



Responding to climate change in the land-based sectors

A social science research strategy for New Zealand

MPI Technical Paper No: 2012/34

Prepared by
The Institute of Environmental Science & Research Limited (ESR)
and Landcare Research

ISBN No: 978-0-478-40447-0 (online)
ISSN No: 2253-3923 (online)

September 2012

Authors

Graeme Nicholas¹ and Dr Karen Cronin²

This report summarises the Strategy presented in a full report to MPI prepared by:

Dr Karen Cronin²

Brendan Doody³

Dr Jeff Foote¹

DR Bob Frame²

Alison Greenaway²

Garth Harmsworth²

Graeme Nicholas¹

Dr Ann Winstanley¹

1: Institute of Environmental Science & Research Limited (ESR)

2: Landcare Research

3: Formerly GNS Science, now University of Durham, UK

Disclaimer

This research strategy ("the Strategy") has been prepared by a team led by the Institute of Environmental Science and Research Limited ("ESR") for the Ministry for Primary Industries and the Ministry for Business, Innovation and Employment under the terms of a Sustainable Land Management and Climate Change research contract.

Neither ESR nor any of its employees or subcontractors makes any warranty, express or implied, or assumes any legal liability or responsibility for use of the Strategy or its contents by any other person or organisation.

The information in this publication is for consultation only: it is not government policy. While every effort has been made to ensure the information in this publication is accurate, the Ministry for Primary Industries does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information. Any view or opinion expressed does not necessarily represent the view of the Ministry for Primary Industries.

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz

Telephone: 0800 00 83 33

Facsimile: 04-894 0300

This publication is also available on the Ministry for Primary Industries website at <http://www.mpi.govt.nz/news-resources/publications.aspx>

© Crown Copyright - Ministry for Primary Industries

Contents

Page

Executive Summary	1
Introduction	3
Approach	3
Context	4
Research Objectives	5
Implementation	8
Review and Revision	9
Social Science and Climate Change: Looking Forward	10
References	11

Executive Summary

This Strategy is to support and enhance New Zealand's response to climate change in the land based sectors through social science research. The Strategy builds on past work, particularly the *Degrees of Possibility: Igniting Social Knowledge around Climate Change* symposium¹ and represents another step in the journey. The Strategy was developed using a collaborative process supported by a literature review and further analysis in the New Zealand context.

The Strategy has been developed by the Institute of Environmental Science and Research Limited (ESR) and Landcare Research via the MPI Sustainable Land Management and Climate Change Research Fund, administered by the Ministry for Business, Innovation and Employment. Its focus is on the social dimensions of sustainable land management and climate change in New Zealand and the role social science can play in understanding these dimensions and designing responses to managing them.

The Strategy summarises the context, aims, objectives, research themes and questions identified in the full report 'Responding to Climate Change in the Land based Sectors: A Social Science Research Strategy for New Zealand.'

The Strategy distinguishes social science from standard practices of implementing policy or social interventions. It offers a short catalogue of ways in which social science can be applied to climate change challenges, and identifies key outcome areas and objectives for research.

Social science can be thought of as the study of "society and the relationships of individual within society"². Such study can inform both the nature and the implementation of policy and social interventions, and may include 'action research' methods that study a situation through intervention. Social science is distinct from the application of established professional practices used to simply 'roll-out' a policy or programme.

This Strategy identifies seven 'outcome areas' for climate change in relation to the land based sectors in New Zealand, each with a set of social science research objectives. The seven outcome areas elaborated in the Strategy are:

- A. **Innovation, dissemination and up-take of practices** in New Zealand land based sectors that will mitigate and/or adapt to the effects of climate change.
- B. **Market development** based on production practices in New Zealand land based sectors that mitigate the effects of climate change.
- C. **Policy support** on New Zealand's strategic direction in relation to climate change and its implications for land based sectors.
- D. **Understanding the challenge of climate change** from multiple perspectives in order to support engagement.
- E. **Innovative approaches to decision-making, governance and participation** that span from national to local levels of governance and incorporate stakeholder and Māori perspectives.
- F. Understand **factors that impact resilience, adaptability and transformability** in the New Zealand land based sectors.
- G. Effective approaches to **transdisciplinary and participatory research methods** and policy formation that integrate the expertise of bio-physical and social scientists, Māori, policy development, and practitioner stakeholders.

¹ See: Cronin, K., Doody, B., & Greenaway, A. (2011). *Degrees of Possibility: Igniting Social Knowledge around Climate Change*. Wellington: New Zealand Climate Change Centre.

² <http://wordnet.princeton.edu/>

Elements necessary to support the Strategy are:

- An institutional home or guardian of the strategy process.
- Sufficient funding for social science projects or social science components in trans-disciplinary projects.
- On-going collaboration between those commissioning and funding research, sector stakeholders and research providers to develop specific research questions, hypotheses and projects that realise the value of social science research.

The proposed implementation plan is a staged and collaborative process between central and local government, land based sectors, research funders and research providers.

Finally, the Strategy will need regular review and up-dating in the light of changing policies, priorities, the state of knowledge and methodological development. A collaborative review process and revision on a three yearly cycle is proposed, initiated by the Royal Society of New Zealand working with social scientists through the New Zealand Climate Change Centre. The review process would be conducted in partnership with the Ministry of Business, Innovation and Employment, the Ministry for the Environment, and the Ministry for Primary Industries, and involve researcher and sector stakeholders.

Responding to climate change in the land-based sectors: A Social Science Research Strategy for New Zealand

INTRODUCTION

This Strategy is to support and enhance New Zealand's response to climate change in the land based sectors through social science research. The Strategy was funded under the Sustainable Land Management and Climate Change Plan of Action, which aims to:

- enhance and support adaptation to climate change,
- reduce agricultural greenhouse gases,
- encourage the establishment of forest sinks and the management of deforestation, and
- capitalise on new business opportunities arising from the world's response to climate change.

Social processes are critical to the success of climate change action. Until recently there has been relatively little research in this area. A more strategic approach to social science research could add value to New Zealand responses to climate change in land based sectors. Well focused social science and capability relevant to the New Zealand context is needed.

The Strategy:

- sketches the current context for climate change response in New Zealand land based sectors,
- summarises the emerging role for social science to support responses to climate change,
- identifies critical objectives for social research in relation to New Zealand's climate change,
- suggests mechanisms for implementing the Strategy, and
- outlines an approach for reviewing and renewing the Strategy over time.

APPROACH

The Strategy addresses five areas of research identified by the Ministry for Primary Industries (MPI) as important:

- The drivers of change, including effective communication, to increase uptake and ensure investment is well targeted.
- How farmers, growers and foresters understand the risks of climate change and how they are motivated to take action.
- The barriers to change or opportunities for behaviour change at the ground/farm level.
- The design, implementation and evaluation of climate change programmes and activities at a farm/ground (production system) level and a national level.
- The design and use of systems approaches that encompass production, Māori, sectors, local and central government elements, as well as education, research, science (physical and social) and technology transfer.

The Strategy is the result of a collaborative process involving representatives of New Zealand's land based sectors, central government agencies, local government, scientists, and research providers. The development of the Strategy was led by a team from the Institute of Environmental Science and Research Limited (ESR), and Landcare Research (LCR). The process involved reviewing literature and other documents and running two stakeholder engagement workshops from which outcome areas and research objectives were distilled.

The Strategy builds on past work, particularly the *Degrees of Possibility: Igniting Social Knowledge around Climate Change* symposium (Cronin, Doody, & Greenaway, 2011). It summarises the research themes and questions identified in the full report, *Responding to Climate Change in the Land based Sectors: Toward a Social Science Research Strategy for New Zealand*.³ That report includes the contents of this Strategy, along with a substantial review and analysis of New Zealand and international literature, and stakeholder consultation conducted in 2011-12.

The Strategy aims to improve decisions about the direction, commissioning and undertaking of research in this field, and is designed to be used by users in various settings.

CONTEXT

It is widely recognised that social processes are critical to the success of climate change action, but until recently there has been relatively little research in this area. The IPCC has identified social science research questions as priorities in the next phase of international climate research (Reisinger, 2010), as has the UNESCO World Social Science Report (Balstad, 2010). International scholars (e.g. Gifford, 2006, 2011) have highlighted the social and psychological factors behind decision-making in relation to the environmental behaviour; others (e.g. Shove, 2010a; Spaargaren, 2011) have emphasised the need to better understand the role of social practices in relation to climate change, and how such practices might be studied and influenced. Shove (2010a, 2010b) argues for broadening the range of what social science can offer in climate change policy. The International Social Science Council has recently identified the cornerstone social research needed for climate change (Hackmann & St. Clair, 2011). In New Zealand, social scientists have been developing their expertise in this field and recently identified theme areas for a NZ Social Science Research Agenda on Climate Change (Cronin et al., 2011).

Social science includes a wide range of disciplines including sociology, psychology, geography, anthropology, political science, and economics. It also includes specialised and interconnecting fields of inquiry including systems theory, policy science, science communication, 'science, technology and society' studies, evaluation and behavioural economics. Social science can provide both frameworks to analyse and understand social processes, and inform and evaluate social interventions. In relation to climate change, this means that social science can help explain human activity contributing to climate change and responding to climate change, and social science can support policy responses and sector and local decision-making about climate change.

Social science capacity needs to be developed, alongside biophysical science, to provide a rich picture of the climate change challenges. In addition, new approaches to integrating social science and biophysical science are needed to produce a fuller knowledge framework and a base for better policy and programme implementation.

It is useful to distinguish social science from standard practices of implementing policy or social interventions. Social science can be thought of as the study of "society and the relationships of individual within society"⁴. Such study can inform both the nature and implementation of policy and social interventions, and may include 'action research' methods that study a situation through intervention, but is distinct from the application of established professional practices used to simply 'roll-out' a policy or programme.

³ Available from <http://www.mpi.govt.nz>

⁴<http://wordnet.princeton.edu/>

Social science can apply to a number of dimensions of climate change, including:

1. The social basis of beliefs, behaviours, technologies, practices and systems that lead to environmental change, including pressures and disruptions, such as climate change.
2. The social processes underlying the production of knowledge about the state of the environment, including the production of biophysical science knowledge about the climate system and climate change.
3. The transfer, interpretation, uptake, acceptance and rejection of biophysical science knowledge on the climate.
4. The impacts of climate change on society and the economy, including the varying impacts for different regions and sections of society.
5. The mental models or worldviews held by different people and groups about the social system and the influence of human society on the biosphere.
6. The different knowledge frameworks that people draw on to form mental models and make judgements about what they see in the world e.g. formal Western science, indigenous knowledge.
7. The way in which the 'climate change problem' is constructed by different individuals and groups in society, and how this influences their reaction.
8. The way in which solutions to the climate change are constructed and contested by different groups.
9. Understanding the drivers for social change and the most effective forms of social intervention to achieve it (e.g. education and communication, technology transfer, policy and regulation, and cultural and political change).
10. The impacts of different climate change mitigation/adaptation programmes on communities, society and the economy.

RESEARCH OBJECTIVES

The following social science outcome areas and objectives for New Zealand make up the framework for this Strategy. The objectives are not organised in priority order, and work has already been undertaken in some areas (marked with asterisk [**]). The outcome areas below are discussed in more detail in the full report, *Responding to Climate Change in the Land Based Sectors: Toward a Social Science Research Strategy for New Zealand*.⁵ Engagement with stakeholders on specific research questions or hypotheses and relative priority is recommended.

Outcome areas

- A. **Innovation, dissemination and up-take of practices** in New Zealand land based sectors that will mitigate and/or adapt to the effects of climate change.

Social Science Research Objectives

1. Develop **models and approaches for monitoring, evaluation and analysis** to support innovation and practice-change in land based sectors that mitigate and/or the effects of climate change. **
2. Identify **examples of 'good practice'** in land based sectors in mitigating or adapting to climate change: How are these understood in their sector? How might they seed practice-change more widely? **
3. Understand the economic, social and other **incentives for and constraints on practice-change** in land based sectors, and how this understanding might be translated into policies and practices. **
4. Understand the **nature and role of networks, knowledge sharing, tools and skills** at local, regional, sector and national levels in responding to climate change. **

⁵ Available at <http://www.mpi.govt.nz>

5. Understand in relation to climate change in land based sectors the **mechanisms of and potential for innovation, practice-change and technology transfer**, at different scales.
6. Identify and understand **examples of effective stakeholder engagement** programmes relevant to engagement with stakeholders in land based sectors, including Māori. How can these be evaluated and extended for climate change mitigation and adaptation?
7. Identify examples of and opportunities for **self-organisation** in response to climate change in land based sectors.

B. Market development based on production practices in New Zealand land based sectors that mitigate the effects of climate change.

Social Science Research Objectives

1. Understand **consumer attitudes and behaviour** in relation to climate change and land based practices. **
2. Develop and test ways to **incentivise consumer behaviour** in relation to climate change and land based practices.
3. Understand and further develop **innovation pathways for alternative exports** that mitigate and/or adapt to climate change.
4. Develop and apply conceptual frameworks for **linking producers, retailers and consumers** as a whole system impacting on mitigation of and adaptation to climate change. **
5. Understand the international **social and consumer trends around food, food security and timber production**, and how such trends might impinge on New Zealand producers and the positioning of New Zealand as a producer economy. **

C. Policy support on New Zealand's strategic direction in relation to climate change and its implications for land based sectors.

Social Science Research Objectives

1. Develop **systemic frameworks** for evaluating interventions, and to show how policies and practices around climate change in the land based sectors are perceived by citizens and key markets; how they interact, reinforce or disrupt one another; and the possibility of unintended consequences. **
2. Demonstrate the **systemic relationship** between climate change policy in the land based sectors, and other government policies and practices, such as water, energy and land use.
3. Develop frameworks to understand the relationship between management of **immediate imperatives and commitment to longer term outcomes**.
4. Develop **methods to model complex adaptive systems** influencing response to climate change in land based sectors, as a support for policy development and decision-making.
5. Understand **what drives or constrains commitment** to policy action.
6. Understand the **role of framing and the role of scientific knowledge** in shaping policy.
7. Understand the **potential and limitations of policy interventions**, including regulatory and price based approaches to behaviour change in land based sectors.
8. Understand the trade-offs and tensions between **costs and benefits** of responding to climate change in land based sectors.

- D. **Understanding the challenge of climate change** from multiple perspectives (e.g. Māori, co-benefits, ethical and justice perspectives, intra- and inter-generational responsibility, and responsibility for the commons) in order to support engagement.

Social Science Research Objectives

1. Understand the needs and implications of climate change policy on **Māori**, including mātauranga Māori in the land based sectors.**
2. Understand **Māori aspirations, opportunities, and understanding** of key concepts in relation to climate change. **
3. Understand **linkages between climate change and other social issues** (including national and global inequalities, food security issues, resilience and vulnerability), as it affects land based sectors.
4. Develop frameworks for understanding climate change in terms of **responsibility for a common resource** and collective responsibility in land based sectors.
5. Describe the dominant **ways in which climate change is understood and debated** in land based sectors, how producers understand the impact on the environment of their activities, and how these understandings might affect policies and practices.
6. Understand the implications of **demographic projections and scenarios** for climate change and responding to climate change in the land based sectors.
7. Understand the **contextual drivers of behaviour** in land based sectors that contribute to climate change.
8. Understand the **relative threats, opportunities and impacts** for different communities, and how people and institutions understand and respond to climate risks

- E. **Innovative approaches to decision-making, governance and participation** that span from national to local levels of governance and incorporate stakeholder and Māori perspectives.

Social Science Research Objectives

1. Evaluate and develop **models of collaborative governance and common commitment** applicable to responding to climate change in land based sectors.
2. Understand how decision-makers in land based sectors make **decisions under conditions of uncertainty**.
3. Understand any distinctive approaches to decision-making, governance and participation that are used in **Māori land based sectors**. How might these approaches be extended to support climate change mitigation and adaptation?
4. Understand how **different forms of knowledge**, local, Māori, and academic have access to and influence on decision-makers, and how knowledge can be made more accessible and useful.
5. Discover in what way **power relationships in socio-ecological systems** affect the development, implementation and evaluation of policy interventions on climate change in land based sectors; and develop approaches to represent vulnerable populations and socio-ecological systems in decision-making.
6. Develop a systemic understanding of actors, institutions and **factors influencing practices** and informing decision-making in the land based sectors.

- F. Understand **factors that impact on resilience, adaptability and transformability**⁶ in the land based sectors.

Social Science Research Objectives

1. Identify the variables that need to be measured to assess **resilience, adaptability and transformability** in land based sectors.
2. Understand **constraints on resilience, adaptability and transformability** in land based sectors.
3. Develop and test **monitoring and analytical methods** to demonstrate resilience, adaptability and transformability in the land based sectors.
4. Understand particular **impacts of climate change for Māori resilience, adaptability and transformability**, including impacts on culture, settlement patterns, health and financial prosperity.
5. Understanding particular **impacts of climate change for community resilience, adaptability and transformability**, including impacts on culture, settlement patterns, health and financial prosperity.
6. Understand the role of social and cultural identities in **how climate change is experienced**, and how people cope with and recover from its impacts.
7. Determine the effectiveness and potential enhancement of key elements in adaptive management in land based sectors: **communication, information and trust**. **

- G. Effective approaches to **trans-disciplinary and participatory research methods** and policy formation that integrate the expertise of bio-physical and social scientists, Māori, policy development, and land based stakeholders.

Social Science Research Objectives

1. Develop and test **methods for involving land based sector practitioners** (e.g. farmers, foresters and businesses) in research and policy development. **
2. Identifying and articulating the **scope for social sciences** to contribute to climate change research in collaboration with other sciences. **
3. Improved understanding and application of **Māori knowledge of natural systems**, including mātauranga Māori and concepts such as kaitiakitanga, to support climate change mitigation and adaptation in land based sectors.
4. Understand **barriers to Māori access to expertise and knowledge** to support climate change mitigation and adaptation.
5. Develop approaches to mediate **different kinds of expertise** contributing to climate change policy development in land based sectors.

IMPLEMENTATION

For the Strategy to have its due influence several ingredients will be required:

- An institutional home or guardian of the strategy process.
- Sufficient funding designated for social science projects or social science components in wider projects.
- On-going collaboration between those commissioning and funding research, sector stakeholders and research providers to develop specific research questions, hypotheses and projects that realise the value of social science research.⁷

⁶ "...resilience thinking focuses on three aspects of social-ecological systems (SES): resilience as persistence, adaptability and transformability" (Folke et al., 2010). Resilience is the tendency of a SES to essentially recover. Adaptability is the capacity of a SES to adjust. Transformability is the capacity to establish a new stable state. See too: Walker et al. (Walker, Holling, Carpenter, & Kinzig, 2004).

⁷ The framework proposed in the NSF Advisory Committee for Environmental Research and Education (Pfirman & the AC-ERE, 2003, p. 9) is useful. It focuses on the framing of questions or problems for investigation, integration of research activity, meta-analysis to define the state of knowledge, and the availability of scientific data, models and conclusions.

A staged implementation process is outlined below for central and local government, land based sectors, research funders and research providers to co-create the identified research outcomes:

1. MPI adopts the strategy and promotes it to stakeholders (policy, funding, land based sectors, research providers).
2. The Ministry for Business, Innovation and Employment (MBIE), MPI, Ministry for the Environment (MfE), Local Government New Zealand and the Royal Society of New Zealand (RSNZ) use the strategy as a key tool for shaping, commissioning, and assessing social science research on climate change in the land based sectors.
3. The Social Science and Humanities Committee of the Royal Society of New Zealand is invited to endorse the strategy. The RSNZ is invited to promote the Strategy to the New Zealand social science community working through the New Zealand Climate Change Centre (NZCCC). This promotion would include: a) special session on social science at the major research conference being planned by NZCCC in 2013; and b) an annual stakeholder workshop, in collaboration with MPI and MBIE, to elucidate and prioritise the outcome areas and research objectives.
4. Further refinement and development of the research priorities can be achieved through an on-line tool developed with this Strategy, which enables stakeholders, including industry government and researchers, to interact with one another. This tool will need to be maintained as part of implementation of the strategy. It is proposed that the tool be hosted through the auspices of the electronic social science hub, eSOCSCI Hui Rangahau Tahi.
5. The findings of the annual stakeholder workshops will supplement the on-line feedback to influence solicitation of and proposals for social science research on climate change in relation to New Zealand land based sectors.
6. Research consistent with the Strategy is commissioned, carried out and evaluated.
7. The Strategy is reviewed and revised on a three yearly cycle.

REVIEW AND REVISION

This strategy reflects the issues and state of research at a moment in time. It will need regular evaluation and review in the light of changing policies, priorities, state of knowledge and methodological development. Collaborative review and revision processes on a three yearly cycle are recommended, initiated by the RSNZ working through the NZCCC and in partnership with MBIE, MfE and MPI.

A collaborative review and revision would involve five elements:

- An analysis of how the Strategy has been used and has influenced decision-making in commissioning, funding, proposing and evaluating social science research on climate change in New Zealand.
- Reference to relevant international research approaches, questions and findings.
- A survey of stakeholders (social science providers, policy and funding bodies, land based sector) inviting comment on what they have found most useful in the strategy, what gaps they have noticed, and what would make the strategy more fit for their purposes.
- A multi-stakeholder workshop to identify and prioritise research areas and topics.
- An opportunity for feedback on the emergent themes and draft revised strategy.

SOCIAL SCIENCE AND CLIMATE CHANGE: LOOKING FORWARD

Social science research can help optimise responses to climate change in the land based sectors by improving our understanding of personal and social drivers, practices, opportunities and impacts. This research strategy provides guidance on social science research to achieve the Sustainable Land Management and Climate Change Plan of Action aims, to:

- enhance and support adaptation to climate change,
- reduce agricultural greenhouse gases,
- encourage the establishment of forest sinks and the management of deforestation, and
- capitalise on new business opportunities arising from the world's response to climate change.

The Strategy includes an outline of the potential contribution of social science, a distillation of critical objectives that social science needs to help address, and a proposal of how to implement and revise the strategy to ensure best outcomes.

Ultimately, the value of the Strategy will depend not on the authority of its contents but on its usability and use by those making decisions about seeking or providing knowledge through research to support New Zealand responses to climate change in the land based sectors. From use will come thought and dialogue, that will define and refine the questions, methods and applications that will constitute the social science contribution to New Zealand.

REFERENCES

- Balstad, R. (2010). The interdisciplinary challenges of climate change research. In F. Caillods, *World Social Science Report 2010* (pp. 210-212): UNESCO Publishing; International Social Science Council.
- Cronin, K., Doody, B., & Greenaway, A. (2011). *Degrees of Possibility: Igniting Social Knowledge around Climate Change*. Wellington: New Zealand Climate Change Centre.
- Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience Thinking: Integrating Resilience, Adaptability and Transformability *Ecology and Society*, 15(4), 20. Retrieved from <http://www.ecologyandsociety.org/vol15/iss4/art20/>
- Gifford, R. (2006). A General Model of Social Dilemmas. *International Journal of Ecological Economics & Statistics*, 5(S06), 23-40.
- Gifford, R. (2011). The Dragons of Inaction: Psychological Barriers that Limit Climate Change Mitigation and Adaptation. *American Psychologist*, 66(4), 290-302.
- Hackmann, H., & St. Clair, A. L. (2011). *Transformative Cornerstones of Social Science Research for Global Change* (ISSC Work-in-Progress Paper): International Social Science Council.
- Pfirman, S., & the AC-ERE. (2003). *Complex Environmental Systems: Synthesis for Earth, Life, and Society in the 21st Century*: (A report summarizing a 10-year outlook in environmental research and education for the National Science Foundation).
- Reisinger, A. (2010). *International climate change research & policy processes*. Paper presented at the Degrees of Possibility NZCCC Social Science Workshop. Retrieved from <http://www.nzclimatechangecentre.org/research/dop>
- Shove, E. (2010a). Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A*, 42(6), 1273-1285.
- Shove, E. (2010b). Social Theory and Climate Change: Questions Often, Sometimes and Not Yet Asked. *Theory, Culture & Society*, 27(2-3), 277-288.
- Spaargaren, G. (2011). Theories of practices: Agency, technology, and culture: Exploring the relevance of practice theories for the governance of sustainable consumption practices in the new world-order. *Global Environmental Change*, 21(3), 813-822.
- Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, Adaptability and Transformability in Social-ecological Systems. *Ecology and Society*, 9(2).