Does knowledge about climate change predict concern?

Concern for climate change and the knowledge-deficit theory

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Abstract

The knowledge-deficit theory suggests that if people are not concerned about climate change, it is because there is a deficit in their knowledge of climate change—they do not properly comprehend the scientific consensus. So do people with higher levels of knowledge about climate change feel more concerned than those with lower knowledge levels? Existing research has been inconclusive but suggests differences between perceived and actual knowledge. This thesis comprises two studies. Study 1 tests the effect of perceived knowledge on concern for climate change with a nationally representative, randomly selected sample of 269 New Zealanders. Study 2 tests the effect of actual knowledge about climate change on concern with a sample of 452 New Zealanders recruited via snowball sampling. Results supported the knowledge-deficit theory for concern for climate change, but only when actual knowledge was tested. Participants in both Study 1 and Study 2 with high perceived knowledge did not have correspondingly high levels of concern, but Study 2 participants with high actual knowledge of climate change did also have high levels of concern. Other variables tested that consistently predicted high concern for climate change were perceived efficacy (the perception that one's actions will influence group outcomes) and environmental values. Demographic variables were not strong or consistent predictors of concern, but overall, younger female participants tended to display higher levels of concern than older male participants.

KEY WORDS: climate change, global warming, attitudes, knowledge-deficit theory, concern, knowledge, information, perceptions, perceived efficacy

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1 Introduction

Environmental policies are strongly based on the assumption that making people aware of environmental problems and telling them how they can address them will lead to attitude and behaviour change. This is called the A-I-D-A (awareness, information, decision, action) model, which is derived from knowledge-deficit theory (Barr & Gilg, 2007; Howell, 2011).

When applied to climate change, the knowledge-deficit theory suggests that if people's perceptions of climate change diverge from the scientific consensus, it is because they do not know enough about climate change. Therefore, providing more and better information is expected to correct this problem.

However, despite the ever-increasing scientific consensus, research shows that public levels of concern for climate change have decreased around the world in recent years (HSBC Climate Partnership, 2010; Jones, 2011a; ShapeNZ, 2010; The World Bank, 2009). This suggests that either the scientific consensus is not getting through to the public, or that it is, but that simply having knowledge of the problem is not enough to motivate concern.

Knowing which of these scenarios applies would help decision-makers, policy-writers, and climate change advocacy groups determine the most effective strategies for increasing public concern for climate change. This thesis contributes to the growing body of research on whether the knowledge-deficit theory applies to concern for climate change.

1.1 Aim

To investigate whether the knowledge-deficit theory applies to concern for climate change.

1.2 Research objectives

1. Review the available literature on the knowledge-deficit theory, climate change knowledge, and concern for climate change.
2. Analyse existing data from the 2008 New Zealand Social Attitudes Survey to examine the relationship between perceived knowledge of climate change and concern.
3. Collect and analyse data from groups of New Zealanders to examine their actual knowledge of climate change. Examine the relationship between actual knowledge of climate change and concern using this data.
4. Discuss the overall findings in relation to predictions. Draw empirically based conclusions on the relationship between perceived and actual knowledge of climate change and concern and use these to reflect on the theories and research studied in Chapters 1 and 2. Propose suggestions for further research.
5. Discuss the implications of this research.

1.3 Thesis structure

Chapter	Explanation	Research objective(s)
Chapter 1 Introduction	<p>Chapter 1 introduces this thesis and reviews research into climate change and the knowledge-deficit theory.</p> <ul style="list-style-type: none">• Sections 1.1–1.3 present the aims, objectives, and structure of this thesis.• Section 1.4 reviews literature on the knowledge-deficit theory and concern for climate change.• Section 1.5 outlines the scientific consensus on climate change.• Section 1.6 explains reasons for studying concern by briefly reviewing psychological research on the attitude-behaviour link.	Objective 1 Review the available literature on the knowledge-deficit theory, climate change knowledge, and concern for climate change.

Chapter	Explanation	Research objective(s)
Chapter 2 Public knowledge and concern	<p>Chapter 2 broadens the focus of Chapter 1 to more widely examine public knowledge of climate change (Section 2.1) and public concern for climate change (Section 2.2).</p> <ul style="list-style-type: none"> Section 2.1 examines how the public learns about climate change, the quality of media reporting on climate change, and reviews research examining public knowledge of climate change. Section 2.2 reviews studies examining public concern for climate change and looks at different variables—demographics, values and worldviews, trust in experts, and perceived efficacy. It examines whether and how these factors affect concern for climate change. Section 2.3 summarises the main findings and identifies gaps in the existing research. 	Objective 1
Chapter 3 Methodology	<p>Chapter 3 describes the methodology for this thesis.</p> <ul style="list-style-type: none"> Section 3.1 presents the overall research questions. Section 3.2 describes the overall research design. 	
Chapter 4 Study 1	<p>Chapter 4 reports the first study, an analysis of existing New Zealand data to examine the relationship between perceived knowledge and concern for climate change.</p> <ul style="list-style-type: none"> Sections 4.1 and 4.2 present the research justification, aim, and predictions for Study 1. Section 4.3 describes the methodology used for the Social Attitudes Survey and the present analysis. Section 4.4 outlines the results. Section 4.5 presents a discussion of the findings specific to Study 1. 	Objective 2 Analyse existing data from the 2008 New Zealand Social Attitudes Survey to examine the relationship between perceived knowledge of climate change and concern.
Chapter 5 Study 2	<p>Chapter 5 reports the second study, a survey of groups of New Zealanders to determine their knowledge of climate change and to examine the relationship between actual knowledge and concern for climate change.</p> <ul style="list-style-type: none"> Sections 5.1 and 5.2 describe the research justification, aim, and predictions for Study 2. Section 5.3 describes the methodology. Section 5.4 outlines the results. Section 5.5 presents a discussion of the findings specific to Study 2. 	Objective 3 Collect and analyse data from groups of New Zealanders to examine their actual knowledge of climate change. Examine the relationship between actual knowledge of climate change and concern for this data.

Chapter	Explanation	Research objective(s)
Chapter 6 Discussion	<p>Chapter 6 discusses the results of both Study 1 and Study 2 in relation to predictions and to the theories and findings described in Chapters 1 and 2.</p> <ul style="list-style-type: none"> • Section 6.1 discusses the main overall findings of this thesis. • Section 6.2 discusses qualifications and limitations of this research. • Section 6.3 proposes potential avenues for future research. 	<p>Objective 4</p> <p>Discuss the overall findings in relation to predictions.</p> <p>Draw empirically based conclusions on the relationship between perceived and actual knowledge of climate change and concern for climate change and use these to reflect on the theories and research studied in Chapters 1 and 2.</p> <p>Propose suggestions for further research.</p>
Chapter 7 Conclusion	<p>Chapter 7 is a brief conclusion of the implications of the main findings.</p>	<p>Objective 5</p> <p>Discuss the implications of this research.</p>

1.4 Climate change and the knowledge-deficit theory

There is an often-assumed causal linear relationship between knowledge and behaviour, that is, that knowledge causes behaviour. One way this has been conceptualised is as a knowledge or information ‘deficit’—the reason people do not act in desired ways when confronted with a problem is that they do not know enough about the problem or how to act to solve it. According to knowledge-deficit theory, the logical solution to this is to give people information on how or why they should act.

1.4.1 Public information about climate change

There is now an unprecedented amount of information available about climate change. Numbers of news articles are steadily increasing (Bell, 1994; Sampei & Aoyagi-Usui, 2009; Trumbo, 1996). Bell (1994) collected and content analysed all stories on climate change from New Zealand radio broadcasts and daily newspapers between March and September 1988. He found that climate change was the biggest ongoing environmental news in New Zealand media and the coverage showed ‘little sign of diminishing’ (p. 259). A search of ScienceDirect shows that the number of scientific papers published each year on climate change is also increasing (see Figure 1). (ScienceDirect is one of the largest online science databases, with peer-reviewed articles from over 2,500 journals.)

Figure 1: Increasing number of papers being published in peer-reviewed journals

(Graph created from data found at ScienceDirect, 2011)

Climate change has also been the subject of several mainstream movies, such as *The Day After Tomorrow* (2004), *Ice Age: The Meltdown* (2006), *An Inconvenient Truth* (2006), *The Great Global Warming Swindle* (2007), and *The Age of Stupid* (2009), as well as numerous documentaries and popular science books. A search of online bookshop Amazon found 9,457 results for ‘climate change’ and 7,788 results for ‘global warming’.

The explicit or implicit goal of these books, movies, and articles is to increase public knowledge of climate change. Kellstedt, Zahran, and Vedlitz (2008) state that ‘an underlying assumption is that providing information about global warming—in effect, taking the scientific consensus and popularizing it—will lead to increased public concern about the risks of global warming’ (p. 113). If the knowledge-deficit theory applied to climate change perceptions, we would expect to see the increasing information about climate change leading to correspondingly higher levels of concern for climate change, which is not the case (Jones, 2011a; Kellstedt, Zahran, & Vedlitz, 2008; Newport, 2010; Pew Research Center, 2009; ShapeNZ, 2010). Of course, this reasoning assumes both that people are encountering information and that the information they encounter is accurate, which (as described in Chapter 2) is not necessarily the case.

The knowledge-deficit theory has been criticised as reducing the complexities of public understanding of science to a simple one-way communication from scientists to the public (The Royal Society, 2004; Wright & Nerlich, 2006).

The Royal Society summarises the elements missing from the knowledge-deficit theory:

The [knowledge-deficit theory] did not adequately conceptualise how publics’ views and attitudes towards science were embedded within wider social, political and institutional understandings, and risked discounting the role of local knowledge and different public values in science debates (2004, p. 10).

The Royal Society’s findings suggest that the wealth of information available about climate change will not be sufficient in motivating concern for climate change.

Research into the effectiveness of information campaigns supports this theory.

1.4.2 Public information campaigns

Public information campaigns are an attempt to bridge the deficit in knowledge between experts and the public.

Ineffective information campaigns

Research increasingly shows that although information campaigns can increase people's knowledge, they often have no effect, or only short-term effects, and do not usually produce long-lasting attitude or behaviour change (Abrahamse, Steg, Vlek, & Rothengatter, 2007; Barr & Gilg, 2007; Lowe et al., 2006; McKenzie-Mohr & W. Smith, 1999; Owens, 2000; Sampei & Aoyagi-Usui, 2009; Schultz, 2002; P. Stern, 1999). Because information campaigns seem intuitively appropriate, and are relatively easy and cheap to run, they are widely used, despite a lack of evidence of their effectiveness (Schultz, 2002). Reasons given for the ineffectiveness of information campaigns are that they often ignore people's motivations for acting or thinking the way that they do, and they do not examine behaviours in their wider social, political, and cultural contexts (Barr & Gilg, 2007; Bulkeley, 2000; Lowe et al., 2006; Owens, 2000; The Royal Society, 2004; Wright & Nerlich, 2006).

Research has shown that people can often interpret the same information in very different ways, according to their own worldviews (Crompton, 2010; Heath & Gifford, 2006; Kahan, Braman, & Jenkins-Smith, 2010; Whitmarsh, 2011). This helps to explain why there are so many conflicting attitudes and beliefs about climate change, in spite of a clear scientific consensus. In their survey of 1,265 randomly selected households in southwest England, Barr and Gilg (2007) found that increased awareness of environmental problems was unlikely to lead to behaviour change, which required changes in attitudes, structures, values, and commitments towards the environment.

Effective information campaigns

There are occasions when information campaigns can be effective—when a lack of knowledge is the real barrier to getting people to act (Nolan, 2010; Schultz, 2002; Stern, 1999). In his review of how the knowledge-deficit theory applied to household recycling programmes in the United States, Schultz (2002) found that information campaigns were effective at changing recycling behaviour in three circumstances: 1) when a new recycling programme started and people did not know the new procedures, 2) when

changes were made to an existing programme and people needed to know the new procedures, or 3) when recycling procedures were complicated or hard to remember.

Stern (1999) similarly found that information campaigns could be effective if they applied lessons from research on communication, social norms, and human decision-making, such as presenting information in the context where the target behaviour will occur (for example, energy-use feedback systems that present consumers with frequent data on their energy use and financial costs). However, with most environmental behaviours, people usually already have the knowledge but not the motivation (Lowe et al., 2006; Nolan, 2010). With climate change, the distance between actions and consequences is so great that it is particularly difficult to design effective information campaigns.

Another example of effective information campaigns (that are increasingly being used) is social norms marketing campaigns (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). These campaigns use normative messages (messages about other people's behaviour) to target socially significant behaviours—such as alcohol consumption and recycling. Such campaigns attempt to reduce undesired behaviour by letting people know that the undesired behaviour is not as widespread as they think (Schultz et al., 2007). It is beyond the scope of this thesis to examine the effect of social norms on concern for climate change, although this is a promising area that would benefit from further study.

1.4.3 Does knowledge predict concern?

There are three possible causal relationships within the knowledge-deficit theory. When applied to concern for climate change, these relationships are as follows.

1. Knowledge causes concern.
2. Concern causes knowledge (when someone feels concerned, they learn more about climate change).
3. Something else causes knowledge and concern (Schultz, 2002).

The main focus of this thesis is on testing the first relationship—whether knowledge predicts concern. Study 1 and Study 2 examine the first relationship. The third relationship is examined by including other variables (demographics and information

and identity variables) in Study 1 and 2 analyses to assess their effect on concern. The next sections review research examining the knowledge-deficit theory and concern for climate change.

Research contradicting the knowledge-deficit theory

Existing research that contradicts the knowledge-deficit theory appears to solely consist of findings based on participants' perceived knowledge levels. Perceived knowledge is self-reported knowledge, where participants assess their own knowledge levels. It can also be thought of more as confidence in one's own knowledge, rather than an objective assessment of actual knowledge levels.

Perceived knowledge

A counter-intuitive finding challenging the knowledge-deficit theory that motivated the research in this thesis, was Kellstedt, Zahran, and Vedlitz's finding in their 2008 survey of 1,093 Americans. They found a *negative* relationship between knowledge and concern. Participants with greater perceived knowledge of climate change had significantly lower levels of concern and responsibility for climate change than those with lower knowledge. Study 1 replicates the methods used for this research in a New Zealand context.

Similarly, Whitmarsh (2011) found, both in her 2003 survey of 589 Britons and her 2008 survey of 551 Britons, that perceived knowledge about climate change did not predict scepticism or uncertainty. This result led her to reject the knowledge-deficit theory as an explanation of why public perceptions of climate change diverge from the scientific consensus.

Research supporting the knowledge-deficit theory

More research was found supporting the knowledge-deficit theory than contradicting it. Studies supporting the knowledge-deficit theory used both perceived and actual measures of knowledge.

Perceived knowledge

In their nationally representative survey of 185 Canadians, Heath and Gifford (2006) found that perceived knowledge of climate change significantly positively predicted whether participants believed that climate change was occurring and whether they believed it had negative effects. They did not find perceived knowledge a significant predictor of behavioural intentions.

In a follow-up study to Kellstedt et al.'s research, Malka, Krosnick, and Langer (2009) analysed nationally representative data from surveys of 1,002 Americans in 2006 and 2007, as well as longitudinal data from a 1997–1998 survey of 497 Americans. Malka et al. found that perceived knowledge of climate change only predicted concern in those participants who trusted scientists, or for Democrat and Independent participants; but not for participants who were sceptical about scientists or for Republican participants (Malka et al., 2009). This conditional support for the knowledge-deficit theory suggests that trust in experts and political party support are better predictors of concern than perceived knowledge. This thesis also examines the effect of these variables on concern for climate change.

In their survey of 192 New Zealanders, Aitken, Chapman, and McClure (in press) found that participants with high perceived knowledge of climate change were significantly more likely to perceive climate change to be a severe problem requiring urgent action than those with low perceived knowledge, providing support for the knowledge-deficit theory. Their study also found that participants with high perceived knowledge were significantly more likely to have already engaged in climate-mitigating behaviour than those with low perceived knowledge.

Actual knowledge

All of the studies reviewed that examined actual knowledge and concern for climate change supported the knowledge-deficit theory, differing only in the strength of the relationship, the length of time that participants remained concerned, and whether there was any corresponding effect on behaviour.

In support of the knowledge-deficit theory, researchers have found that knowing the causes and consequences of climate change is a powerful predictor of both concern for climate change and behavioural intentions, even when controlling for existing beliefs in

negative consequences of climate change and ‘salience measures’—people thinking climate change is important and then becoming informed (Bord, O’Connor, & Fisher, 2000; Leiserowitz, N. Smith, & Marlon, 2010; Sundblad, Biel, & Gärling, 2007).

In another follow-up study to Kellstedt et al., Nolan (2010) found support for the knowledge-deficit theory by testing actual knowledge about climate change. Nolan surveyed 41 American filmgoers attending a free public showing of *An Inconvenient Truth*. She surveyed knowledge and concern levels of participants before and after they saw the movie. She also surveyed American university students as a control group of participants who would not otherwise have seen the movie. Nolan found that participants in both studies had marginally higher knowledge and were significantly more concerned about climate change after watching the movie than they were before they watched it. After watching the movie, participants were also more willing to reduce greenhouse gases. Nolan surveyed the participants again, 1 month later, finding that there was no change in post-viewing increased levels of concern, but there was a marginal increase in post-viewing knowledge levels, and a marginal decrease in motivations to reduce greenhouse gases.

Nolan concluded that this divergence from Kellstedt et al.’s results was because Kellstedt et al. relied on self-reported knowledge of climate change, while Nolan’s study used objective measures of climate change knowledge. However, Nolan had very low numbers of participants (41 participants in the first study and 31 in a second study), making it difficult to draw conclusions from her findings.

Exposure to information

Several studies have examined whether exposing participants to information about climate change increased their concern. Although these studies all implicitly examined the knowledge-deficit theory, the researchers did not actually assess participants’ perceived or actual knowledge levels.

Lowe et al. (2006) surveyed 300 filmgoers in the city of Norwich in the United Kingdom who had just watched *The Day After Tomorrow*, a dramatised account of the abrupt transformation of Earth’s climate into a new ice age. Lowe et al. found that the film increased viewers’ concern for climate change, at least in the short term, but that

viewers found it difficult to distinguish fact from fiction, and beliefs in the likelihood of abrupt climate change were actually lower after watching the film.

Leiserowitz (2004) also examined the effect of *The Day After Tomorrow* on viewers' perceptions of climate change in a nationally representative survey of 529 Americans, some of whom had watched the movie and some of whom had not. He found that 83 percent of participants who had watched the movie said they were somewhat or very concerned about climate change, compared to 72 percent of those who had not watched the movie (Leiserowitz, 2004). However, Leiserowitz did not survey concern levels before participants watched the movie, meaning that viewers could have already had high baseline concern levels, and it is hard to know how much *The Day After Tomorrow* increased their concern.

Howell (2011) also surveyed 162 randomly selected moviegoers in Edinburgh before and after they saw the movie *The Age of Stupid*, over 21 screenings in March 2009, to examine their attitudes and behaviour toward climate change. The movie is a dramatised account of Earth in 2055, destroyed by climate change, with documentary footage about climate change interspersed throughout. Howell found that the movie increased participants' concern about climate change, their motivation to act, and their levels of perceived efficacy (belief that their actions could make a difference), although these effects had not lasted 10–14 weeks later. Howell found that the film also promoted self-reported behaviour change (particularly awareness raising and decisions to take flight-free holidays). Participants' behaviour was constrained by situational barriers, particularly participants living in rented accommodation with limited options for improving home energy efficiency (Howell, 2011). Howell's participants also already displayed very high levels of concern and knowledge before watching the film.

Sampei and Aoyagi-Usui (2009) analysed Japanese daily print media coverage of climate change from 1998–2007, concluding that increased media coverage of climate change corresponded with increased public concern, particularly when the articles were on the front pages of newspapers. They also found, in line with previous research, that the concern produced by each newspaper article was very short-lived—lasting only until the next paper was published (Sampei & Aoyagi-Usui, 2009).

Research into the relationship between knowledge of climate change and concern provides mixed results, although most research appears to support the knowledge-deficit theory. Studies using different measures of knowledge—perceived or actual—have produced different results. Studies that have used perceived measures of knowledge have produced contradictory results, suggesting that perceived knowledge of climate change is not a reliable predictor of concern. All of the studies that have used measures of actual knowledge have produced at least partial support for the knowledge-deficit theory.

This thesis builds on existing research by examining the relationship between knowledge and concern with measures of both perceived (Study 1) and actual (Study 2) knowledge of climate change, as well as testing the effect of other variables, such as demographics, environmental values, and perceived efficacy on participants' concern levels.

1.5 Scientific consensus on climate change

One of the most confounding things about public levels of concern for climate change is that they appear to be decreasing, in spite of the ever-increasing scientific consensus. 'Climate change' in this thesis does not refer to long-term natural climate change, but to the anthropogenic (human caused) climate change that has occurred over the last 100 years, as a direct result of human activities increasing the concentrations of greenhouse gases in the atmosphere and causing average global temperatures to rise and the climate to change in dangerous and unprecedented ways (Pachauri & Reisinger, 2007; Reisinger, 2009). This thesis is based on the findings of the Intergovernmental Panel on Climate Change (IPCC). The IPCC's findings show that there is a global scientific consensus on climate change. This section briefly describes this consensus.

The IPCC is the world's leading authority on climate change. The United Nations Environment Programme and the World Meteorological Organization established the IPCC in 1988 to advise governments and 'provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences' (IPCC, 2010). The IPCC produces seven-yearly reports reviewing and assessing international research on climate change. Thousands of scientists from around the world voluntarily contribute to the IPCC's work, which

incorporates an extensive peer-review process. The IPCC's most recent report at the time of writing, the 2007 Fourth Assessment Report, states that 'warming of the climate system is unequivocal... Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations' (Pachauri & Reisinger, 2007, pp. 30-39). In the IPCC's terminology, 'very likely' means that the probability is greater than 90 percent. Since 2001, the national science academies of 32 countries, including New Zealand, have issued joint declarations confirming the IPCC's findings on anthropogenic global warming, and urging countries to reduce greenhouse gas emissions (G8 + India, Brazil, and China, 2005; G8 + 5, 2007; 2008; 2009; The Royal Society of New Zealand, 2010).

To determine the extent of the scientific consensus in peer-reviewed science articles, Oreskes (2004) analysed 928 papers published in scientific journals between 1993 and 2003 that had the keywords 'climate change' in their abstracts. She found that *none* of them disagreed with the IPCC's position on anthropogenic climate change (75 percent accepted the scientific consensus and 25 percent took no position). Since this study, the IPCC released another round of assessment reports in 2007, showing that the evidence supporting their 2004 findings has grown, making the scientific consensus even stronger.

Further reinforcing the IPCC's findings, a 2007 study published in *Nature* by a group of international scientists compared the IPCC's 2001 projections of temperature and sea level rise to observed measurements in 2007. The authors found that the observed increases for both were in the upper projected ranges, concluding that the IPCC may have underestimated changes, particularly for sea level rise (Rahmstorf et al., 2007). This shows that the IPCC's projections are conservative, particularly as the reports do not include projections of dangerous non-linear tipping points in the climate system (for reviews of tipping points see Lenton, 2009; Lenton et al., 2008).

In 2007, the Statistical Assessment Service at George Mason University in the United States surveyed 489 randomly selected climate scientists from the American Meteorological Society and the American Geophysical Union. Like Oreskes, they found evidence of a strong consensus—84 percent 'personally believed' that anthropogenic warming was occurring and 74 percent agreed that 'currently available scientific evidence' showed this (Lichter, 2008, p. 1). Another survey, by Doran and Zimmerman

(2009), further reinforced the scientific consensus by finding that 90 percent of the 3,146 earth scientists they surveyed agreed that ‘mean global temperatures have risen compared to pre-1800 levels’, and 82 percent agreed that ‘human activity is a significant contributing factor in changing mean global temperatures’ (p. 23). However, out of the 79 scientists who listed climate science as their area of expertise, and had published more than 50 percent of their recent peer-reviewed papers on this subject, 76 (96.2 percent) agreed that ‘mean global temperatures have risen compared to pre-1800s levels’, and 75 out of 77 (97.4 percent) agreed that ‘human activity is a significant contributing factor in changing mean global temperatures’. That is, the scientists with the most authority on climate change were the most convinced of anthropogenic climate change. The authors concluded that ‘it seems that the debate on the authenticity of global warming and the role played by human activity is largely nonexistent among those who understand the nuances and scientific basis of long-term climate processes’ (p. 23).

More recently, Anderegg, Prall, Harold, and Schneider (2010) analysed the publications and citation data of 1,372 climate researchers and, again, found evidence of a strong scientific consensus. They found that 97 to 98 percent of the climate researchers they surveyed supported the IPCC’s findings on anthropogenic climate change. Like Doran and Zimmerman, Anderegg et al. found that the researchers who were less convinced or unconvinced of anthropogenic climate change had substantially less climate expertise and scientific prominence than the convinced researchers. Anderegg et al. identified ‘prominent climate researchers’ as those writing about climate change with both a large number of publications and a large number of citations, although this is only one indicator of scientific credibility.

Taken together, the support of national science academies, peer-reviewed publications, and climate scientists from around the world for the findings of the IPCC makes it clear that there is no real debate about anthropogenic climate change—at least among those qualified to participate in such a debate. Although, as Chapter 2 will show, this is often not the view presented by the media, or perceived by the public.

1.6 Why study concern instead of behaviour?

A potential challenge to this research is ‘why study concern instead of behaviour?’

There are three main reasons:

1. There is a theoretical link between attitudes and behaviour.
2. Public concern is one factor that may drive political change.
3. The research that Study 1 replicates focused on concern rather than behaviour and Study 1 needed to replicate it to allow comparison.

1.6.1 Attitudes predict behaviour

Research implies that high concern for climate change should predict climate change-mitigating behaviour. It is beyond the scope of this thesis to test both the information-concern link and the concern-behaviour link. This thesis focuses on testing the link between information and attitudes (concern) only, as there is a more robust body of evidence supporting the link between attitudes and behaviour (Ajzen, 1991; Barr & Gilg, 2007; Guagnano, P. Stern, & Dietz, 1995; Schultz & Oskamp, 1996; P. Stern, 1999).

Psychologists understand that behaviour results from varying combinations of forces acting on an individual—both internal forces (a person’s attitudes, values, beliefs, norms) and external forces (all physical, financial, social, and legal sources of support or opposition to the behaviour). Different psychological models emphasise different relationships between these forces, and terminology varies (they are also referred to as ‘situational and psychological variables’ or ‘positive and negative external conditions’) (Ajzen, 1991; Barr & Gilg, 2007; Guagnano, P. Stern, & Dietz, 1995; Schultz & Oskamp, 1996; P. Stern, 1999).

In his influential theory of planned behaviour, Ajzen (1991) found that behavioural intentions could be accurately predicted by attitudes, norms, and perceived behavioural control. He also found that actual behaviour could in turn be predicted accurately from behavioural intentions. Later research has built on this by focusing on the enabling or disabling effects of different internal and external forces acting on attitudes and behaviour (Barr & Gilg, 2007; Guagnano et al., 1995; Schultz & Oskamp, 1996; P. Stern, 1999), illustrated in Figures 2 and 3.

Figures 2 and 3 show how having strong attitudes, combined with a set of enabling internal and external forces is likely to predict behavioural intentions, which in turn are likely to predict actual behaviour. This suggests that having high concern for climate change is likely to predict intentions to perform climate-friendly behaviours—for example, riding a bike to work instead of driving a car. This behavioural intention is likely in turn to lead to actual behaviour, when enabling external and internal forces are acting. These forces could include: the knowledge that driving a car contributes to climate change, the perception that riding a bike will actually make a difference in some way, and the existence of bike lanes making the behaviour easy and safe. Barr and Gilg (2007) note that a different combination of internal and external forces will apply to each decision made by each individual.

Schultz and Oskamp (1996) point out that people with strong attitudes are more likely to engage in more difficult behaviours (behaviours less under their control), while people with weaker attitudes will be more likely to engage in easier behaviours (behaviours more under their control). This implies that people with high levels of concern for climate change are more likely to engage in more difficult climate change-mitigating behaviours. Climate change policy directed at individual behaviour change should focus on increasing public concern, as well as on identifying and increasing enabling forces and identifying and reducing disabling forces.

Figure 2: Guagnano, Stern, and Dietz's model of the effects of attitudes and conditions on behaviour

(Guagnano et al., 1995, p. 703)

Figure 3: Barr and Gilg's model of values and behaviour

(Barr & Gilg, 2007, p. 365)

1.6.2 Public concern drives political change

As well as psychological theories linking attitudes and behaviour, an important function of public concern is to create space for political action. Advocacy groups harness public concern to promote government action and changes to policy. This is particularly important for climate change, as individual action (while important) is insufficient to address the problem. Governments too require the ‘consent of the governed’ to take action with short-term costs and long-term benefits. Strong, coordinated intergovernmental action is needed to curb greenhouse gas emissions (N. Stern, 2000), and strong public concern is central to ensuring this happens. Kempton (1993) found that public concern could be a strong driver of political action, though only in specific circumstances. It is beyond the scope of this thesis to test the complex link between public concern and political action.

2 Public knowledge and concern

Chapter 2 broadens the focus of Chapter 1 to examine the two main themes of this research in detail: public climate change knowledge (Section 2.1) and public concern for climate change (Section 2.2).

- The first part of Section 2.1 examines how the public learns about climate change, and the quality of media reporting on climate change. The second part reviews research, mainly survey and poll results, examining public knowledge of climate change.
- The first part of Section 2.2 reviews research on concern for climate change, also based mainly on surveys and polls. The second part looks at variables that might affect concern, other than knowledge.
- Section 2.3 is a brief section describing the overall findings of the literature and identifying relevant research gaps.

Literature is sourced mainly from peer-reviewed journals, although, as there is not yet an extensive literature available on this topic, information from less reliable sources such as newspaper articles, organisational reports, and various polls and surveys are also used (these instances are identified in the review). Journal articles were identified using general and academic search engines and databases and from bibliographies of other peer-reviewed papers on similar topics.

To keep this research as focused as possible, social norms and the broader risk assessment literature are not addressed, but these would be useful areas for further research and literature reviews.

2.1 Climate change knowledge

What does the public know about climate change? To answer this question, Section 2.1 reviews research examining how the public learns about climate change, and aspects of the quality of media reporting on climate change, before moving on to review studies of public knowledge of climate change.

2.1.1 The public's information sources

Research in New Zealand, the United States, and Britain (1993) shows that the public in these countries learn about climate change almost exclusively through the media, particularly from television and newspapers.

Bell (1994) reports an unpublished nationally representative survey of 61 New Zealanders that he conducted in 1989, which found that most New Zealanders' knowledge of climate change came solely from the 'principal daily media', but he does not differentiate between different types of media (p. 259). Updated research is needed to identify which specific sources the New Zealand public gains most of its climate change information from today.

Whitmarsh (2009) conducted a postal survey of 589 participants from southern England in 2003. She found that respondents' main sources of climate change information were television (selected by 91.5 percent of respondents), newspapers (85.1 percent), and radio (65.7 percent). The least popular sources were the internet (selected by 13.2 percent of respondents), journals (18.7 percent), and libraries (7.1 percent) (Whitmarsh, 2009).

Similarly, and more recently, in their nationally representative survey of 2,030 Americans, Leiserowitz, Smith, and Marlon (2010) found that respondents' main sources of climate change information were also television (selected by 88 percent of respondents) and newspapers (71 percent), followed by family and friends (69 percent), books or magazines (68 percent), and the internet (65 percent) (Leiserowitz, N. Smith, et al., 2010).

Whitmarsh's and Leiserowitz's studies both found that television and newspapers were the main sources of climate change information, although they found very different results for the internet as a source of information. Comparatively low numbers of British participants used the internet, while much higher numbers of Americans did (13.2 percent compared to 65 percent). This is probably because Whitmarsh's survey was paper-based and conducted in 2003, when the internet was not as widely used as in 2010. Contrastingly, Leiserowitz, Smith, et al. conducted their survey in 2010, when internet use was far more prevalent, and it was an online survey, meaning that all

respondents were internet users. This makes it difficult to draw any conclusions about British or American use of the internet as a source of climate change information.

Whitmarsh (2009) also found that although mass media sources were the main sources of climate change information, participants had low trust in these sources. She found that respondents believed scientists to be the most trusted source of climate change information (Whitmarsh, 2009). This indicates that her participants received most of their information from sources that they did not trust, perhaps suggesting that they were predisposed to be sceptical of the information that they encountered on television and in newspapers.

2.1.2 The media's information sources

The studies described above indicate that the mass media are overwhelmingly the public's main source of climate change information. So what are the media's sources for this information? This is not a widely researched topic, although there are two studies that suggest that journalists get most of their information from other journalists rather than directly from scientists or from scientific publications (Trumbo, 1996; Wilson, 2000).

Wilson (2000) surveyed 249 reporters from the North American Society of Environmental Journalists, to determine where they sourced the information they reported about climate change. He found that 37 percent of their information came from newspapers, followed (distantly) by interviews with scientists (20 percent) and peer-reviewed science journals (15 percent). All other sources were used very rarely, and included magazines (8 percent), television (3 percent), previous schooling (2 percent), government officials (2 percent), and politicians (1 percent) (Wilson, 2000). Wilson described how reporters' heavy reliance on each other creates a climate change news 'food chain', concluding that 'while more than 50,000 journals and one million scientific papers are published each year, these journalists are not using them as primary sources of scientific information on climate change' (p. 4).

Wilson's findings are particularly interesting as his sample was already selective, comprising entirely environmental journalists. If journalists specially dedicated to communicating science to the public rely so heavily on sourcing information from other media sources over information sourced directly from scientists or journals, then it is

reasonable to assume that non-environmental journalists rely as much, if not more, on other media sources. Further research is needed to determine this, as well as the extent to which this affects the quality of the information reported.

Trumbo's (1996) earlier research reinforces Wilson's finding that the media do not use scientists as the main source of information about climate change. Trumbo conducted a content analysis of 252 articles on climate change from five major United States newspapers. He found that over time, as climate change became more politicised, the volume and number of stories on climate change increased, but there was a significant decline in the percentage of scientists quoted in stories. Instead, media sources shifted from scientists to policy advisers and special-interest groups (Trumbo, 1996).

This departure from scientific sources to policy and special-interest group sources could mean that the information the public encounters is less accurate and more biased or subjective. The public could perceive this and have less trust in what they read and perhaps higher scepticism about climate change since they are exposed to opinions or appeals rather than to scientific facts. Presenting climate change information as a policy discussion could also cause people to interpret the information according to their political views. Further research is needed to link media information with public knowledge of, and concern for, climate change.

2.1.3 Quality of media information on climate change

Research shows that the more media coverage there is of a topic, the more the public prioritises it (Antilla, 2010). However, there is little research investigating the quality of the information on climate change reported by the media. If the knowledge-deficit theory applies to climate change, then if people are ill informed they are unlikely to be concerned, or to perhaps be concerned about the wrong thing. Conflicting information about climate change (such as multiple projected future temperatures) has been shown to lead people to hold onto their existing beliefs and distrust information sources (Sundblad, Biel, & Gärling, 2009). As newspapers and television news appear to be the public's main sources of climate change information, it is important to know how accurately journalists report the science and represent the scientific consensus. Lichter (2008) found that only 3 percent of randomly selected climate scientists surveyed

trusted newspaper or television coverage of climate change. Several studies described below suggest this mistrust may be justified.

Bell (1994) found, in his content analysis of New Zealand newspaper and radio stories on climate change in 1988, that basic scientific facts were ‘overwhelmingly accurate’, although one out of six stories on climate change contained ‘significant misreporting’, including scientific and technical errors, misquotations, exaggerations, omissions, and distorted emphasis (p. 259). As this research was done over 20 years ago, updated analysis is needed before drawing any conclusions, as scientists’ understanding of climate change is far greater and more complex today. In Wilson’s more recent study, he found that only one-third of the environmental reporters surveyed believed that ‘the global warming theory is accepted by most atmospheric scientists’ (2000, p. 7). In fact, most reporters believed that scientists ‘strongly debated’ the topic. As these were environmental journalists, it seems likely that non-environmental journalists could perceive there to be even more debate.

One of the main criticisms of media coverage of climate change is the journalistic norm of ‘balanced reporting’—the tendency to tell both sides of a story—which, although appropriate in many non-scientific stories, distorts and misrepresents the scientific consensus on climate change, giving the mistaken appearance of controversy and disagreement between scientists (Boykoff & Boykoff, 2004; 2007; Cox, 2010; Lowe et al., 2006). For this reason, Cox (2010) suggests that journalists should not attempt to run a parallel peer-review process, but should reflect the scientific consensus—a position arrived at by a well-established and rigorous peer-review process.

To investigate the effect of the journalistic norm of ‘balanced’ reporting on climate change, J. Boykoff and M. Boykoff (2004) content analysed 636 articles (randomly selected from a total of 3,543 articles) on climate change from four prominent American newspapers from 1988 to 2002. They found that 53 percent of these articles were structured on the journalistic norm of balanced reporting, giving equal attention to the view of anthropogenic climate change as to the opposing view that temperature increases could be entirely explained by natural fluctuations. They found that 35 percent of the stories emphasised anthropogenic climate change but still presented both sides of the ‘debate’, while 6 percent of stories expressed doubt in anthropogenic climate change and a further 6 percent exclusively discussed anthropogenic climate change.

This study shows that, by using the journalistic norm of balanced reporting, these newspapers gave the mistaken impression of great debate among the scientific community about whether humans contribute to climate change, presenting information that significantly diverged from the accepted scientific position of the IPCC. J. Boykoff and M. Boykoff (2004) concluded that:

Adherence to the norm of balanced reporting leads to informationally biased coverage of global warming. This bias, hidden behind the veil of journalistic balance, creates both discursive and real political space for the US government to shirk responsibility and delay action regarding global warming' (p. 134).

In a later study, Boykoff and Boykoff (2007) found other journalistic norms that similarly prevented clear and accurate communication of climate change. Specifically they found that journalists' use of first-order journalistic norms (personalisation, dramatisation, novelty) significantly influenced their use of second-order journalistic norms (authority, order, balance). They noted that 'scientists generally employ a lexicon of caution and speak in a language of probability, which usually does not translate smoothly into the crisp, unequivocal commentary that is valued in the press' (2007, p. 1192). Other research echoes this finding that science often gets lost in translation from scientific journals to news headlines (Lowe et al., 2006).

Antilla (2005) content analysed 544 climate science articles from 255 United States newspapers to provide 'a snapshot of the socially constructed news of climate science during the time period of 1 March 2003 to 29 February 2004' (p. 341). Antilla found that not only did journalistic balance often lead to biased reports, but some newspapers repeatedly used climate change sceptics as primary sources causing 'the exponential spread of misinformation' from one paper to another (p. 350).

The knowledge-deficit theory implies an unbroken flow of information from experts to the public. It does not account for the intermediary role of the media in interpreting and communicating the scientific consensus on climate change to the public. Kellstedt et al. (2008) also note that the mass media complicate the matter:

The knowledge-deficit model—as well as the behavior of global-warming activists—leads us to suspect that increasing levels of information will heighten risk perceptions. But, on the other hand, the media’s framing of the global warming issue as an unsettled controversy leads us to expect that information levels will not produce increasing concern for global warming (p. 116).

This thesis contributes to research like Kellstedt et al.’s by examining the relationship between knowledge and concern for climate change. The studies discussed above show that the information that the public encounters on climate change in the media is by no means accurate or unbiased, suggesting that public knowledge of climate change may be low. The rest of this chapter reviews research, mostly polls and surveys, examining public knowledge of climate change and public concern for climate change to see whether the scientific consensus is filtering through. If so, we would expect to find that the public had both high knowledge and high concern for climate change, providing intuitive support that the knowledge-deficit theory applies to concern for climate change.

2.1.4 Public knowledge of climate change

As well as the ‘informationally biased’ information presented in the media, another reason public knowledge of climate change may be low is because climate change information is highly technical and relies on models requiring complex mathematical and scientific knowledge for interpretation, which makes it very difficult for people untrained in climate science to understand. Budescu, Broomell, and Por’s (2009) research illustrates this. They asked 223 American university students to estimate the probability of environmental and climate events described in selected sentences from the 2007 IPCC report. The researchers found that participants did not understand the risks of climate change well, and that they underestimated the risks. Participants’ estimates significantly deviated from the IPCC’s, even when participants had access to the IPCC’s guidelines for interpreting these risks (Budescu, Broomell, & Por, 2009). Budescu et al.’s participants were all university volunteers, meaning that they were more educated than the general public. Perhaps the general public would have even greater difficulty interpreting the risks.

Psychological factors have also been shown to affect people’s knowledge of climate change. Joireman, Truelove, and Duell (2010) found that participants’ beliefs in climate change were very unstable and could be manipulated in psychological experiments.

Specifically, they found that heat-related primes (exposure to words like ‘hot’, ‘boil’, ‘sun’, ‘fry’, etc) could increase participants’ beliefs in climate change. They also found that providing participants with high anchors for possible future temperatures made participants more likely to believe in climate change and more willing to pay to address climate change (they asked some participants whether they thought temperatures would rise by exactly 1°F—a low anchor—and asked others whether they thought temperatures would rise by exactly 10°F—a high anchor). Joireman et al.’s participants were all university psychology students who may have been more attuned to the effects being investigated. Future research should use a more representative sample to see whether stronger, or different, effects were found.

Similarly, Li, Johnson, and Zaval (2011) surveyed 582 Americans and 290 Australians to assess climate change perceptions. They asked respondents to say whether the day they were completing the survey on was colder or hotter than usual. They found that participants from both countries who perceived the day’s temperature to be hotter than usual had higher beliefs in, and concern for, climate change than those who perceived the temperature to be colder than usual. Contrastingly, Joireman et al. (2010) found that participants’ beliefs in climate change were significantly positively correlated with *low* outdoor temperatures.

Even the terms ‘climate change’ and ‘global warming’ affect people’s understanding. Whitmarsh (2009) found that participants responded differently to the terms ‘climate change’ and ‘global warming’, with 4 percent of participants believing them to be separate phenomena (believing, for example, that global warming causes climate change). Whitmarsh also found that 23.1 percent of participants expressed concern for ‘global warming’, while only 16.2 percent expressed concern for ‘climate change’ and that self-reported knowledge about ‘climate change’ is lower than about ‘global warming’ (Whitmarsh, 2009).

Collectively, these studies all suggest that public knowledge of climate change is unstable and easily manipulated, perhaps pointing to general confusion and low understanding of the science. This thesis contributes to this research by examining levels of public knowledge of climate change.

Perceived knowledge of climate change

Dunlap (1998) analysed Gallup survey data from Canada, the USA, Mexico, Brazil, Portugal, and Russia and found that most participants had low levels of perceived knowledge about climate change. Participants who said they understood climate change ‘very well’ ranged from 3 percent of Portuguese participants who said they understood climate change ‘very well’ to 11 percent of American participants and 13 percent of Canadian participants (Dunlap, 1998). Dunlap (1998) also found that, in all six countries, younger, well-educated, male participants had the highest levels of perceived knowledge about climate change.

In their 2006 survey of 959 New Zealanders and 893 Australians, Hatfield-Dodds and Jollands (2006) similarly found that female and younger participants had lower perceived information than male and older participants. They also found that perceived knowledge of climate change and support for climate change policies varied by job type. Specifically they found that farm owners and managers had higher perceived knowledge and lower stated support. They found that farmers displayed the highest perceived knowledge levels of all the groups, but also the lowest levels of concern for climate change (Hatfield-Dodds & Jollands, 2006).

More recently, Leiserowitz, Smith, et al. (2010) similarly found that only 11 to 14 percent thought they were ‘very well informed’ about climate change (how the climate system works, causes, consequences, potential solutions to climate change), while 51 to 52 percent said they were ‘fairly well informed’. In the 12 years between Dunlap’s and Leiserowitz et al.’s studies, the number of Americans considering themselves ‘very well informed’ about climate change remains unchanged at around 11 percent. It would be interesting to know the characteristics of the participants with high perceived knowledge of climate change in Leiserowitz et al.’s study. Future research could further examine whether a correlation exists between young, well-educated men and lack of concern for climate change, or whether young educated men tend to overestimate their perceived knowledge of most things.

Taken together, these studies show low levels of public perceived knowledge of climate change. This thesis contributes to this research by examining New Zealand public perceptions of climate change knowledge in both Study 1 and Study 2.

Actual knowledge of climate change

The rest of Section 2.1 reviews surveys examining public knowledge of climate change. Research shows that most people do accept anthropogenic climate change, but that generally people underestimate how strong the scientific consensus is (Jones, 2011a; Leiserowitz, Roser-Renouf, Mailbach, & Smith, 2010; Leiserowitz, Smith, et al., 2010; Wilson, 2000). Public knowledge of the nature, causes, and consequences of climate change is also low (Bord et al., 2000; Joireman et al., 2010; Leiserowitz, Smith, et al., 2010; O'Connor, Bord, & Fisher, 1999; Pidgeon, Lorenzoni, & Poortinga, 2008).

Kahlor and Rosenthal surveyed 805 Americans in 2005 to identify factors that predicted high knowledge of climate change. They found that the strongest predictors of climate change knowledge were: the number of information sources participants used to find information on climate change (the greater number of information sources, the higher level of knowledge), how well participants thought they understood information about climate change they had previously encountered in the media, general education levels, and self-reported efforts to seek out climate change information (Kahlor & Rosenthal, 2009).

In their 1997 survey of 1,218 Americans, Bord et al. (2000) found that knowledge of the causes of climate change is particularly important—being able to identify true and false causes of climate change was the most powerful predictor of intentions to take voluntary actions and of support for hypothetical government policies to reduce greenhouse gas emissions. They found that people are just as willing to act on inaccurate information as they are on accurate information—participants who believed that unrelated environmental threats (such as pesticides) contributed to climate change were more likely to believe in climate change. Although belief in false causes was correlated with belief in climate change, it was only weakly related to intentions to take voluntary actions, and not at all related to support for government policies. The authors concluded that ‘translating public concern for global warming into effective action requires real knowledge’ (Bord et al., 2000, p. 205). In this vein, the next sections review surveys of actual public knowledge of climate change.

Understanding there is a scientific consensus

Studies examining public perceptions of the scientific consensus on climate change show that people tend to underestimate the scientific consensus, perceiving much greater debate between scientists than there really is (Jones, 2011a; Leiserowitz, Roser-Renouf, et al., 2010; Leiserowitz, Smith, et al., 2010; Newport, 2010; The World Bank, 2009).

The World Bank (2009) polled 13,518 respondents from 15 countries (see Figure 4), using a combination of face-to-face, telephone, and internet surveys. In only nine of the 15 countries did more than 50 percent of respondents perceive most scientists to ‘think the problem is urgent and enough is known to take action’ (p. 7). In four countries (Japan, America, Indonesia, Russia), minorities perceived a scientific consensus.

Figure 4: World Bank survey responses on perceptions of scientific consensus

(Graph created with data from The World Bank, 2009)

American researchers (Leiserowitz, Roser-Renouf, et al., 2010; Leiserowitz, N. Smith, et al., 2010) also found that participants generally underestimated the scientific consensus on climate change. Leiserowitz, Smith, et al. (2010) found that 39 percent of respondents said that most scientists think that climate change is happening, while 38 percent said there was a lot of disagreement among scientists. This is similar to the World Bank’s findings for America (38 percent perceived there to be a scientific

consensus, while 43 percent believed scientists' views to be fairly evenly divided) (The World Bank, 2009).

Gallup, an American polling organisation, conducts a yearly survey of American attitudes toward the environment. Gallup's March 2010 poll found that over the last two years the American public has become more likely to believe that scientists are uncertain about climate change. In 2010, 52 percent thought that scientists 'believe that climate change is occurring'—down from 65 percent in 2006–2008. In 2010, 36 percent of the Americans surveyed believed that scientists were unsure about climate change, and a further 10 percent said most scientists believed climate change was not occurring (Newport, 2010).

These studies show that people appear to be misinformed about the scientific consensus on climate change, perceiving there to be great debate among scientists that does not exist at the scale that they perceive. More research is needed to confirm this and broaden the research to other countries like New Zealand.

Understanding the climate is changing

Previous research shows that majorities of the public in Britain and America accept anthropogenic climate change (Jones, 2011a; Kirby, 2004; Krosnick, 2010; Leiserowitz, Smith, et al., 2010; Newport, 2010; Pew Research Center, 2009; Pidgeon et al., 2008), although longitudinal American surveys show that beliefs in human and natural causes fluctuate, and have decreased overall since 2007 (Jones, 2011a).

A 2004 BBC poll of 1,007 Britons found that 64 percent attributed climate change to human activities while 18 percent said it was too early to determine whether humans are responsible (Kirby, 2004). In their 2005 nationally representative survey of 1,491 Britons, Pidgeon, Lorenzoni, and Poortinga similarly found that 91 percent of participants believed the climate was changing, and that many participants could correctly identify some of the main human causes. The authors concluded that, in Britain, public scepticism about climate change had almost completely disappeared (Pidgeon et al., 2008).

Leiserowitz, Smith, et al. (2010) found that 63 percent of Americans understood that climate change is happening, 19 percent said it was not happening, and 19 percent did not know. Fifty percent said that if climate change is happening it is caused mostly by

human activities, 35 percent said that if it is happening it is caused by natural changes, 7 percent rejected the question and said that climate change was not happening.

Gallup's March 2011 poll representative of 1,021 Americans found that since 2003, the American public has become less certain that temperature increases are due to human activities (see Figure 5). The poll found that Americans have also become less convinced that the effects of climate change are already happening (18 percent in 2011 said the effects would never happen—up from 9 percent in 1997) (Jones, 2011a).

The Pew Research Center's 2009 survey of 1,500 Americans found similar evidence of decreasing beliefs in anthropogenic climate change. Their August 2006 survey found that 77 percent of respondents agreed that there was 'solid evidence that the earth is warming', this dropped to 71 percent by April 2008 survey, and down to 57 percent by October 2009 (Pew Research Center, 2009).

Figure 5: Gallup respondents' beliefs in anthropogenic climate change

'From what you have heard or read, do you believe increases in the Earth's temperature over the last century are due more to the effects of pollution from human activities or natural changes in the environment that are not due to human activities?'

(Jones, 2011a, <http://www.gallup.com/poll/146606/concerns-global-warming-stable-lower-levels.aspx>)

However, Krosnick (2010) questioned the validity of surveys showing trends of decreasing belief in climate change (specifically the 2009 Pew Research Center survey and the 2010 Gallup poll discussed above), as he claims the questions are worded ambiguously. Respondents were often asked their perceptions of scientific evidence or the news, not their personal opinions about climate change, meaning the same question could be interpreted in different ways. Krosnick's own survey, designed to avoid ambiguity, still found a slight decrease in participants' beliefs in climate change. He

surveyed 699 participants in a 2010 Stanford University climate change telephone survey (nationally representative of the United States). He found that 74 percent of respondents agreed that the earth's temperature had increased over the last 100 years, down from 84 percent in 2007 and 80 percent in 2008, and that 75 percent of respondents said that human behaviour was mostly responsible for any warming.

Understanding the causes

Research examining public understanding of the causes of climate change has found that participants overestimated natural causes and underestimated the contribution of personal actions (such as cars and household emissions) and also falsely attributed blame to the ozone hole and 'general pollution' (Bord et al., 2000; Dunlap, 1998; Kempton, 1997; Leiserowitz, N. Smith, et al., 2010; Lorenzoni & Pidgeon, 2006; Pidgeon et al., 2008; Whitmarsh, 2009). People tend to merge climate change information into pre-existing 'mental models'—thought processes explaining how things work. The two main mental models that people tend to assimilate climate change into are the ozone hole model and the general pollution model (Bord et al., 2000; Böhm & Pfister, 2001; Kempton, 1997).

This mingling of separate issues and confusion about causes inevitably leads to people misunderstanding solutions and being unable to perceive the real risks. For example, many people mistakenly believe that banning aerosol spray cans would help mitigate climate change. (Bord et al., 2000; Böhm & Pfister, 2001; Dunlap, 1998; Kempton, 1997; Leiserowitz, N. Smith, et al., 2010; Lorenzoni & Pidgeon, 2006; Pidgeon et al., 2008; Whitmarsh, 2009). Other commonly misperceived (or overestimated) causes of climate change include volcanic eruptions, the sun, acid rain, toxic wastes, the American space programme, insecticides and nuclear power (Bord et al., 2000; Leiserowitz, N. Smith, et al., 2010; Whitmarsh, 2009).

Lorenzoni and Pidgeon (2006) reviewed studies that assessed the climate change knowledge of Europeans and Americans, concluding that both Europeans and Americans had limited knowledge of the causes of climate change.

In Britain, the 2004 BBC poll found that, of the 64 percent of respondents who understood that humans are responsible for climate change, 67 percent referred to transport emissions as a cause, 66 percent referred to deforestation, and 57 percent to

coal and oil-based electricity generation (Kirby, 2004). In 2005, Pidgeon, Lorenzoni, and Poortinga (2008) surveyed 1,491 Britons. When asked, unprompted, what the causes of climate change were, the main causes cited were air pollution (cited by 39 percent of respondents), transport (31 percent), burning fossil fuels (29 percent), industrial emissions (19 percent), the ozone hole (19 percent), deforestation (15 percent), and nuclear power (5 percent). Whitmarsh (2009) found that, when asked unprompted to describe the causes of climate change, survey respondents referred to general pollution (cited by 22.8 percent of survey respondents), natural causes (16.6 percent), ozone layer depletion (19.8 percent), transport emissions (11 percent), industrial emissions (9.8 percent), fossil fuels (9.2 percent), deforestation (8.3 percent), and carbon dioxide or carbon emissions (6.1 percent).

American researchers found similar results. Bord, O'Connor, and Fisher (2000) found that participants underestimated the large contribution of individual and domestic activities (cars, utilities, household heating and cooling) to greenhouse gas emissions. Leiserowitz, Smith, et al. (2010) asked participants to rate how much each item on a list of activities and processes contributed to climate change. The items that participants believed contributed 'a lot' to climate change were cars and trucks (chosen by 49 percent of participants), burning fossil fuels for heat and energy (41 percent), deforestation (38 percent), the ozone hole (34 percent), toxic wastes (32 percent), aerosol spray cans (25 percent), nuclear power plants (23 percent), volcanic eruptions (20 percent), the sun (19 percent), acid rain (18 percent), the space program (10 percent), and cows (9 percent).

In 2009, American researchers surveyed 248 Americans, replicating a mental models-based climate change survey they had conducted of 177 Americans in 1992. They found that in 2009, respondents were much less likely to refer to the ozone hole and much more likely to refer to energy use. They found that in spite of these changes in perceptions, 'changes are smaller than one might expect' (p. 1521) and many respondents in 2009 still did not understand that climate change is mainly caused by increased atmospheric concentrations of carbon dioxide, or that fossil fuel combustion is the main source of these concentrations (Reynolds, Bostrom, Read, & Morgan, 2010). The two studies did not involve the same participants.

It is difficult to directly compare the different studies examining public knowledge of climate change causes, as they all asked slightly different questions, though broad trends are apparent. Whitmarsh (2009) found that different survey methods (qualitative versus quantitative) affected participants' levels of climate change knowledge—if researchers did not give participants a list of possible causes to choose from, their knowledge was lower (Whitmarsh, 2009). Overall it seems that participants generally overestimated natural causes and underestimated the contribution of human activities. Large numbers of participants incorrectly believed that climate change is caused by the ozone hole and general pollution.

Understanding the consequences

Existing research has found that people are least informed about the existing and projected impacts of climate change on human health (Leiserowitz, 2005; Sundblad et al., 2009). In their 2005 survey of 903 Swedes, Sundblad et al. (2009) found that participants' knowledge of the weather, sea, and glacier-related consequences of climate change was higher than their knowledge of human health consequences (increase and spread of tropical diseases, increase of heat-related illnesses and deaths, etc). In his 2003 nationally representative survey of 673 Americans, Leiserowitz (2005) found that participants made no associations to the impacts of climate change on human health (from temperature increases, impacts of extreme weather events, air pollution, water and food-borne diseases, vector and rodent-borne diseases, etc). He also found that very few Americans associated climate change with extreme weather events. Leiserowitz, Malbach, et al. (2010) found that 75 percent of Americans had not heard of coral bleaching, and 77 percent had not heard of ocean acidification.

Collectively, research into public knowledge of climate change finds that, overall, most people accept anthropogenic climate change, although perceive there to be more scientific debate than exists. The British and American publics also appear to underestimate human causes of climate change and overestimate natural causes. Health consequences of climate change appear to be the least well understood by the Swedish and American publics. Study 2 of this thesis contributes to existing research by

examining New Zealanders' knowledge of the state, causes, and consequences of climate change.

2.2 Concern for climate change

How concerned is the public about climate change? What variables other than knowledge affect concern? To answer these questions, this section reviews surveys and polls on public concern levels, and examines the effects of variables such as demographics, values and worldviews, trust in experts, and perceived efficacy on concern for climate change. This will enable results to be located in a wider context and for New Zealand participants' concern levels to be broadly compared to those in other countries.

2.2.1 Global levels of concern for climate change

While the scientific consensus on climate change is increasing, not only are people's beliefs in anthropogenic climate change and the scientific consensus decreasing, levels of concern about climate change also appear to be decreasing (Dunlap, 1998; HSBC Climate Partnership, 2009; Jones, 2011a; Kellsted et al., 2008; Kirby, 2004; Lorenzoni & Pidgeon, 2006; MoRST, 2010; Newport, 2010; Radio New Zealand, 2010; ShapeNZ, 2010; Whitmarsh, 2008).

Lorenzoni and Pidgeon (2006) reviewed European surveys of public perceptions of climate change in the 12 European Union member states from 1988–2002. They found that, although the results were not directly comparable over time, they provided a general indication on changing public perceptions of climate change, illustrating a trend of increasing concern from 1988 to 1992 and then declining concern from 1992 to 2002 (see Figure 6).

Figure 6: European Union member countries' concern for climate change: 1988–2002

(Graph created from data in Lorenzoni & Pidgeon, 2006)

In the World Bank's 2009 poll described earlier, majorities from all 15 countries saw climate change as either a 'very serious' or 'somewhat serious problem' (see Figure 7). Participants from the low-income countries were more likely to see climate change as a 'very serious problem' than participants from the high-income countries. In nine of the 15 countries, majorities of participants believed climate change was already harming people in their country (The World Bank, 2009).

Figure 7: Perceptions of climate change in 15 countries

(Graph created from data in The World Bank, 2009)

The Pew Research Center's 2009 survey found that the proportion of Americans who thought climate change was a 'very serious problem' dropped from 47 percent in April 2008 to 36 percent by October 2009 (Pew Research Center, 2009).

Nielsen and the Oxford University Environmental Change Institute conduct an annual climate change perceptions survey. The most recent survey, of 27,548 online respondents in 54 countries in October 2009, found that 37 percent of respondents said they were 'very concerned' about climate change (dropping from 41 percent in 2007). The country with the highest percentage of very concerned respondents was the Philippines, with 78 percent; the lowest was Estonia with 10 percent. The survey found that concern declined between 2007 and 2009 in 35 out of the 54 countries surveyed, falling most in Poland (by 23 percent) and Canada (by 22 percent) (Nielsen, 2009a).

HSBC commissions a yearly (2007, 2008, 2009, 2010) cross-cultural survey, the Climate Confidence Monitor. It is an online survey of 1,000 people in each of 15 countries, measuring concern, confidence, commitment, and optimism about climate change. This longitudinal survey found that concern levels decreased in most countries between 2008 and 2010, although all countries—except for America, France, and Hong Kong—showed increases in concern from 2009 to 2010 (see Figure 8). The results also point to a difference between countries with different levels of economic development. Respondents from the more economically developed countries like the United Kingdom, the United States, Australia, Canada, Germany, and France consistently showed the lowest levels of concern, while participants from the less economically developed countries like Mexico, Malaysia, India, Brazil, and China showed the highest concern levels (HSBC Climate Partnership, 2010).

Figure 8: Concern for climate change in 15 countries: 2007–2010

(Graph created from data in HSBC Climate Partnership, 2010)

Leiserowitz, Smith, et al. (2010) found that 55 percent of American participants said they were ‘very worried’ (16 percent) or ‘somewhat worried’ (39 percent) about climate change; and 45 percent said they were ‘not very worried’ (26 percent) or ‘not at all worried’ (19 percent).

Gallup’s March 2011 poll asked participants to choose whether they thought the seriousness of climate change is ‘generally exaggerated in the news’, ‘generally correct’, or ‘generally underestimated’ (see Figure 9). Results showed that Americans who believe that the seriousness of climate change is ‘generally exaggerated’ climbed from 31 percent in 2005 to 48 percent in 2010, dropping slightly to 43 percent in 2011 (Jones, 2011a). Although beliefs that the seriousness of climate change is exaggerated have decreased since 2010, the overall trend has been one of increasing scepticism, so time will tell whether this trend has been reversed. Jones notes that 2011 is the third consecutive year where ‘a substantial plurality has believed global warming’s effects are not as bad as they are portrayed, a departure from prior years, when Americans were about evenly split between the three points of view’ (p. 1).

The Gallup poll also found that the percentage of Americans who say they ‘personally worry a great deal’ or ‘a fair amount’ about climate change has fluctuated from a high in 2000 of 72 percent, to a near all-time low in 2011 of 51 percent.

Figure 9: Gallup respondents’ perceptions of climate change in the news

‘Thinking about what is said in the news, in your view, is the seriousness of global warming generally exaggerated, generally correct, or is it generally underestimated?’

(Jones, 2011, <http://www.gallup.com/poll/146606/concerns-global-warming-stable-lower-levels.aspx>)

In their longitudinal study (November 2008–July 2010), Leiserowitz et al. (2010; 2011) segmented the United States public into six groups, ranging along a ‘spectrum of concern’ about climate change. The groups were (from most to least concerned): the Alarmed (convinced of reality and danger of anthropogenic climate change, strongly supported individual and political action), the Concerned, the Cautious, the Disengaged, the Doubtful, and the Dismissive (convinced climate change is not happening, and that *if* it were, it would be due to natural causes; strongly opposed any action). They found that the largest proportion of Americans was consistently in the Concerned group (see Figure 10). In spite of this, between 2008 and 2010 the proportion of Americans in the Doubtful and Dismissive groups increased, though the most recent survey in July 2010 (not depicted in Figure 10) found that they slightly decreased. Between 2008 and 2010 the proportion of Americans in the Alarmed and Concerned groups decreased, though they marginally increased in July 2010 (Leiserowitz & Smith, 2011). Although concern in July 2010 was still lower than in November 2008, the July 2010 results suggest perhaps a stabilising, or reversal, of the trend in declining concern, though further longitudinal research is needed to establish this. It would also be interesting to repeat

this study in other countries to compare the proportions of people in the different groups.

Figure 10: Proportion of US population in each of the six concern groups

(Leiserowitz, Roser-Renouf, et al., 2010, p. 9)

New Zealand public concern for climate change

The ShapeNZ (2010) environmental issues survey is an online survey nationally representative of 1,066 New Zealanders. This survey found that public attitudes towards climate change followed a similar trend to those in America, with a decline in the number of New Zealanders who believed that climate change ‘is a problem to be dealt with now or urgently’—dropping from 76 percent in 2008 to 65 percent in 2010. The number of New Zealanders who believe that climate change is ‘not a problem at all’ increased from 8 percent in 2007 and 9 percent in 2008, to 17 percent in 2010.

Similarly, the Nielsen and Oxford University (2009a) survey discussed earlier found that only 19 percent of New Zealand respondents were ‘very concerned’ about climate change. This was the fifth lowest concern level out of the 54 countries surveyed, equal with Russia.

A 2010 New Zealand telephone poll of 500 people, commissioned by the business lobby group Greenhouse Policy Coalition (made up of some of New Zealand’s largest greenhouse gas emitters), found that in 2009, 42 percent of respondents agreed that

climate change was a serious issue. In 2010 that percentage dropped to 36 percent. New Zealand climate change experts pointed out that the poll's questions were biased and leading (Radio New Zealand, 20 September 2010).

The Ministry of Research, Science and Technology (2010) surveyed 1,200 New Zealanders on their attitudes towards science and technology. This survey was a repeat of a survey done in 2002 and again in 2005. The survey found that the proportion of New Zealanders believing that climate change would benefit from research had decreased since 2002, although majorities still believed research into climate change would be 'quite beneficial' (30 percent) or 'very beneficial' (28 percent) (see Figure 11). Very few New Zealanders believed that research into climate change was 'not at all beneficial' (4 percent) or 'not very beneficial' (9 percent), although the proportion of people in these groups has increased since 2002 (MoRST, 2010).

People's beliefs of whether climate change would benefit from research do not necessarily correspond to their concern about climate change. It is likely that there is a correlation between belief in increased research and concern, although people who do not think that research would be beneficial could be concerned about climate change but think that the science is already robust and conclusive enough without further research. Or perhaps people who believe that climate change would benefit from further research believe this because they are unconvinced by anthropogenic climate change.

Figure 11: New Zealanders' changing beliefs in the benefits of research into climate change

(Graph created from data in MoRST, 2010)

Although the surveys described in this section are not directly comparable, they appear to show a general global trend that concern for climate change increased until 2007 or 2008, and then declined from 2008 to 2009 or 2010. The limited data available suggests that this trend applies for New Zealand public concern for climate change. The more recent international surveys reviewed suggest that this trend is stabilising or perhaps reversing since mid-2010, though longer-term research in a wide variety of countries is needed to confirm this.

Potential causes for decreasing concern could be information fading from the news about the 2007 IPCC report, ‘Climategate’ (discussed further in Section 2.2.2), and the effects of the global financial crisis in the late-2000s causing increased concern for the economy, but decreased concern for climate change. This thesis contributes to this research by examining New Zealand public concern for climate change at four separate time-points from June 2008 to October 2010.

Climate change as a personal and domestic risk

Research shows that people generally don’t think that they personally will be affected by climate change. People tend to see climate change as a temporally and geographically distant phenomenon and, when surveyed, rarely mention personal causes, consequences, or solutions (Bord et al., 2000; Lorenzoni & Pidgeon, 2006; Lorenzoni, Leiserowitz, Doria, Poortinga, & Pidgeon, 2006; Milfont, 2010; Whitmarsh, 2009). Psychologists refer to these biases as ‘environmental hyperopia’ (people tend to be more worried about environmental problems when they are further away, meaning they have higher concern for global environmental problems than local ones), and ‘optimism bias’ (a general tendency to believe that undesirable events are more likely to happen to other people, but less likely to happen to oneself) (Milfont, 2010; Uzzell, 2000).

Illustrating this, a 2004 BBC poll found that although 90 percent of respondents thought the United Kingdom would feel some impact (47 percent expecting ‘a lot’ of effects, and 43 percent ‘a little’), 43 percent said they did not expect climate change to have much effect on them personally, with 9 percent saying it would have no effect on them at all (Kirby, 2004). Similarly, Bord et al. (2000) found that American participants did

not perceive climate change to have significant personal impacts (50 percent believed climate change to be a societal risk, while only 23 percent believed it to be a personal risk). They also found that participants rated climate change much lower than other environmental risks such as hazardous chemicals (24 percent personal risk, 67 percent societal risk), air pollution (39 percent personal risk, 66 percent societal risk), and water pollution (34 percent personal risk, 63 percent societal risk). Leiserowitz's 2003 nationally representative survey of 673 Americans, also found that 68 percent were most concerned about the impacts of climate change on people around the world and on other animals or ecological systems—only 13 percent were most concerned about impacts on themselves, their family, or local community (Leiserowitz, 2006). Sampei and Aoyagi-Usui's (2009) nationally representative monthly survey of 2000 participants in Japan from July 2005 to September 2007, found that the public rated climate change more of a global risk than a domestic risk.

Leiserowitz (2006) noted that issues that the public had higher concern for—both environmental and non-environmental—were all issues with clearly understandable local effects or relevance. He found that 'most Americans lacked vivid, concrete, and personally relevant affective images of climate change, which helps explain why climate change remains a relatively low priority national or environmental issue' (p. 55).

Lorenzoni et al. (2006) reviewed studies of public risk perceptions of climate change in the United Kingdom and United States, and found that both publics had similar perceptions—they considered climate change 'a distant threat, of limited personal importance' (p. 265). Similarly, Whitmarsh (2008) found that the British public did not consider climate change a direct, personal threat.

Contrastingly, Agho, Stevens, Taylor, Barr, and Raphael (2010) found in their 2007 nationally representative telephone survey of 2004 Australians that 56.3 percent were 'extremely concerned' that they or their family would experience negative consequences of climate change.

The high personal concern exhibited by the Australian public in Agho et al.'s study could be because the study was conducted in 2007, the year the latest IPCC report was released, which meant climate change would have been in the news and presumably

Australian media would have drawn public attention to the report's projected climate change consequences for Australia by 2020–2030 (Pachauri & Reisinger, 2007), or it could be that Australians generally have higher concern for climate change than the American or British public (this appears to be confirmed by HSBC's survey, see Figure 8). Australia also experiences droughts, floods, and bush fires, which could lead the public to be more concerned about these increasing due to climate change.

Together, these findings provide support for environmental hyperopia and optimism bias operating on public concern for climate change.

Climate change as a priority

Researchers have also found that participants did not consider climate change to be an urgent priority, often ranking it low on lists of public concerns and even low on lists of environmental concerns (Jones, 2011b; Kirby, 2004; Leiserowitz, 2006; Lorenzoni & Pidgeon, 2006; MoRST, 2010; Radio New Zealand, 2010; Saad, 2011; Whitmarsh, 2008).

Illustrating this, the BBC's 2004 poll asked participants to choose the most important issues facing the United Kingdom. Respondents chose: health (88 percent), crime (88 percent), education (86 percent), terrorism (73 percent), poverty (71 percent), immigration (68 percent), and climate change (53 percent) (Kirby, 2004). Similarly, Lorenzoni and Pidgeon's (2006) review of European and American climate change surveys found that although people were generally concerned about climate change, they were more concerned about other issues in their daily lives, such as health, safety, family, and finances. Whitmarsh (2008) also found that the British public did not consider climate change a priority concern. Sampei and Aoyagi-Usui (2009) found similar results in Japan. When asked to cite the most serious issue in Japan, participants (nationally representative of the Japanese public) did not rank climate change highly, placing it below 'pension', 'falling birthrate and aging population', and 'economy'.

Similarly, in New Zealand, The Greenhouse Policy Coalition's 2010 poll (the business lobby group described earlier) found that participants ranked climate change last out of a list of 10 issues facing people in New Zealand (Radio New Zealand, 2010). A more reputable source, the Ministry of Research, Science and Technology (2010) found that,

overall, of the nine scientific and technological issues listed, respondents thought that climate change and space research would benefit least from research.

The 2011 Gallup poll, in the United States, found ‘the widest margin in 30 years in Americans’ prioritizing economic growth (54%) over environmental protection (36%)’ (Jones, 2011b, p. 1). When Gallup first asked the question in 1984, 61 percent prioritised environmental protection and 28 percent prioritised economic growth. This gap has gradually decreased, narrowing dramatically in the 2000s, and then economic growth climbed above environmental protection between 2008 and 2009.

Research has also found that even when asked to rank environmental problems, climate change was still not prioritised. Böhm & Pfister (2001) found that, when asked to identify global environmental risks from a list of 16 options, only 15.3 percent of German respondents selected climate change, behind air pollution (selected by 40 percent of respondents), ozone depletion (32.7 percent), nuclear power (25.9 percent), deforestation by pollution (23.5 percent), and water pollution (15.6 percent). In Lorenzoni and Pidgeon’s (2006) review of studies examining European and American climate change perceptions, they found that in 2004, climate change was the third environmental issue that members of the European Union were most concerned about (cited, with air pollution, by 45 percent of respondents), following water pollution (47 percent) and ‘human-caused disasters’ (46 percent). It is interesting that climate change was considered separately to the category ‘human-caused disasters’.

Gallup’s 2011 poll found that respondents said they worried least about climate change out of a list of nine environmental problems (toxic waste contamination and water pollution ranked jointly first). This is the same finding as in the 2001 poll, where climate change ranked last out of eight environmental problems (and pollution of drinking water ranked first), although in 2001 63 percent worried ‘a great deal / fair amount’ about climate change, while in 2010 this had dropped to 51 percent (Saad, 2011).

Collectively, the studies described show that the public does not consider climate change a personal threat or a priority concern. However, these studies were from more economically developed, mostly Western countries, with large per-capita greenhouse gas emissions (the United States, the United Kingdom, Japan, and New Zealand). It would be interesting to see more surveys done in countries that are more vulnerable, and less able to adapt, to climate change. It would also be interesting to see studies linking concern levels with perceived vulnerability to climate change.

2.2.2 Variables (besides knowledge) affecting concern

The rest of this chapter looks briefly at variables other than knowledge that previous research has found to varyingly affect concern for climate change. Study 1 and Study 2 include most of the variables discussed below, to examine their effect on concern for climate change alongside knowledge levels.

Demographic variables

The effects of demographic variables on concern for climate change vary, depending on the study. Increasingly, perceived efficacy, environmental values, worldviews, and political ideology are shown to be better predictors of concern for climate change than demographic variables. As a corollary, the explanatory power of demographic variables is often modest in models measuring climate change perceptions (Kellstedt et al., 2008; Whitmarsh, 2011). For example, Leiserowitz, Roser-Renouf et al. (2010) found that their six groups of differing levels of concern for climate change did not differ much demographically—the differences lay in their personal values, beliefs, and political orientations.

Age

Research (Kellstedt et al., 2008; Xiao & McCright, 2007) tends to find that age is negatively correlated with concern for environmental problems such as climate change, with younger people showing higher levels of concern. Heath and Gifford (2006) found that older participants were more likely to believe in natural causes of climate change and in non-negative consequences. They found that older participants were more apathetic about environmental issues in general. However, O'Connor, Bord, and Fisher (1999) found that while younger (American) participants had higher intent to take

voluntary actions to mitigate climate change, older participants were more likely to vote for policies imposing social sacrifices to address climate change.

The Nielsen Company and Oxford University Environmental Change Institute survey found that, of the North American participants, those aged 55–59 years and 30–34 years were the most concerned about climate change (Nielsen, 2009b). It found that 39 percent of North American participants aged 55–59 were ‘very concerned’ about climate change, compared to 21 percent of North American participants under 20 who were ‘very concerned’.

Studies 1 and 2 of this thesis include measures of age to contribute to this research.

Gender

Research generally shows that women are more concerned about environmental problems such as climate change than men are (Brody, Zahran, Vedlitz, & Grover, 2008; Davidson & Freudenburg, 1996; Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000; Flynn, Slovic, & Mertz, 1994; Leiserowitz, 2006; McCright, 2010; Mobley, Vagias, & DeWard, 2010; P. Stern, Dietz, & Kalof, 1993; Xiao & McCright, 2007) and that belief in climate change is lower in men than women (Joireman et al., 2010).

Flynn, Slovic, and Mertz (1994) surveyed 1,275 white Americans and 214 non-white Americans in their nationally representative survey of environmental health risks. They found what has come to be known as the ‘white male effect’, concluding that ‘white males tended to differ from everyone else in their attitudes and perceptions—on average, they perceived risks as much smaller and much more acceptable than did other people’ (p. 1101).

O’Connor, Bord, and Fisher (1999) found that female participants expressed higher intent to take voluntary actions to mitigate climate change than men. Even when the researchers controlled for risk perception and environmental beliefs, they found that ‘male environmentalists are less likely than female environmentalists to take voluntary actions for mitigate [sic] climate change’ (p. 467). They also found that, if they controlled for general beliefs towards government and the environment, men (and older, better educated voters) were more likely to vote for policies imposing public sacrifices to address climate change than women (and younger voters) (O’Connor et al., 1999). This could perhaps reflect differing access to income.

In his analysis of the 2001–2008 environmental Gallup polls, McCright (2010) found that women had greater knowledge of climate change than men, although women underestimated their knowledge more than men did.

In their survey of 621 Swedes, Sundblad et al. (2007) found that female respondents were more worried about climate change than male respondents, although both female and male participants had similar perceptions of the likelihood of serious negative consequences of climate change.

Collectively these studies show that women tend to have higher concern for climate change and other environmental risks than men do. Studies 1 and 2 of this thesis both analyse the relationship between gender and concern to contribute to this research.

Ethnicity

Studies have also found that ethnic minorities (within America) tended to perceive climate change as a greater risk, and that white American participants had lower belief in climate change (Joireman et al., 2010; Leiserowitz, 2006). Illustrating this, Leiserowitz and Ackerlof (2010) found that Hispanics, African Americans, and people of other races often showed the highest levels of support for hypothetical climate change policies, even when the policies imposed greater costs on the public. White Americans showed the lowest levels of concern for climate change.

Study 1 of this thesis includes a measure of ethnicity to contribute to this research.

Education

Research shows that people with higher education levels not only know more about climate change, but are also more concerned about climate change and more likely to support research into climate change and government policies to address it than the less educated (Bord et al., 2000; Kahlor & Rosenthal, 2009; MoRST, 2010; Mobley et al., 2010; O'Connor et al., 1999; Xiao & McCright, 2007). Whitmarsh (2011) found that participants with high education levels were less likely to be sceptical or uncertain about climate change. Studies 1 and 2 of this thesis include measures of education to contribute to previous research.

Geographic location

Research shows that although people from less economically developed countries often have lower general environmental concern than people from more economically developed countries (Mohai & Bryant, 1998), they have higher levels of concern for climate change (HSBC Climate Partnership, 2009; Kellsted et al., 2008; Nielsen, 2009a; The World Bank, 2009). This perhaps reflects that these countries will be disproportionately affected by climate change.

People living in cities and people geographically vulnerable to climate change have been found to display higher levels of concern than those living in rural areas and in less vulnerable regions (Brody, Zahran, Vedlitz, et al., 2008; MoRST, 2010).

The Ministry of Research, Science and Technology's 2010 survey discussed earlier found that 62 percent of respondents from major New Zealand cities believed that 'research into climate change' was beneficial, compared to a lower New Zealand-wide proportion of 58 percent (MoRST, 2010), reinforcing findings that people living in cities are more concerned about climate change than those living in rural areas.

Brody, Zahran, Vedlitz, and Grover (2008) investigated the relationship between physical vulnerability and public perceptions of global climate change in the United States via 1,093 geocoded telephone interviews. They found that respondents who lived on higher ground or further away from coasts were significantly less concerned about the risks of climate change than those living closer to coasts or on lower ground. Brody et al. note that most Americans associate climate change with rising sea levels, which may explain this risk perception. However, Lorenzoni and Pidgeon (2006) report an unpublished qualitative study by Bickerstaff, Simmons, and Pidgeon (2004) that found that even participants living in areas vulnerable to climate change 'had difficulties relating the impacts of climate change (which many were aware of) to their local area or day-to-day life' (p. 81). Similarly, Whitmarsh (2008) found that flood victims in southern England did not have higher concern for climate change than non-flood victims.

Values and worldviews

People's worldviews and underlying values are increasingly being seen as some of the most powerful predictors of concern for climate change (Crompton, 2010; Kahan et al., 2010; Leiserowitz, 2005, 2006; Whitmarsh, 2011). Leiserowitz (2006) describes worldviews as representing different rationalities, or sets of 'pre-suppositions about the ideal nature of society', which leads people with different worldviews to identify and interpret risks in different ways, and to prefer different policy responses (p. 49).

Kahan, Braman, and Jenkins-Smith's 2009 survey of 1,500 Americans found that participants formed opinions about climate change that were inconsistent with the scientific consensus because they 'systemically overestimate the degree of scientific support for positions they are culturally predisposed to accept' (2010, p. 25). Kahan et al. proposed that people's identification with hierarchical and individualist worldviews versus egalitarian and communitarian worldviews leads them to fit their perceptions of scientific consensus (as well as how they search for, interpret, and recall information) with their pre-existing values—polarising extreme opinions even further.

Leiserowitz (2006) found that values were the strongest predictor of participants' preferences for climate change policies—stronger than political ideology or political party support. He found that 'support for national and international climate policies was strongly associated with pro-egalitarian values, while opposition was associated with anti-egalitarian, pro-individualist and pro-hierarchist values' (p. 63).

Similarly, Whitmarsh (2011) found that 'beliefs about climate change are fundamentally linked to existing values and worldviews' (p. 8). She also found that worldviews and values (for example, economic development versus environmental protection) affected participants' perceptions of the meaning and credibility of climate change information, and the trustworthiness of the people presenting it.

Environmental attitudes and values

Environmental attitudes and values are some of the biggest predictors of concern for (as well as belief in) climate change (Bord et al., 2000; Brody, Zahran, Vedlitz, et al., 2008; Heath & Gifford, 2006; Joireman et al., 2010; Kellstedt et al., 2008; Nilsson, von Borgstede, & Biel, 2004; O'Connor et al., 1999; Whitmarsh, 2011).

O'Connor et al. (1999) found that stronger general environmental beliefs were significantly related to higher willingness to take both voluntary and voting actions to address climate change. Bord et al. (2000) found that participants with high environmental values were much more likely to believe in climate change, but did not have higher intentions to engage in specific climate-friendly behaviours. Bord et al. concluded that behavioural intentions require accurate knowledge of the specific causes of climate change (Bord et al., 2000).

Heath and Gifford (2006) examined the relationships between three environmental attitudes (ecocentric—belief in intrinsic value of nature, anthropocentric—belief in instrumental value of nature for humans, and environmentally apathetic) with four variables (beliefs in causes and consequences of climate change, behavioural intentions, self-efficacy, and free-market ideology). They found that ecocentrism was positively correlated with the first three variables, but negatively correlated with support for free-market ideology. They did not find any significant correlations for anthropocentrism. They found that environmental apathy was most strongly negatively correlated with beliefs about causes and consequences of climate change and intention to act. They proposed that ‘environmental apathy may be the most fruitful [negative] predictor of global climate change beliefs and related behavioral intentions’ (p. 63).

Brody et al. (2008) found that environmental values had a strong positive effect on participants’ climate change risk perceptions, with respondents with higher environmental values being significantly more concerned about climate change. Similarly, Kellstedt et al. (2008) found that participants with high environmental values were significantly more concerned for climate change and felt significantly more responsible for, and able to address, climate change. Whitmarsh’s research (2011) also reinforced these findings, as she found that environmental values (and with political ideology) had ‘by far’ the strongest correlations with scepticism and uncertainty about climate change (participants with low environmental values tended to be the most sceptical about the reality and severity of climate change).

Study 1 measures environmental values using the new ecological paradigm (described in more detail in Section 4.3.3).

Political ideology

Research generally finds that people who identify themselves as politically conservative are less concerned about environmental risks (Mobley et al., 2010; Xiao & McCright, 2007). Research specifically focused on climate change also finds similarly that people who identify as politically conservative are less concerned about the risks of climate change and are less likely to accept that climate change is happening than people who identify themselves as politically liberal (Leiserowitz, 2006; Leiserowitz, Roser-Renouf, et al., 2010; Malka et al., 2009; Whitmarsh, 2011).

Heath and Gifford (2006) found that support for free-market ideology was significantly positively correlated with beliefs that climate change is not occurring, that it is not caused by humans, that it will have positive consequences, and with lower behavioural intentions to address it.

Leiserowitz, Roser-Renouf, et al. (2010) found that, out of the six groups illustrating the scale of concern for climate change in America, participants belonging to the Doubtful and the Dismissive groups were much more likely to be politically conservative or Republican, while members of the Alarmed and Concerned groups were much more likely to be politically liberal or Democrats. Participants in the Dismissive group were the most likely to be part of the Tea Party movement (40 percent), followed by the Doubtful (23 percent). The other groups had few Tea Party members.

Whitmarsh (2011) found that political ideology (along with environmental values) was by far the biggest predictor of scepticism and uncertainty about climate change. Participants with rightwing political views were generally the most sceptical about the reality and severity of climate change.

As Figure 12 shows, Gallup's March 2011 poll found large differences between Democrats' and Republicans' climate change perceptions. Democrats had much higher beliefs in, and concern for, climate change than Republicans.

Collectively, the studies described point to a strong difference in the way politically liberal and politically conservative participants respond to climate change information, suggesting that climate change perceptions are highly politicised. Contributing to this research, Studies 1 and 2 of this thesis examine political party support and Study 1 also examines political ideology.

Figure 12: Concern for climate change by American political parties

(Graph created from data in Jones, 2011a)

Trust in experts

Research tends to find that the public trusts scientists more than other sources of information about climate change (Leiserowitz et al., 2010c; Nielsen, 2009a; Whitmarsh, 2009).

Importance of trust

The Ministry of Research, Science and Technology's (2010) science and technology survey identified a group of New Zealanders termed 'the Disengaged', who had less trust in scientists than other New Zealanders, and the lowest beliefs in the benefits of science and technology. Forty-eight percent of the Disengaged did not support the government funding of science 'unless we can be sure of its economic benefits' (p. 35), compared to 19 percent of the rest of the participants. The report found that the Disengaged did not differ much from each other demographically but were unlikely to have any science education.

Similarly, trust in climate change experts is an important factor for belief in climate change. Krosnick (2010) found that American participants who distrusted scientists were more likely to form conclusions on climate change by observing nature and the

weather—cold weather or colder average temperatures led them to conclude that climate change was not happening. Participants who trusted scientists discounted fluctuating weather and temperatures when forming their opinions about climate change. Krosnick found that the recent decline in participants who believed in climate change (84 percent in 2007, to 74 percent in 2010) was due to an increase in the number of participants who distrusted scientists.

Similarly, Leiserowitz and Smith (2011) found that members of the Alarmed and Concerned groups of American participants trusted scientists more than any other information source, while members of the Doubtful and Dismissive groups were most likely to trust their own friends and family as sources of climate change information.

Kahan et al. (2010) found that participants responded to expert opinion according to how the experts fitted with their cultural worldview. Hierarchical individualists responded more positively to an older, clean-shaven man in a suit than to a bearded man in a denim shirt—while the opposite was found for egalitarian-communitarians. By presenting climate change information that people may be culturally disposed to oppose via an expert they are culturally primed to trust, cultural cognition effects could be reversed, resulting in less-biased interpretations of climate change information (Kahan et al., 2010).

This research identifies the importance of trust in determining public beliefs and perceptions of science and climate change, as well as potentially allowing the strong effects of values and worldviews to be overcome. Study 1 of this thesis also examines the relationship between concern for climate change and trust in experts to contribute to this research.

‘Climategate’ and IPCC errors

Two events that have been seen to increase public scepticism about climate change and lower trust in scientists were the highly publicised IPCC errors and so-called ‘Climategate’. The IPCC’s 2007 Working Group II report included an unsupported projection that the Himalayan glaciers could disappear by the year 2035 (Bagla, 2010). IPCC leader Rajendra Pachauri admitted that the error would not have occurred if the IPCC had strictly followed its own procedures (Bagla, 2010). However, an open letter signed by hundreds of climate scientists in support of IPCC’s Fourth Assessment Report

states, ‘none of the handful of mis-statements (out of hundreds and hundreds of unchallenged statements) remotely undermines the conclusion that “warming of the climate system is unequivocal” and that most of the observed increase in global average temperatures since the mid-twentieth century is very likely due to observed increase in anthropogenic greenhouse gas concentrations’ (Yohe, Schneider, Rosenzweig, & Easterling, n.d.).

In November 2009, hackers made public about 1,000 emails from the Climatic Research Unit of the University of East Anglia, England. The hackers presented the emails as evidence undermining climate change data and showing scientists supposedly conspiring to silence those scientists who did not support the scientific consensus on climate change (Krosnick, 2010; Muir, Boulton, Clarke, Eyton, & Norton, 2010). Three separate independent reviews subsequently exonerated the East-Anglia climate scientists, with the final report concluding ‘we find their rigour and honesty as scientists are not in doubt... In particular we did not find any evidence that might undermine the conclusions of the IPCC assessments’ (Muir et al., 2010, p. 11).

There has been a lot of speculation about the effect of the errors and the hacked emails on people’s climate change perceptions and trust in scientists, particularly as the media coverage of the initial scandals was much more comprehensive than its coverage of the exoneration of the East Anglia climate scientists. Figure 13 illustrates New Zealand media coverage of pre and post-exonerating enquiries on ‘Climategate’. As Figure 13 shows, all the media organisations analysed had much less coverage of ‘Climategate’ once the scientists were exonerated, except for Stuff.co.nz. Stuff.co.nz and Radio New Zealand had the lowest coverage of either event (Griffin, 2010).

Several American studies specifically investigated the effect of these highly publicised events on public perceptions of climate change. Krosnick (2010) found no overall decline in American respondents’ trust in environmental scientists (average trust in scientists was 68 percent in 2008, 70 percent in 2009, and 71 percent in 2010). He found that only 9 percent of respondents had heard about the hacked emails and believed it meant they couldn’t trust scientists, and only 13 percent had heard about the IPCC errors and believed it meant they couldn’t trust scientists (Krosnick, 2010).

Leiserowitz, Roser-Renouf et al. (2010) found that these events influenced the perceptions of American participants who were already sceptical of climate change and already distrusted scientists—primarily individuals with strong individualistic worldviews or those who were politically conservative. Of the six groups they identified with differing levels of concern for climate change, the Dismissive and the Alarmed were most likely to have heard about and followed the news about the hacked emails and the errors in the IPCC reports. These stories made the Dismissive and the Doubtful groups less trustful of scientists and more convinced that climate change is not happening. The stories did not affect the Alarmed groups' views on climate change or trust in climate scientists.

These findings again illustrate the importance of trust in forming climate change perceptions. 'Climategate' took place between Study 1 and Study 2 of this thesis, perhaps suggesting that there will be a decline in public trust in scientists.

Figure 13: Keith Ng's graph showing New Zealand media coverage of 'Climategate'
Pre-exonerating enquiries (blue) and post-exonerating enquiries (red)

(Griffin, 2010, <http://sciblogs.co.nz/griffins-gadgets/2010/08/21/how-the-media-lost-interest-in-climategate/>)

Perceived efficacy

Perceived efficacy (also referred to as ‘agency’, ‘self-efficacy’, ‘personal efficacy’, and ‘perceived behavioural control’) is one of the most important predictors of pro-environmental behaviour (Brody, Zahran, Vedlitz, et al., 2008; Eden, 1993; Heath & Gifford, 2006; Howell, 2011; Kellstedt et al., 2008; Kerr, 1989; Kerr & Kaufman-Gilliland, 1997).

Perceived efficacy is a person’s perception that their behaviour will have a significant effect on the outcome of a large group (Heath & Gifford, 2006; Kerr, 1989). When people do not perceive their behaviour to have much impact on a collective outcome, they are less likely to engage in that behaviour (Kerr & Kaufman-Gilliland, 1997). A perceived lack of efficacy in social dilemmas essentially leads to Hardin’s ‘tragedy of the commons’, where people ‘rationally’ pursue their own self-interest at the expense of the collective interest of the group (Kerr & Kaufman-Gilliland, 1997).

Kerr (1989) showed that group members facing social dilemmas believed that self-efficacy declined as group size increased—even when experiments were designed to ensure that this was not the case, and even when experiments were designed so that the opposite was true. This is a particular concern for climate change, given the global nature of the problem (group size = 6.8 billion!).

Unsurprisingly, studies show that high levels of perceived efficacy are some of the strongest predictors of concern for climate change (Brody, Zahran, Vedlitz, et al., 2008; Heath & Gifford, 2006; Kellstedt et al., 2008). Brody et al. (2008) found that respondents with high levels of efficacy and responsibility to mitigate climate change were more concerned about the risks of climate change. Kellstedt et al. (2008) found that high perceived efficacy was the biggest predictor of concern for climate change. Heath and Gifford (2006) found that perceived efficacy was the biggest predictor of participants’ intentions to take actions to mitigate climate change, concluding, ‘it appears that before individuals are ready to act against climate change, they must believe that even a small thing one individual can do will make a meaningful difference’ (p. 64).

In Aitken, Chapman, and McClure’s (in press) survey of 192 New Zealanders, they found that participants who scored highly on powerlessness (‘the feeling that climate

change is too big for my actions to have an impact’) and the commons dilemma (‘feeling that other individuals will not change their actions even if I do’) were less likely to have taken action to mitigate climate change (p. 6). They also found that participants’ perceptions of the commons dilemma and their perceptions of the risks of climate change (concern for climate change) were more effective at motivating action on climate change than perceived knowledge levels. These concepts of powerlessness and the commons dilemma can be seen to represent the opposite of perceived efficacy, and reinforce findings that low perceived efficacy will lead to low concern for, and behavioural intentions to mitigate, climate change.

Studies 1 and 2 of this thesis examine the relationship between perceived efficacy and concern for climate change to build on this research.

2.3 Summary of research and gaps identified

The first half of this review showed that the public has low knowledge of climate change—underestimating the strength of the scientific consensus, overestimating natural causes, underestimating human causes, and confusing causes of climate change with other environmental problems like stratospheric ozone depletion. The second half of this review showed that public concern for climate change is generally high, but varies between countries and individuals, and appears to have decreased overall since 2008. The public generally doesn’t consider climate change to be a priority concern or personal threat.

The inconsistency between the increasing scientific consensus and the low levels of public knowledge and decreasing concern suggest it is unlikely that the knowledge-deficit theory applies to concern for climate change. Further longitudinal research from a wide variety of countries into concern and knowledge levels is required, as is research into the comparative effects of worldviews and values, demographics, and political ideology on concern for climate change.

Few existing studies of climate change perceptions include measures of knowledge. As described in Chapter 1, those that do include these measures do not produce conclusive findings on the relationship between knowledge of climate change and concern, though hint at differences between perceived and actual measures of knowledge. This thesis

seeks to contribute to the growing body of research on this subject. Next, Chapter 3 describes the methodology and research questions for this thesis.

3 Methodology

3.1 Research questions

The following two main research questions and sub-questions address some of the research gaps identified in the literature review and the aim of this thesis: To determine whether the knowledge-deficit theory applies to concern for climate change.

1. *Does perceived knowledge of climate change predict concern?*
2. *Does actual knowledge of climate change predict concern?*
 - What are the comparative climate change knowledge levels of groups of New Zealanders?
 - Which knowledge types (state, causes, consequences, types of consequences) are best and least understood?
3. Do other variables affect concern more than knowledge of climate change?

3.2 Research design

The best way to address these research questions and to meet the research objectives is by conducting and comparing two quantitative survey-based studies, one examining perceived knowledge of climate change and the other measuring actual knowledge of climate change. Two previous studies were selected and adapted for New Zealand participants.

3.2.1 Study 1: Perceived knowledge and concern for climate change

The first study is based on Kellstedt, Zahran, and Vedlitz's study (2008) that examined American participants' perceived knowledge and concern for climate change. Study 1 uses existing data from the 2008 New Zealand Social Attitudes Survey, analysed following Kellstedt et al.'s method. Multiple regression analysis was performed to examine the effects of various demographic, information, and identity variables on participants' levels of concern for climate change (see Section 4.3 for detailed methodology of Study 1).

3.2.2 Study 2: Actual knowledge and concern for climate change

The second study is based on Sundblad, Biel, and Gärling's study (2009) that examined Swedish participants' actual knowledge of climate change (See Section 5.3 for detailed methodology of Study 2). An online survey of groups of New Zealanders' actual knowledge of climate change was conducted, and data was analysed following Sundblad et al.'s method. Analysis of variance was performed to compare participants' knowledge of the state, causes, and consequences of climate change, as well as their confidence in this knowledge. Knowledge was adjusted by confidence to provide more accurate knowledge scores.

Kellstedt et al.'s multiple regression analysis was then performed, this time using a measure of actual knowledge, to examine whether this would provide different results to the measure of perceived knowledge used in Study 1.

4 Study 1: Perceived knowledge and concern for climate change

As Chapters 1 and 2 have shown, previous research into the effect of perceived knowledge on concern for climate change is inconclusive and studies produce contradictory results (Aitken et al., in press; Heath & Gifford, 2006; Kellstedt et al., 2008; Malka et al., 2009; Whitmarsh, 2011). If the knowledge-deficit theory applies, perceived knowledge of climate change will be positively correlated with concern for climate change. Previous research has found that perceived knowledge positively predicted beliefs in negative effects of climate change (Aitken et al., in press; Heath & Gifford, 2006; Malka et al., 2009), and, contrastingly, that there was no significant relationship between perceived knowledge of climate change and scepticism or uncertainty about climate change (Whitmarsh, 2011).

4.1 Kellstedt, Zahran, and Vedlitz (2008)

Kellstedt et al. conducted a telephone survey of 1,093 randomly selected American participants from July to August 2004 to examine the effects of perceived knowledge of climate change, as well as various demographic and identity variables, on participants' levels of concern for climate change. Their main findings are described below.

1. Participants with higher perceived knowledge of climate change were less concerned about the risks of climate change and felt less responsible for, and less able to address, climate change than participants with lower perceived knowledge.
2. Participants with higher confidence in scientists were also less concerned about the risks of climate change and felt less responsible for, and able to address, climate change than participants with lower confidence in scientists (Kellstedt et al., 2008).
3. Perceived efficacy and environmental values were the best predictors of concern for climate change.

The first two findings appear counter-intuitive and led Kellstedt et al. to reject the knowledge-deficit theory for concern for climate change, and conclude that it is an inadequate model for 'understanding mass attitudes about scientific controversies' (2008, p. 123). Study 1 of this thesis replicates Kellstedt et al.'s study in a New Zealand

context. It expands on their study by using a longitudinal design with three time-points over a 12-month period.

4.2 Study 1 predictions

The aim of Study 1 is to determine whether the knowledge-deficit theory applies to concern for climate change, using a measure of perceived knowledge of climate change. To address the relevance of the knowledge-deficit theory, the following main prediction will be tested.

1. *There will not be a significant¹ relationship between perceived knowledge of climate change and concern for climate change.*

Contrary to Kellstedt et al.'s finding that high perceived knowledge was negatively correlated with concern for climate change, it is predicted that there will not be a meaningful relationship between perceived knowledge and concern. This in line with previous research (Aitken et al., in press; Heath & Gifford, 2006; Malka et al., 2009), and others finding it does not (Kellstedt et al., 2008; Whitmarsh, 2011) and the overall research prediction that actual knowledge will predict concern but not perceived knowledge.

A number of sub-predictions will also be tested.

2. Participants with high perceived efficacy will have high concern for climate change.
3. Participants with strong environmental values will have high concern for climate change.
4. Female and younger participants will have high concern for climate change.
5. Participants with high confidence in science and trust in experts will have high concern for climate change.

¹ When discussing results, relationships between variables are referred to as 'significant' or 'non-significant'. Statistical significance describes the probability that a result would have come about by chance. It is described as a value between 0 and 1, labeled ' p '. The following significance levels are commonly used in academic research:

- $p < 0.001$, meaning there is a 0.1 percent chance of getting the results by chance
- $p < 0.01$, meaning there is a 1 percent chance of getting the results by chance
- $p < 0.05$, meaning there is a 5 percent chance of getting the results by chance.
-

That is, it is expected that environmental values and perceived efficacy will be better predictors of concern than perceived knowledge level (Bord et al., 2000; Brody, Zahran, Vedlitz, et al., 2008; Heath & Gifford, 2006; Kellstedt et al., 2008; Nilsson et al., 2004; O'Connor et al., 1999; Whitmarsh, 2011), and that female and younger participants will display higher concern than older and male participants (Brody, Zahran, Vedlitz, et al., 2008; McCright, 2010). The effects of these demographic variables are expected to be weaker than the effects of environmental values and perceived efficacy (Kellstedt et al., 2008; Whitmarsh, 2011).

In contrast to Kellstedt et al., and in line with other research (Krosnick, 2010; Leiserowitz & Smith, 2011), it is expected that participants with high trust in experts or confidence in science will have high concern for climate change.

4.3 Study 1 method

Study 1 uses data collected by Dr Taciano Milfont as part of his 2008 New Zealand Social Attitudes Survey (Milfont, 2008). The Social Attitudes Survey incorporated Kellstedt et al.'s survey questions, enabling close replication of their analysis but with this New Zealand data.

4.3.1 Procedure

Participants completed the Social Attitudes Survey at three time-points over a 12-month period (June 2008–June 2009).

Collecting data

Time 1: June 2008

On 9 June 2008, Time 1 of the Social Attitudes Survey was posted to 2,995 people randomly selected from the New Zealand electoral roll. Each person also received a consent form; a freepost return envelope; a cover letter that explained the Social Attitudes Survey and that invited the person to participate; and, to encourage participation, an entry form for a draw to win \$500 worth of grocery vouchers. The cut-off date for participants to return completed surveys was 9 August 2008.

Time 2: November 2008

On 10 November 2008 (the first business day following the 2008 New Zealand general election), Time 2 of the Social Attitudes Survey was posted with a freepost return envelope, a covering letter, and an entry form for a draw to win \$50 worth of grocery vouchers to participants from Time 1 who had agreed to participate in Time 2. The cut-off date for participants to return completed surveys was 10 January 2009.

Time 3: June 2009

On 5 June 2009, Time 3 of the Social Attitudes Survey was posted with a freepost return envelope, a cover letter, and an entry form for a draw to win \$100 worth of grocery vouchers to the participants from Time 2 who had agreed to participate in Time 3. The cut-off date for participants to return completed surveys was 5 August 2009.

Analysing data

Regression analysis

Three linear multiple regression analyses in SPSS (a statistical analysis program) were performed for each survey time, and the results compared to Kellstedt et al.'s results.

Baseline models

The first multiple regression analysed concern for climate change against a set of independent variables (ethnicity, gender, education, income, age, religious service attendance, political party support, political ideology, and environmental values) for each time-point. This provided a baseline model of concern for climate change.

Expanded models

The second regression analysed concern for climate change against an expanded set of independent variables (adding perceived knowledge level, perceived efficacy, media trust, trust in experts, and confidence in scientists) for each time-point. This provided an expanded model of concern for climate change.

Perceived efficacy models

The final regression analysed the perceived efficacy variable against the expanded set of independent variables for each time-point.

Reliability analysis

Some of the variables used in this study are index variables. Index variables comprise a group of related variables. For example, the variable measuring ‘environmental values’ comprised 15 statements representing different aspects of the human-environment relationship, measured by the new environmental paradigm (NEP) scale (Dunlap, Liere, Mertig, & Jones, 2000). Reliability analysis measures and tests how internally consistent these 15 statements are at measuring the same underlying attribute (‘environmental values’). The Cronbach’s alpha statistic is the most commonly used measure of internal reliability. A general rule of thumb is that Cronbach’s alpha must be greater than 0.70 for a variable to be reliable (Pallant, 2010).

Other statistics reported are eigenvalue statistics and factor loadings. Eigenvalues indicate the amount of total variance explained by a variable; and factor loadings are the correlation coefficients.

4.3.2 Participants

To ensure a nationally representative sample, the participants for Study 1 were randomly selected from the 2007 New Zealand electoral roll, using a Microsoft Excel random number generator. The selected households were split across the 69 New Zealand electorates, with sample sizes proportional to electorate size (Blackwell, 2009). Three thousand households were selected, resulting in an initial sample of 2,995, as five addresses turned out to be invalid. The final number of participants to complete and return all three surveys was 269 (see Table 1).

Table 1: Number of participants who completed the survey at each time-point

Participants	Time 1 June 2008	Time 2 November 2008	Time 3 June 2009
Total number of participants who responded to survey	581	377	355
Number of participants providing data for this thesis (who completed the survey at all three time-points)	269	269	269

This section describes the characteristics of the Study 1 participants, comparing them to the general New Zealand population, as measured in the 2006 census (the most recent census at the time of writing).

Sample characteristics

Ethnicity

It is difficult to compare participants' ethnicity with the general New Zealand population, because the Social Attitudes Survey and the 2006 census used different ethnicity classifications. Table 2 provides the main comparisons, showing that Pākehā were over-represented while New Zealanders of Māori, Pacific Island and Asian descent were under-represented (Statistics New Zealand, 2006a).

Table 2: Ethnicity distribution for Time 1, compared to national data

Ethnicity	Time 1 (%)	2006 census data (%)
Pākehā	86.2	64.8 ('European')
Other	11.8	11.6
Māori	2.2	14.0
Pacific Peoples	1.5	6.6
Asian	1.5	8.8

Gender

Female participants were over-represented at all three time-points (Statistics New Zealand, 2006a). The ratio of female to male participants varied marginally at each time-point because some participants did not indicate their gender at each time-point of the survey (see Table 3).

Table 3: Gender distribution over the three time-points, compared to national data

Gender	Time 1 (%)	Time 2 (%)	Time 3 (%)	2006 census data (%)
Female	66.5	66.2	66.7 (N = 267)	51.2
Male	33.5	33.8	33.3 (N = 267)	48.8

Age

Participants' ages ranged from 18 to 89 years and the median age increased consistently from Time 1 to Time 3 (see Table 4), as expected given the 12-month survey period. The participants' median age was much higher at all three time-points (54, 55, 56 years) than the national median age of 35.9 years. This is because the survey was only sent to participants aged 18 or older, while the census records data on people of all ages (Statistics New Zealand, 2006b).

Table 4: Age distribution over the three time-points

Age	Time 1 (years) (N = 268)	Time 2 (years) (N = 268)	Time 3 (years) (N = 268)
Mean	54.2	54.6	55.2
Standard deviation	15.9	15.9	15.9
Median	54.0	55.0	56.0
Range	18–89	18–89	19–89

Education

Participants without a high school education and participants with NCEA / school certificate as their highest level of qualification were under-represented. Participants with polytechnic and university qualifications were over-represented (see Table 5).

Table 5: Education levels for Time 1, compared to national data

Education level	Time 1 (%)	2006 census data (%)
Less than high school	19.3	22.4 (‘No qualification’)
NCEA / school certificate	24.6	35.5 (‘Levels 1, 2, & 3 certificate’ and ‘overseas secondary school qualification’)
Polytechnic	21.2	17.6 (‘Level 4 certificate’ and ‘levels 5 & 6 diploma’)
Undergraduate degree	18.9	10
Postgraduate degree	15.9	4.2

Income

Participants earning over \$100,000 were over-represented, as were participants earning under \$10,000 (see Table 6) (Statistics New Zealand, 2006c).

Table 6: Income levels for Time 1, compared to national data

Personal income (NZ\$)	Time 1 (%)	2006 census data (%)
< 10,000	20.6	14.2
11,000–20,000	18.1	19.5
21,000–40,000	20.6	26.5
41,000–100,000	31.3	21.2
> 101,000	9.5	3.3

Regional distribution

The participants' regional distribution was similar to the general population, although Auckland was under-represented and Canterbury and Wellington over-represented (see Table 7) (Statistics New Zealand, 2006b, 2006d).

Table 7: Regional distribution for Time 1, compared to national data

Region	Time 1	2006 census data (%)
Auckland	23.1	32.4
Canterbury	14.6	13.0
Wellington-Wairarapa	13.4	11.1
Waikato	7.1	9.5
Otago	7.1	4.8
Manawatu-Wanganui	6.0	5.5
Bay of Plenty	5.6	6.4
Taranaki	5.6	2.6
Hawke's Bay	5.2	3.7
Northland	3.4	3.7
Marlborough	2.6	1.1
Southland	2.2	2.3
Gisborne	1.1	1.1
Nelson	1.1	1.1
West Coast	1.1	0.8
Tasman	0.7	1.1

Political party support

Participants had higher support for the New Zealand centre-right political party, the National Party, at all three time-points, than they did for the centre-left party, the Labour party (see Table 8). This is consistent with the political situation in New Zealand at the time, as the government changed from Labour to National in November 2008, 10 days before Time 2. Time 2 levels of support for National were the highest.

Table 8: Support for the Labour Party and the National Party

Time-point	Support or strongly support Labour (%)	Support or strongly support National (%)
Time 1	37.7	43.7
Time 2	46.4	59.1
Time 3	40.5	53.1

Although many of the participants' main socio-demographic characteristics are similar to the general population, it is important to bear in mind that the Study 1 participants were, on average, whiter, richer, older, and better educated than the New Zealand population at the time of the 2006 census.

4.3.3 Instruments

The main instrument for Study 1 was the Social Attitudes Survey (human ethics approval granted on 22 May 2008: School of Psychology Human Ethics Committee number: 0835 May). See Appendix A for a reproduction of the relevant pages. All measures and variable scores were computed following Kellstedt et al.'s method.

Dependent variable

The main dependent variable in this study was concern for climate change, measured by calculating participants' average scores for six questions / statements on climate change risks, creating an index variable. Three questions measured concern for public risks of climate change and were assessed on a 4-point scale from 1 (no risk) to 4 (extreme risk). Three statements measured concern for personal risks of climate change and were assessed on a 4-point scale from 1 (strongly disagree) to 4 (strongly agree). See Table 9

for the specific survey questions and statements that made up the variable, the factor loadings of the questions, and the eigenvalue and Cronbach's alpha scores.

Table 9: Factor analysis of concern for climate change variable

Survey question / statement	Factor loading		
	Time 1	Time 2	Time 3
What is the risk of global warming and climate change exerting a significant impact on <i>public health</i> in your town or city?	.775	.817	.805
What is the risk of global warming and climate change exerting a significant impact on <i>economic development</i> in your town or city?	.803	.797	.825
What is the risk of global warming and climate change exerting a significant impact on <i>the environment</i> in your town or city?	.829	.822	.827
Global warming and climate change will have a noticeably negative impact on my health in the next 25 years.	.752	.789	.783
Global warming and climate change will have a noticeably negative impact on my economic and financial situation in the next 25 years.	.662	.715	.763
Global warming and climate change will have a noticeably negative impact on the environment in which my family and I live.	.682	.750	.780
Eigenvalue	3.402	3.674	3.817
Cronbach's alpha	.846	.873	.885

Independent variables

Knowledge and efficacy variables

Perceived efficacy

As described in Chapter 2, perceived efficacy is a person's perception that their behaviour will have a significant effect on the outcome of a large group. Responses to three statements were averaged to create an index variable combining perceptions of responsibility and efficacy, indicated on a 4-point scale from 1 (strongly disagree) to 4 (strongly agree) (see Table 10).

Table 10: Factor analysis of perceived efficacy variable

Statement	Factor loading		
	Time 1	Time 2	Time 3
I believe my actions have an influence on global warming and climate change.	.860	.869	.867
My actions to reduce the effects of global warming and climate change in my community will encourage others to reduce the effects of global warming through their own actions.	.782	.808	.838
Human beings are responsible for global warming and climate change.	.735	.743	.792
Eigenvalue	1.891	1.959	2.081
Cronbach's alpha	.703	.729	.778

Perceived knowledge level

Participants were asked to indicate how well informed they considered themselves to be about climate change on an 11-point scale ranging from 0 (not at all informed) to 10 (very well informed).

Media trust

Participants were asked to indicate their level of trust in climate change information provided by four different media sources: newspapers, television news, radio, and internet, indicating their level of trust in each on an 11-point scale ranging from 0 (not at all trustworthy) to 10 (very trustworthy). Cronbach's alpha scores were .913 (Time 1), .911 (Time 2), and .928 (Time 3).

Trust in experts

Participants were asked to indicate their level of trust in climate change information provided by six different types of experts: university academics, scientists, government agencies, non-profit organisations, environmental interest groups, and other interest groups. Participants indicated their level of trust in each on an 11-point scale ranging from 0 (not at all trustworthy) to 10 (very trustworthy). Cronbach's alpha scores were .902 (Time 1), .909 (Time 2), and .908 (Time 3). This differed from Kellstedt et al., who did not include academics or scientists in their analysis.

Confidence in scientists

Participants were asked to indicate their level of confidence in scientists' understanding of climate change on a 4-point scale ranging from 1 (very unclear understanding) to 4 (very clear understanding).

*Identity and ideology variables**Environmental values*

Environmental values were examined using the new ecological paradigm (NEP) scale. The NEP scale was first published in 1978 by Dunlap et al., and was revised in 2000 (Dunlap et al., 2000). The Social Attitudes Survey used the full 15-item version of the NEP, while Kellstedt et al. used an abbreviated 8-item version. Participants indicated their level of agreement or disagreement with 15 statements about the relationship between humans and the environment, on a 5-point scale ranging from 1 (strongly

disagree) to 5 (strongly agree) (see Table 11). The reverse-scored items were reversed before computing the alpha and mean score for this variable. The Social Attitudes Survey only measured environmental values at Time 1, so participants' Time 1 NEP scores were used for the regression analyses for Time 2 and Time 3.

Table 11: Factor analysis of the new environmental paradigm (NEP) variable

Statement	Factor analysis
We are approaching the limit of the number of people the earth can support.	.590
Humans have the right to modify the natural environment to suit their needs.	-.541
When humans interfere with nature it often produces disastrous consequences.	.515
Human ingenuity will insure [sic] that we do not make the earth unliveable.	-.654
Humans are severely abusing the environment.	.524
The earth has plenty of natural resources if we just learn how to develop them.	-.437
Plants and animals have as much right as humans to exist.	.558
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	-.626
Despite our special abilities humans are still subject to the laws of nature.	.370
The so-called 'ecological crisis' facing humankind has been greatly exaggerated.	-.645
The earth is like a spaceship with very limited room and resources.	.659
Humans were meant to rule over the rest of nature.	-.441
The balance of nature is very delicate and easily upset.	.622
Humans will eventually learn enough about how nature works to be able to control it.	-.471
If things continue on their present course, we will soon experience a major ecological catastrophe.	.720
Eigenvalue	4.812
Cronbach's alpha	.844

Political party support

Participants were asked to indicate their level of support for different political parties on 7-point scales ranging from 1 (strongly oppose) to 7 (strongly support). Only support for Labour and National were analysed, to compare results with Kellstedt et al.'s 'partisanship' variable, measured as either Democrat or Republican. The Social Attitudes Survey did not include the question on political party support at Time 3, so a variable was created that was the mean of each participant's Time 1 and Time 2 answers for the Time 3 regression analysis.

Religious service attendance

Participants were asked to indicate whether or not they had attended a religious service (excluding a wedding or funeral) in the last 7 days.

Political ideology

Participants were asked to indicate their political ideology on a 7-point scale ranging from 1 (extremely liberal) to 7 (extremely conservative).

Demographic variables

Participants were asked to indicate their ethnicity, gender, age, education level, and income. Ethnicity categories were combined to measure ethnicity nominally, as either Pākehā (1) or non-Pākehā (0), to be able to compare results with Kellstedt et al.'s 'race' variable (measured as either white or non-white). Gender was measured nominally as male (1) or female (0). Age was measured in years. Participants indicated their highest level of education out of five categories (secondary school incomplete; NCEA, School Certificate, or other secondary school qualification; polytechnic qualification or trade certificate; undergraduate degree; postgraduate degree). Participants estimated their gross personal income for 2007, choosing from nine categories ranging from 'less than \$10,000' to 'more than \$141,000', in NZ \$10,000–\$20,000 increments.

4.4 Study 1 results

4.4.1 Summary of main findings

The aim of Study 1 was to determine whether the knowledge-deficit theory applied to concern for climate change, using a measure of perceived knowledge. Multiple regression analyses showed that perceived knowledge level was not a significant predictor of concern for climate change (though the observed relationship was positive). This finding suggests that, for this data, the knowledge-deficit theory does not apply to concern for climate change, when using a measure of perceived knowledge. Perceived efficacy and environmental values were found to be good positive predictors of concern for climate change.

4.4.2 Regression analyses

Baseline model of concern for climate change

The second columns of Tables 13–15 present the results of the baseline models at each time-point.

Main findings

In the baseline model, the profile of a person with high concern for climate change would be a younger female participant with high environmental values who supported Labour and had recently attended a religious service.

The strongest significant predictor of concern was environmental values, with positive correlations at all three time-points. However, the strength of the correlation decreased at each time-point. Age was a weak but significant negative predictor of concern at Times 1 and 2. Other variables that were significant at one of the time-points were support for Labour (weak significant positive predictor at Time 1), religious service attendance (weak significant positive predictor at Time 2), and gender (being male) (slightly stronger significant negative predictor at Time 3).

Expanded model of concern for climate change

The third columns of Tables 13–15 present the results of the expanded models at each time-point.

Main findings

In the expanded model, the profile of a person with high concern for climate change would be a younger participant with high levels of perceived efficacy and high environmental values.

Perceived efficacy was the strongest significant predictor of concern, with positive correlations at all three time-points. However, the strength of the correlation decreased at each time-point. The environmental values variable was the second strongest positive predictor of concern overall, and was stronger than efficacy at Time 3. The strength of the environmental values correlation was weaker in the expanded model than it was in the baseline model. Age was only very weakly, yet significantly, negatively correlated with concern at Time 1. Perceived knowledge was not a significant predictor of concern for climate change.

Overall, the expanded models were better models, as they explained more of the participants' concern for climate change than the baseline models. This is described by the statistical concept of explained variance (R^2). The Time 1 expanded model of concern for climate change had a variance of 45.2 percent, meaning that the variables making up the expanded model explained 45.2 percent of the participants' total amount of concern for climate change, while the Time 1 baseline model explained only 27.7 percent of participants' total amount of concern. See Table 12 for the variances of the different models and time-points.

Table 12: Explained variance of the two models compared over the three time-points

	Baseline model: Adj R^2 (%)	Expanded model: Adj R^2 (%)
Time 1	27.7	45.2
Time 2	22.9	38.0
Time 3	18.9	35.1
Kellstedt et al.	31.8	42.7

Table 13: Time 1: Baseline and expanded models of concern for climate change

Independent variable	Baseline model				Expanded model			
	B	Std error	Beta	t	B	Std error	Beta	t
Ethnicity (Pākehā)	.029	.096	.018	.305	-.075	.086	-.047	-.867
Gender (male)	-.077	.075	-.064	-1.021	-.003	.069	-.002	-.037
Education	.019	.027	.045	.704	.016	.024	.038	.671
Income	.007	.019	.025	.349	-.001	.017	-.003	-.048
Age	-.007	.002	-.196	-3.111**	-.005	.002	-.130	-2.278*
Religious service attendance	.106	.089	.071	1.197	.092	.081	.060	1.140
Support for Labour	.054	.023	.174	2.365*	.035	.022	.110	1.595
Support for National	.013	.024	.043	.542	.020	.021	.068	.947
Political ideology	.026	.029	.062	.897	.041	.026	.097	1.558
Environmental values	.449	.064	.463	7.071***	.329	.060	.336	5.473***
Perceived knowledge level					.027	.019	.080	1.428
Perceived efficacy					.359	.056	.410	6.437***
Trust in media					.005	.021	.016	.234
Trust in experts					-.003	.024	-.010	-.129
Confidence in science					.087	.048	.112	1.824
Constant	.836	.412		2.030*	-.110	.381		-.288
R ²	.310				.491			
Adj. R ²	.277				.452			
F	9.347				12.844			
N	269				269			

Note: The dependent variable is concern for climate change (see Table 9).

*** = $p < 0.001$

** = $p < 0.01$

* = $p < 0.05$

Table 14: Time 2: Baseline and expanded models of concern for climate change

Independent variable	Baseline model				Expanded model			
	B	Std error	Beta	t	B	Std error	Beta	t
Ethnicity (Pākehā)	.003	.111	.001	.023	-.072	.101	-.041	-.715
Gender (male)	-.163	.087	-.123	-1.882	-.095	.081	-.072	-1.181
Education	.024	.031	.050	.764	-.014	.029	-.030	-.490
Income	.023	.022	.077	1.058	.018	.020	.059	.885
Age	-.007	.003	-.165	-2.531*	-.005	.003	-.112	-1.786
Religious service attendance	.217	.097	.137	2.234*	.125	.091	.078	1.363
Support for Labour	.034	.028	.112	1.188	-.008	.028	-.027	-.294
Support for National	-.019	.029	-.066	-.644	-.042	.028	-.147	-1.502
Political ideology	.025	.034	.052	.732	.038	.032	.082	1.215
Environmental values	.400	.076	.370	5.251***	.206	.074	.193	2.799**
Perceived knowledge level					.013	.021	.038	.635
Perceived efficacy					.329	.070	.357	4.716***
Trust in media					.000	.029	.000	-.004
Trust in experts					.041	.034	.114	1.220
Confidence in scientists					.068	.058	.077	1.177
Constant	1.175	.531		2.211*	.927	.504		1.838
R ²	.264				.424			
Adj. R ²	.229				.380			
F	7.430				9.578			
N	269				269			

Note: The dependent variable is concern for climate change (see Table 9).

*** = $p < 0.001$

** = $p < 0.01$

* = $p < 0.05$

Table 15: Time 3: Baseline and expanded models of concern for climate change

Independent variable	Baseline model				Expanded model			
	B	Std error	Beta	t	B	Std error	Beta	t
Ethnicity (Pākehā)	.004	.105	.002	.036	-.008	.097	-.005	-.086
Gender (male)	-.198	.083	-.155	-2.382*	-.126	.080	-.098	-1.570
Education	.031	.030	.069	1.044	.010	.028	.023	.370
Income	.008	.021	.026	.359	.007	.020	.025	.369
Age	-.002	.003	-.055	-.847	.000	.002	.000	.006
Religious service attendance	.161	.095	.104	1.698	.121	.088	.077	1.375
Support for Labour	.051	.030	.160	1.709	.009	.029	.028	.316
Support for National	-.025	.031	-.081	-.800	-.045	.030	-.147	-1.519
Political ideology	.015	.032	.034	.470	.042	.030	.096	1.434
Environmental values	.319	.073	.303	4.392***	.221	.068	.209	3.237**
Perceived knowledge level					.027	.021	.075	1.275
Perceived efficacy					.217	.068	.239	3.183**
Trust media					.021	.030	.064	.705
Trust experts					.049	.034	.140	1.439
Confidence in scientists					.083	.062	.090	1.343
Constant	1.298	.506		2.565*	.489	.516		.947
R ²	.225				.395			
Adj. R ²	.189				.351			
F	6.322				8.969			
N	269				269			

Note: The dependent variable is concern for climate change (see Table 9).

*** = $p < 0.001$

** = $p < 0.01$

* = $p < 0.05$

Perceived efficacy

Because perceived efficacy was such a strong predictor of concern for climate change, Kellstedt et al. ran a final regression to find out why some participants had high levels of efficacy (and therefore concern) for climate change, and why others had low levels of efficacy (and concern) for climate change. (See Table 10 for the statements making up the perceived efficacy variable.) The perceived efficacy model analysed the same full list of variables from the expanded model, but used perceived efficacy as the dependent variable instead of concern for climate change. Overall, the perceived efficacy model accounted for 32.8 percent (Time 1), 44.7 percent (Time 2), and 32.2 percent (Time 3) of the explained variance in perceived efficacy (see Table 16).

Main findings

In the perceived efficacy model, a profile of a person with high perceived efficacy and responsibility for climate change would be a younger, female participant with a high level of trust in experts and high environmental values.

Trust in experts was the strongest significant predictor of perceived efficacy, with positive correlations at all three time-points (though the Time 3 correlation was half as strong as those at Times 1 and 2). The environmental values variable was the next strongest predictor, with positive correlations at Times 2 and 3. Age was a significant negative predictor at Time 2 only, and gender (being male) a significant negative predictor at Time 3 only. Perceived knowledge level did not significantly predict perceived efficacy at any of the time-points.

Table 16: Models of perceived efficacy: All three time-points

Independent variable	Time 1				Time 2				Time 3			
	B	Std error	Beta	t	B	Std error	Beta	t	B	Std error	Beta	t
Ethnicity (Pākehā)	.060	.109	.033	.552	.075	.103	.039	.726	-.037	.099	-.022	-.378
Gender (male)	-.154	.086	-.112	-1.777	-.069	.082	-.048	-.839	-.185	.080	-.145	-2.321*
Education	-.003	.031	-.007	-.110	.041	.030	.079	1.380	.014	.029	.030	.478
Income	.000	.021	.000	-.003	-.002	.021	-.006	-.093	.012	.020	.043	.620
Age	-.005	.003	-.114	-1.814	-.008	.003	-.175	-3.018**	-.001	.002	-.023	-.373
Religious service attendance	.057	.102	.033	.557	.155	.093	.090	1.669	.128	.090	.082	1.428
Support for Labour	-.017	.028	-.048	-.621	-.001	.028	-.003	-.029	.007	.029	.023	.254
Support for National	-.041	.027	-.119	-1.511	-.040	.028	-.128	-1.393	-.057	.030	-.186	-1.897
Political ideology	-.012	.033	-.026	-.375	.045	.032	.089	1.408	.035	.030	.080	1.168
Environmental values	.144	.075	.129	1.915	.246	.073	.212	3.353**	.247	.069	.233	3.563***
Perceived knowledge level	.022	.024	.058	.933	.026	.022	.066	1.193	.027	.022	.077	1.273
Media trust	.027	.027	.078	1.006	.055	.029	.144	1.889	.037	.031	.111	1.204
Trust in experts	.125	.030	.352	4.204***	.141	.033	.358	4.237***	.077	.034	.218	2.272*
Confidence in scientists	.063	.061	.071	1.043	.027	.060	.028	.448	.106	.063	.114	1.684
Constant	1.583	.470		3.370**	.693	.499		1.388	.707	.497		1.424
R ²	.371				.484				.365			
Adj. R ²	.328				.447				.322			
F	8.483				13.108				8.511			
N	269				269				269			

Note: The dependent variable is perceived efficacy (see Table 10).

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

4.4.3 Changing knowledge and concern levels over time

As Tables 17 and 18 show, perceived knowledge levels were measured on a scale from 0 (not at all informed' to 10 (very well informed) and decreased from 6.09 at Time 1 to 6.03 at Time 2, and then increased from Time 2 to their highest level of 6.21 at Time 3. Concern levels, measured on a scale from 1 (no risk) to 4 (extreme risk), were stable at 2.53 over the 12-month period.

Table 17: Perceived knowledge of climate change: June 2008 to June 2009

Table 18: Concern for climate change: June 2008 to June 2009

4.5 Study 1 discussion

4.5.1 Knowledge and concern

Prediction 1: There will be no significant relationship between perceived knowledge of climate change and concern—confirmed

Study 1 could not confirm the knowledge-deficit theory for concern for climate change. The relationship between concern and knowledge found in Study 1 was positive, although very weak and non-significant (see Tables 13–15). Kellstedt et al. found that more informed participants felt significantly less concern for climate change than participants who were not as well informed (Kellstedt et al., 2008). We cannot confirm that the knowledge-deficit theory applies to perceived knowledge of climate change and concern for climate change. This is similar to Whitmarsh's (2011) finding that attitudes of scepticism for, and uncertainty about, climate change are unrelated to participants' perceived knowledge levels.

Kellstedt et al.'s baseline accounted for more variance than Study 1's baseline models, while Study 1's Time 1 expanded model accounted for more variance than Kellstedt et al.'s expanded model (and Study 1's Time 2 and 3 expanded models, slightly less) (see Table 12). One reason for these differences in variance could be differences in the American and New Zealand publics' sources of information about climate change. Perhaps the American public's sense of concern is largely explained by demographic variables: Kellstedt et al.'s baseline model—containing mostly demographic variables—explained twice the variance that Study 1's baseline models did. It is possible that the New Zealand public's sources of concern could be better explained by knowledge and efficacy variables: Kellstedt et al.'s expanded model—including knowledge and efficacy variables—only improved on the variance of their baseline model by 10 percent, while Study 1's expanded models improved on the variance of the baseline models by 20 to 30 percent.

Changing knowledge and concern over the survey period

Tables 17 and 18 showed that concern remained stable at all three time-points, while perceived knowledge levels decreased slightly and then increased. Although the scores cannot be compared to other studies (Kellstedt did not report the scores, and no other studies use these scales) to see how New Zealand concern levels compare, it is

interesting to note the trends—that mean concern levels did not change over the year, but perceived knowledge levels did. One reason for the slight decrease and then increase in perceived knowledge levels could be because of the timing of the three time-points in relation to international climate change talks and conferences. As Table 19 shows, the Time 1 survey period took place 6 months after the major Bali United Nations climate conference, COP 13 and at the time of other, though less well-publicised, climate talks. Between the Time 1 and Time 2 survey periods there were no major climate conferences, and only one round of talks, which could explain the decrease in perceived knowledge. The second half of the Time 2 survey period overlapped with the Poznań conference (COP 14), and this would have been expected to influence late survey respondents. The increase in perceived knowledge from Time 2 to Time 3 could correspond to the media attention given to Poznań, and perhaps to media attention to the two smaller rounds of talks in Bonn. Another major time-related event was the New Zealand general election held directly before the Time 2 survey period. This is discussed in Section 6.1.1.

Table 19: UNFCCC talks and conferences compared to survey points

3–15 December 2007	Bali COP 13 (major, well-publicised conference)
31 March–4 April 2008	Bangkok UNFCCC talks
2–13 June 2008	Bonn UNFCCC talks
9 June–9 August 2008	Time 1 survey period
21–27 August 2008	Accra UNFCCC talks
10 November–10 January 2008	Time 2 survey period
1–12 December 2008	Poznań COP 14 (major, well-publicised conference)
29 March–5 April 2009	Bonn UNFCCC talks
2–13 June 2009	Bonn UNFCCC talks
5 June–5 August 2009	Time 3 survey period

4.5.2 Perceived efficacy

Prediction 2: Participants with high perceived efficacy will have high concern for climate change—confirmed

In line with previous research (Brody, Zahran, Vedlitz, et al., 2008; Heath & Gifford, 2006; Kellstedt et al., 2008), Study 1 found that perceived efficacy was a strong predictor of concern for climate change. It was consistently the strongest predictor of concern at all three time-points.

Perceived efficacy model

Results for the multiple regression with perceived efficacy as the dependent variable varied from Kellstedt et al.'s findings.

Kellstedt et al. found that participants with high levels of perceived knowledge felt lower levels of perceived efficacy. Study 1 found a non-significant positive correlation between perceived knowledge level and perceived efficacy. Kellstedt et al. also found that participants with high trust in experts and confidence in science had low levels of perceived efficacy. Contrastingly, Study 1 found that participants with high trust in experts had the highest levels of perceived efficacy. Kellstedt et al. found age to be a positive predictor of perceived efficacy, while Study 1 found it to be a negative predictor of efficacy though only significant at Time 2.

Similarly to Kellstedt et al., Study 1 found environmental values to be a significant positive predictor of perceived efficacy.

4.5.3 Environmental values

Prediction 3: Participants with high environmental values will have high concern for climate change—confirmed

The environmental values variable was a significant positive predictor of concern in all models, though stronger in the baseline models than in the expanded models and the strength of the correlation decreased at each time-point. This could perhaps be because environmental values were only measured at Time 1, and the Time 1 score used for the Time 2 and Time 3 analyses. This variable was the strongest predictor of concern in the baseline models and the second strongest in the expanded models (after perceived efficacy). This is in line with previous research that suggests that environmental values

are some of the strongest predictors of concern for climate change (Bord et al., 2000; Brody, Zahran, Vedlitz, et al., 2008; Heath & Gifford, 2006; Joireman et al., 2010; Kellstedt et al., 2008; Nilsson et al., 2004; O'Connor et al., 1999; Whitmarsh, 2011). Kellstedt et al. similarly found environmental values to be the biggest predictor of concern in their baseline model, and second biggest after efficacy in their expanded model.

4.5.4 Gender, age, and concern

Prediction 4: Female and younger participants will have high concern for climate change—partially confirmed

Gender was only a significant predictor of concern in the baseline model at Time 3, with female participants showing significantly higher concern levels than male participants. This trend is supported by previous research finding women display higher concern for environmental risks like climate change (Brody et al., 2008; Davidson & Freudenburg, 1996; Finucane et al., 2000; Flynn et al., 1994; Leiserowitz, 2006; McCright, 2010; Mobley et al., 2010; Stern et al., 1993; Xiao & McCright, 2007).

Age was a significant negative predictor of concern for Times 1 and 2 in the baseline models and in the Time 1 expanded model, with younger participants showing higher concern than older participants. This is in line with previous research that suggests that values are better predictors of concern than demographic variables like age and gender. The environmental values variable was a better predictor of concern than gender and age, but perceived efficacy was stronger than both demographic variables and environmental values.

4.5.5 Confidence in science and trust in experts

Prediction 5: Participants with high confidence in science and trust in experts will have high concern for climate change—unconfirmed

Kellstedt et al. found that participants with high confidence in science had lower concern for climate change than those with lower confidence in science. Study 1 found no significant correlations between these variables. However, the correlations were all positive (bar trust in experts at Time 1), just non-significant.

This could be because Study 1 did not measure actual knowledge levels. The information that participants encountered was unlikely to have accurately represented the scientific consensus (Antilla, 2010; M. Boykoff, 2008; M. Boykoff & J. Boykoff, 2004, 2007; Lowe et al., 2006). Conceivably, participants could both highly trust scientists yet have low concern for climate change, as the messages they could perceive scientists to be giving—via the media—are that there is enough uncertainty and debate to justify lower concern. Participants may have perceived experts to be unconcerned, or at least undecided, about climate change.

5 Study 2: Actual knowledge and concern for climate change

Study 1 suggested that, contrary to the knowledge-deficit theory, participants with high knowledge of climate change did not feel greater concern than participants with low knowledge. A likely explanation for this finding is that Study 1 measured perceived knowledge, which did not accurately reflect participants' knowledge about climate change—instead perhaps reflecting the amount of misinformation present in the media, which is the public's main source of climate change information. Study 2 tests whether the knowledge-deficit theory applies to concern for climate change, when participants' actual knowledge levels are tested.

5.1 Sundblad, Biel, and Gärling (2009)

To measure climate change knowledge, a Swedish study by Sundblad, Biel, and Gärling was replicated and expanded on. Sundblad et al.'s study examined the following areas.

1. Participants' knowledge of the state, causes, and consequences of climate change.
2. Participants' confidence in their knowledge.
3. The comparative knowledge levels (and confidence levels) of four groups: the general public (N = 621), environmental journalists (N = 72), environmental politicians (chairs of environmental committees, N = 145), and climate change experts (academics and scientists, N = 65) (Sundblad et al., 2009).

Sundblad et al. then created adjusted knowledge scores for each group, by adjusting participants' knowledge scores according to their confidence in that knowledge. This allowed them to assess how well confidence levels corresponded to actual knowledge, providing a more accurate measure of knowledge.

This study was chosen as it provided the template for a survey measuring actual knowledge of climate change. Building on existing research would also enable comparison of New Zealanders' knowledge levels to Swedish knowledge levels using the same instruments and analysis.

Sundblad et al.'s (2008) main findings were as follows.

1. Experts had the highest levels of knowledge about climate change, followed by journalists, politicians, and the general public.
2. Experts had the highest levels of confidence in their knowledge about climate change, followed by journalists, politicians, and the general public.
3. After adjusting knowledge by levels of confidence, journalists scored higher than experts.
4. All groups' knowledge of causes was greater than their knowledge of state and of consequences.
5. Knowledge of health consequences was lower than knowledge of weather consequences and of sea level and glacier consequences.

As well as examining the four groups from the original study, five extra groups were included: environmental and non-environmental experts, policy advisers, managers, and farmers. These extra groups were analysed separately (see Appendix D) to compare results to Sundblad et al.'s study, but are discussed briefly in Section 5.5.1.

5.2 Study 2 predictions

The aim of Study 2 is to determine whether the knowledge-deficit theory applies to concern for climate change, using a measure of actual knowledge of climate change. To address this, the following main prediction will be tested.

1. ***Actual knowledge of climate change will predict concern for climate change.***

Previous research has found that actual knowledge levels are good predictors of concern for climate change (Bord et al., 2000; Leiserowitz, Smith, et al., 2010; Nolan, 2010; Sundblad et al., 2007).

A number of sub-predictions will also be tested:

2. Accurate knowledge of climate change will be a better predictor of concern than perceived knowledge.
3. Participants with high perceived efficacy will have high concern for climate change.

4. Female and younger participants will have high concern for climate change.
5. Knowledge of the causes of climate change will predict concern better than knowledge of state or consequences.
6. Climate change experts will have the highest knowledge and confidence in knowledge of climate change, followed by journalists, then politicians, then the public.
7. Participants will have higher knowledge of causes than of state or consequences.

According to Bord et al. (2000), accurate knowledge of causes is the best predictor of intentions to engage in climate change mitigating behaviour and to support government climate change policies. Sundblad et al. (2007) found that accurate knowledge of causes and consequences, particularly health consequences, predicted whether participants were concerned about climate change. These studies suggest that knowledge of the causes of climate change will predict concern best, followed by knowledge of consequences.

5.3 Study 2 method

5.3.1 Participants

Sample characteristics

Study 2 was not intended to be a nationally representative sample. Instead, participants were required who fitted into distinct groups—scientists, academics, politicians, journalists, policy advisers, managers, farmers, and ‘other’. With the exception of farmers, these groups were, by definition, more highly educated, in higher-paying jobs, and more likely to live in Wellington than the general population (except perhaps managers who may be more likely to live in Auckland). One of the groups—‘general public’—was intended to broadly represent the general New Zealand population who do not work in jobs that relate to the environment or climate change, and was selected via snowball sampling. This section compares both the total sample (all participants) and the general public group to the 2006 New Zealand census data and to data from Study 1 participants (the average of the three time points). This is to compare the general public group from Study 2 with the Study 1 participants, as these two groups are compared in Chapter 6.

Excluding people who were not born in New Zealand and those who did not complete the survey, the total number of participants who completed the survey was 1,129 (see Table 20). After creating the groups used by Sundblad et al., the final sample was 452 (the remaining 677 participants did not fall into the job types used in Sundblad et al.’s analysis).

Table 20: Study 2 participants' job type distribution

Job type	Number of participants	Percentage of sample
Other	438	38.8
Academics	168	14.9
Scientists	230	20.4
Politicians (central or local government)	29	2.6
Public policy advisers	103	9.1
Journalists or reporters	37	3.3
Managers	93	8.2
Farmers	31	2.7
Total	1129	100.0

Gender

Males were slightly over-represented in the total sample, though females were over-represented in the general public group (Statistics New Zealand, 2006a) (see Table 21). The general public group was closer to the 2006 census gender data than the participants in Study 1 were.

Table 21: Study 2 participants' gender distribution

Gender	All Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (mean of all three time-points)	2006 census data (%)
Female	46.7	54.5	66.5	51.2
Male	53.3	45.5	33.5	48.8

Age

Table 22 shows that participants ranged in age from 17 to 88 years. The mean age was 42.8 years, and the median 41 years—higher than the national median age of 35.9 years, and lower than the Study 1 median of 55 years. This difference to the national median age is probably because Study 2 participants were 17 years or older, while the census records data on people of all ages living in New Zealand (Statistics New Zealand, 2006b).

Table 22: Study 2 participants' summary stats for age distribution

Age	Study 2 participants (years)	Study 2 general public group (years)	Study 1 participants (years) (mean of all three time-points)
Mean	42.3	42.8	54.7
Standard deviation	15.6	16.6	15.9
Median	41.0	40.0	55
Range	17–88	17–85	18–89

Education

Table 23 shows that participants were much more highly educated than the New Zealand population. The general public group was also more highly educated than the general population, though not as highly educated as the total sample. The general public group was also more highly educated than the Study 1 participants.

Table 23: Study 2 participants' education levels

Education level	Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (Time 1 data)	2006 census data (%)
Secondary school incomplete	1.2	1.0	19.3	22.4 (‘No qualification’)
NCEA, School C, or other secondary school qualification	5.8	9.0	24.6	35.5 (‘Levels 1, 2, & 3 certificate’ and ‘overseas secondary school qualification’)
Polytechnic qualification or trade certificate	6.7	10.0	12.2	17.6 (‘Level 4 certificate’ and ‘levels 5 & 6 diploma’)
Undergraduate degree	31.2	40.5	18.9	10
Postgraduate degree	55.2	39.4	15.9	4.2

Income

Table 24 shows that participants generally had higher incomes than the New Zealand population (Statistics New Zealand, 2006c). The general public group was more similar to the 2006 census data than the Study 1 participants were.

Table 24: Study 2 participants' income levels

Income bracket	Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (Time 1 data)	2006 census data (%)
< 10 000	13.9	19.0	20.6	14.2
11 000–20 000	9.3	9.7	18.1	19.5
21 000–40 000	13.7	16.5	20.6	26.5
41 000–100 000	50.0	47.3	31.3	21.2
> 101 000	13.0	7.5	9.5	3.3

Regional distribution

Table 25 shows that participants from Wellington-Wairarapa and Otago were over-represented, while participants from Auckland, Canterbury, and Waikato were under-represented (Statistics New Zealand, 2006b, 2006d). The general public group was similarly over-represented in Wellington-Wairarapa and Otago and under-represented in Auckland, Canterbury, and Waikato.

Table 25: Study 2 participants' regional distribution

Region	Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (Time 1 data)	2006 census data (%)
Wellington-Wairarapa	48.9	55.7	13.4	11.1
Auckland	16.0	17.3	23.1	32.4
Otago	9.2	7.6	7.1	4.8
Canterbury	9.1	8.3	14.6	13.0
Waikato	4.6	2.1	7.1	9.5
Bay of Plenty	2.6	2.4	5.6	6.4
Manawatu-Wanganui	2.4	2.4	6.0	5.5
Hawke's Bay	1.7	1.0	5.2	3.7
Taranaki	1.1	1.0	5.6	2.6
Nelson	0.9	0.3	1.1	1.1
Southland	0.9	1.4	2.2	2.3

Region	Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (Time 1 data)	2006 census data (%)
Tasman	0.8	0.3	0.7	1.1
Marlborough	0.6	0.0	2.6	1.1
Northland	0.5	0.0	3.4	3.7
West Coast	0.5	0.0	1.1	0.8
Gisborne	0.2	0.0	1.1	1.1

Political party support

Table 26 shows that Study 2 participants strongly supported Labour over National, the general public group to an even greater extent. This is very different to the Study 1 participants, who supported National over Labour.

Table 26: Support for National and Labour parties

	All Study 2 participants (%)	Study 2 general public group (%)	Study 1 participants (%) (mean of all three time-points)
Support or strongly support Labour	60.3	63.2	41.5
Support or strongly support National	22.8	20.7	52.0

Groups

Climate change experts (N = 97)

The climate change experts group was created by combining all of the participants who selected either the job type ‘academic’ or ‘scientist’ and who also specified that the work that they personally did related to climate change ‘very frequently’ or ‘always’.

To recruit scientists, emails were sent to New Zealand scientific organisations and research centres. The Royal Society of New Zealand included a link to the survey in their national weekly electronic newsletter and in their Wellington-specific electronic newsletter. To recruit academics, emails were sent to relevant departments at all New Zealand universities. Notices about the survey were also posted around Victoria University of Wellington.

Politicians (N = 29)

The politicians group was created by combining all the participants who selected the job type ‘politician (central or local government)’. As low numbers of politicians completed

the survey, the sample could not be further split to examine environmental politicians as Sundblad et al. did. Seventeen politicians specified that the work they did ‘very frequently’ or ‘always’ related to the environment.

To recruit politicians, emails were sent to all New Zealand Members of Parliament and to all New Zealand political parties, as well as to administrative staff for circulation. Emails were sent to the mayors and councillors at all New Zealand local and regional councils, and also to administrative staff.

Journalists (N = 37)

The journalists group was created by combining all the participants who selected the job type ‘journalist or reporter’. As with the politicians, this was too low a number of journalists to further split the sample to examine environmental journalists, although 10 journalists specified that the work they did ‘very frequently’ or ‘always’ related to the environment.

To recruit journalists, emails were sent to all New Zealand regional newspapers, and relevant television and radio stations. Media contacts at the Dominion Post, TV3, and Radio New Zealand were asked to forward the invitation email to their colleagues.

General public (N = 289)

The general public group was created by combining all the participants who selected the job type ‘other’. To ensure this group did not mistakenly include environmental specialists, it also excluded any participants who said that the work that they personally did related to the environment ‘very frequently’ or ‘always’.

Snowball sampling was used by sending an invitation email—with a description of the survey and link to the survey—to friends, family, and colleagues asking them to forward the email on to their contacts and so on. A public Facebook page was also created and the link was sent around, again using snowball sampling.

5.3.2 Instruments

The survey had three parts: Part 1: Climate change knowledge, Part 2: Climate change risk assessment, and Part 3: Demographic questions. The climate change risk assessment questions posed in Part 2 are not addressed in this thesis, as they are not

directly related to this analysis. There were three versions of the survey, which were identical except the questions were in different orders. This was to determine whether the ordering of the questions affected participants' answers.

Types of knowledge

Climate change knowledge was measured by presenting participants with 22 true statements and 22 false statements about climate change—eight statements about the state of the climate, 14 statements about the causes of climate change, and 22 statements about the consequences of climate change (weather, sea-level rise, health, and New Zealand-specific consequences) (see Appendix B).

The 22 true statements were taken from Sundblad et al.'s survey, which was based on the IPCC reports and checked with independent experts. Sundblad et al.'s survey was followed as closely as possible, but it was updated with more recent science and New Zealand-specific information (Pachauri & Reisinger, 2007; Reisinger, 2009). A New Zealand climate change expert with the IPCC reviewed the revised statements². The 22 false statements were to detect participants who answered true to all statements, and were a combination of common misperceptions about climate change and contrasts to the true statements.

Following Sundblad et al. (2008), seven variables were created that were groups of the true statements, intended to represent different types of knowledge of climate change (see Appendix C). These variables were: the state of the climate, the causes of climate change, and projected consequences of climate change. The consequences variables were: weather consequences, sea level and glacier consequences, New Zealand-specific consequences, and health consequences. Like Sundblad et al. (2008), the false statements were not included in the results analysis because they were not directly comparable with the true statements. Knowledge scores were calculated as the mean correct answers for each variable.

Confidence in knowledge

For each question, participants also had to rate how confident they felt about their answer on a 6-point Likert scale, from 1 (very uncertain) to 6 (very certain). Confidence

² Thanks to Dr Andy Reisinger for kindly reviewing the survey questions.

scores were calculated by averaging confidence ratings for answers to the true statements.

Repeated information, identity, and demographic variables from Study 1

The survey included some of the same questions used in the Social Attitudes Survey. This was to be able to re-run multiple regression analysis reported in Study 1 to see whether adding an objectively tested knowledge variable produced a different result supporting the knowledge-deficit theory.

The variables repeated from Study 1 were: concern for climate change, perceived efficacy, support for Labour and support for National, perceived knowledge level, and demographic variables (age, income, education, gender, region).

5.3.3 Procedure

Collecting data

Human ethics approval was granted on 14 September 2010 (approval number RM017957). On 5 October 2010, emails were sent inviting recipients to complete an online survey about climate change that ran until 1 November 2010. When participants typed in the URL to access the survey they were automatically rerouted via a separate website and randomly allocated to one of the three survey versions. The instructions on each survey asked participants to assess whether 44 statements about climate change were true or false, and to indicate how certain they were in each of their answers. The invitation email informed participants that they could choose to enter a draw for a \$50 grocery voucher as an incentive for participating in the survey. A reminder email was sent on 19 October 2010.

Analysing data

Data was analysed using SPSS. Following Sundblad et al., means were calculated, repeated measures analysis of variance (ANOVA) performed, and Pearson's correlations calculated. Finally, multiple regression analyses were performed.

Calculating means

To determine each group's average level of knowledge and confidence, mean scores were calculated for each group for the different knowledge types (state, causes,

consequences, and the types of consequences—weather, sea level and glacier, New Zealand, health) and each knowledge type's corresponding mean confidence level.

Analysis of variance

Analysis of variance (ANOVA) is a statistical technique used to calculate whether there are significant differences between two or more means, allowing researchers to determine whether there are significant relationships between variables. ANOVA produces an 'F ratio', which represents the variability in scores *between* the variables divided by the variability in scores *within* the variables. A large F ratio suggests that there is more variability between the variables than there is within each variable (Pallant, 2010).

Following Sundblad et al., a repeated measures ANOVA was performed for each knowledge type and another for each associated confidence level. Repeated measures ANOVA is used when testing a sample under several different conditions. ANOVA allows researchers to test for the 'main effect' of each independent variable and also any potential 'interaction effects'. An interaction effect is when the effect of one independent variable on the dependent variable is affected by the level of another independent variable (Pallant, 2010). In the instance of an interaction effect, the main effect cannot be relied on to tell the full story.

Post-hoc statistical tests

ANOVA will determine whether or not there are significant differences but they will not describe what any differences are. Post-hoc tests help to interpret any differences identified in the ANOVAs. In line with Sundblad et al., post-hoc Bonferroni corrections were applied to any significant effects identified in the ANOVAs.

A Bonferroni correction is a statistical method that addresses the problem of multiple comparisons. When many comparisons are simultaneously tested (as in an ANOVA), an overall significance level is found for all comparisons. Bonferroni corrections break the comparisons down and provide measures of significance for each comparison.

Bonferroni corrections are conservative tests that control for the overall Type I error rate (the chance of mistakenly thinking that an effect has been found) over multiple significance tests. This means that it is more likely that a significant effect will be missed than a significant effect will be observed when one does not exist.

Pearson's correlations

Bivariate Pearson's correlations were calculated to produce adjusted group mean knowledge scores for each type of knowledge with its corresponding mean confidence scores. These Pearson's correlations can be interpreted as adjusted knowledge level scores that better reflect accurate knowledge—a high, significant score represents high knowledge that was well calibrated with confidence in that knowledge. A non-significant score means that there was no significant relationship between knowledge and confidence in knowledge. A negative score means that confidence was lower for correct answers, perhaps implying that participants were guessing.

Regression analysis

A similar multiple regression analysis to that used in Study 1 was performed, to examine participants' concern for climate change, and see whether including an objectively tested measure of climate change knowledge revealed a different relationship between knowledge and concern.

Study 2 used the concern for climate change dependent variable from Study 1, though it did not have exactly the same set of independent variables. The Study 2 survey did not include questions on: ethnicity, religious service attendance, political ideology, new ecological values, trust in media, trust in experts, or confidence in scientists. It included the same measure of self-reported knowledge. To assess objectively tested knowledge levels, a new variable was created, which was the mean number of true questions that participants correctly answered.

A second regression analysis included three knowledge variables—knowledge of state, knowledge of causes, and knowledge of consequences of climate change. This was to test whether knowledge of causes was a more powerful predictor of concern than state or consequences (Bord et al., 2000; Sundblad et al., 2007).

As Study 1 looked at public concern for climate change, the regression analyses were only run for the participants in the general public group.

5.4 Study 2 results

5.4.1 Summary of main findings

The multiple regression analyses showed that, unlike perceived knowledge, actual knowledge of climate change significantly positively predicted concern for climate change, specifically knowledge of the consequences of climate change, rather than knowledge of state or causes. This suggests that the knowledge-deficit theory holds for this data.

Comparing mean knowledge levels showed that journalists had higher knowledge of state and causes of climate change, while experts had highest knowledge of consequences. The public had the third highest knowledge levels, and politicians had the lowest. This order varied for confidence, with experts showing the highest confidence in their knowledge, followed by politicians, then journalists, and the public with the lowest confidence in their knowledge.

Adjusting knowledge by levels of confidence, the public had the best match between knowledge and confidence, followed by experts. Journalists had no significant relationship between their knowledge and their confidence. Politicians also had no significant relationship between knowledge and confidence, and had several negative relationships, suggesting high confidence in inaccurate answers.

Overall, participants' knowledge of the causes of climate change as well as the health consequences and sea level and glacier consequences were highest, and their knowledge of consequences, specifically knowledge of weather consequences, was lowest.

5.4.2 Knowledge

Knowledge of state, causes, and consequences

Comparing mean knowledge levels of the state, causes, and consequences of climate change showed that journalists had the highest knowledge of state and causes, followed by climate change experts, then the public, and lastly politicians. Climate change experts had the highest knowledge of consequences, followed by journalists, the public, and lastly politicians (see Table 28 and Figure 14).

Table 27 presents the ANOVA results for knowledge types. Overall, this analysis showed that participants had higher knowledge of the causes of climate change than of the state of the climate or of the consequences of climate change. Of the four groups, climate change experts and journalists had significantly higher overall knowledge of climate change than politicians.

Table 27: Summary of ANOVA results for knowledge type

Statistical test	Finding	Explanation
Type of ANOVA	4 (group) x 3 (knowledge type) repeated measures ANOVA, with repeated measure on knowledge type	The groups were: climate change experts, politicians, journalists, and the public. The knowledge types were: state, causes, and consequences of climate change.
Main effect of knowledge type	$F(1.85, 812.75) = 48.77, p < .0005$, Greenhouse-Geisser $\epsilon = .92$	Knowledge levels significantly varied by knowledge type.
Main effect of group (job type)	$F(3, 440) = 2.93, p < .05$	Knowledge levels significantly varied by group.
Interaction effects	None	The lack of significant interactions between knowledge type and group; knowledge type and survey version; or knowledge type, group, and survey version means that the relationship between knowledge level and knowledge type was the same for each group and each survey version.
Bonferroni on knowledge type	Pairwise comparisons between state and causes were significantly different ($p < .0005$), as were those between causes and consequences ($p < .0005$), but not between state and consequences ($p = .42$).	Participants had similar levels of knowledge of state and consequences, but different levels of knowledge of causes. Figure 14 shows that all the groups' knowledge of causes was much higher than knowledge of state or consequences.
Bonferroni on group	Politicians had significantly less accurate knowledge than climate change experts ($p < .05$) and journalists ($p < .05$).	See Figure 14.

Table 28: Mean levels of climate change knowledge

Group	State		Causes		Consequences	
	Mean	SD	Mean	SD	Mean	SD
Climate change experts (N = 97)	0.75	0.26	0.84	0.19	0.75	0.19
Politicians (N = 29)	0.64	0.27	0.79	0.19	0.60	0.27
Journalists (N = 37)	0.78	0.22	0.88	0.17	0.74	0.17
Public (N = 289)	0.71	0.26	0.84	0.18	0.68	0.20

(The highest mean scores are in bold.)

Figure 14: Mean levels of climate change knowledge

Knowledge of consequences

Comparing mean knowledge levels of the different climate change consequences showed that, overall, experts had the highest knowledge levels followed by journalists, then the public, and lastly politicians (see Table 30 and Figure 15).

Table 29 presents the ANOVA results for consequence types. Overall, this analysis showed that participants had significantly higher knowledge of the New Zealand-specific and health consequences of climate change than of the weather consequences or sea level and glacier consequences. Of the four groups, climate change experts and journalists had significantly higher overall knowledge of climate change consequences than politicians.

Table 29: Summary of ANOVA results for consequence types

Statistical test	Finding	Explanation
Type of ANOVA	4 (group) x 4 (consequence type) repeated measures ANOVA, with repeated measure on consequence type	The groups were: climate change experts, politicians, journalists, and the public. The consequence types were: weather, sea level and glacier, New Zealand, and health.
Main effect of consequence type	$F(2.48, 1090.77) = 40.55, p < .0005$, Green house-Geisser $\epsilon = .83$	Knowledge levels significantly varied by consequence type.
Main effect of group (job type)	$F(3, 440) = 3.51, p < .05$	Knowledge levels significantly varied by group.
Interaction effects	None	
Bonferroni on consequence type	All pairwise comparisons were significantly different ($p < .0005$), except for those between New Zealand consequences and health consequences ($p > .05$).	Figure 15 shows that knowledge of weather consequences was lowest, followed by sea level and glacier consequences. Knowledge of New Zealand and health consequences was highest.
Bonferroni on group	Climate change experts had significantly more accurate knowledge of consequence types than politicians ($p < .01$), and that politicians had significantly lower knowledge of consequence types than journalists ($p < .05$).	See Figure 15.

Table 30: Mean levels of knowledge of climate change consequences

Group	Weather		Sea level / glacier		NZ		Health	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Experts (N = 97)	0.62	0.31	0.79	0.21	0.85	0.32	0.87	0.26
Politicians (N = 29)	0.51	0.36	0.64	0.29	0.69	0.41	0.67	0.38
Journalists (N = 37)	0.65	0.31	0.77	0.18	0.85	0.29	0.85	0.29
Public (N = 289)	0.61	0.29	0.70	0.21	0.78	0.35	0.80	0.30

(The highest mean scores are in bold.)

Figure 15: Mean levels of knowledge of climate change consequences

5.4.3 Confidence in knowledge

Confidence in knowledge of state, causes, and consequences

Comparing participants' mean confidence levels showed that experts were the most confident in their knowledge of state, causes, and consequences of climate change, followed by politicians, then journalists, then the public (See Table 32 and Figure 16).

Table 31 shows the ANOVA results for confidence in knowledge type. Overall, this analysis showed that participants had significantly higher confidence in their knowledge of the causes of climate change than in their confidence in their knowledge of state or consequences. This differed only for politicians, who had significant similarly high confidence in their knowledge of both causes and consequences. Of the four groups, climate change experts had significantly higher overall confidence in their knowledge of climate change than both journalists and the public, but not politicians.

Table 31: Summary of ANOVA results for confidence in knowledge type

Statistical test	Finding	Explanation
Type of ANOVA	4 (group) x 3 (knowledge type) repeated measures ANOVA, with repeated measure on knowledge type.	The four groups were climate change experts, politicians, journalists, and the public. The three knowledge types were the state, causes, and consequences of climate change.
Main effect of knowledge type	$F(1.85, 811.83) = 49.64, p < .0005$, Greenhouse-Geisser $\epsilon = .92$	Confidence levels significantly varied by knowledge type.
Main effect of group (job type)	$F(3, 440) = 23.64, p < .0005$	Confidence levels significantly varied by group.
Interaction effects	$F(5.54, 811.83) = 2.66, p < .05$, Greenhouse-Geisser $\epsilon = .92$	The difference across confidence in knowledge type significantly varied by group. The difference was that politicians' confidence followed a different pattern to the other groups. Experts had similarly high levels of confidence in consequences as they did in causes, while all other groups had relatively similar levels of knowledge of state and consequences (see Figure 16).
Bonferroni on knowledge type	All pairwise comparisons were significant ($p < .0005$), except between confidence in knowledge of state and confidence in knowledge of consequences ($p = .09$).	Participants were more confident in their knowledge of causes than in their knowledge of state or consequences.
Bonferroni on group	Climate change experts had significantly higher confidence in their knowledge of state, causes, and consequences than journalists ($p < .0005$) and the public ($p < .0005$).	See Figure 16.

Table 32: Mean levels of confidence in climate change knowledge

Group	Confidence in state		Confidence in causes		Confidence in consequences	
	Mean	SD	Mean	SD	Mean	SD
Experts (N = 97)	4.74	0.65	5.20	0.56	4.73	0.54
Politicians (N = 29)	4.38	0.89	4.63	0.70	4.58	0.71
Journalists (N = 37)	4.19	0.85	4.57	0.94	4.22	0.84
Public (N = 289)	3.99	0.91	4.45	0.79	4.11	0.79

(The highest mean scores are in bold.)

Figure 16: Mean levels of confidence in climate change knowledge

Confidence in knowledge of different consequences

Comparing participants' mean levels of confidence in their knowledge of consequences showed similarly that experts had the highest confidence levels, followed by politicians, then by journalists, and lastly the public (see Table 34 and Figure 17).

Table 33 summarises the ANOVA findings. Overall, this analysis showed that participants had significantly higher confidence in their knowledge of health and New Zealand-specific consequences of climate change than of weather consequences or of sea level and glacier consequences. Of the four groups, climate change experts had significantly higher overall confidence in their knowledge of climate change consequences than journalists and the public, and politicians had significantly higher confidence than the public.

Table 33: Summary of ANOVA results for confidence in consequence type

Statistical test	Finding	Explanation
Type of ANOVA	4 (group) x 4 (consequence type) repeated measures ANOVA, with repeated measure on consequence type	The groups were: climate change experts, politicians, journalists, and the public. The consequence types were: weather, sea level and glacier, New Zealand, and health.

Statistical test	Finding	Explanation
Main effect of consequence type	$F(3, 1320) = 46.49, p < .0005$	Confidence levels significantly varied by consequence type.
Main effect of group (job type)	$F(3, 440) = 14.31, p < .0005$	Confidence levels significantly varied by group.
Interaction effects	$F(9, 1320) = 2.13, p < .05$	As with confidence in knowledge type, the difference across confidence in knowledge of consequence type significantly varied by group. The difference was that experts' knowledge followed a different pattern to the other groups (see Figure 17). Experts had a much higher knowledge of sea level and glacier consequences than the other groups, and a (comparatively) much lower knowledge of health consequences.
Bonferroni on consequence type	All pairwise comparisons were significantly different ($p < .0005$), except for those between sea level and glacier consequences and New Zealand consequences ($p = .48$).	Participants had significantly higher knowledge of health and New Zealand consequences than of weather or sea level and glacier consequences (see Figure 17).
Bonferroni on group	Climate change experts had significantly higher confidence in their knowledge of the types of consequences of climate change than journalists ($p < .05$) and the public ($p < .0005$). Politicians had significantly higher confidence in their knowledge of the types of consequences of climate change than the public ($p < .05$).	See Figure 17.

Table 34: Mean levels of confidence in knowledge of climate change consequences

Group	Weather		Sea level and glacier		New Zealand		Health	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Experts (N = 97)	4.38	0.88	4.88	0.65	4.69	0.84	5.12	0.77
Politicians (N = 29)	4.29	1.06	4.57	0.63	4.90	0.79	4.95	0.86
Journalists (N = 37)	3.94	0.95	4.28	0.90	4.45	1.13	4.66	0.98
Public (N = 289)	3.82	0.94	4.13	0.90	4.25	1.08	4.67	0.94

(The highest mean scores are in bold.)

Figure 17: Mean levels of confidence in knowledge of climate change consequences

Relationship between knowledge and confidence

Overall, the general public had the best match between knowledge and confidence, causes was the best-matched knowledge type, and knowledge of health consequences the best-matched consequence type.

As Table 35 shows, the match between knowledge and confidence was best for the public, followed by climate change experts, then journalists, and lastly politicians. Of the three main knowledge types (state, causes, consequences), climate change experts and the public had the best match for causes (these were the only significant correlations for knowledge type). Of the four consequence types, climate change experts had the best match for sea level and glacier consequences, while the public had the best match for health consequences, followed by New Zealand consequences (these were the only three significant correlations for consequence type). Politicians and journalists had no significant correlations at all.

Table 35: Relationships between knowledge and confidence in knowledge (Pearson's correlation coefficients)

	Experts	Politicians	Journalists	Public
State	.11	.12	.05	.11
Causes	.22*	-.02	.13	.21**
Consequences	-.03	-.11	.03	.08
— Weather	-.10	.05	-.00	.03
— Sea level and glacier	.24*	-.09	.14	.07
— New Zealand	.01	.06	.26	.19**
— Health	.16	.16	.29	.25**

(Significant scores are in bold. Asterisks indicate the degree of significance.)

** = $p < 0.01$

* = $p < 0.05$

This analysis showed that the public and climate change experts had a better balance between their actual knowledge of climate change and how confident they were in their knowledge than journalists or politicians. Overall, participants had a more accurate and well balanced knowledge of the causes of climate change than for any of the other knowledge and consequence types.

5.4.4 Regression analyses

Knowledge and concern

Testing concern with an overall measure of accurate knowledge

Table 36 shows that accurate knowledge of climate change was a significant positive predictor of concern for climate change. Perceived efficacy was also positively correlated with concern, and was the strongest predictor in the model. Gender (male) and support for Labour were both small but significant negative predictors of concern. As in Study 1, perceived information level was not a significant predictor of concern for climate change. The variance explained by the model was 37.9 percent.

A profile of a participating member of the public with high concern for climate change would be a female participant with low support for Labour, high levels of perceived efficacy and responsibility, and high accurate knowledge of climate change.

Testing concern with three separate measures of knowledge: State, causes, consequences

For the second multiple regression, the accurate knowledge of climate change variable was split into three separate variables measuring accurate knowledge of the state, causes, and consequences of climate change. Table 37 shows that knowledge of consequences was the only type of knowledge that significantly predicted concern for climate change, with a highly significant positive correlation. As in the previous model, gender (being male) and support for Labour were significantly negatively correlated with concern (though with slightly weaker correlations), and perceived efficacy was a significant positive predictor (with a slightly stronger correlation). Perceived efficacy remained the strongest predictor of concern, followed by knowledge of consequences. This model accounted for slightly more variance than with the single accurate knowledge variable reported in Table 36 (38.1 percent compared to 37.9 percent).

Perceived efficacy regression

Because perceived efficacy was such a powerful predictor of concern, the perceived efficacy regression from Study 1 (see Table 16) was re-run. The regressions cannot be precisely compared, as several of the Study 1 variables were not included in Study 2. The missing variables are ethnicity, religious-service attendance, political ideology, environmental values, media trust, trust in experts, and confidence in science. Only environmental values and trust in experts were consistent significant predictors of concern in Study 1. The single measure of actual knowledge was included in this regression also. Table 38 shows that actual knowledge was a highly significant, relatively strong positive predictor of perceived efficacy. Support for Labour was also highly significant, and was a positive predictor of perceived efficacy.

Table 36: Public concern for climate change with one measure of knowledge

Independent variables	B	Standard error	Beta (β)	t
Gender (male)	-0.238	0.062	-0.211	-3.815***
Education	-0.004	0.030	-0.008	-0.145
Income	0.010	0.015	0.035	0.684
Age	0.000	0.002	-0.001	-0.027
Support Labour	-0.042	0.020	-0.124	-2.080*
Support National	-0.034	0.018	-0.107	-1.876
Perceived knowledge level	0.020	0.014	0.086	1.501
Perceived efficacy	0.363	0.060	0.391	6.065***
Accurate knowledge level	0.915	0.201	0.273	4.549***
Constant	1.347	0.265		5.081***
R ²	.401			
Adj. R ²	.379			
F	18.20			
N	289			

Note: The dependent variable is concern for climate change (see Table 9).

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

Table 37: Public concern for climate change with three measures of knowledge

Independent variables	B	Standard error	Beta	t
Gender (male)	-.229	.063	-.203	-3.647***
Education	.001	.031	.001	.019
Income	.008	.015	.028	.546
Age	.000	.002	-.007	-.120
Support Labour	-.041	.020	-.120	-2.008*
Support National	-.028	.018	-.089	-1.544
Perceived knowledge level	.019	.014	.079	1.379
Perceived efficacy	.375	.061	.405	6.197***
Knowledge of state	.070	.125	.032	.554
Knowledge of causes	.045	.212	.014	.210
Knowledge of consequences	.739	.185	.255	3.988***
Constant	1.357	.266		5.110***
R ²	.408			
Adj. R ²	.381			
F	15.212			
N	289			

Note: The depended variable is concern for climate change (see Table 9).

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

Table 38: Perceived efficacy

Independent variable	B	Std error	Beta	t
Gender (male)	-.099	.066	-.081	-1.492
Education	-.015	.032	-.024	-.477
Income	.028	.016	.087	1.708
Age	-.002	.002	-.051	-.948
Support for Labour	.100	.021	.274	4.842***
Support for National	-.035	.019	-.104	-1.854
Perceived knowledge level	.005	.014	.019	.327
Actual knowledge level	1.649	.187	.456	8.830***
Constant	1.643	.262		6.260***
R ²	.411			
Adj. R ²	.392			
F	21.492			
N	289			

Note: The dependent variable is perceived efficacy (see Table 10).

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

5.5 Study 2 discussion

5.5.1 Knowledge findings

Knowledge

Contrary to expectations, journalists had the highest knowledge of state and causes, although experts had the highest knowledge of consequences. Politicians had the lowest levels of all types of knowledge and consequence.

A reason for journalists scoring surprisingly higher than climate change experts on state and causes of climate change could be because of the wording of the survey. A number of scientists emailed afterwards to say that they felt uncomfortable being asked to express scientific predictions with simple true or false answers, as uncertainty is inherent in science. It is possible that scientists answered conservatively because of this. Another possible reason could be that the survey did not explicitly differentiate between anthropogenic climate change and historic natural climate change. Scientists again emailed criticising this, and it is possible that their answers reflected this concern. However, more relevant for the bigger picture is the balance between knowledge and confidence, discussed below.

It is interesting that politicians consistently had the lowest knowledge levels, while the public had higher levels of knowledge more similar to journalists than to politicians. This could be partly because New Zealand local government contains a disproportionate number of farmers, and farmers have very low knowledge of climate change (see Appendix D).

These findings differ from Sundblad et al.'s findings as they found that experts had the highest levels of knowledge for all knowledge and consequence types, followed by journalists, then politicians, and then the public. It is important to remember that Sundblad et al.'s politicians were all environmental politicians—members of environmental committees, and their journalists also environmental journalists, while Study 2 did not have large enough samples to replicate this. This may explain why Swedish politicians had higher knowledge levels than New Zealand politicians. Sundblad et al. do not mention feedback from Swedish participants similar to the feedback received on Study 2, such as that from experts critical of the survey wording

(wording was taken directly from Sundblad's translation of their own survey) as well as feedback from climate sceptics (discussed later). This points to interesting differences between Swedish and New Zealand participants, which it would be interesting to explore further. Are New Zealanders generally more sceptical about climate change? It could also point to language and translation differences, as the survey was based on an English translation of the original Swedish survey. Some meaning or intent could have been lost in translation, although it is important to highlight again that all statements were checked by an expert who worked for the IPCC.

Prediction 7: Participants will have higher knowledge of causes than of state or consequences—confirmed

As predicted, participants had a higher knowledge of causes than of state or consequences. Across all groups, knowledge of causes was highest, followed by knowledge of state, and knowledge of consequences was lowest (except for climate change experts who had equal knowledge of state and consequences). This is similar to Sundblad et al.'s findings. Swedish participants also had highest knowledge of causes, followed by state and consequences.

Sundblad et al. note that although the state of the climate is the more easily verifiable knowledge type (relying on scientific observations), it is more difficult to convey to the public as it is expressed as numbers (such as concentrations of greenhouse gases, measurements of sea level and temperature, and emissions of carbon dioxide). Knowledge of causes is higher because it is probably more easily represented as narratives and also, consequentially, as news stories. Knowledge of consequences is knowledge of what the future will be like. It is inherently uncertain and based upon models and predictions, which are constantly being refined and revised. Understandably knowledge of consequences was lowest.

Of the consequence types, participants' knowledge of health consequences was highest, then New Zealand consequences, followed by sea level and glacier consequences, and knowledge of weather consequences was lowest. Interestingly, Sundblad et al. found health knowledge was the lowest for Swedish participants. However, as discussed below, the questions relating to health were not directly comparable. Scientists do not predict as devastating consequences of climate change for New Zealand in the short term as for most other countries. The IPCC only includes two projected consequences

for New Zealand, increased drought and fire in certain regions and increased water security problems by 2030 (Pachauri & Reisinger, 2007). This could mean that New Zealanders do not feel they need to be particularly informed about the consequences of climate change, as they perceive themselves to be relatively immune to them.

Participants had lowest knowledge of weather consequences and sea level and glacier consequences. This could partly be due to the fact that, as Sundblad et al. noted for state-related information, these consequences are similarly expressed numerically, in terms of meters of sea level rise and degrees of temperature increases, meaning they are harder to understand and remember, and appear to constantly be changing. Many of the statements relating to these consequence types also referred to northern hemisphere weather patterns, or to consequences for the Arctic rather than Antarctica, meaning they were less relevant to New Zealand participants and probably contributed to low scores on knowledge of consequences.

Confidence

Similarly to knowledge levels, confidence was higher for knowledge of causes, although confidence in consequences was higher than confidence in state. Sundblad et al. found that confidence levels varied between groups similarly to knowledge levels, with experts having highest levels of confidence (and knowledge), followed by journalists, then politicians, then the public. This was not the case for the New Zealand groups. New Zealand experts had the highest levels of confidence for all knowledge and consequence types, followed by politicians, then journalists, and the public had the lowest confidence levels.

It is particularly interesting that politicians had such high levels of confidence in their low knowledge of climate change, and probably reflects a tendency for politicians to generally overestimate their own knowledge (perhaps a necessary prerequisite for a career in politics).

Knowledge adjusted by confidence

Prediction 6: Climate change experts will have the highest knowledge and confidence in knowledge of climate change, followed by journalists, then politicians, then the public—unconfirmed

Overall, participants (at the group level) did not have a significant match between knowledge and confidence, although the public and experts were better matched than journalists and politicians. Journalists had high actual knowledge but it was matched with low confidence, suggesting perhaps some good guesswork. Politicians were the opposite, with low knowledge yet high confidence, suggesting a general over-confidence in their knowledge. Sundblad et al. found, contrastingly, that journalists and experts had a better match between confidence and knowledge than politicians and the public, with journalists surprisingly better matched than experts. One reason for this could be because the group sizes of journalists and politicians were much lower than the group sizes for the public and for experts (see Table 20), as well as the fact that Sundblad et al. surveyed environmental journalists and environmental politicians.

The general public and experts had the best match between knowledge and confidence, meaning they were more realistic in terms of their level of knowledge and confidence in their knowledge (Table 35).

Of the knowledge types, causes had the best match between knowledge and confidence, but it was still not well matched. There was no significant relationship between knowledge and confidence for state or consequences, suggesting a high degree of confusion among participants, and perhaps a lot of guesswork when answering these questions.

Even the significant correlations for the public and for experts are still quite small (the highest is .25** for the public's knowledge of health consequences). The overall lack of calibration between knowledge and confidence in knowledge is consistent with research that has found that the public's main source of climate change information, the media, misrepresents the scientific consensus and increases public (and apparently journalists' and politicians') uncertainty about climate change (Antilla, 2010; Boykoff, 2008; 2009; Boykoff & Boykoff, 2004; Cox, 2010; Lowe et al., 2006; Wilson, 2000).

Analysis of other groups

Although Appendix D's analysis of other groups (environmental experts, non-environmental experts, policy advisers, managers, and farmers) cannot be compared to Sundblad et al.'s findings, it is interesting to briefly address these findings and compare the results to the main Study 2 analysis.

This analysis found that policy advisors had the highest levels of knowledge for all the knowledge and consequence types, followed by environmental experts, then non-environmental experts, then managers, and finally—and distantly—by farmers. Confidence levels did not follow this same pattern and varied particularly among consequence types, but, overall, environmental experts were by far the most confident in their knowledge, followed by non-environmental experts, then managers and policy advisers, and finally farmers.

When the knowledge scores were adjusted by confidence levels, policy advisers had the best match, followed by environmental experts, then managers, then non-environmental experts, and finally farmers.

Comparing all the groups, Table 39 shows that policy advisers had the highest knowledge of causes and consequences, while journalists had the highest knowledge of state. The public outperformed managers, politicians, and farmers.

Overall, the groups in this second analysis had much better matches between their knowledge and confidence than the main groups discussed in Study 2. Policy advisers had by far the best match between knowledge and confidence out of all the groups examined in this thesis. They displayed positive and relatively strong correlations for all the knowledge and consequence types bar weather consequences.

An explanation for policy advisers and journalists outperforming climate change experts and environmental experts could be that policy advisers were highly knowledgeable about climate change, but were also more comfortable with the true / false statements and the certainty scales than experts were (discussed later).

Figure 18: All groups' knowledge of climate change

5.5.2 Regression findings

Knowledge and concern

Prediction 1: Actual knowledge of climate change will predict concern for climate change—confirmed

Prediction 5: Actual knowledge of climate change will be a better predictor of concern than perceived knowledge—confirmed

As in Study 1, perceived knowledge level did not significantly predict concern for climate change. However, the measure of actual knowledge *did* significantly predict concern. Actual knowledge was a significant positive predictor, and the second best predictor of concern after perceived efficacy. This suggests that the knowledge-deficit theory applies to actual knowledge of climate change, but not to perceived knowledge. This is discussed more fully in Chapter 6, the general discussion section.

Prediction 5: Knowledge of the causes of climate change will predict concern better than knowledge of state or consequences—unconfirmed

Contrary to expectations, knowledge of the consequences of climate change was the only significant predictor of concern. This is contrary to what was predicted based on the findings of Bord et al. (2000), that accurate knowledge of causes is the best predictor of behavioural intentions to act and vote to mitigate climate change. On closer inspection this seems reasonable, as the measure of concern (taken from Kellstedt et al.) was actually a measure of belief in the impact of negative consequences of climate change. This finding confirms research by Sundblad et al. (2007), which found that knowledge of consequences, particularly health consequences, predicted concern for climate change.

Perceived efficacy

Prediction 3: Participants with high perceived efficacy will have high concern for climate change—confirmed

As in Study 1, perceived efficacy was the best predictor of concern for climate change. It was highly significantly positively associated with concern. This reinforces findings from Study 1 and from previous research suggesting that perceived efficacy is one of the strongest predictors of concern for climate change (Brody, Zahran, Grover, et al., 2008; Heath & Gifford, 2006; Kellstedt et al., 2008).

Perceived efficacy regression

Because the Study 2 perceived efficacy regression excluded the main significant variables from Study 1 (environmental values and trust in experts), it is difficult to compare the two models and draw firm conclusions, though broad comparisons can be made. Perceived knowledge level was not a significant predictor of perceived efficacy in either model, while actual knowledge level was a highly significant and relatively strong positive predictor of perceived efficacy in the Study 2 model. Support for Labour was also a highly significant predictor in Study 2. None of the demographic variables were significant in the Study 2 model.

Interestingly, when the perceived efficacy regression was run for the total Study 2 sample (see Appendix E), not just the non-environmental public group used for all the Study 2 regressions, gender (male) was found to be a significant negative predictor of perceived efficacy ($\beta = -.14^{***}$), as was support for Labour ($\beta = .21^{***}$) and (National

($\beta = -.096^{***}$). This suggests that among the participants who were scientists, academics, politicians, journalists, and members of the public whose work related to the environment, there were significant differences by gender and by political party support. It appears that among participants who work in environmental fields, women and participants with high support for Labour and low support for National have higher levels of perceived efficacy.

Gender and political party support

Prediction 4: Female and younger participants will have higher concern for climate change than male and older participants—partially confirmed

Gender was highly significantly negatively correlated with concern, meaning that male participants showed significantly less concern for climate change than female participants. Age was not significantly related to concern for these participants. The limited effect of demographic variables compared to information and identity variables is consistent with findings from previous research (Kellstedt et al., 2008; Whitmarsh, 2011).

Support for Labour was surprisingly negatively correlated with concern, suggesting participants with high support for Labour had lower levels of concern for climate change. This is a similar finding to Kellstedt et al., who found that, in their baseline model, being Republican was significantly correlated with high concern for climate change, a finding inconsistent with the literature on this subject (Heath & Gifford, 2006; Leiserowitz, 2005; Leiserowitz, Roser-Renouf, et al., 2010; Malka et al., 2009; Mobley et al., 2010; Whitmarsh, 2011; Xiao & McCright, 2007). Kellstedt et al. attributed their finding to the influence of the new ecological paradigm (NEP). However, it is possible that the present results may reflect Green party voters and other minor party voters having strong climate change concern. Support for National was also negatively correlated with concern, though it was nonsignificant.

Study 2 did not include the NEP, suggesting that perhaps this finding was perhaps due to the exclusion of the NEP or to the inclusion of the measure of actual knowledge. This finding for Labour is the opposite of that found for Study 1, where participants with high support for Labour had significantly higher concern for climate change at Time 1.

5.5.3 Limitations

Group sizes

The size of the journalist and politician groups were quite small, with only 29 politicians and 37 journalists. This means that the results relating to these groups are less reliable than the results relating to climate change experts and to the public. It is an interesting finding in itself that journalists, politicians, and farmers were the most reluctant to complete the survey.

Several of the variables measuring different types of climate change knowledge also had low numbers of statements (see Appendix C). In particular, knowledge of New Zealand consequences and knowledge of health consequences both comprised only two statements. This is because Sundblad et al. had six health statements, including Swedish-specific health consequences. Because there are fewer health consequences projected for New Zealand, Sundblad et al.'s health questions were split into two groups: New Zealand-specific statements (two statements), and general health statements (two statements). Consequentially, results relating to these knowledge types may be less reliable than results relating to knowledge types composed of larger groups of statements.

No nationally representative sample

As Study 2 replicated an overseas study, it did not aim for a nationally representative sample of New Zealanders, rather representatives of certain groups. While this was suited to the specific task of comparing knowledge levels of different groups, it means the findings cannot be extrapolated to the general New Zealand population, nor perfectly compared to Study 1 results.

The sampling method was snowball and self-selection as this was the best method possible given the resourcing and nature of the study. Hence it is not as representative as a random sample would be.

6 General discussion

6.1 Main findings

6.1.1 Knowledge and concern

Study 1 and Study 2 both found that perceived knowledge of climate change did not significantly predict concern for climate change (although knowledge and concern were positively related). Study 2 found that actual knowledge of climate change did predict concern for climate change. Together, Study 1 and Study 2 suggest that the knowledge-deficit theory applies to concern for climate change, but only when using a measure of actual knowledge. In other words, this research suggests that people with high levels of actual knowledge of climate change will be more concerned about climate change than those with lower knowledge levels, and that there is no relationship between perceived knowledge and concern for climate change.

Perceived knowledge

The most likely reason for Study 1's and Kellstedt et al.'s divergence from the knowledge-deficit theory appears to be that they used measures of perceived knowledge, not actual knowledge. Study 2 supports this explanation.

As Study 1 relied on perceived knowledge of climate change, it is impossible to know whether participants' perceived knowledge was accurate or not. Not all of the information available on climate change accurately represents the scientific consensus, and some websites, books, and movies actively attempt to do the opposite and aim to discredit scientists and spread scepticism. It is relatively easy for someone sceptical of climate change to exist in a bubble of scepticism and only encounter and focus on information written by other sceptics. Testing the knowledge-deficit theory with a measure of perceived knowledge could reveal high perceived knowledge and low concern (as Kellstedt et al. found). This does not necessarily mean the knowledge-deficit theory does not apply, but could mean that it is working perfectly well according to the information that people have encountered. This is why it is important to examine actual knowledge of climate change as well as perceived knowledge.

The media is the main source of public information on climate change (Bell, 1994; Leiserowitz, Smith, et al., 2010; Whitmarsh, 2009). American research has shown how journalistic norms, particularly the need to present a ‘balanced’ story, create a greatly exaggerated perception of scientific debate on climate change (M. Boykoff & J. Boykoff, 2004, 2007; Lowe et al., 2006). Other research has shown that journalists themselves, even environmental journalists, have low knowledge of climate change, and rely on other media sources rather than scientists or scientific publications (Antilla, 2005; Trumbo, 1996; Wilson, 2000). However, Sundblad et al. (2009) found that Swedish journalists had a good match between knowledge and confidence in knowledge of climate change (a better match than climate experts in fact). Contrastingly, my research found that, although New Zealand journalists scored highly in a climate change knowledge test, they had low confidence in their knowledge, suggesting perhaps good guesswork but general confusion about climate change, or perhaps undue modesty in their fairly high level of knowledge.

Taking the problems with media reporting on climate change into account, it is possible that participants could have believed themselves to have high knowledge of climate change but to also have believed that scientists are still making up their minds about whether climate change is a real risk. This could have led participants to be confused about the risks of climate change and could help to explain why research examining the relationship between perceived knowledge of climate change and concern produces such inconclusive and contradictory results. This also supports the proposition that the knowledge-deficit theory does not (or perhaps cannot) apply when the knowledge is really people’s perceptions of their own knowledge, or confidence in their knowledge, not objectively tested knowledge.

Changing levels of perceived knowledge and concern over time

Other longitudinal research has identified a trend in decreasing concern for climate change (HSBC Climate Partnership, 2010; Jones, 2011a; Leiserowitz, Roser-Renouf, et al., 2010; Lorenzoni & Pidgeon, 2006; Nielsen, 2009a; Pew Research Center, 2009; Radio New Zealand, 2010; ShapeNZ, 2010; The World Bank, 2009).

It is difficult to compare Study 1 and 2 levels of concern and perceived knowledge, as the studies involved completely different participants, with different socio-demographic characteristics. Overall, Study 1 over-represented females and Study 2 over-represented

males (compared to the 2006 census data). Study 1 participants had a higher median age, while Study 2 had a lower median age. Participants from both studies were much more highly educated (particularly in Study 2), had higher incomes (particularly Study 2), and were over-represented by participants from the Wellington-Wairarapa region than the 2006 census respondents.

Bearing this in mind, Table 39 shows that concern levels were stable from June 2008 to June 2009 for Study 1 participants, though perceived knowledge levels fluctuated. Both perceived knowledge levels and concern levels were lower in October 2010 for Study 2 non-environmental public participants than for Study 1 participants at any of the three time-points. Although these findings cannot be generalised to the New Zealand population, the slightly decreased concern levels from Study 1 to Study 2 do correspond with observed trends in other research. Perceived knowledge levels would be expected to fluctuate in response to media coverage of, and political attention to, climate change (see Table 19).

Examining the political context in New Zealand over this time period also allows interesting speculation on potential causes of changing concern and perceived knowledge levels. At Time 1 of Study 1 (June 2008), the New Zealand Labour government was still in power. The Labour government (centre-left on the political spectrum) had prioritised climate change. Five months later, at Time 2 of Study 1 (November 2008), New Zealand had just had a general election and the government changed to a National-led government (centre-right on the political spectrum). The National government formed a coalition with the ACT Party (far right on the political spectrum), which is openly sceptical about climate change, and is determined to abolish the New Zealand Emissions Trading Scheme (ETS) and withdraw New Zealand from the Kyoto Protocol. Since coming to power, the National-led government has reduced the priority given to climate change, is reviewing the New Zealand ETS, and has weakened New Zealand's emissions targets.

This change in government and decreased political priority of climate change could have contributed to the decreasing concern between Study 1 and Study 2, in spite of the increasing scientific consensus on climate change. Another event that could have contributed to this is 'Climategate', which occurred in November 2009, between Study 1 and Study 2.

Table 39: Study 1 and Study 2: Changing levels of perceived knowledge and concern

	Study 1: Time 1 June 2008	Study 1: Time 2 November 2008	Study 1: Time 3 June 2009	Study 2 October 2010
Perceived knowledge level	6.09	6.03	6.21	5.90
Concern level	2.53	2.53	2.53	2.51

Actual knowledge

Study 2 found that accurate knowledge of climate change, particularly of the consequences of climate change, was the second strongest positive predictor of concern after perceived efficacy. The higher participants' accurate knowledge of climate change, the higher their concern levels. This supports the knowledge-deficit theory and reinforces similar findings in previous studies assessing the relationship between actual knowledge of climate change and climate change attitudes and beliefs (Bord et al., 2000; Leiserowitz, N. Smith, et al., 2010; Nolan, 2010; Sundblad et al., 2007).

The scientific consensus on climate change suggests that the public should have high levels of concern for climate change. Study 1 found that perceived knowledge levels did not accurately predict concern and probably reflected the high level of confusion and uncertainty confounding public understanding of climate change. Misleading media reporting leads to confused perceptions of the scientific consensus. Actual knowledge of climate change represents an understanding of the scientific consensus on climate change. As predicted, and in line with the knowledge-deficit theory and the scientific consensus on climate change, Study 2 found that high accurate knowledge led to high concern.

6.1.2 Perceived efficacy

Perceived efficacy was consistently the strongest predictor of concern for climate change at all three time-points in Study 1 and for Study 2. Participants who had stronger perceptions that their actions could make a difference (and influence others to make a difference), and who also had stronger beliefs that climate change is due to human activity, had significantly higher concern for climate change. Perceived efficacy and environmental values were the only consistently significant predictors of concern at all survey points. Although environmental values were not measured in Study 2, based on Study 1 results, it is reasonable to assume that it would also have been a significant positive predictor of concern in Study 2.

Study 1 and 2 perceived efficacy findings reinforce previous research suggesting that perceived efficacy is one of the strongest predictors of concern for climate change (Brody, Zahran, Grover, et al., 2008; Heath & Gifford, 2006; Kellstedt et al., 2008). Believing in anthropogenic climate change, and believing that one's actions can actually make a difference, appear to be some of the most important predictors of concern.

Promoting perceived efficacy

This research reinforces the findings in the literature, and suggests that policies aiming to increase public concern for climate change should strongly focus on increasing public perceptions of efficacy and on ensuring that the scientific consensus on climate change is filtering through to the public. Further research could examine ways of increasing public perceptions of efficacy and on how the New Zealand media communicates climate change.

The perceived efficacy models from Study 1 (without the accurate knowledge variable) found that high trust in experts was the strongest predictor of perceived efficacy, followed by environmental values. Age and gender (male) were negative predictors of perceived efficacy. The Study 2 model (without the trust or environmental values variables) found that accurate knowledge was the strongest predictor of perceived efficacy—this was the largest coefficient in any of the perceived efficacy models—followed by support for Labour.

The perceived efficacy models suggest that increasing public knowledge of climate change, increasing public trust in climate change experts, and activating environmental values would lead to higher public perceptions of efficacy, in turn leading to higher concern for climate change. Further research should focus on the most effective ways of doing this.

Identity variables like environmental values and political ideology and party support had significant effects on participants' concern for climate change and perceived efficacy. These identity variables tapped into participants' cultural worldviews and underlying values, which have been found to be some of the strongest predictors of beliefs in, and perceptions of, climate change (Crompton, 2010; Kahan et al., 2010; Leiserowitz, 2005, 2006; Whitmarsh, 2011). Kahan et al. (2010) found that they could overcome the effect of cultural worldviews and values on participants' interpretation of

the scientific consensus of climate change by presenting information that participants were culturally primed to oppose via experts that they are culturally primed to trust. Research like this in a New Zealand context is needed.

Policies aiming to increase public concern and perceived efficacy should be informed by research like Kahan et al.'s, and take into account the range of different values and worldviews that affect how people differently interpret and respond to information, particularly about a topic as polarising and value-laden as climate change.

6.1.3 Demographic variables

Gender and age

Gender (being male) was significantly negatively associated with concern for climate change in the baseline model at Time 3 of Study 1, and in Study 2. Age was also significantly negatively associated with concern in the baseline models of Time 1 and Time 2 of Study 1 and in the expanded model at Time 1 of Study 1, but not in Study 2. The only other demographic variable tested that significantly predicted concern for climate change was religious service attendance, which was a positive predictor of concern in the baseline model at Time 2 of Study 1. The fact that it was non-significant at all other time-points and models suggests that its effect is explained by other variables. This thesis has not examined research on religious service attendance on concern for climate change, but a possible reason for higher concern could be if church leaders were expressing concern to their congregations. If so, this would be a good example of people accepting messages from trusted information sources. Further research could examine this.

Findings on age and gender from Studies 1 and 2 suggest that, although female and younger participants generally showed higher concern for climate change than male and older participants, these variables have varying effects, and can be cancelled out after introducing more powerful explanatory variables such as perceived efficacy, environmental values, and measures of actual knowledge. This ties in with previous research finding that identity and efficacy variables can reduce the explanatory power of demographic variables (Kellstedt et al., 2008; Whitmarsh, 2011).

6.1.4 Political party support

Political party support had varying effects on concern for climate change. In Study 1, support for Labour was positively correlated with concern in the baseline model of Time 1 only. In Study 2, support for Labour was, surprisingly, negatively correlated with concern. These limited and contradictory findings suggest that political party support was not a good predictor of concern for climate change for New Zealand participants in these surveys. Although previous research has found identity variables such as political ideology and political party support to be strong predictors of concern (Heath & Gifford, 2006; Leiserowitz, 2005; Leiserowitz, Roser-Renouf, et al., 2010; Leiserowitz, N. Smith, et al., 2010; Whitmarsh, 2011), this does not appear to be the case for these New Zealand participants. This could perhaps be due to the effect of the strong predictive ability of the perceived efficacy, environmental values, and actual knowledge variables, which explained the effect of political party support or political ideology. Another reason could be that New Zealanders are perhaps less partisan than Americans, who were participants in most previous studies on this topic. The inclusion of other New Zealand political parties in the analysis, such as the Green Party, could also have produced more significant results.

6.2 Qualifications and limitations

6.2.1 Concern variable

Malka et al. (2009) criticised Kellstedt et al. for not asking broad questions to measure concern. Malka et al. noted that by asking about the ‘perceived effects of GW [global warming], researchers have apparently presumed that concern is based upon perceptions of events: people who believe GW will have more undesirable consequences are presumably more likely to be concerned about it’ (p. 634). This suggests perhaps a cyclic relationship between concern and negative consequences of climate change, as they appear to measure the same thing. Study 1 and Study 2 kept Kellstedt et al.’s concern variable to allow the results to be compared.

6.2.2 Perceived efficacy variable

Kellstedt et al.'s perceived efficacy variable mingles the separate concepts of perceived responsibility (accepting that human behaviour causes climate change) and perceived efficacy (perceived ability to influence group outcomes and influence other people).

When Kellstedt et al. discussed the contribution of the perceived efficacy variable to their model, they often referred to it simply as 'responsibility', which is misleading. For example, they state that high perceived knowledge was correlated with low responsibility for climate change—when it is impossible to know from their research whether it is perceived efficacy or responsibility that produces this effect). Study 1 and Study 2 used the combined variable to allow comparison with Kellstedt et al.'s results.

Separating these concepts into two variables and re-running the analyses (see Appendix E) revealed that perceived efficacy and responsibility were both highly significant predictors of concern for both Study 1 and Study 2, although responsibility was stronger than perceived efficacy.

6.2.3 Missing variables from Study 1 regression analysis

The Study 2 survey did not include questions on: ethnicity, religious service attendance, political ideology, environmental values, trust in media, trust in experts, or confidence in scientists. None of these variables, except environmental values, were significantly associated with concern in Study 1, so it seemed reasonable to exclude them and simplify Study 2. Due to an error in the Study 1 data analysis, at the time of designing the Study 2 survey it appeared that environmental values were not significant predictors of concern in the expanded model, causing the variable to be excluded from Study 2. It was too late to add the variable once the error had been corrected.

Malka et al. (2009) proposed that a possible reason for Kellstedt et al. finding a negative correlation between perceived knowledge and concern for climate change could be precisely because they included the new ecological paradigm (NEP) in their analysis. They proposed that, although the NEP is meant to represent general environmental attitudes, some of the specific statements (particularly 'If things continue on their present course, we will experience a major ecological catastrophe' and 'When humans interfere with nature, it produces disastrous consequences') appeared to 'tap the

dependent variable they predicted: perception of undesirable environmental consequences of human activity' (p. 644). This led Malka et al. to conclude that it was not sensible to use the NEP as a predictor of climate change risk perceptions. Study 2's exclusion of the NEP could mean this potential problem was avoided for Study 2.

6.2.4 Qualitative feedback

One of the most interesting aspects of this research has been the quantity (and tone) of unsought feedback received about the Study 2 survey. It is not the purpose of this thesis to analyse these comments, but they reveal the strong reactions that climate change often provokes. Many of the comments reveal deep suspicion about climate change and distrust of the IPCC, indicating that people have a strong attachment to their knowledge claims about climate change. These participants may have found the survey threatening to their worldviews, leading them to discount the information presented by the IPCC as unreliable and discredited. A selection of example comments is included as Appendix F.

The main criticisms that participants had of the survey content and methodology are summarised below.

Lack of distinction between anthropogenic and historical climate change

A number of Study 2 participants emailed after taking the survey to complain that the survey did not make an explicit distinction between the anthropogenic climate change of the last 100 years and the historic ongoing natural climate change. The survey described climate change in this way to be consistent with Sundblad et al.'s survey and IPCC findings and because it was not believed to be confusing or misleading. None of the climate change experts who reviewed the survey mentioned this as a potential problem.

Advice was sought from Victoria University climate change experts as to whether these were justified criticisms.

This quote best expresses the feedback received:

Most of these answers are precious. It is clear from the context what you are talking about, even if some of the complainants might be technically correct. E.g. “*Climate change is mainly caused by increased concentrations of greenhouse gases*” clearly refers to recent climate change, since there has been limited climate change other than anthropogenic change for the last 1000 years. Technically, it might have been better to say ‘Climate change over the last century has been mainly caused by increasing concentrations of greenhouse gases’ to head off this nitpicking but I don’t think this is a significant criticism.

The survey was also quite long for an online survey (taking participants 15–30 minutes to complete) and would have been much longer, far less readable, and therefore likely to have a lower completion rate if it had precisely defined climate change every time it was referred to. Striking a balance between simplicity and technical accuracy is another of the many challenges of climate change research.

Regardless of this, some participants were confused and this would have affected how they answered the survey.

True / false questions and confidence scales

A few participants were concerned about the confidence scales. The main concern was that some found it unclear as to whether they were expressing certainty in their own knowledge, or in the scientific consensus. Some participants felt that the survey asked them to express too much confidence in projected future consequences, and they were uncomfortable determining scientific statements as either ‘true’ or ‘false’, as science requires systemic doubt. Although these are legitimate criticisms, the survey necessarily followed Sundblad et al.’s survey to allow comparison, and their survey was structured in this way.

Researchers designing future surveys should consider ways to avoid these potential pitfalls and make it explicit whether they are seeking confidence in participants’ own knowledge, or confidence in their perceptions of the scientific consensus.

6.2.5 Selection biases

Although Study 1 used a mail survey, data from Study 2 relied on data from an online survey. Such surveys automatically exclude anyone without access to the internet or a computer, biasing participants towards being better educated and with higher incomes.

People with higher concern about the environment are more likely to participate in a voluntary survey about the environment, biasing participants to being more environmentally conscious. Climate change is a particularly polarising environmental problem, and polarising problems can lead to extreme responses. Extreme concern for climate change or extreme scepticism can be seen to reflect this polar effect. Extreme scepticism was reflected in the amount and degree of critical unsought feedback received about the Study 2 survey, suggesting that non-environmentally conscious respondents also took part in this study.

Strict criteria were applied to the participants making up the Study 2 public group (used for the regression analysis on knowledge and concern) to try and minimise any environmental selection bias. This group excluded participants who worked in jobs relating to environment and climate change issues.

6.3 Further research and policy recommendations

Research into promoting concern for climate change should focus on identifying motivators and barriers to:

- increasing public perceptions of the scientific consensus
- identifying and countering the effects of worldviews
- activating environmental values
- increasing public perceptions of perceived efficacy and human responsibility.

Further research assessing the effect of actual knowledge on concern should include a measure of environmental values, as Study 2 did not examine this. It would be useful to know whether accurate knowledge is a better predictor of concern than environmental values. Study 1 suggests not, but research is needed to confirm this. To avoid potential problems with the NEP identified by Malka et al., a different measure of environmental values could be used.

This research has shown the importance of clear, explicit, and consistent terminology in climate change communication. This is also necessary in policy and media reporting, which need to focus on getting the right balance between simplicity and technical accuracy while minimising public confusion and reactance.

As described in Chapter 1, attitudes like concern for climate change lead to behavioural intentions and to actual behaviour. Therefore, focusing on increasing public concern for climate change is likely to lead to intentions to perform climate-friendly behaviour, which is likely in turn to lead to these behaviours being performed. As well as increasing concern, future research and policy should focus on identifying and increasing the many different internal and external forces that enable desired behaviours, and on identifying and reducing those forces that disable or inhibit desired behaviours.

7 Conclusion

The aim of this thesis was to determine whether the knowledge-deficit theory applied to concern for climate change. The knowledge-deficit theory implies that high knowledge of climate change should correspond to high concern for climate change.

This research has shown that participants with high perceived knowledge of climate change did not have correspondingly high levels of concern, but those with high actual knowledge did. These findings provide support for the knowledge-deficit theory with a measure of actual knowledge, and suggest that parties aiming to increase public concern for climate change should focus on making sure that the public comprehends the scientific consensus on climate change. Further analysis found that actual knowledge of the consequences of climate change significantly predicted concern, but that actual knowledge of the state of the climate or the causes of climate change did not.

Although actual knowledge of climate change was a significant positive predictor of concern, it was not the best predictor of concern identified in this research. Perceived efficacy (comprising the concepts of efficacy and human responsibility) was a stronger predictor of concern than actual knowledge, and Study 1 suggests that environmental values would have remained a strong predictor of concern, had it been included in Study 2.

As discussed in Chapters 1 and 2, there is already a great deal of climate change information available to the public but, in spite of this, public concern levels have been declining in recent years. The media have been shown to misrepresent the scientific consensus, causing the public to underestimate the human causes of climate change, perhaps contributing to declining concern levels. This thesis has found that understanding that human activities cause climate change is one of the most important predictors of concern, as is an understanding of the consequences of climate change. Given the importance of public understanding in motivating public concern, information campaigns should not be abandoned, but they should be smarter.

Climate change communications should provide information that accurately represents the scientific consensus and explains that climate change is due to human activities and describes the consequences of climate change. Because perceived efficacy is also such a strong predictor of concern, climate change communications should emphasise the

different ways that people can act and the effectiveness of taking such actions. This thesis also supported research finding that trust in experts and people's underlying values and worldviews are important for predicting concern and perceived efficacy. Climate change communications should provide information tailored to different sets of values and worldviews, coming from trusted information sources.

This thesis and previous research described in Chapters 1 and 2 suggest that policies and communications taking these findings into account will be more effective at increasing public concern for climate change.

References

- Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, 27(4), 265-276. doi:10.1016/j.jenvp.2007.08.002
- Agho, K., Stevens, G., Taylor, M., Barr, M., & Raphael, B. (2010). Population risk perceptions of global warming in Australia. *Environmental Research*, 110(8), 756-763. doi:10.1016/j.envres.2010.09.007
- Aitken, C., Chapman, R., & McClure, J. (in press). Climate change, powerlessness and the commons dilemma: Assessing New Zealanders' preparedness to act. *Global Environmental Change, In Press, Corrected Proof*. doi:10.1016/j.gloenvcha.2011.01.002
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211.
- Anderegg, W., Prall, J., Harold, J., & Schneider, S. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences*, 107(27), 12107-12109. doi:10.1073/pnas.1003187107
- Antilla, L. (2005). Climate of scepticism: US newspaper coverage of the science of climate change. *Global Environmental Change*, 15, 338-352. doi:10.1016/j.gloenvcha.2005.08.00
- Antilla, L. (2010). Self-censorship and science: a geographical review of media coverage of climate tipping points. *Public Understanding of Science*, 240-256. doi:10.1177/0963662508094099 19:
- Bagla, P. (2010). Climate science leader Rajendra Pachauri confronts the critics. *Science*, 327(5965), 510-511. doi:10.1126/science.327.5965.510
- Barr, S., & Gilg, A. W. (2007). A conceptual framework for understanding and analyzing attitudes towards environmental behaviour. *Geografiska Annaler: Series B, Human Geography*, 89(4), 361-379. Retrieved from <http://dx.doi.org/10.1111/j.1468-0467.2007.00266.x>
- Bell, A. (1994). Media (mis)communication on the science of climate change. *Public Understanding of Science*, 259-275. doi:10.1088/0963-6625/3/3/002 3:
- Blackwell, S. (2009). *Electricity conservation in context: A mixed methods study of residential conservation behaviour during an electricity shortage in New Zealand* (Environmental Studies). Victoria University of Wellington, Wellington, New Zealand.
- Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). In what sense does the public need to understand global climate change? *Public Understanding of Science*, 9(3), 205-218. doi:10.1088/0963-6625/9/3/301
- Boykoff, M. (2008). Media and scientific communication: a case of climate change. *Geological Society, London, Special Publications*, 305(1), 11-18. doi:10.1144/SP305.3
- Boykoff, M. (2009). We speak for the trees: Media reporting on the environment. *Annual Review of Environment and Resources*, 34(1), 431-457. Retrieved from <http://www.annualreviews.org/doi/abs/10.1146/annurev.environ.051308.084254>
- Boykoff, M., & Boykoff, J. (2004). Balance as bias: global warming and the US prestige press. *Global Environmental Change Part A*, 14(2), 125-136. doi:10.1016/j.gloenvcha.2003.10.001
- Boykoff, M., & Boykoff, J. (2007). Climate change and journalistic norms: A case-study of US mass-media coverage. *Geoforum*, 38, 1190-1204.
- Böhm, G., & Pfister, H. (2001). Mental representation of global environmental risks. *Research in Social Problems and Public Policy*, 9, 1-30.
- Brody, S., Zahran, S., Grover, H., & Vedlitz, A. (2008). A spatial analysis of local climate change policy in the United States: Risk, stress, and opportunity. *Landscape and Urban Planning*, 87(1), 33-41. doi:10.1016/j.landurbplan.2008.04.003
- Brody, S., Zahran, S., Vedlitz, A., & Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment*

and Behavior, 40, 72-95. Retrieved from <http://eab.sagepub.com/cgi/content/abstract/40/1/72> N2

- Budescu, D. V., Broomell, S., & Por, H.-H. (2009). Improving communication of uncertainty in the reports of the Intergovernmental Panel on Climate Change. *Psychological Science*, 20(3), 299 - 308. doi:10.1111/j.1467-9280.2009.02284.x
- Bulkeley, H. (2000). Common knowledge? Public understanding of climate change in Newcastle, Australia. *Public Understanding of Science*, 9, 313-333.
- Cox, B. (2010, December 1). *Science: A challenge to TV orthodoxy*. Presented at the The Royal Television Society Huw Wheldon Memorial Lecture, BBC2. Retrieved from <http://www.youtube.com/watch?v=QPrdK4hWffo&feature=related>
- Crompton, T. (2010). *Common cause: The case for working with our common values*. WWF-UK. Retrieved from http://www.wwf.org.uk/wwf_articles.cfm?unewsid=4224
- Davidson, D. J., & Freudenburg, W., R. (1996). Gender and environmental risk concerns: A review and analysis of available research. *Environment and Behavior*, 28(3), 302-339.
- Doran, P., & Zimmerman, M. (2009). Examining the scientific consensus on climate change. *Eos*, 90(3), 22-23. doi:10.1029/2009EO030002
- Dunlap, R. E. (1998). Lay perceptions of global risk. *International Sociology*, 13(4), 473 -498. doi:10.1177/026858098013004004
- Dunlap, R. E., Liere, K. D. V., Mertig, A. G., & Jones, R. E. (2000). New trends in measuring environmental attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues*, 56(3), 425-442. Retrieved from <http://dx.doi.org/10.1111/0022-4537.0017>
- Eden, S. (1993). Individual environmental responsibility and its role in public environmentalism. *Environment and Planning A*, 25(12), 1743-1758.
- Finucane, M., Slovic, P., Mertz, C. K., Flynn, J., & Satterfield, T. (2000). Gender, race, and perceived risk: The “white male” effect. *Health, Risk & Society*, 2(2), 159 - 172. Retrieved from <http://www.informaworld.com/10.1080/713670162>
- Flynn, J., Slovic, P., & Mertz, C. K. (1994). Gender, Race, and Perception of Environmental Health Risks. *Risk Analysis*, 14(6), 1101-1108. Retrieved from <http://dx.doi.org/10.1111/j.1539-6924.1994.tb00082.x>
- G8 + 5. (2007, May). Joint science academies’ statement on growth and responsibility: sustainability, energy efficiency and climate protection. Retrieved from www.scj.go.jp/ja/info/kohyo/pdf/kohyo-20-s4.pdf
- G8 + 5. (2008, June). Joint Science Academies’ Statement: Climate Change Adaptation and the Transition to a Low Carbon Society. Retrieved from www.insaindia.org/pdf/Climate_05.08_W.pdf
- G8 + 5. (2009, May). G8+5 Academies’ joint statement: Climate change and the transformation of energy technologies for a low carbon future. Retrieved from www.nationalacademies.org/includes/G8+5energy-climate09.pdf
- G8 + India, Brazil, and China. (2005, July). Joint science academies’ statement: Global response to climate change. Retrieved from www.nationalacademies.org/onpi/06072005.pdf
- Griffin, P. (2010, August 21). How the media lost interest in Climategate | Griffin’s Gadgets. *Sciblogs*. Retrieved December 9, 2010, from <http://sciblogs.co.nz/griffins-gadgets/2010/08/21/how-the-media-lost-interest-in-climategate/>
- Guagnano, G., Stern, P., & Dietz, T. (1995). Influences on attitude-behavior relationships. *Environment and Behavior*, 27(5), 699 -718. doi:10.1177/0013916595275005
- HSBC Climate Partnership. (2009). *Climate confidence monitor 2009*. HSBC Holdings plc. Retrieved from <http://www.hsbc.com/1/2/sustainability/2009-reports/ccm-2009>
- HSBC Climate Partnership. (2010). *Climate confidence monitor 2010* (pp. 1-8). HSBC Holdings plc. Retrieved from <http://www.hsbc.com/1/2/sustainability/ccm-2010>

- Hatfield-Dodds, S., & Jollands, N. (2006). *Issues in communicating the impacts of climate change policy options* (pp. 1-29). Wellington, New Zealand: New Zealand Ministry for the Environment.
- Heath, Y., & Gifford, R. (2006). Free-market ideology and environmental degradation. *Environment and Behavior*, 38(1), 48 -71. doi:10.1177/0013916505277998
- Howell, R. A. (2011). Lights, camera ... action? Altered attitudes and behaviour in response to the climate change film *The Age of Stupid*. *Global Environmental Change*, 21(1), 177-187. doi:10.1016/j.gloenvcha.2010.09.004
- IPCC. (2010). IPCC - Intergovernmental Panel on Climate Change. Retrieved December 10, 2010, from <http://www.ipcc.ch/organization/organization.shtml>
- Joireman, J., Barnes Truelove, H., & Duell, B. (2010). Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *Journal of Environmental Psychology*. doi:10.1016/j.jenvp.2010.03.004
- Jones, J. (2011a, March 14). In U.S., concerns about global warming stable at lower levels. *Gallup*. Retrieved March 28, 2011, from http://www.gallup.com/poll/146606/Concerns-Global-Warming-Stable-Lower-Levels.aspx?utm_source=tagrss&utm_medium=rss&utm_campaign=syndication&utm_term=Environment
- Jones, J. (2011b, March 17). Americans increasingly prioritize economy over environment. *Gallup*. Retrieved March 28, 2011, from <http://www.gallup.com/poll/146681/Americans-Increasingly-Prioritize-Economy-Environment.aspx?version=print>
- Kahan, D., Braman, D., & Jenkins-Smith, H. (2010). Cultural cognition of scientific consensus. *Journal of Risk Research*, forthcoming.
- Kahlor, L., & Rosenthal, S. (2009). If we seek, do we learn? *Science Communication*, 30(3), 380 -414. doi:10.1177/1075547008328798
- Kellstedt, P., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis*, 28(1), 113–126. doi:10.1111/j.1539-6924.2008.01010.x
- Kempton, W. (1993). Will public environmental concern lead to action on global warming? *Annual Review of Energy and Environment*, 18(1), 217-245. doi:10.1146/annurev.eg.18.110193.001245
- Kempton, W. (1997). How the public views climate change. *Environment*, 39(9), 12. Retrieved from <http://helicon.vuw.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9711074131&site=ehost-live>
- Kerr, N. (1989). Illusions of efficacy: The effects of group size on perceived efficacy in social dilemmas. *Journal of Experimental Social Psychology*, 25(4), 287-313. doi:10.1016/0022-1031(89)90024-3
- Kerr, N., & Kaufman-Gilliland, C. (1997). "... and besides, I probably couldn't have made a difference anyway": Justification of social dilemma defection via perceived self-inefficacy. *Journal of Experimental Social Psychology*, 33(3), 211-230. doi:10.1006/jesp.1996.1319
- Kirby, A. (2004, July 29). Britons unsure of climate costs. BBC News, . Retrieved October 27, 2010, from <http://news.bbc.co.uk/2/hi/science/nature/3934363.stm>
- Krosnick, J. (2010, June 8). The climate majority. *The New York Times*. Retrieved from <http://www.nytimes.com/2010/06/09/opinion/09krosnick.html>
- Leiserowitz, A. (2004). Before and after The Day After Tomorrow: A US study of climate change risk perception. *Environment*, 46(9).
- Leiserowitz, A. (2005). American risk perceptions: Is climate change dangerous? *Risk Analysis*, 25(6), 1433-1442. doi:10.1111/j.1540-6261.2005.00690.x
- Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, 77, 45-72. doi:10.1007/s10584-006-9059-9
- Leiserowitz, A., & Akerlof, K. (2010, April). Race, ethnicity and public responses to climate change. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change. Retrieved from <http://environment.yale.edu/uploads/RaceEthnicity2010.pdf>

- Leiserowitz, A., & Smith, N. (2011). *Knowledge of climate change across global warming's six Americas*. New Haven, CT: USA: Yale University. Retrieved from <http://environment.yale.edu/climate/publications/knowledge-of-climate-change-across-global-warmings-six-americas/>
- Leiserowitz, A., Roser-Renouf, C., Mailbach, E., & Smith, N. (2010). *Global warming's six Americas, June 2010* (No. a). New Haven, CT: Yale Project on Climate Change: Yale University and George Mason University. Retrieved from <http://environment.yale.edu/climate/files/SixAmericasJune2010.pdf>
- Leiserowitz, A., Smith, N., & Marlon, J. (2010). *Americans' knowledge of climate change* (No. b). Yale University. New Haven, CT: Yale Project on Climate Change Communication. Retrieved from <http://environment.yale.edu/climate/files/ClimateChangeKnowledge2010.pdf>
- Lenton, T. (2009). *Tipping points in the Earth system*. Norwich: University of East Anglia. Retrieved from <http://researchpages.net/ESMG/people/tim-lenton/tipping-points/>
- Lenton, T., Held, H., Kriegler, E., Hall, J., Lucht, W., Rahmstorf, S., & Schellnhuber, H. (2008). Tipping elements in the Earth's climate system. *Proceedings of the National Academy of Sciences*, 105(6), 1786-1793. Retrieved from http://researchpages.net/media...008/02/08/Tipping_elements.pdf
- Lichter, R. (2008, April 24). Climate scientists agree on warming, disagree on dangers, and don't trust the media's coverage of climate change. Statistical Assessment Service: George Mason University, United States. Retrieved from http://stats.org/stories/2008/global_warming_survey_apr23_08.html
- Lorenzoni, I., & Pidgeon, N. (2006). Public views on climate change: European and USA perspectives. *Climatic Change*, 77(1-2, July, 2006), 73-95. doi:10.1007/s10584-006-9072-z
- Lorenzoni, I., Leiserowitz, A., Doria, M., Poortinga, W., & Pidgeon, N. (2006). Cross-national comparisons of image associations with "global warming" and "climate change" among laypeople in the United States of America and Great Britain. *Journal of Risk Research*, 9(3), 265-281. Retrieved from <http://www.informaworld.com/10.1080/13669870600613658>
- Lowe, T., Brown, K., Dessai, S., de França Doria, M., Haynes, K., & Vincent, K. (2006). Does tomorrow ever come? Disaster narrative and public perceptions of climate change. *Public Understanding of Science*, 435 -457. doi:10.1177/0963662506063796 15:
- Malka, A., Krosnick, J. A., & Langer, G. (2009). The association of knowledge with concern about global warming: Trusted information sources shape public thinking. *Risk Analysis*, 29(5), 633-647. Retrieved from <http://dx.doi.org/10.1111/j.1539-6924.2009.01220.x>
- McCright, A. (2010). The effects of gender on climate change knowledge and concern in the United States. *Population and Environment*, 32, 66-87. doi:10.1007/s11111-010-0113-1
- McKenzie-Mohr, D., & Smith, W. (1999). *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing*. Gabriola Island, British Columbia: New Society Publishers.
- Milfont, T. (2008). Social Attitudes Survey 2008. Victoria University of Wellington.
- Milfont, T. (2010). Global warming, climate change and human psychology. *Psychological approaches to sustainability: Current trends in theory, research and practice* (pp. 19-42). New York: Nova Science.
- MoRST. (2010). *Science and the general public 2010* (No. NZ200177). Wellington, New Zealand: Ministry of Research, Science and Technology.
- Mobley, C., Vagias, W. M., & DeWard, S. L. (2010). Exploring additional determinants of environmentally responsible behavior: The influence of environmental literature and environmental attitudes. *Environment and Behavior*, 420 -447. doi:10.1177/0013916508325002 42:
- Mohai, P., & Bryant, B. (1998). Is there a "race" effect on concern for environmental quality? *The Public Opinion Quarterly*, 62(4), 475-505. Retrieved from <http://www.jstor.org/stable/2749675>
- Muir, R., Boulton, G., Clarke, P., Eyton, D., & Norton, J. (2010). *The independent climate change e-mails review*. Retrieved from <http://www.cce-review.org/News.php>

- Newport, F. (2010, March 11). Americans' global warming concerns continue to drop. *Gallup*. Retrieved December 2, 2010, from <http://www.gallup.com/poll/126560/Americans-Global-Warming-Concerns-Continue-Drop.aspx>
- Nielsen. (2009a, December 6). Global survey: Concern for climate change cools off. *NielsenWire*. Retrieved March 15, 2011, from <http://blog.nielsen.com/nielsenwire/global/global-survey-concern-for-climate-change-cools-off/>
- Nielsen. (2009b). *Climate change concern cools: A Canadian perspective*. The Nielsen Company and Oxford University Institute of Climate Change.
- Nilsson, A., von Borgstede, C., & Biel, A. (2004). Willingness to accept climate change strategies: The effect of values and norms. *Journal of Environmental Psychology*, 24(3), 267-277. doi:10.1016/j.jenvp.2004.06.002
- Nolan, J. (2010). "An Inconvenient Truth" increases knowledge, concern, and willingness to reduce greenhouse gases. *Environment and Behavior*, 1-16. doi:10.1177/0013916509357696
- Oreskes, N. (2004). Beyond the ivory tower: The scientific consensus on climate change. *Science*, 306(5702), 1686. doi:10.1126/science.1103618
- Owens, S. (2000). "Engaging the public": information and deliberation in environmental policy. *Environment and Planning*, 32(7), 1141-1148. Retrieved from <http://ideas.repec.org/a/pio/envira/v32y2000i7p1141-1148.html>
- O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis*, 19(3), 461-471. Retrieved from <http://dx.doi.org/10.1023/A:1007004813446>
- Pachauri, R. K., & Reisinger, A. (2007). *IPCC Fourth Assessment Report: Climate Change 2007 (AR4)*. IPCC. Retrieved from http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html
- Pallant, J. (2010). *SPSS Survival Manual* (4th ed.). McGraw-Hill House, Berkshire, England: Open University Press.
- Pew Research Center. (2009, October 22). Fewer Americans see solid evidence of global warming. Retrieved December 2, 2010, from <http://pewresearch.org/pubs/1386/cap-and-trade-global-warming-opinion>
- Pidgeon, N., Lorenzoni, I., & Poortinga, W. (2008). Climate change or nuclear power--No thanks! A quantitative study of public perceptions and risk framing in Britain. *Global Environmental Change*, 18(1), 69-85. doi:10.1016/j.gloenvcha.2007.09.005
- Radio New Zealand. (2010, September 20). Climate change lower priority - survey. Retrieved from <http://www.radionz.co.nz/news/national/57305/climate-change-lower-priority-survey>
- Rahmstorf, S., Cazenave, A., Church, J., Hansen, J., Keeling Ralph F., R., Parker, D., & Somerville, R. (2007, May 4). Recent climate observations compared to projections. *Science*, 316(5825), 709(1). Retrieved from <http://find.galegroup.com/gtx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=AONE&docId=A163704722&source=gale&reprod=AONE&userGroupName=vuw&version=1.0>
- Reisinger, A. (2009). *Climate Change 101 - An Educational Resource*. Institute of Policy Studies and New Zealand Climate Change Research Institute: Victoria University of Wellington.
- Reynolds, T. W., Bostrom, A., Read, D., & Morgan, M. G. (2010). Now what do people know about global climate change? Survey studies of educated laypeople. *Risk Analysis*, 30(10), 1520-1538. Retrieved from <http://dx.doi.org/10.1111/j.1539-6924.2010.01448.x>
- Saad, L. (2011, March 28). Water issues worry Americans most, global warming least. *Gallup*. Retrieved March 31, 2011, from <http://www.gallup.com/poll/146810/Water-Issues-Worry-Americans-Global-Warming-Least.aspx?version=print>
- Sampei, Y., & Aoyagi-Usui, M. (2009). Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. *Global Environmental Change*, 19(2), 203-212. doi:10.1016/j.gloenvcha.2008.10.005

- Schultz. (2002). Knowledge, information, and household recycling: Examining the knowledge-deficit model of behavior change. *New Tools for Environmental Protection* (pp. 67-82). Washington DC: National Academy of Sciences.
- Schultz, P., & Oskamp, S. (1996). Effort as a moderator of the attitude-behavior relationship: General environmental concern and recycling. *Social Psychology Quarterly*, 59(4), 375-383. Retrieved from <http://www.jstor.org/stable/2787078>
- Schultz, P., Nolan, J., Cialdini, R., Goldstein, N., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, 18(50), 429-434.
- ScienceDirect. (2011). ScienceDirect search results for articles containing “climate change” or “global warming.” Retrieved February 21, 2011, from http://www.sciencedirect.com/science?_ob=ArticleListURL&_method=list&_ArticleListID=1649093104&_sort=r&_st=4&_acct=C000053190&_version=1&_urlVersion=0&_userid=1495406&md5=ff69e803d28f3e0d7f3da5518518ce75&searchtype=a
- ShapeNZ. (2010). *ShapeNZ environmental issues survey 2010: A national survey of 1066 New Zealanders on environmental issues*. Auckland, New Zealand: New Zealand Business Council of Sustainable Development.
- Statistics New Zealand. (2006a). QuickStats about culture and identity. *Statistics New Zealand*. New Zealand government website, . Retrieved June 30, 2010, from <http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/quickstats-about-a-subject/culture-and-identity/ethnic-groups-in-new-zealand.aspx>
- Statistics New Zealand. (2006b). QuickStats about New Zealand’s population and dwellings. Retrieved June 30, 2010, from <http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/quickstats-about-a-subject/nzs-population-and-dwellings/population-counts.aspx>
- Statistics New Zealand. (2006c). QuickStats about incomes. Retrieved June 30, 2010, from <http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/quickstats-about-a-subject/incomes.aspx>
- Statistics New Zealand. (2006d). About a place. Retrieved July 5, 2010, from <http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/AboutAPlace.aspx>
- Stern, N. (2000). *The Stern review on the economics of climate change* (pp. 1-700). United Kingdom: UK Office of Climate Change.
- Stern, P. (1999). Information, incentives, and proenvironmental consumer behavior. *Journal of Consumer Policy*, 22(4), 461-478. Retrieved from <http://dx.doi.org/10.1023/A:1006211709570>
- Stern, P., Dietz, T., & Kalof, L. (1993). Value orientations, gender, and environmental concern. *Environment and Behavior*, 25(5), 322 -348. doi:10.1177/0013916593255002
- Sundblad, E.-L., Biel, A., & Gärling, T. (2007). Cognitive and affective risk judgements related to climate change. *Journal of Environmental Psychology*, 27(2), 97-106. doi:10.1016/j.jenvp.2007.01.003
- Sundblad, E.-L., Biel, A., & Gärling, T. (2009). Knowledge and confidence in knowledge about climate change among experts, journalists, politicians, and laypersons. *Environment and Behavior*, 281 - 302. doi:10.1177/0013916508314998 41:
- The Royal Society. (2004). *Science in society* (pp. 1-25). The Royal Society. Retrieved from <http://royalsociety.org/>
- The Royal Society of New Zealand. (2010). *Climate change: A summary of the science* (pp. 1-16). The Royal Society.
- The World Bank. (2009). *Public attitudes toward climate change: Findings from a multi-country poll* (World Development Report). The World Bank.
- Trumbo, C. (1996). Constructing climate change: claims and frames in US news coverage of an environmental issue. *Public Understanding of Science*, 5(3), 269 -283. doi:10.1088/0963-6625/5/3/006

- Uzzell, D. (2000). The psycho-spatial dimension of global environmental problems. *Journal of Environmental Psychology*, 20(4), 307-318. doi:10.1006/jevp.2000.0175
- Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research*, 11(3), 351-374. Retrieved from <http://www.informaworld.com/10.1080/13669870701552235>
- Whitmarsh, L. (2009). What's in a name? Commonalities and differences in public understanding of "climate change" and "global warming." *Public Understanding of Science*, 401 -420. doi:10.1177/0963662506073088 18:
- Whitmarsh, L. (2011). Scepticism and uncertainty about climate change: Dimensions, determinants and change over time. *Global Environmental Change, In Press, Corrected Proof*. doi:10.1016/j.gloenvcha.2011.01.016
- Wilson, K. M. (2000). Drought, debate, and uncertainty: measuring reporters' knowledge and ignorance about climate change. *Public Understanding of Science*, 1 -13. doi:10.1088/0963-6625/9/1/3019:
- Wright, N., & Nerlich, B. (2006). Use of the deficit model in a shared culture of argumentation: the case of foot and mouth science. *Public Understanding of Science*, 15(3), 331 -342. doi:10.1177/0963662506063017
- Xiao, C., & McCright, A. (2007). Environmental concern and sociodemographic variables: A study of statistical models. *Journal of Environmental Education*, 38(2), 3-14. Retrieved from <http://helicon.vuw.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=24660423&site=ehost-live>
- Yohe, G., Schneider, S., Rosenzweig, C., & Easterling, W. (n.d.). Open letter from U.S. scientists on the Intergovernmental Panel on Climate Change and errors contained in the Fourth Assessment Report: Climate Change 2007. Retrieved from <http://www.openletterfromscientists.com/>

Appendices

Appendix A: Study 1: New Zealand Social Attitudes Survey

In general, when it comes to politics, do you usually think of yourself as...

Extremely liberal Liberal Slightly liberal Moderate Slightly conservative Conservative Extremely conservative
1 2 3 4 5 6 7

PART 2. General questions about environmental issues

Listed below are statements about the **relationship between humans and the environment**. Please indicate the extent to which you *agree* or *disagree* with each of the following statements.

1 Strongly disagree	2 Disagree	3 Unsure	4 Agree	5 Strongly agree
We are approaching the limit of the number of people the earth can support.				
1 2 3 4 5				
Humans have the right to modify the natural environment to suit their needs.				
1 2 3 4 5				
When humans interfere with nature it often produces disastrous consequences.				
1 2 3 4 5				
Human ingenuity will insure that we do not make the earth unlivable.				
1 2 3 4 5				
Humans are severely abusing the environment.				
1 2 3 4 5				
The earth has plenty of natural resources if we just learn how to develop them.				
1 2 3 4 5				
Plants and animals have as much right as humans to exist.				
1 2 3 4 5				
The balance of nature is strong enough to cope with the impacts of modern industrial nations.				
1 2 3 4 5				
Despite our special abilities humans are still subject to the laws of nature.				
1 2 3 4 5				
The so-called "ecological crisis" facing humankind has been greatly exaggerated.				
1 2 3 4 5				
The earth is like a spaceship with very limited room and resources.				
1 2 3 4 5				
Humans were meant to rule over the rest of nature.				
1 2 3 4 5				
The balance of nature is very delicate and easily upset.				
1 2 3 4 5				
Humans will eventually learn enough about how nature works to be able to control it.				
1 2 3 4 5				

If things continue on their present course, we will soon experience a major ecological catastrophe.

1 2 3 4 5

PART 3. Questions about global warming and climate change

How well-informed do you consider yourself to be on global warming and climate change?

Not at all
informed

Somewhat
informed

Very well
informed

0 1 2 3 4 5 6 7 8 9 10

How clearly do you think scientists understand global warming and climate change?

Very unclear
understanding

Very clear
understanding

1 2 3 4

What is **the risk** of global warming and climate change exerting a significant impact on...

risk No risk 1 2 3 4 Extreme

Public health in your town or city?

1 2 3 4

Economic development in your town or city?

1 2 3 4

The environment in your town or city?

1 2 3 4

Please indicate the extent to which you **agree** or **disagree** with the following statements.

1 Strongly disagree	2 Disagree	3 Agree	4 Strongly agree
Global warming and climate change will have a noticeably negative impact on my health in the next 25 years.			1 2 3 4
Global warming and climate change will have a noticeably negative impact on my economic and financial situation in the next 25 years.			1 2 3 4
Global warming and climate change will have a noticeably negative impact on the environment in which my family and I live.			1 2 3 4
I believe my actions have an influence on global warming and climate change.			1 2 3 4
My actions to reduce the effects of global warming and climate change in my community will encourage others to reduce the effects of global warming through their own actions.			1 2 3 4
Human beings are responsible for global warming and climate change.			1 2 3 4

Please indicate the **trustworthiness of information** on global warming and climate change provided by the following media and groups.

Not trustworthy at all	Very trustworthy									
0 1 2 3 4 5 6 7 8 9 10										
Newspapers	0 1 2 3 4 5 6 7 8 9 10									
Television news	0 1 2 3 4 5 6 7 8 9 10									
Radio	0 1 2 3 4 5 6 7 8 9 10									
Internet	0 1 2 3 4 5 6 7 8 9 10									
University academics	0 1 2 3 4 5 6 7 8 9 10									
Scientists	0 1 2 3 4 5 6 7 8 9 10									

Government agencies	0	1	2	3	4	5	6	7	8	9	10
Nonprofit organisations	0	1	2	3	4	5	6	7	8	9	10
Environmental interest groups	0	1	2	3	4	5	6	7	8	9	10
Other interest groups	0	1	2	3	4	5	6	7	8	9	10

PART 6. Background questions (Please remember that your responses are confidential)

1. How old are you? _____ years.	2. What is your gender? ☐ Female ☐ Male	3. Are you member of any environmental organisation (e.g., Greenpeace)? ☐ Yes ☐ No
---	---	--

4. Which of these best describe your highest educational qualification?

☐ Secondary School Incomplete
☐ NCEA, School Certificate, or other secondary school qualification
☐ Polytechnic qualification or Trade Certificate
☐ Undergraduate Degree ☐ Postgraduate Degree ☐ Masters ☐ Doctorate

5. Which country were you born in?

6. Which ethnic group(s) do you belong to? (**Tick** as many as apply. If you identify with multiple groups, then please **circle** the group that you feel you *most strongly belong to*)

☐ New Zealand European (Pakeha) ☐ Māori
☐ Pacific Nations ☐ Asian
☐ Indian ☐ Other (please specify): _____

7. In which of the following areas do you live?

☐ Northland ☐ Gisborne ☐ Wellington-Wairarapa ☐ West Coast
☐ Auckland ☐ Hawke's Bay ☐ Tasman ☐
 Canterbury
☐ Waikato ☐ Taranaki ☐ Nelson ☐
 Otago
☐ Bay of Plenty ☐ Manawatu-Wanganui ☐ Marlborough ☐ Southland

8. Which of the following best describes where you *grew up*? **I grew up in a...**

☐ Rural area (under 1,000 population) ☐ A medium-sized town (10,000-29,999 population)
☐ A small town (1,000-9,999 population) ☐ A large town or city (30,000+ population)

9. Do you have any children? ☐ Yes ☐ No

9.1. If YES, how many? _____ What is the age of your youngest child? _____(years) _____(months)

10. Which religious or philosophical orientation do you most identify with? (**tick** only one)

☐ Agnostic ☐ Atheistic ☐ Buddhist ☐ Christian
☐ Hindu ☐ Jewish ☐ Muslim ☐ Other: _____
☐ I do not identify with any specific religious or philosophical orientation

11. Have you attended a religious service in the last 7 days (not including funeral, wedding)?

☐ Yes ☐ No

12. Please estimate your *own personal* earnings from paid employment (before tax) for the year 2007.

☐ under \$10,000	☐ \$41,000 - \$60,000	☐ \$101,000 - \$120,000
☐ \$11,000 - \$20,000	☐ \$61,000 - \$80,000	☐ \$121,000 - \$140,000
☐ \$21,000 - \$40,000	☐ \$81,000 - \$100,000	☐ More than - \$141,000

13. Please indicate how strongly you support/oppose each of the following political parties in the upcoming New Zealand election.

Strongly oppose					Strongly support		
1	2	3	4	5	6	7	
The Green Party					1	2	3 4 5 6 7
The Labour Party					1	2	3 4 5 6 7
The Māori Party					1	2	3 4 5 6 7
The National Party					1	2	3 4 5 6 7
The NZ First Party					1	2	3 4 5 6 7
Other (specify): _____					1	2	3 4 5 6 7

Appendix B: Study 2: Climate change knowledge survey

Statements about climate change	True	False	Very uncertain	Fairly uncertain	More uncertain than certain	More certain than uncertain	Fairly certain	Very certain
Sea levels have risen by a global average of 17cm over the last 100 years.	☒	☐	☐	☐	☐	☐	☐	☐
Climate change is mainly caused by increased concentrations of greenhouse gases.	☒	☐	☐	☐	☐	☐	☐	☐
The average global temperature has increased about 0.7°C over the last 100 years.	☒	☐	☐	☐	☐	☐	☐	☐
Globally, negative health impacts caused by climate change will be more severe for poor, marginalised people.	☒	☐	☐	☐	☐	☐	☐	☐
Changes to Earth's albedo contribute to climate change. (Albedo is the solar energy Earth reflects back into space.)	☒	☐	☐	☐	☐	☐	☐	☐
If the Greenland ice sheet melted completely, sea levels would rise by 12–13 metres.	☐	☒	☐	☐	☐	☐	☐	☐
Climate change will intensify water security problems in parts of New Zealand by 2030.	☒	☐	☐	☐	☐	☐	☐	☐
Atmospheric methane concentrations have increased by more than 200% since the pre-industrial period.	☒	☐	☐	☐	☐	☐	☐	☐
The 1990s and 2000s were no warmer than other decades over the last 100 years.	☐	☒	☐	☐	☐	☐	☐	☐
Increasing greenhouse gases increases ultra violet (UV) radiation, creating a greater risk of skin cancer.	☐	☒	☐	☐	☐	☐	☐	☐

Statements about climate change	True	False	Very uncertain	Fairly uncertain	More uncertain than certain	More certain than uncertain	Fairly certain	Very certain
The increase in greenhouse gases is mainly caused by intensified agricultural practices.	☐	☒	☐	☐	☐	☐	☐	☐
Over the next 100 years sea levels will rise by less than we can measure.	☐	☒	☐	☐	☐	☐	☐	☐
Many extreme weather events (precipitation, floods, tropical cyclones, heat waves, droughts, etc) have increased in frequency and intensity over the last 100 years.	☒	☐	☐	☐	☐	☐	☐	☐
Atmospheric carbon dioxide concentrations have increased by more than 30% since the pre-industrial period.	☒	☐	☐	☐	☐	☐	☐	☐
Heavy precipitation events (rain and snow fall) have increased over most land areas since the 1950s.	☒	☐	☐	☐	☐	☐	☐	☐
If the Arctic sea ice melted completely, sea levels would rise by about 3 metres.	☐	☒	☐	☐	☐	☐	☐	☐
Climate change is mainly caused by the ozone hole.	☐	☒	☐	☐	☐	☐	☐	☐
Sea levels have risen by a global average of 87cm over the last 100 years.	☐	☒	☐	☐	☐	☐	☐	☐
Global precipitation (rain and snow fall) will decrease over the next 100 years in most subtropical regions.	☒	☐	☐	☐	☐	☐	☐	☐
The increase in greenhouse gases is mainly caused by increased volcanic eruptions.	☐	☒	☐	☐	☐	☐	☐	☐
It is not possible to determine whether the last 100 years had a different temperature to the last 1000 years.	☐	☒	☐	☐	☐	☐	☐	☐

Statements about climate change	True	False	Very uncertain	Fairly uncertain	More uncertain than certain	More certain than uncertain	Fairly certain	Very certain
If the Greenland ice sheet melted completely, sea levels would rise by 6–7 metres.	●	○	☐	☐	☐	☐	☐	☐
Climate change is mainly caused by natural variations in solar radiation.	○	●	☐	☐	☐	☐	☐	☐
Melting snow and glaciers cause sea levels to rise.	●	○	☐	☐	☐	☐	☐	☐
Global precipitation (rain and snow fall) will increase over the next 100 years in high latitudes.	●	○	☐	☐	☐	☐	☐	☐
The increase in greenhouse gases is mainly caused by human activities.	●	○	☐	☐	☐	☐	☐	☐
The warmest two decades over the last 100 years were the 1990s and 2000s.	●	○	☐	☐	☐	☐	☐	☐
Melting sea ice and floating ice shelves breaking up cause sea levels to rise.	○	●	☐	☐	☐	☐	☐	☐
Atmospheric carbon dioxide concentrations have increased by between 20% and 30% since the pre-industrial period.	○	●	☐	☐	☐	☐	☐	☐
Global sea levels have not risen over the last 100 years.	○	●	☐	☐	☐	☐	☐	☐
Over the next 50 years, incidents of malaria, dengue fever, and other infectious diseases will increase and spread globally due to climate change.	●	○	☐	☐	☐	☐	☐	☐
Deforestation contributes to climate change.	●	○	☐	☐	☐	☐	☐	☐
The average global temperature has increased about 3.1°C over the last 100 years.	○	●	☐	☐	☐	☐	☐	☐

Statements about climate change	True	False	Very uncertain	Fairly uncertain	More uncertain than certain	More certain than uncertain	Fairly certain	Very certain
Over the next 100 years sea levels will rise by at least 2–3 metres.	☐	☒	☐	☐	☐	☐	☐	☐
Carbon dioxide is mainly emitted through fossil fuel combustion.	☒	☐	☐	☐	☐	☐	☐	☐
Climate change will cause increased drought and fire in parts of New Zealand by 2030.	☒	☐	☐	☐	☐	☐	☐	☐
The ice mass of the Arctic is expected to increase over the next 100 years.	☐	☒	☐	☐	☐	☐	☐	☐
Carbon dioxide is responsible for about 45% of greenhouse gas emissions.	☐	☒	☐	☐	☐	☐	☐	☐
The change in average global temperatures over the last 100 years is the largest change over the last 1000 years.	☒	☐	☐	☐	☐	☐	☐	☐
Over the next 100 years sea levels will rise by 0.5–1.5 metres.	☒	☐	☐	☐	☐	☐	☐	☐
Methane is mainly emitted through fossil fuel combustion.	☐	☒	☐	☐	☐	☐	☐	☐
It is not yet possible to determine whether extreme weather events (precipitation, floods, tropical cyclones, heat waves, droughts, etc) have increased in frequency and intensity over the last 100 years.	☐	☒	☐	☐	☐	☐	☐	☐
The average global temperature has been more or less stable over the last 100 years.	☐	☒	☐	☐	☐	☐	☐	☐
Increasing the temperature of seawater causes sea levels to rise.	☒	☐	☐	☐	☐	☐	☐	☐

Statements about climate change	True	False	Very uncertain	Fairly uncertain	More uncertain than certain	More certain than uncertain	Fairly certain	Very certain
Climate change is mainly caused by increased concentrations of greenhouse gases.	☒	☐	☐	☐	☐	☐	☐	☐

Appendix C: Study 2: Statements making up knowledge variables

Knowledge of the state of the climate

1	The average global temperature has increased about 0.7°C over the last 100 years.
2	The two warmest decades over the last 100 years were the 1990s and 2000s.
3	The change in average global temperatures over the last 100 years is the largest change over the last 1000 years.
4	Heavy precipitation (rain and snowfall) events have increased over most land areas since the 1950s.

Knowledge of the causes of climate change

1	Climate change is mainly caused by increased concentrations of greenhouse gases.
2	Deforestation contributes to climate change.
3	Changes to Earth's albedo contribute to climate change. (Albedo is the solar energy Earth reflects back into space.)
4	Atmospheric carbon dioxide concentrations have increased by more than 30% since the pre-industrial period.
5	Atmospheric methane concentrations have increased by more than 200% since the pre-industrial period.
6	Carbon dioxide is mainly emitted through fossil fuel combustion.
7	The increase in greenhouse gases is mainly caused by human activities.

Knowledge of the consequences of climate change

1	Many extreme weather events (precipitation, floods, tropical cyclones, heat waves, droughts, etc) have increased in frequency and intensity over the last 100 years.
2	Global precipitation (rain and snowfall) will increase over the next 100 years in high latitudes.
3	Global precipitation (rain and snowfall) will decrease over the next 100 years in most subtropical regions.
4	Sea levels have risen by a global average of 17 cm over the last 100 years.
5	Melting snow and glaciers cause sea levels to rise.
6	Increasing the temperature of seawater causes sea levels to rise.
7	Over the next 100 years sea levels will rise by 0.5 – 1.5 metres.
8	If the Greenland ice sheet melted completely, sea levels would rise by about 6 – 7 metres.
9	Climate change will intensify water security problems in parts of New Zealand by 2030.
10	Climate change will cause increased drought and fire in parts of New Zealand by 2030.
11	Over the next 50 years, incidents of malaria, dengue fever, and other infectious diseases will increase and spread globally due to climate change.
12	Globally, the negative health effects of climate change will be more severe for poor, marginalised people.

Knowledge of specific weather consequences of climate change

1	Many extreme weather events (precipitation, floods, tropical cyclones, heat waves, droughts, etc) have increased in frequency and intensity over the last 100 years.
2	Global precipitation (rain and snowfall) will increase over the next 100 years in high latitudes.
3	Global precipitation (rain and snowfall) will decrease over the next 100 years in most subtropical regions.

Knowledge of specific sea level and glacier consequences of climate change

1	Sea levels have risen by a global average of 17 cm over the last 100 years.
2	Melting snow and glaciers cause sea levels to rise.
3	Increasing the temperature of seawater causes sea levels to rise.
4	Over the next 100 years sea levels will rise by 0.5 – 1.5 metres.
5	If the Greenland ice sheet melted completely, sea levels would rise by about 6 – 7 metres.

Knowledge of specific New Zealand consequences of climate change

1	Climate change will intensify water security problems in parts of New Zealand by 2030.
2	Climate change will cause increased drought and fire in parts of New Zealand by 2030.

Knowledge of specific health consequences of climate change

1	Over the next 50 years, incidents of malaria, dengue fever, and other infectious diseases will increase and spread globally due to climate change.
2	Globally, the negative health effects of climate change will be more severe for poor, marginalised people.

Appendix D: Study 2 results for expanded groups

As part of Study 2, the same analysis was run for a different set of groups: environmental experts, non-environmental experts, policy advisers, managers, and farmers. As discussed in Chapter 2, Hatfield-Dodds and Jollands found that New Zealand farm owners and managers displayed the highest levels of perceived knowledge of climate change as well as the lowest levels of support for climate change policies. Farmers and managers were added to the Study 2 analysis to replicate this research. Examining the climate change knowledge of farmers is particularly interesting in New Zealand, as 50 percent of our greenhouse gas emissions come from agriculture.

Participants

Environmental experts (N = 190)

The environmental experts group was created by combining all the participants who selected either the job type ‘academic’ or ‘scientist’ and who also specified that the work they personally did related to the environment ‘very frequently’ or ‘always’.

Non-environmental experts (N = 208)

The non-environmental experts group was a combination of all the participants who selected either the job type ‘academic’ or ‘scientist’ and excluded those who also specified that the work they personally did related to the environment ‘very frequently’ or ‘always’.

Policy advisers (N = 103)

Policy advisers were those participants who selected the job type ‘public policy adviser’. Of these, 49 were environmental policy advisers. To recruit policy advisers, emails were sent to relevant government organisations. A contact at Ministry for the Environment placed a description of, and link to, the survey on the Ministry for the Environment’s intranet.

Managers (N = 93)

The managers group was created by combining all the participants who selected the job type ‘manager’. Of these, 26 were environmental managers. Managers were recruited using the rolling snowball technique, asking other participants to forward the survey to any managers they knew who they thought might like to participate.

Farmers (N = 31)

The farmers group was created by combining all the participants who selected the job type ‘farmer’. To recruit farmers, emails were sent to farming organisations, such as Federated Farmers, Dairy NZ, Rural Women, and the Farm Environment Awards network. Federated Farmers included a description of, and link to, the survey in their weekly electronic newsletter for member farmers, but response rates from farmers were low.

Knowledge results

Knowledge of state, causes, and consequences

This analysis found that policy advisers had the highest levels of knowledge of climate change, followed by environmental experts, non-environmental experts, managers, and lastly farmers (see Table 42 and Figure 19).

Table 41 summarises the ANOVA results. Overall, this analysis showed that these participants had significantly higher levels of knowledge of causes than of state or of consequences. Of the five groups, policy advisers had significantly more accurate knowledge than managers, and farmers had significantly less accurate knowledge than environmental and non-environmental experts and managers.

Table 40: Summary of ANOVA results for knowledge type

Statistical test	Finding	Explanation
Type of ANOVA	5 (group) x 3 (knowledge type) repeated measures ANOVA, with repeated measure on knowledge type	The groups were: environmental and non-environmental experts, policy advisers, managers, and farmers. The knowledge types were: state, causes, and consequences.
Main effect of knowledge type	$F(1.83, 1117.84) = 105.79, p < .0005$, Greenhouse-Geisser $\epsilon = .92$	Knowledge levels significantly varied by knowledge type.
Main effect of group (job type)	$F(4, 610) = 8.77, p < .0005$	Knowledge levels significantly varied by group.
Interaction effects	$F(3.67, 1117.84) = 5.175, p < .01$, Greenhouse-Geisser $\epsilon = .92$	The interaction was between knowledge type and survey version, meaning that the relationship between knowledge level and knowledge type was different for the different survey versions.
Bonferroni on knowledge type	Pairwise comparisons between state and causes were significantly different ($p < .0005$), as were those between causes and consequences ($p < .0005$), but not those between state and consequences ($p = .08$).	Participants had higher knowledge of causes than of state or consequences (see Figure 19).

Bonferroni on group	Farmers had significantly less accurate knowledge than environmental experts ($p < .0005$), non-environmental experts ($p < .0005$), and managers ($p < .05$). Policy advisers had significantly more accurate knowledge than managers ($p < .05$).	See Figure 19.
Bonferroni on survey version	Pairwise comparisons between version 1 and version 3 were marginally significant ($p = .06$), but not between version 1 and version 2 ($p = .63$) or version 2 and version 3 ($p = .78$).	Figure 20 shows that survey version 1 was different to versions 2 and 3. Participants answering version 1 scored higher on the state questions and lower on the consequence questions than those participants answering versions 2 and 3.

Table 41: Mean knowledge levels

Group	State		Causes		Consequences	
	Mean	SD	Mean	SD	Mean	SD
Environmental experts (N = 190)	0.73	0.25	0.87	0.16	0.74	0.18
Non-env. experts (N = 208)	0.71	0.26	0.84	0.19	0.68	0.21
Policy advisers (N = 103)	0.76	0.26	0.89	0.15	0.76	0.16
Managers (N = 103)	0.68	0.28	0.81	0.24	0.66	0.21
Farmers (N = 31)	0.56	0.28	0.70	0.25	0.51	0.30

(The highest mean scores are in bold.)

Figure 19: Mean knowledge levels by group

Figure 20: Mean knowledge levels by survey version

Knowledge of different consequences

This analysis found that, again, policy advisers had the highest knowledge, followed by environmental experts, non-environmental experts, managers, and then farmers were again quite far behind (see Table 44 and Figure 21).

Table 43 presents the ANOVA findings. Overall, participants had lower levels of knowledge of weather consequences and of sea level and glacier consequences, and higher levels of knowledge of New Zealand consequences and of health consequences. Of the five groups, policy advisers had significantly more accurate knowledge than non-environmental experts and managers. Farmers had significantly less accurate knowledge than all the other groups.

Table 42: Summary of ANOVA results for consequence type

Statistical test	Finding	Explanation
Type of ANOVA	5 (group) x 4 (consequence type) repeated measures ANOVA, with repeated measure on consequence type	The groups were: environmental and non-environmental experts, policy advisers, managers, and farmers. The consequence types were: weather, sea level and glacier, New Zealand, and health.
Main effect of consequence type	$F(2.43, 1485.02) = 78.27, p < .0005$, Greenhouse-Geisser $\epsilon = .81$	Knowledge levels varied by consequence type.
Main effect of group (job type)	$F(4, 610) = 12.20, p < .0005$	Knowledge levels varied by group.

Statistical test	Finding	Explanation
Interaction effects	None	
Bonferroni on consequence type	Pairwise comparisons for weather and sea level / glacier were significant ($p < .0005$), for weather and New Zealand were significant ($p < .0005$), for weather and health were significant ($p < .0005$), for sea level / glacier and New Zealand were significant ($p < .01$), for sea level / glacier and health were significant ($p < .0005$); but for New Zealand and health were non-significant ($p = .45$).	Overall, participants had significantly higher knowledge of New Zealand consequences and of health consequences than of weather or sea level and glacier consequences. See Figure 21.
Bonferroni on group	Farmers had significantly less accurate knowledge of consequence types than environmental experts ($p < .0005$), non-environmental experts ($p < .0005$), policy advisers ($p < .0005$), and managers ($p < .01$); and that policy advisers had significantly more accurate knowledge of consequence types than non-environmental experts ($p < .01$) and managers ($p < .01$).	See Figure 21.

Table 43: Knowledge of climate change consequences

Group	Weather		Sea level and glacier		New Zealand		Health	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Environmental experts (N = 190)	0.64	0.29	0.77	0.19	0.82	0.33	0.86	0.27
Non-env. experts (N = 208)	0.57	0.34	0.72	0.22	0.75	0.38	0.81	0.30
Policy advisers (N = 103)	0.66	0.27	0.79	0.17	0.89	0.25	0.90	0.22
Managers (N = 103)	0.52	0.33	0.71	0.22	0.79	0.35	0.76	0.31
Farmers (N = 31)	0.39	0.35	0.55	0.31	0.52	0.46	0.56	0.40

(The highest mean scores are in bold.)

Figure 21: Mean levels of knowledge of consequences

Confidence results

Confidence in knowledge of state, causes, and consequences

This analysis found that environmental experts had the highest confidence in their knowledge of climate change, followed by non-environmental experts, then policy advisers, managers, and finally farmers (see Table 46 and Figure 22).

Table 44 shows the main ANOVA findings. This analysis shows that, overall, participants had higher confidence in their knowledge of the causes of climate change than of the state or of consequences. Of the five groups, environmental experts had significantly higher confidence in their knowledge than all of the other groups.

Table 44: Summary of ANOVA findings for confidence in knowledge type

Statistical test	Finding	Explanation
Type of ANOVA	5 (group) x 3 (knowledge type) repeated measures ANOVA, with repeated measure on knowledge type.	The groups were: environmental and non-environmental experts, policy advisers, managers, and farmers. The knowledge types were: state, causes, and consequences.
Main effect of knowledge type	$F(1.92, 1172.99) = 135.53, p < .0005$, Greenhouse-Geisser $\epsilon = .96$	Confidence levels significantly varied by knowledge type.
Main effect of group (job type)	$F(4, 610) = 6.50, p < .0005$	Confidence levels significantly varied by group.
Interaction effects	None	
Bonferroni on knowledge type	Pairwise comparisons between confidence in knowledge of state and confidence in knowledge of causes were significant ($p < .0005$), as were those between confidence in knowledge of causes and confidence in knowledge of consequences ($p < .0005$), but not between confidence in knowledge of state and confidence in knowledge of consequences ($p = .69$).	Participants were significantly more confident in their knowledge of causes than of state or consequences. See Figure 22.
Bonferroni on group	Environmental experts had significantly higher confidence in their knowledge of state, causes, and consequences of climate change than: non-environmental experts ($p < .01$), policy advisers ($p < .01$), managers ($p < .01$), and farmers ($p < .01$).	See Figure 22.

Table 45: Confidence in climate change knowledge

Group	Confidence in state		Confidence in causes		Confidence in consequences	
	Mean	SD	Mean	SD	Mean	SD
Environmental experts (N = 190)	4.46	0.75	4.99	0.60	4.50	0.66
Non-env. experts (N = 208)	4.24	0.91	4.73	0.73	4.24	0.74
Policy advisers (N = 103)	4.13	0.96	4.59	0.95	4.20	0.86
Managers (N = 103)	4.19	0.91	4.55	0.81	4.21	0.81
Farmers (N = 31)	4.06	0.96	4.35	0.84	4.08	0.91

Figure 22: Confidence in knowledge of climate change

Confidence in knowledge of different consequences

Comparing participants' mean levels of confidence in their knowledge of consequences shows that environmental experts again had the highest confidence levels, followed by

policy advisers, then non-environmental experts, then managers, and finally farmers (see Table 47 and Figure 23).

Table 46 presents the ANOVA findings for confidence in consequence type. This analysis found that, overall, participants had lower levels of confidence in their knowledge of weather consequences and of health consequences, but higher levels of confidence in their knowledge of sea level and glacier consequences and of New Zealand consequences. Of the five groups, environmental experts had significantly higher confidence in their knowledge than non-environmental experts.

Table 46: Summary of ANOVA findings for confidence in consequence type

Statistical test	Finding	Explanation
Type of ANOVA	5 (group) x 4 (consequence type) repeated measures ANOVA, with repeated measure on consequence type	The groups were: environmental and non-environmental experts, policy advisers, managers, and farmers. The consequence types were: weather, sea level and glacier, New Zealand, and health.
Main effect of consequence type	$F(2.93, 1786.20) = 106.58, p < .0005$	Confidence levels significantly varied by consequence type.
Main effect of group (job type)	$F(4, 610) = 4.28, p < .01$	Confidence levels significantly varied by group.
Interaction effects	None	
Bonferroni on consequence type	All pairwise comparisons were significantly different ($p < .0005$), except for those between sea level / glacier consequences and New Zealand consequences ($p = 1.00$).	Participants were significantly more confident in their knowledge of health consequences. See Figure 26.
Bonferroni on group	Environmental experts had significantly higher confidence in their knowledge of the types of consequences of climate change than non-environmental experts ($p < .05$).	See Figure 26.

Table 47: Confidence in knowledge of consequences

Group	Confidence in weather		Confidence in sea level & glacier		Confidence in New Zealand		Confidence in health	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Environmental experts (N = 190)	4.13	0.87	4.61	0.78	4.53	0.96	4.96	0.83
Non-env. experts (N = 208)	3.80	0.96	4.41	0.87	4.24	1.04	4.77	0.87
Policy advisers (N = 103)	3.79	0.97	4.27	0.97	4.42	1.06	4.76	1.08
Managers (N = 103)	3.92	0.97	4.24	0.92	4.30	1.18	4.70	0.94
Farmers (N = 31)	3.76	1.01	4.17	1.00	4.19	1.09	4.50	1.12

(The highest mean scores are in bold.)

Figure 23: Confidence in knowledge of consequences

Relationship between knowledge and confidence

Overall, policy advisers had the best match between knowledge and confidence, knowledge of causes was the best-matched knowledge type, and knowledge of health consequences the best-matched consequence type.

As Table 48 shows, the match between knowledge and confidence was best for policy advisers, followed by environmental experts, then managers, then non-environmental experts, and lastly farmers. Of the three main knowledge types (state, causes, consequences), environmental experts had a better match for state and causes, while managers had a better match for causes and consequences. Policy advisers had a good match for all three, and non-environmental experts only had a significant match for causes. Farmers had no significant matches. Of the four consequence types, environmental experts, policy advisers, managers, and farmers all had the best match between knowledge and confidence for health consequences, followed by sea level and glacier consequences.

Policy advisers had the best match between knowledge and confidence of all the groups examined in this thesis (see Section 5.5.1).

Table 48: Relationships between knowledge and confidence in knowledge

	Env experts	Non-env experts	Policy advisers	Managers	Farmers
State	.14*	.10	.32**	.14	.09
Causes	.22**	.15*	.42**	.32**	.28
Consequences	.07	.11	.38**	.23*	.32
— Weather	-.06	.02	-.02	.06	.05
— Sea level and glacier	.18*	.20**	.55**	.30**	.31
— New Zealand	.11	.10	.33**	.19	.09
— Health	.20**	.15*	.56**	.32**	.41*

(Significant scores are in bold. Asterisks indicate the degree of significance.)

** = $p < 0.01$

* = $p < 0.05$

Appendix E: Additional multiple regression analyses

Concern for climate change regressions with separate measures of perceived efficacy and responsibility

Study 1

Independent variable	Time 1	Time 2	Time 3
	Beta	Beta	Beta
Ethnicity (Pakeha)	-0.05	-0.03	-0.00
Gender (male)	-0.01	-0.08	-0.11
Education	0.04	-0.04	0.02
Income	0.01	0.08	0.02
Age	-0.13*	-0.11	0.00
Religious service attendance	0.06	0.09	0.07
Support for Labour	0.11	0.00	0.03
Support for National	0.07	-0.13	-0.14
Political ideology	0.08	0.07	0.10
Environmental values	0.33***	0.18*	0.19**
Perceived knowledge level	0.08	0.04	0.09
Perceived efficacy	0.26***	0.19**	0.11*
Humans responsible	0.22**	0.27***	0.18
Trust media	0.03	0.01	0.05
Trust experts	-0.03	0.09	0.14
Confidence in scientists	0.11	0.04	0.09

(Significant scores are in bold. Asterisks indicate the degree of significance.)

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

Study 2

Independent variables	Beta
Gender (male)	-0.10***
Education	-0.03
Income	-0.02
Age	0.02
Support Labour	-0.00
Support National	-0.10***
Perceived knowledge level	-0.04
Actual knowledge level	0.24***
Perceived efficacy	0.20***
Humans responsible	0.23***

(Significant scores are in bold. Asterisks indicate the degree of significance.)

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

Study 2: Perceived efficacy regression for total sample

Independent variables	Beta
Gender (male)	-0.14***
Education	-0.03
Income	0.02
Age	-0.04
Support Labour	0.21***
Support National	-0.10***
Perceived knowledge level	0.05
Actual knowledge level	0.51***

(Significant scores are in bold. Asterisks indicate the degree of significance.)

*** = $p < 0.001$ ** = $p < 0.01$ * = $p < 0.05$

Appendix F: Study 2 participants' feedback on climate change knowledge survey

Below is a selection of quotes from survey respondents. These are grouped under general themes, but all of the comments could not be included, nor could the pages of detailed graphs, references, and detailed refutations of each of the survey questions be included. The questions in the survey were taken from Sundblad et al.'s survey, to allow comparison of the two studies.

No such thing as anthropogenic climate change

'I have spent hundreds of hours researching man-made global warming (aka climate change aka climate disruption) over the last year. I have performed an academic's task and followed most claims and counterclaims back to the original sources, read journal papers and books. I have taken the survey but will score very badly on accuracy. This is because most of the answers in the survey, while reflecting the view of many prominent climate scientists, go against common sense and common science. If I were to take this survey again in another 5 years I'm sure the 'correct' answers would be very different. I am not mad, crazy, a big oil shill, or a denier in the holocaust sense. I am merely a sceptic as any scientist should be (well, engineer actually). There is nothing available to science today to disprove the null hypothesis that global warming is not caused by man. Models are not evidence and global warming is not proof of a man-made cause.'

'What evidence do you have to say climate change is caused by greenhouse gasses? [sic] To go back one further and considering the problems now apparent, what irrefutable evidence do you have to say that climatic change recently is not within normal variations? Could I respectfully suggest that you might get a copy of Carter's book and Wisharts if you have not already read them both and then compile a survey which starts from a different position...'

'As you must/should be aware the climate changes naturally. Over the next few months it will almost certainly cool driven by the SOI. Over the next few years, it will almost certainly cool, driven by the last, unusually long sunspot cycle. The fact that you do not have an objective view on the subject is obvious from the way your have slanted the questions. I suspect that, as a result, your research will not be of much value.'

'Obviously being a student you are heavily influenced by your lecturers. As a result you may be unaware that Anthropogenic Global Warming (if that is what you are meaning when you say climate change) is a theory and has yet to be proved. A great number of your answers to your survey are in dispute, I would therefore question any results of the survey. Because of your confusion of the terms AGW and climate change you have resulted in a survey that is redundant.'

Climate change models are flawed

'Having taken your 'survey', I think the questions are too loaded. That you assume that current models are accurate indicates a large degree of hubris -I have personally looked into these models. In my opinion they cannot fore and backcast -because their physics is incomplete and possibly fatally flawed (e.g. there is NO radiative balance in the lower atmosphere and convection is the major transport process there). I object to being sent a PDF that suggests that the crystal ball projections of the IPCC models are the 'correct answers' to many questions. Is this not you distributing pro-AGW propaganda?'

The IPCC is incorrect and discredited

‘Your answers are based on one source which has been found to be in error on a number of its statements and produced by a small group of select scientists who conspire to hide declines and pressure journals not to publish dissenting views.’

‘It's worth noting as well that there is a shift occurring in attitude towards the rather confident conclusions made previously by the UN's IPCC and other bodies. For example, the Royal Society was forced by many of members to re-issue their previously bland statement endorsing the IPCC's conclusions with this one (see attached). While it still holds dear to a lot of what the IPCC says, for the first time it also addresses some of the cloud of uncertainties that surround such a complex subject.’

‘I have considered filling in your survey but I am astounded that a perhaps independent survey can load questions and vainly state that you know the answers to the questions you ask, based on the sources of Panchuri and IPCC. In addition it does not surprise me that Wellington University would come up with a survey like this. The IPCC's reputation is in tatters. There are 31,000 scientists including 9000 PHD SCIENTISTS that do not agree with Panchuri and IPCC. To say that or infer the science is agreed or settled is like saying that apples fall upwards. To ask questions then subsequently give answers based on IPCC etc is in itself more of the ongoing nonsense of the biggest scam in the history of mankind. IPCC wants to take trillions of dollars from the West on the basis of an unproven theory which is in tatters... It is the information provided by this organization that you seek to examine our knowledge of and presumably “mark” on the basis of the worthless view of IPCC. That in itself really is rather insulting to us. Science does not deliver truths from on high by concocted consensus as IPCC does, science is the facts.’

‘I would seriously disagree with about 50% of your true or false answers. If one looks at all the distorted temperature figures, sea level measuring distortion in Hong Kong, tree ring information from Russia, Urban Heat Island effects not corrected for, inadequate assessment of CO2 ex volcanoes above and below sea level, world cooling since 1998, computer programs that can not accurately predict historical trends when loaded with actual historic information, - there is not a lot that IPCC say that can not be seriously questioned.’

‘Why is it that IPCC has to distort data? Why will they not let anybody review their computer programs? Why cant the computer programs predict actual historical changes if fed historical data? ...We have been cooling since 1998 how much more cooling do you want to say the world is not warming.’

‘At the finish, you present the "model answers". These are not all correct. You have based them on publications by people who have been discredited by reliable and proven science. The worst of these is Pachauri, who has a huge financial vested interest in the IPCC outcomes. He has been asked to resign because of this (though, to be politically correct, the required resignation is disguised as having served on the IPCC for too long). I could work through them all, but that would be pointless. Suffice to say that far too many of the 'model answers' are incorrect. This is not my view, but that of reputable experts in the field based upon hard scientific fact.’

Scientists can't be trusted

‘Your questions all presume that 1) members of the scientific community who are providing data generally have integrity 2) the mechanisms for informing the public are unbiased and have the our [sic] best interests at heart 3) human beings across all strata of capability are in general good, well meaning and seeking the betterment of mankind I have strong evidence that these assumptions are false. Before you leap to the preprogrammed 'conspiracy theorist' response, I invite you to consider that there is no such thing as a conspiracy theory (however a case may be made for including the false theory that Iraq had weapons of mass destruction). Claims are

either true or false. How many Y2Ks, 911s, Birdflus, Swineflus and Global warmings will it take for intelligent people to figure out that there is a dark agenda behind most of these propaganda - and the perpetrators are experts at offering 'evidence' bolstering their propaganda and negating the true information. Your choice is to intelligently question and investigate, or to become a quisling minion by compliance.'

Climate change not such a bad thing

'Your survey offers no scope for anyone to express an opinion, via answers to questions, that they believe that there are benefits from climate change. Your survey and the thinking behind it seems to come from a pre conceived view that climate change is bad.'

'One implication of the survey is that climate change is a malignant process. This is dissonant with our cellular awareness.'

Information that contradicts anthropogenic climate change is suppressed

'I can quote many well-founded articles written by reputable experts in their field that have been submitted to the media, but they have all been refused, since they debunk the published scare stories. I wish you well in your thesis, but I urge you to risk being controversial and to present both sides of the argument, not just the politically acceptable version that may please your professors, for such theses stay with you forever (as witness that of Jim Salinger, which is now subject to a High Court action due to its misuse of and manipulation of data). It could come back to bite you in the proverbial nether regions.....'

'You see we have all been fed the pro warming garbage for 15-20 years with very little recognition of any other point of view. Partly because, in the EU for instance, and other countries, you can not get research funding unless it is pro global warming.'

'I would suggest that you have a look at the links below. They are only a few of the many that I have looked at. Quite often, they come from extremist publications, but those who oppose the AGW brigade can only be published in such media. On the major cause of climate change, it is now being accepted that the prime cause is solar radiation, tied in with solar flares. Even US Government bodies, such as NASA, are conceding this.'