Routledge
Taylor & Francis Group

Kōtuitui: New Zealand Journal of Social Sciences Online

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tnzk20

# Trusted storytellers as freshwater restoration knowledge brokers: individual and collective voices can both be effective

Katharina Doehring, Cathy Cole, Paula Casanovas, Roger Young & Nancy Longnecker

**To cite this article:** Katharina Doehring, Cathy Cole, Paula Casanovas, Roger Young & Nancy Longnecker (25 Jan 2024): Trusted storytellers as freshwater restoration knowledge brokers: individual and collective voices can both be effective, Kōtuitui: New Zealand Journal of Social Sciences Online, DOI: 10.1080/1177083X.2023.2298914

**To link to this article:** https://doi.org/10.1080/1177083X.2023.2298914



Published online: 25 Jan 2024.

KOTUITUI: NEW ZEALAND JOURNAL OF SOCIAL SCIENCES ONLINE
https://doi.org/10.1080/1177083X.2023.2298914

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

# Trusted storytellers as freshwater restoration knowledge brokers: individual and collective voices can both be effective

Katharina Doehring[a,b], Cathy Cole[b,c], Paula Casanovas[a], Roger Young[a] and Nancy Longnecker[b]

[a]Cawthron Institute, Nelson, New Zealand; [b]Department of Science Communication, University of Otago, Dunedin, New Zealand; [c]Centre for Alternative Technology, Machynlleth, UK

**ABSTRACT**

Aotearoa New Zealand's aquatic ecosystems are declining despite widespread awareness of mitigation needs. This study employs storytelling to address this issue, testing the role of the messenger in encouraging freshwater restoration in rural catchment communities. We quantified peer-to-peer knowledge exchange on three cognitive processes (retention and extraction of information, motivation to reproduce modelled restoration behaviour, and recall of acquired information), using ArcGIS® 'StoryMaps'. We created two restoration stories; one told through the voice of a respected catchment group member known for leadership, and one through a collective catchment group voice. We surveyed freshwater community members ($N = 82$) before and after reading the stories, and one month later, and found that participants reading either catchment restoration story (1) accepted both the catchment collective and the respected individual member as a trusted source, and could therefore relate to either, and (2) thought the story was informative and contained new details, independent of the time span land holders have been actively restoring. While our study found no significant differences between individual or collective storytellers, it confirms the value of trusted messengers as restoration knowledge brokers in rural catchment communities, a critical step in value-led freshwater restoration at large scales.

**ARTICLE HISTORY**
Received 11 September 2023
Accepted 21 December 2023

**KEYWORDS**
Observational learning; catchment freshwater restoration; sustainable land management; water quality

## Introduction

Globally, the restoration of freshwater ecosystems has become a large and growing challenge, mitigating against damaging human activities. Intensive agricultural practices especially have resulted in water quality degradation (Mateo-Sagasta et al. 2017; UN Water – WWAP 2022; NZ Ministry for the Environment and Stats NZ 2023). Restoration, including similar concepts like river rehabilitation or mitigation can include physical measures (e.g. the re-establishment of natural flow regimes through expanding floodplains, sustainable management of the land surrounding a waterway (Sayer et al.

**CONTACT** Katharina Doehring kati.doehring@cawthron.org.nz

2018; Gann et al. 2019)) as well as social-ecological interventions (e.g. stakeholder participation in decision-making (Reed 2008; Scott 2015; Newig et al. 2023)).

With regards to the latter, community-led freshwater collectives are a collaboration of people who take ownership of a problem, jointly addressing the most pressing issues at local scales. These collaborations build from existing connections between people who share an attachment to the land and people in their catchment[1], often because they live close to the waterway of concern. Together they bring about on-the-ground change by working collectively and sitting at the core of decision-making, a principle commonly termed 'grassroot' community engagement (O'Meara et al. 2007; Ministry of Agriculture and Forestry 2010). They foster governance and responsibilities grounded in local culture and social and community values (Wakefield et al. 2006), generating positive social and environmental outcomes (Gunningham and Holley 2016; Bodin 2017; Innes and Booher 2018). These groups are commonly supported by substantial investments by government, industry and philanthropic organisations (Shanahan et al. 2021).

Community-based catchment (or watershed) management is currently prevalent around the globe (e.g. da Costa Silva 2011; Pumicestone Region Catchment Coordination Association Inc 2017; Mekuriaw and Amsalu 2023). In Aotearoa New Zealand, for example, the Southland region has established 35 community catchment groups since 2013, forming a network covering over 90% of the Southland region. Their vision is to 'create a prosperous Southland, healthy people, healthy environment from the mountain to the sea.' (Thriving Southland 2023). These catchment groups achieve their goals by supporting farmers to navigate regulation changes and future challenges such as climate change and help them to get ahead of issues by participating in events and projects to develop localised responses that reflect their expertise and experience. In 2021/22 the Southland Region groups held 156 catchment meetings and events with 2,657 attendees, receiving NZ$ 623,015 worth of funding that covered 41 projects (Thriving Southland 2022). Similarly, a group of farmers and growers from the Taranaki Region came together in 2020 as 'Taranaki Catchment Communities' to establish 15 catchment groups under the region-wide umbrella organisation. Their collective aim is to 'lead, engage and mobilise Taranaki's rural sector to ensure a more environmental, economic and socially sustainable future' (Taranaki Catchment Communities 2023). Within three years, the Taranaki region has had 6000 volunteer hours committed to setting up the 15 groups and facilitated 60 events which have been attended by more than 500 farmers. This surge in community-led freshwater restoration groups means that a large (and growing) proportion of rural citizens now participate in freshwater ecosystem restoration activities in Aotearoa New Zealand (Peters et al. 2015; Tadaki et al. 2020; McFarlane et al. 2021).

### *The value of stories for information exchange*

Collaboration in freshwater restoration takes place at all scales, from small district to large regional scales. As the scale increases, so does the complexity of restoration decision-making due to the differences and heterogeneity in environmental, cultural and social values, economies and politics (Kark et al. 2015). This complexity should also be considered for cross-boundary knowledge exchange. In Aotearoa New Zealand, many freshwater restoration groups have been restoring their catchments for decades and have a wealth of knowledge about actions that have and haven't worked.

Exchanging restoration knowledge between catchment communities across boundaries allows freshwater restoration communities to learn from each other about their restoration experiences (Doehring et al. 2023), help prevent mistakes being repeated and enable more impactful pro-environmental behaviour (Blackmore 2007; Armitage et al. 2008).

To encourage behaviour change, it is important to know which intervention strategies are most effective and under which circumstances for particular groups of people. More recently, the role of storytelling in freshwater management has been explored as a way to contextualise various types of knowledge to support management processes through collaborative action (Stevens 2022), and for the sharing of restoration knowledge as a strategy to maintain restoration momentum (Doehring et al. 2023).

Stories have been integral to human culture and are instrumental in our cognitive processes of retention and extraction of information (e.g. Morris et al. 2019; Goyes 2022; Robin et al. 2022). Stories allow us to effectively share knowledge and learning, engage us by evoking emotion and compel us to think and behave differently (Dahlstrom 2014). Van Bavel et al. (2021) suggest that stories about personal experiences that are shared in a genuine and caring manner are more digestible than argumentative or generic commentary. And Negrete and Lartigue (2010) suggest that information conveyed in the form of stories is retained for longer periods than information presented in a factual way, making stories an 'important means for science communication to transmit information in an accurate, memorable and enjoyable way' (p. 104).

However, while information provision (in form of stories) is a critical component of behaviour change, information is made meaningful only after it is placed within a certain social network. If we then also believe this network (in our study restoration catchment groups) to be trustworthy, an audience is likely to feel the same about knowledge that comes from that social network (i.e. that knowledge is considered to be true) (Collins 1992; Jasanoff 1998). Essential here is the element of trust, a heuristic used to evaluate information which is based, amongst other factors, on whether new information comes from credible sources that are also trusted by peers (Lewandowsky et al. 2012). For example, Brown and Roper (2017) showed that farmers are more likely to adopt new practices and technologies when that demonstration was undertaken within farmer networks, because these networks already provided that interpersonal trust. Similarly, farmers did not tend to trust information that came from people with limited farming experience (Mauro et al. 2009; Rust et al. 2020; Skaalsveen et al. 2020). So, social similarity to an audience allows them to identify with the storyteller and is key in building trust (Neef and Neubert 2011). Once an audience can identify with a storyteller and content is understood, modelled behaviour (in our case the uptake of sustainable restoration actions and the act of sharing restoration knowledge) is more likely to be adopted (Toolan 1988; Oatley 1999; Dahlstrom 2014; Sundin et al. 2018).

The potential of storytelling to trigger behaviour change has not been fully recognised as an effective technique for engaging behaviour-changing pathways in the conservation and restoration sectors. While researchers have started to address this knowledge gap (e.g. Morris et al. 2019; Goyes 2022; Robin et al. 2022), evidence is lacking about the part messengers (in our case storytellers) play as trusted role models. Our research aims to bridge this knowledge gap. Specifically, we explore the role that an individual or a collective storyteller voice may play in encouraging freshwater communities to increase on-land restoration actions. In this study, we used digital storytelling as a medium for sharing freshwater restoration knowledge.

### Digital stories as a medium for peer-to-peer restoration knowledge exchange

Online interactive communication tools to share information in the form of stories are popular due to their ability to engage a wide range of audiences, their relative simplicity for users, and their potential for wide reach over a short timespan (Cortes Arevalo et al. 2020). Restoration knowledge and advice networks are important components of rural communities' innovation systems (Fielke et al. 2020). Worldwide, land managers and catchment groups build 'digital relationships' online with their peers, communicating with each other and potentially forming communities of practice (Rust et al. 2022). Peer-to-peer information exchange enables rural communities to engage and learn from each other. Farmers, for example, often believe that information conveyed from another farmer is more useful than from others, especially where this information has demonstrated value and benefits to other farmers in their network (Blackstock et al. 2010). Rust et al. (2022), for example, documented farmers' preference for learning about restoration actions from other farmers through in-person events such as farm visits. Further research confirms the critical role of peers as advisors and support, suggesting successful sharing occurs when the farmer sharing the knowledge does not have a conflicting agenda but has applied, practical experience relevant to the farmer seeking information (Wood et al. 2014; McKitterick et al. 2019; Rust et al. 2022). This means that farmers see themselves and other farmers as experts (Palmer et al. 2009), acknowledging the many different sources from which knowledge is generated, notably by the farming community themselves (Chambers et al. 1989).

Many catchment groups have active Facebook pages where they publish information about freshwater restoration, publicise upcoming community engagements and link to other restoration-related knowledge and/or activities (e.g. Brisbane Catchments Network Australia 2023, 2200 followers; Friends of the River Roding 2023, UK, 2700 members; Pomahaka Catchment Project 2023, Aotearoa New Zealand, 1200 followers). However, while digital storytelling is a popular tool amongst catchment groups to share information, it is unclear whether this supports pro-environmental behaviour. To fill this gap, we quantitatively tested the effect of recognised freshwater restoration storytellers on information uptake, recall and motivation to restore. To do this we used ArcGIS® 'StoryMaps' (esri; https://storymaps.arcgis.com/; accessed 18.05.2023) as a digital storytelling medium to exchange restoration knowledge across restoration communities in Aotearoa New Zealand. We created one story that was told by a catchment group through a 'collective voice'and one story that was told by an individual member or 'influencer'. We tested these two storytelling methods in the context of Social Cognitive Theory.

### Social cognitive theory and pro-environmental behaviour change

Learning through modelling the behaviour of peers is a concept recognised as 'observational learning' in Bandura's *Social Cognitive Theory* (Bandura 1989), the theoretical framework used in our research. Observational learning postulates that learning can occur by observation and/or interaction with others in communities through the process of behaviour modelling, rather than individual cognitive learning. In the field of environmental management, it has been recognised that observational learning can help avoid repetition of past management failures in complex social-ecological systems (Blackmore 2007; Armitage et al. 2008). In rural catchment community terms, this would be 'looking over the fence to see what my neighbour has done', rather than solely 'learning by doing'. The land holder over the fence then acts as a 'model' or an 'influencer', a critical source of learning within farming communities (Burton 2004; Zeng et al. 2022).

Social Cognitive Theory provides a framework for understanding psycho-social mechanisms that influence human thought, and for predicting and changing human behaviour (Bandura 1989). Story parts or narrative elements influence cognitive involvement by sparking the interest of the audience in a way that they can identify, recall, remember, and contextualise the content (Dahlstrom 2014). Providing information that resonates with the audience is an important aspect of whether new information is used (Longnecker 2016, 2023).

We hypothesised that audiences who received freshwater restoration knowledge shared by an individual 'model', in our case a farmer called Mark on behalf of 'his' catchment group, would pay greater attention to the information, remember more of the information provided, and be more likely to restore in the future. In contrast, we predicted that audiences who received restoration knowledge from a catchment community (i.e. a collective voice) would take up less information, recall fewer details and be less motivated to restore their freshwaters. The following four cognitive processes were used to test our hypotheses (Figure 1).

### *Retention and extraction of information | hypothesis 1*

Attentional processes determine what people observe from modelling influences and what information they retain and extract from what they notice (Bandura 1989). In

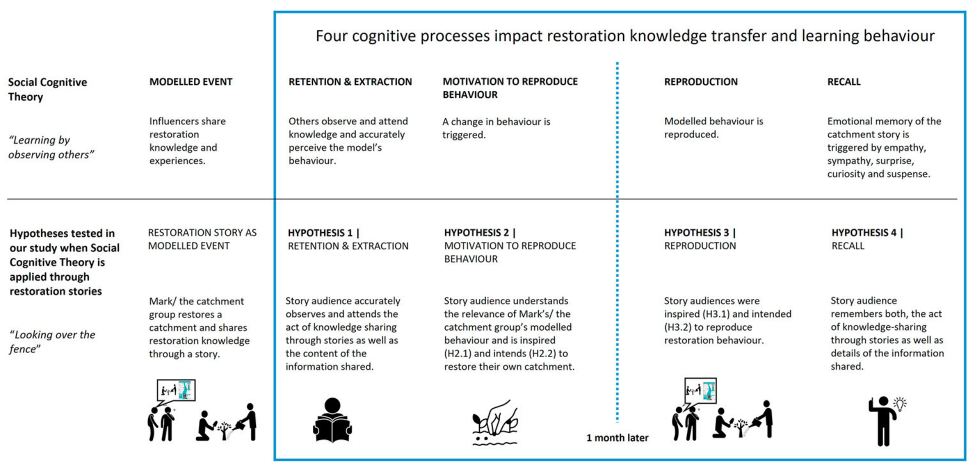


**Figure 1.** Four cognitive processes that impact restoration knowledge transfer and pro-environmental behaviour change tested by applying Social Cognitive Theory.

our case, the individual storyteller, Mark, is an influential model who shares his freshwater restoration knowledge in the form of a catchment story. We predicted that audiences who observed Mark's behaviour would be more likely to pay attention to his behaviour and extract information from what they notice, in comparison to audiences that read the story with a collective storytelling voice.

### *Motivation to reproduce modelled behaviour | hypothesis 2*

For a modelled behaviour to be copied, the reader needs to be motivated. We tested this with our second hypothesis whereby we asked about the audience's inspiration in response to the story (H2.1) and intention (H2.2) to restore and share knowledge. We predicted that our audience's inspiration and intention to restore would be influenced by the credibility of the storyteller and his/their modelled restoration behaviour.

### *Reproduction | hypothesis 3*

Reproduction of a modelled behaviour is a desired outcome that may occur after the viewer's interaction with the text, visuals, and interface of a story. Our third hypothesis tested whether participants acted on their inspirations (H3.1) and intentions (H3.2) to restore and share knowledge one month later.

### *Recall | hypothesis 4*

Recall refers to the mental process of retrieval of information that was previously seen or experienced. For learning to take place, it requires that the information that is processed is committed to memory and can be recalled when needed. In our study, we hypothesised that landholders who observed an individual's catchment story could better recall details presented in the story, compared to the same details presented in the collective voice story.

## *The need for this research*

As freshwater ecosystems deteriorate globally, guidance for on-land freshwater restoration is widely available to counter these trends. However, the abundance of information can lead to overload, complicating the distinction between valuable and subpar content. According to Baumgart-Getz et al. (2012), quality information – not quantity – drove successful adoption of agricultural best practices in the United States. In Aotearoa New Zealand, rural land holders need to be able to filter and prioritise any information that comes their way, too, making knowledge exchange from trusted sources more important than ever. To enhance trust and usability, information should be communicated in an understandable, relatable manner (McKitterick et al. 2019) and we argue that catchment restoration stories may be a suitable tool, minimising the risk of information overload and resulting in meaningful information uptake.

In addition, Aotearoa New Zealand's land holders have consistently faced demands to comply with recently established freshwater management legislation as part of the National Policy Statement for Freshwater Management 2020 (NZ Ministry for the Environment 2020). This policy mandates completion of regional plan changes by 2025, listing 22 standards for which the primary mechanism to achieve improvement is individual farm plans. Not only do these plan alterations require land holders to understand what changes they will have to implement to comply with the law, they also must adapt land management practices within a relatively short timeframe. Restoration communication through storytelling is likely to help with the effective implementation of these required changes.

## Materials and methods

### *Storymaps as a testing mechanism*

To test the effects of storytelling on information extraction, recall and motivation to restore and share knowledge, we created two stories. One story was told in a 'collective voice' by a catchment group with no identified individual storyteller (referred to as 'Collective's story'; https://arcg.is/GOC4D; accessed 2023 Sept 06). This story described restoration efforts of the Rangitīkei Rivers Catchment Community, a community-based freshwater restoration group in the North Island of Aotearoa New Zealand (Rangitīkei Rivers Catchment Community 2023). The farmer-led group was established in 2017 to encourage and facilitate farmers to work collectively within their catchment to 'set environmental standards that improve our waterways, soils, and enhance biodiversity'. We used this group as a pilot to quantify the effects of 'collective learning' using restoration storytelling. The second story was told by an individual 'influencer' who is a known and respected Rangitīkei Rivers Catchment Community member, Mark (referred to as 'Mark's story'; https://arcg.is/0L8Lmj; accessed 2023 Sept 06). Both stories were co-designed with the Rangitīkei Rivers Catchment Community to ensure authenticity of the content and 'voices' used.

To tell the story in an interactive and engaging way, we used ArcGIS® StoryMaps (ESRI 2023) which are a visual storytelling tool that offers a mixed media approach combining different functionalities such as maps, videos, graphs, and text into a simple online interface. On the tool, stories are set-up like a website, whereby users scroll through the content, allowing them to engage and interact with the story (Kallaher and Gamble 2017) through navigating, zooming and hyperlinking, thereby being a 'complete and promising means of communication' (Oubennaceur et al. 2021, p. 2). By using this tool, we were able to test two independent stories hosted on the same platform using the same system, ensuring information shared on the platform was kept secure and was accessible by our survey participants only. This allowed us to analyse user-specific behaviour through Google Analytics. StoryMaps have become a well-recognised tool for conveying environmental information in Aotearoa New Zealand with a broad user-base including national government (e.g. NZ Ministry for the Environment 2023), regional government (e.g. Northland Regional Council 2022), community organisations (e.g. NZ Landcare Trust 2022) and catchment care groups (e.g. Te Hoiere Project 2021) alike.

To enable qualitative and quantitative comparisons, the layout and content were the same apart from a short additional introduction of Mark as the storyteller in Mark's story which increased the word count from 1057 (Collective's story) to 1184 words (Mark's story).

## Data collection

### Survey design and set up

We used a web-based survey to collect our data designed and hosted through Qualtrics© software (https://www.qualtrics.com). The survey questionnaire was workshopped and pilot tested with representatives of Aotearoa New Zealand catchment groups with whom we had existing relationships. It was refined based on their feedback to ensure questions and terminology were clear. Pilot testing can help decrease question context effects (Cobanoglu et al. 2001) and our pilot testing did so. This allowed us to measure retention and recall of information, and motivation for restoration reliably and validly, before using the questions in a real situation, as recommended by Etchegaray and Fischer (2011).

The overall survey structure consisted of two separate surveys – the Intervention Survey and the Follow-up Survey (Figure 2). The Intervention Survey consisted of four parts: Part 1 which covered welcome pages and general introductory questions, Part 2 which randomly assigned participants to one of the two storytelling methods (Collective's or Mark's story) and Part 3 which quantified the effect of the storytelling methods as part of the Intervention Survey. Participants who expressed interest in being part of a Follow-up Survey (Part 4), provided their contact details at the end of Part 3 and were contacted one month later. Without further reference to the story, the

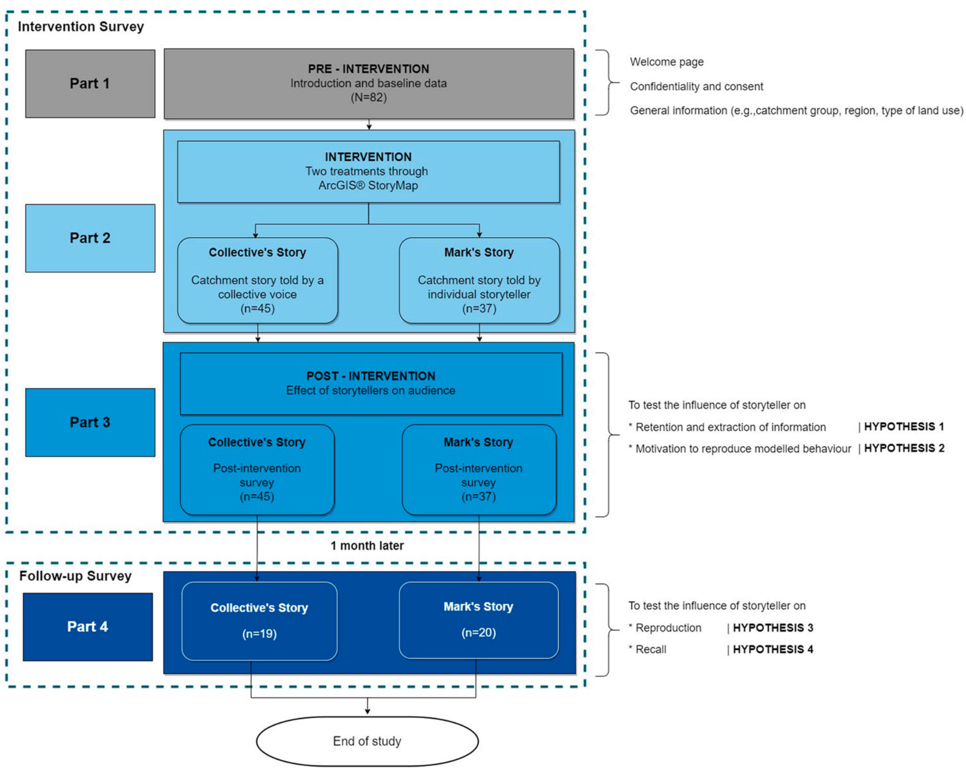


**Figure 2.** Two surveys were conducted for data collection – the Intervention Survey (Parts 1–3) and the Follow-up Survey (Part 4) which was sent to willing participants one month later.

Follow-up Survey repeated the same questions as Part 3, to test for reproduction of the modelled behaviour and recall of facts, and differed only in their reference to the story-teller (Figure 2).

The survey consisted of a range of question formats, including open-ended (free-form) questions (e.g. 'What makes the story relatable to you?'), closed-ended nominal questions (e.g. 'What is your age?'), partially closed-ended questions (e.g. 'other: please specify'), ranking questions (e.g. 'What actions have you most commonly done, in terms of resources spent'), multiple choice questions (e.g. 'What holds you back from restoring your catchment?'), and Likert-scale slider questions allowing participants to choose where to position the slider between 0 and 100 (e.g. 'How much do you agree with the following statements?').

Our research was approved by the University of Otago's Human Ethics Committee (D20/037); it also adhered to Cawthron Institute's research ethics protocol (CAW-ETH-200804). Prior to the start of the survey, all participants were reminded that their participation was voluntary with the option to pull out any time. Responses were anonymous but, if participants chose to contribute to the Follow-up Survey (Part 4), they had the option to provide their names and email address. Final responses were anonymised prior to analysis.

### *Survey recruitment and implementation*

Target audiences for our study were rural landholders of all types of land uses (e.g. dairy, sheep, beef, forestry) across Aotearoa New Zealand. Because waterway degradation is most widespread in rural areas in Aotearoa New Zealand (NZ Ministry for the Environment and Stats NZ 2023), we purposefully recruited communities that can bring about the biggest change in pro-environmental behaviour in these areas. Survey participants were recruited via mailing lists of catchment and/or community environment groups in Aotearoa New Zealand. Access had been established through existing connections and related research programmes. In addition, the New Zealand Ministry for Primary Industries, the New Zealand National Science Challenge Our Land and Water, as well as certain industry umbrella groups (i.e. NZ Farming, Silver Fern Farms) promoted the survey on their social media platforms. A single email address per group was used, where possible addressed to the lead coordinator or lead communication contact. A reminder to non-respondents was sent out two weeks after the initial recruitment email. To incentivise participation, we explained NZ$5 would be donated to the Rural Support Trust (www.rural-support.org.nz) for each completed survey.

### *Analysis of survey results*

For quantitative survey analysis, we used a generalised linear model approach to explore if the responses to the survey were different between the Collective's and Mark's story and among categories of the demographic variables (Dobson 1990). We fitted these models using a binomial family for the error distribution. The responses to the survey questions of interest were not categorised; the participants could choose any value between 0 and 100 on a sliding-scale. This allowed us to investigate the responses in more granularity and understand the variability across responses. Even though the response variable for the survey was not based on a percentage or proportion, the data distribution had the same properties (bounded between 0 and 100). We then computed the estimated marginal means for specified groups in the linear models and the contrasts among them. Probability values were adjusted using the Tukey method for comparing a family of estimates (Lenth 2023). All quantitative analyses were carried out using the statistical computing software R v4.2.3 (R Core Team 2023). We used the tidyverse v2.0.0 (Wickham et al. 2019) metapackage for data manipulation and the emmeans package for estimating marginal means (Lenth 2023).

Demographics data were summarised using descriptive statistics. For analysis of qualitative, open-ended survey responses, we thematically grouped responses and tested 20% of them for inter-rater agreements with other researchers. The final agreement was Cohen's kappa of 0.904 with a percentage agreement of 99% which was considered sufficient to validate the robustness of the coding manual (Lombard et al. 2002).

## Results

### *Survey responses and participant demographics*

The Intervention Survey (Parts 1, 2 and 3; Figure 2) ran from 16 March 2023 to 7 June 2023 and received a total of 126 responses, 82 of which were fully completed and included in the data analysis. For Mark's story ($n = 37$), respondents took on average 17 min to complete the survey, of which they spent on average 2 min and 45 s engaging with Mark's Story. For the Collective's story ($n = 45$), participants took on average 19 min to complete the survey of which they spent on average 3 min and 50 s engaging with the Collective's Story.

Survey responses were evenly distributed across Aotearoa New Zealand with 13 of the country's 16 regions represented. Most participants were in the Auckland (18%), Tasman (16%) and Otago (16%) regions, with the least in the Wellington, Southland, Nelson and Manawatū-Whanganui Regions (Table 1). The 55–64 years age group was most represented (26.8%), with the 34 year and under age group the least represented (9.8%; Table 1). More than half of participants were sheep and beef farmers (61%), with the second highest land use type being lifestyle[2] farming (41.5%; Table 1).

All but one participant were actively restoring their land, with 37% of participants ($n = 30$) having actively restored their land for more than 9 years. Sixty-five of the 82 participants (79%) were a member of a catchment group, with almost a third of participants (30.5%) having been part of a catchment group for less than three years. When asked to rank land management actions based on the most resources (time and money) spent for restoration on their land, 82% of participants indicated that they have spent most resources on vegetation actions (e.g. planting of riparian zones, steep hill country planting), followed by stock exclusion and grazing actions (e.g. fencing of waterways; 26%) and erosion control actions (e.g. cover crop after harvesting; sediment traps; afforestation; 20%) (Table 1).

### *Retention and extraction of information | hypothesis 1*

Scores were consistently high for retention and extraction of information across both storytellers (median score ≥ 80, Figure 3), indicating that participants substantially enjoyed reading the stories. For both storytelling methods, most participants reported

**Table 1.** Summary of participant's demographics, land use type and restoration resources spent of survey participants ($N = 82$) ranked from highest to lowest in each category.

| Metric | Category | Percent (%) | n |
|---|---|---|---|
| Age | 55–64 | 26.9 | 22 |
| | > 65 | 24.4 | 20 |
| | 45–54 | 23.2 | 19 |
| | 35–44 | 15.9 | 13 |
| | Under 34 | 9.8 | 8 |
| Geographical Region | Auckland | 18.3 | 15 |
| | Otago | 15.9 | 13 |
| | Tasman | 15.9 | 13 |
| | Canterbury | 14.6 | 12 |
| | Waikato | 7.3 | 6 |
| | Taranaki | 6.1 | 5 |
| | Hawkes Bay | 4.9 | 4 |
| | Northland | 4.9 | 4 |
| | Bay of Plenty | 2.4 | 2 |
| | Manawatu-Wanganui | 2.4 | 2 |
| | Nelson | 2.4 | 2 |
| | Southland | 2.4 | 2 |
| | Wellington | 2.4 | 2 |
| Type of land use | Sheep & Beef | 61.0 | 50 |
| | Lifestyle | 41.5 | 34 |
| | Dairy | 26.8 | 22 |
| | Arable | 20.7 | 17 |
| | Forestry | 15.9 | 13 |
| | Horticulture | 11.0 | 9 |
| | Deer | 9.8 | 8 |
| | Other | 26.8 | 22 |
| Catchment group member | Yes | 79.3 | 65 |
| | No | 19.5 | 16 |
| | NA | 1.2 | 1 |
| Time in catchment group | <3 years | 30.5 | 25 |
| | 4–6 years | 20.7 | 17 |
| | 7–9 years | 7.3 | 6 |
| | 10–19 years | 7.3 | 6 |
| | >20 years | 6.1 | 5 |
| | NA | 28.1 | 23 |
| Actively restoring land to improve water quality | Yes | 98.8 | 81 |
| | No | 1.2 | 1 |
| Duration of actively restoring | > 9 years | 36.6 | 30 |
| | 4 - 6 years | 22.0 | 18 |
| | < 3 years | 20.8 | 17 |
| | 7 - 9 years | 14.6 | 12 |
| | Other/ doesn't apply | 4.9 | 4 |
| | NA | 1.2 | 1 |
| Most resources spent (time and money), ranked from most resources to least | Vegetation | 81.7 | 67 |
| | Grazing/ Stock exclusion | 25.6 | 21 |
| | Erosion control | 19.5 | 16 |
| | Nutrient management | 15.9 | 13 |
| | Water management | 6.1 | 5 |

that they could relate to the restoration story (median score >80, $n = 81$, Figure 3A), thought that both stories were trustworthy (median score >80, $n = 72$, Figure 3C), thought the story contained interesting facts (median score >80, $n = 82$, Figure 3D), learned something new (median score = 80, $n = 81$, Figure 3E), and liked reading the story (median score ≥80, $n = 81$, Figure 3F). One participant scored consistently low (<20) across all questions as shown by the outlier in Figures 3A, C, D, E and F. We

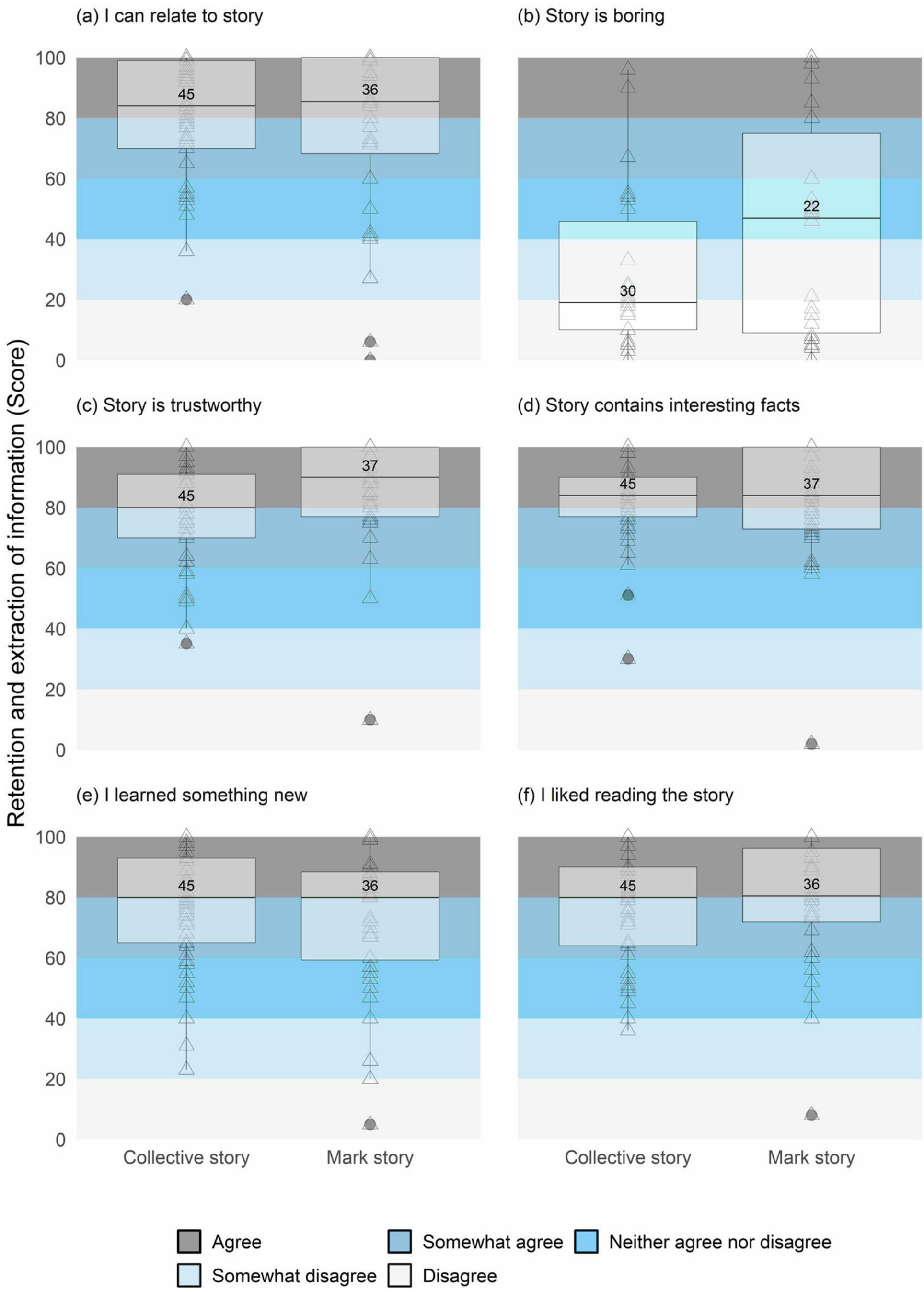


**Figure 3.** Cognitive process of 'Retention and Extraction of restoration knowledge' (response distributions) for the stories told by either the Collective or Mark. The line inside the boxes represents the median. The lower and upper hinges correspond to the 25th and 75th percentiles. The upper whisker extends from the hinge to the largest value no further than 1.5 * distance between the first and third quartiles (interquartile range (IQR)). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Dots beyond the end of the whiskers are considered outliers, and triangles show all responses collected from the survey (sliding-scale 0–100).

were unable to detect any statistical differences between storytelling methods for the cognitive process of retention and extraction of information.

When asked to describe the stories using three words, participants used similar vocabulary for each story, using the same four most frequently mentioned words for both stories (i.e. inspirational was mentioned 31 times out of 243 words for both storytelling methods, informative was mentioned 16 times, community was mentioned 15 times and interesting was mentioned 12 times). To understand overall perceptions participants had of the stories, we categorised any words that contained emotional descriptions into positive and negative categories. Of the 243 words used to describe both stories, we could attribute 86 words to an emotion (Figure 4). Of those 86 words, 62 were attributed to positive emotions (e.g. visionary, motivating, insightful, fantastic) and 23 words to negative emotions (e.g. exaggerated, frustrating, idealistic, regressive, sad). This finding concurs with participant's responses that they learned something new (Figure 3E), that the story contained interesting facts (Figure 3F), and that they liked reading the story (Figure 3F).

## *Motivation to reproduce modelled behaviour | hypothesis 2*

All participants agreed that restoration knowledge sharing is important (i.e. median score > 75, $n = 82$, Figure 5C), were inspired by the stories to restore in the future (i.e. median score ≥ 75, $n = 78$; Figure 5E), and intended to engage in restoration actions in the future (i.e. median score > 90, $n = 80$; Figure 5F). Still scoring medium to high, participants somewhat intended to share the story (i.e. median score > 40, $n = 77$, Figure 5D). They felt that the story had a small impact on their intentions to restore (i.e. median score > 30, $n = 44$, Figure 5A). We were unable to detect any statistical differences between the two storytelling methods


**Figure 4.** Word cloud showing all words used ($N = 121$) to describe the Collective's and Mark's stories. The size of the text depicts their frequency, with larger words being mentioned more often. The colour of the text indicates whether it describes a positive emotion (blue, $n = 62$), a negative emotion (black, $n = 23$), or neutral/not applicable emotion (grey, $n = 46$).

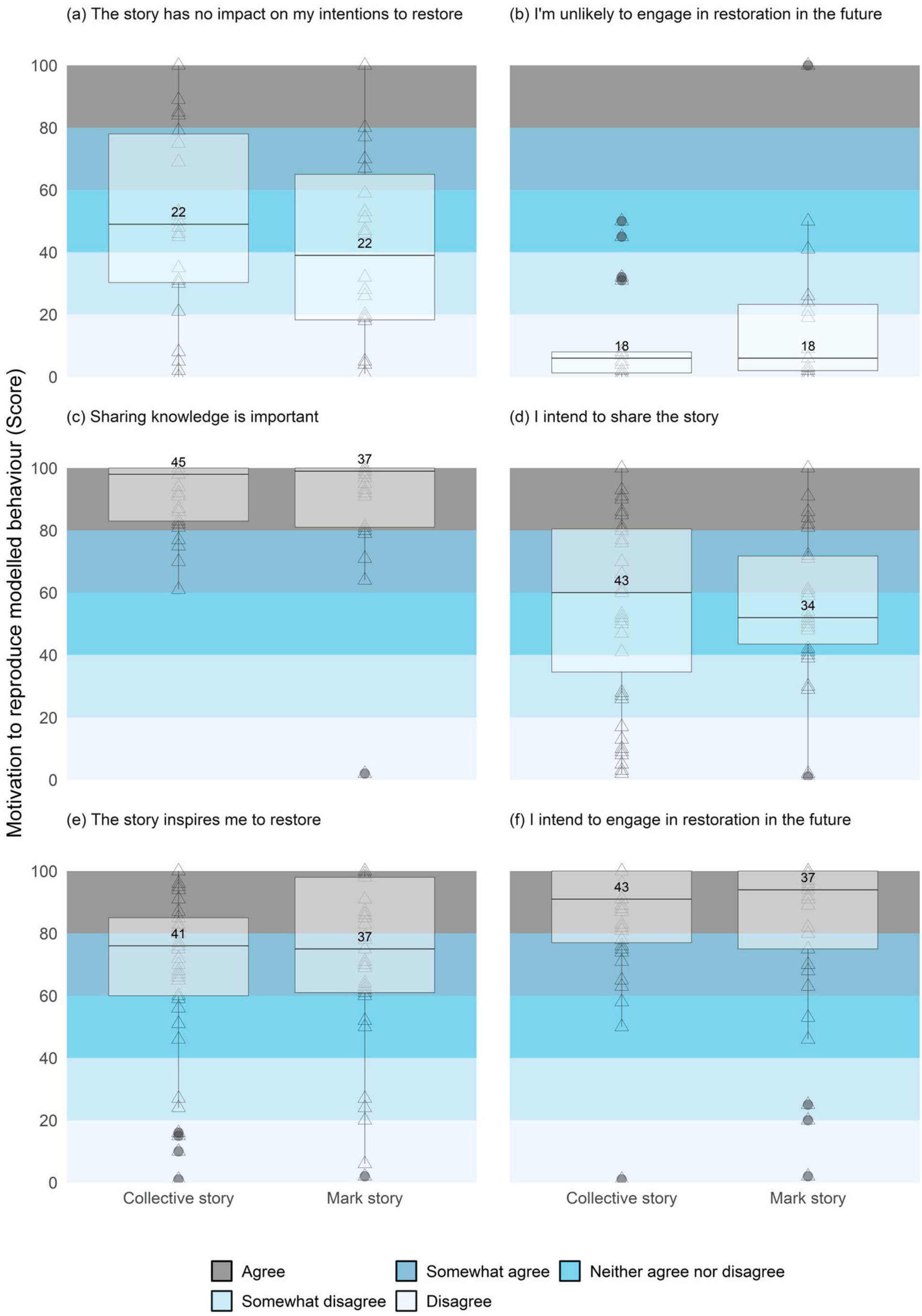


**Figure 5.** Cognitive process of 'Motivation to reproduce modelled behaviour' (response distributions) for the stories told by either the Collective or Mark. The line inside the boxes represents the median. The lower and upper hinges correspond to the 25th and 75th percentiles. The upper whisker extends from the hinge to the largest value no further than 1.5 * distance between the first and third quartiles (interquartile range (IQR)). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Dots beyond the end of the whiskers are considered outliers, and triangles show all responses collected from the survey (sliding-scale 0–100).

when asked to what degree participants were motivated to reproduce modelled behaviour by the storytellers.

## *Reproduction | hypothesis 3*

We tested whether participant's *intentions* and *inspirations* to restore their land and share restoration knowledge held true to what they had indicated a month prior. Of the 82 participants who had completed the first survey, almost half (48%, $n = 39$, 19 from the Collective's story and 20 from Mark's story) agreed to be contacted for a follow-up survey one month later.

### *Intention and inspiration to restore their land*

There were no significant differences between the two storytelling methods, meaning that our participant's intention and inspiration to restore over a one-month period were similar between storytellers.

When looking across both storytelling methods and across both intention and inspiration, of the 39 people that filled in the Follow-up Survey, more participants reported that they had engaged in restoration actions ($n = 27$, (Figures 6A and C)), than not engaged in restoration actions ($n = 12$, Figures 6B and D) over the one-month period between the two surveys. Even the three participants who read the Collective's story but were not inspired by the story (score <20) engaged in restoration actions one month later (Figure 6C).

Of the twelve people who did not restore, the most stated reasons across both storytelling methods were that one month between the questionnaires was too short a timeframe to conduct any actions (six people), that autumn was the wrong season to do any restoration actions (five people), and that they were too busy to restore (two people). Two participants made the clear distinction that while they had been restoring over the last month, they had not implemented any 'new' restoration actions. We were unable to determine whether the participant's restoration behaviour was a result of our stories, or because they were already an actively restoring community, a limitation we will further discuss below.

### *Intention and inspiration to share restoration knowledge and reach out to the influencer.*

We hypothesised that participants who read Mark's story would be more likely to *share restoration knowledge* one month later than participants that read the Collective's story. Of the 41 participants who took part in the Follow-up Survey, 33 (80%) reported that they had shared restoration knowledge over the last month, with no significant difference in responses between the two storytelling methods. This finding aligns with the responses we collected for the Intervention Survey where participants had agreed that sharing knowledge is important (score >60, Figure 7A). Only six participants (15%) reported that they had not shared any restoration knowledge over the last month, and even these had reported that sharing is important one month prior (Figure 7B).

Of the 33 participants who had shared restoration knowledge, 17 (52%) reported that they had shared information with their wider (restoration) community, nine (27%) with their catchment group, three (9%) with farmers and four (12%) with 'others'

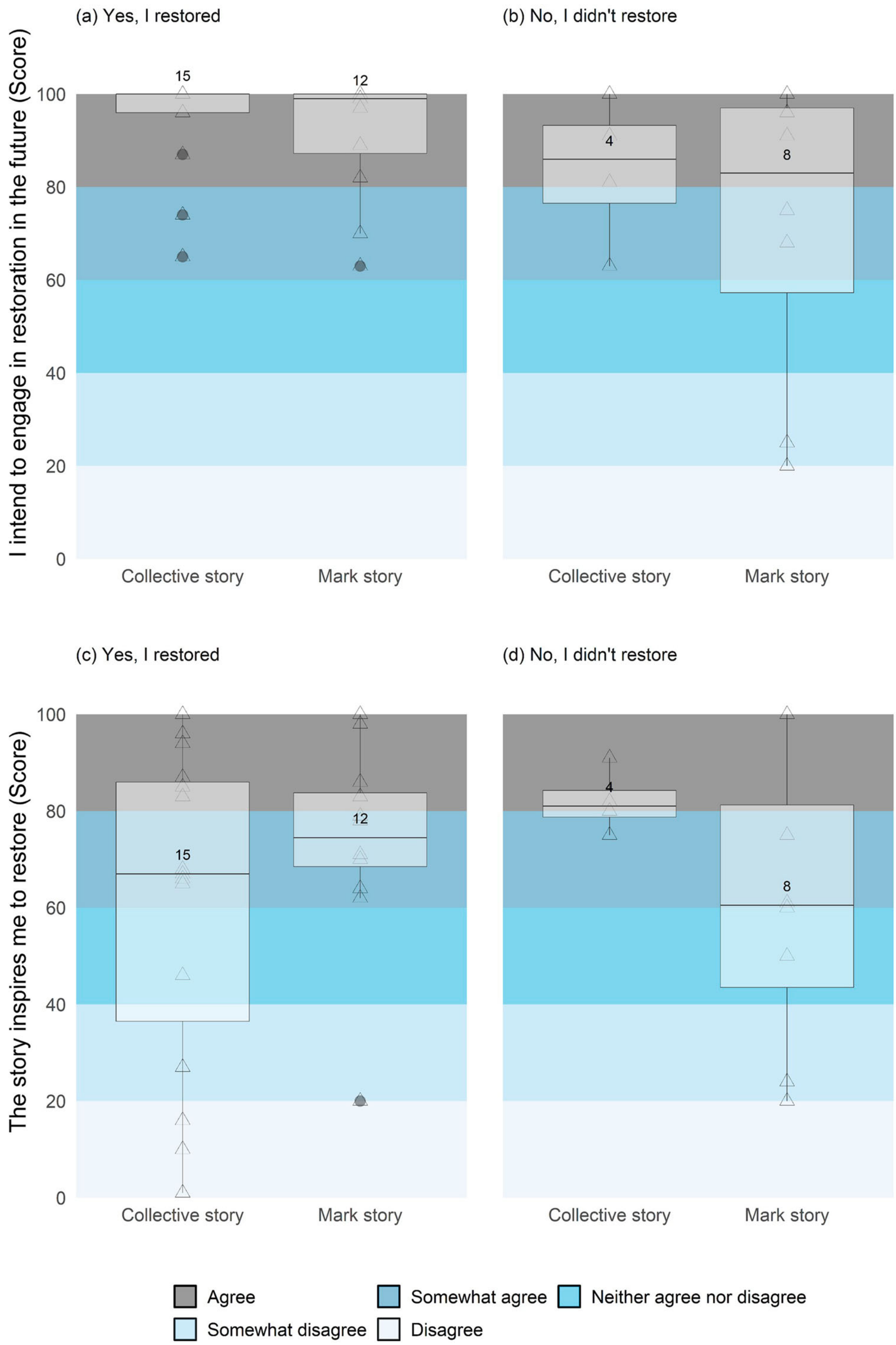


**Figure 6.** Participants who intended to engage in restoration or were inspired by the story to restore one month ago (y-axis) either restored over the last month (Yes, I restored) or didn't restore over the last month (No, I didn't restore) compared across the two storytelling methods (x-axis; Collective story and Mark story). The line inside the boxes represents the median. The lower and upper hinges correspond to the 25th and 75th percentiles. The upper whisker extends from the hinge to the largest value no further than 1.5 * distance between the first and third quartiles (interquartile range (IQR)). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Dots beyond the end of the whiskers are considered outliers, and triangles show all responses collected from the survey (sliding-scale 0–100).

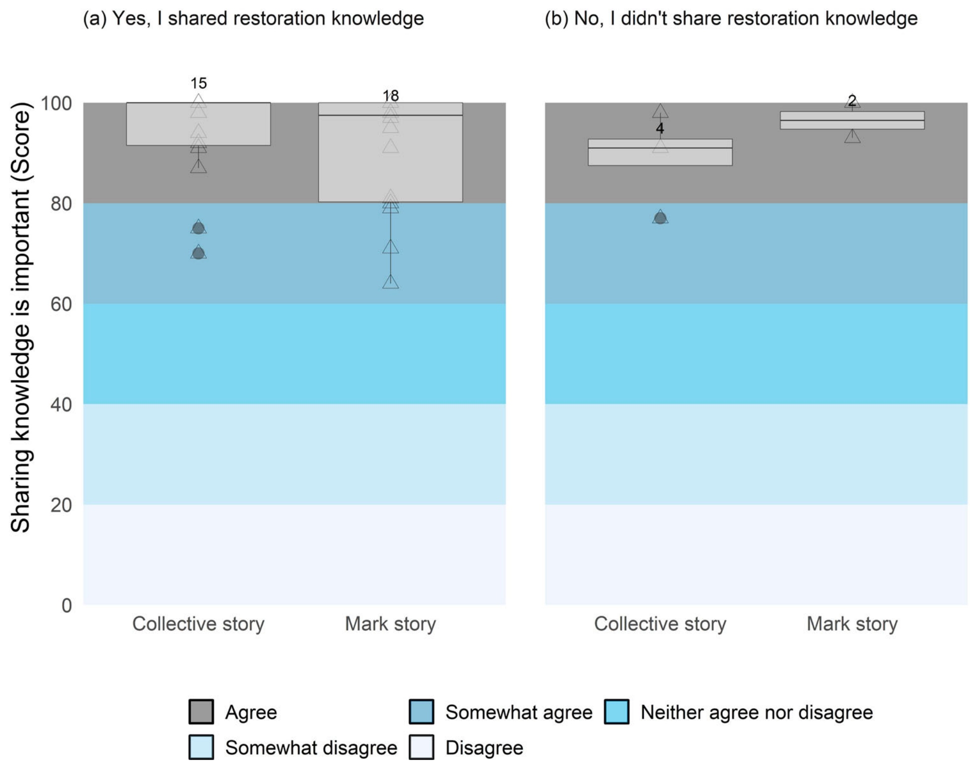


**Figure 7.** Participants who intended to share restoration knowledge one month ago (y-axis) shared knowledge over the last month (Yes, I shared knowledge), or didn't share knowledge over the last month (No, I didn't share) for the two storytelling methods (Collective story and Mark story). The line inside the boxes represents the median. The lower and upper hinges correspond to the 25th and 75th percentiles. The upper whisker extends from the hinge to the largest value no further than 1.5 * distance between the first and third quartiles (interquartile range (IQR)). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Dots beyond the end of the whiskers are considered outliers, and triangles show all responses collected from the first survey one month prior (sliding-scale 0–100).

(e.g. business, clients, students). The six people that had not shared any restoration knowledge (Figure 7B) said they did not do so because they were too busy ($n = 2$), didn't have the opportunity over the last month ($n = 2$), didn't feel qualified enough to share their knowledge ($n = 1$), or hadn't associated with relevant people ($n = 1$).

We hypothesised that participants who read Mark's story would be more likely to *share his story* compared to participants who read the Collective's story. Analysis showed that storytellers had no significant influence on whether participants shared a story, or not. Of the 41 participants that completed the Follow-up Survey, 30 (73%) reported that they had not shared their specific story over the last month, even though the majority had (somewhat) agreed to do so one month previously (median score > 50, Figure 8B). Of the eight participants who ended up sharing the story, four (10%) reported that they 'neither agreed nor disagreed' to share the story and four (10%) 'somewhat agreed' to share the story one month prior (Figure 8A). Six (75%) shared their specific story with the wider (restoration) community

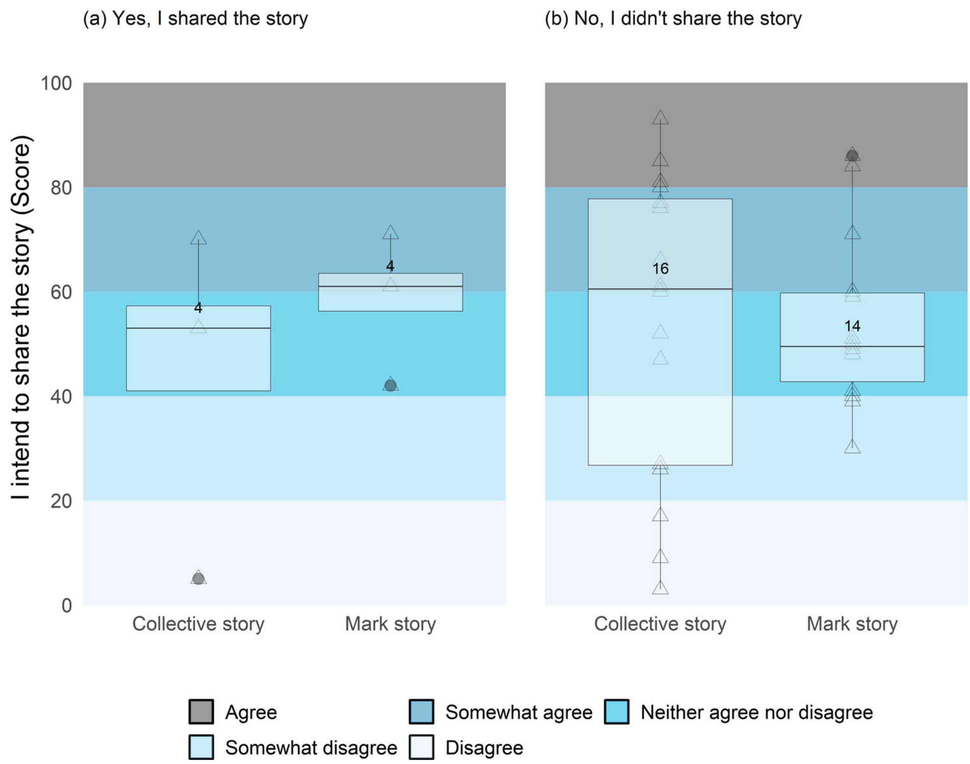


**Figure 8.** Participants' intention to share the story one month ago (y-axis) and their behaviour one month later (Yes, I shared the story/ No, I didn't share the story) for the two storytelling methods (Collective story and Mark story). The line inside the boxes represents the median. The lower and upper hinges correspond to the 25th and 75th percentiles. The upper whisker extends from the hinge to the largest value no further than 1.5 * distance between the first and third quartiles (interquartile range (IQR)). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Dots beyond the end of the whiskers are considered outliers, and triangles show all responses collected from the first survey one month prior (sliding-scale 0–100).

and two (25%) with their catchment group. Two participants that read Mark's story didn't reply to the intention question in the first survey, however one of those two did share the story. We did not perform a generalised linear model to test for the differences described above, because of the imbalance in the distribution of participants between the storytelling methods (Figure 8). The four most stated reasons for not sharing the story were that the participant's community was already actively restoring ($n = 9$, 23%), they forgot to share the story ($n = 6$, 15%), they ran out of time between the Intervention Survey and the Follow-up Survey ($n = 6$, %15%), the story didn't contain anything new to share ($n = 6$, 15%), and there was a lack of relatable content ($n = 5$, 13%).

We also hypothesised that participants who had read Mark's story would be more inspired to reach out to Mark, compared to those who read the Collective's story. Our results showed that none of the 41 participants in the Follow-up Survey had contacted Mark or the catchment group over the last month, reasons why they did not reach out are shown in Figure 9.

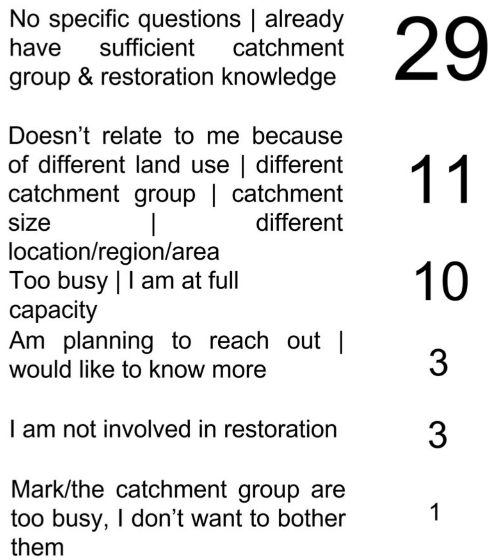


**Figure 9.** Six key reasons why participants did not contact their storytellers over a month-long period.

### *Recall | hypothesis 4*

Our stories described three 'Challenges' and three 'Lessons Learnt' that the Rangitīkei Rivers Catchment Collective had experienced as part of their restoration journey. To test for recall ability of these six details we hypothesised that participants who read Mark's story would have better recall than participants who read the Collective's story. In our survey, participants were given five possible answers, of which they were asked to select the three that were mentioned in each part of the story. The 'correct' way to answer the five questions was by selecting the three correct details, and not selecting the two incorrect answers (i.e. 'five right answers').

Recall was not influenced by the storytellers, and there were no differences between the storytelling methods on the number of right answers that the participants provided one month after they read the stories. There were only two participants who scored five by answering all questions correctly; both participants read the Collective's story. Most participants across both storytelling methods and both questions scored three out of five correct answers, remembering at least one correct detail. More participants selected four correct details for the 'Challenges' (44% for the Collective's story and 35% for Mark's story) than for the 'Lessons Learnt' (10% for Mark's story, and none for the Collective's story).

### *Effect of demographics on retention and extraction of information and reproduction of modelled behaviour*

While we did not find any significant differences between storytellers for any of the cognitive processes, we wanted to explore whether certain demographics (i.e. region, land use type, age, time in catchment group and duration of active restoring) may influence how readers extract information and may become motivated to reproduce modelled behaviour. We only tested the regions that had the highest response rate (>10%; Auckland, Canterbury, Otago, Tasman (Table 1)), to avoid bias towards under-represented regions. We hypothesised that sheep and beef farmers may relate better to Mark's story, because Mark himself is a sheep and beef farmer, however, we found no meaningful and statistically significant differences for any of the demographic categories, or for the cognitive processes tested.

## Discussion

Our research aimed to explore how freshwater restoration storytellers influence the sharing of restoration knowledge and motivate pro-environmental behaviour in rural communities in Aotearoa New Zealand. We hypothesised that there would be significant differences in cognitive processes in our participants depending on whether they read a story told by a collective voice or an individual member from a catchment group, but we found no quantitatively significant differences between the storytelling methods. Nonetheless, interpretation of the combined dataset gave us two valuable insights into cognitive and behavioural principles relevant to freshwater restoration storytelling.

### *Both individual and collective storytellers can be relatable and trustworthy knowledge brokers*

Firstly, we found that the role of a single freshwater restoration champion or influencer was not as important for information processing in our audience as we hypothesised. Our participants could relate the same way to both stories, independently of whether their story was told by a collective or an individual. Comments provided by participants showed that Mark, as the individual storyteller, was indeed influential and relatable (e.g. 'give him a medal'; 'inspirational'), so this suggests that the content of the story outweighed the effect of storyteller on our participants cognitive processes. Each story profiled collective restoration action, highlighting the community aspect of freshwater restoration in catchment contexts. Making collective action the focal point of our stories by lifting the collective efforts into the role of protagonist (rather than the actual storyteller), allowed our readers to make contextual connections between themselves and the story content. Because the content of each story was the same, we found no differences in any of the cognitive processing tested.

Our participants also considered the storytellers and the content of the stories as trustworthy, independently of whether the story was told by an individual or a collective. Trust affects the reader's belief in the information and their likelihood of pro-environmental behaviour change (e.g. Blackstock et al. 2010; Small et al. 2016; Rust et al. 2022), an outcome desired in our study. Both of our storyteller voices were active freshwater restorers, suggesting that our audience was building on trust that already existed between them and the storytellers, serving as a foundation for the acceptance of (new) information (Zeng et al. 2022).

Once an audience can identify with a storyteller and content is understood, modelled behaviour (in our case the uptake of sustainable restoration actions and the act of sharing restoration knowledge) is more likely to be adopted (Toolan 1988; Oatley 1999; Dahlstrom 2014; Sundin et al. 2018). Our stories were true and depicted real-life experiences that were achieved and told by a community that lives and works around their river. In our study, participants (many of whom were already active restorers) could relate to different storytellers and found them inspirational independent of whether they are an individual or a collective, as long as they're a trusted voice.

Our findings underscore the importance of trust and relatability as a critical element in freshwater restoration storytellers, especially in the agricultural context. Authenticity and reliability of information sources play a crucial role to the effectiveness of communication efforts, and we suggest communicators and policy makers should be mindful of the credibility of the messenger and the narratives they employ. Including this understanding in freshwater communication initiatives may have significant implications for how, and by whom, restoration stories should be told and shared to maintain freshwater restoration momentum over long periods of time. For future research, we suggest repeating a similar sample design, but testing stories that compare trusted with 'less-trusted' storytellers (e.g. local government) (Small et al. 2016). This will provide valuable insights into how trust of information sources (or the lack thereof) may be a potential hurdle for the diffusion of information. Additionally, we recommend focusing on non-restorers or land managers who are not currently part of a catchment group. This will provide useful insights into the role storytellers may have in motivating pro-environmental behaviour change in a sample more representative of Aotearoa New Zealand's non-restoration population.

### *Catchment restoration stories provided new knowledge to short and long-term restorers but did not increase recall*

Secondly, most participants reported learning something new from the stories and thought they contained interesting details. '*Informative*' was the third and second most frequently used word to describe the Collective's and Mark's story, respectively. Even though most participants were already actively restoring for longer than four years, the information shared in our restoration stories still provided new knowledge to an experienced audience. This shows that restoration knowledge sharing is not only relevant for communities that are just starting out on their restoration journey, but also for those, who have been restoring for several years.

Research by Doehring et al. (2022) found that rural stakeholders in Aotearoa New Zealand were willing to share restoration knowledge, and our current study was able to demonstrate this in action. Eighty percent of our participants reported sharing some form of restoration knowledge with others over the one-month period since reading the story (e.g. sustainable land management practices, farm environment planning, nutrient and sediment interventions). Many factors influence whether an audience engages with new information and whether they act on it (Longnecker 2016), a desired outcome of freshwater restoration. Unfortunately, we did not probe survey participants to clarify why they had shared restoration knowledge, what knowledge they considered 'new', and whether the act of sharing knowledge was specifically influenced by our stories. So, we were unable to link any specific information provided in the story to their statement, a limitation of our study which we suggest future studies could focus on.

We also quantified our participants' ability to recall information by testing whether they would correctly answer key details mentioned in the 'Lessons Learnt' and

'Challenges' sections of the story. Of the 41 participants, only two were able to recall all correct 'Challenge' details one month later (none remembered the 'Lessons Learnt'), substantially less than we had hypothesised. Recall is commonly triggered through emotions, such as empathy, sympathy, surprise, curiosity and suspense (Keen 2006), so by including content that may arouse a positive emotional response (i.e. Lessons Learnt) or a negative emotional response (i.e. Challenges), we anticipated more participants would answer correctly. In hindsight, we suggest that the lack of recall may be because both sections were written as factual, bullet-points, rather than as narratives, failing to trigger emotional responses in our audience. Research suggests that negative information more effectively triggers recall than neutral information (Adolphs 2000; Hamann 2001). Although low in number, the information correctly recalled in our study were details that were mentioned as part of the 'Challenges', potentially indicating that details arousing negative emotions may have been better recalled. While we did not test for any emotional arousal to our stories, more positive words were used to describe the stories than negative words, suggesting that our audiences felt positively inspired after reading our stories. While inspiration may not increase recall of facts, including positive and negative emotions in restoration knowledge exchange plays a critical role in motivating long-term restoration (Doehring et al. 2023).

## Conclusions

The poor health of Aotearoa New Zealand's rivers, lakes and wetlands severely impacts the wellbeing of Aotearoa New Zealanders. Given the complexity of this problem, exploring innovative tools to transfer evidence more effectively to multiple audiences (e.g. decision-makers, land managers, catchment communities) is critical. We acknowledge that observational learning in the form of storytelling is not a silver-bullet for addressing freshwater health decline, however, it serves as a valuable addition to the toolbox of methods for transferring knowledge of freshwater restoration. Globally, the principle of collectivism is increasingly recognised in policy, with Aotearoa New Zealand being no different as demonstrated by the ongoing rise of rural communities of action across the country. But for collective action to be meaningful, a shared understanding is required to tackle the ongoing freshwater health crisis. We argue that freshwater restoration storytelling can be a suitable tool to create this shared understanding, enabling knowledge exchange between groups who implement freshwater restoration *in situ* through trusted voices, regardless of whether it is done through a collective voice or an individual respected storyteller.

## Notes

1. A catchment (also commonly referred to as watershed) is defined as the natural drainage area of rainwater where it gets collected and transported from the source to the sea.
2. Type of smallholding or small farm (<4 ha) run as a hobby, not as a commercial enterprise.

## Acknowledgements

The authors thank all survey participants for their time and Vicki Compton and the Longnecker Lab for their contributions at various stages throughout the research.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This work was supported by National Science Challenge "Our Land and Water- Toitu te whenua, Toiora te wai" [grant number C10X1901]; and the Ministry for Primary Industry Postgraduate Science Scholarship.

## References

Adolphs R. 2000. A role for the human amygdala in recognizing emotional arousal from unpleasant stimuli. Neurocase. 6(6):441–441. doi:10.1093/neucas/6.6.441.

Armitage D, Marschke M, Plummer R. 2008. Adaptive co-management and the paradox of learning. Global Environmental Change. 18(1):86–98. doi:10.1016/j.gloenvcha.2007.07.002.

Bandura A. 1989. Social cognitive theory. In: R. Vasta, editor. Annals of child development Vol 6 Six theories of child development. Vol. 6. Greenwich, CT: JAI Press; p. 1–60.

Baumgart-Getz A, Prokopy LS, Floress K. 2012. Why farmers adopt best management practice in the United States: a meta-analysis of the adoption literature. Journal of Environmental Management. 96(1):17–25. doi:10.1016/j.jenvman.2011.10.006.

Blackmore C. 2007. What kinds of knowledge, knowing and learning are required for addressing resource dilemmas? A theoretical overview. Environmental Science & Policy. 10(6):512–525. doi:10.1016/j.envsci.2007.02.007.

Blackstock KL, Ingram J, Burton R, Brown KM, Slee B. 2010. Understanding and influencing behaviour change by farmers to improve water quality. Science of the Total Environment. 408(23):5631–5638. doi:10.1016/j.scitotenv.2009.04.029.

Bodin Ö. 2017. Collaborative environmental governance: achieving collective action in social-ecological systems. Science (American Association for the Advancement of Science). 357 (6352):659–659.

Brisbane Catchments Network. 2023. [Accessed 2023 Sept 6]. https://www.facebook.com/BrisbaneCatchmentsNetwork.

Brown P, Roper S. 2017. Innovation and networks in New Zealand farming. Australian Journal of Agricultural and Resource Economics. 61(3):422–442. doi:10.1111/1467-8489.12211.

Burton RJF. 2004. Seeing through the 'good farmer's' eyes: towards developing an understanding of the social symbolic value of 'productivist' behaviour. Sociologia Ruralis. 44(2):195–215. doi:10.1111/j.1467-9523.2004.00270.x.

Chambers R, Pacey A, Thrupp LA. 1989. Farmer first: farmer innovation and agricultural research. London: Intermediate Technology Publications.

Cobanoglu C, Warde B, Moreo PJ. 2001. A comparison of mail, fax and web-based survey methods. International Journal of Market Research. 43(4):441–415. doi:10.1177/147078530104300401.

Collins HM. 1992. Artificial Experts: social knowledge and intelligent machines. Cambridge, MA: The MIT Press. doi:10.7551/mitpress/1416.001.0001.

Cortes Arevalo VJ, Verbrugge LNH, Sools A, Brugnach M, Wolterink R, van Denderen RP, Candel JHJ, Hulscher SJMH. 2020. Storylines for practice: a visual storytelling approach to strengthen the science-practice interface. Sustainability Science. 15(4):1013–1032. doi:10.1007/s11625-020-00793-y.

da Costa Silva G. 2011. Assessing environmental justice of community-based watershed management: a tool to build adaptive capacity in Latin America? Local Environment. 16(5):445–460. doi:10.1080/13549839.2011.565467.

Dahlstrom MF. 2014. Using narratives and storytelling to communicate science with nonexpert audiences. Proceedings of the National Academy of Sciences. 111(Supplement 4):13614–13620. doi:10.1073/pnas.1320645111.
Dobson AJ. 1990. An introduction to generalized linear models, 4th ed. London: Taylor & Francis Group.
Doehring K, Cole C, Young RG, Longnecker N. 2023. Collective storytelling as a river restoration tool: the role of catchment communities in inspiring environmental change. Frontiers in Communication. 7:1–17. doi:10.3389/fcomm.2022.1061634.
Doehring K, Longnecker N, Cole C, Young RG, Robb C. 2022. A missing piece of the puzzle of on-farm freshwater restoration: what motivates land managers to record and report land management actions? Ecology and Society. 27(4). doi:10.5751/ES-13562-270425.
ESRI. 2023. ArcGIS® StoryMaps. Redlands, CA: Environmental Systems Research Institute. https://storymaps.arcgis.com/.
Etchegaray JM, Fischer WG. 2011. Understanding evidence-based research methods: pilot testing surveys. Health Environments Research & Design Journal. 4(4):143–147. doi:10.1177/193758671100400411.
Fielke S, Taylor B, Jakku E. 2020. Digitalisation of agricultural knowledge and advice networks: a state-of-the-art review. Agricultural Systems. 180:102763. doi:10.1016/j.agsy.2019.102763.
Friends of the River Roding. 2023. [Accessed 2023 Dec 19]. https://www.facebook.com/groups/riverroding.
Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, et al. 2019. International principles and standards for the practice of ecological restoration. Restoration Ecology. 27(S1):S1–S46. doi:10.1111/rec.12842.
Goyes DR. 2022. The importance of stories in wildlife management. Ecological Management & Restoration. 23(3):237–243. doi:10.1111/emr.12567.
Gunningham N, Holley C. 2016. Next-generation environmental regulation: law, regulation, and governance. Annual Review of Law and Social Science. 12(1):273–293. doi:10.1146/annurev-lawsocsci-110615-084651.
Hamann S. 2001. Cognitive and neural mechanisms of emotional memory. Trends in Cognitive Sciences. 5(9):394–400. doi:10.1016/S1364-6613(00)01707-1.
Innes JE, Booher DE. 2018. Planning with complexity: an introduction to collaborative rationality for public policy, 2nd ed. London: Routledge.
Jasanoff S. 1998. The fifth branch: science advisers as policymakers. Cambridge, MA: Harvard University Press.
Kallaher A, Gamble A. 2017. GIS and the humanities: presenting a path to digital scholarship with the Story Map app. College & Undergraduate Libraries. 24(2-4):559–573. doi:10.1080/10691316.2017.1327386.
Kark S, Tulloch A, Gordon A, Mazor T, Bunnefeld N, Levin N. 2015. Cross-boundary collaboration: key to the conservation puzzle. Current Opinion in Environmental Sustainability. 12:12–24. doi:10.1016/j.cosust.2014.08.005.
Keen S. 2006. A theory of narrative empathy.. Narrative (Columbus, OH). 14(3):207–236.
Lenth R. 2023. Estimated marginal means, aka least-squares means. R package 'emmeans'. Version 1.8.8. [Accessed 2023 Aug 7]. https://CRAN.R-project.org/package=emmeans.
Lewandowsky S, Ecker UKH, Seifert CM, Schwarz N, Cook J. 2012. Misinformation and its correction: continued influence and successful debiasing. Psychological Science in the Public Interest. 13(3):106–131. doi:10.1177/1529100612451018.
Lombard M, Snyder-Duch J, Bracken CC. 2002. Content analysis in mass communication: assessment and reporting of intercoder reliability. Human Communication Research. 28(4):587–604. doi:10.1111/j.1468-2958.2002.tb00826.x.
Longnecker N. 2016. An integrated model of science communication — more than providing evidence. Journal of Science Communication. 15(05). doi:10.22323/2.15050401.
Longnecker N. 2023. Good science communication considers the audience. In: Rowland S, Kuchel L, editors. Teaching science students to communicate: a practical guide. Springer; p. 21–30.

Mateo-Sagasta J, Zadeh SM, Turral H. 2017. Water pollution from agriculture: a global review. Rome: Food and Agriculture Organization of the United Nations. [Accessed 2023 Sept 6]. https://www.fao.org/3/i7754e/i7754e.pdf. https://www.fao.org/3/i7754e/i7754e.pdf.

Mauro IJ, McLachlan SM, Acker V, C R. 2009. Farmer knowledge and a priori risk analysis: pre-release evaluation of genetically modified Roundup Ready wheat across the Canadian prairies. Environmental Science and Pollution Research. 16(6):689–701. doi:10.1007/s11356-009-0177-6.

McFarlane K, Wallace K, Shanahan D. 2021. Collective approaches to ecosystem regeneration in Aotearoa New Zealand. Prepared for New Zealand's Biological Heritage National Science Challenge. Cawthron Report No. 3725. [Accessed 2023 Sept 6]. https://bioheritage.nz/wp-content/uploads/2019/04/McFarlane-et-al-2021-CawRpt_3725_Bioheritage-report_Collective-action.pdf.

McKitterick L, Quinn B, Tregear A. 2019. Trust formation in agri-food institutional support networks. Journal of Rural Studies. 65:53–64. doi:10.1016/j.jrurstud.2018.11.008.

Mekuriaw A, Amsalu T. 2023. Assessing the effectiveness of community-based watershed management practices in reversing land degradation in the Finchwuha watershed, Gojjam, Ethiopia. International Journal of River Basin Management. 21(4):697–709. doi:10.1080/15715124.2022.2079658.

Ministry of Agriculture and Forestry - Te Manatū Ahuwhenua, Ngāherehere. 2010. Ten years of grassroots action 2010. Wellington, NZ.

Morris BS, Chrysochou P, Christensen JD, Orquin JL, Barraza J, Zak PJ, Mitkidis P. 2019. Stories vs. facts: triggering emotion and action-taking on climate change. Climatic Change. 154(1):19–36. doi:10.1007/s10584-019-02425-6.

Neef A, Neubert D. 2011. Stakeholder participation in agricultural research projects: a conceptual framework for reflection and decision-making. Agriculture and Human Values. 28(2):179–194. doi:10.1007/s10460-010-9272-z.

Negrete A, Lartigue C. 2010. The science of telling stories: evaluating science communication via narratives (RIRC method). Journal Media and Communications Studies. 2(4):98.

Newig J, Jager NW, Challies E, Kochskämper E. 2023. Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. Global Environmental Change. 82:102705. doi:10.1016/j.gloenvcha.2023.102705.

Northland Regional Council. 2022. Improving freshwater in Northland. [Accessed 2023 Dec 13]. https://storymaps.arcgis.com/stories/b3e7e7d96e2c44cb90a1d1761c4d5f9e.

NZ Landcare Trust. 2022. NZ Landcare Trust. [Accessed 2023 Dec 13]. https://storymaps.arcgis.com/stories/ab30c587ea2d4352963dbd4541dcf3c1.

NZ Ministry for the Environment. 2020. National Policy Statement for Freshwater Management 2020 - Amended February 2023. https://environment.govt.nz/publications/national-policy-statement-for-freshwater-management-2020-amended-february-2023/.

NZ Ministry for the Environment. 2023. Navigating our freshwater environment. [Accessed 2023 Dec 7]. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjjlJbBofyCAxXdzTQHHaaSBOEQFnoECBMQAQ&url=https%3A%2F%2Fstorymaps.arcgis.com%2Fstories%2F155527d42155408c8b08649ca971dad0&usg=AOvVaw1aqWW5DPUqoXqWeoRL2fvq&opi=89978449.

NZ Ministry for the Environment, Stats NZ. 2023. New Zealand's environmental reporting series: our freshwater 2023. [Accessed 2023 Sept 6]. https://environment.govt.nz/assets/publications/our-freshwater-2023.pdf.

Oatley K. 1999. Meetings of minds: dialogue, sympathy, and identification, in reading fiction. Poetics. 26(5):439–454. doi:10.1016/S0304-422X(99)00011-X.

O'Meara P, Pendergast C, Robinson A. 2007. Grassroots community engagement: the key to success in a community building program. Rural Society. 17(2):155–164. doi:10.5172/rsj.351.17.2.155.

Oubennaceur K, Chokmani K, El Alem A, Gauthier Y. 2021. Flood risk communication using ArcGIS StoryMaps. Hydrology. 8(4):152. doi:10.3390/hydrology8040152.

Palmer S, Fozdar F, Sully M. 2009. The effect of trust on West Australian farmers' responses to infectious livestock diseases. Sociologia Ruralis. 49(4):360–374. doi:10.1111/j.1467-9523.2009.00495.x.

Peters MA, Hamilton D, Eames C. 2015. Action on the ground: a review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. New Zealand Journal of Ecology. 39(2):179–189. English.
Pomahaka Catchment Project. 2023. [Accessed 2023 Aug 1]. https://www.facebook.com/PomahakaCatchmentProject/.
Pumicestone Region Catchment Coordination Association Inc. 2017. Pumicestone Passage Catchmen action plan 2017-2020. https://www.moretonbay.qld.gov.au/files/assets/public/services/environment/pumicestone-passage-action-plan.pdf.
Rangitīkei Rivers Catchment Community. 2023. [Accessed 2023 Sept 06]. https://rrcc.co.nz/.
R Core Team. 2023. A language and environment for statistical computing. R Foundation for statistical computing. Vienna, Austria. https://www.R-project.org
Reed MS. 2008. Stakeholder participation for environmental management: a literature review. Biological Conservation. 141(10):2417–2431. doi:10.1016/j.biocon.2008.07.014.
Robin L, Robin K, Camerlenghi E, Ireland L, Ryan-Colton E. 2022. How dreaming and indigenous ancestral stories are central to nature conservation: perspectives from Walalkara Indigenous Protected Area, Australia. Ecological Management & Restoration. 23(S1):43–52. doi:10.1111/emr.12528.
Rust N, Ptak E, Graversgaard M, Iversen S, Reed M, de Vreis J, Ingram J, Mills J, Neumann R, Kjeldsen C, et al. 2020. Social capital factors affecting uptake of sustainable soil management practices: a literature review.
Rust N, Stankovics P, Jarvis RM, Morris-Trainor Z, de Vries JR, Ingram J, Mills J, Glikman JA, Parkinson J, Toth Z, et al. 2022. Have farmers had enough of experts? Environmental Management. 69(1):31–44. doi:10.1007/s00267-021-01546-y.
Sayer C, Bennion H, Gurnell A, Goodyer E, Kotze D, Lindsay R. 2018. Restoration of freshwaters: principles and practice. Oxford: Oxford Univesity Press.
Scott T. 2015. Does collaboration make any difference? Linking collaborative governance to environmental outcomes. Journal of Policy Analysis and Management. 34(3):537–566. doi:10.1002/pam.21836.
Shanahan D, Maseyk F, Johnston G, Doole M. 2021. Social and ecological outcomes from community-led conservation. Collaborative research project prepared for Predator Free 2050 Ltd. The Catalyst Group Contract Report No. 2021/160.
Skaalsveen K, Ingram J, Urquhart J. 2020. The role of farmers' social networks in the implementation of no-till farming practices. Agricultural Systems. 181:102824. doi:10.1016/j.agsy.2020.102824.
Small B, Brown P, Montes de Oca Munguia O. 2016. Values, trust, and management in New Zealand agriculture. International Journal of Agricultural Sustainability. 14(3):282–306. doi:10.1080/14735903.2015.1111571.
Stevens E. 2022. An exploration of the potential role of storytelling in development of catchment management plans (CMPs). Auckland: The University of Auckland New Zealand.
Sundin A, Andersson K, Watt R. 2018. Rethinking communication: integrating storytelling for increased stakeholder engagement in environmental evidence synthesis Neal Haddaway, Sally Crowe. Environmental Evidence. 7(1):1–6. doi:10.1186/s13750-018-0116-4.
Tadaki M, Sinner J, Stahlmann-Brown P, Greenhalgh S. 2020. Does collaborative governance increase public confidence in water management? Survey evidence from Aotearoa New Zealand. Water Alternatives. 13(2):302–323.
Taranaki Catchment Communities. 2023. [Accessed 2023 Aug 14]. https://www.taranakicc.nz/.
Te Hoiere Project. 2021. Te Hoiere Catchment Enhancement Plan - 'Haere, kakea te ara poka hou'. [Accessed 2023 Dec 13]. https://storymaps.arcgis.com/stories/db492eaf502d40b0a7ae57a9c8b570d6.
Thriving Southland. 2022. Thriving Southland Annual Report 2021 - 2022. [Accessed 2023 Sept 11]. https://www.thrivingsouthland.co.nz/site_files/24893/upload_files/AnnualReport2021-2022(1).pdf?dl = 1.
Thriving Southland. 2023. [Accessed 2023 Aug 4]. https://www.thrivingsouthland.co.nz/catchment-groups/.

Toolan MJ. 1988. Narrative: a critical linguistic introduction. London: Routledge.
UN Water - WWAP. 2022. The United Nations world water development report 2022: groundwater. Making the invisible visible. Italy. [Accessed 2023 Sept 6]. UN-Water https://www.undp.org/publications/united-nations-world-water-development-report-2022-groundwater-making-invisible-visible.
Van Bavel JJ, Reinero DA, Spring V, Harris EA, Duke A. 2021. Speaking my truth: why personal experiences can bridge divides but mislead. Proceedings of the National Academy of Sciences. 118(8):e2100280118. doi:10.1073/pnas.2100280118.
Wakefield SEL, Elliott SJ, Eyles JD, Cole DC. 2006. Taking environmental action: the role of local composition, context, and collective. Environmental Management. 37(1):40–53. doi:10.1007/s00267-004-0323-3.
Wickham H, Averick M, Bryan J, Chang W, McGowan L, François R, Grolemund G, Hayes A, Henry L, Hester J, et al. 2019. Welcome to the Tidyverse. Journal of Open Source Software. 4 (43):1686. doi:10.21105/joss.01686.
Wood BA, Blair HT, Gray DI, Kemp PD, Kenyon PR, Morris ST, Sewell AM. 2014. Agricultural science in the wild: a social network analysis of farmer knowledge exchange. PLoS One. 9(8).
Zeng Y, Qiu F, Zhang J. 2022. The impacts of observational learning and word-of-mouth learning on farmers' use of biogas in rural Hubei, China: does interpersonal trust play a role? Energy, Sustainability and Society. 12(1):1–16. doi:10.1186/s13705-022-00350-8.