



# Marine education and risk communication literature review for biosecurity best practice, Southland Coastal Marine Area

Martina Cepeda-Rios, University of Canterbury  
Donald Matheson, University of Canterbury

Envirolink report number 2348-ESRC180

Unpublished report for Environment Southland Dec 2023

# Contents

Introduction .....	2
<i>Central government</i> .....	2
<i>Environment Southland</i> .....	2
<i>Fiordland Marine Area</i> .....	3
<i>Scope: Key risk groups</i> .....	4
Awareness .....	4
<i>Border biosecurity awareness</i> .....	5
<i>Post-border biosecurity awareness</i> .....	5
<i>Biosecurity risk vs recreational value</i> .....	6
<i>Boat cleaning action</i> .....	6
<i>An awareness campaign case study</i> .....	6
Multi-level campaigns .....	9
<i>Decision journeys</i> .....	9
<i>Diffusion of innovations theory</i> .....	9
<i>Engaged or distracted recreational water users</i> .....	10
Engagement.....	11
<i>Community groups</i> .....	11
<i>Deeper engagement</i> .....	12
Biosecurity and te ao Māori .....	13
Signage .....	14
Pull media: Pamphlets and websites .....	18
Education .....	18
Conclusion .....	19
Recommendations.....	21
Acknowledgments .....	22
References.....	23

# Introduction

Environment Southland is seeking guidance on marine biosecurity communication best practice in order to communicate how best to clean, check and dry boats and gear, prior to visiting the Southland coastal marine area (CMA), particularly the Fiordland Marine Area. Building on a prior Envirolink report that outlines best practice cleaning methods, this report presents a literature review of marine education and communication good practice from New Zealand and overseas, with a particular focus on recreational boat users.

In New Zealand, marine biosecurity risk and management responses, including education and risk communication, are led by the central government. To provide context, the roles and responsibilities of various government agencies and the relevant legislation are briefly outlined below. Details of the scope of this report, its methods and its findings are discussed and recommendations specific to Southland are made.

## Central government

The New Zealand Biosecurity Act 1993 requires that the Ministry for Primary Industries (MPI) and regional councils prevent the arrival and manage the impact of harmful organisms in New Zealand. This is particularly challenging in freshwater and marine environments, as once established, aquatic harmful organisms are difficult, if not impossible, to eradicate (Hulme 2020).

The Biosecurity 2025 Direction Statement lists five key strategies for a resilient and future-focused biosecurity system in Aotearoa that addresses public engagement, scientific research, data, leadership and workforce (MPI 2016). Public engagement, particularly communication around the role that boat users can play, is the major tool in tackling risk in this area. To prevent marine species new to New Zealand establishing, MPI enforces biofouling guidelines and the Craft Risk Management Standard (CRMS) 2023 for biofouling of vessels arriving to New Zealand. The Fiordland Marine Regional Pathway Management Plan 2017 (FMRPMP) is the first regional pathways plan in New Zealand and is aimed at slowing the spread of invasive marine species to Fiordland. Four other marine pathway plans for the Top of the North (Auckland, Waikato and the Bay of Plenty), and the Top of the South (Marlborough, Nelson and Tasman) are also being developed.

## Environment Southland

In partnership with MPI, Environment Southland (ES) is one of 11 regional councils in New Zealand responsible for preventing, eradicating or slowing the spread of harmful invasive species in New Zealand.

The Long Term Plan (LTP 2021–2031) (Environment Southland 2021) sets out a goal of providing biosecurity information and advice that can be easily accessed by those who need it (p.23). Overall, the goal is to encourage the surrounding, and wider, community to actively engage in the prevention of invasive marine species being spread. Rules to slow their spread are implemented through the Southland Regional Pest Management Plan 2019-2029 (SRPMP) and the FMRPMP (Environment Southland 2019).

The SRPMP (2019-2024) states that non-regulatory measures, particularly building awareness of risks and making knowledge and materials available to communities and land/water users, are preferred to regulatory measures. It lists 7 of the 13 nationally-listed invasive marine species: including the algae *Undaria*, Asian paddle crab, Mediterranean fanworm and four sea squirts. *Undaria* (*Undaria pinnatifida*) is a progressive containment pest, whilst Asian paddle crab (*Charybdis japonica*), Mediterranean fanworm (*Sabella spallanzanii*) and four types of sea squirts (*Styela clava*, *Eudistoma elongatum*, *Pyura doppelgangera* and

*Didemnum vexillum*) are exclusion pests. Mediterranean fanworm is listed as a notifiable organism, which means it must be reported to the Ministry of Primary Industries. *Undaria* is an unwanted organism which means that it “cannot be sold, distributed or propagated” (Biosecurity Act 1993).

ES has previously secured Envirolink grants to assist users in managing these species/complying with the rules in the SRPMP and FMRPMP. To date, advice has focussed on monitoring marine farms, limiting the spread of *Undaria* by harvest and a surveillance plan in the Southland CMA. This report complements a prior Envirolink report (Newell 2023) which collated literature, both from New Zealand and internationally, on best practice cleaning methods. Recommendations included specific guidance on methods of removal for each species and an overall recommendation for the use of bleach for all the species of concern.

## Fiordland Marine Area

ES is particularly concerned about managing marine biosecurity risks within the Fiordland Marine Area (FMA) Te Moana o Atawhenua. The FMA is managed by ES, in partnership with the Fiordland Marine Guardians, under the Fiordland Marine Management Act 2005 and the FMRPMP.

As surveillance is difficult and costly, detecting new invasions usually only occurs years after the species is well established. A large infestation of *Undaria* was found in Sunday Cove, Te Puaitaha/Breaksea Sound, Fiordland in 2010 and a control programme is ongoing as eradication was not considered possible given a lack of resources and other factors (Gnanalingam & Hepburn 2019). A further *Undaria* incursion was found in Tamatea/Dusky Sound in 2022, as well as *Undaria* and *Didemnum vexillum* incursions in Rakiura/Stewart Island waters in 2022 which were reported by members of the public, indicating that these incursions had been present for some years (Environment Southland 2022).

Other species identified in the SRPMP are not yet present in Fiordland but pose an invasion risk. The Asian paddle crab was first found in 2000 in northeastern New Zealand and is commonly found in estuaries (Marine Biosecurity n.d.). The Mediterranean fanworm was first recorded in Lyttelton Harbour, Christchurch in 2008 and in the Auckland region in 2009 (Read et al. 2011). *Styela clava* and *Eudistoma elongatum* were first found in Auckland in 2005 (MPI 2017, Page et al. 2011). *Pyura doppelgangera* was discovered in Northland in 2007 (Atalah et al. 2021). *Didemnum vexillum* was identified as a threat in Shakespeare Bay, near Picton, in 2001 and has been the focus of eradication attempts since (Coutts and Forrest 2007).

## Scope: Key risk groups

The following report will focus on communication best practice for two major groups with a heavy emphasis on recreational boat users. Booth and Espiner (2010) identified specific groups using the FMA:

Commercial fishers
Recreational fishers/boaties
Tourism operators/employees
Other (including kayakers, divers, hunters, researchers, government employees)
Commercial boat passengers

*Table 1: Based on Booth & Espiner 2010*

Two distinct categories can be identified as posing a risk of spreading invasive marine species through their vessels or equipment. The first category includes commercial fishers, shipping and those involved with related movement of goods, aquaculture and mariculture facilities, water-based tourism providers and research and education institutions. This category includes groups that can be readily identified, are small in number and are relatively stable in their make-up. Consequently, they can be reached through targeted communication with some confidence (as discussed further below). Their actions can also be managed through regulation. In Southland, the risk of these groups spreading invasive species is being actively managed, although further information on best practice on communication with them is desirable.

The second category is recreational fishers and boaties. This category includes groups that are not readily identified, and are variable in their make-up. Consequently, this category poses challenges for engagement and behaviours are harder to regulate successfully. Nationally, and in Southland, recreational fishers and boaties, particularly those that use any type of equipment or gear that has been in or underwater for long periods of time, pose a high marine biosecurity risk. Fortunately, due to the remote location of the FMA, they are a relatively small, coherent group, which allows communication to be targeted. Booth and Espiner (2010) found that a large majority of recreational fishers/boaties using the FMA were from Southland or Otago (85%), a similar proportion were over the age of 30 and two thirds were male. While boat users are required to take steps to ensure they do not harbour pests, there is currently limited active education to educate these recreational groups on the importance of having clean gear on board.

## Awareness

Awareness of biosecurity risks in general and of specific risks to the FMA is widely agreed to be a precursor to knowledge and action among members of the public. It should be noted that awareness raising does not necessarily lead to changes in behaviour and so should be

combined with engagement campaigns that aim to develop deeper biosecurity knowledge among target groups and embed that knowledge within the wider community.

In public health, for example, it is widely acknowledged that people do not generally respond according to rational argument or information from experts about their behaviours. Instead, people respond according to their own needs and social contexts and therefore in diverse ways (see Kelly and Barker 2016). In the marine context, communication must therefore be relevant to users' social realities. This means that communication awareness campaigns need to connect with the specific needs and desires of recreational boat users and recognise the diversity of this group.

In addition, addressing environmental risk often provides no direct benefit to the user but rather a collective or third-party benefit. For these 'impersonal' risks, actions such as seeking out more information may be linked to people's sense of what others in their peer group or wider society think is important (Kahlor et al. 2006). For these reasons, awareness-raising around risks or behaviour change campaigns are often regarded as part of the solution, but must be accompanied by longer-term engagement, including two-way communication. These include partnering with communities on risk management so that risk understanding is built collectively. Rickard (2021) argues that partnership, in which user groups have a role in the full risk management process, is particularly important when risks are unclear, such as as-yet unidentified biosecurity incursions. This means that raising public awareness will be a useful tool when a specific threat is being targeted, such as transporting *Undaria* on vessel hulls, because it starts the process of boat users finding out more and thinking about their own actions. But, as detailed below, other forms of engagement are needed for sustained action by users and widespread culture change.

## Border biosecurity awareness

General public awareness of biosecurity risks was surveyed at the border of Aotearoa New Zealand in 2017 (Colmar Brunton 2018). There was a general receptiveness to messages: 61% of adult residents thought they had a good understanding of what biosecurity meant and could articulate why it was important. Personal values aligned with government values, e.g. 96% valued protecting the country from unwanted pests, weeds and diseases. Knowledge of biosecurity, however, was patchy, particularly among the young. Significantly, support for the range of biosecurity tools and activities to manage, control and eradicate pests which established post-border was lower, at 54%, with 44% holding negative views.

Among businesses, a similar survey found a high self-rating for knowledge about biosecurity (77% scored themselves 7/10 or higher) and high reported rates of documentation, processes and communication around biosecurity best practice and risks (76% for producers; 91% for transport businesses). Marine businesses were not identified as a group in the survey.

The lower rates of knowledge about biosecurity among younger members of the public and the mismatch between a universal public desire to protect the country and patchy support for post-border biosecurity need to be addressed.

## Post-border biosecurity awareness

Specific awareness of those involved in post-border water-based recreational activities is measured in detail by a very small number of studies. Le and Campbell (2022) conducted a public opinion survey on marine bio-invasive risks in Aotearoa, which found moderately high awareness of non-invasive marine species incursions (63%). Those who were more aware were more likely to have had personal experience and to be concerned about impacts. Men, those over the age of 45, people who visited beaches and coastal areas, people who lived rurally and people with higher levels of education, all reported significantly higher concern about bio-

invasive impacts on marine and coastal environments. There was a very high expectation placed on state agencies, including councils, to manage the risk, although few seemed aware of the role of regional councils. These findings suggest a relatively high, but focused, concern, in which the marine environment itself is of less concern than enjoyment of the coastline.

## Biosecurity risk vs recreational value

The greater value placed by members of the public on recreational opportunities over the impact that invasive species have on the environment reinforces the findings of Lotze et al. (2018), from a study of 21 countries, including Aotearoa New Zealand, that invasive species are not widely regarded as major threats, despite this country's vulnerability. The study showed a high emphasis on the value of water quality, including safe recreation, which Le and Campbell (2022) link to the visibility of impacts as a major factor in societal concern and response. Unfortunately, by this stage, impacts are widespread and require large scale management. To address this, messaging needs to highlight the value of water quality and how that links to the absence of threats such as invasive pests.

The much higher awareness of biosecurity among some groups suggests that 'recreational avidity' (Eiswerth et al. 2011), or the tendency of people to be more concerned about things that threaten the places from which they get enjoyment. It is therefore likely that regular recreational boat users will be open to communication on marine biosecurity, and not resistant to interference with their boating activities, because they care about the impact of marine pests on recreation. On the other hand, irregular users pose a higher risk because they are less likely to have a long-term commitment to the places at risk. Messaging on marine invasive species is likely to lead to higher awareness when it links recreational and environmental benefits.

## Boat cleaning action

The current major biosecurity message for boat users within Aotearoa New Zealand is "check, clean, dry" (Ovenden & Studholme 2021) or "clean and dry" (Newell 2023), which is generally targeted at freshwater users. Among freshwater boat users, Ovenden and Studholme (2021) found only moderate awareness of these messages and lower adherence to proper boat and kayak cleaning etiquette. When they surveyed 341 visitors to lakes near Auckland, they found only half had heard of "check, clean, dry", and only a quarter of those said they 'always' followed procedures. These figures are consistent with other surveys of recreational users around message recognition and compliance, in which the impact of informational campaigns on behaviour is often low (for further specifics, see the discussion of signage below). If these findings also apply to boat users in the FMA, messaging campaigns will not alone achieve the required results.

## An awareness campaign case study

Good, targeted awareness-raising campaigns among recreational water users around invasive species can be successful in beginning the process of information seeking and in changing behaviours of those who are engaged.

Seekamp et al.'s (2016) key study found a relationship between familiarity with an informational campaign aimed at freshwater boat users and fishers in the US and increased knowledge. However, they also found gaps in the knowledge about the correct actions to take when users were asked to discuss what they knew. Seekamp's research evaluated a campaign called Stop Aquatic Hitchhikers! (SAH!), which targeted freshwater recreational water users in Illinois and Indiana to reduce the spread of aquatic pests (see Figure 1). The five key messages were:

1. Inspect and remove aquatic plants, animals, and mud from boat, motor, trailer, and equipment;
2. Drain water from boat, motor, bilge, livewell, and bait containers away from landing;
3. Dispose of unwanted live bait, fish parts, and worms in trash;
4. Spray/rinse boat and equipment with high-pressure/hot water or dry everything for at least 5 days before going to another body of water; and
5. Never release organisms from one waterbody into another (Seekamp et al. 2016, p.1746).

Their survey of boaters, anglers and boater-anglers (a 30-30-40 percent split) found greater familiarity with the campaign to be related to “increased knowledge, greater personal responsibility, and somewhat regular practice of most recommended behaviours” (p.1751).

Boater-anglers in particular scored highest: they were more familiar with the campaign, had more knowledge of aquatic invasive species and felt more personal responsibility to prevent their spread. The participants also found it difficult to recall all the behaviours that were encouraged by the campaign and some held misconceptions such as that biosecurity measures were only needed when moving a vessel between states and not between bodies of water, or that drying the boat was sufficient to prevent the spread of pests.

A focus group (largely men with an average age of 58 years) revealed that many had difficulty remembering where they had been exposed to the SAH! campaign (other than boat shows). The focus groups identified some key barriers to changes in behaviour, including the inconvenience of spraying or rinsing equipment as boat ramps did not have cleaning stations, and resistance to the instruction to allow boats to dry for five days before reusing. They concluded that messaging must be clear, concise and spread widely.

Awareness-raising campaigns can play a significant role in biosecurity, when the messaging is clear and distributed widely via a range of media, although uptake may be variable among groups.



## PROMOTIONAL ITEMS

Magnets, Keychains, Tattoos, Stickers



## BOOKS, BROCHURES AND PRINTED PRODUCTS

Brochures, Flyers, Reports, Presentations



## BANNERS & POSTERS

Banners



Posters



## LARGE FORMAT - OUTDOOR MEDIA

Billboards



Signs



Figure 1: Examples of the Stop Aquatic Hitchhikers Campaign media and products (Seekamp et al. 2016)

## Multi-level campaigns

The management of invasive species is a classic ‘complex problem’ (Hulme 2006), which requires work on multiple levels because the risk is spread across so many different groups who are not well coordinated and whose actions cannot easily be managed. This is likely to involve different strategies for different groups, but also the integration of communication with other tools, as detailed below.

## Decision journeys

Marketing research (e.g. Dierks 2017, Santos and Gonsalves 2021) recognises that action, whether a purchase or a social action, is rarely linear and may not fit models of rational decision-making. It is often instead a ‘decision journey’ where change in behaviour is the result of events such as noticing or suddenly realising something as a result of a trigger. Change can be triggered or nudged through engaging with people at those touch points when they are most open to influence.

Ovenden and Studholme (2021) prototyped various triggers, through the combined use of “instructional signs, directional signs, commitment boards, a boat cleaning kit, and a kayak pest checking station” in an attempt to motivate both awareness and action surrounding freshwater pests (see Figure 3 in Signage below). While the commitment boards received little engagement and were not recommended by them, they suggest that free boat cleaning kits at the point of boat departure created a sense of obligation which encouraged lake goers to clean their gear and their vessels.

In terms of the decision journey theory, the provision of free or subsidised cleaning gear to recreational fishers may provide the right motivation at the right moment to apply proper care techniques to their boats and lead to longer-term alignment. Similarly, Smith et al. (2023) in a UK study of anglers, found that the provision of a hose or cleaning station was a major factor in anglers’ (self-reported) likelihood to clean their equipment.

Ovenden and Studholme’s case differs in some key respects from recreational boat users in Southland. The two fresh-water lakes, Lake Rototoa and Lake Tomorātā, located rurally in the Auckland region, were primarily used for swimming and most groups were families who lived locally. The second most common user group were boaties: kayaking and paddle boarding on Lake Rototoa, motorboating and jet skiing on Lake Tomorātā. Like boat users in Fiordland, these are a high risk group because of potential contamination of vessels and gear.

The overall campaign asked lake goers “to check their gear for any signs of pests, to clean all gear with 5% detergent solution, and/or for all gear to be dry to the touch for at least 48 hours when moving between freshwater bodies” (Ovenden & Studholme 2021, p.14). For lake Rototoa, the desired behaviour was for visitors to arrive with a clean kayak and/or paddleboard “by checking for pests before putting the vessel in the water” (p.14). Furthermore, they were encouraged to clean their gear once they were home again. At Lake Tomorātā, motorboats and jet skis needed to be clean before entering the lake. The recommended behaviour changes were “checking for pests before leaving the lake, cleaning the vessel at home, and checking again for pests before travelling to the lake” (p.14). The required behaviours were similar, however it was easier to clean kayaks/paddleboards compared to motorboats/jet skis.

The provision of cleaning and checking stations at the entry and exit point to/from the water is likely to trigger thought and action (see Signage below for further discussion).

## Diffusion of innovations theory

MPI’s 2017 survey led to the identification of a large cohort, the ‘blissfully ignorant’ (43% of people), who have lower understanding of biosecurity and who undertake no or few actions to

reduce risks (Colmar Brunton 2018). Alongside this, they identified smaller cohorts who were alternatively active or passive in actions or high or low in knowledge.

Diffusion of innovations theory helps to differentiate the less engaged groups further, into a “distracted early majority”, “resistant late majority” and “laggards/sceptics” (O’Neill 2004). Each group has different informational needs and responds differently to messages and each affects the other. Research suggests that clarity and brevity have value for public communication on biosecurity, because those messages can reach all but the most sceptical. Specific strategies relevant to other groups include: providing large amounts of high quality information for highly engaged participants, as they can then act as advocates and create the social pressure for behaviour change among others; appealing to the early majority with argument; and appealing to the late majority through directives to ‘do the right thing’ that invoke social norms.

Kahlor et al. (2006) found, for example, that the strongest driver for people to seek out more information about environmental risks is their perception of social pressure. It is a good strategy to reach reluctant information seekers. In relation to anglers in the UK, Smith et al. (2023) found social expectations within the peer group were a key driver in anglers washing their gear after use, and in fact exceeded by far the anglers’ knowledge of campaigns calling them to do so. It is likely that starting those peer conversations and making gear cleaning highly visible by providing facilities at boat ramps are likely to be influential for other recreational water users such as boat users.

Groups can also be segmented according to the mix of sources of information they use, including mass media, ‘pull media’ such as pamphlets and websites, word of mouth and their attention to peers or thought leaders through social media. Given the many attractive sources of information and entertainment competing for people’s attention in the contemporary media environment, strategies that focus on communicating in just one mode for a particular group are likely to be risky.

## Engaged or distracted recreational water users

Research on attitudes among recreational users of marine environments to regulation and protection of them suggest wide variation in how engaged or distracted they are with messages around their environmental responsibilities. McAuliffe et al. (2014) found that, among boat users in the Hamble Estuary in the UK, 45% agreed that a marine conservation zone proposal represented over-regulation, while only 20% disagreed. While the particular proposal and consultation on it may have played a role in the negativity, the users’ concerns about freedom of movement suggests fundamental tensions. McAuliffe et al. (2014) recommended that consultation rather than information, including discussion of the benefits of marine regulation, be used.

In contrast, Hastings and Ryan (2017) found recreational fishers generally supportive of a newly-created marine park in West Australia, although they also found low awareness of marine parks in general. They recommended community education through communication and engagement, with different approaches for locals with a strong attachment to place compared to visitors. Tonin and Lucaroni (2017) found high awareness of marine reserves and support for protection of these areas among residents near coralligenous areas in Italy, but low knowledge about the fragile environments themselves. Smith et al. (2023) found very high support for cleaning gear among UK anglers (only 7.9% of those surveyed indicated they did not clean their gear). At the other end of the scale, Melly and Hanrahan (2020) found only 7.2% of tourists visiting Ireland could recall seeing biosecurity communication; of those 78.8% took no biosecurity measures, although 90.6% participated in outdoor recreational activities.

Consultation and community education are recommended because they bridge the gap between high awareness and low knowledge. The varied findings from existing studies of boat

users suggest a wide continuum of understanding, with tourists disengaged from biosecurity knowledge. Those most likely to engage will be those with the highest recreational avidity (Eiswerth et al. 2011), who form a self-monitoring peer group.

A study of English and Welsh boat users (Shannon et al. 2020) cautions, however, that recreational boat users form too loose a social network for social pressures or incentives to have much purchase. For those loosely articulated groups, they recommend instead practical steps aimed at individual boat users, such as (as already noted) boat cleaning stations, with 'nudges' to encourage compliance. They cite the examples of reminders on fish-measurement rulers (Mackay et al. 2018) and posters of 'watching eyes' at boat ramps (Pfattheicher & Keller, 2015) that were successful in prompting compliant behaviour, particularly among those who were sensitive to social pressure.

## Engagement

A major limitation in most empirical risk communication has been the tendency to see audiences as in deficit, that is, as lacking in sound information or understanding, with the assumption that communication should bring public and science knowledge into alignment. As Hyland-Wood et al. (2021) note, this neglects the extent to which expertise already exists in parts of the community and removes the opportunity to connect with the values and experience in a community. They argue, in the context of health communication around Covid-19, that: engagement with communities will lead to greater trust; that identifying shared values will allow for campaigns that bring communities on board; and that communities are more likely to own decisions if involved in their creation.

A key finding was that messaging which empowers communities leads to greatest adherence. Harnessing the power of togetherness is critical – in recent data from nearly 6000 respondents across eleven countries, messaging and support for 'we are all in this together, and we all need to come out of it together' was the best predictor of adherence (Jetten et al. 2020, Hyland-Wood et al. 2021). In biosecurity, the high shared values among people in Aotearoa New Zealand provide a foundation for mobilising community support. This requires sustained and long-term stakeholder engagement.

## Community groups

Research on community groups identifies them as a powerful potential partner – or also a source of resistance – in action on invasive species. When mobilised, Hardie-Boys (2010) calculated in an Aotearoa New Zealand study, they can return any financial investment given to them three-fold. MPI's strategy of involving New Zealanders in monitoring for pest species requires a partnership approach at all levels so as to build community capacity.

There is high community interest in coastal areas: Peters et al.'s (2015) survey of Aotearoa New Zealand environmental groups found a third (36.8%) were in coastal areas. However, as only three of the respondent organisations were in Southland, and marine conservation was not surveyed specifically and DOC-administered land was excluded, these results should be applied to ES with caution.

On the other hand, Hulme (2020) warns that resistance to public education around pests can be high from communities of interest when it cuts across recreational or amenity value, citing Aotearoa New Zealand gardeners who are reluctant to report the attractive water hyacinth (*Eichhornia crassipes*). Educating community groups is therefore likely to be a fruitful strategy in monitoring and eradicating pests and in reducing harmful activities within the community. Face-to-face, other interpersonal communication, early consultation and newsletters with in-depth information with these groups will be more successful than generalised content.

McEntee (2017) provides strong evidence that when eradication campaigns rely on a 'narrow operational focus' via mass media or one-way information and provide communities with few opportunities to shape the campaign, those communities can become actively oppositional. In Fiordland, neglect of communities of interest such as fishers, trampers and hunters is likely to lead to less adherence to biosecurity advice and to negative attitudes towards eradication campaigns that curtail freedoms or involve intensive interventions in areas they use.

## Deeper engagement

The literature is clear that engagement must begin early and be bi-directional. Thompson et al. (2009), in a review for the Australian Bureau of Rural Sciences, found that most biosecurity engagement programmes in Australia focused on one-way, top-down information exchange and failed to engage people's aspirations for the communication process. They write: "A shift from communication programmes to participatory programmes, which have the potential to be longer-term and self-sustaining, could improve impact and effectiveness" (p.iii). These include using knowledge brokers, community champions and trusted intermediaries. Overall, they emphasise building longer-term relationships on which specific campaigns can be built. This involves attention to social structures, including building the capacity in a community to become informed and involved in biosecurity, and to political structures, such as co-governance arrangements where communities have a large role in decision-making on biosecurity. Involving communities early in surveillance of a potential or of a spreading pest also has longer-term benefits.

Diprose et al. (2022) interviewed stakeholders from central government agencies, councils, universities, research organisations and environmental groups in the Aotearoa New Zealand response to myrtle rust (*Austropuccinia psidii*) and found many expressed a high level of frustration at a passive and ad hoc response that did not actively draw on community monitoring of the spread. The study reports that 'they saw reporting diseases like myrtle rust as one way to foster social connections, express care and potentially foster change' (p.183).

The Australian Department of Agriculture, Fisheries and Forestry's *Biosecurity Engagement Guidelines* (Kruger et al. 2012) organise communication activities on a continuum from shallow to deep (Figure 2). In common with widely agreed engagement principles, they regarded action plans developed with communities themselves as the most powerful in mobilising and empowering groups, although these are appropriate only in contexts where communities themselves have a strong stake in an issue, have the capacity to take up the work and are capable of the collective work required.

Engagement activities can be imagined as connecting people with science or official plans, but tools such as the continuum advocate for providing social groups with the tools to build their own knowledge and plans around biosecurity. Royce (2011) found in his study of a northern Australian agricultural community that the most powerful biosecurity communication was between individuals who were well connected with each other, often in face-to-face conversation. He writes that "the strength of relations within social networks not only determines access and volume of information shared but whether information is accepted as credible or accurate and taken up as new knowledge" (p.98).

For those rich conversations about achieving biosecurity to happen, ES would need to engage in a range of activities, depending on its existing relationships, to develop action plans with representatives of Southland communities, manawhenua, businesses and recreational groups so as to build common cause with them around risks and incursions. These processes are slow and are appropriate for biosecurity capacity building rather than as a response to particular incursions.

	Type of engagement	Description	Examples of tools	Level and longevity of engagement	
Shallow	<b>Inform</b> One-way communication Message giving	Advertising, education	Newsletters, media, brochures, letters, websites	Passive	Non-ongoing
↑ ↓	<b>Consult</b> One or two-way communication with decision-making not resting with community	Information gathering, reporting	Toll-free numbers, public meetings, surveys, focus groups, panels	Increasing level of engagement	Increasingly self-sustaining nature of engagement
	<b>Involve</b> Creating shared understanding and solutions pursued by one partner only	Community consultation and involvement	Community advisory groups, joint planning groups, forums		
	<b>Partner</b> Developing shared action plans through collaboration	Community participation and negotiation	Community management committees, workshops, negotiation processes		
Deep	<b>Mobilise and empower</b> People take independent initiatives and develop contacts with external institutions for resources and advice	Self-direction planning with limited support through governance arrangements	Action plans developed and implemented by the community with access to experts and resources available through government	Proactive	Ongoing

Sources: CEN 2005; Dare et al. 2008; Hashagen 2002

Figure 2: Engagement continuum (Kruger et al. 2012)

## Biosecurity and te ao Māori

Research and guidance on Māori perspectives on biosecurity emphasises the desire from manawhenua to be involved early in decision-making, via a co-design process (Arawhiti n.d.). Teulon et al. (2015), for example, pointed to a lack of engagement with Māori in preparing for and responding to the risk of the spread of myrtle rust throughout Aotearoa New Zealand and called for a tangata whenua rōpū to play a leadership role in that response. They cite Waitangi Tribunal claim WAI262, in which tīpuna affirmed iwi relationships with taonga species as central to Māori identity and being. They called for protection mechanisms of those species and of the mātauranga associated with them as part of tribal relationships with the Crown.

Kuru et al. (2021) similarly called for better communication between biosecurity agencies and Māori as part of planning processes, so as to include: their intergenerational knowledge; their close association with the environment; the values base of kaitiakitanga that informs that knowledge; and the worldview underpinning it that iwi and whenua are not separate but interdependent. They also called for Māori practices related to biosecurity, such as rāhui and surveillance practices, to be integrated with state agency practices. They note an historic and ongoing failure of both science and government agencies to connect across differences in

communication styles and knowledge practices and they point to the need for considerable effort to be put into relationship-building for successful projects.

Within these frameworks, communication with Māori publics, such as whānau with customary rights to gather tītī from islands near Rakiura Stewart Island, must be preceded by a first step of co-design of biosecurity structures, with communication strategies then arising out of that engagement. It is argued that they cannot be successful without those processes as they will fail to engage with Māori practices, knowledge or values and so will lack buy-in. Māori stakeholder consultation in 2016 noted that taonga species are often neglected by biosecurity decision-makers in favour of economically important species (MPI 2016). Some Māori publics are well-defined, such as Ngāti Māmoe/Ngāi Tahu tītī right-holders, and manawhenua relationships can be used to design robust communication practices, but others are more diffuse.

Communicating with those less defined Māori audiences on biosecurity has not been widely researched but the evidence to date reinforces wider research on communication with Māori publics that messages should be tailored. Māori biosecurity expert Melanie Mark-Shadbolt recommended use of te reo Māori alongside English because it would engage kaitiaki in rural areas in surveillance for the spread of myrtle rust (Scion 2018). Black et al. (2022), in the only detailed survey-based study on the relationship between Māori attitudes and biosecurity, point to specific beliefs and values sets that characterise Māori publics. Although the sample size was small and focused on mammalian pest control, their findings could have wider applicability. They found strong support for biosecurity measures, linked to commitments to both family wellbeing and general social wellbeing and to traditional customs and values. They also found that Māori participants expressed moderate trust in science (lower than for the overall population), although higher trust in scientists than for other authorities in society. Extrapolating from the results, we suggest that communication with Māori publics should tap into similar but distinct values sets to the general population, but prioritising the cultural value of species over economic value, whānau over individual action and scientific knowledge over respect for authority.

## Signage

Signs are a major tool in reaching recreational boat users, but current usage for biosecurity in Fiordland may not be best practice. Communication at point of activity benefits from high relevance, making them feel relevant to people and likely to be meaningful. On the other hand, many users may already be committed to what they are doing and not open to new messages at the point of activity (Melly & Hanrahan 2021) – although they are likely to be more open to communication when returning to a boat ramp at the end of the day.

Roggenbuck (1992) found evidence that signs have the most impact on those who are uninformed or have weaker information skills and have less impact on those with existing knowledge. Signs are also often cryptic one-way forms of communication that need to be carefully designed as they depend heavily on processing strategies to decode them.

Sellnow and Seeger state that “warning systems are most effective when they are simple and easy to interpret” (2013, p.55). Some studies on changing behaviour in recreational natural settings have found that repetition of simple signs that prohibit or require a particular activity and are clearly attributed to an authority are most effective, particularly when compliance is made easy (e.g. Hockett et al. 2017). On the other hand, specific wording explaining the negative impacts of a behaviour is regarded as good practice in environmental contexts, where the risk is impersonal rather than to the individual.

A number of scholars point to the value of focusing at the same time on the contrasting approaches of simplicity and depth, that is, the double persuasive power of simple cues and in-

depth arguments. Ham et al. (2009) for example, concluded that signs needed to use both persuasive strategies, providing compelling evidence as well as simple headings and reliance on authority. Research on the associated topic of warnings points to multiple factors that impact the effectiveness of warning systems, including “level of noise, failures in foresight, inability to interpret risk cues, breakdowns in vigilance and various forms of distraction” (Sellnow & Seeger 2013, p.58).

Studies show wide variation in effectiveness, suggesting the particular signage strategy used is important. In reviewing literature on signs aimed at stopping hikers going off trail, Schoenleber et al. (2022) found changes in behaviour ranging from 15% to 44%. One study of signs that encouraged shoe-cleaning in a park in Montana, USA, showed the importance of good visual design. Compliance was more likely with ‘typography as image’ design. This type of design fused text and imagery so the two forms of communication were processed together. Text that was high-contrast and had images of the plants to be protected also did well. It should be noted that the highest success sign in their experiment still led to only 27.6% compliant behaviour under their experimental conditions. Another study (Schoenleber et al. 2022) found that a narrative sign at a beach, which required considerable engagement by users, led to higher compliance (in that case, avoiding the dry sand where plovers were nesting) because of the greater empathy people felt. They did not find an association between ease of reading the message and compliance, but the reverse.

As noted above, Ovenden and Studholme’s (2021) study integrated directional (telling users what to do) and informational signage with other interventions, including commitment boards, boat cleaning kits and a kayak cleaning station (see Figures 3 & 4). The communication was designed in conjunction with a graphic designer and local iwi, Ngāti Whātua o Kaipara and Ngāti Manuhiri. Māori text was incorporated into the headings.

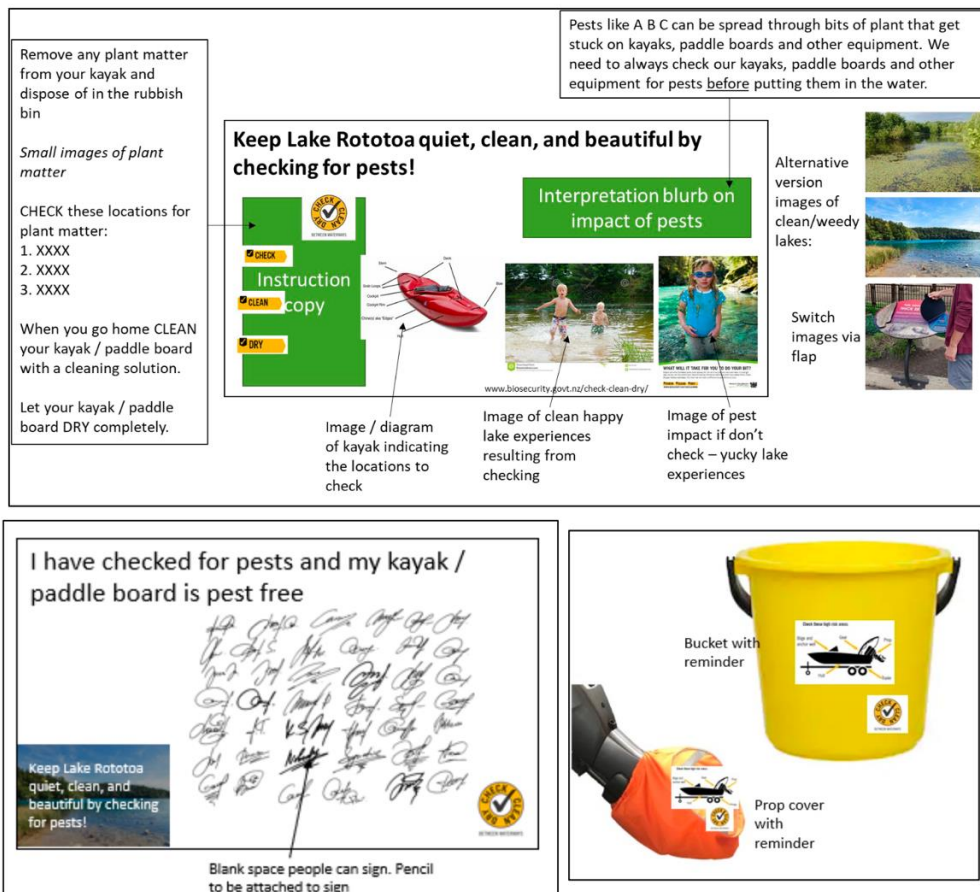


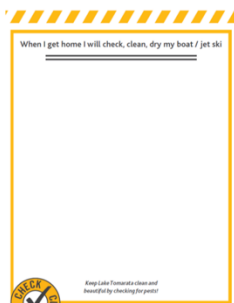
Figure 3: Mock-up of signage for fresh-water lake signage (Ovenden & Stodholme 2021)



Results showed that there was existing awareness (one in five) of the ‘check, clean, dry’ campaigns that led many to associate the campaign with phrases like “stopping the spread of pests like didymo”, “being for lakes around New Zealand”, “checking for vessels before entering water and when you are at home”. The white and yellow ‘caution’ stripe colour scheme grabbed the audience’s attention. Some associated the signs with the ‘check, clean, dry’ campaign (p.17) while others “associated it with COVID-19” (p.29), resulting in engagement with the signs from some participants, but lower interest from others “as they were experiencing ‘COVID-19 fatigue’” (p.29). Many misunderstood signs and believed the signs were referring to “terrestrial pests (such as possums)” (p.31).

Ovenden and Studholme (2021) concluded that it is possible to increase awareness and normalise procedures relating to freshwater biosecurity in part through signage. The lessons for Southland are to integrate signage within a wider campaign and in particular in combination with boat cleaning facilities.

Good signage has good visual design, with (as noted above) more detailed informational signs for groups willing to engage and simple, clear messages for those who use quick heuristics (mental short-cuts). Biosecurity signs at boat ramps do not do well according to the above criteria. They suffer from a high level of noise and distraction due to excessive signage that uses different kinds of cues and informational approaches, which is likely to hinder the audience's ability to interpret the risk cues. There are many agencies at boat ramps that are attempting to communicate their own messages.



#### Commitment Boards

- Ask visitors for a commitment to undertake the key behaviour.
- Aim to be relevant to target visitor audience by representing their values of the lakes ‘clean and beautiful’ as identified in survey.



#### Instructional Signs

- Attract attention through use of flaps, bright yellow colour, and caution stripe.
- Inspire curiosity by encouraging visitors to look closer for pests through use of flaps with zoomed in images of a kayak.
- Deliver a simple instruction to ‘make a plan’ with the use of icons.
- Aim to be relevant to target visitor audience by reflecting the value they place on the lakes being ‘clean and beautiful’ as identified in survey, targeting families with children, and illustrating the impact of pests on swimming (the most common recreational activity).



#### Boat Cleaning Kit

- Attract attention by using a bright yellow colour and caution stripe.
- Deliver a prompt to check for pests at the right time (i.e., when visitors are cleaning their boats).



#### Directional Signs

- Attract attention by asking a question, using a bright yellow colour, and caution stripe.
- Aim to be relevant to target visitor audience by including gear they have and representing their sentiment towards the lake: 'love Lake Rototoa'.
- Single instruction to 'go to kayak checking station'.
- Spots on gear intended to demonstrate that pests are potentially present, but hidden.

Figure 4: Signage tested by Ovenden & Studholme (2021)

The boat user is addressed in different terms by each: in Sellnow and Seeger's terms, the ramp information environments do "not have well-defined audiences" (2013, p.50). The signage located in Piopiotahi Milford Sound (Figure 5), for example, has varied and confusing messaging, targeting anyone using the Sound, which means it can range from all types of ages, users and interests. It is important that the boat ramp context meets the conditions of clarity of purpose and is relevant to the audiences in order to contribute to behaviour change. Good signage is about more than the individual sign.



Figure 5: Overuse of signage at Piopiotahi Milford Sound (image: Kathryn McLachlan)

## Pull media: Pamphlets and websites

Pull media such as websites and pamphlets are useful for users seeking out further, in-depth information and answers to specific questions. In public health they are regarded as an important complement to push media (such as advertising, news media or signage) because they provide guidance at a moment when people are more engaged with the issue: they therefore align more with the user's desires and interests; they are connected by the user to their own knowledge and experiences; they are perceived as more credible; they meet their specific needs; and they leave the user in more control (Dearing & Creuter 2010). However, to do so, they must be tailored to the needs of those groups and therefore be preceded by an assessment of what people need and want to know about.

Pamphlets are also enduring media, available in the car glove compartment or shelf at home to refer to multiple times. They take effort to read, however. It may be that they are most effective for those most engaged. A study of health practitioners, for example, found very high readership of a pamphlet about rare side-effects of a drug and much higher correct knowledge among them.

Most researchers rate pamphlets as a 'shallow' form of communication as opposed to 'deep' forms such as engagement and education. Because pamphlets are one-way, one-off and generalist, they can be easily ignored. When used in isolation, such as mail drops, Kruger et al. (2012) regard them as "virtually useless". They argue that an over-reliance on print materials is a barrier to users engaging with biosecurity.

Websites enable large amounts of up-to-date information to be provided in a way that is easily accessible by web search. Biosecurity-related studies are rare but one study suggests that professionals (in this case veterinarians) used websites, email and newsletters from "already established authoritative organisations and agencies" such as veterinary associations and some government agencies (McDonald & McKinnon 2019). Seventy percent of respondents used these sources and they were widely trusted, although the study authors were surprised that 32% did not use government websites at all. Social media was well used (50%) but not so trusted. Less is known on harder to reach audiences such as recreational boat users. The use of websites and social media is likely to be most effective as part of wider campaigns and most effective when combined with engagement activities.

## Education

Educating local communities has been shown to result in more active participation in conservation activities. A study conducted by Trewhella et al. (2005) found that environmental education programmes (EEP) about an endangered fruit bat located in three different islands in the Western Indian Ocean, Comoros, Pemba and Rodrigues, led to positive outcomes not just among the school students targeted but among members of the local communities. For example on the Tanzanian island of Pemba, villagers changed local bylaws on the capture or shooting of bats after an EEP introduced into local schools. Through word of mouth, students became "ambassadors to spread information on bats with their community" (p.81), leading to positive feedback. On the Mauritian island of Rodrigues, the impact of classroom-based EEPs went still further, reaching local radio and television (Trewhella et al. 2005).

This study illustrates the value of a multidisciplinary approach to complex issues. The Western Indian Ocean study integrated different disciplines such as ecology, biology and sociology to produce a more holistic educational offering that was able to extend beyond the classroom and foster community responsibility and awareness. It also highlights the value of collaboration between conservation organisations, government agencies, education institutions and the local community. Conversations started by New Zealand school pupils about the FMA

after hearing from ecologists, marine biologists and those involved with Fiordland industries could lead to conversations at home.

Ram (2019) cautions, however, against piecemeal educational engagement. He found year 9 students in two Aotearoa New Zealand schools engaged emotionally with a poster showing a girl trying to swim in didymo-affected freshwater, but failed to understand the message because they lacked prior understanding of biosecurity issues. However, he advocates socio-scientific education, that is, building students' scientific understanding through the study of contemporary controversies and challenges which they will feel are relevant to their lives. The challenge of marine pests to Fiordland ecosystems is a good case of such an approach.

## Conclusion

There is high alignment between government bodies and residents at a values level around protecting the country from pests, but support for post-border biosecurity controls is lower and patchy. However, there is a relatively coherent group visiting the FMA (aged 30 and above, resident in Otago or Southland who commonly use boats to fish) that will have high 'recreational avidity'. Their enjoyment can be mobilised by connecting risks to their activities with risks to the ecosystem. Māori publics respond more to appeals to cultural value of species over economic value, to whānau over individual action and to scientific knowledge over respect for authority. Younger people and those who are occasional visitors to the FMA are less likely to be aware or act on messages. They are also harder to reach.

Raising awareness of the need to clean boats and gear is unlikely by itself to lead to the three shifts needed: greater knowledge of biosecurity risks, a sense of responsibility and behaviours that pose less of a risk of spreading marine pest. Evaluations from other campaigns suggest many people do not remember messages or respond to them. Finding triggers to move people along their decision journey towards taking actions is advocated. This includes communication at moments when they are open to making decisions and prompting action in public places where boat users are accountable to each other, such as by providing facilities to clean equipment at boat ramps.

Information can spread by word of mouth when those who are highly engaged with biosecurity knowledge or who are receptive to learning are provided with a high level of detail. They may in turn provide that information to others who are resistant to other forms of messaging. Pamphlets and websites play an important role in building understanding among engaged groups. Current signage is losing the battle for attention at boat ramps. Signs at boat ramps and other key locations similarly play a role in reminding recreational boat users and fishers of actions they need to take. However, evidence-based guidance from Australia and elsewhere says they must be used strategically and in conjunction with other tools. This includes using pamphlets to deepen understanding among those already concerned about biosecurity and combining well-designed and targeted informational and directive signs with further information that builds understanding. The research is clear that that signage be directive, explicit, well-designed and visually appealing. It must provide quick messages backed up by explanations of the reasons and be clearly attributed to authority.

Campaigns are recommended that use a range of media, from signs, stickers and consumables to pamphlets and web-based media. This balance of media will help to address engaged and disengaged audiences, including: a balance of simple, directive communication for the reluctant majority and explanatory material that deepens understanding among those who care more; and a balance of media that is enduring, such as fridge magnets or pamphlets, and media, such as social media posts, that is able to reach beyond the converted.

Best practice recommends moving from awareness-raising to engagement. Communities contain expertise and care or kaitiakitanga that can be mobilised to great effect through good engagement campaigns. When biosecurity is embedded in the culture of a group such as fishers, adherence to good practices such as checking and washing gear is high. When people feel they are taking part in a collective endeavour, as at the high point of the Covid-19 response, they follow guidance as the activity is contributing to social togetherness. Communities, particularly manawhenua, also expect to be engaged early, before decisions on how to respond to pests have been made: communication campaigns arise out of that. When communities are excluded, they can feel alienated and become resistant.

Decisions therefore need to be made early on the relevant level of engagement. ES also needs to commit to long and slow processes of engagement, which will pay off in the future. Efforts to build the capacity of a range of communities around biosecurity through seminars, meetings with representatives of communities and information tailored for those groups' interests will give them the tools to deepen their knowledge and commitment. Involvement in decision-making increases the level of commitment within communities. Education campaigns with school children can lead to further conversations at home, but engagement with schools needs to be in person and sustained.

## Recommendations

Focus on the relatively coherent group of (mostly) men who live in Southland and Otago and who fish recreationally on a regular basis. They can be reached at events, such as a stand at The Rock Southland Boat Show, hunting and fishing magazines, public Facebook groups and organisations such as Fish and Game Southland.

Target communication at key decision points for recreational fishers, divers and other boat users, including when they are buying gear or bait, planning trips and launching their craft. This can include posters/pamphlets in boat/dive shops and dairies/petrol stations where bait is bought, on informational websites and apps and at boat ramps.

Invest in the design stage of visual media to ensure they attract viewers, strengthen the textual message and assist recall.

Collateral, such as stickers, fridge magnets or keyrings, are persistent media with the power to reinforce campaign messages.

Use existing consultation structures, such as the FMRPMP process, to engage with already interested groups such as commercial fishers and tourism companies. This communication should be relationship-focused, led by those at ES with existing relationships.

Communication with Māori publics should arise out of a co-design process with manawhenua groups. That communication should focus on cultural values, whānau and science.

Engagement structures to communicate with recreational user groups should aim for long-term relationship-building with organisations and networks of fishers, hunters and trampers and build on shared care for the FMA.

Differentiate communication from unpopular top-down biosecurity campaigns by including community representatives as advocates and allies in messaging on social media, pamphlets and websites.

Communication should be in partnership with DOC, Fisheries NZ and Biosecurity NZ, both in relation to rationalising signage and building relationships with recreational groups.

Use visible risks such as *Undaria* as entry points for building understanding about invasive species.

Ensure signage at boat ramps and wharves in Southland is visually well-designed. Be both directive (to remind regular users and to reach irregular users of the water, including tourists) and rich with information (to build understanding among those who are more engaged). Use QR codes for further information if the site has cell phone coverage.

Provide the means for trailer-borne craft and fishing or diving gear to be cleaned at boat ramps and places. This can include free-to-use brushes, hoses and runoff containment measures.

Educate children so they can educate their parents and grow up as kaitiaki. Stickers, magnets and other collateral can be taken home to spread messages, particularly if integrated into wider campaigns. At high school level, engage in socio-scientific work with schools where classes discuss how pests are spreading and being contained.

## Acknowledgments

With thanks to Kathryn McLachlan, Team Leader Marine, Environment Southland, Brenda Greene, Research Advisor, University of Canterbury and Bill Dyck, Knowledge Broker for their support of this project.

## References

- Arawhiti, n.d. *Crown engagement with Māori framework*.  
<https://www.tearawhiti.govt.nz/assets/Tools-and-Resources/Crown-engagement-with-Maori-Framework.pdf>
- Atalah, J., Fletcher, L. M., & Forrest, B. M. (2021). Impacts of a putative invasive ascidian on rocky shore communities. *Marine Environmental Research*, 168, 105308. doi: 10.1016/j.marenvres.2021.105308.
- Black, A., Garner, G., Mark-Shadbolt, M., Balanovic, J., MacDonald, E., Mercier, O., & Wright, J. (2021). Indigenous peoples' attitudes and social acceptability of invasive species control in New Zealand. *Pacific Conservation Biology*, 28(6), 481–490.  
<https://doi.org/10.1071/PC21049>
- Booth, K., & Espiner, S. (2010). *Fiordland (Te Moana o Atawhenua): Marine user study, Vol. 1*.  
<https://www.fmg.org.nz/sites/default/files/2018-11/fma-user-study-2010.pdf>
- Colmar Brunton (2018). *Biosecurity 2025: Public biosecurity baseline report*. MPI, March.  
<https://www.mpi.govt.nz/dmsdocument/29852-Biosecurity-2025-public-survey-baseline-report>
- Coutts, A. D., & Forrest, B. M. (2007). Development and application of tools for incursion response: Lessons learned from the management of the fouling pest *Didemnum vexillum*. *Journal of Experimental Marine Biology and Ecology*, 342(1), 154–162.
- Dearing, J. W., & Kreuter, M. W. (2010). Designing for diffusion: How can we increase uptake of cancer communication innovations? *Patient Education and Counseling*, 81, S100–S110.
- Dierks, A. (2017). *Re-modeling the brand purchase funnel*. Springer Gabler.
- Diprose, G., Kannemeyer, R., Edwards, P., & Greenaway, A. (2022). Participatory biosecurity practices: Myrtle rust an unwanted pathogen in Aotearoa New Zealand. *New Zealand Geographer*, 78(3), 175–185.
- Eiswerth, M. E., Yen, S. T., & van Kooten, G. C. (2011). Factors determining awareness and knowledge of aquatic invasive species. *Ecological Economics*, 70(9), 1672–1679.
- Environment Southland (2019). *Southland Regional Pest Management Plan 2019-2029*. Publication no. 2019-03.  
<https://www.es.govt.nz/repository/libraries/id:26qi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/regional-plans/southland-regional-pest-management-plan/documents/Southland%20Regional%20Pest%20Management%20Plan%202019%20-%202029.pdf>.
- Environment Southland (2021). *To tātou haerenga. Our journey. Tough decisions, strong future. Te Mahere Wā-Roa. Long Term Plan 2021-2031*.  
<https://www.es.govt.nz/repository/libraries/id:26qi9ayo517q9stt81sd/hierarchy/about-us/plans-and-strategies/council-plans/long-term-plan/documents/2021-2031%20Long-term%20Plan.pdf>.
- Environment Southland (2022). Two marine pest species discovered at Rakiura Stewart Island. *News*, 12 July. <https://www.es.govt.nz/about-us/news?item=id:2iptmq5c217q9s24evgg>



- Gnanalingam, G., & Hepburn, C.D. (2019). Control of *Undaria pinnatifida* in Breaksea Sound, Fiordland. Envirolink Report: 1919-ESRC290. <https://www.envirolink.govt.nz/assets/1919-ESRC290-Control-of-Undaria-pinnatifida-in-Breaksea-Sound-Fiordland-reduced.pdf>
- Ham, S. H., Brown, T. J., Curtis, J., Weiler, B., Hughes, M., & Poll, M. (2009). Promoting persuasion in protected areas: A guide for managers who want to use strategic communication to influence visitor behaviour. Technical report. Cooperative Research Centre for Sustainable Tourism. <https://researchportal.murdoch.edu.au/esploro/outputs/report/Promoting-persuasion-in-protected-areas-A/991005541679307891/filesAndLinks?index=0>
- Hardie-Boys N. (2010). Valuing community group contributions to conservation. *Science for Conservation*, 299. New Zealand Department of Conservation.
- Hastings, K., & Ryan, K. L. (2017). Differences in perception of a newly created Marine Park in south-west Western Australia by boat-based recreational fishers and the broader community. *Marine Policy*, 77, 65–77.
- Hockett, K. S., Marion, J. L., & Leung, Y. F. (2017). The efficacy of combined educational and site management actions in reducing off-trail hiking in an urban-proximate protected area. *Journal of Environmental Management*, 203, 17–28.
- Hulme, P. E. 2006. "Beyond Control: Wider Implications for the Management of Biological Invasions." *Journal of Applied Ecology* 43 (5): 835–847.
- Hulme, P.E. (2020). Plant invasions in New Zealand: global lessons in prevention, eradication and control. *Biol Invasions* 22, 1539–1562. <https://doi.org/10.1007/s10530-020-02224-6>
- Hyland-Wood, B., Gardner, J., Leask, J. et al. (2021). Toward effective government communication strategies in the era of COVID-19. *Humanities and Social Sciences Communication* 8, article 30. <https://doi.org/10.1057/s41599-020-00701-w>
- Jetten J., Reicher S.D., Haslam S.A., & Cruwys T. (2020). *Together apart: The psychology of COVID-19*. Sage.
- Kahlor, L., Dunwoody, S., Griffin, R. J., & Neuwirth, K. (2006). Seeking and processing information about impersonal risk. *Science Communication*, 28(2), 163–194.
- Kelly, M. P., & Barker, M. (2016). Why is changing health-related behaviour so difficult? *Public Health*, 136, 109–116.
- Kilroy, C., & Bothwell, M. L. (2012). *Didymosphenia geminata* growth rates and bloom formation in relation to ambient dissolved phosphorus concentration. *Freshwater Biology*, 57(4), 641–653. <https://doi.org/10.1111/j.1365-2427.2011.02727.x>
- Kruger, H., Stenekes, N., Clarke, R., & Carr, A. (2012). *Biosecurity engagement guidelines: Principles and practical advice for involving communities*. ABARES report to client prepared for the Office of the Chief Plant Protection Officer, Department of Agriculture, Fisheries and Forestry, Canberra.
- Kuru, R., Marsh, A., & Ganley, B. (2021). Elevating and recognising knowledge of indigenous peoples to improve forest biosecurity. *Frontiers in Forests and Global Change*, 4, 719106. <https://doi.org/10.3389/ffgc.2021.719106>

- Le, C. T., & Campbell, M. L. (2022). Public's perceptions of marine bioinvasive risks and responsible parties: Implications for social acceptability and better-informed communication in the marine biosecurity context. *Marine Pollution Bulletin*, 185, 114283.
- Lotze, H.K., Guest, H., O'Leary, J., Tuda, A., Wallace, D. (2018). Public perceptions of marine threats and protection from around the world. *Ocean Coastal Management*, 152, 14–22. <https://doi.org/10.1016/j.ocecoaman.2017.11.004>
- McAuliffe, S., Potts, J., Canessa, R., & Baily, B. (2014). Establishing attitudes and perceptions of recreational boat users based in the River Hamble Estuary, UK, towards Marine Conservation Zones. *Marine Policy*, 45, 98–107.
- McEntee, M. J. (2007). Participation and communication approaches that influence public and media response to scientific risk: A comparative study of two biosecurity events in New Zealand. *International Journal of Interdisciplinary Social Sciences*, 2(4), 195–2-4.
- Mackay, M., Jennings, S., van Putten, E. I., Sibly, H., & Yamazaki, S. (2018). When push comes to shove in recreational fishing compliance, think 'nudge'. *Marine Policy*, 95, 256-266.
- McDonald, I. J., & McKinnon, M. (2019). Communicating biosecurity information to Australian-registered veterinarians. *Australian Veterinary Journal*, 97(10), 394-397.
- Marine Bioscurity (n.d.) Asian paddle crab. *Marine Biosecurity Porthole*. <https://www.marinebiosecurity.org.nz/charybdis-japonica/>
- Melly, D., & Hanrahan, J. (2020). Tourist biosecurity awareness and risk mitigation for outdoor recreation: management implications for Ireland. *Journal of Outdoor Recreation and Tourism*, 31, 100313. <https://doi.org/10.1016/j.jort.2020.100313>
- MPI (2016). Biosecurity 2025: Summary of Māori focus group engagement. Ministry for Primary Industries. <https://www.mpi.govt.nz/dmsdocument/29126-Biosecurity-2025-Summary-of-feedback-from-the-Maori-Focus-Group>
- MPI (2017). Sea squirt (clubbed tunicate). Biosecurity New Zealand public database, 30 August. <https://www.mpi.govt.nz/biosecurity/how-to-find-report-and-prevent-pests-and-diseases/search-for-a-pest-or-disease/?article=1346>
- Newell, C. (2023). Review of best practice treatment methods and current educational efforts for marine pests. Envirolink Report: 2330-ESRC300. <https://www.envirolink.govt.nz>
- O'Neill, P. (2004). *Developing a risk communication model to encourage community safety from natural hazards*. New South Wales State Emergency Services, June. <https://silo.tips/download/developing-a-risk-communication-model-to-encourage-community-safety-from-natural>
- Ovenden, K and B Studholme (2021). Enabling check, clean, dry compliance: A freshwater biosecurity behaviour change case study. Auckland Council technical report, TR2021/18 <https://knowledgeauckland.org.nz/media/2204/tr2021-18-enabling-check-clean-dry-compliance.pdf>
- Page, M. J., Morrisey, D. J., Handley, S. J., & Middleton, C. (2011). Biology, ecology and trials of potential methods for control of the introduced ascidian *Eudistoma elongatum* (Herdman, 1886) in Northland, New Zealand. *Aquatic Invasions*, 6(4), 515–517.

- Peters, M. A., 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.
- Pfattheicher, S., & Keller, J. (2015). The watching eyes phenomenon: The role of a sense of being seen and public self-awareness. *European Journal of Social Psychology*, 45(5), 560–566.
- Ram, R. (2020). Engaging young people in science education through socioscientific issues of biosecurity. *Kōtuitui: New Zealand Journal of Social Sciences Online*, 15(1), 22–37.
- Read, G. B., Inglis, G., Stratford, P., & Ahyong, S. T. (2011). Arrival of the alien fanworm *Sabella spallanzanii* (Gmelin, 1791)(Polychaeta: Sabellidae) in two New Zealand harbours. *Aquatic Invasions*, 6(3), 273–279.  
[http://www.aquaticinvasions.net/2011/AI\\_2011\\_6\\_3\\_Read\\_etal.pdf](http://www.aquaticinvasions.net/2011/AI_2011_6_3_Read_etal.pdf)
- Rickard, L. N. (2021). Pragmatic and (or) constitutive? On the foundations of contemporary risk communication research. *Risk Analysis*, 41(3), 466–479.
- Roggenbuck, J. W. (1992). Use of persuasion to reduce resource impacts and visitor conflicts. In M. J. Manfredi (ed.), *Influencing human behavior: Theory and applications in recreation, tourism and natural resource management* (pp. 149–208). Sagamore Publishing Co.
- Royce, P. (2011). Using a community approach to foster effective biosecurity practices across social borders. In I. Falk, R. Wallace, & M. L. Ndoen (eds), *Managing Biosecurity Across Borders* (pp. 93-107). Springer Netherlands.
- Santos, S., & Gonçalves, H. M. (2021). The consumer decision journey: A literature review of the foundational models and theories and a future perspective. *Technological Forecasting and Social Change*, 173, 121117.
- Schoenleber, C., D'Antonio, A., & Hall, T. E. (2022). Are signs enough? Using normative and narrative messaging to protect the western snowy plover (*Charadrius nivosus*) in coastal Oregon. *Journal for Nature Conservation*, 69, 126251.
- Scion (2018) Citizens report on myrtle rust. *Scion Connections* 28.  
<https://www.scionresearch.com/about-us/about-scion/corporate-publications/scion-connections/past-issues-list/scion-connections-issue-28,-june-2018/Citizens-report-on-myrtle-rust>
- Seekamp, E., McCreary, A., Mayer, J., Zack, S., Charlebois, P., & Pasternak, L. (2016). Exploring the efficacy of an aquatic invasive species prevention campaign among water recreationists. *Biological Invasions*, 18(6), 1745–1758. <https://doi.org/10.1007/s10530-016-1117-2>
- Sellnow, T. L., & Seeger, M. W. (2021). *Theorizing crisis communication*. John Wiley & Sons.
- Shannon, C., Stebbing, P. D., Dunn, A. M., & Quinn, C. H. (2020). Getting on board with biosecurity: Evaluating the effectiveness of marine invasive alien species biosecurity policy for England and Wales. *Marine Policy*, 122, 104275.
- Smith, E. R., Heal, R., & Wood, L. E. (2023). Understanding and improving biosecurity among recreational anglers in Great Britain. *Journal of Fish Biology*, 102, 1177–1190.  
<https://doi.10.1111/jfb.15345>

- Teulon, D. A. J., Alipia, T. T., Ropata, H. T., Green, J. M., Rollinson, S. L. H. V., Cromey, M. G., Arthur, K., MacDiarmid, R. M., Waipara, N. W., & Marsh, A. T. (2015). The threat of Myrtle Rust to Māori taonga plant species in New Zealand. *New Zealand Plant Protection*, 68, 66–75. <https://doi.org/10.30843/nzpp.2015.68.5869>
- Thompson, L., Stenekes, N., Kruger, H., & Carr, A. (2009). *Engaging in biosecurity: Literature review of community engagement approaches*. Bureau of Rural Sciences, Australian Government.
- Tonin, S., & Lucaroni, G. (2017). Understanding social knowledge, attitudes and perceptions towards marine biodiversity: The case of tegrùe in Italy. *Ocean & Coastal Management*, 140, 68–78.
- Trewhella, W. J., Rodriguez- Clark, K. M., Corp, N., Entwistle, A., Garrett, S. R. T., Granek, E., ... & Sewall, B. J. (2005). Environmental education as a component of multidisciplinary conservation programs: lessons from conservation initiatives for critically endangered fruit bats in the western Indian Ocean. *Conservation Biology*, 19(1), 75-85.