if fences are constructed to be species specific (i.e., 2.4 m in height for large ungulates and 0.2-1.0 m for small mammals). For example, in Arizona, a retrofitted fence stretching 9.17 km of road alongside Interstate-17, was fitted with a 2.4 m high fence to guide elk *(Cervus Canadensis)* to two large wildlife overpasses and two modified transportation interchanges. It was concluded that, during a 2 year study of elk collisions in this region, accidents had reduced by 97% along this 9.17 km stretch of road (Gagnon et al., 2015). While fencing can have positive effects in helping reduce mortality on roads, there is still debate over the appropriate length of a fence to reduce mortality on the road. The 'fence-end effect' refers to the situation that animals move along the fence and attempt to cross the road at the end of the fence creating new mortality hotspots (Spanowicz et al., 2020).

2.2.2.3. Roadside Animal Detection Systems

Similarly to road signs, animal detection systems are not meant to keep wildlife off the road but rather they are targeted at changing driver behaviour (Grace et al., 2017). Grace et al., (2017) tested a roadside animal detection system (RADS) installed in Big Cypress National Park (Florida, USA) in 2012 as a response to increased numbers of Florida panther mortalities. The field study concluded that the animal detection system put into place only reduced driver speed by 3.82 km/hr. Although this study did not explicitly study mortality, the study did find that small reductions in speed is linearly correlated to the decrease in roadkill for species such as opossums and coyotes. While roadside animal detection systems have proven marginally successful in reducing driver speed, there is still debate over where to put these detection systems. It is suggested that these systems be placed along roads with lower speed limits (<100km/hr) as motorists are more likely to be more responsive at lower speeds (Grace et al., 2017). It is also recommended that road roadside animal detection systems be coupled with other mitigation measures to ensure that both motorist and animal behaviour are being influenced to increase the chance of both animal and human survival (Gordon et al., 2004).

2.2.2.4 Wildlife Shelving in Existing Culverts

Wildlife underpasses have been successfully studied by Caldwell & Klip. (2020) with the use of wildlife cameras at three different locations in California, U.S. The underpasses were predominantly be used by mule deer *(Odocoileus hemionus)*, bobcats *(Lynx rufus)*, mountain lions *(Puma concolor)*, and coyotes *(Canis latrans)*. One major issue encountered with the use of wildlife underpasses is the tendency of predator species to avoid these areas due to high human disturbances. Amongst coyotes, avoidance was common due to human interactions such as all-terrain vehicles and the movement of cattle (Caldwell & Klip, 2020). Many different carnivorous

species tended to avoid underpasses used by humans, but the mule deer successfully used these underpasses, seldom being deterred by human activity. While underpasses pose a viable solution and reduce the rate of wildlife-vehicle collisions they need to be designed to be species specific. Where carnivore populations are high, a reduction in human activity is necessary (Caldwell & Klip, 2020). Although the use of culverts seems to be more species specific a study by Brunen et al., (2020) along highway 10 in Quebec, found that the presence of water and the culvert material influence mammal entry, with polyethylene culverts deterring mammals more than the steel and concrete ones. To enhance the use of culverts by mammals, it was suggested that culverts be retrofitted with dry ledges. Another study along Highway 175 in Quebec found that wooden ledges are preferred by squirrels (Martinig & Bélanger-Smith, 2016). Coupling retrofitted culverts with other mitigation measures such as fences is expected to increase the suitability of culverts as crossing structures (Brunen et al., 2020).

2.2.2.5 Wildlife Overpasses

Despite the evidence brought forward by scientists that wildlife crossing structures significantly reduce the rates of wildlife mortality, implementation of these structures is slow across North America (Lister et al., 2015). To date, across Canada, prototype wildlife overpasses have only been implemented in Alberta, British Columbia, and Ontario (Lister et al., 2015). Banff National Park in Alberta Canada is one of the most highly visited locations with over four million visitors per year, putting immense pressure on the natural ecosystem (Sawaya et al., 2014). Recently, the Ministry of Transportation of Ontario (MTO) installed a $3.9 million dollar wildlife overpass south of Sudbury (Scott, 2012; Healy, 2019). The overpass was designed as part of Highway 69 in an area which is known for high population of moose and re-introduced elk, which were experiencing a higher level of wildlife-vehicle collisions (Scott, 2012; Healy,

2019). As of March 2012, studies on this particular overpass monitored the use of the overpass by wildlife using trackpads and monitoring systems and found that the passage was being used by a variety of species (Scott, 2012). Transportation agencies often prioritize the immediate economic costs associated with wildlife structures, overlooking the long-term cost effectiveness. When strategically placed along high-risk areas for both humans and wildlife, these structures can reduce collisions and associated expenses. Given an overpasses lifespan of 75 years, they offer sustained benefits for both wildlife and driver safety.

Given the ongoing failure worldwide to meet biodiversity conservation goals, there need to be identifiable methods to increase the level of commitment for biodiversity conservation to be successful (Buxton et al., 2019). While some of these mitigation measures are put in place, they fail to address the problem of biodiversity loss at higher levels of government. Mitigation measures are useful, but they act as a temporary solution and better policies should be put in place to ensure that roads are designed in ways that take into consideration the natural environment.

2.2.3. Policies and Biodiversity Today: Are they working?

Transportation policy research in relation to biodiversity is very limited but there are treaties and policies today that have been designed with of the main goal being biodiversity conservation. The most notable treaty is the Convention on Biological Diversity which states that

"The Earth's biological resources are vital to humanity's economic and social development. As a result, there is growing recognition that biological diversity is a global asset of tremendous value to present and future generations. At the same time, the threat to species

and ecosystems has never been so great as it is today. Species extinction caused by human activities continues at an alarming rate." (Convention on Biological Diversity, 2011, pg.1)

The CBD has a desire to promote sustainable development and has, over the decades, been the predecessor of other biodiversity conservation strategies including the 2020 Aichi targets and the Sustainable Development Goals for 2030. The likelihood of these objectives (concerning biodiversity conservation) being met are low due to human population growth and the need for natural resources to sustain a growing population (Seddon et al., 2016). Countries who signed the CBD were required to submit NBSAP's (National Biodiversity Strategic Action Plans) describing how participating nations would set targets to limit biodiversity loss and implement measures to sustainably manage biological resources. For example, in Canada, the NBSAP consists of multiple documents that encourages different levels of government (federal, provincial, and territorial) to ensure the sustainable use of biological resources. Firstly, Canada responded to the CBD in 1995. The Canadian Strategy states that

"Conserving biodiversity and using our biological resources in a sustainable manner are essential parts of Canada's effort to achieve sustainable development" (Canada, 1995 pg, 8).

Canada has also implemented its biodiversity conservation goals for 2020, *The 2020 Biodiversity Goals and Targets for Canada* which describe "aspirational goals and targets results to be achieved through the collective efforts of a diversity of players both public and private whose actions and decisions have an impact on biodiversity" (2020 Biodiversity Goals & Targets for Canada, 2016, pg. 2). Although Canada is described as a key player country within the context of biodiversity conservation, Canada has unfortunately fallen short of its commitment to the protection of biodiversity. Rather than reaching their target goal of protecting 17% of its landmass and freshwater through the Aichi Biodiversity Targets by 2020, Canada has only

protected an estimated 10% (MacKinnon et al., 2015, Coristine et al., 2018). In the case of Canada's 2020 biodiversity strategy, it is argued that new layers of bureaucracy were added to the policy creating multiple layers of confusion and complexity (Lemieux et al., 2019). With the argument that policies are designed to be as well-rounded and holistic as possible, the Canadian government failed to include Indigenous people in the consultation process when these targets were being discussed and implemented (Lemieux et al., 2019).

While the Aichi Biodiversity Targets provide a framework to promote biodiversity conservation, shortcomings of the targets have been studied and some problematic elements have been identified. Butchart et al., (2016) identified several shortcomings, including ambiguous phrasing of targets, which can lead to confusion during implementation. The strategy was also found to lack a method of quantifying the degree of biodiversity conservation. Without a standard of measure it is difficult to determine what progress has been made or if the reporting of progress is accurate. Otero et al., (2020) studied the Aichi Biodiversity Targets and found that while the targets mention taking into consideration *"the impacts of use of natural resources […] within safe ecological limits",* the targets fails to mention the relationship between economic growth and the pressures that a growing economy places on the earth's ecological processes. This means that several of the Aichi targets, and any future targets, may be unachievable unless there are clearly stated interactions between economic growth and biodiversity loss (Otero et al., 2020).

2.2.4 How are Transport Policies Designed Today?

One often cited issue within policy design is that economic growth is a necessity in addressing poverty and achieving economic prosperity (Otero et al., 2020). Over the past 50 years there have been significant developments within the transport sector from making travel

more affordable to increasing the safety of traveling individuals. There has been growing awareness of environmental and social problems generated by high-mobility transport systems, leading to some efforts to mitigate those impacts. However, this growth has led to transportation agencies facing a range of challenges, particularly environmental impacts, stemming from the expansion of road networks (Vieira et al., 2007). Establishing targets is crucial for competitively driven economies, but their implementation remains understudied. Decision-making and target development are often guided by intuition rather than technical evidence (Vigar, 2017). Consequently, research in decision making and policy development frequently reveals a significant disconnect with policies not adequately addressing the real-world issues at hand (Marsden & Reardon, 2017).

The problems with policy making arise when mobility and wildlife are considered as separate issues. Policies must begin to recognize that mitigation measures will only be successful if there is collaboration between transportation agencies, ecologists, economists, and engineers (Seiler & Bhardwaj, 2020). Properly planning transportation infrastructure is important when considering how policies can mitigate the negative effects of roads on wildlife. In cases where road construction is not necessary, the optimal approach would be to avoid road development altogether. However, when road construction is required, all phases of design and planning need to be carefully considered. This ensures that implementation of effective wildlife management strategies allows for the establishment of regulations and standards which can facilitate development of appropriate solutions (Seiler & Bhardwaj, 2020). Rands et al., (2010) suggests three ways to continue in biodiversity conservation efforts. They are to; manage biodiversity as a public good, to integrate biodiversity into public and private decision-making, and to create enabling conditions for policy implementation. Here, we justify the need to study the mandates

of transportation agencies regarding their level of implementation of biodiversity into their mandates as a way to better integrate biodiversity into road-related decision making. While a broader review of policy documents could offer additional insights, focusing on the transport agencies' mission statements was a deliberate choice to ensure the feasibility of the project and to keep the dataset manageable. Mission statements reflect institutional priorities and can guide policy development, making them a logical starting point for this type of analysis. Therefore, more pressure should be placed on transportation agencies to better consider and minimize the effects of roads on biodiversity.

2.3 Implementing a Framework for Our Study: What Can Work?

Transportation agencies have begun acknowledging that investing in more costly mitigation measures would help significantly reduce the number of collisions happening on the road, and partially restore connectivity (van der Ree et al., 2015). As emphasized by Rytwinski et al. (2016), it is crucial for road agencies to recognize the necessity of more expensive, long-term mitigation measures. Now, with biodiversity levels on the decline worldwide, transportation agencies should be held accountable for the effects that they have on biodiversity. Addressing this issue requires adopting new environmentally conscious approaches that reflect the urgency of today's biodiversity loss (Lister et al., 2015). In North America, there exists a policy gap as no agency is responsible for the planning and construction of road mitigation measures. However, more compelling arguments are being brought forward that transportation agencies should be challenged to meet community and government expectations for environmental preservation through more rigorous environmental legislation (van der Ree et al., 2015). It is recognized that to achieve the goals of designing policies that combat environmental issues, such as habitat

fragmentation and biodiversity loss, there needs to be a recognition of the interdisciplinary nature of the issues as these integrate social and economic aspects (Lister et al., 2015).

A clearer understanding of political frameworks is essential for integrating biodiversity into transportation policies. It is believed that for real change in policy design, concepts must align with the framework of Ecological Economics (EE). It has the main goal of addressing emerging ecological and social crises driven by the current economic growth system (Farley & Kish, 2021). EE has challenged the neoclassical economic paradigm by taking into consideration the limits to growth (within planetary boundaries), taking into consideration important interdependencies between the economy and the environment, and takes into consideration the role of time by understanding that natural resources are as important today as they will be for future generations (Venkatachalam, 2007). EE views the economy as an integral part of a larger complex and finite planetary system i.e., understanding that the economy is but a subsystem of a larger local and global system and recognizes limits to the amount of physical growth of the economy (van den Bergh, 2001). EE emerged as one of the pioneering transdisciplinary domains aimed at governing human interactions with the natural world. It promotes cooperation between various disciplines to better understand and try to solve larger environmental and social issues using a combination of physical and social sciences (Farley & Kish, 2021). EE promotes the integration of ecology and economics, sustainability for future generations, valuing ecosystems and the services they provide, and encouraging an interdisciplinary approach to solving environmental problems.

The valuation of nature can additionally play a role in EE. Humans have overused and misused the environment and their actions reflect an ideology in which they believe that the use of these ecosystems and ecosystem services is “free” (Costanza & Farber, 2002). It is argued that

the more humans treat resources as “free”, they fail to recognize the adverse effects that their usage can have on society today and in the years to come and there must be a more rigorous consideration of ecological effects of social and economic decisions (Costanza & Farber, 2002). While the monetary valuation of nature remains a contentious issue in EE, the ‘Polluter Pays Principle’ (PPP) has been used as an economic, ethical, and legal instrument that has the potential to affect global responsibility for adaptation and mitigation (Khan, 2015). While PPP is more broadly studied within the context of atmospheric pollution, we argue that it can applied to other areas of mitigating adverse anthropogenic environmental effects. PPP states that those who benefit from activities that cause pollution should be the ones to bear the costs associated with the resulting environmental damage and is commonly invoked in policy discussions on environmental issues (Ambec & Ehlers, 2016) in which the polluter can be liable for the damage they incur (Barthakur, 2021). We argue that PPP can be transferred to other fields such as resource depletion, habitat destruction, water scarcity and contamination, and biodiversity loss.

2.3.1 ‘Polluter Pays Principle’ and Biodiversity Loss

Phelps et al. (2021) argue that the ‘polluter pays principle’ introduces the notion of environmental liability litigation. While environmental liability litigation follows the main ideology of the ‘polluter pays principle’ it adds that plaintiffs can ask courts to order responsible parties to provide remedies such as habitat restoration, public apologies, species reintroduction, and financial compensation. For the purposes of our study, we will be using the concept of the ‘polluter pays principle’ and EE to better understand the role of transportation agencies and if their policies are sufficiently addressing biodiversity loss and habitat fragmentation. We look at transportation agencies as they are responsible for the development and management of road networks. Therefore, we argue that if there is any environmental degradation caused by the

construction of roads then it is the responsibility of transportation agencies to take up the responsibility of proposing better planning designs and solutions to mitigate the negative effects of roads on wildlife and respective habitats.

2.4 Study of the Mandates of Transportation Agencies: How and Why?

Simply put, the Merriam-Webster Dictionary definition of a mandate is "to direct or require (someone) to do something" ("Mandate"). Therefore, the research will center on a series of road-related transportation mission statements from a series of OECD countries including, but not limited to, Canada, the United States of America, Germany, France, the Netherlands, Switzerland, Scotland, and Ireland. Countries are mainly chosen based on their involvement in the Convention on Biological Diversity with the exception of the U.S. The goal is to examine the extent to which environmental issues, particularly biodiversity, has been integrated into mission since the signing of the Convention on Biological Diversity (CBD) in 1992. This post-1992 timeline reflects more than 30 years of potential policy evolution since global recognition of the importance of biodiversity. Countries that have ratified the CBD should exhibit more awareness of biodiversity-related concerns. While the U.S. has not ratified the convention, it should recognize these issues as it has been more than 30 years since the initial signing. We argue that economic and environmental goals and policies should work in tandem to be both economically and ecologically sound. To study this, we performed an international comparison of transportation mission statements along with a survey questionnaire among professionals within the transportation sector (namely biologists, ecologists, and environmental specialists). We want to discover to what extent the transport mission statements consider ecological impacts such as biodiversity loss, habitat fragmentation, and habitat loss with the construction of road networks. The main goal is to understand if mission statements follow a more neo-classical approach to

policy design today or if they are following the principles of EE and taking into consideration the effects of roads on biodiversity and habitat connectivity. We hypothesize that countries involved in the signing of the CBD should recognize the importance of biodiversity and the consequences of roads on biodiversity. We then argue that there should be a reasonable level of inclusion of biodiversity within the transport sector as roads are one of the leading causes of biodiversity loss globally.

3. Manuscript 1: To what extent is biodiversity considered in mission statements of transportation agencies? An international comparison using cluster analysis

Sabrina Mruczek and Jochen A.G. Jaeger

Abstract

Transportation infrastructure has caused significant adverse effects on biodiversity by diminishing and fragmenting natural habitats and increasing wildlife mortality through wildlife-vehicle collisions. This study examines to what degree transportation agencies have included biodiversity considerations into their mission statements. We hypothesized that countries that have signed the Convention on Biological Diversity (CBD) should have biodiversity considered in their transportation mandates by now, more than 30 years after the original document was signed by 169 governments. This study argues that transportation agencies should bear the responsibility for mitigating the effects of roads on biodiversity. This study investigates whether transportation mission statements have been improved by integrating biodiversity and explores current opportunities and challenges for including biodiversity into these mission statements. It also addresses the question if there have been any shifts in how transport ministries view biodiversity and if their mandates reflect newer and more 'ecologically advanced' ways of considering biodiversity. By analyzing 77 regions, including national and sub-national units globally, including Canada, the U.S., and selected European countries, we use cluster analysis with the Jaccard index to create four dendrograms using the Complete, Average, Single, and Ward linkage methods and to evaluate differences and gaps in biodiversity consideration. Our findings reveal a predominant focus on driver safety, and no mentioning of biodiversity apart from France whose mission statement explicitly mentions the conservation of biodiversity, which

can be used as a model for future mission statements. Interestingly, the term 'environment' appeared, yet its usage was often vague and did not adequately address biodiversity concerns. Despite the adoption of the CBD in 1992, inclusion of 'biodiversity' in transportation mission statements is still lacking almost everywhere. The results highlight the urgent need for more involvement of transport ministries in biodiversity conservation, for accepting their share of responsibility, and for including biodiversity in their mission statements.

3.1 Introduction

Transportation agencies can be characterized by their mandates, as reflected in their mission statements commonly used to summarize their identities (Bart et al., 2001; Alegre et al., 2018). They emphasize the most important values and purpose of the organization guiding their intended actions. They indicate how an organization is intending to operate, reflecting their philosophy, identity, values, and how they differ from other organizations (Law & Breznik, 2018). A mission statement has been described by Kemp & Dwyer (2003) as an organization's *"cultural glue"* providing a cohesive ideology internally ensuring an understanding among employees about the intentions and objectives of the organization. While a mission statement is not legally binding, it provides a clear understanding of the organization's goals and how they plan to achieve them. Mission statements allow the target audience to understand the immediate goals of an organization and imply that these goals are attainable (Aljebrini et al., 2025). According to Kemp & Dwyer (2003), an effective mission statement should be clear in defining an organization's main activities and purpose. It serves as a strategic tool to set priorities and allocate resources accordingly. It must communicate the organization's objectives clearly to both internal and external stakeholders, fostering a shared understanding of its values and long-term

goals. In essence, an effective mission statement answers the question *"What does the organization do"?* Well-designed mission statements include elements such as identification of principal products and services, description of self-concept, and articulation of a desired public image (Fitzgerald & Cunningham, 2016). In contrast, being overly general introduces ambiguity leading to an ill-defined, vague, or insubstantial mission statement. Indicators of weak mission statements include being unnecessarily wordy, incomplete, providing no description of services, and a lack of clarity regarding the organization's follow-through actions to achieve their goals (Kemp & Dwyer, 2003).

The design and implementation of effective mission statements can be a long and arduous process. Ireland & Hirc (1992) found that an effective mission statement cannot be prepared easily or quickly as every word must be chosen carefully to accurately reflect the organization and its goals. They further argued that developing a mission statement requires diligence, tolerance for ambiguity, and a significant investment of time and energy. As a result, agencies may struggle in producing well-structured and clearly defined mission statements, sometimes rushing their mandates (Ireland & Hirc., 1992; Duygulu et al., 2016). This issue is exemplified when organizations attempt to incorporate real-world complexities, such as environmental concerns, into mission statements. When mission statements aim to address complex challenges, this can increase the overall complexity of mission statements (Janssen et al., 2023).

Considering our question "do mission statements matter", the response is yes because the mission statement can describe an organization's actions and intentions (Aljebrini et al., 2025). However, mission statements fall short when they fail to reflect relevant, real-life issues, such as biodiversity loss (Fischer et al., 2007). This gap may result from the overemphasis of policy

design within the organization and insufficient attention paid to external, on-the-ground challenges. When policies are disconnected from the realities of biodiversity loss they will fail to effectively protect biodiversity. As Fischer et al. (2007) argue, policy formulation should go beyond bureaucracy and incorporate science-based knowledge to ensure that policies reflect environmental issues like biodiversity loss, habitat destruction, and habitat degradation. The integration of scientific knowledge into policy design can increase effectiveness of policies and can be best developed to address these challenges.

While mission statements can influence the policies of a particular organization, this highlights the importance of science playing a more critical role in the designing of the mission statement and other organizational policies (Claudet et al., 2020). At higher levels of management, a well-designed mandate, or mission statement, can greatly impact the formulation of policies and implementation of strategies (Alegre et al., 2018). Science-based policies should become the standard as they allow policy makers to gain a better understanding of real-world issues and implement targeted solutions. This is of high interest for the current study which addresses the consideration of biodiversity within the mission statements of road transportation agencies. Policies within the field of sustainable transportation often focus on climate change and the reduction of greenhouse gas emissions (Jelti et al., 2023). While this is an important environmental issue within the transport sector, scholars argue that other urgent environmental issues are overlooked, including biodiversity loss (Teren & Collinson, 2022). We argue that the protection of biodiversity should become, in part, the responsibility of the transport sector for several key reasons.

Firstly, we argue that the agency to take charge of the development and maintenance of the roads should also be the agency to act in reducing the effects of wildlife-vehicle collisions (WVCs), which can cause injury and death to drivers. For example, between the years 2000 and 2014, 474 people were killed on Canadian roads in wildlife-vehicle collisions. Canadians often encounter wildlife while driving (Vanlaar et al., 2019). Large ungulates such as moose, elk, and deer pose the greatest threat to driver safety, while smaller mammals are also at risk of colliding with drivers including porcupines, skunks, and squirrels. In the United States, between 1995 and 2004, on average, 165 people were killed annually because of WVCs, which increased to 210 fatalities per year by 2008 (Sullivan, 2011). More recently, Laliberté & St-Laurent (2020) concluded that the province of Quebec alone saw 1,116 collisions involving large mammals (deer and moose) in 2012 which increased to 1,946 collisions in 2018.

Secondly, we argue that it can take pressures off the departments in charge of overseeing environmental concerns which are subject to institutional budgeting fragmentation and a lack of allocated resources. According to Khmara & Touchton (2024) in the U.S., a lack of consensus between the governing bodies, due to budgeting fragmentation, can prevent collaborative decision making on large-scale environmental projects. Allocating responsibility to departments with more resources may significantly advance conservation efforts. The number of roads is anticipated to expand with a global increase of 25 million new kilometers of roads by 2050, a 60% increase since 2010 (Dulac, 2013; Laurance et al., 2014). This global expansion of roads serves the pursuit of natural resources including timber, minerals, and oil and the promotion of regional trade (Laurence et al, 2014; Inman et al., 2024). While roads often positively support social and economic development, they increase habitat loss, habitat deterioration, and biodiversity loss.

The ongoing commitment to sustainable development is emphasized in the CBD along with the conservation of biological diversity and the fair and equitable sharing of benefits derived from genetic resources (Convention on Biological Diversity, 1992). For this study, we use Article 10, point (b) *adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity* to explore to what extent biodiversity is being considered in mission statements of transportation agencies, more than 30 years after the signing of the CBD. Both Gannon (2021) and Findlay (2023) similarly argue that both Environmental Impact Assessment (EIA) legislation and targets set out by the United Nations biodiversity conferences (COPs 15 and 16) are underperforming on their commitments to biodiversity. Hosted in Canada, in 2022, COP15 resulted in the adoption of the Kunming-Montreal Global Biodiversity Framework (GBF), which aims to address biodiversity loss, restore ecosystems, and protect indigenous rights. However, within the transport sector, there are few actionable policies that reflect the main biodiversity goals of COP15. Findlay (2023) criticized the COP15 targets by noting there is little mention of how these biodiversity targets will be achieved along with the non-legally binding nature of the agreements. As a result, there is no legal drive to protect biodiversity and no accountability for countries failing to meet their targets. The development of more sustainable practises involves the integration of social, economic, and environmental sectors which requires the recognition how these policies can form actionable and attainable goals (Newell et al., 2022). Therefore, it is important to recognize that every sector must contribute to biodiversity conservation.

Therefore, I argue that, as urban land conversions and road construction are expected to increasingly drive habitat and biodiversity loss (Simkin et al., 2022), the agencies responsible for the building and the maintenance of roads (i.e., transportation agencies) should also be

responsible to mitigate the adverse effects that roads have on biodiversity. To support this argument, we apply the 'polluter pays principle', according to which the polluter should bear responsibility for taking necessary actions to protect the environment and maintain it in a sustainable state and ensuring the sustainable use of natural resources (Pinto-Bazurco, 2022). This study aims to answer the following research questions:

1. What are the dimensions of the mandates of road agencies according to their mission statements? Which ones are more commonly used than others?
2. How often and how detailed are environmental issues included in these mandates?
3. How often and how detailed is biodiversity considered in these mandates?
4. How often and how detailed is safety included within these mandates?
5. How similar are the mandates of road agencies across sub-national regions (including Canadian provinces and territories, U.S. states, and other key player countries)?
6. How many clusters of transport mandates can be distinguished based on their similarities and differences?

Answers to these questions will promote a better understanding of the main concerns and values of transportation agencies. As there is a push for a transition towards more sustainable practises, mission statements should reflect a collective ambition to improve systematic preparedness and push for adaptation (Kirchherr et al., 2023). Mission statements can be transformative and innovative and therefore they have the potential to align with change-oriented activities (Janssen et al., 2021).

Results can identify mission statements that are more "ecologically advanced" than other and could be role models for others.

3.2 Methods

3.2.1 Search Terms

We searched for the mission statements of road agencies of all U.S. states, Canadian provinces, and territories along with a selection of countries believed to have more environmentally conscientious regulations, using Google Search Engine. For the U.S. states, the search terms included "state name, DOT, mission statement," such as "Vermont DOT mission statement." Mission statements were all found through the official transportation agency websites except for Maryland, which published its mission statement on Twitter. We used the terms "mission statement" and "mandate" synonymously as sometimes we found the agency's mission statement while other times it was referred to as their mandate. For Canadian provinces and territories, the search terms included "province/territory name, transportation agency, mandate/mission statement," such as "British Columbia, transportation agency, mission statement." The only exception was Quebec, where the search was conducted in French ("MTQ mission"). The final step involved finding mission statements or mandates from countries including Switzerland, the Netherlands, France, Germany, England, Sweden, Finland, New Zealand, Australia, Ireland, and Scotland, Canada, Norway, and the United States (Table 3.1). We chose these countries as they have all signed the Convention on Biological Diversity (CBD) and were, therefore, hypothesized to have a better understanding of issues relating to biodiversity and its conservation. All mission statements were sourced from the official transportation branches of government websites. Mission statements were available in English, except for those from France, Germany, and Switzerland, which required translation from French or German to English.

Table 3.1 Search Terms Used in Google Search Engine to obtain transportation mission statements for each country

Country	**Search engine terms and phrases used**
Australia	*'Australia DOT mission statement'*
Canada	'*Canada department of transport mission statement'*
England	*'England department of transport mission statement'*
Finland	'*Finland department of transport mission statement'*
France	*'Ministère de la transition écologique et de la cohésion des territoires mission'*
Germany *	*'Ministry of transportation mission statement, Germany'*
Ireland	*'Ireland department of transport mission statement'*
Netherlands	*'Netherland's ministry of infrastructure and water management mission statement'*
New Zealand	*'New Zealand transport ministry mission statement'*
Scotland	*'Scotland department of transport mission statement'*
Sweden	'*Swedish department of transport mission statement'*
Switzerland	'*Suisse département transport mission'*
United States (has not ratified the CBD)	'*United States DOT mission statement'*

* Note that to retrieve the German Department of Digital and Transports mission statement, the navigation of the government website must be conducted in German.

3.2.2 Dimension Extraction and Binary Table

Once the mission statements were collected, common themes or dimensions were identified and used to create corresponding headers in an Excel document. These extracted dimensions served as keywords that helped understand the core values transportation agencies prioritized in their mission statements. Examples of these values included 'safety,' 'economy,' and 'quality of life.' Across 77 mission statements, 22 distinct dimensions were identified. Using a binary table, we assigned a value of 1 to each dimension present within a mandate and 0 to

indicate its absence (full table in Appendix A2). This data-organization method has been used in previous studies (Cibulkova et al., 2020; Macías, 2021). The purpose was to better understand and interpret trends in the data (Fletcher & Islam, 2018), enabling the application of cluster analysis and visualization of the results in Section 3 below.

3.2.3 Hierarchical Cluster Analysis

We performed a cluster analysis using the Jaccard index to identify patterns of similarity within the data. The Jaccard index, introduced in 1901 by botanist Paul Jaccard, is widely used to measure the similarity (or dissimilarity) between sets of data (Bouchard et al., 2013; Verma & Aggarwal, 2020). This index helped understand the relationships between transportation mission statements. The subsequent cluster analysis groups them into smaller and larger subgroups to investigate and visualize patterns in the data.

3.2.3.1 Jaccard Index

The Jaccard index is calculated by dividing the size of the intersection of two samples by the size of their union (i.e., the number of shared elements over the total number of distinct elements across both sets), mathematically defined as

$$J = a / (a + b + c)$$

where J = the Jaccard index of similarity, a = the number of shared dimensions, b = the number of dimensions included in only one state, c = the number of dimensions included only in the other state. The number of elements that are not included in either of the two samples are not included in the formula.

3.2.3.2 Example using Arkansas and Virginia

The following contingency table uses Arkansas and Virginia as examples to calculate their similarity. Table 3.2 shows the binary table of the dimensions.

Table 3.2 Example of binary table for the states of Arkansas and Virginia (1 = present, 0 = absent)

State/Province/Country	Safety/Reliability	Economy	Quality of Life	Environment	Mobility of Goods	Efficiency	Effective	Reliable and/or Resilient	Provision and Management	Modal Transport	Innovation/Modernize	Accessibility	Cost-Effective	Sustainable	Natural Resources	Leadership	Policies/Regulations	Social Vitality	Green Economy	Biodiversity	Connectivity	Environmental Protection
Arkansas	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Virginia	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3 summarizes the numbers of present (1) and absent (0) dimensions of the 22 potential dimensions in the mission statements for Arkansas and Virginia.

Table 3.3 Contingency table for Arkansas and Virginia

		Virginia	
		Dimension Present	Dimension Absent
Arkansas	Dimension Present	$a = 2$	$b = 1$
	Dimension Absent	$c = 0$	$d = 19$

The Jaccard index is

$$J = \text{a} / (a + b + c) = 2 / 3,$$

indicating a high degree of similarity of the mission statements of Arkansas and Virginia.

3.2.3.3 Transition to a Dissimilarity Matrix

Hierarchical cluster analysis requires a dissimilarity matrix that captures the degree of how different mission statements are from one another. The following formula is used

$$\text{Dissimilarity} = 1 - \text{Jaccard index}$$

The Arkansas and Virginia pair has a dissimilarity of $1 - 2/3 = 1/3$,

indicating that their degree of dissimilarity is rather low.

3.2.3.4 Dissimilarity Matrix

We calculated the Jaccard index (similarity matrix) for each pair of regions from the original binary matrix (77x22), which resulted in a 77x77 Jaccard matrix, providing 5,929 similarity values. These values were converted to their corresponding dissimilarity scores. Programs like **hclust** use agglomerative clustering, i.e., each data point (mission statement) is

first clustered into its own group based on the lowest dissimilarity scores (highest similarity). Through an iterative process, data points are merged based on their lower dissimilarity scores. We used 4 clustering linkage techniques including 'Complete', 'Average', 'Single', and 'Ward.D2' (Lee & Willcox, 2014) to explore how the corresponding dendrograms would differ. These methods differ based on the linkage criteria used to determine the distances between the clusters. All algorithms begin by considering each data point as its own cluster and then iteratively add more data points to some clusters based on certain criteria. Given the exploratory nature of the project and the absence of a testable hypothesis about which clustering method would be most appropriate for our purpose, the use of multiple linkage methods allowed us to compare a range of clustering behaviours. Each method offers unique advantages and disadvantages, therefore exploring all four of them allows us to better understand patterns in our data, assess the stability of the emerging patterns across methods, and identify consistent groupings among the mission statements that might help inform further interpretation or relevance of these patterns. All analyses were done in R (R Core Team, 2020).

The Jaccard index is one of the most widely used indices (Fletcher & Islam, 2018; Macías, 2021). The hierarchical cluster dendrograms were used due to their ability to analyze various types of data, including nominal data within the scope of policy analysis, making it a versatile tool for visualization (Cibulková & Kupková, 2022).

3.2.3.5 Silhouette Scoring

We used Silhouette scoring to determine the most suitable number of clusters to understand the differences and similarities between mission statements. Data points that are well clustered

will have a Silhouette score closer to 1, while a score of 0 indicates that data points are very close to the boundaries between clusters.

3.3. Results

3.3.1 Dimensions included in the mission statements

All the mission statements that were used for the analysis can be found in Appendix A1. The analysis of 77 transportation mission statements covered 50 U.S. states, 10 Canadian provinces and 3 Canadian territories and at the national level, 14 countries including Australia, Canada, England, Finland, France, Germany, Ireland, the Netherlands, New Zealand, Norway, Scotland, Sweden, Switzerland, and the United States. Twenty-two dimensions were identified and included, in order of decreasing frequency: *'safety', 'economy', 'efficiency', 'provision and management', 'quality of life', 'environment', 'mobility of goods', 'sustainable', 'innovation/modernize', 'reliable/resilient', 'modal transport', 'effective', 'policies/regulations', 'accessibility', 'cost-effective', 'leadership', 'social vitality', 'natural resources', 'green economy', 'biodiversity', 'connectivity',* and *'environmental protection'*. The most frequent dimension was *'Safety'* appearing 58 times across 77 mission statements, followed by *'Economy'* in 40 mission statements, and *'Efficiency'* accounting for 27 mission statements (Figure 4.1). The term *'Environment'* was present in 18 mission statements including those of Alabama, Alberta, California, Canada, France, Florida, Illinois, Kentucky, Manitoba, Mississippi, Nevada, New Mexico, Netherlands, New Zealand, North Carolina, Sweden, Vermont, and West Virginia. Less frequently used terms that were deemed important for the purpose of this study included *'Environmental Protection'*, *'Connectivity'*, *'Biodiversity'*, and *'Natural Resources'*. The full

binary table showing the absence or presence of extracted dimensions can be found in Appendix A2.

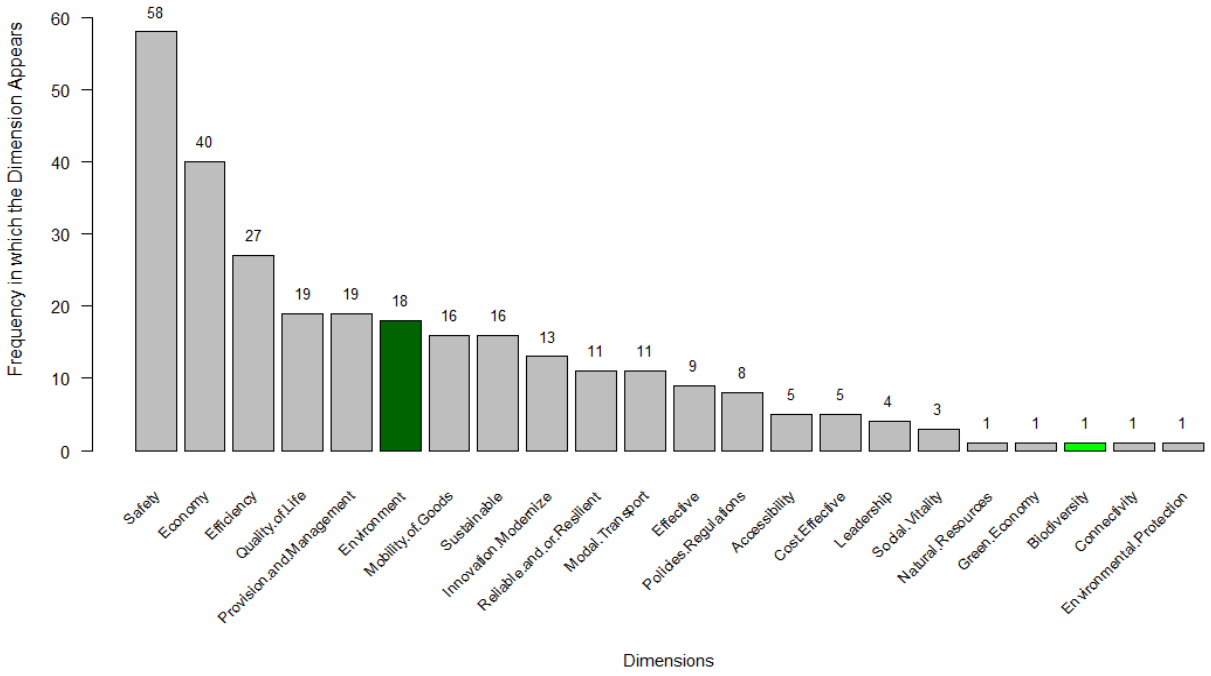


Figure 3.1 Bar Diagram Depicting the Frequencies of 22 Dimensions in 77 Mission Statements of Transport Agencies (from most frequent to least frequent)

3.3.2 Determining a Suitable Number of Clusters for Cluster Analysis

To determine a suitable number of clusters for the dendrograms, we used the Silhouette score (Rousseeuw, 1987). It uses a silhouette value for each point *i* which is based on its cohesion (how close it is to the other points in its cluster) and separation (how far it is from the nearest cluster). The average Silhouette score describes the overall quality of the clustering and uses values between -1 and 1. A value close to 1 indicates that the cluster is well defined while a score close to 0 indicates that the clusters could be malformed and bordering other clusters. A

score closer to -1 would indicate that there is no distinct clustering (Rousseeuw, 1987; Mulaomerović-Šeta et al., 2023).

We used a total of 69 mission statements for Silhouette scoring, accounting for 8 'duplicate' data points (which were counted as a single entry). For example, New Brunswick and Ontario would be considered as 1 point because their mission statements have the same dimensions. Similarly, the states of Tennessee, Maine, and New York contain the same dimensions and were also counted as 1 mission statement. We considered Texas even though its mission statement has no identifiable dimensions. This resulted in 69 unique mission statements as opposed to 77. The optimal number of clusters for these 69 mission statements was 46, 40, 66, and 39 for the 'Complete', 'Average', 'Single', and 'Ward.D2' methods, respectively. Clustering this type of highly dimensional data can lead to an 'over-fitting trap' where each data point is placed into its own cluster (Njah et al., 2021), to which our data may be prone as we have 22 dimensions in total.

3.3.2.1 Silhouette Scores

The optimal number of clusters for 69 mission statements was 46, 40, 66, and 39 for the 'Complete', 'Average', 'Single', and 'Ward.D2' methods, respectively with associated Silhouette scores of 0.28, 0.27, 0.24, and 0.39. Table 3.4 refers to the optimal number of clusters for each associated method with its associated coefficient.

Table 3.4 Optimal number of clusters and associated Silhouette scores (for 69 clusters)

Method	Optimal Number of Clusters	Silhouette Score
Complete	46	0.28
Average	40	0.27
Single	66	0.24

Ward.D2	39	0.39

A high number of clusters (> 30) would not be feasible as the dendrogram would be over-crowded. Therefore, we needed a method to decrease the number of clusters that would allow us to visualize the data with few difficulties. Our chosen semi-arbitrary number was 12 clusters due to the ability to both design the dendrograms and analyse the differences and similarities between the clusters of mission statements without the dendrograms being overly crowded. We found the following suitable number of clusters and their associated Silhouette coefficients (Table 3.5).

Table 3.5: Optimal number of clusters and associated Silhouette scores (for 12 clusters)

Method	Optimal Number of Clusters (out of 12)	Silhouette Score	Silhouette score (for 12 clusters)
Complete	12	0.15	0.10
Average	4	0.19	0.07
Single	2	0.22	-0.15
Ward.D2	12	0.19	0.19

3.3.2.2 Graphical Representations of Silhouette Scores

Figures 3.2 (a) and (b), 3.3 (a) and (b), 3.4 (a) and (b), and 3.5 (a) and (b) are visual representations of the Silhouette scores for the ‘Complete’, ‘Average’, ‘Single’ and ‘Ward’ linkage methods with (a) representing the optimal number of clusters out of 69 clusters (equal to

the total amount of unique data points) and (b) representing the optimal number of clusters for 12 clusters.

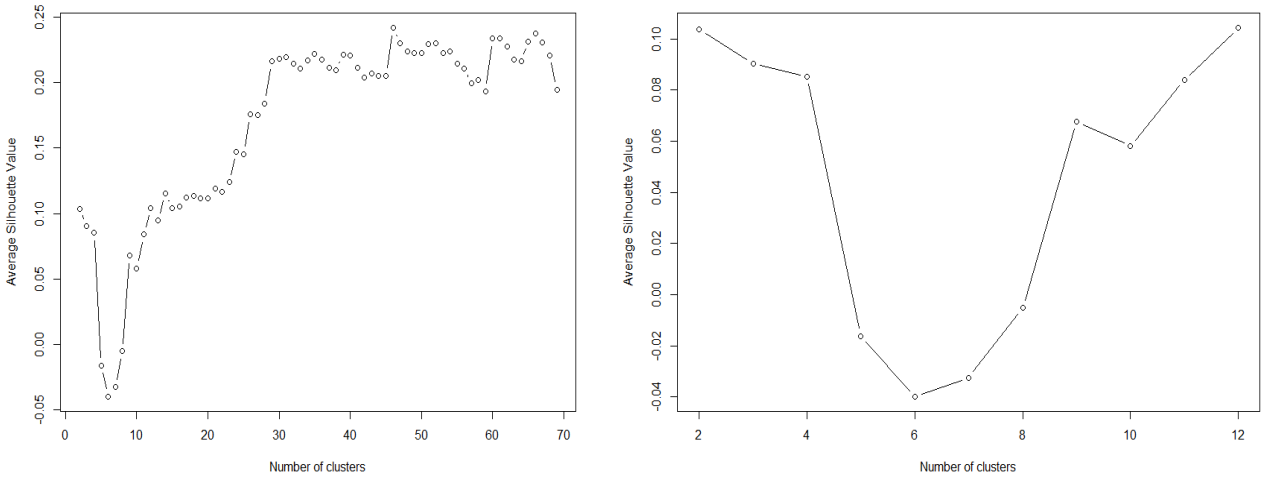


Figure 3.2 Average Silhouette Scores for Complete Method for (a) 2 to 69 clusters and (b) for 2 to 12 clusters

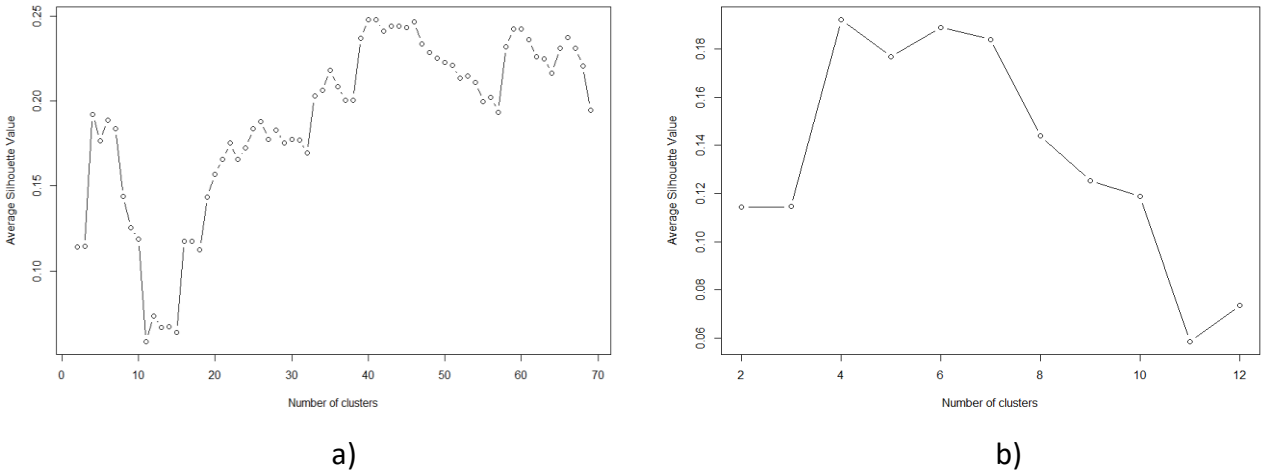
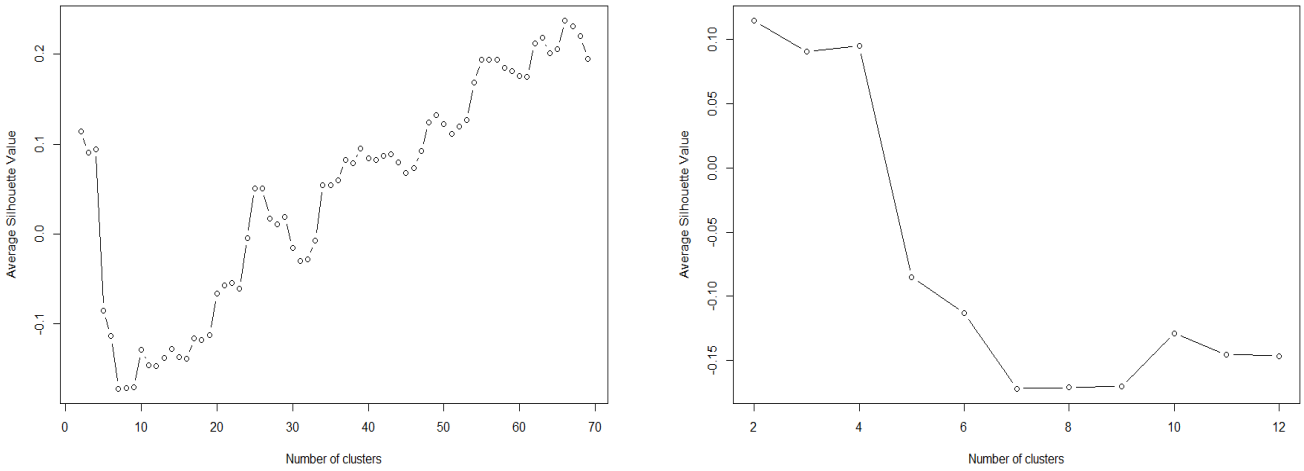
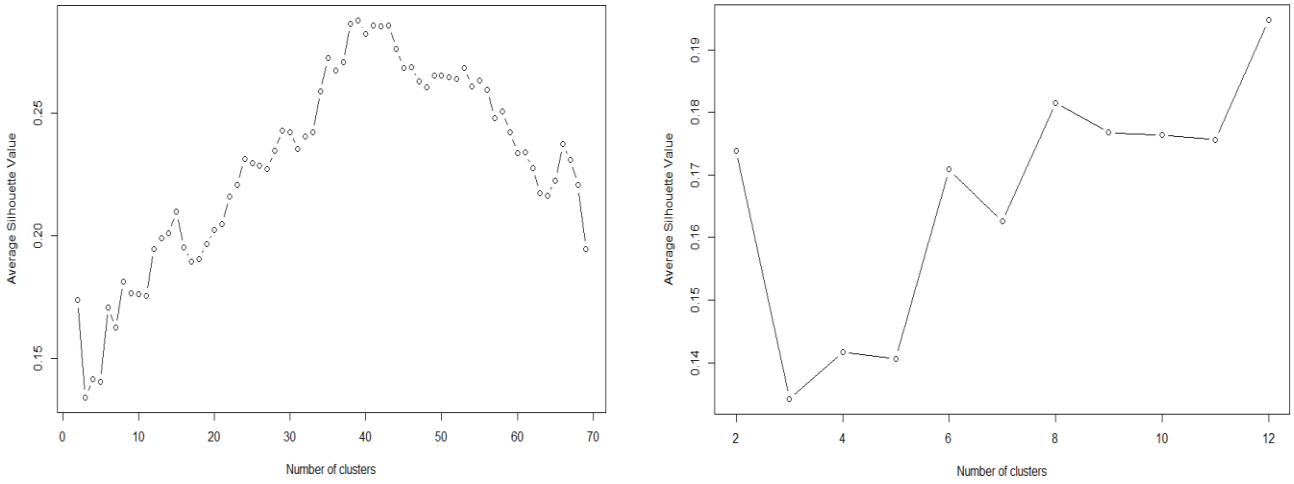


Figure 3.3 Average Silhouette Scores for Average Method with (a) 2 to 69 clusters and (b) for 2 to 12 clusters



a) b)

Figure 3.4 Average Silhouette Scores for Single Method with (a) 2 to 69 clusters and (b) for 2 to 12 clusters



a) b)

Figure 3.5 Average Silhouette Scores for Ward Method for (a) 2 to 69 clusters and (b) for 2 to 12 clusters

These silhouette scores were used to determine the most suitable number of clusters to analyse trends and patterns while assuring that the dendrograms were not overcrowded.

3.3.3 Hierarchical Clustering

3.3.3.1 Hierarchical Cluster Dendrogram According to the 'Complete' Method

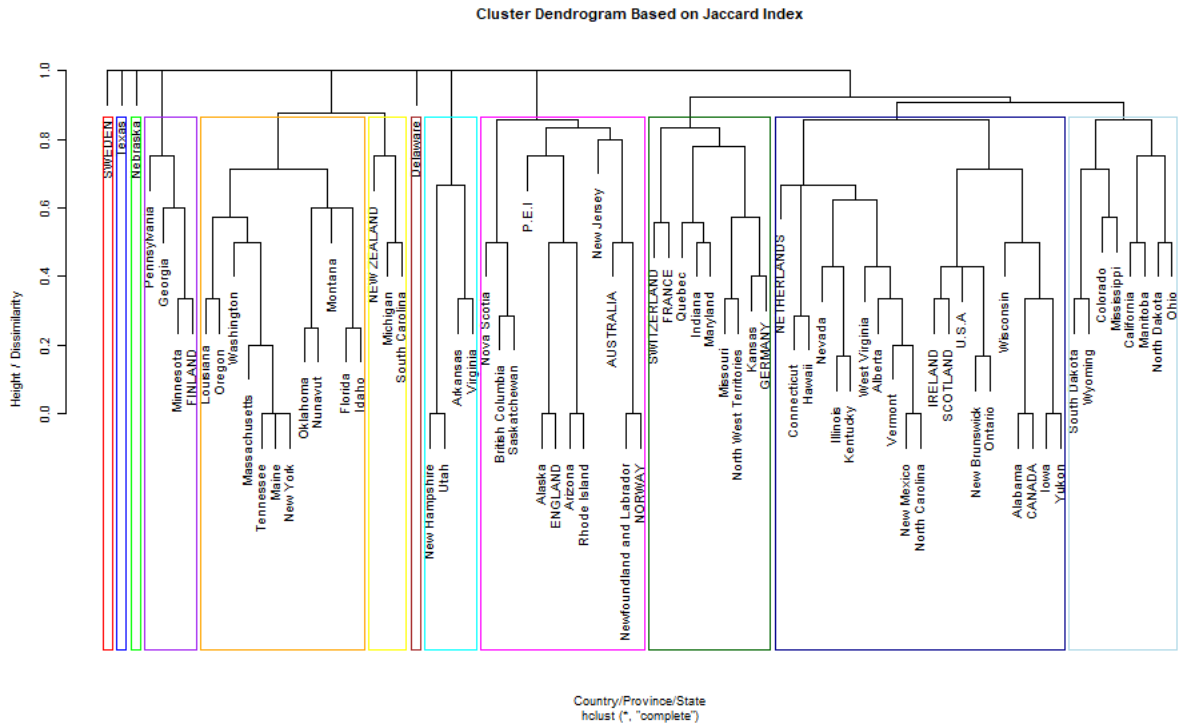


Figure 3.6 Dendrogram of mission statements according to the "Complete" method

The 'Complete' linkage method calculates the distance between 2 clusters as the maximum distance between any 2 data points (one in each of the two clusters), i.e., by considering the farthest points from each other. Figure 3.6 represents the resulting dendrogram. To differentiate the countries from the states, provinces, and territories, the mission statements of the countries are capitalized (e.g., IRELAND) in all 4 dendrograms (Figs. 3.6 - 3.9). We determined that 12 clusters were optimal for the analysis of the mission statements for the 'Complete' linkage method.

3.3.3.2 Hierarchical Cluster Dendrogram According to the ‘Average’ Method

The ‘Average’ linkage method uses the average distance between all pairs of points in 2 clusters (Figure 3.7) and12 clusters were identified.

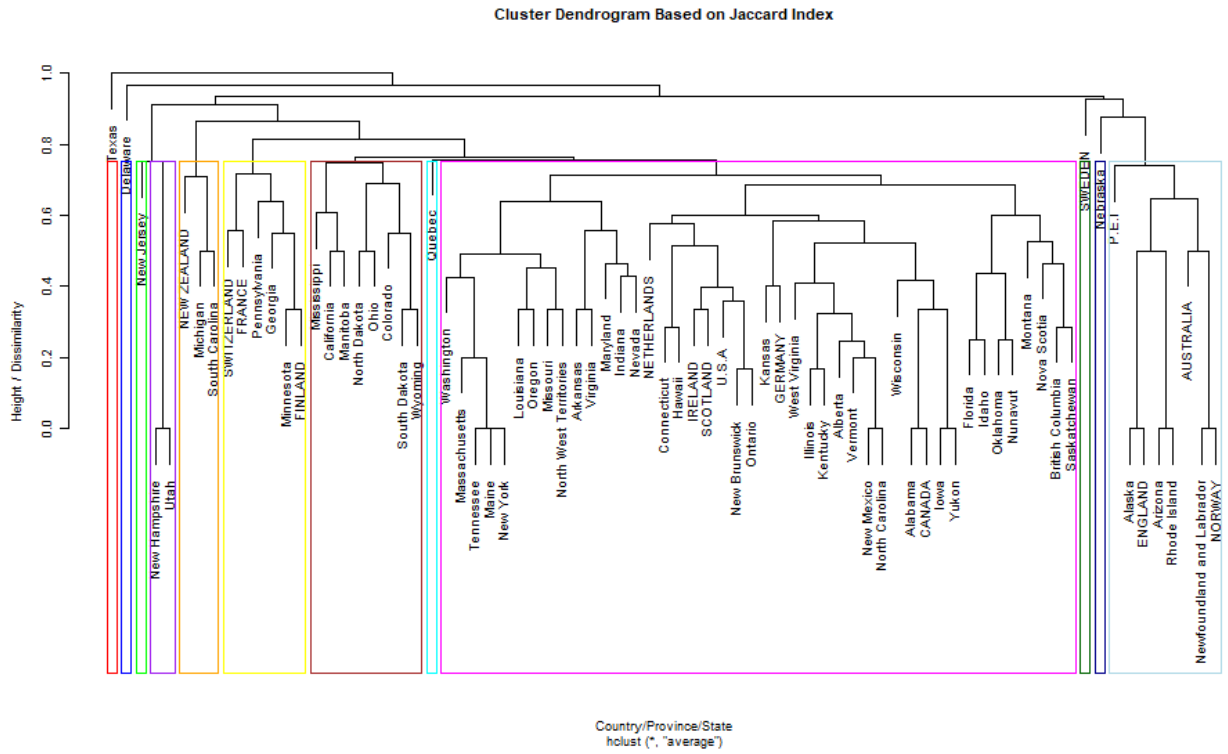


Figure 3.7 Dendrogram of mission statements according to the “Average” method

3.3.3.3 Hierarchical Cluster Dendrogram According to the ‘Single’ Method

In the hierarchical dendrogram produced using the ‘Single’ linkage method, the clusters are based on the distance of the closest pair of points, with one point from each cluster (Figure 3.8). As before, 12 clusters were identified.

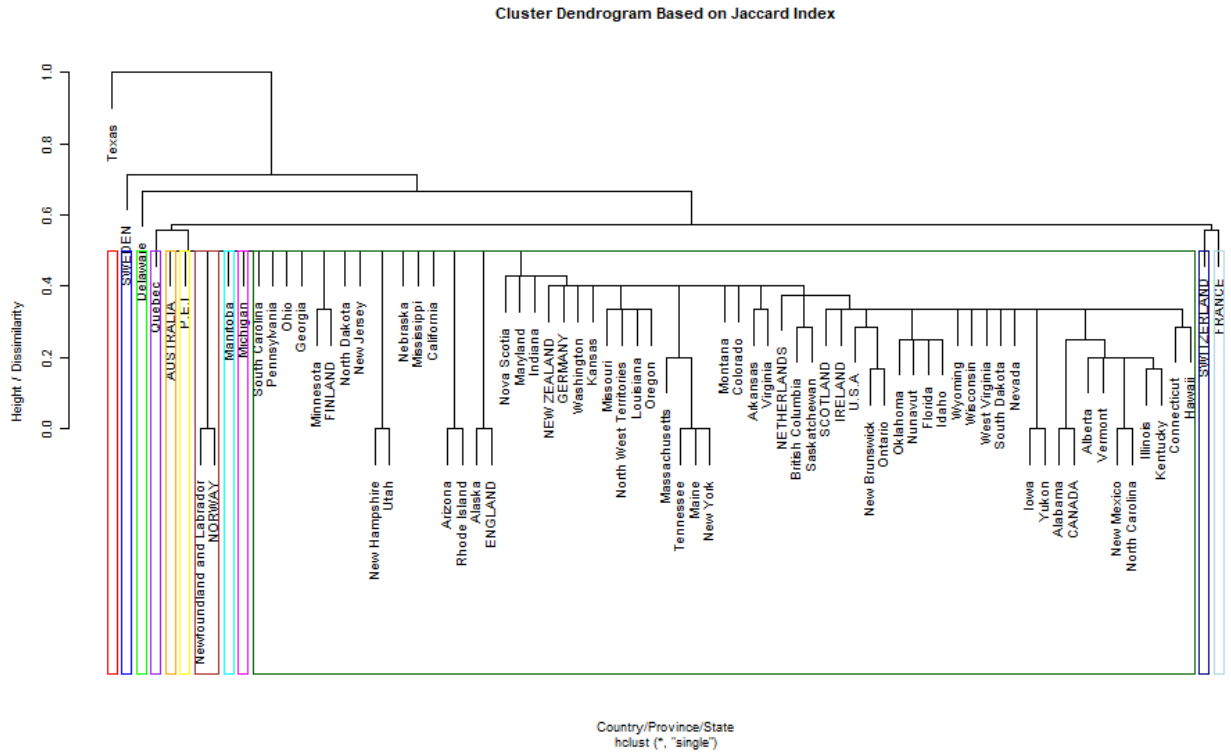


Figure 3.8 Dendrogram of mission statements according to the “Single” method

3.3.3.4 Hierarchical Cluster Dendrogram According to the 'Ward.D2’ Method

The ‘Ward.D2’ linkage method determines the clusters based on the goal of minimizing the variance within each cluster (Figure 3.9). The distance between any two clusters is determined by measuring by how much the sum of squared deviations from the mean changes when the clusters are merged. It starts with each data point in its own cluster, then gradually merges clusters based on how much combining them increases the overall variance within the group. Clusters are merged if they lead to the smallest overall increase in the variance.

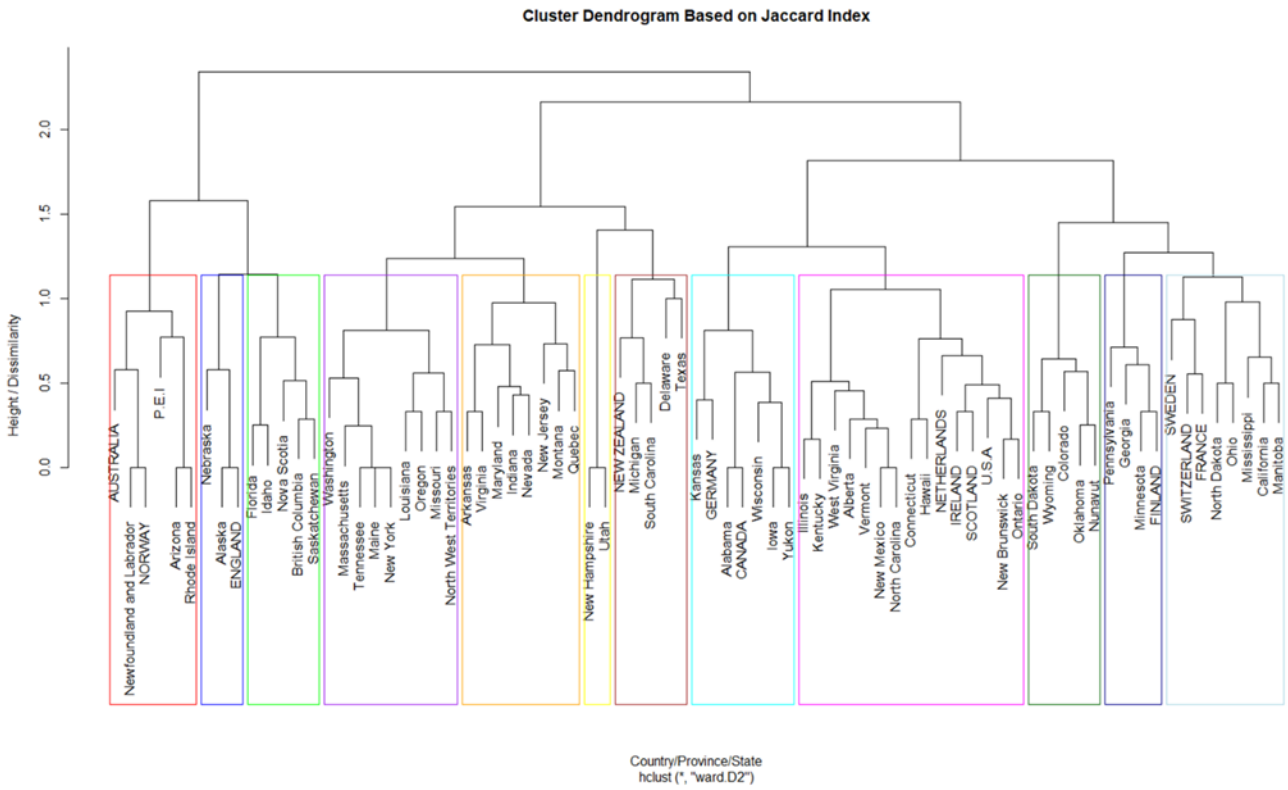


Figure 3.9 Dendrogram of mission statements according to the "Ward" method

3.4. Discussion

3.4.1 Dimensions

Of the mission statements analyzed (n = 77), some dimensions appeared more frequently than others (Figure 3.1). The most common dimensions were 'safety', 'economy', and 'efficiency'. The term 'safety' was used in 58 mission statements (76%), confirming its role as one of the most important objectives within transport agencies. The term 'safety' refers to ensuring passenger safety on roads.

The second most frequent dimension was 'economy' appearing in 40 mission statements (52%). Contextually, this term refers to the maintenance of the economic vitality of a region by

facilitating the movement of people and goods. The presence of the term in the mission statement suggests a more neoclassical approach to transportation, prioritizing the economic growth of a region through efficient transport networks.

The third most apparent dimension was the term ‘efficiency’ appearing in 27 mission statements (35%). While the term may be ambiguous, coupled with the term ‘economy’ it can indicate that transport agencies strive to achieve economic growth in a well-organized and efficient manner.

‘Provision and management’ and ‘quality of life’ appeared as the fourth and fifth most common dimensions, still indicating a high level of importance in mission statements, each appearing 19 times (25%). The term ‘provision and management’ typically addressed the maintenance and improvement of infrastructure while ‘quality of life’ described the quality of life for people by providing more access to social and economic opportunities. Both dimensions suggest that transport networks are not only seen as a functional tool for mobility but also as way to ensure economic prosperity and supporting people and their broader economic and social interests.

Lastly, the sixth most frequent dimension was the term ‘environment’ appearing in 18 mission statements (23%). While the incorporation of the term is a positive step forward in the inclusion of environmental considerations into transport planning, its use was often ambiguous, leading to varied interpretation of the term or misinterpretation altogether. The term ‘environment’ can have a broad range of meanings. In some contexts it can refer to the reduction of greenhouse gas emissions by encouraging the use of greener alternatives within the transport sector. However, the term ‘environment’ can also be unrelated to carbon emissions, implying the preservation of natural landscapes. Most mission statements did not specify what aspects of the

environment they are referring to, aside from France and Sweden, which explicitly mentioned the reduction in carbon emissions. While some mission statements were more specific, the majority used this term ambiguously which makes it challenging to hold the transport sector accountable for its role in environmental degradation and biodiversity loss. To ensure more effective environmental accountability, a notable change that would need to take place is the reduction in ambiguity of the term and a better definition of the aspects of environmental degradation they are referring to.

Similarly, to the term 'environment', shortcomings in ambiguity were also apparent for the term 'safety' in mission statements. While 'safety' was found most frequently, we argue that the term may fail to take into consideration all facets of safety. For example, wildlife-vehicle collisions occur globally which causes injuries and driver fatalities but are not explicitly mentioned in mission statements, aside from that of France, which explicitly mentions the importance of maintaining regional connectivity to decrease wildlife presence on roads. This would aid in decreasing the risk of collisions with wildlife on roads. We argue that a comprehensive approach to safety should consider these collisions. To reduce the occurrence of wildlife-vehicle collisions, mission statements should incorporate terms including 'biodiversity' or 'wildlife' into them to emphasize the importance of protecting human safety as well as animal safety. The later component of my research project, which analyzes responses from a survey questionnaire completed by members of transport agencies in the U.S. and Canada, support this idea by citing that "conservation or restoration of natural resources, including biodiversity, has to result in or support obvious human benefit (ecosystem services to people, extractive value) […]" (ID-1). Therefore, there is some understanding that framing biodiversity as a benefit to humans may be possible.

In addition, while the term 'safety' focuses on driver safety on roads, large mammals, including black bears, moose, elk, and deer, are cited to be prioritized as they are the greatest threat to human safety on roads. However, we argue that biodiversity should be considered in the planning process because species that require increased habitat connectivity may currently be overlooked. For example, a wildlife passage designed for large ungulates may not be suitable for other species. Therefore, to ensure greater human safety and biodiversity preservation on roads, biodiversity should play a larger role within the transportation sector. Adding biodiversity considerations to the mission statements of transportation agencies, which can hold the agencies more accountable for the effects of roads on biodiversity, is a strong starting point.

The term 'economy' ranked as one of the top three dimensions reinforces more neo-classical economic theory which prioritizes economic growth over other considerations. While it advocates for continual economic expansion, other schools of thought, including EE, promote a more sustainable approach to development. EE suggests that continuous economic growth would have detrimental effects on the environment, including biodiversity loss. Terms that promote the economy are used consistently with little or no ambiguity whereas the term 'environment' is used ambiguously and applied in a variety of contexts. This makes it difficult to recognize specific environmental goals of transport agencies.

The interplay between the economy and the environment is apparent in Resolution 40-3, adopted during the 40th Conference of New England Governors and Eastern Canadian Provinces. It primarily focuses on environmental aspects including ecological connectivity, climate change adaptation, and biodiversity conservation but highlights how the economy plays a role in conservation efforts (St-Pierre et al., 2019). This dual approach emphasizes the potential for policies and models that promote both long-term health of the economy and the environment.

3.4.2 Cluster Dendrogram According to the ‘Complete’ Method

The dendrogram in Figure 6 follows the ‘Complete’ method. Similar data points are grouped together based on the maximum distance between 2 points of any two clusters. This criterion tends to produce a dendrogram that is more sensitive to outliers compared to other linkage methods (Macías, 2021). This is due to the complete linkage method merging clusters based on the maximum distance between points. By increasing the distance between clusters, outliers can lead to inaccurate merges which can distort the dendrogram. This means that if an outlier is present in one cluster, it can significantly increase the maximum distance between the two clusters, causing premature or inaccurate merges. The outlier can disproportionately influence the merging process, leading to a dendrogram that may not accurately reflect the true structure of the data. The 12 resulting clusters are separated as indicated in Table 3.6.

Table 3.6 Table Depicting How the 12 Clusters are determined by most Common Dimension based on the ‘Complete’ Method

Cluster	**Dimension**
Cluster 1	Accessibility/Environment/Policies
Cluster 2	No identifiable dimensions
Cluster 3	Mobility of Goods
Cluster 4	Sustainable
Cluster 5	Economy AND Safety
Cluster 6	Economy
Cluster 7	Cost-Effective/Modal Transport
Cluster 8	Quality of Life
Cluster 9	Provision and Management
Cluster 10	Safety AND Innovation and Modernization
Cluster 11	Safety
Cluster 12	Safety

In Table 3.6, the "/" symbol indicates the presence of distinct, separate dimensions within the cluster. For example, Cluster 1 includes "Accessibility", "Environment," and "Policies" as individual dimensions. On the other hand, "AND" is used to denote clusters that are influenced by two, or more, dimensions, which could not be ranked in terms of their importance. This is due to the use of the Jaccard matrix in the study, which did not apply any weighting to the dimensions, thus preventing the ability to determine which dimension has a greater influence. For instance, Cluster 5 is influenced by both "Economy" and "Safety", but the relative importance of these dimensions remains undetermined. This logic was additionally used in all subsequent tables showing clustering by their most common dimensions (Tables 3.7 - 3.9).

3.4.2.1 Clustering from Silhouette Score

Twelve was used to as a suitable number of clusters to visualize the dendrogram using the 'Complete' method due to the optimal number of clusters being too numerous to properly analyze trends in the data. Finding the optimal number of clusters using 69 data points yielded 46 clusters with a Silhouette score of 0.28 (Table 3.4). However, a dendrogram with 46 clusters would cause overcrowding and be difficult to analyze, so we decided to limit the number of clusters to 12 to determine clearer trends. To test for the efficacy of the 12 clusters, we performed a similar analysis to determine the optimal number of clusters within this limit. Twelve clusters were determined to be the optimal for the 'Complete' method, dropping the overall Silhouette score from 0.28 to 0.10 (Table 3.5).

3.4.2.2 Associated Clusters in the Dendrogram

Among clusters 10, 11, and 12, 'safety' was the common dimension. However, each cluster is further influenced by the presence of other common dimensions. In cluster 10, the

dimension ‘safety’ is paired with the dimension ‘innovation and modernization’, while cluster 11 includes ‘economy’, ‘environment’, and ‘efficiency’ alongside ‘safety’. Cluster 12, although primarily organized by the dimension of ‘safety’, is further influenced by the dimension ‘effective’. The dendrogram is organized based on the original Jaccard matrix which treated all dimensions equally as no weights were applied. This resulted in the inability to rank the relative importance of the dimensions, but still revealed patterns in the data. Patterns included the effects of dimensions within hierarchical clustering and differences between the clusters of the dendrograms. (Appendix A3). Given that ‘safety’ was the most frequently mentioned dimension, dendrograms being strongly influenced by it reflects its overall importance within transportation agencies.

Similarly, we can examine different clusters to identify the main commonalities in the dimensions. Cluster 6 is characterized by the dimension ‘economy’ while cluster 5 could be characterized by either ‘economy’ or ‘safety’. Although relative ranks cannot be determined, this aligns with Figure 3.1, which shows these two as the most frequently mentioned dimensions, indicating their importance in mission statements. Cluster 8 is categorized by ‘quality of life’, though in that group, Arkansas and Virginia were more influenced by the dimension ‘safety’. Cluster 9 was identified by ‘provision and management’ with subgroupings influenced by additional shared dimensions. For example, the placement of Nova Scotia, British Columbia, and Saskatchewan on the dendrogram reflects their shared dimensions. Nova Scotia is placed on a separate branch due to having fewer dimensions in common, yet still enough commonality for proximity within the grouping (Appendix A3). Cluster 4 which features ‘sustainable’ as its common dimension between Pennsylvania, Georgia, and Minnesota and, Finland. Although other regions emphasize the dimension, the linkage method influences their categorization. For

example, Switzerland includes ‘sustainable’ but is grouped in cluster 10 due to stronger commonalities with ‘safety’ and ‘innovation and modernization’. This highlights that while environmental considerations are present, the term ‘sustainable’ can be ambiguous, describing environmental or infrastructure sustainability. Like ‘environment’ the meaning can vary within the context of the mission statement. This variability, and lack of terminology standardization, complicates comparisons, as terms can convey multiple, different interpretations.

The lack of standardization in terms used in mission statements are further illustrated in cluster 6 which includes New Zealand alongside the states of Michigan and South Carolina, categorized by their shared dimension ‘economy’. This cluster, among others, combines a larger country with smaller states or provinces, showing that geographic location is not the primary driver of clustering. While we expected New Zealand to be grouped with Australia, based on geography, Australia appears in cluster 9, categorized under ‘provision and management’ with ‘economy’ influencing its position on the dendrogram (Figure 10, Appendix A3). Similarly, several U.S. states and Canadian provinces are scattered throughout the dendrogram suggesting that geographic proximity does not correspond with shared mission statements. For example, cluster 8 includes geographically diverse U.S. states including New Hampshire, Utah, Virginia, and Arkansas, indicating how mission statements can show similarities regardless of location. However, sometimes, geographic closeness can align with similar dimensions, as seen in cluster 11, where Ireland and Scotland are grouped together. The regions share four out of five total dimensions including ‘safety’, ‘efficient’, ‘sustainable’, and ‘economy’. While geography can play a role in mission statements, often they are more influenced by political, economic, and societal priorities. Geographic proximity alone does not represent a definitive factor in shaping the language and focus of mission statements.

The dimension ‘environment’ ranked among top five most frequently mentioned in mission statements (Figure 3.1). However, we found no cluster is categorized by ‘environment’. While it does not seem to act as a categorizing factor in any cluster, it still appears to influence the placement of regions in the dendrogram. For example, in cluster 11, Nevada, Illinois, Kentucky, West Virginia, Alberta, Vermont, New Mexico, and North Carolina all share the common dimensions ‘safety’, ‘economy’, and ‘environment’ with further subcategorization based on other dimensions. Therefore, while ‘environment’ can play a role in clustering, the ambiguity of the term should be addressed. To best clarify the impact of the term, transport agencies should focus on what aspects of the environment they are focusing on such as carbon emissions, biodiversity loss, habitat preservation, or ecological connectivity. This task requires a deeper analysis of mission statements to better understand why certain terms may or may not be used and how they are formulated in relation to the agency’s priorities.

3.4.3 Cluster Dendrogram According to the ‘Average’ Method

Figure 3.7 follows the ‘Average’ method which uses the average distance between points belonging to two clusters. At each iteration, clusters that have the smallest average distance, are merged and process continues until all the data points are placed into the dendrogram. While this method is more robust to outliers, relying on average distances, a drawback is that it is sensitive to the size of the clusters which is due to the averaging process. Larger clusters that contain more points can influence the overall average distance within the cluster. Therefore, this method may favor larger clusters and distort the clustering resulting in unbalanced clusters of varying sizes. This could explain the imbalance seen in cluster 9, being larger than the others. The cluster dendrogram is characterized by Table 3.7.

Table 3.7 Table Depicting How the 12 Clusters are determined by most Common Dimension based on the 'Average' Method

Cluster	**Dimension**
Cluster 1	No dimension identified
Cluster 2	Modal Transport/Cost-Effective
Cluster 3	Quality of Life/Provision and Management/Economy/Natural Resources
Cluster 4	Quality of Life
Cluster 5	Economy
Cluster 6	Sustainable
Cluster 7	Safety
Cluster 8	Safety/Economy/Provision and Management/Innovation/Accessibility/Green Economy/Leadership
Cluster 9	Safety
Cluster 10	Environment/Accessibility/Policies
Cluster 11	Mobility of Goods
Cluster 12	Provision and Management

3.4.3.1 Clustering from Silhouette Score

Like the 'Complete' linkage method, 12 clusters were determined to be a suitable number of clusters in the dendrogram. Although the optimal number of clusters for the 69 mission statements was 40, with a Silhouette score of 0.27 (Table 3.4), visualizing such a large number of clusters would be impractical. Given the strong performance of the 12 clusters using the 'Complete' method, we tested the efficacy of using 12 clusters with the 'Average' method as well. We found that the optimal number of clusters out of 12 would have been four, with a silhouette score of 0.19 (Table 3.5). However, the clusters were too broad to effectively analyze trends or patterns in the data. While using 12 clusters resulted in a lower Silhouette score of 0.07, it was still a positive value. In Figure 3.3 (b), there is a small up-tick in the scoring at 12 clusters which supported our decision to retain 12 clusters.

3.4.3.2 Associated Clusters in the Dendrogram

Clusters 7 and 9 are organized through the common dimension ‘safety’. However, both clusters are further influenced by other dimensions. For example, in cluster 7, Mississippi, California, and Manitoba have ‘safety’ as their common dimension but are further influenced by ‘environment’. Similarly, in the same cluster, the U.S. states of Colorado, South Dakota and Wyoming are further influenced by the dimension ‘effective’.

Cluster 9 is categorized by the common dimension ‘safety’ shared across all 44 regions, which we determined served as the basis for its organization. However, other shared dimensions between the regions influence their relative positions on the dendrogram (Figure 3.7). For example, Washington, Massachusetts, Tennessee, Maine, New York, Louisiana, and Oregon are all grouped closely together. While they all contain the dimensions ‘safety’, ‘economy’, and ‘reliable’, further sub-groupings emerge. Tennessee, Maine, and New York are more closely associated due to their shared dimension ‘quality of life’, whereas Louisiana and Oregon are more influence by ‘modal-transport’. While Figures 3.6 and 3.7 clearly depict this sub-categorization, notably cluster 9 is significantly larger than the others. This contributes to the sense that the ‘Average’ linkage method is not as well balanced as the ‘Complete’ linkage method.

Similarly to the ‘Complete’ linkage method, there is a cluster according to the dimension ‘sustainable’. Cluster 6 includes Switzerland, France, Pennsylvania, Georgia, Minnesota, and Finland where the dimension ‘sustainable’ serves as a primary commonality. While this dimension appears in other mission statements, it acts as a secondary influencing factor. For example, the provinces of New Brunswick and Ontario, in cluster 9, include ‘sustainable’ in their

mission statements. However, their placement in the dendrogram is more heavily influenced by dimensions such as ‘safety’ and ‘efficient’ (Appendix A4).

In this dendrogram, only a small group is characterized by the common dimension ‘economy’, for example, in Cluster 5, comprised of New Zealand, Michigan, and South Carolina. While ‘economy’ is the second most observed dimension overall, it may function more as a secondary influence on region positioning in the dendrogram as opposed to serving as the dimension categorizing the cluster. Similarly, ‘environment’ ranked among the top five most frequently mentioned dimensions (Figure 3.1), but no cluster was defined by it. Instead, it served as a secondary factor, further influencing the position of regions on the dendrogram. For example, in cluster 7, Mississippi, California, and Manitoba, were influenced by having the dimension ‘environment’ as its second common dimension, after ‘safety’. The dimension ‘environment’ also influenced the sub-categorization of West Virginia, Illinois, Kentucky, Alberta, Vermont, New Mexico, North Carolina, Alabama, and Canada within cluster 9 (Appendix A4). Other than the sizing of the clusters and some minor differences in how the regions were clustered, the ‘Average’ method yielded similar results to the ‘Complete’ method.

3.4.4 Cluster Dendrogram According to the ‘Single’ Method

The ‘Single’ linkage method uses the minimum distance between any pair of points from two clusters (Figure 3.8). While this method is widely used, it can produce clustering abnormalities, which can be described as elongated chains of data points that are connected through intermediate points. This explains the unusually large size of cluster 10 with the categorization of each cluster outlined in Table 3.8.

Table 3.8 Table depicting how the 12 clusters are determined by their most common dimension based on the 'Single' Method

Cluster	**Dimension**
Cluster 1	Mobility of Goods
Cluster 2	Environment/Accessibility/Policies
Cluster 3	Modal Transport/Cost-Effective
Cluster 4	Provision and Management/Economy/Innovation/Safety/ Accessibility/Green Economy/Leadership
Cluster 5	Provision and Management/Economy/Innovation/Policies
Cluster 6	Provision and Management/Effective/Efficient
Cluster 7	Provision and Management/Policies
Cluster 8	Provision and Management/Safety/Environment
Cluster 9	Economy
Cluster 10	**Difficult to determine due to large cluster size**
Cluster 11	Safety/Innovation/Sustainable/Policies/Efficiency/Connectivity/Protection
Cluster 12	Safety/Innovation/Sustainable/Policies/Environment/Biodiversity

3.4.4.1 Clustering from Silhouette Score

Similar to the 'Complete' and 'Average' methods, we selected 12 clusters as the most suitable for the 'Single' linkage method. To identify the optimal number of clusters, we analyzed the 69 mission statements, accounting for the duplicates. The optimal number was 66 with an associated Silhouette score of 0.27 (Table 3.4). Since 12 clusters worked reasonably well with the other two linkage methods, the effectiveness of 12 clusters was evaluated with the 'Single' method. The optimal number of clusters was two which had a slightly lower Silhouette score of 0.22. However, two clusters resulted in overly large groupings, still making it difficult to analyze regional differences and similarities. To maintain consistency across methods, we used 12 clusters, despite the poor performance reflected in a Silhouette score of -0.15 (Table 3.5). This negative value indicates substantial inaccuracies in the clustering but meaningful insights could still be extracted.

3.4.4.2 Associated Clusters in the Dendrogram

Among the four linkage methods, the ‘Single’ linkage proved to be hardest to interpret due to the size of cluster 10 containing 66 out of 77 mission statements (87%). While the majority of mission statements are grouped in this cluster, some regions that were previously clustered together now appear in their own clusters using the ‘Single’ method. For example, the province of Prince Edward Island (P.E.I.) was found in its own in cluster 6 which is characterized by less common dimensions such as ‘provision and management’, ‘effective’, and efficient’. Similarly, Australia was found in cluster 5, characterized by the dimensions ‘provision and management’, ‘economy’, ‘policies’, and ‘innovation and modernization’ (Appendix A5).

In contrast, both regions were placed together in cluster 9 using the ‘Complete’ linkage method sharing the common dimension ‘provision and management’ with 11 other regions in that cluster. From the ‘Average’ method, both regions were found in cluster 12, still categorized by ‘provision and management’, with 7 other regions. However, P.E.I. and Australia, within those clusters were often found on their own respective branches due to the presence of less common dimensions (Figures 3.6 and 3.7).

Cluster 10 was too large to analyze effectively and therefore we focused on the regions that formed their own clusters, which yielded more promising results. These regions tended to have more unique combinations of dimensions, such as ‘‘biodiversity’, ‘leadership’, and ‘policies’. A total of 12 regions including Texas, Sweden, Delaware, Quebec, Australia, P.E.I., Newfoundland and Labrador, Norway, Manitoba, Michigan, Switzerland, and France had the most unique mission statements. Their dimensions were less commonly found together, making them more distinct from those in cluster 10 (Figure 3.8). However, while those regions are

categorized as ‘different’, this does not imply that their mission statements are well-designed or effective for biodiversity conservation.

For example, we were unable to identify any dimensions in the mission statement of Texas due to its lack of clarity. Here, it was its own cluster in the ‘Complete’ and ‘Average’ linkage methods. Notably, the only mission statement that explicitly mentioned ‘biodiversity’ was that of France, while others refer to ‘sustainable’ or ‘environment’. As discussed earlier, those terms can be ambiguous.

3.4.5 Cluster Dendrogram According to the ‘Ward.D2’ Method

The ‘Ward.D2’ method is based on minimizing the variance, i.e., the within-cluster sum of squares (Fig. 3.9). The distance between the clusters is determined by the sum of squared deviations of the variables from the centroid (Macías, 2021).

Table 3.9 Table Depicting How the 12 Clusters are determined by most Common Dimension based on the ‘Ward’ Method

Cluster	**Dimension**
Cluster 1	Provision and Management
Cluster 2	Mobility of Goods
Cluster 3	Mobility of Goods AND Safety
Cluster 4	Safety AND Economy
Cluster 5	Safety
Cluster 6	Quality of Life
Cluster 7	Economy
Cluster 8	Efficient AND Safety
Cluster 9	Efficient AND Safety
Cluster 10	Effective AND Safety
Cluster 11	Sustainable
Cluster 12	Safety

3.4.5.1 Clustering from Silhouette Score

We determined that 12 clusters would be the most suitable for the dendrogram. Testing for the optimal number of clusters resulted in 39 clusters with a Silhouette score of 0.39 (Table 3.4). However, 39 clusters proved too numerous to interpret the data efficiently. To maintain consistency with the other linkage methods used, we tested 12 clusters, which yielded the most suitable result with a Silhouette score of 0.19 (Table 3.5).

3.4.5.2 Associated Clusters in the Dendrogram

Among the four linkage techniques, Ward.D2 was frequently cited as the most effective for its ability to handle a variety of variables including interval-scaled and symmetric binary variables. Saraçli et al. (2013) and Macías (2021) suggest that Ward.D2 normally outperforms the other methods. In contrast to the three other methods, no region was placed in its own cluster (Figure 3.9). The visualization tree (Appendix A6) reveals that regions clustered on their own in previous linkage methods were all successfully clustered together.

One notable example is the state of Texas which had no identifiable dimensions. In the ‘Complete’, ‘Average’, and ‘Single’ linkage methods, Texas was placed in its own cluster. However, in the ‘Ward.D2’ method, it was grouped in cluster 7 along with New Zealand, Michigan, South Carolina, and Delaware, which all had identifiable dimensions. This grouping likely reduced the within-cluster variance. Similarly, Delaware, which was placed in its own cluster by the ‘Complete’, ‘Average’, and ‘Single’ linkage methods, was also included in cluster 7. Additionally, New Jersey, despite its lack of the dimension ‘safety’ was placed in cluster 5, categorized by ‘quality of life’ and ‘safety’. New Jersey, with its unique dimension ‘natural resources’ was still successfully clustered.

Pennsylvania, Georgia, Minnesota, and Finland were all grouped in cluster 11 due to their common dimension ‘sustainable’. The dimensions ‘sustainable’ and ‘environment’ also influenced region placement in cluster 9. For example, while all the regions in cluster 9 shared the dimensions ‘efficient’ and ‘safety’, the dimension ‘sustainable’ influenced the position of the Netherlands, Ireland, Scotland, the U.S.A., New Brunswick, and Ontario. However, the dimension ‘environment’ influenced the position of Illinois, Kentucky, West Virginia, Alberta, Vermont, New Mexico, and North Carolina in (Appendix A6). While these dimensions played a role in the positioning of the regions, they acted as secondary factors and did not seem to be the primary drivers for clustering the dendrogram.

While the Ward.D2 method successfully grouped all the mission statements, including the outlier regions from previous linkage techniques, it can cause confusion as seen in the visualization tree (Appendix A6). Some mission statements seem out of place which is a distinction seen more clearly with other linkage methods. This suggests that a more careful analysis of the dendrograms is needed if the specific interest is in identifying mission statements that differ from the majority.

3.4.6 Comparison of the Dendrograms

Across the first three linkage methods, Sweden, Texas, and Delaware were consistently placed in their own clusters, likely due to their unique combinations of dimensions not found in the mission statements of other regions. Texas had no identifiable dimensions, while Sweden’s included ‘environment’, ‘accessibility’, and ‘policies’. While ‘policies’ appeared in other mission statements (e.g., Switzerland, France, and Australia), Sweden’s combination of dimensions was less common. Switzerland and France also featured the more common

dimension ‘safety’ and Australia had ‘provision and management’. Similarly, Delaware’s mission statement, characterized by ‘modal transport’ and ‘cost effective’, was a less common combination of dimensions, causing it to cluster separately more often than not.

The dendrograms from the ‘Complete’ and ‘Average’ showed different ways of clustering mission statements based on common dimensions. In contrast, the ‘Single’ method provided limited insights due to the “chaining effect”, with multiple data points grouped in the same cluster (Macías, 2021). Despite this, the ‘Single’ method successfully identified mission statements with unique, less commonly combined dimensions. The only dendrogram that successfully clustered all the regions, without outlier regions, was the Ward.D2 method. While this resulted in a very balanced and visually appealing dendrogram, it can still raise questions as to why certain mission statements were placed in particular clusters. According to the Silhouette scores for 12 clusters, the best dendrogram method is the Ward.D2 method (0.19), followed by ‘Complete’ (0.10), ‘Average’ (0.07), and lastly ‘Single’ (-0.15).

The use of hierarchical clustering allowed us to explore patterns of similarity and variability across mission statements in a structured way. While we did not have a hypothesis about the behaviour of different linkage methods, comparing multiple linkage methods provided us with a more nuanced view of the relationships between regions. Each linkage method offers a different perspective and the use of all four allowed us to examine the robustness of the patterns and see how groupings might shift under different linkages. Their comparison revealed the extent to which some mission statements were consistently grouped together, suggesting strong underlying similarities, while others shifted between the clusters, depending on the method used. For example, we had speculated that regions geographically located to one another, or sharing similar environmental concerns, might be grouped closer together on the dendrograms, which

was not the case. The clustering helped us uncover the shared language present across the mission statements and the subtle, yet significant, differences in how regions may conceptualize their roles relating to social issues and environmental issues. The dendrograms offered ways to interpret the variability in the dataset, even if at first glance the data may seem somewhat homogenous. Mission statements exist on a spectrum sharing multiple levels of similarity or differences.

All four linkage techniques are theoretically valid under the right conditions. The key to finding the most suitable linkage technique lies in determining the specific goals of the analysis. This study explored four methods of hierarchical clustering and visualized commonly used linkage techniques even if they were not necessarily the best fit for our dataset.

We also found that not all environmental commitments are included in the primary mission statement of the transport agency. In only a handful of cases, some additional values centered on the environment were found within the statements of environmental branches within the broader transport organization. This suggests that some transport agencies may compartmentalize environmental responsibility by placing it within a more specialized division. In these cases, environmental priorities may be underrepresented in the main mission statement despite being present within the agency. For example, Vermont's *Department of Transportation Project Delivery (Environmental)* branch has the following mission: "To proactively and timely integrate environmental considerations into all VTrans projects and activities in order to avoid, minimize, and mitigate environmental impacts of the transportation system". While this language reflects a commitment to environmental responsibility, it remains vague. Biodiversity is not mentioned. This highlights a broader issue, even when environmental goals are mentioned,

because the absence of specific language makes it difficult to assess how seriously the agency intends to act on those values or how it plans to implement them.

3.4.7 Comparison with other studies

The cluster analysis of mission statements is a new research topic, with only a handful of studies having been conducted in the field of management studies or the service industry. While previous studies used binary matrices to categorize dimensions, this study is the first to employ dendrograms for enhanced data visualization. An increasing number of studies are showing how mission statements can potentially help guide policy changes due to the behavioural changes they can bring about within the organization (Alegre et al., 2018; Hekkert et al., 2020), yet few studies have investigated mission statements this way. While few studies have looked at mission statements, there has been a growing concern with the lack of fauna-sensitive road design (Johnson et al. 2024). Research indicates that environmental considerations within transport departments and institutions are rarely subject to critical analyses. As a result, legal documents and policies often reflect a limited understanding of road impacts, leaving transport planners without the necessary tools to address ecologically sensitive areas, engage stakeholders effectively, or secure funding for meaningful mitigation strategies. Notably, only one critique of transportation policies in Australia was conducted, echoing findings similar to ours, namely the uniformity of policies across Australian states and territories and a tendency to focus on broad environmental concerns without clear prioritization (Bray et al., 2011). Likewise, our analysis of 77 regions revealed a striking similarity in mission statement content, suggesting that they may be more frequently crafted for "show" rather than substance. Additionally, our study found that environmental language used in mission statements was overly broad and superficial, making it

difficult to prioritize specific ecological issues. Without more targeted terminology, efforts to mitigate the harmful effects of roads are at risk of being less effective in guiding practical and impactful mitigation strategies.

3.4.8 Strengths and Limitations of the Study

The focus was on patterns of biodiversity consideration in road agencies according to mission statements. The analysis performed best with the 'Ward.D2' and 'Complete' linkage techniques, yielding the highest Silhouette scores, whereas the 'Average' and 'Single' linkage techniques, with lower Silhouette scores, were useful to compare how techniques would perform that are less suitable for our data.

One limitation of the study lies in the researcher's ability to accurately identify the dimensions present in the mission statements. While most were clearly identifiable, some were more ambiguous and subject to interpretation. Conversely, some mission statements such as Switzerland's, were lengthy, which may have led to the oversight of certain dimensions. Another limitation was the need to keep the data pool small enough (n = 77) to avoid overcrowding the dendrogram and ensure manageable interpretation of the regions. Future research could include the mission statements from all CBD-signatory countries to compare similarities and differences, potentially creating model mission statements for better biodiversity conservation in the transport sector. Given the limitations of using binary data, future studies might benefit from exploring other linkage techniques or incorporating weighted dimensions which would assign levels of importance to different dimensions. Despite the possible limitations, the study's strength lies in applying common linkage techniques to create a cluster analysis for mission statements.

3.5 Conclusion

This study compared the mission statements of 77 regions including all U.S. states, all Canadian provinces and territories, and selected CBD-signatory countries using cluster analysis with four different linkage criteria ('Complete', 'Average', 'Single', Ward.D2') to determine their similarities and explore new ways of analysing mission statements. Results indicated that the 'Ward.D2' and 'Complete' linkage methods performed best. However, coupling the dendrograms with the visualization trees to better understand the distribution of dimensions, is encouraged.

Our analysis found no clear standardization across transport agencies' mission statements, particularly in the use and meaning of key terms. While terms such as 'sustainable' and 'environment' are often poorly defined, others like 'safety' and 'economy' are more clearly defined. We can conclude that the mission statements of transport agencies do not align with theories grounded in EE but are more influenced by neo-classical economic principles which prioritize the expansion of economic opportunities. Further research with transportation agency officials is needed to better understand why certain dimensions were included or omitted from mission statements. Particularly, it would help in understanding why the term 'biodiversity' is almost never included in mission statements and if its inclusion could be considered in future.

Given the growing concern about wildlife-vehicle collisions, we argue that agencies responsible for the design and maintenance of roads should be held accountable for mitigating these adverse on biodiversity. France's mission statement, which explicitly mentions biodiversity, currently serves as our "golden standard". We believe that adding biodiversity to

the mission statements would be a crucial first step among transportation agencies to begin addressing the urgency of biodiversity loss.

4. Manuscript 2: Exploring Barriers to the Integration of Biodiversity in the Mission Statements of Transportation Agencies: Insights from Canada and the U.S.

Sabrina Mruczek and Jochen A.G. Jaeger

Abstract

Due to increasing environmental concerns, transport agencies are increasingly being tasked to consider integrating more environmentally conscientious practises into their policies. This study examines the perceptions of employees within the environmental branches of transportation agencies to gain insights regarding the potential inclusion of biodiversity into the mission statements of transport agencies or if doing so would lead to increased complications within the sector. A survey was conducted using two distinct questionnaires: one for agencies that do not currently include biodiversity in their mission statements, and another for agencies where biodiversity is already included. Both questionnaires, comprising of approximately 40 questions, were distributed to officials via email through government-specific channels, which received 39 responses. Results revealed a hopeful openness to the inclusion of biodiversity as an approach to improve the consideration of biodiversity, but several key barriers were identified. Responses indicated that the local politics of a region (countries or sub-national regions), resistance to change by higher management due to standardized procedures, concerns about public perceptions that might regard it as misallocation of funds, increasing the cost of infrastructure, and the possible perception of 'greenwashing' if biodiversity is not properly acted upon were some reasons discouraging the inclusion of biodiversity into mission statements. While this study highlights the potential benefits of incorporating biodiversity into mission statements, such as increasing awareness about the environmental issue at hand, drawbacks of

this decision must also be taken into consideration due to possible practical, political, and financial constraints. While there is a general openness to include biodiversity into the mission statements of transport agencies, this decision needs to be considered in combination with other political, social, and economic factors. A holistic approach would be best to ensure the most effective action is taken to better consider biodiversity within the transport sector.

4.1 Literature Review

4.1.1 Understanding biodiversity loss

Biodiversity globally is decreasing so quickly that the declines may result in the next mass extinction, caused by human activities (Palombo, 2021). Biodiversity loss causes a variety of issues to human populations including, but not limited to, the altering of ecological mechanisms, the restructuring of food systems, loss of important ecological services, and higher probability of contact with vector-borne diseases, creating more opportunities for diseases to spread (Palombo, 2021). Considering biodiversity loss globally and the resulting threats to human livelihoods, this study poses the question of how biodiversity loss is being handled by government agencies that are responsible for negative impacts on biodiversity.

4.1.2 Responses to biodiversity loss

In response to global biodiversity decline, continued efforts of the United Nations' Convention on Biological Diversity (CBD) led to the Conference of the Parties (COP 15 and COP16) to the United Nations Convention on Biological Diversity in 2022 and 2024. The CBD was signed by 196 countries in 1992 and officially ratified in 1993 (Convention on Biological Diversity, 2011) and has the main goal to "conserve biological diversity, the sustainable use of

its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources" (Convention on Biological Diversity, 2011). Signatory countries are required to submit their National Biodiversity Strategic Action Plan (NBSAP), which provide explanations of how these countries intend to reach their biodiversity conservation goals. While some action has been taken, the question remains of how well these efforts are working. COP 15 took place in 2022 in Montreal, Canada, where global leaders agreed on a new set of goals to guide global action through 2030 to mitigate and reverse the loss of biodiversity. This includes the setting of targets to address biodiversity loss, financial incentives to drive finances towards sustainable investments, and the integration of indigenous knowledge in biodiversity conservation plans (COP 15, 2022).

4.1.3 Critiques of how biodiversity loss is being addressed

While, on the surface, plans for promoting biodiversity conservation may seem well thought out, critiques of these efforts exist and need to be addressed. The signing of the CBD in 1992 stressed the importance of addressing biodiversity loss within Environmental Impact Assessment (E.I.A). However, while nearly all countries have national EIA legislation, the consideration of the issues pertaining to biodiversity in EIA is often inadequate (Gannon, 2021). It is also argued that the United Nations' Biodiversity Conferences fail to meet their commitments to biodiversity conservation. Findlay (2023) argued that there is often little mention of how biodiversity targets would be achieved. Additionally, these targets are not legally binding which results in little pressure for countries that do not reach their biodiversity goals resulting in a lack of accountability. Conservation strategies often lack methods for

quantifying biodiversity, which makes conservation performance difficult to report, with the possibility of inaccurate reporting (Butchart et al., 2016).

4.1.4 Issues pertaining to biodiversity affected by road networks

We argue that biodiversity conservation should not only be the responsibility of a few organizations or agencies specifically relating to the environment. The development of more sustainable practises must involve more collaboration within the social, economic, and environmental sectors, which requires a more integrated approach, as argued by Newell et al. (2022). Therefore, this research project is pushing for the transportation sector to engage more actively in biodiversity conservation. Roads negatively impact biodiversity in various ways from wildlife-vehicle collisions (WVCs) to habitat destruction and fragmentation (van der Ree et al., 2015). Between 2000 and 2014, 474 people were killed on Canadian roads in WVCs. Large ungulates (such as moose, elk, and deer) threaten driver safety if encountered on the road, while smaller mammals such as racoons, skunks, and squirrels can also be affected (Vanlaar et al., 2019). On average, 165 people were killed annually in WVCs in the United States between 1995 and 2004 (Sullivan, 2011). More recently, Quebec saw 1,116 collisions, in 2012, involving large mammals (moose and deer) which increased to 1,946 in 2018 (Laliberté & St-Laurent, 2020). The total length of roads on the planet is projected to increase by 60% between 2010 and 2050, equating to an addition of 25 million kilometers of new road (Dulac, 2013; Laurance et al., 2014). We argue that road agencies should contribute more significantly to the protection of biodiversity.

This argument is grounded in the “Polluter Pays Principle,” which asserts that the responsibility for bearing the costs associated with pollution prevention and the implementation

of improved management strategies should rest with the entity responsible for the pollution. Therefore, the polluter should bear the responsibility for carrying out the necessary steps to mitigate harmful effects and protect the environment (Pinto-Bazurco, 2022). Following this principle, we argue that transportation agencies, responsible for the planning, construction, and maintenance of roads, should bear the responsibility for mitigating their effects on biodiversity by incorporating measures to better protect biodiversity.

4.1.5 Research Questions and Goals

This study builds on an earlier analysis of the mission statements of road agencies from 77 regions including 14 countries and 63 subnational units. Although mission statements are not legally binding, they act as guidelines and serve to ensure that all employees within an organization understand their role (Kemp & Dwyer, 2003). A strong mission statement can help the subsequent creation of more legally binding policies and therefore, a strong mission statement might, eventually, equate to a strong policy regarding a specific issue (Claudet et al., 2020). However, to what degree has biodiversity been considered in current mission statements? The earlier study seldom found terms relating to either biodiversity or the environment in mission statements, whereas the terms ‘economy’ and ‘quality of life’ were present in the majority of these statements. Therefore, here we ask, what is impeding biodiversity from being considered more substantially by transportation agencies? To answer the question, we employed a survey questionnaire to transport agency officials about their professional and personal perceptions regarding the role of biodiversity within the mission statement of their road agency to address the following research questions:

1. Do members of transport agencies believe that their mission statements are adequate regarding issues pertaining to biodiversity?

2. What key factors within transport agencies could be hindering the inclusion of biodiversity in their mission statements?

3. Do transport agency officials believe that the inclusion of biodiversity in their mandates would simply imply some level of greenwashing without real improvements?

4. Do agents within the transport sector believe that biodiversity should be at least, in part, the responsibility of the transport sector?

The answers will promote a better understanding of the internal workings of road agencies and the decision-making process as to why mission statements are currently worded in a particular way and generate insights into the possibility of the term 'biodiversity' being incorporated into the mission statements in the future. We wish to determine the level of openness from transport officials to incorporate biodiversity or certain other environmental aspects within mission statements as they could one day be the precursor for more environmentally conscientious, and legally binding, policies.

4.2. Methods

4.2.1 Survey Outreach

This study utilized a survey questionnaire, a widely used tool to investigate participants' perceptions in ecological management, of human impacts on wildlife, and in interdisciplinary studies that encompass both ecological and non-ecological components (White et al., 2005). Given that our research focuses on the intersection of ecological and non-ecological

perspectives, a survey was the most suitable method for data collection with university level ethics clearance from Concordia University.

The survey aimed to gather perspectives from civil servants in the environmental services branches of road agencies regarding the integration of biodiversity into their mission statements. These branches were selected due to their hypothesized knowledge of biodiversity-related issues within their organizations. The survey was distributed to selected individuals across all 50 U.S. states, as well as all Canadian provinces and territories, excluding Quebec due to the English-only format. Contact details for potential respondents were primarily sourced from the agencies' official websites, however, some email addresses were not publicly accessible. In such cases, we reached out to the agencies via their general inquiries contact email, providing a brief description of the study and specifying the intended participants within the agency. Participant details were recorded in an Excel File. Conducted from early October 2024 to the end of January 2025, the survey involved 1,500 total emails, sent in four separate rounds: an initial invitation followed by three strategically timed reminders. Participation was voluntary and not incentivized.

4.2.2 Survey Questionnaire

The survey provided two response pathways, one for road agencies in which biodiversity is included in their mission statement and another for those that did not include biodiversity. Respondents were directed to a tailored set of questions based on their agency's stance. The first questionnaire focused on transport agencies in which biodiversity *is not* explicitly mentioned in the mission statement. It explored three key themes: (1) Awareness of the impacts that roads have on biodiversity and corresponding agency responsibilities, (2) perspectives about the inclusion of biodiversity into the mission statement, including potential internal conflicts, and (3)

perceived importance of biodiversity and future plans to address it in the transport sector. The thematic structure facilitated a more streamlined analysis. The full survey consisted of 40 questions including a mix of Likert-scale, short answer, and yes/no formats.

The second questionnaire was designed for agencies where biodiversity is included in their mission statements, similarly structured around three themes: (1) awareness of biodiversity issues and knowledge of the transportation sector's impact, (2) current integration of biodiversity into the agency's mandate, and (3) internal collaboration to support and sustain the inclusion of biodiversity considerations within the transport sector. The third theme offered insight into opportunities for further strengthening of biodiversity considerations, marking a key distinction from the first questionnaire. This version included 42 questions, using a mix of Likert-scale, short answer, and yes/no formats.

4.2.3 Participant information and individual variables

Data analysis was conducted using R (R Core Team, 2020). For open-ended responses, we manually reviewed the data to extract relevant themes. The initial phase of the analysis focused on responses from the questionnaire in targeting agencies that do not include biodiversity in their mission statement. This version included 8 nominal variables, 24 ordinal variables, and 8 open-ended questions. The second version, for agencies with biodiversity included in their mission statements, comprised of 8 nominal variables, 21 ordinal variables, and 13 open-ended questions. Qualitative responses were converted into numerical data (Appendix C), enabling the translation of Likert-scale questions into quantifiable metrics for visualization. The data was represented using stacked bar graphs. To assess the relationships between variables, Spearman's rank correlations coefficients were calculated. Statistical significance was

determined using a *p*-value threshold of 0.05, and results were depicted with jitter plots (Figure 4.6).

4.2.4 Thematic analysis of open-ended questions

The open-ended questions were analyzed alongside the closed questions to provide deeper insight into survey responses. Thematic analysis was applied to the qualitative data. Microsoft Forms was initially used to identify broad themes within the responses which were then manually refined through detailed review to ensure consistency and accuracy. Emphasis was placed on analyzing the open-ended responses. The analysis aimed to uncover broader themes that would explain both the exclusion of biodiversity from agency mission statements along with reasons as to why some respondents indicated its inclusion despite prior evidence to the contrary.

4.2.5 Non-parametric analysis between survey questionnaires

Due to the low response rate for the questionnaire completed by participants who indicated that biodiversity was included in their agency's mission statement ($n = 6$), we used a Wilcoxon Rank-Sum Test (Mann-Whitney U Test) to compare responses from this group to those from the larger group of respondents whose agencies did not include biodiversity in their mission statements. As the test compares two independent groups and is non-parametric, it was the most appropriate. It evaluates whether the ranks of the data from one group are systematically higher or lower than those of another group. It does not consider the means of the two groups, making it more robust to outliers and skewed data (McKnight & Najab, 2010), unlike parametric tests that rely on assumptions about the data's distribution. The test was

applied to six questions that were the same, or comparable, between the two survey pathways, allowing for a consistent basis of comparison across groups.

4.3 Results

A total of 39 responses were received, corresponding to a 2.6% response rate. Of these, 33 respondents reported that biodiversity was not included in the agency's mission statement, while 6 reported that it is included. The respondents who answered that biodiversity was not included in their mission statements were from the following agencies: Alaska, Minnesota, Louisiana, Manitoba, Pennsylvania, Colorado, New Mexico, British Columbia, Idaho, Nevada, Ohio, Kentucky, Oregon, Ontario, Oklahoma, Tennessee, Saskatchewan, Vermont, Arizona, Northwest Territories, California, Wisconsin, Montana, and Prince Edward Island. Respondents who reported that biodiversity was included in their mission statement were from Colorado, Montana, Ontario, and Connecticut. Due to each response reflecting an individual's interpretation of their agency's mission statement, it is possible that some agencies appear in both categories. This suggests that perceptions of biodiversity inclusion may vary among staff, depending on how they interpret or prioritize the language in their agency's official documents.

4.3.1 Surveys Not Including Biodiversity in Transport Agency Mission Statements

4.3.1.1 Participant information

Participant information includes the distribution of genders, age, and work experience; however, these variables were not analyzed for statistical significance (Figure 4.1). A total of 33 responses were received for survey questionnaire version 1, addressing agencies where biodiversity is not included in the mission statement. Of these, 19 (58%) respondents were men

and 11 (33%) were women. Two did not answer and one preferred not to say. The largest age group was 45-54 years (39%), followed by the 55 years-and-over group (24%) and 35-44 years group (21%). Most of the respondents reported over 20 years of work experience at their agency (30%), with the second largest group having 10-14 years experience (27%). All respondents work within the environmental branch of their respective transport agency, holding roles such as biologists, ecologists, environmental scientists, and environmental planners.

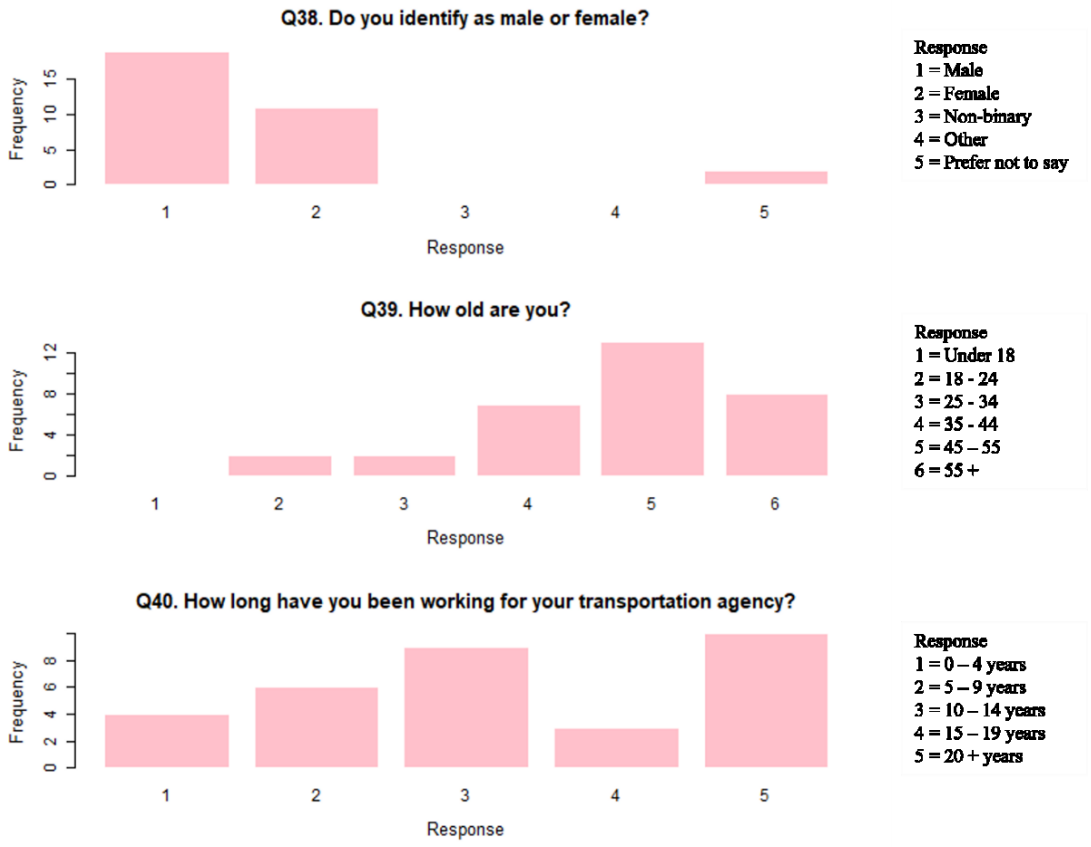


Figure 4.1 Participant information for survey responses from transport agency officials who stated that biodiversity was not included in their mission statement

4.3.1.2 Single-Variable Results

Respondents were presented with a series of Likert-scale questions ranging from "strongly agree" to "strongly disagree". These questions explored their perceptions of how effectively they believe their transport agency is addressing biodiversity concerns as well as their personal views about the potential integration of biodiversity into their agency's mission statement (Figure 4.2). One participant did not answer certain questions, resulting in a total of 32 responses instead of 33. These missing responses were reflected in the varying lengths of corresponding bar graphs.

How much do you agree or disagree with the following statement?

Figure 4.2 Likert-scale questions pertaining to respondents' perceptions of the agency and the inclusion of biodiversity in their transport agency's mission statement.

We then asked participants "Yes"-or-"No" questions regarding any changes they may have observed in their agency's mission statements over the past 30 years. This included questions about their awareness of the presence of key terms, such as 'environment' within the mission statement (Figure 4.3). Responses left blank to these questions explain the variation in the lengths of the corresponding bar graphs.

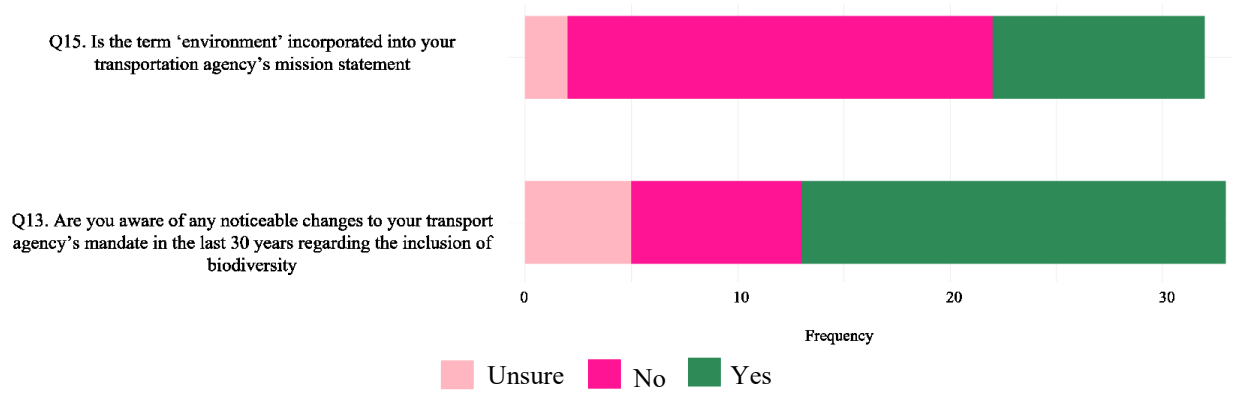


Figure 4.3 Participant responses relating to the frequency of yes or no answers from transport agency officials whose agencies do not include biodiversity in their mission statements.

Respondents were asked to rank their level of knowledge concerning the negative effects of roads on biodiversity on both plants and animals. As the survey targeted environmental branches of transport agencies, it was assumed that participants would possess a working knowledge of these impacts (Figure 4.4). While respondents generally reported a good understanding of the negative effects of roads on biodiversity, specific knowledge related to plants was somewhat less pronounced.

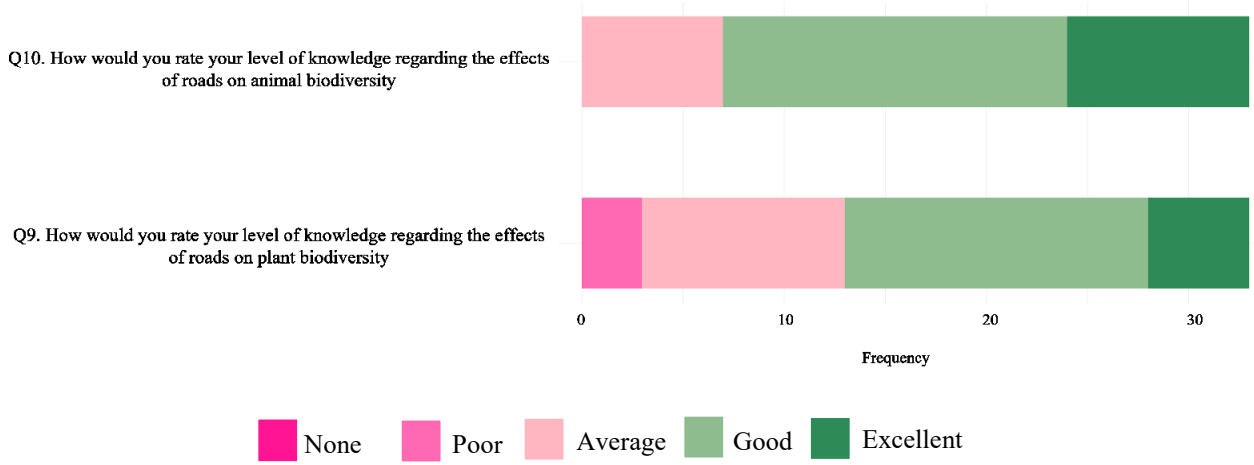


Figure 4.4 Participant responses when asked to rank their knowledge concerning the negative effects of roads on animal and plant biodiversity

Finally, we assessed perceived importance of six hypothesized factors potentially influencing the exclusion of biodiversity from transport agency mission statements. Figure 4.5 illustrates the distribution of participants' rankings for each factor. Variations in the length of the bar graphs account for the questions that were left unanswered.

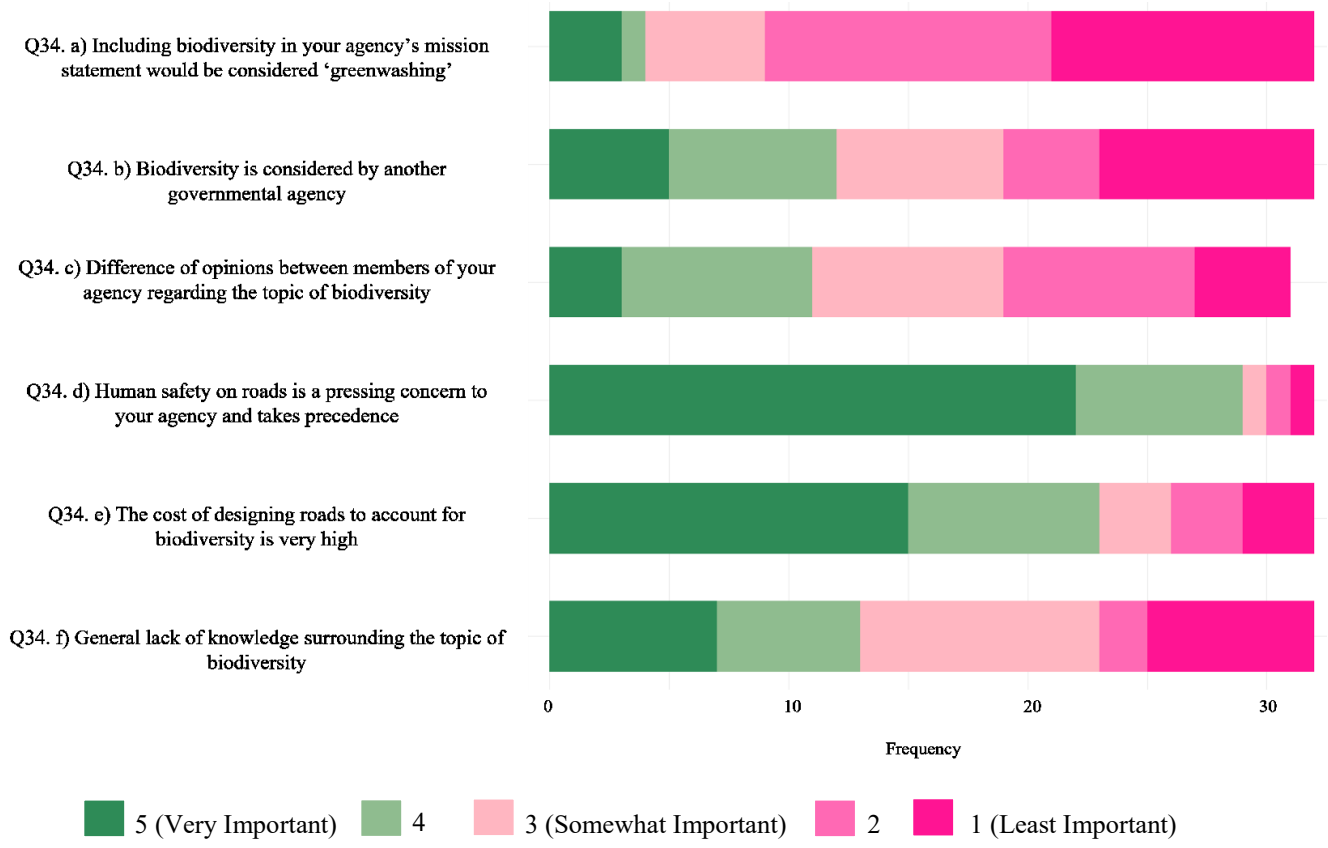


Figure 4.5 Participant responses when asked to rank their perceived importance of six hypothesized reasons potentially influencing the exclusion of biodiversity from mission statements.

The last few questions (Q21, Q32, and Q37) were analyzed separately (Appendix B1). Q21 asked if there has been a significant push to include biodiversity into their mission statement with many respondents stating there was little or no such effort. Q32 asked respondents how they would incorporate biodiversity within their agency with many suggesting that adding it into

policy would be the most effective. Q37 asked whether respondents would personally engage in further discussions regarding biodiversity and its conservation. Most were somewhat open to personally advocating more for its inclusion. However, due to an error in the ranking scale, this question was left out of the analysis. We can only infer a general sense of openness regarding advocating more for biodiversity inclusion.

4.3.1.2 Associations between variables

Five relationships were identified and tested using Spearman's rho to examine associations between key themes that emerged throughout the survey. The main themes included: (1) awareness of the impacts of roads on biodiversity and agency responsibility; (2) support for biodiversity inclusion in mission statements and perceived internal conflicts; and (3) the perceived importance of biodiversity and potential future action plans proposed by the transport agency. The goal was to better understand the strength of associations between specific questions within these themes.

4.3.1.2.1 Theme 1: Awareness of the Impacts of Roads on Biodiversity and Agency Responsibility

Under the first theme, we examined the relationship between self-reported knowledge of plant and animal biodiversity (Q9 and Q10) and the respondents' perceived understanding of the effects of roads on wildlife (Q10 and Q11). Respondents who reported having a good working knowledge of plant biodiversity (Q9) also tended to report having a similar knowledge of animal biodiversity (Q10). We found a moderately significant correlation (Spearman rho = 0.485; p = 0.0042) suggesting that the knowledge of plant and animal biodiversity are often understood in

tandem within professional contexts and likely considered together within decision-making processes (Figure 4.6a). However, no significant association was found between self-reported knowledge of animal biodiversity (Q10) and the belief that their transport agency has a good understanding of the effects of roads on wildlife (Q11). The correlation was weak and not statistically significant (rho = 0.217, $p = 0.225$) indicating a possible disconnect between individual expertise and perceptions of agency knowledge (Figure 4.6b).

4.3.1.2.2 Theme 2: Support for Biodiversity Inclusion in Mission Statements and Perceived Conflicts

We explored the relationship between perceived internal disagreement about the inclusion of biodiversity in mission statements and the perceived conflict regarding the broader importance of biodiversity. Respondents who reported more disagreement within their agency about including biodiversity in their mission statements (Q23) were also more likely to perceive a higher level of conflict concerning the overall importance of biodiversity (Q24). The correlation (rho = 0.56; $p = 0.000704$) indicated a strong association and suggests that disagreement over the formal inclusion of biodiversity is closely related to broader agency-level tensions about the topic (Figure 4.6c).

Additionally, we tested the relationship between the perceived internal opposition to the inclusion of biodiversity into the mission statement (Q25) and the belief that doing so could be perceived as 'greenwashing' (Q28). We obtained a Spearman rho value of 0.373, indicating a moderate association ($p = 0.03$). This suggested that internal resistance may, in part, stem from concerns that incorporating biodiversity into agency mission statements could be viewed as 'symbolic' rather than substantive (Figure 4.6d).

4.3.1.2.3 Theme 3: The perceived importance of biodiversity and future plans to address it

The final theme explored the potential relationship between the perceived positive effects of including biodiversity in the mission statement (Q26) and the presence of active discussions within the agency to include biodiversity into their mission statement (Q36). The Spearman rank correlation was 0.351 (p = 0.049) indicating a moderate association. This suggests that individuals who view biodiversity inclusion as beneficial may also be more attuned to or involved in efforts to promote its integration within agency mission statements (Figure 4.6e).

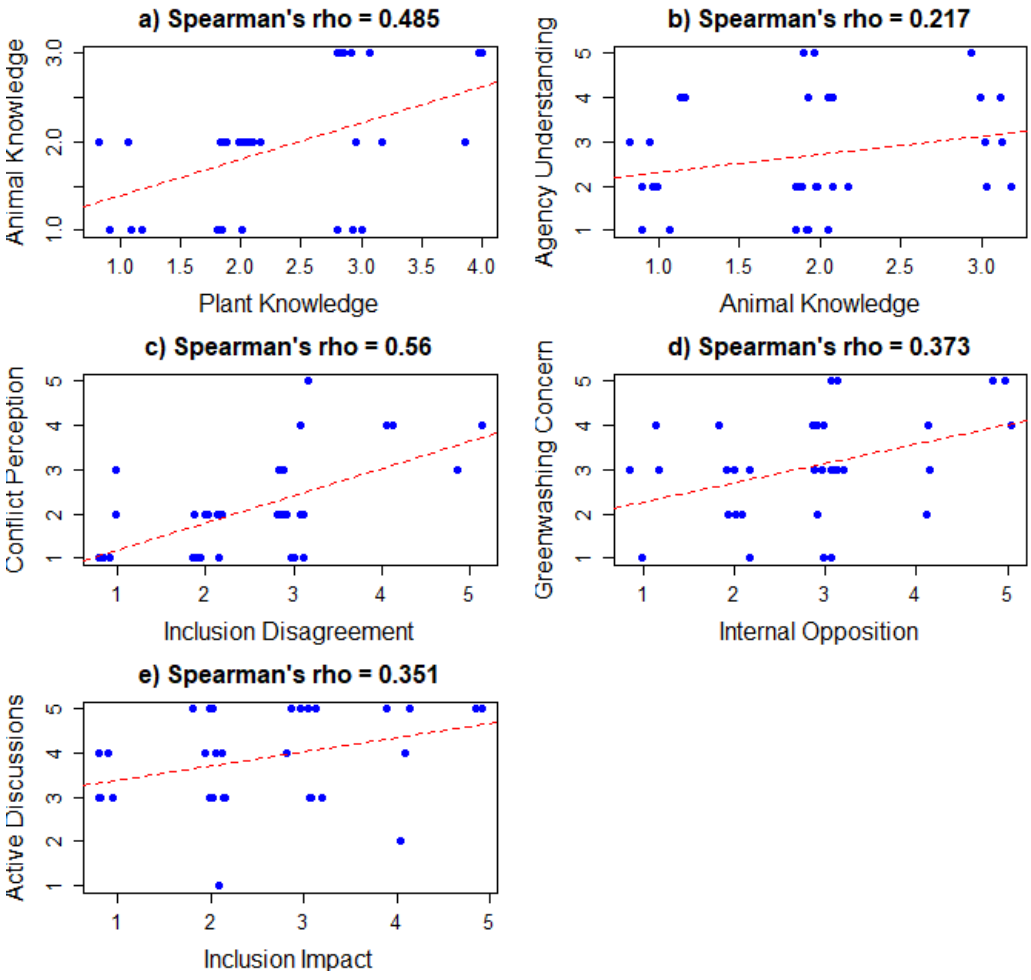


Figure 4.6 Spearman's rank correlations between single questions having potential relationships.

4.3.2 Surveys including biodiversity in mission statements

4.3.2.1 Participant information

Participant information represents gender, age, and years of work experience. Six respondents reported biodiversity in their agency's mission statement: five men (83%) and one woman (17%). Half of the respondents (50%) were aged 55 and older, while the other 3 respondents fell into the age brackets of 35-44 years, 25-34 years, and 18-24 years. Work experience varied with three (50%) having worked for their agency for over 20 years, two (33%) working 0-4 years, and one (17%) answered having 5-9 years of work experience with their agency. All respondents were affiliated with the environmental branch of their respective transport agencies.

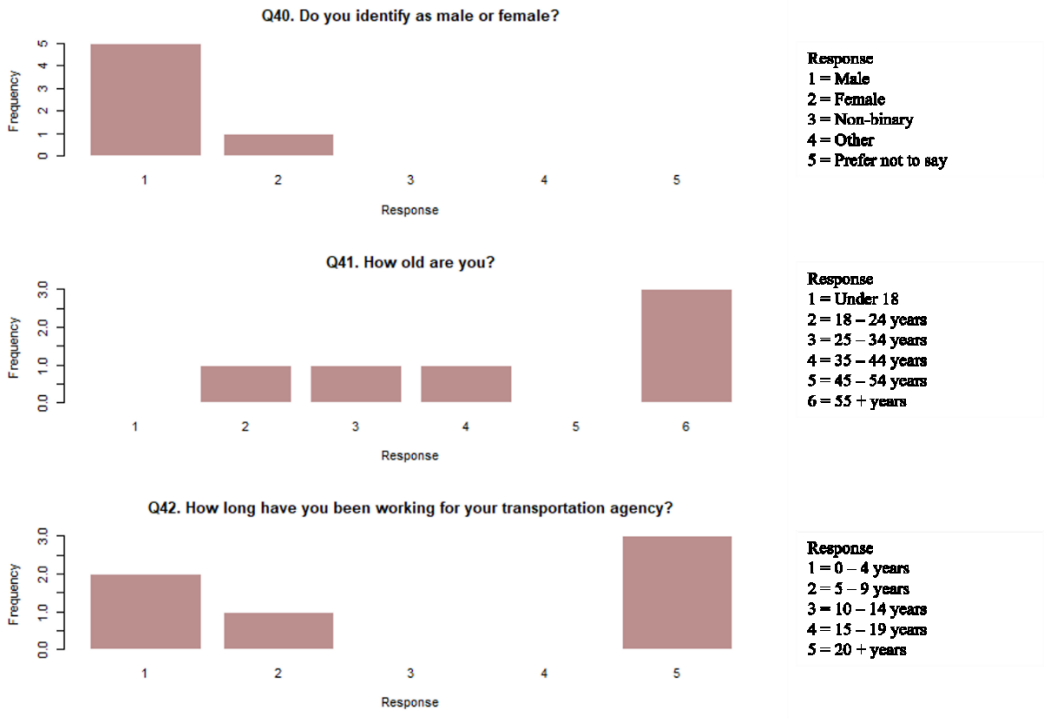


Figure 4.7 Distribution of participant demographics for survey responses from transport agency officials who stated that biodiversity was included in their mission statement

4.3.2.1 Single variable results

Due to the small sample size ($n = 6$), we did not test the significance of correlations between any of the single variable results. Instead, a Mann-Whitney U Test was performed on pertinent questions shared by both questionnaires. All single variable results are provided in Appendix B2 of this paper.

4.3.2.2 Statistical testing

We performed a non-parametric test between the answers to the two questionnaires to compare the responses to the same questions asked in both questionnaires. We performed a Wilcoxon Rank-Sum Test (Mann-Whitney U Test) as it does not assume homogeneity or normality in the data. For a series of 6 Wilcoxon Rank-Sum Tests, none was statistically significant (Table 4.1).

Table 4.1 Questions analyzed via Wilcoxon Rank-Sum Tests between the two survey questionnaires and associated p-values

Questions from Questionnaire 1 (Mission statement not including biodiversity)	Questions from Questionnaire 2 (Mission statement including biodiversity)	Associated *p*-value from Wilcoxon Rank-Sum Test
You have experienced a difference of opinions among other members of your transport agency regarding the inclusion of biodiversity within your transport agency's mission statement.	You have experienced a difference in opinions among other members of your transport agency regarding the inclusion of biodiversity in your transport mission statement.	0.965
Are you aware of any noticeable changes to your transport agency's mandate in the last 30	Are you aware of any noticeable changes to your transport agency's mandate in the last 30 years	0.303

years regarding the inclusion of biodiversity?	regarding the inclusion of biodiversity?	
Including biodiversity in your agency's mission statement would have an overall positive effect on biodiversity.	Having biodiversity present in a road agency mission statement has had noticeable positive impacts on biodiversity in your region.	0.24
The inclusion of biodiversity into your road agency's mission statement would be considered a form of 'greenwashing' (i.e., an unsubstantiated claim to deceive the public into believing that something is environmentally conscientious).	The inclusion of biodiversity in your agency's mission statement is a form of "greenwashing" (i.e., an unsubstantiated claim to deceive the public into believing that something is environmentally conscientious).	0.494
If biodiversity were to be considered in your transport agency, how do you think it would be considered?	How is biodiversity integrated in your transportation agency?	0.627
Your transport agency has future plans to better address the effects of roads on biodiversity.	Your transport agency has future plans to continue addressing the needs of biodiversity	0.447

4.4. Discussion

4.4.1 Agency perceptions

4.4.1.1 Perceptions of terminology used

The general perception of the term 'biodiversity' varies among respondents influenced by various factors shaping their perspectives regarding how biodiversity is addressed by the transport agency. Results indicate that many respondents possess a good awareness of biodiversity, encompassing both for plant and animal biodiversity. Respondents generally showed a greater familiarity regarding animal biodiversity (Figure 4.4 and Appendix B2). Participants acknowledged the multifaceted negative effects of roads on animal biodiversity

including habitat fragmentation, the spread of invasive species, genetic isolation, and the contribution to noise and chemical pollution.

Initially, respondents were asked to define 'environment' within the context of their respective transport agencies. We found a variety of answers, reflecting ambiguity with the use of the term (see selected notable quotes in Table 4.2).

Table 4.2 Responses to the question: *In your professional opinion, what does the term 'environment' entail for your transportation agency? Please describe in detail.*

Quote	Respondent Identification Key
"Originally meant to capture the human environment but has increasingly been re-interpreted to emphasize the natural environment."	*MN - 1*
"Environment seems to refer to an awareness that there is an environment to protect, but in practice, this often means not being completely destructive and creating a setting that is aesthetically pleasing. It is a ubiquitous term that varies across departments."	*KY - 1*
"Environment includes both natural, social, and cultural elements."	*PA - 1*
"Usually impacts to the human environment."	*CO - 3*
"Basically, everything that might fall under NEPA jurisdiction."	*NM - 1*
"Both natural and cultural resources of the state."	*VT - 1*
"A range of resources, including natural (biodiversity would be in that category), cultural, and community aspects (such as health, economy, and social cohesion)."	*ID - 1*
"Consideration of a balance between human activity and natural ecosystems to benefit humans and all organic forms of life."	*OK - 2*

These responses indicate how the meaning of the term 'environment' shifts depending on the respondent. Many indicated that the term was primarily associated with the human environment which aligns with our earlier findings in which mission statements tended to focus more on dimensions such as 'safety', 'economy', and 'quality of life'. More recently, the term environment has been expanded to include the natural environment. As one respondent remarked "it is a ubiquitous term that varies across departments" *(KY – 1)*. While the term 'environment' is used in mission statements, its meaning can change depending on

the individual's interpretation, department, or specific context within the agency. This could mean that different branches might apply the term in their own ways, leading to inconsistent understandings across the agency.

4.4.1.2 Perception of agency responsibilities

A key focus of the study was to assess whether members of transportation agencies perceive biodiversity loss as an issue that warrants greater consideration within the transport sector. Results suggest that many respondents believe that the transport sector should play a more proactive role regarding conservation efforts (Figure 4.2, Q19).

A follow-up question about their perspectives revealed several key insights. Many respondents expressed wanting more collaboration with other state agencies or environmental departments to better address the impacts of roads on biodiversity. While they recognized the role of the transport sector, both how roads negatively contribute to biodiversity loss and what their role could be in its preservation (i.e., better roadway design and mitigation practises), limitations were noted in what the agency can do within their jurisdiction. Several respondents felt they had limited control over biodiversity conservation efforts.

More education and training on (the topic of) biodiversity to better integrate it into the planning, design, construction, and maintenance of road systems, was emphasized. Furthermore, a strong emphasis for long-term planning was also suggested so that biodiversity considerations would be accounted for at all stages of the road development process, rather than treating it as an "afterthought". Some respondents tended to express concerns that significant changes in road development practises would not take place until biodiversity is more formally mandated through policies, regulations, or laws. As one respondent noted "*most of the highways were constructed*

prior to or at the beginning of the understanding of habitat fragmentation or impacts to ecosystems. Most road infrastructure was designed for slower-moving vehicles and lower volumes of traffic. Noise impacts were never thought of" (CO-3). Responses suggest that there is a need for greater adaptation to contemporary environmental issues, both through policy shifts within the transport agency and behavioural changes. Environmentally conscientious road design now requires the active recognition of biodiversity considerations and ecological designs that better address todays' environmental concerns. Interestingly, some respondents who disagreed that biodiversity was the agency's responsibility appeared to have misunderstood the question, citing that there would be "significant impacts to biodiversity" if it were not taken into consideration. Therefore, there are some indications that road agency officials personally believe that their transport agency should bear more responsibility, especially in collaboration with other agencies.

4.4.1.3 Perceptions of 'greenwashing' and 'backlash'

Another important task of the study was to assess whether transport agency officials would tend to believe that the addition of biodiversity to their mission statements would be considered 'greenwashing'. A potential relationship was observed between concerns about 'greenwashing' and the internal opposition to the inclusion of biodiversity into the mission statement. Some respondents indicated that opposition to biodiversity inclusion might stem from concerns regarding how it would be perceived publicly. Although opinions varied, the responses reflected a range of perspectives on whether such inclusion would be viewed as genuine or misleading.

A follow-up question was asked to explore the types of 'backlash' agency officials might expect if biodiversity were incorporated into the mission statement. Perceived backlash to the inclusion of biodiversity included several key concerns. Some respondents argued that the adding the term biodiversity may be inappropriate as a standalone concept, given that mission statements tend to focus more heavily on the human environment. Instead, they suggested that it may be more suitably placed under the umbrella term of 'environmental protection', as to not imply that biodiversity is the most important environmental issue. Others expressed concerns that adding the term might complicate the mission statement, decreasing its overall clarity. Previous findings (from Chapter's 2 and 3) indicate that that clear and concise statements tend to be more effective and can reduce the risk of possible misinterpretation of key terms. While there was a general support for transport agencies playing a more active role in biodiversity conservation, many emphasized that it should not be their primary responsibility. Instead, this responsibility was seen more appropriately belonging to agencies such as Parks and Wildlife or Natural Resources.

Furthermore, there was a division in opinions regarding concerns about potential 'greenwashing'. Some respondents argued that the meaningful inclusion of biodiversity was possible, while others argued that the gesture would be ineffective unless properly supported with concrete actions. One suggestion was to frame biodiversity in terms of its benefits to the human environment which might reduce the opposition to its inclusion *(MT-1)*. Concerns regarding political and public perception on the inclusion of biodiversity were also raised. In more politically conservative regions, conservation efforts could be perceived as a threat to economic interests *(OH-2)*. Financial implications of integrating biodiversity into mission statements was another key concern. Respondents noted that funding for infrastructure is already

limited, and prioritizing biodiversity could divert resources away from current maintenance needs. Additionally, respondents also cited the possible burden on staff particularly regarding the management of additional permitting requirements. It was acknowledged that, while the inclusion of biodiversity could potentially be beneficial, many factors would need careful consideration before its implementation.

4.4.1.4 Perceptions of importance of issues within the agency

The researchers hypothesized six potential reasons why the inclusion of biodiversity might be hindered and asked respondents to rank their importance (Figure 4.5). One of the most frequently mentioned barriers to the inclusion of biodiversity in the mission statement was the higher cost associated to designing roads if biodiversity was to be considered. Human safety was also consistently identified as the top priority, aligning with the earlier findings of the study highlighting those dimensions such as ‘safety’ and ‘economy’ dominate as main themes in transport agency mission statements. In contrast, concerns about biodiversity being perceived as ‘greenwashing’ or already being the primary responsibility of another agency were generally viewed as less significant. However, there was a notable variation in how respondents viewed these concerns, possibly reflecting different institutional roles and communication strategies. Additionally, responses revealed a wide range of opinions on issues such as the general lack of knowledge about biodiversity among agency members and differing views about the topic itself, offers no clear consensus.

4.4.1.5 Perception of overall positive effects if biodiversity was added to mission statements

We asked respondents to rank their personal beliefs regarding whether the inclusion of biodiversity in their mission statements would have an overall positive impact on biodiversity (Figure 4.2, Q26). The responses reflected a variety of perspectives, ranging from strong agreement to strong disagreement. While some respondents supported the statement, others expressed a level of uncertainty, highlighting the diversity of the responses among participants. The results align with earlier findings, particularly among respondents who expressed support for the inclusion of biodiversity in their mission statement. Those who strongly or somewhat agreed with the statement tended to view the inclusion of biodiversity positively and did not necessarily associate it with 'greenwashing'. In contrast, respondents who were more neutral, or who disagreed with the statement, questioned the inclusion of biodiversity, suggesting its ineffectiveness without proper implementation and follow-through.

A follow-up question invited participants to elaborate on the potential benefits adding biodiversity into the mission statement could have. The responses received highlighted several positive benefits of including biodiversity into the mission statements of transport agencies. Respondents noted that its inclusion could increase both awareness and accountability both in and outside the transport agency (*VT – 1*). Even in the absence of more rigorous legal requirements, its addition would hold the agency more accountable for conservation efforts. This could also encourage biodiversity considerations earlier in the planning process, possibly leading to more wildlife-conscious projects such as the protection and restoration of wildlife corridors that improve habitat connectivity, and reduction of wildlife-vehicle collisions. Respondents believed that the inclusion of biodiversity could influence funding priorities and support internal

policy shifts *(BC - 1)*. As previous findings showed, mission statements can possibly shape the directionality of agency policies and referencing biodiversity could help justify additional resources for biodiversity-related initiatives and serve as a catalyst for more environmentally responsible decision making.

However, the idea of adding biodiversity was also met with some skepticism. Some respondents expressed concern that, without concrete actions and follow-through, its addition would be considered 'greenwashing' and ultimately fail to bring about a meaningful change *(MN - 1)*. Others argued that biodiversity considerations are already being addressed by other governing agencies or existing legislation, citing the Species at Risk Act, and therefore did not need to be repeated. Finally, while the addition of biodiversity could possibly enhance the agency's environmental image, political concerns were raised, primarily in conservative states, where the prioritization of biodiversity over human well-being could be viewed as contentious.

4.4.1.6 Changes to the mission statement over time and for the future

Finally, we explored their awareness of any changes to these statements over the past 30 years. While recognizing that younger or newer employees may have more limited insight, the intention was to investigate if respondents have begun noticing incremental shifts in the agency' mission statement, or other internal policies, over time. The responses show that there is a high degree of awareness of such changes among agency members (Figure 4.3, Q13).

Respondents were asked to elaborate on the types of changes they have observed. While there has been no explicit mention of biodiversity in mission statements, more implicit changes were noticed. For example, there was a growing awareness of regulatory scrutiny related to biodiversity, with state regulations such as NEPA (National Environmental Policy Act) and the

Endangered Species Act cited as key drivers for increased environmental awareness within transport projects. Biodiversity is also seen being integrated into existing policies and practises, including increasing funding for the protection of native plant species and construction of wildlife crossings, improving connectivity to benefit biodiversity. Additionally, participants reported more targeted programs dedicated to protecting pollinators, bats, and migratory birds. Despite these advancements, challenges remain when fully integrating biodiversity into mission statements. These include the lack of clarity about biodiversity-related objectives, resistance to change amongst professionals, and knowledge gaps which were frequently cited as barriers. Overall, while there has been some progress in environmental considerations, efforts to fully integrate biodiversity within mission statements was reported to having remained slow and incremental.

Responses indicated a moderate level of openness towards including biodiversity within the transport agency's mission statement. This is accompanied by the perception that such an inclusion *could* strengthen biodiversity conservation efforts. To further explore this, we asked if transport agency officials were aware of any internal discussions related to biodiversity or its potential inclusion into the mission statements (Figure 4.2, Q36). Given the recognition of the potential benefits that including biodiversity can have, we hypothesized that this awareness might correspond with possible ongoing discussions around the topic. However, findings revealed that active discussions about possibly including the term biodiversity in mission statements was very limited. While respondents showed an openness to the idea, there appeared to be a general absence of sustained dialogue and a lack of concrete steps towards its eventual integration into the mission statements. Findings suggest that, while there is some conceptual

support for biodiversity integration, it has yet to translate into meaningful institutional action or policy changes.

4.4.2 Influence of politics within environmental considerations

The political landscape of a region has been cited as one of the major barriers to the inclusion of biodiversity into mission statements or other statewide policies. To better incorporate biodiversity into road planning, respondents were asked how they believe biodiversity should be integrated to achieve the greatest impact within their transport agency (Appendix B1).

Out of the 32 responses, the majority indicated that biodiversity should be integrated through policies, while others suggested other avenues such as its integration through regulations, laws, or mission statements, or other mechanisms. Although the terms law, regulation, policy, and mission statement appear similar, they differ slightly in terms of integration and enforceability which can impact how biodiversity is addressed. Laws are the most binding, usually enforced by courts, and regulations are binding within the scope of the law and normally enforced by agencies. Policies act like guidelines but are enforceable internally within the organization, while mission statements, which are more aspirational in nature, are not legally binding.

Respondents believed that better integration of biodiversity through policies would yield the most effective outcomes. When asked to elaborate, many noticed that biodiversity not being incorporated in the mission statement directly reflects its lower institutional visibility. Overall, respondents noted that biodiversity is not currently a core value within the transport agency. Respondents emphasized that a combination of policies and regulations can lead to a more

formal and systematic inclusion of biodiversity. This combination can help establish a more formalized and coordinated approach on issues pertaining to biodiversity and how these issues can be mitigated. While biodiversity is recognized to a limited degree through existing policies and regulatory requirements, it is not seen as an issue that should take precedence within the agency and faces major challenges relating to funding. A blended approach, particularly through policy and regulatory frameworks, was seen as a precursor towards more meaningful inclusion of biodiversity in transportation.

4.4.3 Non-parametric test between questionnaires

4.4.3.1 Wilcoxon Rank-Sum Test (Mann-Whitney U Test)

Due to the small size of the group, who indicated that biodiversity was in the mission statement ($n = 6$), we used a non-parametric test to compare a few questions that were the same, or similar, across both questionnaires. A Spearman's rank correlation was avoided as it may not have been reliable given the limited sample size of the second group. The p-values from six comparisons were obtained using a Wilcoxon Rank-Sum Test, (Table 4.1), were all greater than 0.05, indicating no statistically significant differences between the two groups. This suggested that, despite the variation in whether biodiversity was included in the mission statement or not, both groups expressed similar views on key topics investigated throughout the study. These topics included;

1. Differing opinions within their transport agency regarding the inclusion of biodiversity in the mission statement.
2. Awareness of changes in the agency's mandate related to biodiversity.

3. Belief that including biodiversity in the mission statement equates to an overall positive impact on biodiversity.
4. Concerns that such inclusion could be perceived as greenwashing without proper actions to support biodiversity.
5. How biodiversity would best be incorporated into the mission statement. Those with biodiversity included in their mission statements mentioned how biodiversity is found within existing policies, while the other group felt policies would be the most effective way to integrate it.
6. Agreement that their agencies have plans to continue addressing biodiversity in the future.

Although respondents answered slightly different questionnaires we found some overlap in their views. *P*-values greater than 0.05 suggest that responses received were statistically similar. Both groups recognized the importance of biodiversity, acknowledged that it can have positive impacts if properly integrated into the mission statements, and expressed concerns that, without proper follow-through, such inclusion could be viewed as 'greenwashing'. Findings can help inform ways on how better incorporate biodiversity into the transport sector and support broader biodiversity conservation efforts.

4.4.4 A discussion on important quotes

Important quotes from members of transport officials were compiled which were then interpreted and translated to important themes. Table 4.3 presents a selection of important quotes and illustrate how their importance was translated for the purposes of this study.

Table 4.3: Table of important quotes from respondents and associated interpretation

Respondent's answer	Interpretation
"Transportation agencies should take into account the effects that roads have on biodiversity and try to limit the impacts; however, I do think the problem should be addressed via coordination between multiple agencies […]" (LA - 1)	Emphasizes the importance of collaboration between different agencies and that the biodiversity might be a difficult issue to handle alone. Advocates for collaboration between multiple agencies for broader environmental issues
"It would be something the department would have to live up to, which could open the door to adopting programs or practices that protect or enhance biodiversity beyond what we already do." (MB - 1)	Suggests that it would hold the agency more accountable and implies that more, or different, practises would need to be implemented which could go beyond what the department already does
"Backlash could come from individuals saying project delivery being delayed. Project costs could escalate. Perception that impacts would never be able to be completed because of the extended processes" (CO - 3) *"More backlash would come from political figures and investors than the general public. Often due to conservation measures having a low profit margin and more work to consider." (KY - 1)*	Concerns might emerge when focusing on timelines and costs of projects. Prioritizing biodiversity could lead to higher costs, lower profit margins, and delays when it comes to project completion. Potential backlash has also been cited as an issue that could also come from political figures and investors

"Many feel that it's important but would not consider it to be a primary goal of the agency." (OK - 2)	While biodiversity has been acknowledged as important, it is not viewed as one of the primary goals of the agency. Biodiversity could still be viewed as an "afterthought" which does not require full attention from the agency.
"This state is pretty conservative. I think the non-environmental staff, especially older ones, would think it is a waste of money and time. I doubt anyone in the public actually reads our mission statement. I had to look it up to see what was in it." (OH - 2)	Highlights that politics of a region and the age of someone can impact how biodiversity is be viewed (in this case as a waste of time and money). General lack of understanding what the mission statement might be.
"Environment seems to refer to an awareness that there is an environment to protect, however in practical application this simply means not being completely destructive and create a setting that is aesthetically pleasing. Environment is a ubiquitous term that varies from department." (KY - 1)	The term environment is a term that has many meanings and possibly lacks clarity depending on which department is asked

4.4.5 Importance of the study and the case for including biodiversity in mission statements

Targets 14 and 15 are key components of the Kunming-Montreal Biodiversity Framework (K-M GBF) that we used to address specific aspects pertaining to biodiversity conservation in this study (Findlay, 2023). These targets highlight that effective biodiversity conservation can only be done if the 'upstream drivers', or the root causes, of biodiversity loss are properly addressed. Findlay specifically points out that business activities, including those within the financial sector, play a major role in contributing to these threats.

In this context, "business" refers to sectors that influence road development, with the economic dimension of road planning playing a critical role. Roads are inherently 'biodiversity-negative,' meaning they damage ecosystems and have an overall negative effect on biodiversity. This study argues that one of the primary drivers of biodiversity loss is the construction and continued usage of road networks that support economic expansion. As transport agencies are responsible for the design, planning, and construction of roads, we argue that they must be held more accountable in accordance with the CBD. We propose that the integration of biodiversity into the mission statements is a crucial first step towards this accountability. This would signal a level of commitment to environmental responsibility and influence the policies to prioritize biodiversity in the road design and planning process rather than treating it as an 'after-thought'. This shift could help reduce the threat from roads to biodiversity through increased funding for wildlife passages, enhanced habitat connectivity, and other mitigation measures.

While environmental adaptation may appear straightforward in theory, we recognize that implementing changes, especially those that are perceived as more environmentally conscientious, is much more complex in practise. Challenges often stem from regional politics,

limited funding, and the need for clearly defined terms and initiatives to avoid potential backlash or accusations of 'greenwashing'. Despite the U.S. not being an active member of the CBD, it remains a valuable framework to follow. More than thirty years after its adoption, it is a reasonable expectation that regions would have developed laws, regulations, and practises that reflect its principles and actively support measures to ensure the conservation of biodiversity.

Bray et al. (2011) and Johnson et al. (2022) examined the shortcomings in Australian environmental policies within the transport sector which echoed the findings of our study as well. It was suggested that environmental consequences of transport infrastructure were addressed only in more recent strategies, focusing mainly on greenhouse gas emissions. We found that the inclusion of the term 'environment' only recently started encompassing the natural environment but still favouring the human environment. Johnson et al. (2024) argued that there has been little acknowledgment in fauna-sensitive road design, a worrying finding considering the role linear infrastructure plays in the destruction of wildlife habitats and the decrease in biodiversity and few studies critically examining the role of environmental policies within transport departments and institutions. A poor understanding of road impacts in legal documentation and policy guidelines can leave transport planners ill-equipped to address these issues (Papp et al., 2022). This was also highlighted in our study as many road agents cited the feeling of 'powerlessness' noting that even when they cared about biodiversity, they often lacked the authority or resources to take meaningful action.

4.4.6 Strengths and limitations of the study

While this study is a pilot, it aimed to explore the perceptions of transport agency officials about biodiversity and specifically how they view their agency's role in biodiversity

conservation and what barriers they believe can hinder the inclusion of biodiversity into the mission statements. One limitation is its small sample size (n = 39) which may not reflect the broader range of perspectives of transport agency officials across regions. For instance, some respondents from more conservative regions ('red states') expressed a genuine interest in participating in the study and in advocating for the transport sector to better consider biodiversity. Therefore, while the political climate of a region was stated as a barrier to the inclusion of biodiversity, some agency officials did not reflect the ideologies of their transport agencies. Additionally, the survey was opinion based and not incentivized and some participants expressed potential discomfort in answering certain questions by leaving them blank or choosing not to elaborate on their responses. Additionally, some regions declined participating altogether, effectively refusing to engage in the study. A few respondents reached out personally, expressing genuine interest in the study but chose not to participate due to their apprehension on the opinion-based nature of the questions about how their agency was performing on issues pertaining to biodiversity. This variability highlights the challenges in capturing representative populations meaning that generalizations can be made from the surveyed sample.

While we had believed that distributing the survey via a Microsoft Forms link would maximize our outreach, respondents raised concerns about its legitimacy. Some feared it could be a phishing attempt, while others reached out and explicitly mentioned that their agency prohibits them from opening external links. This likely contributed to the low response rate. To address this issue, future iterations of this study could benefit from in-person data collection to avoid the limitations of online surveys. Additionally it would be useful to clarify the distinction between the terms 'mission statement' and 'mandate' as some respondents seemed to have confused the two. This confusion may explain why a small number of respondents indicated that

their agency's mission statement included biodiversity, even though none actually had biodiversity mentioned in their mission statement, according to the first part of the study. While mission statements did not include biodiversity, respondents described biodiversity consideration as an implicit effort, referring to other federal or state regulations that consider biodiversity.

The distinction between the terms 'mission statement' and 'mandate' needs to be more clearly defined. Future iterations of the study should design questions that explicitly relate to one or the other instead of assuming that they were interchangeable. Additionally, we suggest condensing the survey and incorporating more targeted questions asking how respondents might improve their agency's mission statement. These new questions could address these suggested changes and how such changes could be effectively implemented and better explore strategies to overcome the barriers to integrating biodiversity into mission statements.

4.5. Conclusion

While there appears to be a general awareness about the negative effects of roads on biodiversity along with a willingness to address the issue, follow-through in terms of integrating biodiversity into the mission statements of transport agencies is lacking. Several barriers to the inclusion were identified including political influence, limited funding, often allocated primarily towards the construction of new roads or the maintenance of existing road infrastructure, and differing perspectives regarding the relevance of biodiversity within the transport sector. These challenges can make it difficult to prioritize biodiversity in agency operations.

Despite these challenges, we argue that its incorporation into mission statements, while not legally binding, would be a crucial first step towards holding the road agencies more accountable

for the environmental impacts of roads and may lead to broader policy reforms. By including biodiversity into the mission statements, transport agencies would be encouraged to integrate it throughout all phases of road development including planning, design, and construction. Over time, integration could help position biodiversity as a key consideration, potentially leading to new funding opportunities for conservation. Moreover, its inclusion would be more aligned with global commitments outlined by the CBD, which emphasizes conservation and the sustainable use of natural resources. This change could enhance the sector's role in environmental stewardship, contributing to greater sustainability and ecological resilience in infrastructure projects.

Members of transport agencies generally believe that biodiversity is being considered by their agencies to some extent; however, a commonly cited barrier is the limited power and influence they hold within their own organizations. Other key factors, such as political pressures, restricted funding allocation to environmental conservation within the agency, and the prioritization of human-centric concerns, often take precedence over environmental issues, including that of biodiversity. Without concrete implementation strategies, concerns over greenwashing emerge, as respondents mentioned that the inclusion of biodiversity would only serve as a symbolic gesture and would not amount to any meaningful commitment. Despite these challenges, there is a broad consensus among agency officials that their respective transport agencies could, and should, play a more significant role in biodiversity conservation, even though it is not currently viewed as a priority.

While we recognize the difficulties in integrating biodiversity, the need for greater accountability is clear and urgent. Embedding biodiversity could be the catalyst needed to equip

transport agencies with the tools necessary to address the long-term environmental challenges associated with transportation infrastructure.

5. Thesis Recommendations

To effectively integrate biodiversity into the transportation sector, it would be required to develop clear and action-oriented biodiversity language in their mission statements. This includes standardizing methods to measure biodiversity, developing clear action plans as to how to conserve biodiversity, creating actionable conservation plans, and explicitly linking biodiversity protection to the sector's core values and services. Adding biodiversity to the mission statements may influence how conservation efforts are funded and prioritized within the sector. However, we argue that awareness alone is not enough. Bridging the gap between scientific knowledge and practical action requires a better understanding of how biodiversity intersects with transportation operations along with the establishment of key indicators within the sector. These indicators can include the reduction in habitat disturbance, including population abundance and impact assessments (Barrientos et al., 2025), increased staff training on biodiversity, and tracking biodiversity-related projects. Addressing internal barriers is also essential. Further research into regional challenges can help tailor biodiversity strategies that reflect local contexts and overcome regional implementation obstacles. Transport agencies can further build on existing regulations by enhancing and strengthening current efforts and biodiversity goals which can enhance credibility and accountability in the agency. Embedding biodiversity into governance structures, through advisory committees, designated transport agents, and consistent reporting, can ensure long-term integration. Encouraging sector-wide and

cross-sector collaboration through dialogue and shared case studies can accelerate progress and foster collective progress and help inspire biodiversity conservation practises.

6. Thesis Conclusion

This study employed two methods of data collection and analysis to better understand how biodiversity is considered in the mission statements of transportation agencies. The first part used hierarchical cluster dendrograms to analyze mission statements from 77 regions globally, including Canada and its 13 provinces and territories, the United States and its 50 states and 13 countries that have signed the Convention on Biological Diversity (CBD). We applied four clustering methods including the 'Complete', 'Average', 'Single', and 'Ward.D2' to examine the similarities and differences among mission statements and assess the effectiveness of using such visualization methods to interpret qualitative data. Overall, we argue that these methods facilitate the interpretability of textual data and can provide valuable insights.

The second part of our study complemented the first part by investigating the barriers to integrating biodiversity into transport agency mission statements through a survey of transport agency officials. Results showed a general openness to the inclusion of the term 'biodiversity' into their mission statements but also showed skepticism and concern over its practical integration. Respondents noted that transport agencies still prioritize the human environment over other environmental concerns despite the CBD having been signed over thirty years ago.

To summarize our research questions and key research findings; while some incremental changes regarding environmental considerations have occurred, mainly through agency-specific programs, there still has not been a shift to include biodiversity in the mission statements of road agencies. Most remain centered on safety and economy with environmental language either

absent or vague. In comparison to other selected industrialized countries, Canada's compares largely to the mission statement of the United States, prioritizing economic and infrastructural goals with little attention to environmental issues. In contrast, countries like Switzerland and the Netherlands incorporate more general environmental language with France standing out as the only country to explicitly mention biodiversity, making it a potential model for other regions. The majority of road mission statements still follow an economy-centered paradigm. Although a few agencies have adopted sustainability language, this is not the norm. Ecological considerations are often secondary and are rarely included within the core values of the agency's mission statement. Lastly, there exists a possibility of considering biodiversity within the transport agency. Survey responses indicate that while there is a degree of openness to its inclusion, there are concerns regarding the feasibility and relevance of incorporating biodiversity into road agencies' mission statements.

We argue that the inclusion of biodiversity in mission statements can serve as an important step towards environmental policy and stronger biodiversity conservation priorities within the transport sector. However, several barriers must be acknowledged including regional politics, concerns over both public and internal backlash regarding funding allocations and fears about being perceived as 'greenwashing' if proper follow-through is not conducted. These concerns highlight the necessity of careful and transparent integration of newer environmental language, including the term 'biodiversity'.

Despite these challenges, there has been some slow gradual progress as some transport agencies have begun considering biodiversity through a variety of projects including habitat and wildlife protection initiatives and efforts to improve habitat connectivity. While these are steps in

the right direction, they are highly insufficient in light of the current biodiversity crisis and the urgent need for more systematic action.

We argue that transport agencies, as the primary contributors to habitat fragmentation and other adverse environmental impacts, should be held responsible under the 'Polluter Pays Principle'. These agencies must begin to assume a leadership role in mitigating biodiversity loss. As of now, France is the only country that explicitly mentions biodiversity in its transport agency's mission statement. We propose France's approach as a model for future mission statement revisions, demonstrating that its incorporation is possible and can lead to a meaningful outcome.

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8. *Appendices*

Appendix A1: Table of Mission Statements used and analyzed for the project

Country	**State/Province**	**Mission Statement**
U.S.A	Alabama	*"To provide a safe, efficient, and environmentally sound transportation system for all customers."*
U.S.A	Alaska	*"Keep Alaska Moving through service and infrastructure."*
U.S.A	Arizona	*"We provide highway infrastructure and transportation services"*
U.S.A	Arkansas	*"To deliver a modern transportation system to enhance safety and quality of life in Arkansas"*
U.S.A	California	*"Provide a safe and reliable transportation network that serves all people and respects the environment."*
U.S.A	Colorado	*"To provide the best multi-modal transportation system for Colorado that most effectively and safely moves people, goods, and information."*
U.S.A	Connecticut	*"The mission of the Connecticut Department of Transportation is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region"*
U.S.A	Delaware	*"Excellence in Transportation* *Every Trip • Every Mode • Every Dollar • Everyone"*
U.S.A	Florida	*"The department will provide a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities"*
U.S.A	Georgia	*"As the organization in charge of developing and maintaining all state and federal roadways in the U.S. state of Georgia, we want to deliver a transportation system focused on innovation, safety, sustainability and mobility."*
U.S.A	Hawaii	*"To provide a safe, efficient, accessible, and sustainable inter-modal transportation system that ensures the mobility of people and goods, and enhances and/or preserves economic prosperity and the quality of life"*

U.S.A	Idaho	*"Your Safety* *Your Mobility* *Your Economic Opportunity"*
U.S.A	Illinois	*"It is our mission to provide safe, cost-effective transportation for Illinois in ways that enhance quality of life, promote economic prosperity, and demonstrate respect for our environment."*
U.S.A	Indiana	*"Collaboratively plan, build, and maintain safe and innovative transportation infrastructure that enhances quality of life, drives economic growth, and accommodates new modes of transport."*
U.S.A	Iowa	*"Getting you there safely, efficiently, and conveniently."*
U.S.A	Kansas	*"To provide a safe, reliable, innovative statewide transportation system that works for all Kansans today and in the future."*
U.S.A	Kentucky	*"To provide a safe, efficient, environmentally sound and fiscally responsible transportation system that delivers economic opportunity and enhances the quality of life in Kentucky."*
U.S.A	Louisiana	*"Plan, design, build and sustain a safe and reliable multimodal transportation and infrastructure system that enhances mobility and economic opportunity."*
U.S.A	Maine	*"To support economic opportunity and quality of life by responsibly providing our customers the safest and most reliable transportation system possible, given available resources."*
U.S.A	Maryland	
U.S.A	Massachussetts	*"Our mission is to deliver excellent customer service to people traveling in the Commonwealth by providing transportation infrastructure which is safe, reliable, robust and resilient. We work to provide a transportation system which can strengthen the state's economy and improve the quality of life for all."*
U.S.A	Michigan	*"Serving and connecting people, communities, and the economy through transportation."*
U.S.A	Minnesota	*"Connect and serve all people through a safe, equitable and sustainable transportation system"*

U.S.A	Mississippi	*"The Mississippi Department of Transportation is responsible for providing a safe intermodal network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner."*
U.S.A	Missouri	*"Our mission is to provide a world-class transportation system that is safe, innovative, reliable and dedicated to a prosperous Missouri."*
U.S.A	Montana	*"MDT's mission is to plan, build, operate, and maintain a safe and resilient transportation infrastructure to move Montana forward."*
U.S.A	Nebraska	*"We provide the best possible statewide transportation system for the movement of people and goods."*
U.S.A	Nevada	*"Provide, operate, and preserve a transportation system that enhances safety, quality of life and economic development through innovation, environmental stewardship and a dedicated workforce."*
U.S.A	New Hampshire	*"Transportation excellence enhancing the quality of life in New Hampshire."*
U.S.A	New Jersey	*"NJDOT will provide a world class transportation system that:* *-Enhances the quality of life for residents and traveling public* *-Achieves consistent progress through focused investments to keep infrastructure in a State of Good Repair* *-Stimulates and sustains smart development and economic growth* *-Employs the latest technologies to adapt to changing conditions and environments* *-Respects and protects the distinctive and delicate character of the State's natural resources* *-Eagerly embraces its role as a customer service organization"*
U.S.A	New Mexico	*"Provide a safe and efficient transportation system for the traveling public, while promoting economic development and preserving the environment of New Mexico."*
U.S.A	New York	*"It is the mission of NYSDOT to provide a safe, reliable, equitable, and resilient transportation system that connects communities, enhances quality of life, and supports the economic well-being of New York State."*

U.S.A	North Carolina	*"Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina"*
U.S.A	North Dakota	*"Safely move people and goods."*
U.S.A	Ohio	*"To provide a transportation system that is safe, accessible, well maintained, and positioned for the future."*
U.S.A	Oklahoma	*"The mission of the Oklahoma Department of Transportation is to provide a safe, economical and effective transportation network for the people, commerce and communities of Oklahoma."*
U.S.A	Oregon	*"We provide a safe and reliable multimodal transportation system that connects people and helps Oregon's communities and economy thrive."*
U.S.A	Pennsylvania	*"Enhance, connect and add value to our communities by providing a sustainable, equitable transportation system and quality services for all."*
U.S.A	Rhode Island	*"The Rhode Island Department of Transportation (RIDOT) designs, constructs, and maintains the state's surface transportation system. This includes not only roads and bridges but also the state's rail stations, tolling program, bike paths and ferry service."*
U.S.A	South Carolina	*"SCDOT connects communities and drives our economy through the systematic planning, construction, maintenance and operation of the state highway system and the statewide intermodal transportation and freight system."*
U.S.A	South Dakota	*"To efficiently provide a safe and effective public transportation system."*
U.S.A	Tennessee	*"Provide a safe & reliable transportation system to support economic growth & quality of life."*
U.S.A	Texas	*"Connecting you with Texas."*
U.S.A	Utah	*"Enhance quality of life through transportation"*
U.S.A	Vermont	*"Through excellent customer service, provide for the safe and efficient movement of people and goods in a socially, economically, and environmentally sustainable manner."*

U.S.A	Virginia	*"Our mission is to plan, deliver, operate and maintain a transportation system that is safe, enables easy movement of people and goods, enhances the economy, and improves our quality of life."*
U.S.A	Washington	*"We provide safe, reliable and cost-effective transportation options to improve communities and economic vitality for people and businesses."*
U.S.A	West Virginia	*"It is the mission of the West Virginia Department of Transportation to create and maintain for the people of West Virginia, the United States and the world a multi-modal and inter-modal transportation system that supports the safe, effective and efficient movement of people, information and goods that enhances the opportunity for people and communities to enjoy environmentally sensitive and economically sound development."*
U.S.A	Wisconsin	*"Provide leadership in the development and operation of a safe and efficient transportation system."*
U.S.A	Wyoming	*"Provide a safe and effective transportation system"*
Canada	Alberta	*"Provides a safe and efficient transportation system to support Alberta's economic, social and environmental vitality."*
Canada	British Columbia	*"The Ministry of Transportation and Infrastructure (TranBC) is about moving people and goods safely, and fueling our provincial economy, through transportation networks, transportation services and infrastructure, transportation policies and related acts and regulations."*
Canada	Manitoba	*"The Department of Transportation and Infrastructure is responsible for establishing and managing public infrastructure, including: provincial highways and roads, highway bridges and structures, water and flood control works, and northern airports and marine services. It develops, communicates and administers motor carrier regulatory and safety services. The department also oversees and coordinates emergency preparedness, emergency response and disaster recovery to prevent the loss of life and minimize damages to property and the environment."*

Canada	New Brunswick	*"To contribute to New Brunswick's economy and quality of life by providing and supporting sustainable infrastructure that allows for the safe and efficient movement of people and goods and accommodates the provision of government services to the public."*
Canada	Newfoundland and Labrador	*"The mandate of the Department of Transportation and Infrastructure is derived from the Executive Council Act and includes responsibility for the administration, supervision, control, regulation, management and direction of all matters relating to transportation and public works, including:* *Design, construction, improvement, repair and maintenance of highways, local roads, airstrips, ferry terminals and related facilities;* *Acquisition, use, maintenance and operation of ferries under ownership, charter or administration;* *Acquisition, use, maintenance and operation of provincial air ambulance, waterbomber and other aircraft and services under ownership, charter or administration;* *Property that belongs to or is held or occupied by the Crown, and the works and properties acquired, constructed, extended, enlarged, repaired or improved at the expense of the province, or for the acquisition, construction, extension, enlargement, repair or improvement of which public funds are voted and appropriated by the Legislature, other than property and works assigned to another Minister or department of the Government of Newfoundland and Labrador;* *Property management including the design, construction, repair, maintenance, heating, lighting, cleaning and security of buildings that belong to or are held or occupied by the Crown and grounds that belong to those buildings;* *The leasing of real property by the Crown and related activities;* *The disposition of surplus real property; and,* *The administration of Acts under the responsibility of the department and of all orders and regulations passed or made under those Acts, including those powers, functions or duties necessary or desirable for carrying out the purpose of those Acts."*

Canada	Nova Scotia	*"The Department of Public Works builds and maintains provincial highways, roads and bridges. We provide a safe and efficient transportation system that helps move people and goods throughout the province. We also build and maintain government buildings and operate the province's 7 ferries.* *The department is also responsible for road safety initiatives, Registry of Motor Vehicles, provincial highway cameras and road condition updates with the 511 service."*
Canada	Ontario	*"Moving people and goods safely, efficiently and sustainably across Ontario to improve quality of life and support a globally competitive economy."*
Canada	P.E.I	*"The Department of Transportation and Infrastructure provides for essential transportation systems for the travelling public and the effective and efficient transport of goods. It provides the infrastructure for government services in building construction, crown land management, building maintenance and accommodations. The department works to improve Prince Edward Island's physical assets and ensure highways and roads are safe for all Islanders.* *Some of the priorities in this mandate are to:* *Develop infrastructure renewal plans and partner with other governments to carry them out* *Provide and improve front-line government services though Access PEI"*
Canada	Saskatchewan	*"The ministry manages and provides for the future development of an integrated sustainable provincial transportation system, which supports economic growth and prosperity for Saskatchewan. Our infrastructure investments will be guided by strategic transportation policy and incorporate operating and maintenance practices which promote the safe and efficient movement of people and goods."*
Canada	Quebec	*"Mission et mandats* *Favoriser la mobilité durable des personnes et des marchandises par des systèmes de transport sécuritaires et accessibles qui contribuent au développement du Québec : en exploitant nos actifs routiers, maritimes, ferroviaires, aéroportuaires, aériens et immobiliers ainsi que nos équipements roulants de façon responsable et innovante; en*

		réalisant des projets de maintien, d'amélioration et de développement de nos actifs dans une perspective intégrée de mobilité; en investissant dans les projets et les mesures favorisant la mobilité durable au bénéfice d'une économie verte tels que le transport collectif et actif; en assumant un leadership qui s'exerce par l'ingénierie, l'expertise et l'innovation de même qu'un encadrement normatif et sectoriel."
Canada	Yukon	*"The Department of Highways and Public Works is responsible for ensuring safe and efficient public highways, airstrips, buildings and information systems."*
Canada	Northwest Territories	*"To provide and promote a safe, reliable and sustainable multi-modal transportation system by strengthening connections, capturing opportunities and embracing innovation."*
Canada	Nunavut	*"Working in partnership to support Nunavummiut in stimulating and strengthening the economy, and to ensure the safe and effective movement of people, goods, and knowledge."*
CANADA		*"We work to make our transportation system safe, secure, efficient and environmentally responsible."*
U.S.A		*"To deliver the world's leading transportation system, serving the American people and economy through the safe, efficient, sustainable, and equitable movement of people and goods. "*
ENGLAND		*"We work with our agencies and partners to support the transport network that helps the UK's businesses and gets people and goods travelling around the country. We plan and invest in transport infrastructure to keep the UK on the move."*
SWITZERLAND		*"L'Office fédéral des transports (OFT) s'engage pour que les transports publics et le transport de marchandises en Suisse soient exploités de manière durable et adaptés constamment en fonction des besoins et des développements.* *L'OFT a quatre tâches principales :* *Politique : préparer et mettre en œuvre les décisions politiques du Conseil fédéral, du Parlement et du peuple ;* *Sécurité : garantir un niveau de sécurité élevé mais finançable des chemins de fer, des bus , des bateaux et des installations à câbles ;* *Financement : permettre des services de transport de qualité*

		élevée grâce à une utilisation efficiente des ressources ; Infrastructure : veiller à ce que les infrastructures nécessaires soient construites en temps utile et en conformité avec les prescriptions. *Du fait de sa situation au cœur de l'Europe et de ses interdépendances internationales sans cesse croissantes, la Suisse ne peut accomplir ses tâches qu'en étroite collaboration avec les pays voisins et l'Union européenne. L'OFT est en contact régulier avec ses partenaires nationaux et internationaux. "*
FRANCE		*Le ministère de la Transition écologique et de la Cohésion des territoires prépare et met en œuvre la politique du Gouvernement dans les domaines du développement durable, de la cohésion des territoires, de la lutte contre les inégalités territoriales, notamment dans les quartiers populaires des zones urbaines et les territoires ruraux, de l'environnement, notamment du climat et de l'efficacité énergétique, de la protection de la nature et de la biodiversité, de la prévention des risques naturels et technologiques, de la sécurité industrielle, des transports et de leurs infrastructures, de l'équipement et du logement, de l'urbanisme, de la ville, de l'aménagement et de la lutte contre l'étalement urbain ainsi que de la mer."*
GERMANY		*"FBA mission statement: Who we are and what we want NEW WAYS. MODERN WORK. GROWING TOGETHER.* *The Federal Roads Authority (FBA) is a higher federal authority within the portfolio of the Federal Ministry of Digital and Transport (BMDV). We are an independent supervisory and approval authority for federal highways and federal roads under federal administration. As part of the reform of the Federal Highway Administration, we contribute to the common goal of permanently providing an efficient and safe infrastructure with nationwide quality standards."* TRANSLATED FROM GERMAN USING DEEPL
NETHERLANDS		*"The Ministry of Infrastructure and Water Management is committed to improving quality of life, access and mobility in a clean, safe and sustainable environment. The Ministry strives to create an efficient network of roads, railways,*

		waterways and airways, effective water management to protect against flooding, and improved air and water quality."
FINLAND		*"Sustainable growth, wellbeing, safety and security through data and future-proof connections."*
SWEDEN		*"The Swedish Transport Agency is working to achieve good accessibility,* *high quality, secure and environmentally aware rail, air, sea and road transport. We have overall responsibility for drawing up regulations and ensuring that authorities, companies, organisations and citizens abide by them."*
NORWAY		*"The Ministry of Transport has overall responsibility for the framework conditions for postal activities, for the civil aviation, public roads and rail transport sector and ferry services forming part of the national road system.* *The ministry's field of responsibility includes long-range planning, research and analysis as well as regulatory development and budgetary matters in the above sectors. The ministry manages the Public Roads Administration, Norwegian Raiway Directorate, Civil Aviation Authority, Norwegian Railway Authority, Road Supervisory Authority, Statutory Services – Aerial Ropeways and the Accident Investigation Board Norway. The ministry also manages the government owner interests in Avinor AS, Bane NOR SF, Vy Group and Nye Veier AS."*
IRELAND		*"To deliver an accessible, efficient, safe and sustainable transport system that supports communities, households and businesses."*
SCOTLAND		*"We seek to deliver a safe, efficient, cost-effective and sustainable transport system for the benefit of the people of Scotland, playing a key role in helping to achieve the Scottish Government's Purpose of increasing sustainable economic growth with opportunities for all of Scotland to flourish."*
AUSTRALIA		*"Our work connects, and enriches every Australian community, underpins our economy and society, and empowers our regions. We provide strategic policy advice, administer fit-for-purpose regulation and deliver programs and services in the major infrastructure, transport, communications and arts sectors, supporting our regions, cities and territories.*

		This work includes planning for the global digital economy, designing liveable future-facing cities and creating the transport and telecommunications systems of tomorrow. We also help empower our regional communities, promote our thriving arts sector and protect and celebrate the culture, heritage and languages of First Nations people."
NEW ZEALAND		*"We are the Government's system lead on transport. Our purpose is to enable New Zealanders to flourish, reflecting transport's role in shaping our society, economy and environment."*

Appendix A2: Binary Table of Dimensions

State/Province/Country	Safety	Economy	Quality of Life	Environment	Mobility of Goods	Efficiency	Effective	Reliable and/or Resilient	Provision and Management	Modal Transport	Innovation/Modernize	Accessibility	Cost-Effective	Sustainable	Natural Resources	Leadership	Policies/Regulations	Social Vitality	Green Economy	Biodiversity	Connectivity	Environmental Protection
Alabama	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alaska	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Arizona	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkansas	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
California	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colorado	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Connecticut	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Delaware	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Florida	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Georgia	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0

Hawaii	1	1	1	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Idaho	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Illinois	1	1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Indiana	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Iowa	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Kentucky	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Louisiana	1	1	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Maine	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maryland	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0
Massachusetts	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Michigan	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minnesota	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Mississippi	1	0	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Missouri	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Montana	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nebraska	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nevada	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
New Hampshire	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Jersey	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
New Mexico	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New York	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Carolina	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

North Dakota	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ohio	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Oklahoma	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pennsylvania	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Rhode Island	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
South Carolina	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
South Dakota	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tennessee	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Texas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utah	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Vermont	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Virginia	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
West Virginia	1	1	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Wisconsin	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Wyoming	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alberta	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
British Columbia	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Manitoba	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
New Brunswick	1	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

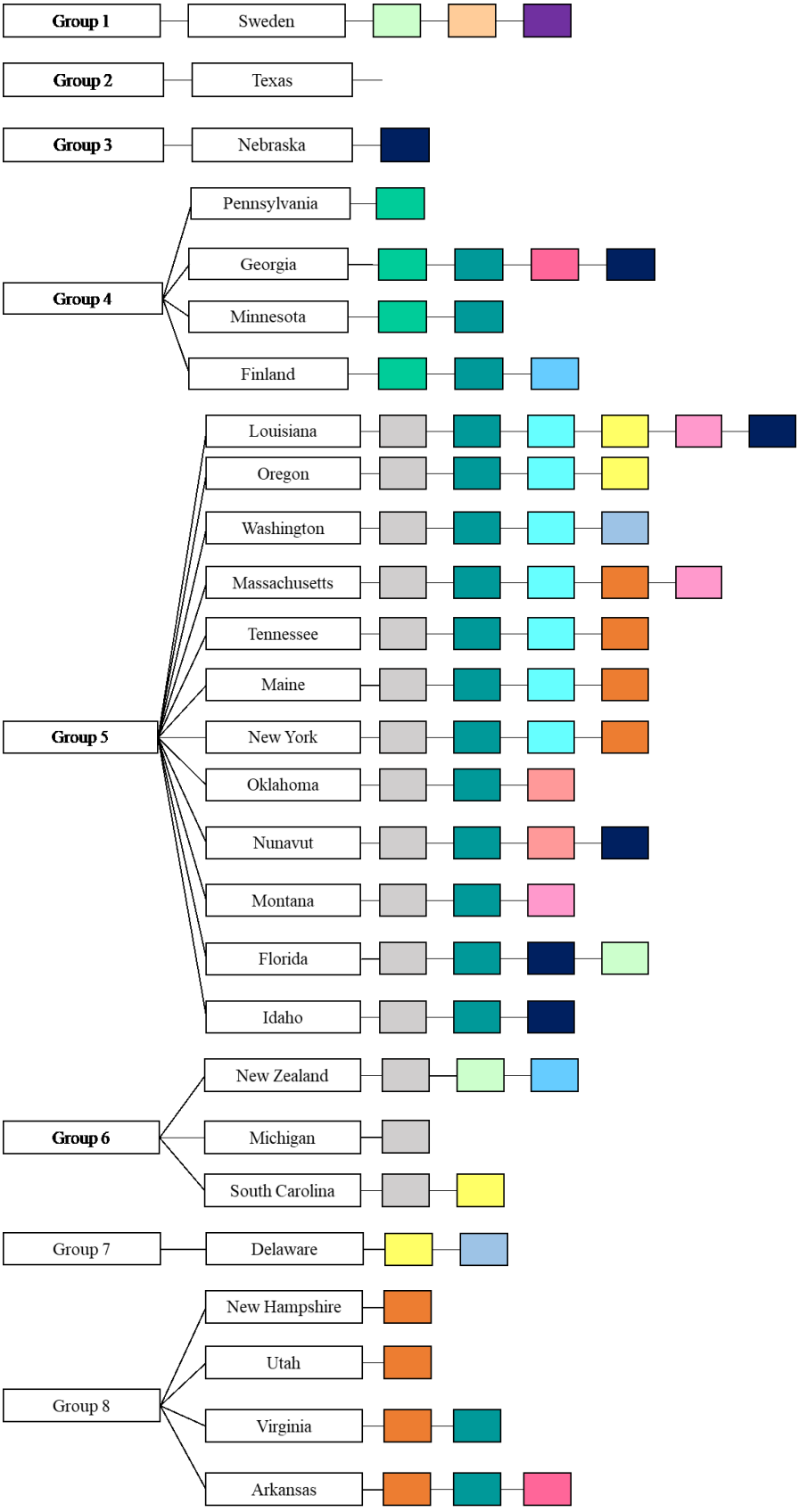
Newfoundland and Labrador	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Nova Scotia	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ontario	1	1	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P.E.I	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Quebec	1	1	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	0	0	0
North West Territories	1	1	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0
Yukon	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nunavut	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saskatchewan	1	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0
CANADA	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

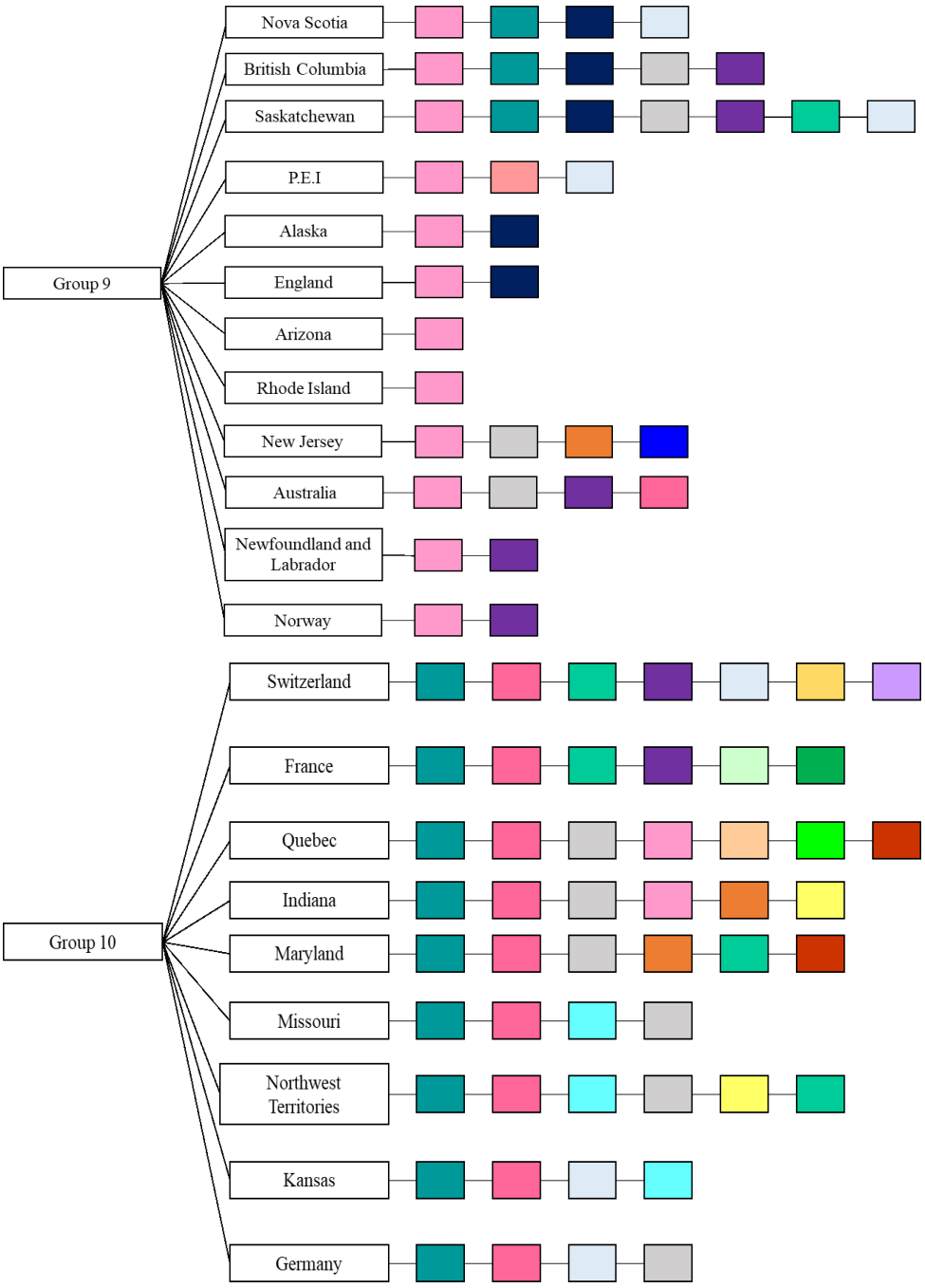
U.S.A	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
SWITZERLAND	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	1	1
NETHERLANDS	1	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
FRANCE	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0
GERMANY	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
ENGLAND	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SWEDEN	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
FINLAND	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
NORWAY	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
IRELAND	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
SCOTLAND	1	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
AUSTRALIA	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0

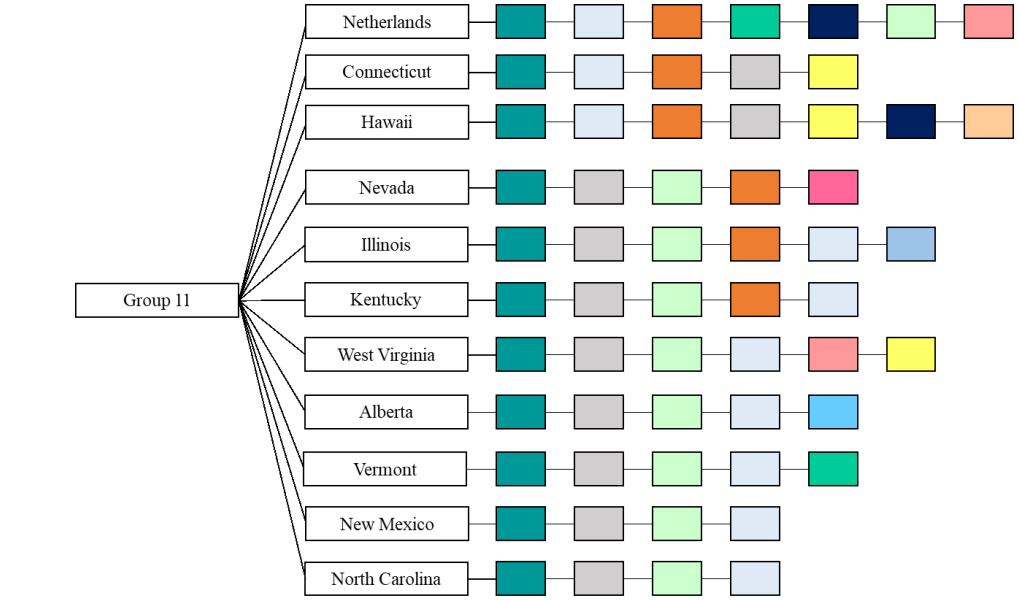
NEW ZEALAND	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

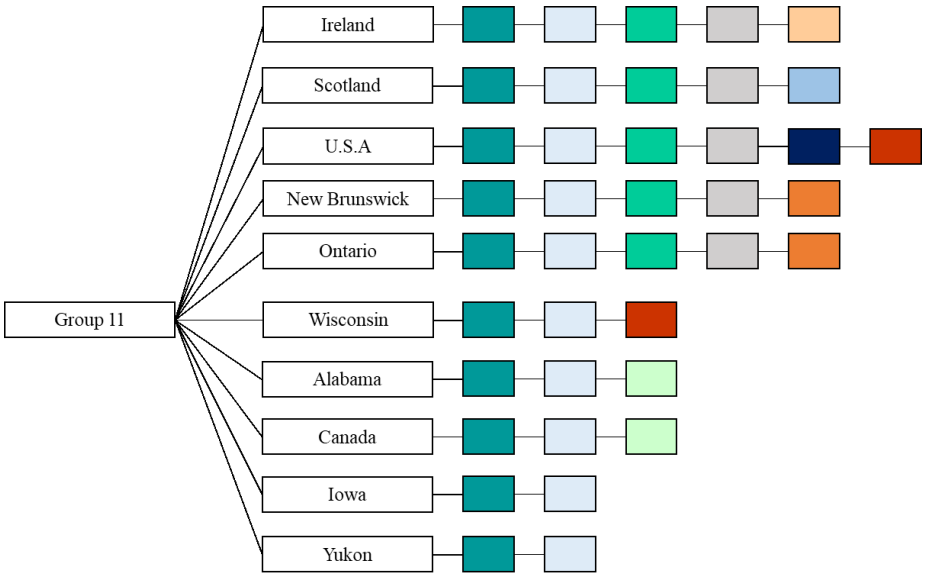
Appendix A3: Dendrogram Visualization Legend

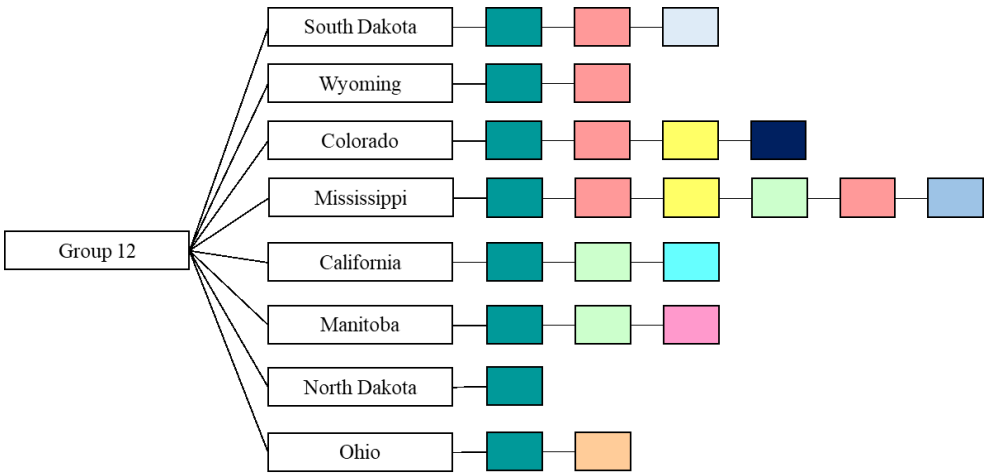
Appendix A4: Visualization of Dendrogram using the 'Complete' Linkage Method



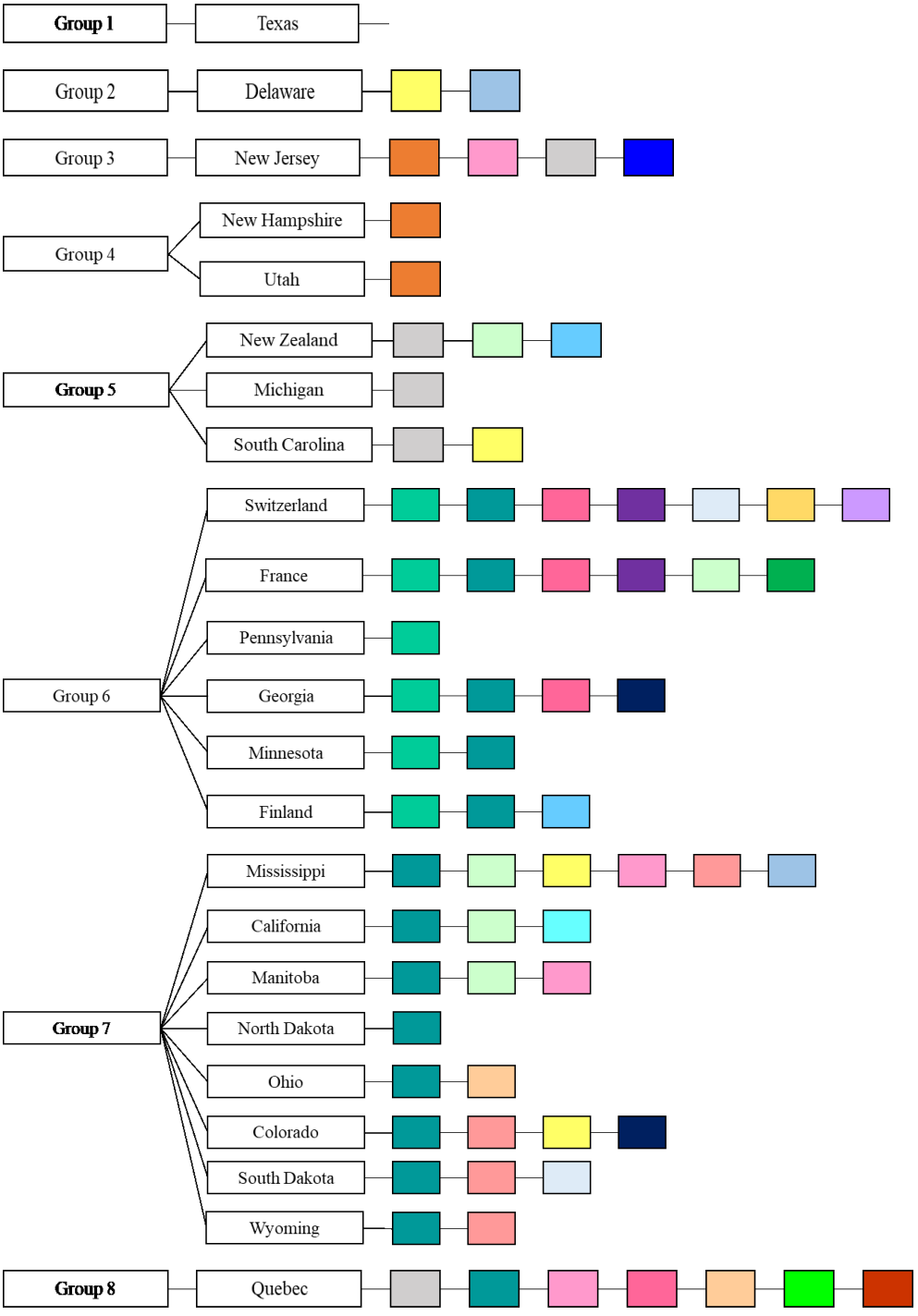

Group 9
Nova Scotia
British Columbia
Saskatchewan
P.E.I
Alaska
England
Arizona
Rhode Island
New Jersey
Australia
Newfoundland and Labrador
Norway
Group 10
Switzerland
France
Quebec
Indiana
Maryland
Missouri
Northwest Territories
Kansas
Germany

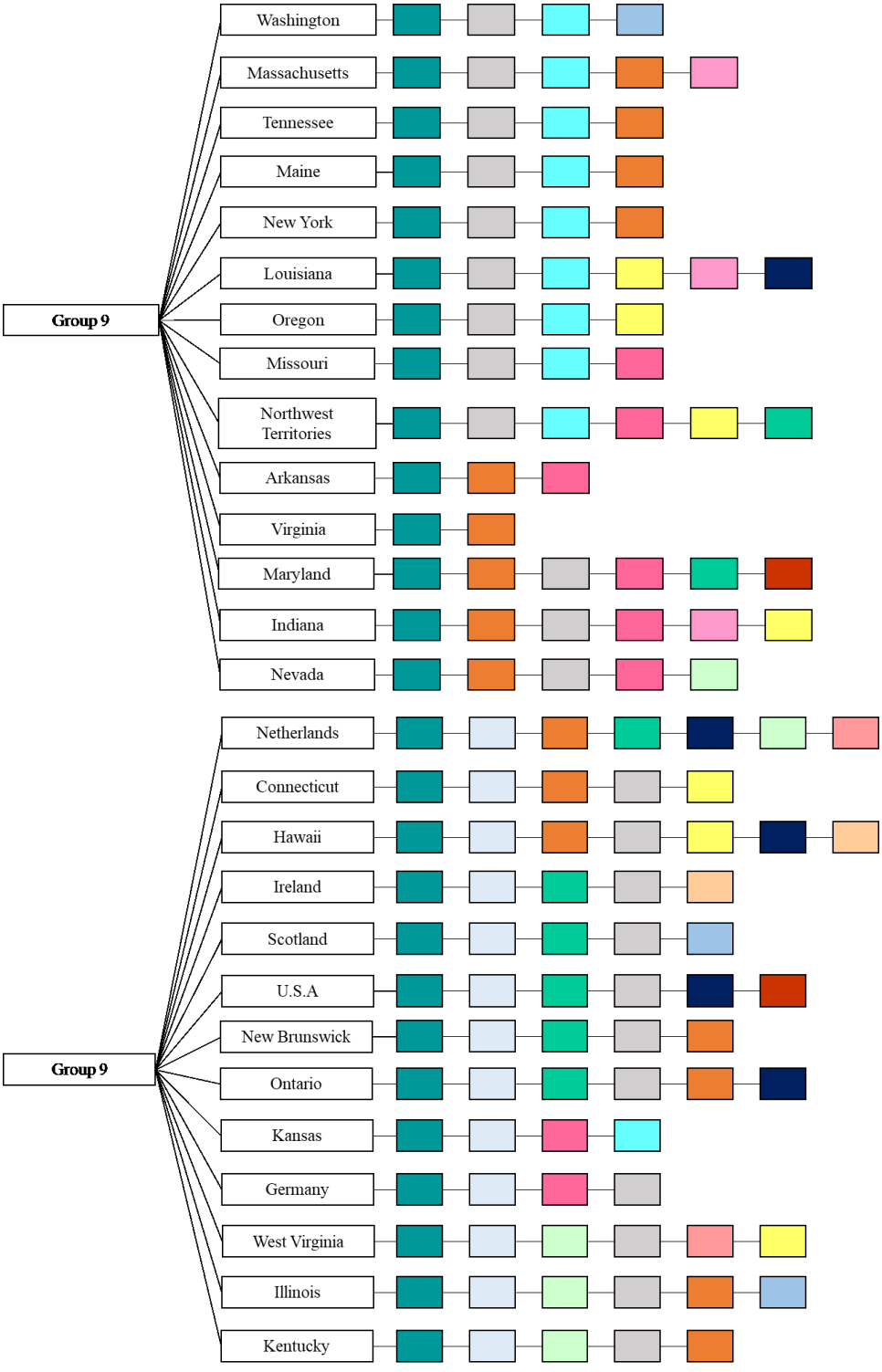

Group 11
Netherlands
Connecticut
Hawaii
Nevada
Illinois
Kentucky
West Virginia
Alberta
Vermont
New Mexico
North Carolina

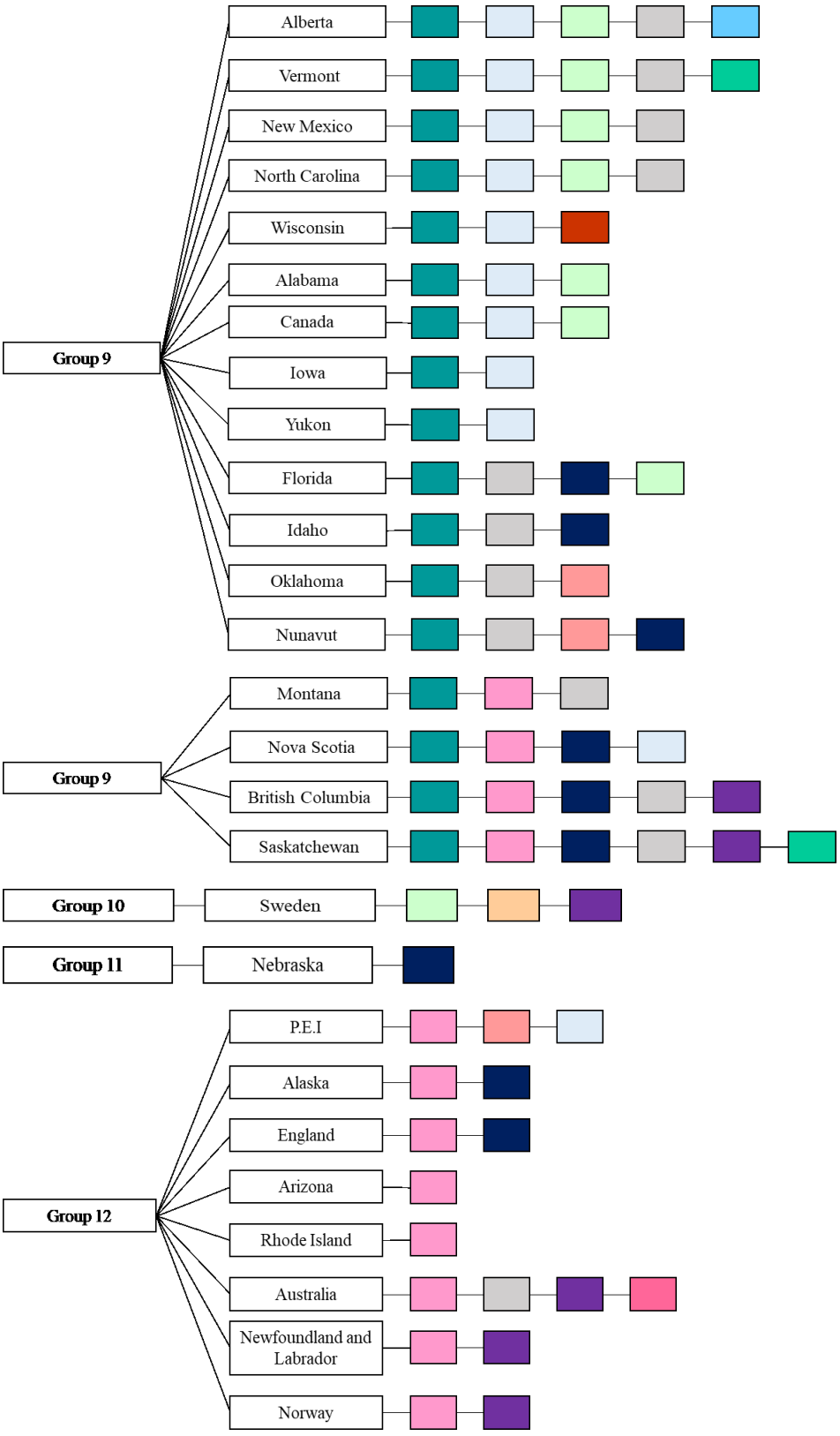

Group 11
Ireland
Scotland
U.S.A
New Brunswick
Ontario
Wisconsin
Alabama
Canada
Iowa
Yukon


Group 12
South Dakota
Wyoming
Colorado
Mississippi
California
Manitoba
North Dakota
Ohio

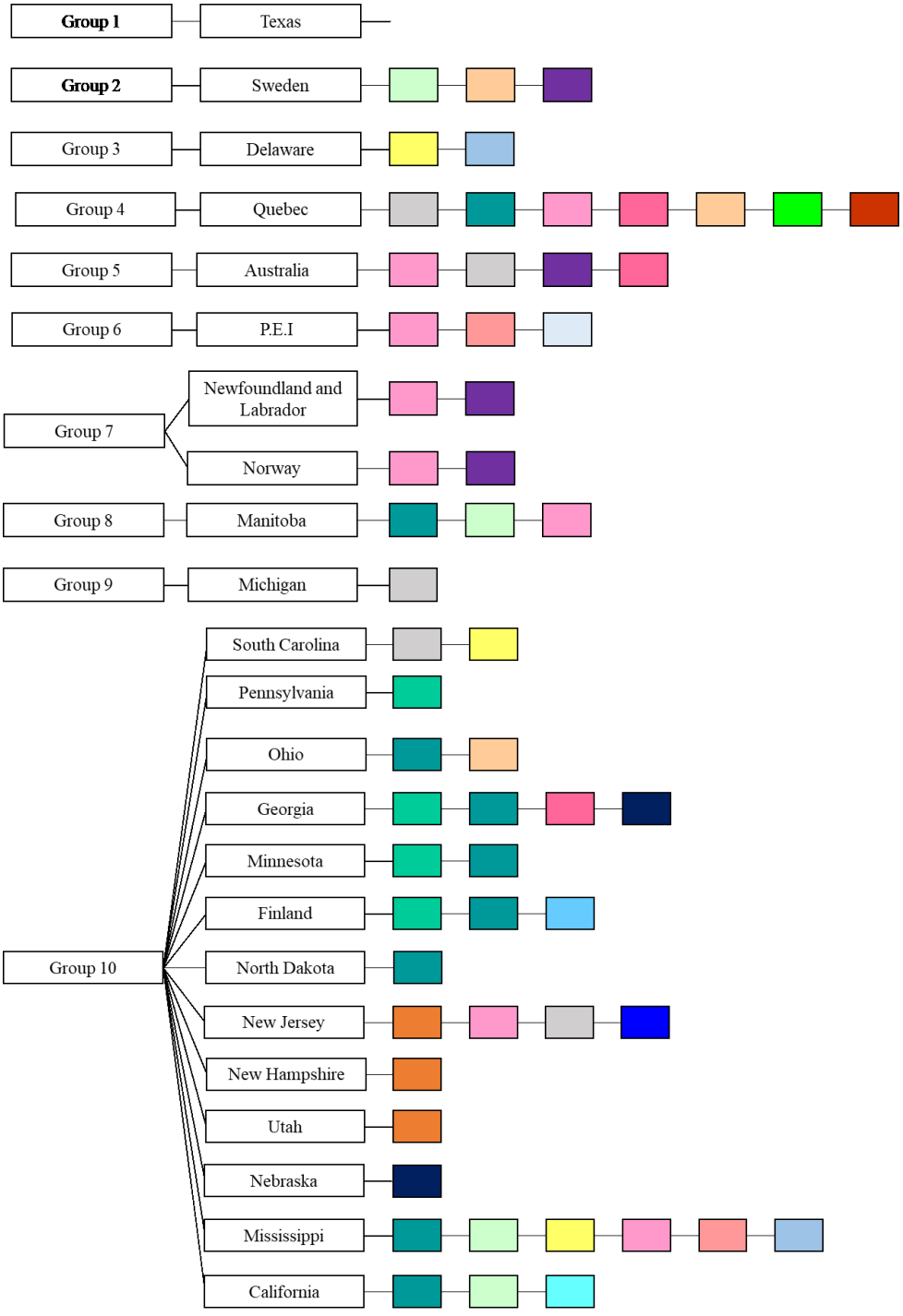
Appendix A5: Visualization of Dendrogram using the 'Average' Linkage Method

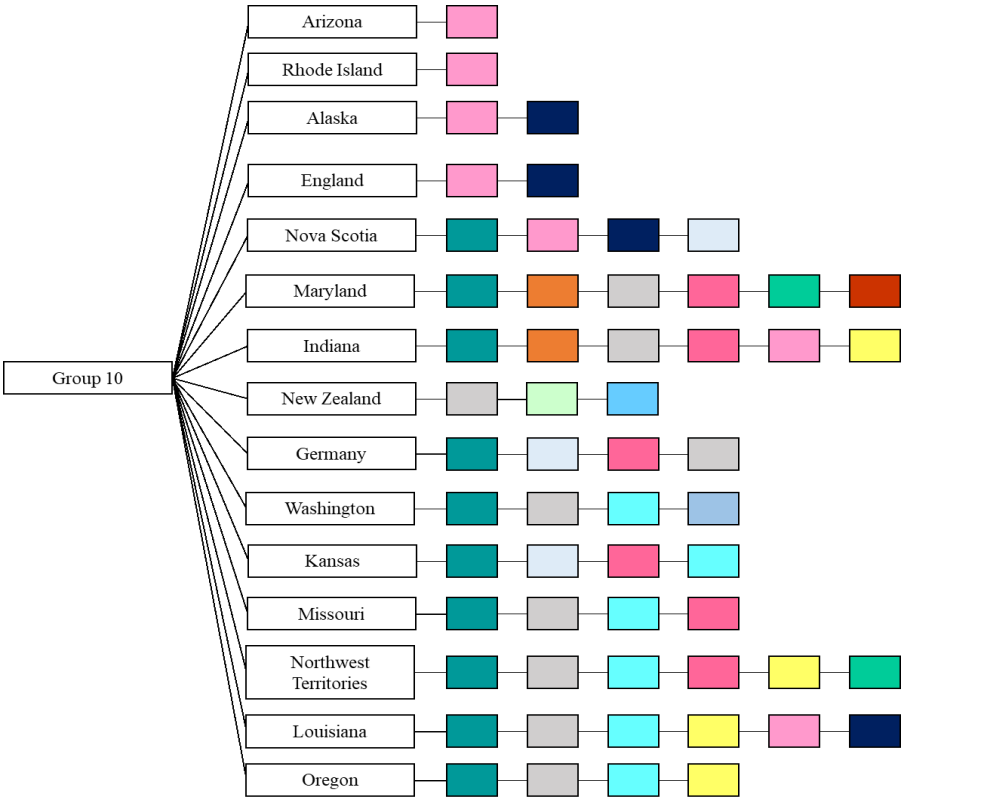


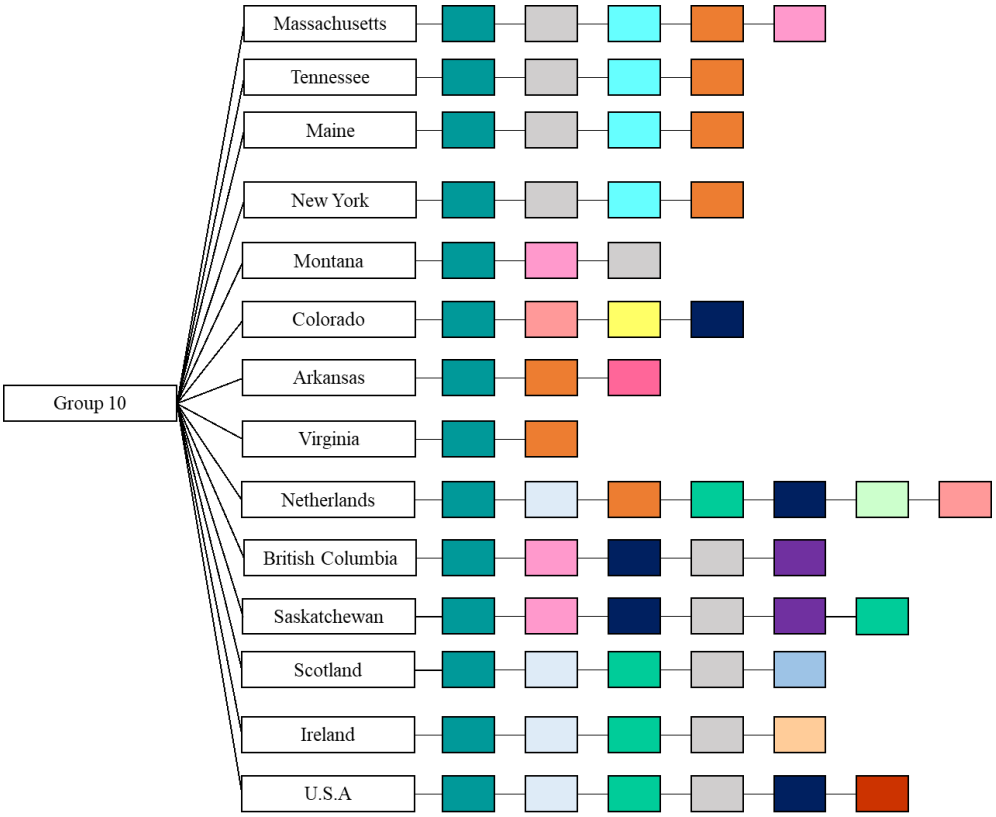

Group 9
Washington
Massachusetts
Tennessee
Maine
New York
Louisiana
Oregon
Missouri
Northwest Territories
Arkansas
Virginia
Maryland
Indiana
Nevada
Group 9
Netherlands
Connecticut
Hawaii
Ireland
Scotland
U.S.A
New Brunswick
Ontario
Kansas
Germany
West Virginia
Illinois
Kentucky

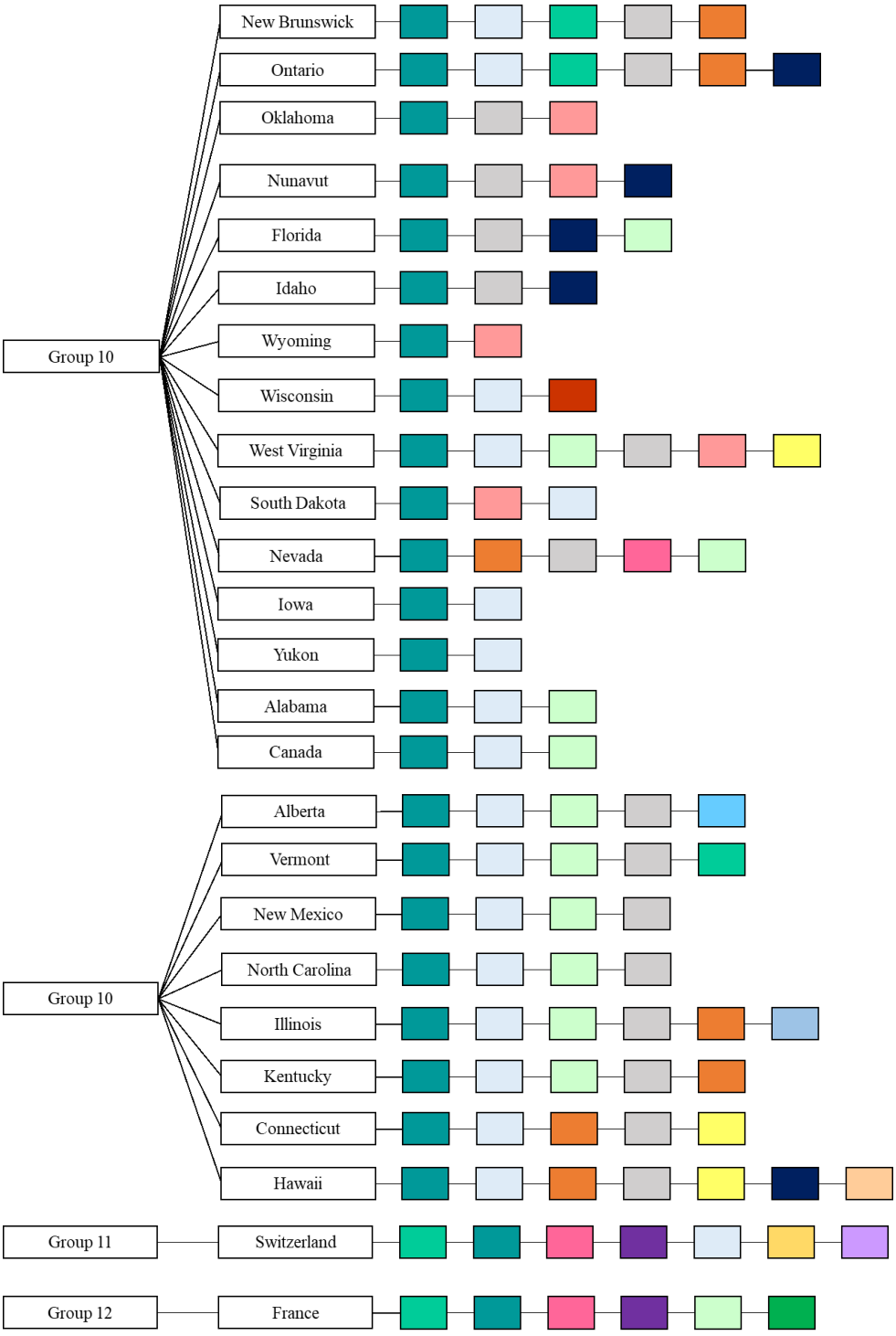

Alberta
Vermont
New Mexico
North Carolina
Wisconsin
Alabama
Canada
Group 9
Iowa
Yukon
Florida
Idaho
Oklahoma
Nunavut
Montana
Nova Scotia
Group 9
British Columbia
Saskatchewan
Group 10
Sweden
Group 11
Nebraska
P.E.I
Alaska
England
Arizona
Group 12
Rhode Island
Australia
Newfoundland and Labrador
Norway

Appendix A6: Visualization of Dendrogram using the 'Single' Linkage Method

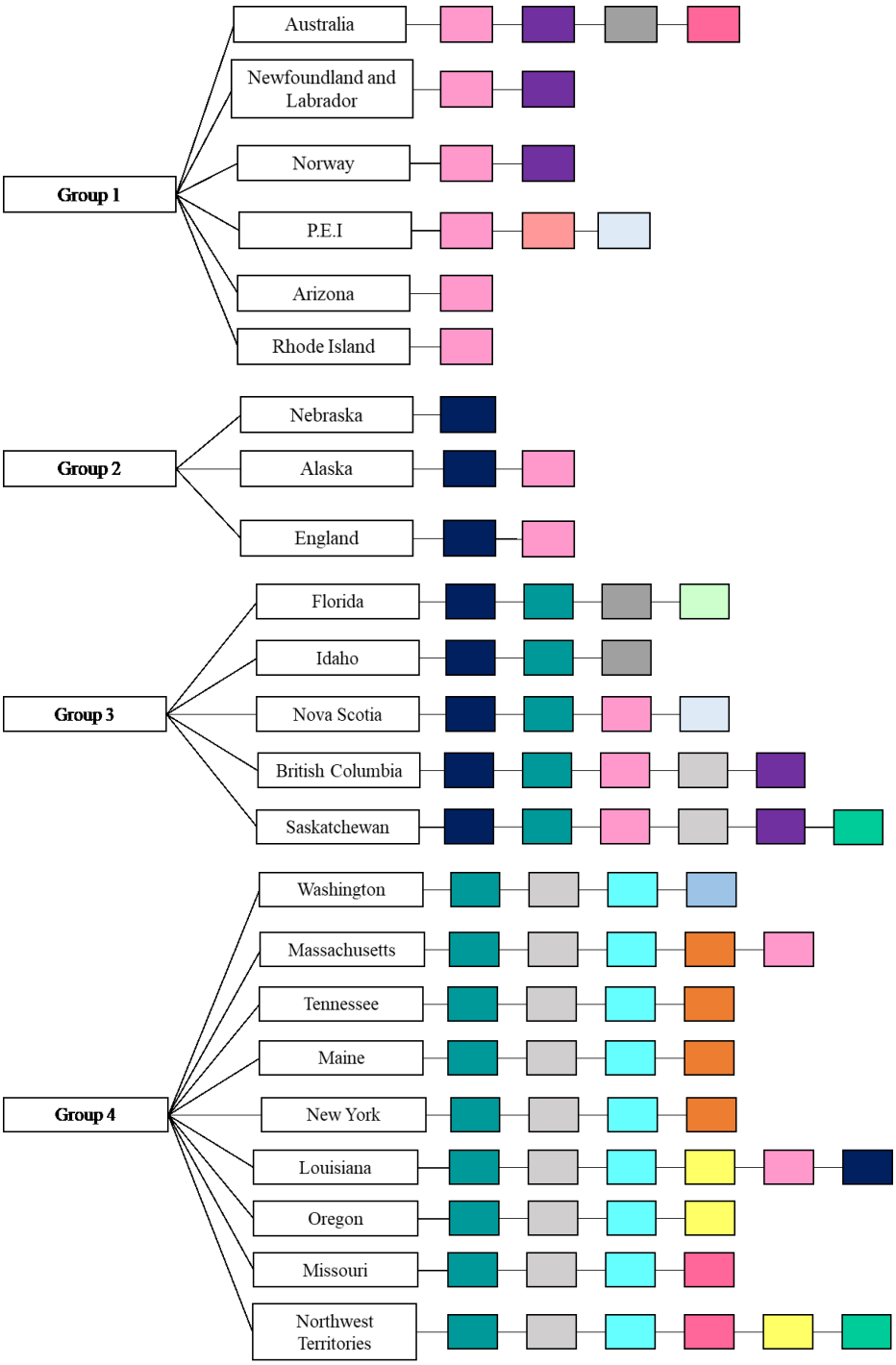


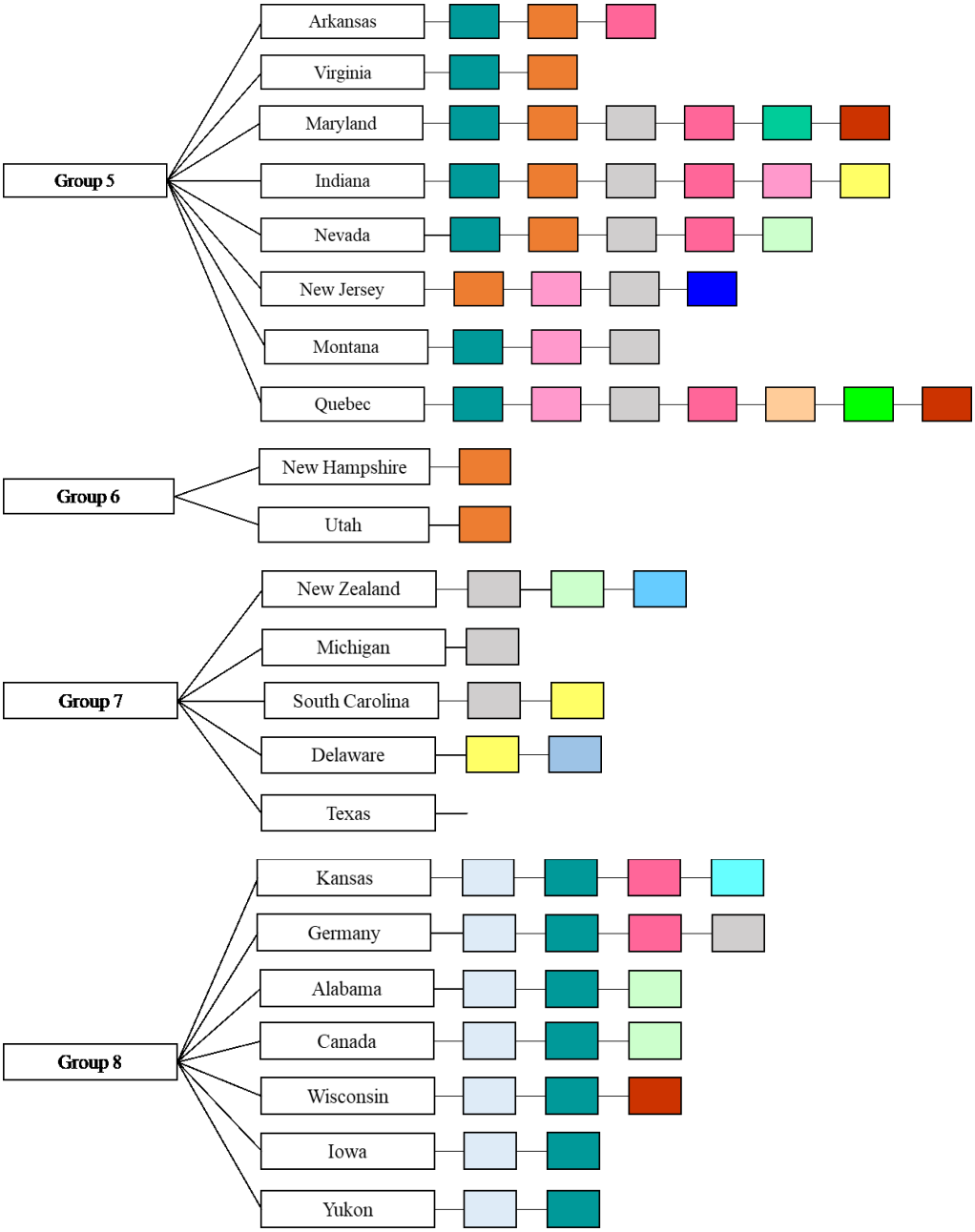

Group 10
Arizona
Rhode Island
Alaska
England
Nova Scotia
Maryland
Indiana
New Zealand
Germany
Washington
Kansas
Missouri
Northwest Territories
Louisiana
Oregon

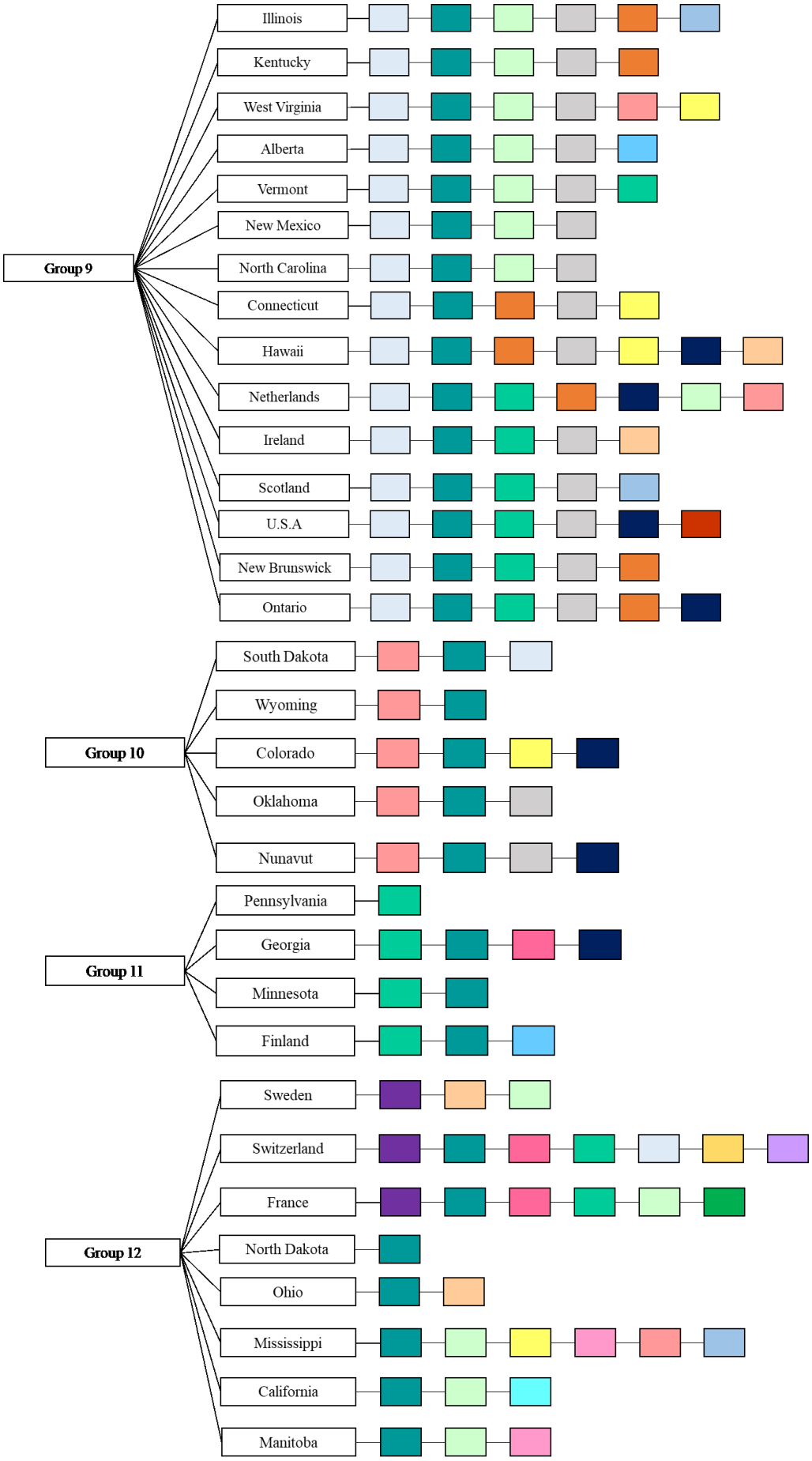

Group 10
Massachusetts
Tennessee
Maine
New York
Montana
Colorado
Arkansas
Virginia
Netherlands
British Columbia
Saskatchewan
Scotland
Ireland
U.S.A


New Brunswick
Ontario
Oklahoma
Nunavut
Florida
Idaho
Wyoming
Group 10
Wisconsin
West Virginia
South Dakota
Nevada
Iowa
Yukon
Alabama
Canada
Alberta
Vermont
New Mexico
North Carolina
Group 10
Illinois
Kentucky
Connecticut
Hawaii
Group 11
Switzerland
Group 12
France

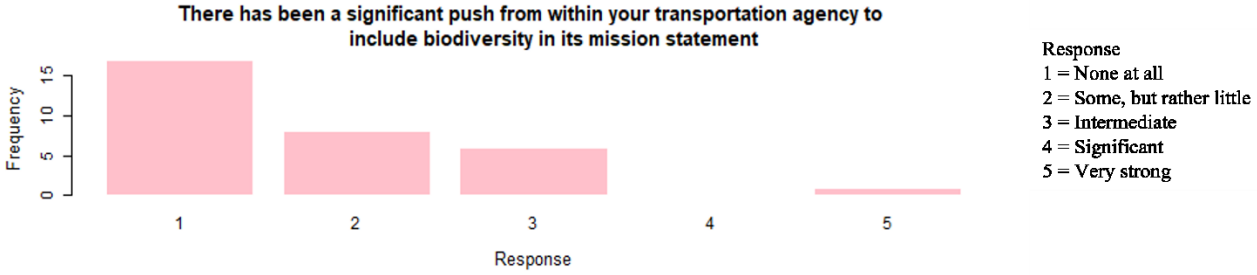
Appendix A7: Visualization of Dendrogram using Ward.D2 Linkage Method

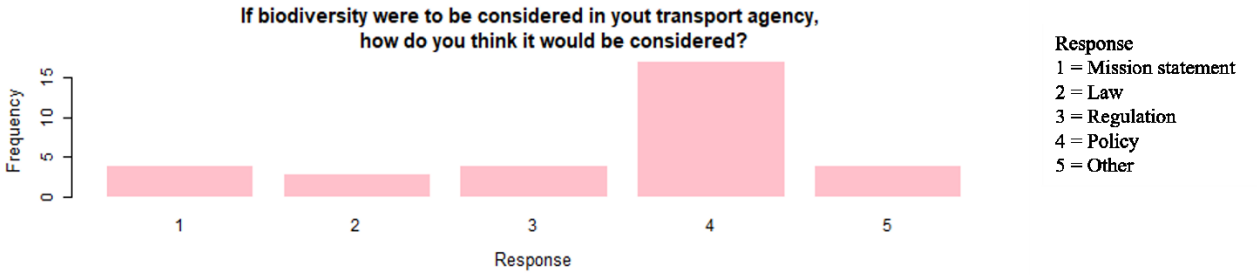


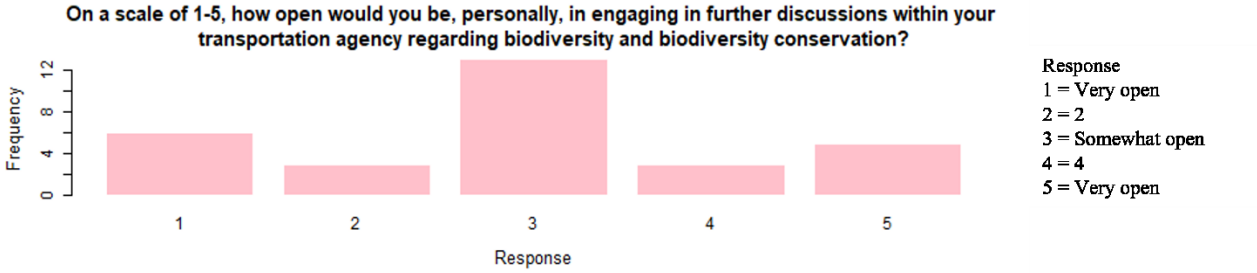

Group 5
Arkansas
Virginia
Maryland
Indiana
Nevada
New Jersey
Montana
Quebec
Group 6
New Hampshire
Utah
Group 7
New Zealand
Michigan
South Carolina
Delaware
Texas
Group 8
Kansas
Germany
Alabama
Canada
Wisconsin
Iowa
Yukon


Group 9
Illinois
Kentucky
West Virginia
Alberta
Vermont
New Mexico
North Carolina
Connecticut
Hawaii
Netherlands
Ireland
Scotland
U.S.A
New Brunswick
Ontario
Group 10
South Dakota
Wyoming
Colorado
Oklahoma
Nunavut
Group 11
Pennsylvania
Georgia
Minnesota
Finland
Group 12
Sweden
Switzerland
France
North Dakota
Ohio
Mississippi
California
Manitoba

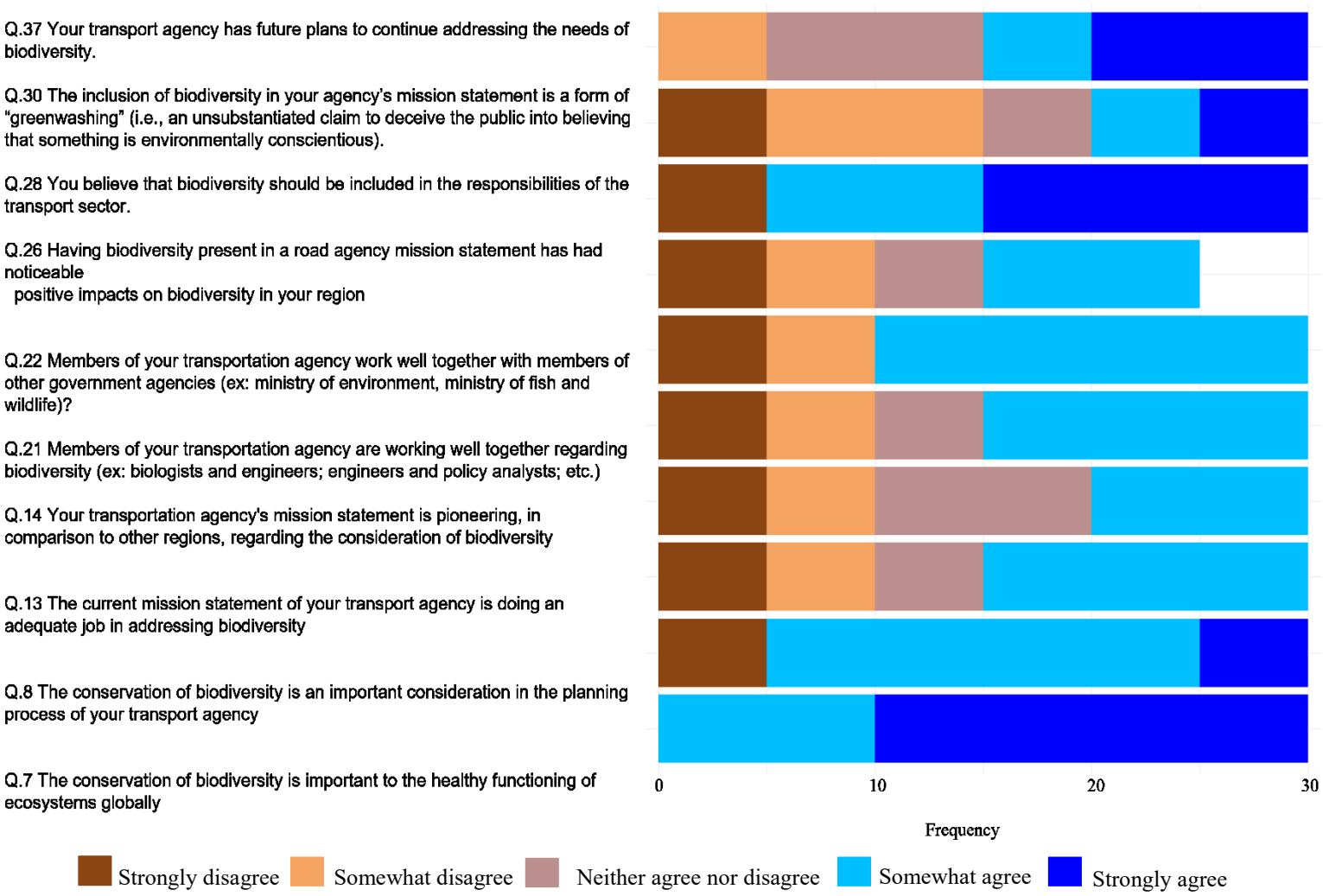
Appendix B1: Supplementary Single Variable Results for the n = 33 set of responses in which respondents answered that biodiversity was not included in the mission statements.



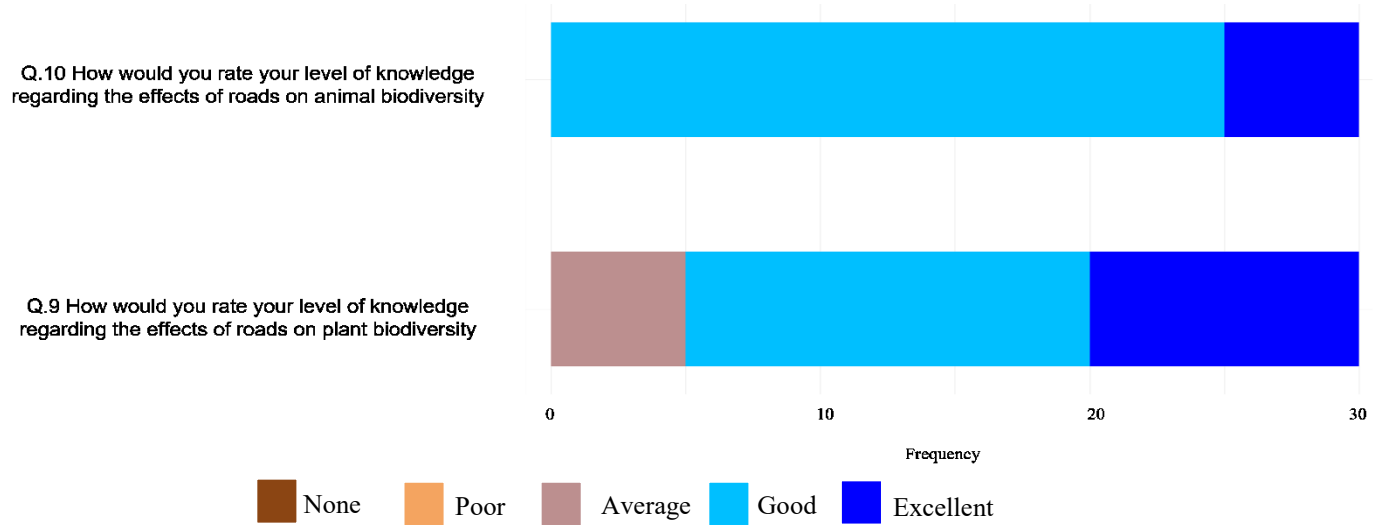




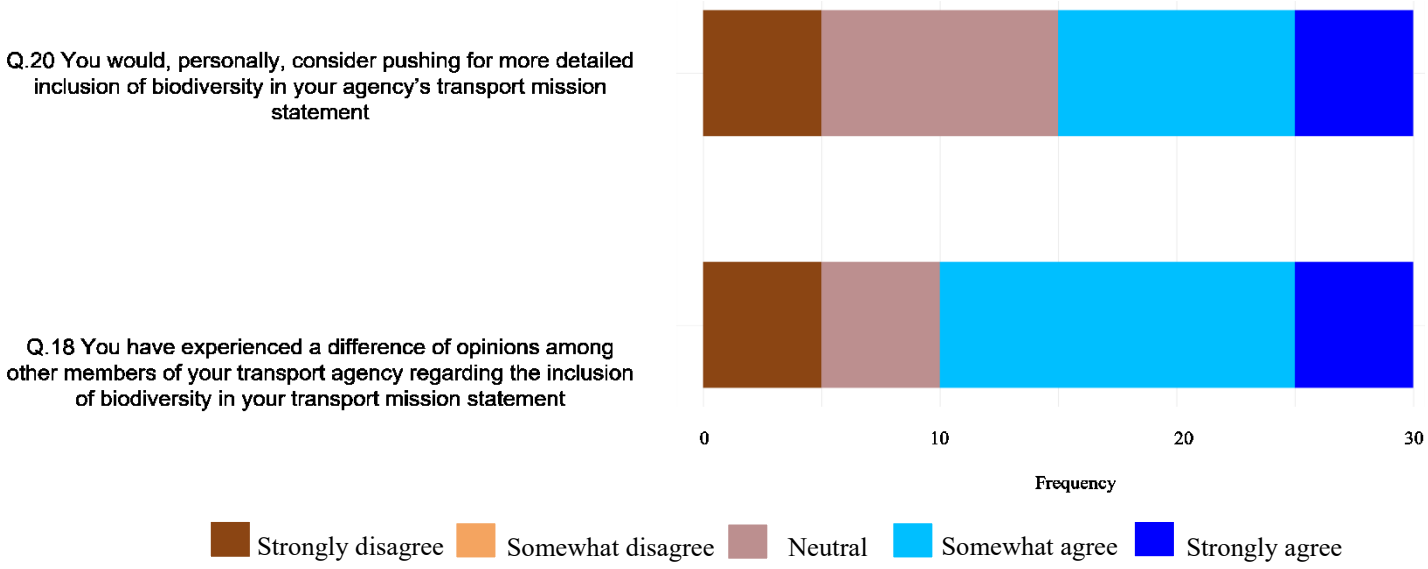
Appendix B2: Single Variable Results for n = 6 set of responses in which respondents answered that biodiversity was included in the mission statements.



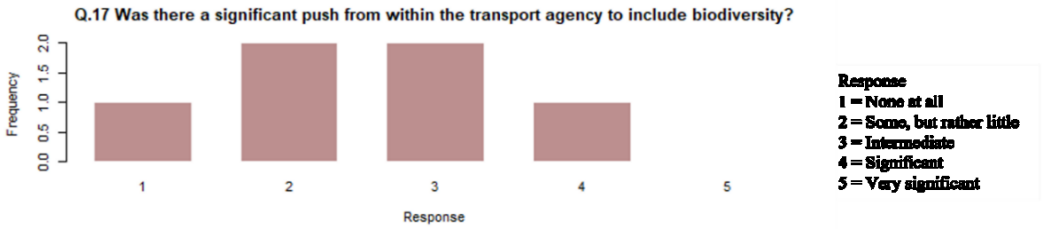
Appendix B3: Single Variable Results for n = 6 set of responses in which respondents answered that biodiversity was included in the mission statements.

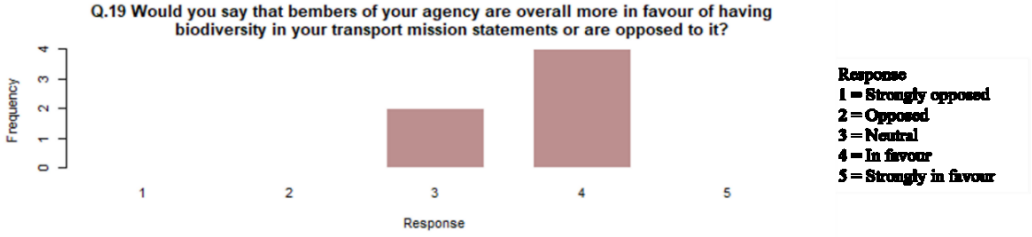


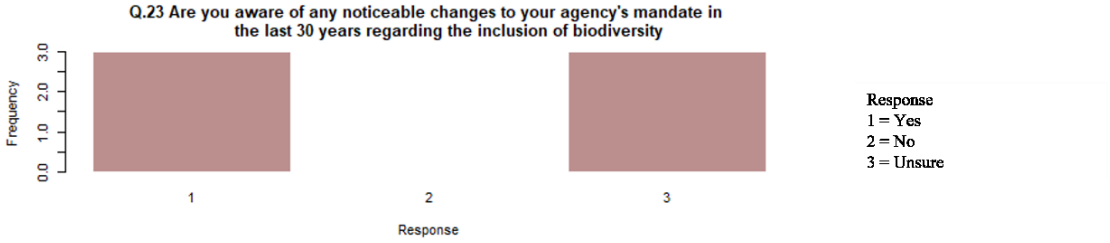
Appendix B4: Single Variable Results for n = 6 set of responses in which respondents answered that biodiversity was included in the mission statements.

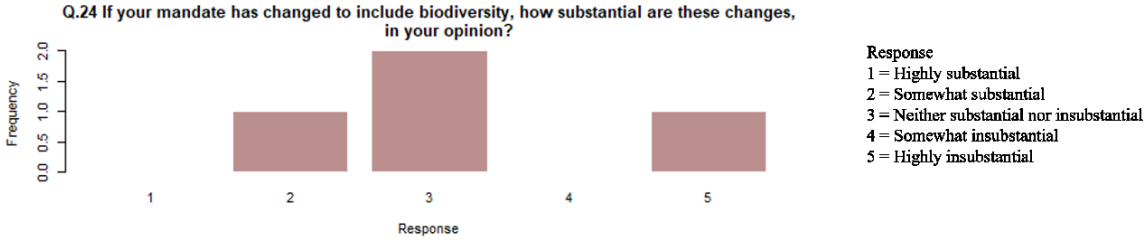


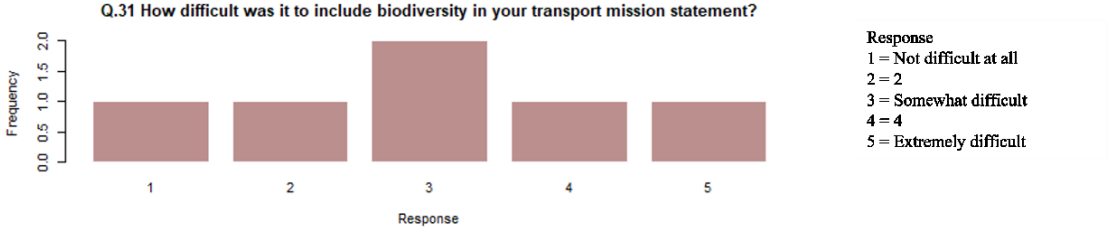
Appendix B5: Supplementary Single Variable Results for the n = 6 set of responses in which respondents answered that biodiversity was included in the mission statements.

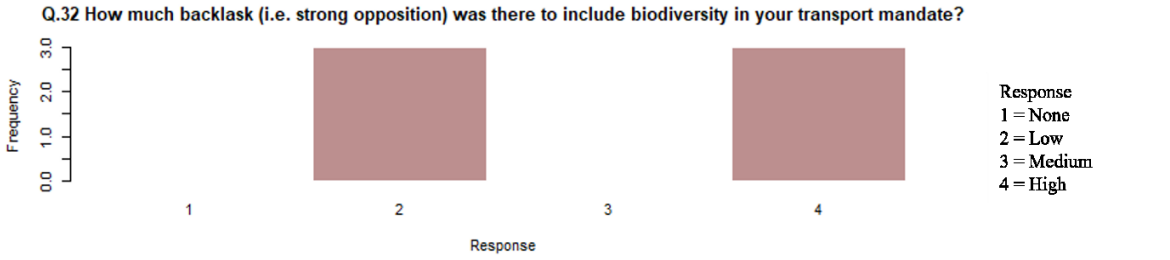


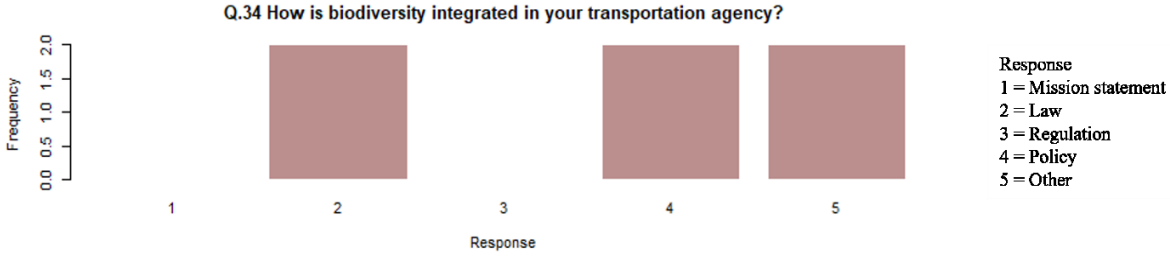


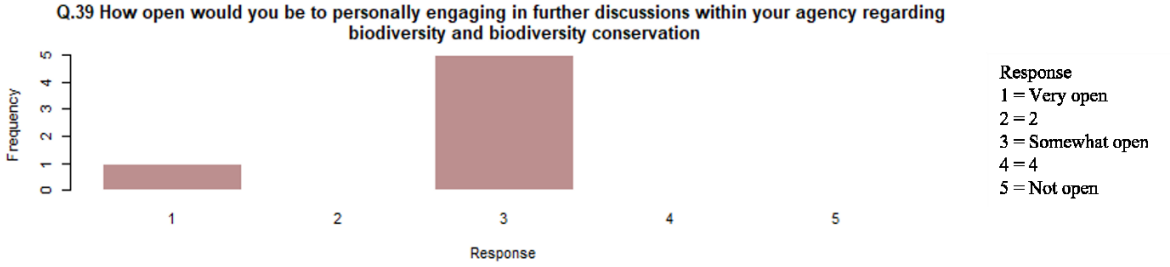







Q.32 How much backlash (i.e. strong opposition) was there to include biodiversity in your transport mandate?
Frequency
0.0
1.0
2.0
3.0
1
2
3
4
Response
Response
1 = None
2 = Low
3 = Medium
4 = High


Q.34 How is biodiversity integrated in your transportation agency?
Frequency
0.0
0.5
1.0
1.5
2.0
1
2
3
4
5
Response
Response
1 = Mission statement
2 = Law
3 = Regulation
4 = Policy
5 = Other


Q.39 How open would you be to personally engaging in further discussions within your agency regarding biodiversity and biodiversity conservation
Frequency
0
1
2
3
4
5
1
2
3
4
5
Response
Response
1 = Very open
2 = 2
3 = Somewhat open
4 = 4
5 = Not open

Appendix C: Survey Codebook

Survey Codebook and Scoring – Mission Statements **Not** Including Biodiversity
Updated: January 2025

Variable	Item	Scoring
S1	Please fill in your name in the box below.	
S2	Which country/state/province is your transport agency located in?	
S3	What department or transport agency are you affiliated with and what is your role at this agency (ex: analyst, engineer, environment, planner, etc.)?	
S4	To what degree do you agree or disagree with the following statement? The conservation of biodiversity is important to the healthy functioning of ecosystems globally.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S5	To what degree do you agree or disagree with the following statement? The conservation of biodiversity is an important consideration in the planning process of your transport agency.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S6	How would you rate your level of knowledge regarding the effects of roads on **plant** biodiversity?	1 = Excellent 2 = Good 3 = Average 4 = Poor 5 = None
S7	How would you rate your level of knowledge regarding the effects of roads on **animal** biodiversity?	1 = Excellent 2 = Good 3 = Average 4 = Poor 5 = None
S8	To what degree do you agree or disagree with the following statement? Your transport agency as a whole, in your opinion, has a good understanding of the impacts that road networks have on wildlife (animals in particular).	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S9	Could you briefly describe some of the effects of roads on biodiversity (animals or plants) that you are aware of, if any?	
S10	Are you aware of any noticeable changes to your transport agency's mandate in the last 30 years regarding the inclusion of biodiversity?	1 = Yes 2 = No 3 = Unsure
S11	Could you briefly describe these changes, if any?	
S12	Is the term 'environment' incorporated into your transportation agency's mission statement?	1 = Yes 2 = No 3 = Unsure

S13	In your professional opinion, what does the term 'environment' entail for your transportation agency? Please describe in detail.	
S14	To what degree do you agree or disagree with the following statement? The effects of roads on biodiversity is adequately being taken into consideration by another department or agency.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S15	Please indicate which department or agency is considering the effects of roads on biodiversity.	
S16	To what degree do you agree or disagree with the following statement? You personally believe that the effects of roads on biodiversity is not the responsibility of the transportation agency.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S17	Please elaborate your answer to the above question in as much detail as possible.	
S18	To what degree do you agree or disagree with the following statement? There has been a significant push from within your transportation agency to include biodiversity in its mission statement	1 = None at all 2 = Some, but rather little 3 = Intermediate 4 = Significant 5 = Very strong
S19	To what degree would you agree or disagree with the following statement? You would, personally, consider pushing for the inclusion of biodiversity in your transportation agency's mission statement	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S20	To what degree would you agree or disagree with the following statement? You have experienced a difference of opinions among other members of your transport agency regarding the inclusion of biodiversity within your transport agency's mission statement.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S21	To what degree would you agree or disagree with the following statement?	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree

	Members of your transportation department or agency possess conflicting views on the importance of biodiversity.	
S22	To what degree would you agree or disagree with the following statement? Members of your transportation department or agency are more opposed to biodiversity inclusion within the agency's mission statement.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S23	To what degree would you agree or disagree with the following statement? Including biodiversity in your agency's mission statement would have an overall positive effect on biodiversity.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S24	In your opinion, what would be some overall positive effects on biodiversity should your agency consider biodiversity within its mission statement?	
S25	To what degree would you agree or disagree with the following statement? The inclusion of biodiversity into your road agency's mission statement would be considered a form of 'greenwashing' (i.e., an unsubstantiated claim to deceive the public into believing that something is environmentally conscientious).	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S26	To what degree do you agree or disagree with the following statement? Your transport agency will include biodiversity into its mission statement in the next 5-10 years.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S27	To what degree would you agree or disagree with the following statement? Strong 'backlash' (i.e. strong opposition) is expected if biodiversity were to be incorporated in your agency's mission statement.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree

S28	In relation to the question above, please briefly describe what would you expect this 'backlash' to be?	
S29	If biodiversity were to be considered in your transport agency, how do you think it would be considered?	1 = As a mission statement 2 = As a law 3 = As a regulation 4 = As a policy 5 = Other
S30	Please specify how biodiversity might be considered within your agency?	
S31	What are the reasons for not including biodiversity in your agency's mission statement and its corresponding importance (1 indicating the least important, 5 indicating the highest importance)?	
S31a	General lack of knowledge surrounding the topic of biodiversity	1 = Least important 2 3 = Somewhat important 4 5 = Very important
S31b	The cost of designing roads to account for biodiversity is very high	
S31c	Human safety on roads is a pressing concern to your agency and takes precedence	
S31d	Difference of opinions between members of your agency regarding the topic of biodiversity	
S31e	Biodiversity is being considered by another governmental agency	
S31f	Including biodiversity in your agency's mission statement would be considered 'greenwashing'	
S32	To what degree would you agree or disagree with the following statement? Your transport agency has future plans to better address the effects of roads on biodiversity.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree

S33	To what degree would you agree or disagree with the following statement? Your transport agency is actively discussing how it can better add biodiversity into its mission statement. Single choice.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S34	On a scale of 1-5, how open would you be, personally, in engaging in further discussions within your transportation agency regarding biodiversity and biodiversity conservation?	1 = Very open 2 3 = Somewhat open 4 5 = Very open
S35	Do you identify as male or female?	1 = Male 2 = Female 3 = Non-binary 4 = Other 5 = Prefer not to say
S36	How old are you?	1 = Under 18 2 = 18 – 24 3 = 25 – 34 4 = 35 – 44 5 = 45 – 54 6 = 55 +
S37	How long have you been working for your transportation agency?	1 = 0 – 4 2 = 5 – 9 3 = 10 – 14 4 = 15 – 19 5 = 20 +

Survey Codebook and Scoring – Mission Statements Including Biodiversity
Updated: January 2025

Variable	Item	Scoring
S1	Please fill in your name in the box below.	
S2	Which country/state/province is your transport agency located in?	
S3	What department or transport agency are you affiliated with and what is your role at this agency (ex: analyst, engineer, environment, planner, etc.)?	
S4	To what degree do you agree or disagree with the following statement? The conservation of biodiversity is important to the healthy functioning of ecosystems globally.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S5	To what degree do you agree or disagree with the following statement? The conservation of biodiversity is an important consideration in the planning process of your transport agency.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S6	How would you rate your level of knowledge regarding the effects of roads on **plant** biodiversity?	1 = Excellent 2 = Good 3 = Average 4 = Poor 5 = None
S7	How would you rate your level of knowledge regarding the effects of roads on **animal** biodiversity?	1 = Excellent 2 = Good 3 = Average 4 = Poor 5 = None
S8	Could you briefly describe some of the effects of roads on biodiversity (animal or plants) that you are aware of, if any?	
S9	How true is the following statement? Biodiversity is heavily considered in your transport agency's mission statement.	1 = Extremely true 2 = Somewhat true 3 = Neither true or untrue 4 = Somewhat untrue 5 = Not true at all 6 = Unsure
S10	To what degree do you agree or disagree with the following statement? The current mission statement of your transport agency is doing an adequate job in addressing biodiversity.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree

S11	To what degree do you agree or disagree with the following statement? Your transportation agency's mission statement is pioneering, in comparison to other regions, regarding the consideration of biodiversity.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S12	Please describe how your transportation agency is actively considering biodiversity within its mission statement (ex: specific conservation programs, project development, etc.)	
S13	Do you currently know what branch/sub-division of your agency oversees the effects of roads on biodiversity? Please enter it here	
S14	Was there a significant push from within your transportation agency to include biodiversity in your mission statement?	1 = None at all 2 = Some, bur rather little 3 = Intermediate 4 = Significant 5 = Very significant
S15	To what degree would you agree or disagree with the following statement? You have experienced a difference in opinions among other members of your transport agency regarding the inclusion of biodiversity in your transport mission statement.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree
S16	Would you say that members of your agency overall are more in favor of having biodiversity included in your transport mission statements or are opposed to it?	1 = Strongly opposed 2 = Opposed 3 = Neutral 4 = In favour 5 = Strongly in favour
S17	To what degree would you agree or disagree with the following statement? You would, personally, consider pushing for more detailed inclusion of biodiversity in your agency's transport mission statement.	1 = Strongly agree 2 = Somewhat agree 3 = Neutral 4 = Somewhat disagree 5 = Strongly disagree
S18	To what degree would you agree or disagree with the following statement? Members of your transportation agency are working well together regarding biodiversity	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree

	(ex: biologists and engineers; engineers and policy analysts; etc.)	
S19	To what degree would you agree or disagree with the following statement? Members of your transportation agency work well together with members of other government agencies (ex: ministry of environment, ministry of fish and wildlife)?	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S20	Are you aware of any noticeable changes to your transport agency's mandate in the last 30 years regarding the inclusion of biodiversity?	1 = Yes 2 = No 3 = Unsure
S21	If your mandate has changed to include biodiversity (it was not included before) how substantial are these changes, in your opinion?	1 = Highly substantial 2 = Somewhat substantial 3 = Neither substantial or insubstantial 4 = Somewhat disagree 5 = Strongly disagree
S22	Could you briefly describe these changes, if any?	
S23	How strongly do you agree or disagree with the following statement? Having biodiversity present in a road agency mission statement has had noticeable positive impacts on biodiversity in your region.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S24	Please specify any noticeable positive effects on biodiversity you have noticed with the inclusion of biodiversity in your mandate, if any.	
S25	To what degree would you agree or disagree with the following statement? You believe that biodiversity should be included in the responsibilities of the transport sector.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S26	Please explain in detail your reasoning for the answer provided above.	

S27	To what degree do you agree with the following statement? The inclusion of biodiversity in your agency's mission statement is a form of "greenwashing" (i.e., an unsubstantiated claim to deceive the public into believing that something is environmentally conscientious).	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S28	On a scale from 1 to 5 (1 being not difficult at all, and 5 being the most difficult), how difficult was it to include biodiversity in your transport mission statement?	1 = Not difficult at all 2 3 = Somewhat difficult 4 5 = Extremely difficult
S29	How much backlash (i.e., strong opposition) was there to include biodiversity in your transport mandate?	1 = None 2 = Low 3 = Medium 4 = High
S30	Please briefly describe the "backlash" experienced, if any.	
S31	How is biodiversity integrated in your transportation agency?	1 = As a mission statement 2 = As a law 3 = As a regulation 4 = As a policy 5 = Other
S32	If your answer to Question 31 was 'Other', please specify how biodiversity has been integrated or considered within your transport agency.	
S33	Please state WHEN and HOW biodiversity was integrated in your mission statement in the box below.	
S34	To what degree do you agree or disagree with the following statement? Your transport agency has future plans to continue addressing the needs of biodiversity.	1 = Strongly agree 2 = Somewhat agree 3 = Neither agree or disagree 4 = Somewhat disagree 5 = Strongly disagree
S35	Could you briefly describe what future plans your agency has to continue addressing the needs of biodiversity, if any?	
S36	On a scale of 1-5, how open would you be, personally, in engaging in further discussions	1 = Very open 2 3 = Somewhat open

	within your transportation agency regarding biodiversity and biodiversity conservation?	4 5 = Not open
S37	Do you identify as male or female?	1 = Male 2 = Female 3 = Non-binary 4 = Other 5 = Prefer not to say
S38	How old are you?	1 = Under 18 2 = 18 – 24 3 = 25 – 34 4 = 35 – 44 5 = 45 – 54 6 = 55 +
S39	How long have you been working for your transportation agency?	1 = 0 – 4 2 = 5 – 9 3 = 10 – 14 4 = 15 – 19 5 = 20 +