

# Biosecurity engagement with hikers A study at Rowardennan, Scotland

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The Research Agency of the Forestry Commission



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# Executive summary

#### Introduction

The trees of Britain face increasing challenges from a range of potentially damaging pests and diseases, most of which have been accidently introduced from overseas. A growing recognition of the impact of introduced tree pests and diseases highlights the need to explore all possible means of dispersal, and measures to limit or prevent such 'pathways' where possible. One potential means of spread is the presence and movement of recreationists, including hikers. Hence there is a need to engage these groups in positive biosecurity behaviours for tree health.

*Phytophthora ramorum* is a fungus-like pathogen which is particularly damaging to economically important larch trees (*Larix* species) and some other species associated with woodlands in the UK. In 2017 *P. ramorum* was detected in larch trees at a Forestry Commission site at Rowardennan on the shores of Loch Lomond. Following the detection of *P.ramorum* at Rowardennen, Forestry Commission Scotland has undertaken a number of related actions. A large area of larch trees has been felled alongside the Ben Lomond hill path and a number of posters put up along the path to highlight the issues associated with the disease and provide some information to hikers. To evaluate this on the ground biosecurity messaging and equipment, Forestry Commission Scotland businesses at Rowardennan in 2018.

The first part of the study was a literature review (see appendix 7). The aims were to:

- Demonstrate the role of recreationists in the spread of pests, diseases, seeds, weeds and non-native invasive species in both terrestrial and marine environments.
- Present a snapshot of existing literature that has investigated what the 'public' understand and think about biosecurity and issues around tree health and invasive species.
- Provide a summary of some key principles of stakeholder engagement for behavioural change, thereby helping to inform the social science study design.
- Highlight whether existing behavioural change interventions for biosecurity have achieved the desired changes, and what lessons there are for the current study.

The detailed aims of primary research with hikers were to establish:

- What people know, what they think, and what they do, in relation to biosecurity and tree and plant health.
- Who and what information sources they use and trust for finding out about issues relating to the environment and plants and trees.
- What facilities and resources they would require to be more 'biosecure', and where they would like these to be located.

A short questionnaire was designed that could be completed face to face in situ with hikers at Rowardennan, primarily those walking the Ben Lomond Hill Path or the West Highland Way, but also to include any hikers doing other walks local to the area. A total of 76 questionnaires was completed over four days on site.



To add to the questionnaires with hikers, telephone interviews were conducted with businesses and organisations operating in the area who have regular contact with the hikers. This included organisations in the following sectors: accommodation, visitor management, transport, travel companies, and land management. The aims of the interviews were to find out:

- What they know about tree health and plant biosecurity.
- What they already do in relation to biosecurity e.g. what information and facilities they provide.
- Whose role they think it is to address issues relating to biosecurity.
- What role(s) they would be able to play in terms of providing information and equipment.

Six interviews were completed with key informants over the winter 2018/2019.

#### Findings and recommendations

- Levels of awareness of tree pests and diseases, and the role of hikers in dispersing them through the countryside, was found to be low.
- There was a lack of awareness of the need to clean boots and other equipment for reasons related to biosecurity.
- Concern about the issue of tree pests and diseases was expressed by the questionnaire respondents but largely because they were being questioned about it.
- Awareness of the 'Keep it Clean' campaign was very low and most respondents who said they had heard of it were certain that it was about not leaving litter in the countryside.

To raise awareness, and encourage and facilitate behaviours, a biosecurity engagement campaign needs to be designed around the values, motivations and concerns of the target audience (in this case, hikers passing through areas where *P.ramorum* is known to be present). The campaign then needs to be disseminated and communicated through information sources and organisations that people trust and utilise, and in locations where people will observe and note the messages. Alongside this the campaign needs to ensure that the required actions and behaviours are not inconvenient for people to carry out. This study has provided considerable evidence to address all of these points.

#### **1.** Design messaging that links to peoples' values and motivations.

Design messaging that emphasises how scenery and wildlife will be impacted by tree diseases such as *P. ramorum*.

# **2.** Frame messages that link to the environmental threats that people are aware of and concerned about, for example:

- Visitor impacts The spread of tree pests and diseases can be framed as another visitor impact.
- Climate Change Climate change could increase the likelihood of new diseases and pests. This could be used as a message for biosecurity engagement.
- Loss of biodiversity Loss of biodiversity could occur as a result of tree pests and diseases. This could be used as a message for biosecurity engagement.

#### 3. Use peoples' motivations for boot cleaning to encourage better biosecurity.

People who clean their boots do so for one of two reasons – for cleanliness or to protect and prolong the life of the boots. By connecting biosecurity action messages to these



motivations for cleaning, it may be possible to more successfully increase positive biosecurity in hikers.

#### 4. Take advantage of the fact that many people are regular hikers.

The results showed that many people walk frequently. This should be positive for an engagement campaign since it means there is ample opportunity for people to be confronted with messages and biosecurity equipment.

# **5.** Address the misconceptions and misunderstanding of the `Keep it Clean' campaign.

Reconsider the 'Keep it Clean' slogan and add direct reference to trees and diseases in the slogan headline.

#### 6. Provide information through sources and organisations people already use.

People get information about the environment and about plants and trees online. Conservation organisations were mentioned as trusted sources they use to find out about trees and plants.

#### 7. Provide biosecurity information where people say it would be useful.

Respondents wanted to see information at the start of trails, along trails, at carparks and places such as the Rowardennan toilet block. They also wanted information to be online and in the press. It is important to note that information on its own is unlikely to lead to behaviour change, and other findings from the study suggest that placing information where there are lots of additional signs and messages (such as car park and toilet block) may not be the most impactful because of 'information overload' (point 9 below).

#### 8. Tailor messages to different 'stages' of peoples' walks.

Tell people what actions to take before setting off, what actions to take along the route, and what actions to take at the end of the walk.

# 9. Avoid adding biosecurity messages at locations where multiple posters, signs and messages are on display.

Biosecurity messages will get lost amongst other messages and signs if placed where there are a lot of other signs and information notices. This links back to point 7 and suggests the need to consider location carefully, even when people indicate where they think it would be most useful to locate messaging.

# **10.** Use online information sources aimed at overseas visitors to Scotland as communication vehicles.

Accessible walking locations such as Rowardennan are popular with overseas visitors and they are keen to know about issues such as biosecurity when they visit particularly as they may not exist at their home locations.

#### **11.** Provide biosecurity equipment where people say it would be useful.

People want to be able to access cleaning equipment (for boots etc) at carparks. They also want equipment at the start of routes, at points along hiking routes, at visitor centres and locations like the toilet block building at Rowardennan. It would be of value



initially to install some biosecurity equipment in the locations people referred to and monitor usage before largescale installation at many locations.

#### 12. Remember the importance of social norms.

People are positively influenced by the opinions and actions of their friends and families, and by seeing other people performing behaviours. Thus changing the behaviour of one individual may have a wider influence on the behaviours of others. In order to understand whether this is happening with regard to biosecurity a more indepth studies of influences and influencers would be informative.

#### 13. Businesses and organisations have an important role to play.

Businesses and organisations would welcome more information being provided for them to help them inform their customers and visitors about issues around biosecurity.

There is willingness to provide the necessary biosecurity equipment for hikers, such as brushes, boot scrapers and taps. In a number of cases, such facilities are already provided (but not for biosecurity purposes) and it was felt important to be able to add information and interpretation in order to raise awareness and encourage use.

Businesses and organisations provided a range of suggestions for how to disseminate information about biosecurity to their customers and visitors, including through existing correspondence with customers, their website, marketing publications, and strategically placed signs and posters.



# 1. Introduction

## 1.1 Tree pests and diseases

The trees of Britain face increasing challenges from a range of potentially damaging plant pests and diseases, most of which have been accidently introduced from overseas. In their native habitats and ecosystems these invertebrates and pathogens may cause few problems, as they have a natural niche in their established environments and are in balance with other species around them. However, in new environments some of these imported organisms can be fast-spreading and damaging to native and established species and habitats as there are none of the same environmental or biological controls which are found in their native environments elsewhere in the world<sup>1</sup>. One such introduced pathogen is *Phytophthora ramorum (P. ramorum*).

*P. ramorum* is a fungus-like pathogen which is particularly damaging to economically important larch trees (*Larix* species) and some other species associated with woodlands. It was first detected in the UK in 2002 and it is believed that it was introduced to the UK via international horticultural trade. Larches can succumb very quickly to *P. ramorum*, and produce extremely high levels of infective spores, which can be spread widely from tall trees by wind and moist air currents. Where they fall to the ground they can be further dispersed in mud and soil on footwear, tyres and animals (Forestry Commission Scotland, 2017).

A growing recognition of the impact of introduced tree pests and diseases highlights the need to explore all possible means of dispersal, and measures to limit or prevent such 'pathways' where possible. Tree pests and diseases can be transported between or within countries via a number of pathways, including:

- Live plant and tree products, such as potted plants;
- Timber and wood packaging materials (WPM), such as shipping crates and pallets;
- Dirty tools, kit, machinery and vehicles, such as chainsaws, boots and all-terrain vehicles;
- Soil and organic material, such as leaf litter;
- Natural methods, such as wind and water<sup>2</sup>.

The interest in this study is in the spread and dispersal of pests and diseases, specifically *P. ramorum*, through the countryside once they have established. One potential means of dispersal is the presence and movement of recreationists, including hikers. Hence there is a need to engage these groups in positive biosecurity behaviours for tree health.

Studies have found a connection between recreationists and tourists, and the presence of pests, pathogens, non-native invasive species, seeds, and weeds in the environment (see, e.g. Cushman & Meentemeyer, 2008; Turton, 2005; Buckley et al, 2004). These

<sup>&</sup>lt;sup>1</sup> <u>https://www.gov.uk/government/collections/tree-pests-and-diseases</u>

<sup>&</sup>lt;sup>2</sup> <u>https://www.gov.uk/guidance/prevent-the-introduction-and-spread-of-tree-pests-and-diseases</u>



studies provide evidence demonstrating how recreationists, such as hikers, can be instrumental through their outdoor activities in spreading unwanted species that can be damaging to environments such as forests (Hall et al, 2018). When asked, the public, including hikers, express a high level of willingness to take action related to biosecurity (Urquhart et al, 2017; Young, 2006; BP&A and Auckland Council's Research, Consultation and Engagement Team, 2013) – however, this is likely to be dependent on good levels of awareness and understanding, a degree of concern about the issue, and a lack of personal cost (time, effort and financial), such that the perceived benefits of action outweigh the perceived costs (Hall et al, 2018).

# 1.2 Rowardennan

### 1.2.1 Phytophthora Ramorum at Rowardennan

First found in Scottish plant nurseries in 2002 and in gardens and parks in 2007, *P. ramorum* is causing extensive damage and mortality to larch trees and other plants in (mainly) the west of Scotland where it is generally wetter. In 2010, it was found on Japanese larch at a site on the Craignish peninsula in western Scotland (Forestry Commission Scotland, 2017). In 2011, further sites of infection were detected on Mull and at several locations in Dumfries and Galloway. Since then the disease has spread to a number of new, relatively localised sites with the exception of south west Scotland where particularly favourable weather conditions in 2012 led to a major surge in the scale and intensity of infection<sup>3</sup>. In 2017 *P. ramorum* was detected in larch trees at a Forestry Commission site at Rowardennan on the shores of Loch Lomond (figure 1).

<sup>&</sup>lt;sup>3</sup> https://scotland.forestry.gov.uk/supporting/forest-industries/tree-health/phytophthora-ramorum



# Hikers and biosecurity



#### Figure 1: Location of Rowardennan

Following the detection of *P.ramorum* at Rowardennen, Forestry Commission Scotland has undertaken a number of related actions. A large area of larch trees has been felled alongside the Ben Lomond hill path and a number of posters put up along the path to highlight the issue of the disease and provide some information to hikers (figures 2 & 3).



# Hikers and biosecurity



Figure 2: 'Tree killer' poster

www.forestry.gov.uk/keepitclean Figure 3: `What's happening here' poster

In addition, a dry rubber mat has been placed across the path (figures 4 & 5) and a hand brush is provided at the start of the track. Additional items such as a feather banner, posters and postcards for the 'Keep it Clean' campaign have been placed in and near the toilet block at Rowardennan carpark.



Figure 4: Mat information poster



Figure 5: Type of mat in place on Ben Lomond Hill Path

To evaluate this on-the-ground biosecurity messaging and equipment, Forestry Commission Scotland commissioned Forest Research to conduct a social science study with hikers and organisations at Rowardennan in 2018. This report presents the results from that study.

### 1.2.2 Aims of the study

Following the literature review (see appendix 7) the aims of this study are to add to the scant literature on hikers' knowledge and awareness of, and attitudes towards, tree health and biosecurity, and to inform interventions designed to encourage positive biosecurity behaviours for tree health among visitors to the countryside.

The detailed aims of the research are to establish:

- What hikers know, what they think and what they do in relation to biosecurity and tree and plant health.
- Who and what information sources hikers use and trust for finding out about issues relating to the environment and plants and trees.
- What facilities and resources hikers would require to be more 'biosecure' and where they would like these to be.
- What organisations in the area know about tree health and plant biosecurity.
- What organisations in the area already do in relation to biosecurity what facilities they provide, what information.
- Whose responsibility organisations in the area think it is to address issues relating to biosecurity.
- What role(s) organisations in the area would be able to play in terms of providing information and equipment.

Following this introduction, the report is divided into ten sections. Section two describes the approach taken to carry out the research and analyse the data. Following that there are six sections that contain the results from the questionnaires, in the following order:

- Section three: Details about the respondents;
- Section four: Hikers' values, perceptions, concerns and knowledge;
- Section five: Preferred information sources and trusted organisations;
- Section six: Biosecurity behaviours;
- Section seven: Effectiveness of current biosecurity messaging and campaign;
- Section eight: Suggestions from the respondents about what would help them to engage with biosecurity behaviours to help prevent the further spread of *P. ramorum* and other tree diseases.

Section nine presents the results from the telephone interviews with businesses and organisations. Two final sections (Sections ten and eleven) present discussion of the findings, key messages and recommendations for future biosecurity engagement programmes.



# 2. Method

# 2.1 Questionnaire design, delivery and data analysis

A short questionnaire was designed that could be completed face to face with hikers at Rowardennan, primarily those walking the Ben Lomond Hill Path or the West Highland Way, but also to include any hikers doing other walks local to the area (see Appendix 1 for the full questionnaire). The questionnaire featured 26 questions, and was designed to take no more than 10 minutes to complete. Questions were mostly closed with response options provided for hikers to select. In most cases, however, the option was provided for respondents to suggest other answers if their own choice or opinion was not listed. There was also a small number of open-ended questions giving respondents the opportunity to express their own thoughts and views entirely unprompted and unguided. The questionnaire design was underlaid by the framework shown in figure 6 which demonstrates that questions covered topics such as values, attitudes, knowledge, information sources and behaviours, as well as standard socio-demographic questions and questions about their walk on the day. The review carried out by Forest Research as part of this study (Appendix 7) identified a number of recurring principles for stakeholder engagement from the literature. These are:

- Build engagement programmes around the interests and motivations of the stakeholder target group.
- Where necessary utilise trusted information sources and organisations to communicate the programme to the intended stakeholders.
- Ensure that any required behavioural change or adoption of new behaviours is supported by the necessary infrastructure so that stakeholders feel able to adopt the required actions without additional cost (time, effort or financial) to themselves.

These principles require understanding of the interests and motivations of the target stakeholder group, knowledge about where they look for information and who they talk to and trust, and information about what infrastructure and facilities they would require to engage with the required actions. Thus it is these principles that informed the design of the question framework shown in figure 6, and subsequently the design of the questionnaire.



# Hikers and biosecurity



#### Figure 6: Framework behind questionnaire design

Questionnaires were carried out at Rowardennan over four days in August 2018 covering two week days and two days at the weekend in order to capture a selection of different socio-demographic groups (figure 7). There were two surveyors for all four days. The questionnaire needed to be carried out during the peak summer months as walking in the area tends to be seasonal.



# Figure 7: On site at Rowardennan, with the Ben Lomond hill path and West Highland Way in the background

On completion of the four days of data collection, the data was entered into IBM SPSS V19. Analysis consists of descriptive statistics (frequencies) and some thematic analysis of the qualitative data from the open-ended questions and free text responses.



# 2.2 Number of completed questionnaires and on-site weather conditions

A total of 76 questionnaires was completed over four days on site. On three of the four days the weather conditions were wet and so likely had an impact on the number of people out walking (table 1).

	or questionnun es una meather		
Day of the week	Number (percentage) of questionnaires	Weather conditions	
	compicted		
TUE	18 (24)	Rained on and off most of the day	
WED	17 (22)	Rained on and off most of the day	
SAT	29 (38)	Dry and sunny all day	
SUN	12 (16)	Rained heavily all day	
Total	76 (100)		

#### Table 1: Number of questionnaires and weather conditions on the day

# 2.3 Telephone interviews with businesses and organisations in the area

An interview schedule was developed (Appendix 2) to help structure the telephone interviews with businesses and organisations working in the area around Rowardennan, all of whom have regular contact with the hikers and walkers who visit. The interview schedule included questions on the following themes:

- Background information about the business or organisation. This included details of how long they had been in operation in the area, the number of customers/visitors they received throughout the year, and the proportion of these that were walkers or hikers.
- Background information about the role of the interviewee within the organisation or business. In particular, this focused on their contact with the hikers/walkers.
- Their views about the key environmental issues in the area.
- What they know about the issue of tree pests and diseases in the area, about the problem with P. ramorum in the area, and the Keep it Clean campaign.
- The relevance of biosecurity to them and their organisation or business.
- What their customers or visitors ask about environmental issues, if anything.
- What information they provide about environmental issues in general, and tree health and biosecurity in particular.
- If not already provided, what information materials they would be able to provide, what media this could be through, and what support they would need in order to provide this information to their customers or visitors.
- Information about the ways in which their organisation or business currently communicates with customers/visitors.



- What equipment or facilities they currently provide that could be used for biosecurity for hikers (e.g. boot cleaning equipment like mats, boot scrapers, brushes, and taps).
- If nothing is currently provided, what boot cleaning equipment they could provide, and what support they would need in order to do this.
- What networks they have in the area with other businesses and organisations that could provide a forum for sharing information and updates about tree health issues.
- Any other suggestions about how businesses and organisations could be better supported to engage with the issue of biosecurity, and thereby help their customers and visitors to engage.

The interview was designed to take between 30-45 minutes.

A stakeholder mapping exercise was conducted to identify businesses and organisations operating in the area, in the following sectors:

- Accommodation
- Tour and travel companies
- Visitor management
- Land management
- Luggage transfer
- Transport

Stakeholder mapping produced a list of 20 potential interviewees. Six of these were subsequently deemed not relevant, for example, because their location was too far from the area of interest. Fourteen potential interviewees were contacted.

Six interviews were completed during the winter of 2018/19. A category of business absent from the interviews was the luggage transfer companies who proved to be difficult to get hold of. This was most likely because they are, in many cases, one self-employed person with a van, who may not have considered the topic of relevance to them. Future research could seek to find other ways to engage with them.

All interviews were digitally recorded, transcribed in full and imported into NVivo (version 8) for coding using the coding framework (table 2).

Parent node	Child node	No. of transcripts containing data coded to this node	No. of text extracts coded to this node
Contact with hikers	Numbers	6	17
	Means of contact	6	10
Environmental issues in the area		6	13
	Questions about environment	6	9

#### Table 2: Coding framework and items coded to each node



Biosecurity information	Current information provision	4	15
	Future potential provision	6	16
	Avenues for communication (business to customer)	3	6
	Networks for engagement (business to business)	5	9
Biosecurity equipment	Current provision	5	6
	Future potential	5	14
	Barriers to providing and using equipment	3	4
Support needed by businesses		5	8
Awareness of		6	18
biosecurity, tree			
diseases, P Ramorum			
Background - history of		6	7
business in the area		_	
Responsibility for		6	10
biosecurity			

The results from the interviews with businesses and organisations are presented in chapter nine, following the results from the questionnaires with hikers.



# 3. The questionnaire respondents

## 3.1 The questionnaire respondents

The majority of the questionnaire respondents were in the 16-35 age range (68%, n=52) (figure 8). Fifty nine percent (n=45) were working full-time, with 24% (n=18) in full time education (figure 9). Fifty seven percent (n=43) of respondents were male, 43% (n=33) female.











Fifty four percent (n=41) of respondents stated that they live in the UK (figure 10), and 46% (n=35) live overseas in 18 other countries (table 3). Of those, 15 respondents were from Germany and five were from France.



Figure 10: Residential locations of UK-based questionnaire respondents (based on partial postcode data)

Country	No. of respondents	Country	No. of respondents
Germany	15	Canada	1
France	5	Czech Republic	1
Malaysia	3	Finland	1
Austria	2	Israel	1
Denmark	2	Italy	1
Ireland	2	New Zealand	1
Netherlands	2	Switzerland	1
Australia	1	Thailand	1
Belgium	1	USA	1

#### Table 3: Countries of residence of overseas questionnaire respondents

## 3.2 How many hikers were walking the different paths?

Thirty four percent (n=26) of questionnaire respondents were about to start the Ben Lomond hill path, 29% (n=22) were returning having walked up Ben Lomond, and 33% (n=25) were walking the West Highland Way. The remaining 4% (n=3) were doing shorter local walks. Data has been provided by Forestry Commission Scotland from people counters on the Ben Lomond Hill Path and the West Highland Way near Rowardennan for each of the four days the surveyors were on site. This is provided in table 4.

#### Table 4: People counter data

Date	Ben Lomond total - people counter	Ben Lomond ascent - people counter	Ben Lomond descent - people counter	West Highland Way - people counter
Tue 14 Aug 2018	42	6	36	168
Wed 15 Aug 2018	141	65	76	265
Sat 25 Aug 2018	1066	469	597	180
Sun 26 Aug 2018	143	59	84	108



# 4. Hikers' values, perceptions, concern and knowledge

## 4.1 Walking habits

Most of those questioned were regular hikers, with 22% (n=17) stating that in the last 12 months they had visited the countryside for walking every week, and another 39% (n=30) stating once or twice a month (figure 11).



Figure 11: Frequency of walking in the countryside

Eighty five percent (n=65) were walking with other people (friends, family, partner or with a group). On average people were in a group of 2.4 (this average excludes two questionnaire respondents who were walking with a large charity group of 30 people). Forty three percent (n=33) of the total respondents were walking with friends. Fifteen percent (n=11) were walking on their own.

## 4.2 Motivations for walking

Respondents were asked what were their reasons for wanting to do their walk. The option most frequently selected was "To see the scenery" (75% (n=57) of respondents selected this) (table 5). They were allowed to select more than one option.

The options have been recoded to be used as proxies for peoples' values, as follows:

- The options "To see the scenery" and "To see wildlife" have been recoded as 'Environmental values'.
- The options "To spend time with other people" and "For charity" have been recoded as 'Social values'.



- The options "For health reasons" and "To get some exercise" have been recoded as 'Health values'.
- The options "For a personal challenge" and "To visit somewhere new" have been recoded as 'Achievement values'.

Eighty percent (n=61) of respondents were motivated by at least one of the environmental values, and 25% (n=19) of these selected both environmental values. Sixty two percent (n=47) were motivated by at least one of the achievement values, and 9% (n=7) of these selected both achievement values. Fifty one percent (n=39) were motivated by at least one of the health values, and 4% (n=3) of these selected both health values. Thirty three percent (n=25) were motivated by one of the social values. Overall, it can be said that the environmental values were most commonly highlighted.

#### Table 5: Reasons (motivations) for walking, and underlying value categories

Reason	Value category	Number (percentage) of respondents who selected this option
To see the scenery	Environmental	57 (75)
To get some exercise	Health	31 (41)
To visit somewhere new	Achievement	28 (37)
For a personal challenge	Achievement	24 (32)
To spend time with other people	Social	21 (28)
To see wildlife	Environmental	20 (26)
For health reasons	Health	10 (13)
For charity	Social	4 (5)

## 4.3 Perceived threats to the countryside

Respondents were asked what they thought were the biggest threats to the countryside. The two threats selected most frequently by the respondents were 'Visitor impacts' (70% (n=53)) of respondents selected this), and 'Climate change' (46% (n=35)) (table 6). Again, they were allowed to select more than one option. Of the topics of direct interest to this study, 18% (n=14) selected 'Pests and diseases in the environment' and 11% (n=8) selected 'Non-native, invasive species'. Twenty percent (n=15) thought that 'Forestry activities (eg planting, felling)' were one of the biggest threats to the countryside.

Table 6. The ats to the countryside	
What do you think are the biggest threats to the countryside?	Number (%) of respondents
Visitor impacts	53 (70)
Climate change	35 (46)
Loss of biodiversity	25 (33)
Development	19 (25)
Forestry activities	15 (20)
Pests diseases	14 (18)
Agricultural practices	12 (16)

### Table 6: Threats to the countryside



Water pollution	10 (13)
Extreme weather	9 (12)
Invasive species	8 (11)

## 4.4 Concern about the threat from tree diseases

Questionnaire respondents were asked how concerned they were about the threat to trees from pests and diseases, on a 10 point scale from 1 ("Not at all concerned") to 10 ("Extremely concerned"). The average score from all 74 respondents who provided an answer to this was 5.98. (Two people said they did not know enough about the topic to answer this question). However, many people made it clear that before the questionnaire began they would have said they were not concerned because they did not know it was a problem. It was after being asked a number of questions about the topic that they were starting to realise it was a problem and hence something they should be concerned about.

## 4.5 Knowledge and awareness of tree pests and diseases

### 4.5.1 Self reported knowledge

Twelve percent (n=9) of respondents claimed to have a "Reasonable level of knowledge" of tree pests and diseases. A further 59% (n=45) said they had a "Small amount of knowledge". Twenty nine percent (n=22) admitted they had "No knowledge". However, when asked if they could name any tree pests or diseases only 34% (n=26) were able to do so. Some of the pests and diseases mentioned by respondents were: Dutch Elm Disease (mentioned by 10 people) and Ash Dieback (mentioned by two people plus three others mentioned 'Ash' but did not recall the name of the disease). There were also a number of pests and diseases given in their native languages. These included: "Borkenkaefer" (bark beetle); "Birkenspinner" (Birch moths); Buchsbaumzunsler (The Boxwood Cinder (Cydalima perspectalis) Box tree moth); "Champignon de l'hetre" "Eichen-Prozessionsspinner" (Armillaria, and (Thaumetopoea Honey Fungus); processionea, OPM). Also, there were others where people mentioned a pest or disease so had some awareness but did not know the name. These included the disease that is affecting the Plane Trees along Canal du midi in France, a disease that affects sweet chestnut, and a pest or disease in Israel that attacks the Date Palm.

#### 4.5.2 Awareness of Phytophthora

Only 13% (n=10) of the respondents said they had heard of *P.ramorum* and these were either people who had just returned down the Ben Lomond Hill Path and had seen the posters, or who recalled something broadcast on Scottish media (TV or radio). Of those who said they had heard of *P.ramorum*, 60% (n=6) had just returned down the Ben Lomond Hill Path.



# 5. Information sources used and organisations trusted by hikers

## 5.1 Information about environmental issues

The majority of respondents said they got information about environmental issues online (91% (n=69)). They were allowed to select more than one source. Thirty seven percent (n=28) said they got information through the TV, 36% (n=27) through social media, and 32% (n=24) from other people including friends, family and colleagues. All other sources were selected by less than 25% of respondents (table 7).

Where do you get information about environmental issues?	Number (%) of respondents
Online	69 (91)
TV	28 (37)
Social media	27 (36)
Friends, family, colleagues, neighbours	24 (32)
Magazines	18 (24)
Radio	17 (22)
Newspapers	16 (21)
Posters	10 (13)
Events	6 (8)
Post	5 (7)

#### Table 7: Where do hikers get information about environmental issues?

Information sources not listed in the response options that were mentioned by the questionnaire respondents are listed below (table 8) and include specific publications and organisations that people referred to.

### Table 8: Other sources of environmental information mentioned by respondents

#### Information about environmental issues – Where else do people get this from?

PUBLICATIONS Academic journals Scientific magazines Books In the news Nature magazine Greenpeace magazines Trail magazine Town and Country magazine

#### ORGANISATIONS



National Trust
SNH
Friends of the Earth
Greenpeace

#### TV PROGRAMMES

Countryfile Springwatch Programmes like Planet Earth and Blue Planet

#### OTHER

Events through university Forums Online (specifically Google) Search engines Through work - works for Environment Agency

## 5.2 Information about plants and trees

There was an open-ended question asking where they would look or who they would ask if they wanted to find out something about plants or trees. These responses have been subjected to thematic analysis and the emerging themes are listed in table 9. The figures in column two represent the number of mentions of each theme or source. The Forestry Commission and Google were mentioned most frequently. However, it should be borne in mind that questionnaires were being conducted at a Forestry Commission site which may have influenced peoples' responses to this question.

#### Table 9: Where do hikers go for information about plants and trees?

Source of information about plants and trees	Number of times mentioned
Forestry Commission	8
Google	8
Online (no specific website or organisation mentioned)	5
Bund (German organisation for plants and nature)	5
People they know	4
WWF (or the German equivalent WNF)	4
Books/field guides	3
NABU (Nature And Biodiversity Conservation Union) (environment	3
association in Germany)	
National Trust	3
RHS	3
Greenpeace	2
Australian National Parks foundation	2
Farming organisations	2



# Hikers and biosecurity

Sustainable city organisations	2
Other sources or organisations mentioned once (see Appendix 4 for full list)	13



# 6. Biosecurity behaviours of hikers

## 6.1 Cleaning footwear

Twenty four percent (n=18) of the questionnaire respondents said that they had cleaned their footwear before starting the walk that day. The reasons given for cleaning boots before the walk generally fell into two categories: One was to keep the boots in good condition and for their longevity; the second was for cleanliness (table 10). One person said "because of the signs" (the 'Keep it Clean' posters at the campsite).

#### Table 10 : Reasons for cleaning boots before the walk that day

To protect the boots	For cleanliness
Always do - general cleaning - for longevity of boots	Cleaned at end of yesterday so as not to get dirt in the B&B
Before came to Scotland, for water proofing, so they last longer	Like clean footwear
Habit of cleaning - for boot longevity	Muddy
Keep shoes in better condition	They were very muddy
To keep in good condition	To get the mud off
Waterproofing.	Remove mud.
These are new (so want to look after them).	To make them look cleaner. Anti-bacterial.

As for the reasons given for not cleaning boots before the walk that day, these also fell into two categories: One was because the boots/shoes were new; the second group of reasons was because they looked clean already.

Only 17% (n=13) of the questionnaire respondents said they "always" clean their footwear between walks at different locations. The majority, 63% (n=48), said they did this "sometimes", and reasons given were usually associated with how muddy their boots were. Eighteen percent (n=14) said they "never" clean their boots between walks.

## 6.2 Using mats

Thirty two percent (n=24) of the respondents said they had seen mats that day for cleaning their boots on. Eighty three percent (n=20) of these were people who were returning having come down the Ben Lomond hill path and thus had walked over the mat that was lying across the path by the felled larch trees. The others were West Highland Way hikers and one person setting off up the Ben Lomond Hill Path, who had seen mats elsewhere including in a shop doorway and at the campsite where they had stayed. These were not necessarily mats provided specifically for biosecurity purposes. Twenty six percent (n=20) had used mats somewhere that day (they were not asked to specify where), hence only four people who had seen mats did not use them. Reasons given for not using them were that their boots were clean.



# 7. Effectiveness of biosecurity messaging and 'Keep it Clean'

## 7.1 Recall of information on posters

While 45% (n=34) of respondents stated that they had seen posters about tree pests and diseases (mostly on the Ben Lomond path), only 25% (n=19) were able to correctly remember some detail of the messages on the posters. The comments were a mix of messages about the disease (five comments), the reasons for felling the trees (seven comments), and the instructions to hikers about cleaning footwear etc (13 comments). The messages that people recalled are listed in full (verbatim) in table 11.

Table 11: what people recalled about information on tree disease posters			
Comments about disease (5)	Comments about felling (7)	Comments about actions for hikers (13)	
Tree disease	On trail. Tree felling and why- for Ramorum, and result ie felling	Movement of disease on boots and paws	
Affects larch	Larch require felling	Clean boots when leaving	
Tree killer	Impressed with the information. Reasons for cutting down the larch. Doesn't look nice so it's good that it's explained.	Clean shoes on mat to avoid spread	
Latin name - spreads through different forests	Trees got infected, needed to fell	Wash shoes, pets, backpacks	
Explaining that trees affected by disease	Trees removed to control spread of disease	Wipe feet to prevent disease	
	Explanation of felling and disease	Wipe your feet so you don't spread tree pests and diseases	
	Explanation of felling and disease	Clean boots Clean shoes Boot cleaning It (the tree disease) is because of people, from different peoples' boots It is "us", people transmitting diseases with our shoes Be careful with shoes, dogs, bike Rub shoes on mat	

Table 11: What people recalled about information on 'tree disease' posters

However, table 12 highlights that some were unable to recall anything specific or provided an incorrect comment.

Table 12: What could people remember about the posters?		
Nothing specific recalled	Incorrect	



Didn't read it carefully	Green sign with green triangle. Tree inside triangle.
Didn't read them	Seen posters for ticks
Didn't really read them just saw them	Ticks
Nothing	
Not very much	
Remembers seeing the posters but not the message	
Possibly saw it but didn't read	
Nothing particular. Saw signs about environment	
Saw FC banner. Keep it clean (no detail recalled)	
Saw one at Sallochy	
Yesterday – saw sign at Balmaha visitor centre	

# 7.2 Keep it Clean

Similar to the results about stated knowledge of tree diseases and ability to name any (section 4.5), 57% (n=43) of respondents said they had heard of the 'Keep It Clean' campaign but only 8% (n=6) correctly stated what it is and what advice it gives. The majority were certain that the campaign was about not leaving litter in the countryside, using bins or taking litter away with you, and this encompassed comments about staying on paths, not starting fires, and leaving no human trace behind. There were comments from 25 people who were all certain that the campaign is about not leaving litter. These responses were not related to any information in the vicinity. Thus only six people were able to correctly state that the campaign was about removing mud, and cleaning shoes, bikes, and dogs, to avoid spreading the mud (full comments are included verbatim in Appendix 3).



# 8. What would help hikers take positive biosecurity action?

## 8.1 Information, advice, evidence

Respondents were asked what would assist or encourage them to take positive action to help prevent the spread of tree pests and diseases through the countryside – they were able to select more than one option. Seventy nine percent (n=60) said that more information about the problem would help, and 54% (n=41) selected 'advice about what to do or what not to do', as a walker. In addition, 18% (n=14) said that evidence of the role of hikers in spreading pests and diseases would help, and 8% (n=6) wanted biosecurity information about specific locations they wanted to visit (table 13). Among the additional, unprompted, comments that were made at this point in the questionnaire were the following:

"Information is key - inform and people will act"

"Information needed particularly for overseas visitors"

"Need to know consequences of diseases to make more inclined to do something. Get people excited about a place and give the incentive to get involved. Tell a story - getting outreach and engagement with public. Not extra signage necessarily" "Better positioning of signage"

There was also an open-ended question asking where people wanted to see more information. These responses have been subjected to thematic analysis yielding the following results. (Figures are the number of times each type of location was mentioned by a respondent). (The full list of comments is included in Appendix 5).

•	Along trails, at start of trails	19
•	At carpark, toilet block	19
•	Online / Social media	16
•	In the press / media	10
•	At accommodation	9
•	Information centres	7
•	On maps	2
•	Other physical locations	6

## 8.2 Infrastructure, equipment

In terms of practical support, equipment and infrastructure, 53% (n=40) wanted to see cleaning equipment at carparks, and 21% (n=16) selected `cleaning equipment at accommodation and catering outlets' (table 13). There were also many free text comments from people about the need for equipment at the start of routes, at points



along hiking routes, at visitor centres and locations like the toilet block building at Rowardennan (see Appendix 6 for full list of comments).

# 8.3 Social norms

One of the other options that people could select was "seeing other people act". Thirty two percent (n=24) said this would encourage them to take action (table 13). Given that almost a third of the respondents selected this optionit highlights the importance of 'social norms'<sup>4</sup>, albeit it was the fourth most frequently selected.

 Table 13: What would help hikers to take action to prevent spread of tree diseases?

What would help or encourage you to take action?	Number (%) of respondents
Information about problem	60 (79)
Advice about what to do / not to do	41 (54)
Cleaning equipment at carparks	40 (53)
Seeing other people act	24 (32)
Cleaning equipment at accommodation / catering	16 (21)
Evidence of role of hikers	14 (18)
Biosecurity information about location I want to visit	6 (8)

<sup>&</sup>lt;sup>4</sup> Social norms are certain behaviours in a particular group, community, or culture which are accepted as 'normal' and with which people in that group are expected to conform. <u>https://www.simplypsychology.org/social-roles.html</u>



# 9. Telephone interviews with organisations and businesses

## 9.1 The organisations and their customers

Organisations<sup>5</sup> had been in operation in the area for between six and 69 years (the individual responses were: 6, 7, 15, 23, 40, 69).

The number of customers/visitors they receive and the approximate proportion of these who are hikers or walkers is shown in table 14.

#### Table 14: Number of customers and proportion of them who are hikers

Type of organisation	Number of customers/visitors	Proportion of them who are hikers/walkers
Accommodation	10 per night maximum.	Majority. 85%.
Tour company	500 on WHW per year.	All.
Accommodation	97 per night maximum. 12,000 per year.	Majority.
Accommodation/ visitor management	160-180 per night maximum.	100% in summer during the week. 50% at weekends.
Transport	130,000-140,000 per year.	Minimal but increasing every year
Visitor management/ land management	120,000 per year.	In the summer, 70-80% are walkers. In the winter, 90% are walkers.

Interviewees described a range of ways in which they were in contact with the hikers and walkers, as follows:

- Interacting with customers face to face
  - Meeting guests / Working in reception / Welcome point for people
- Offering services
  - $\circ~$  Eg. hiring fire-pits and selling wood for the fire-pits
- Visitor management
  - Reminding people of the rules of the campsite / Enforcing the bylaws
- Education groups
- Communication via email and phone calls
  - Managing bookings / Dealing with customer enquiries
- Marketing

<sup>&</sup>lt;sup>5</sup> Throughout these results the word 'organisation' is used for all interviewees. All results are anonymised so the results present generic messages and findings to inform future engagement activities. Due to the small number of interviews this is essential to protect identities of individuals.



o Promoting walking trails / Marketing in activity publications and website

The following quote illustrates the engagement one interviewee has:

"When we're out on patrol, you're on the West Highland Way. You're passing through places... you're passing the walkers. The walkers are passing you and you're speaking to them mainly about the camping legislation or the camping management legislation".

## 9.2 Key environmental issues in the area

#### 9.2.1 Litter

When asked what they thought were the key environmental issues in the area, a number of the interviewees talked about problems connected to litter. This was related to people having barbecues and leaving all their waste behind afterwards. It was also related to illegal camping by people (not walkers) who set up camp for an overnight party and again, leave all their waste behind when they leave. Concerns about littering also extended to problems with fly-tipping of larger items such as TVs. However, one of the interviewees noted that the impacts of a lot of the littering was largely visual and localised. While acknowledging that this was definitely a negative issue, particularly for local people, the interviewee was of the opinion that "wildlife learns to cope with that" and added "there are other things that you can't necessarily see going on" that are more serious environmental issues, in terms of impacts on wider habitats.

#### 9.2.2 Over-use

Other issues raised by the interviewees were in regard to the numbers of visitors to the area. This was viewed as leading to various problems including "cars parked everywhere" and degradation of tracks and paths in the area. In addition, it was felt that there is inadequate infrastructure for the volume of usage, such that waste management was not sufficient for the numbers of people.

### 9.2.3 People not staying on designated trails

Another concern was raised about needing to make sure that people do use the designated, waymarked tracks and not stray off into undergrowth and woodland causing damage to these areas. Hence the over-riding concern in this case was to make sure the environment is protected for all hikers to use.

### 9.2.4 Illegal campfires

Illegal campfires was also mentioned as being a concern.

### 9.2.5 Tree health

Only one of the interviewees mentioned tree health at this stage of the interview, saying:

"There's the whole thing about ash dieback and Phytophthora ramorum being in the area and how that either got here or spread".



# 9.3 Knowledge of tree pests and diseases in the area and the Keep it Clean campaign

Next, interviewees were asked what they know about tree pests and diseases, and then specifically about the problem with *P. Ramorum* in the area. Responses depended on the organisation they were from, with those from the land management organisations being aware of the problem because they had received various alerts, emails, presentations and so on. Other interviewees either stated that they knew very little or nothing, or commented that they only knew what they had found out when given posters and postcards by the Forestry Commission. One person commented he remembered seeing the mat on Ben Lomond the last time he walked up there, but that was unconnected to his business or professional role.

Similarly, there was virtually no knowledge of the 'Keep it Clean' campaign from those not in the land management organisations. The exception was one person who recalled that it was mentioned on the posters they were given to put up for customers to see. One interviewee, similar to the responses from the hikers, questioned if it was about littering.

### 9.4 Is biosecurity relevant to their organisation?

As an issue, biosecurity is considered relevant to the interviewees from the land management organisations as it forms part of their environmental management and protection roles (or that of their colleagues). In other cases, interviewees felt it was important, to the extent that their business interests are built on the quality and attributes of the natural environment, and anything that threatens that also threatens their business. However, one individual commented that it was an interest to himself but he could not say whether it was considered by his employer.

### 9.5 Responsibility for biosecurity

The question of responsibility for biosecurity elicited a range of responses. Some believe it is the responsibility of the landowner, the "guardian of the land", and land managers. Others noted that individuals, the hikers, should take responsibility for themselves. However, in both these cases it was stated that more information is needed from 'experts' to inform people about the problem and what they need to do. "There needs to be some kind of information or education role on it to come from the specialists".

Others were of the opinion that all the businesses who rely on the area have a responsibility to help protect the environment there, even if that sense of responsibility is driven by commercial self-interest. One person commented:

"At the end of the day, I think our belief, in our team, is that we all benefit from the outdoors so we feel we have a responsibility to, kind of, improve it." "it's part of our duty, I suppose – duty of care, that we should do that".

Some were also conscious that they, as the organisations in regular face to face contact with hikers, have a role to play in relaying messages to the public.


#### 9.6 Do visitors ask about environmental issues?

Responses generally demonstrated that customers and visitor do not often ask about anything to do with environmental issues in the area. As one of the accommodation providers said, most of the conversations with walkers and the questions they ask are about where they can eat that night or where they can get replacement boot laces and other practical issues. Interviewees who could recall questions about the environment commented that this had been about environmental change ("*why have these trees been felled?*") and where they might be able to see wildlife such as red squirrels. In other cases the comments from interviewees were "*it's quite rare we get specific questions about it*" and "*It's not a specific topic that comes up directly with ourselves*".

#### 9.7 Information provided for customers

#### 9.7.1 Information about environmental issues

The organisations that interviewees work for do provide information about environmental issues. The examples they gave included providing information on their website, providing information packs to customers, through social media, and having materials such as posters and information panels on site. The kind of information being communicated was either about the sustainability principles of the organisation or educational materials and activities about the environment.

#### 9.7.2 Information about tree health and biosecurity

Some of the interviewees noted they had been provided with posters and postcards about *P.ramorum* at Rowardennan, and displayed these for their customers and visitors to see. Thus, these posters and postcards have been distributed in the area, and are found at various locations where hikers could come across them. As a result, some of the interviewees noted that they had been asked occasional questions by visitors and guests, who had read the information on the postcards and wanted to know more. However, interviewees stressed that this was only a handful of people.

For those organisations not currently providing information about *P.Ramorum* and the biosecurity messages connected to that, there was willingness expressed to do this in future, if materials were to be provided, and information passed on by the Forestry Commission. Interviewees also had some ideas about how best to communicate with hikers. This included:

- Using existing notice boards,
- Leaflets in bedrooms in accommodation,
- On the trails themselves,
- Using information packs sent out to customers,
- On 'useful information for visitors to Scotland' sheets,
- In the same location as any biosecurity equipment provided for public use (see below),
- In education packs for school groups,
- At transport points such as ferry landing stages that are used by hikers,
- In B&B information folders,



- At ticket offices,
- In publications such as the West Highland Wayfarer,
- On interpretation boards in visitor information centres, and
- In toilet cubicles.

In terms of where not to place information, the following quote was stated:

"You've got more chance there of getting it across [on the BL Hill path] than down in the clutter that is the visitor centre at Rowardennan, at the building at Rowardennan".

There were also suggestions about the nature of the information, interpretation and messaging that could be provided. In particular, it should be specifically relevant to the area and the current problem, rather than a generic biosecurity message. Also, it needs to be 'fun', perhaps using cartoons, rather than the type of message that gives instructions or tells people what they should or should not do.

Some of the relevant comments from interviewees are:

"It needs to be immediate and 'in the now- So, I think a sign that says, "We have tree disease here. Please don't take it anywhere else. Wash your boots," is going to have far more effect than the 'just in case' scenario".

"I think if we put a notice up saying, "Tree disease in Rowardennan. Please don't spread it. Wash your boots before you leave, or else," we're more likely to get people to do it".

"In Finland ... they just use massive signs, that must be about well above A0 size and they've got cartoons. It was a wee girl, leading a mammoth for a walk but it was to keep your pets under control. That makes a bit of fun out of it and folk aren't thinking, 'all you do is tell me what to do".

When asked about the Keep it Clean campaign, those who are aware of it had various comments, in particular that it needs to be clearer and more obviously about tree diseases.

"The campaign must be clearer. It needs to hook people and explain it much more succinctly and less subtly. Like I say, that design is very clever and a lovely design, but it's too clever".

"The other thing is that for all it's a clever poster, it doesn't really catch the attention. That kind of splat and the blue, and there's not enough interpretation to get to the public, to go 'look at this one, not look at the rest, look at this'. I don't think... I certainly don't think that poster does that. It doesn't go 'look, look look this is what I'm talking about'. It's not one that makes you go 'what's that all about? So, you need something that really grabs".

"... I would say that people are not exactly aware of what has to be cleaned. I think people don't see that it's about tree diseases, and don't understand what has to be cleaned, and what else... So, I believe that, yes, it could be clearer".

Finally, interviewees were keen to state that there needs to be "a little bit more, yes, communication with local operators to facilitate any information that needs to be put across to people in the area. Because obviously, we're in more direct contact than, I guess, they are". Hence, they are aware of the role they could play.



#### 9.8 Biosecurity equipment

Some of the interviewees with premises in the vicinity noted that facilities were already available for visitors to clean their boots, for example, taps and brushes. However, none of these were promoted as being related to biosecurity behaviours and none of the interviewees were able to report having seen anyone cleaning their boots.

Those interviewees not currently providing any such equipment were open to the idea but felt it would be important for the equipment to be provided together with interpretation and information. At one of the locations the interviewee suggested they could run a mini-campaign for a short period of time with someone in place to offer to clean hikers boots, and thus promote awareness of the issue in that way. Another suggestion was to target one of the local inns where many people go on their way through.

When asked if they thought people would use such equipment the feeling was that "*If it was prominent enough and the information was clear as to, … what it was for, then there would be a lot of people that would*". This belief was connected to the view that many of the walkers do care about the environment and are well aware of environmental issues, often more so than 'the general public'.

In terms of potential barriers to use there was a comment that some people might be concerned about damaging their boots if using disinfectant solutions. There was also a comment that such solutions would have to be guaranteed natural products. Other potential barriers to use were related to the fact that at the end of the day, the West Highland Way walkers are generally tired, often cold and wet, and just want to shower and have some hot food. It was thought under this scenario people might be more likely to use boot cleaning equipment the next day before setting off again.

As the provision of cleaning equipment requires the use of land there were some comments about land ownership and the fact that that could restrict what can be provided, where organisations are not the land owner themselves.

#### 9.9 Networks

Finally, the interviewees were asked what networks they engaged with in the area that might provide a forum for exchanging information and updates about tree health and biosecurity, when required. The list of networks provided is as follows:

- Association of Independent Tour Operators.
- Wild Scotland.
- Federation of Small Business (although interest in the topic might be limited to very few members in the sectors where it may be relevant, eg tourism).
- Destination group within the National Park.
- Love Loch Lomond, which has a lot of accommodation provider members.
- National Park Access Forum.
- West Highland Way Race Organisation.
- Local walking groups.



#### 9.10 Summary

- Businesses and organisations in and around Rowardennan would welcome more information being provided to them to help them inform their customers and visitors about issues around biosecurity.
- There is willingness to provide the necessary biosecurity equipment for hikers, such as brushes, boot scrapers and taps. In a number of cases, such facilities are already provided and it was felt important to be able to add information and interpretation in order to raise awareness and encourage use.
- Businesses and organisations provided a range of suggestions for how to disseminate information about biosecurity to their customers and visitors, including through existing correspondence with customers, their website, marketing publications, and strategically placed signs and posters.



# 10. Discussion

# 10.1 Hikers' views, understanding and attitudes in relation to tree health and biosecurity

In line with previous studies (e.g. Urquhart et al, 2017; Fuller et al, 2016), levels of awareness of tree pests and diseases, and the role of hikers in dispersing them through the countryside, was found to be low. In addition, there was a lack of awareness of the need to clean boots and other equipment for reasons related to biosecurity. Hikers expressed some concern about the threat to trees from pests and diseases but many said this was primarily because they were being asked questions about it and so were realising that this was an issue about which they should be concerned.

Awareness of the 'Keep it Clean' campaign was very low and most respondents who said they had heard of it were certain that it was about not leaving litter in the countryside. When people had just descended the Ben Lomond Hill Path and seen the posters, some (but not all) were able to recall some detail of the information, relating to the disease or the reasons for felling or the actions that hikers needed to take for biosecurity.

# 10.2 How can the results inform interventions designed to encourage positive biosecurity behaviours?

#### 10.2.1 Values

In line with the recognised principles for stakeholder engagement (as summarised in the review in Appendix 7) interventions designed to encourage positive biosecurity behaviours by hikers should draw on an understanding of the values and motivations of the target audience. This study has provided considerable information about these.

The results show that, regarding peoples' motivations for hiking, environmental values were the strongest underlying values. In particular people were hiking because they wanted to see the scenery and to see wildlife. Hence, designing messaging that emphasises how these will be impacted by tree diseases such as *P. ramorum*, could help people connect with the issue and the actions required.

There were three environmental threats that concerned more of the respondents. These were visitor impacts, climate change and loss of biodiversity. All three of these threats could be linked to the problem of tree health and used in messaging.

1. Visitor impacts – The spread of tree pests and diseases can be framed as another visitor impact. The respondents were generally thinking about visitor impact in terms of cars, litter, and numbers of people, but 'the spread of tree diseases' could be added to the narrative of 'visitor impacts' and used in messaging.

2. Climate Change – As this is viewed as a threat to the countryside by many people, messaging could be linked to this issue. For example, the argument can



be made that climate change could increase the likelihood of new diseases and pests.

3. Loss of biodiversity – Messaging could emphasise that loss of biodiversity could occur as a result of tree pests and diseases. On the topic of biodiversity it has been claimed that an effective framing of biodiversity issues needs to reflect everyday stories about nature and humanity that are already circulating in the society (Simon Christmas Ltd, 2013). This could provide useful lessons to follow here.

In all cases, the purpose here would be to present people with messages about an issue with which they are familiar and that concerns them and connect to that. However, focussing solely on negative issues or threats can make people feel defensive, powerless, and apathetic in the face of a problem that is too big and too difficult to tackle (Simon Christmas Ltd, 2013). Therefore, in any biosecurity messaging that uses the threats with which people are familiar the focus needs to be on the positive actions that people can take.

Further, the results from this study provide some evidence that could be used to present messages about boot cleaning. Results have shown that generally people who clean their boots do so for one of two reasons – either for cleanliness or to protect and prolong the life of the boots. By connecting biosecurity action messages to these motivations for cleaning it may be possible to more successfully increase positive biosecurity in hikers.

The results showed that many people walk frequently. This should be positive for such an engagement campaign since it means there is ample opportunity for people to be confronted with messages and equipment.

#### 10.2.2 Knowledge

As reported, there is a lack of knowledge of the problem. It has been widely demonstrated that simply providing information does not lead to action<sup>6</sup>, however, this is still an important part of the engagement process, especially when awareness is so low.

The results highlighted that there is a high degree of misconception and misunderstanding about the 'Keep it Clean' campaign. The connection that people most commonly made was with 'litter' (possibly because of other campaigns such as 'Keep Britain Tidy' and 'Keep Scotland Beautiful'). Part of the problem could be that the slogan makes no direct mention of trees or diseases.

<sup>&</sup>lt;sup>6</sup> The information deficit model assumes that the gap between 'experts' and the public is a result of a lack of information or knowledge, and that the remedy is a one-way communication model where information flows from experts to publics in an effort to change individuals' attitudes, beliefs, or behaviours. The deficit model has been highly criticised for being overly simplistic and inaccurately characterising the relationship between knowledge, attitudes, beliefs, and behaviours, particularly for politically polarised issues (Brianne Suldovsky, 2017. The Information Deficit Model and Climate Change Communication, Climate Science. Oxford Research Encyclopedias).

http://climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-301



#### 10.2.3 Information

This study has gathered considerable evidence about where people access and search for information about environmental issues, and trees and plants. It also provides results about where people say they would like to see information about tree pests and diseases and biosecurity messages. All of these results could be used in the design of biosecurity engagement programmes.

Overwhelmingly people stated that they get information about the environment and about plants and trees online. Also, conservation organisations were mentioned as trusted sources they would use to find out something about trees and plants.

For information about biosecurity, people were keen to stress that this needed to be at the start of trails, along trails, at carparks and places such as the Rowardennan toilet block. Online and in the press were also mentioned by some. Previous work on communication with countryside visitors about ticks highlighted the importance of, not only message content and suitable media, but also the different messages appropriate at different times (O'Brien, 2017). Specifically, the tick and lyme disease communication framework suggests how to influence specific actions and behaviours at different points (in this case, post countryside visit, post tick bite, and post infection (Quine et al, 2011). This approach could be considered with regard to hikers and biosecurity behaviours, for example, advice about actions to take before setting off, actions to take along the route, and actions to take at the end of the walk. This approach could be related to the places where people wanted to see more information (e.g. at the start of trails and along trails) and suggests the need for slightly different advice depending on location.

It is worth emphasising that much of the current information does not appear to be working well. For example, the feather banner and postcards at the carpark and toilet block appeared not to be noticed by anyone doing the questionnaires even when standing next to them. However, the posters alongside the path, by the felled area and next to the mat were more impactful (though not with everyone ). Possibly the problem at the carpark and toilet block is that there is a lot of other information, multiple signs, posters, and leaflets etc.

In addition, the inability to recall details and messages even when having seen the signs suggests these are not resonating with some people. This emphasises the need to use different messages that need to be appropriately framed using the results above about motivations, values and interests. Following a larger study it might be possible to segment hikers based on their values thus enabling targeted messaging.

One final point about information is that the sample contained a large proportion of hikers of other nationalities who were visitors to Scotland. However, it also makes it clear that the target of any biosecurity information campaign needs to be international. Hence any online sources aimed at overseas visitors to Scotland could be useful communication vehicles.



#### 10.2.4 Biosecurity equipment

More than half of the questionnaire respondents wanted to see cleaning equipment (for boots etc.) at carparks. There were also many comments from people about the need for equipment at the start of routes, at points along hiking routes, at visitor centres and locations like the toilet block building at Rowardennan. This emphasises how important it is to make the required action as easy as possible for people by providing the equipment and facilities needed and placing them at locations suitable for them. Such actions minimise the cost people have to pay, in terms of time, effort and perceived inconvenience, which is important as an activity that is perceived as inconvenient will potentially impact peoples' enjoyment. For example, a study in New Zealand found that 14% of respondents to a questionnaire about Kauri dieback disease stated that the prevention actions affected their enjoyment of the areas they visited because of the inconvenience of cleaning (BP&A and Auckland Council's Research, Consultation and Engagement Team, 2013).

#### 10.2.5 Role of social norms

Nearly a third of the respondents thought it would help to see other people cleaning boots etc. This stresses the importance of social norms in behavioural change and habit forming. The more places where there is the necessary equipment the more 'normal' it will become for people to use it and the more people use it, the more people realise they should be doing this too because it is "what good hikers do". One short term option following installation might be to have volunteers and any on site staff in place at regular times to be seen using the cleaning infrastructure. Also, the majority of hikers were walking with other people, hence it is a social activity for many. Thus the role of 'important others' and what they think and do is likely to be highly relevant. This is illustrated by data collected in the USA relating to the 'Don't Move Firewood' campaign to prevent the spread of Emerald Ash Borer by campers moving infected firewood. Findings were that campers were motivated by two important social groups, family and friends, to differing degrees. Nearly 61% of questionnaire respondents agreed that their family wanted them to limit movement of firewood, and 45.4% reported friend-based influence (Diss-Torrance et al, 2018).

# 10.3 The role of organisations in biosecurity engagement with hikers

The businesses and organisations who were interviewed were aware of the potential role they could play in engaging hikers in issues of biosecurity and tree health. However, the organisations themselves require support and information in order to fill this role. Between them the organisations had many suggestions for how to communicate with hikers, what kind of messages and information is needed, and where this could be put in place. One key point from the interviews with businesses is that information and equipment need to go hand in hand.



# 11. Key messages and recommendations

The key messages from this study are:

- Levels of awareness of tree pests and diseases, and the role of hikers in dispersing them through the countryside, was found to be low.
- There was a lack of awareness of the need to clean boots and other equipment for reasons related to biosecurity.
- Concern about the issue of tree pests and diseases was expressed by the questionnaire respondents but largely because they were being questioned about it.
- Awareness of the 'Keep it Clean' campaign was very low and most respondents who said they had heard of it were certain that it was about not leaving litter in the countryside.

To raise awareness and encourage biosecurity behaviours any engagement campaign needs to be designed around the values, motivations and concerns of the target audience (in this case, hikers passing through areas where *P.ramorum* is known to be present). The campaign should then be disseminated and communicated through information sources and organisations that people trust and utilise, and in locations where people will observe and note the messages. Alongside this, the campaign needs to ensure that the required actions and behaviours are not inconvenient for people to carry out. This study has provided considerable evidence to address all of these points and provides the following recommendations:

#### 1. Design messaging that links to peoples' values and motivations.

Design messaging that emphasises how scenery and wildlife will be impacted by tree diseases such as *P. ramorum*.

# 2. Frame messages that link to the environmental threats that people are aware of and concerned about.

1. Visitor impacts – The spread of tree pests and diseases can be framed as another visitor impact.

2. Climate Change – Climate change could increase the likelihood of new pests and diseases. This could be used as a message for biosecurity engagement.

3. Loss of biodiversity – Loss of biodiversity could occur as a result of tree pests and diseases. This could be used as a message for biosecurity engagement.

#### 3. Use peoples' motivations for boot cleaning to encourage better biosecurity.

People who clean their boots do so for one of two reasons – for cleanliness or to protect and prolong the life of the boots. By connecting biosecurity action messages to these motivations for cleaning it may be possible to more successfully increase positive biosecurity in hikers.

#### 4. Take advantage of the fact that many people are regular hikers.



The results showed that many people walk frequently. This should be positive for an engagement campaign since it means there is ample opportunity for people to be confronted with messages and equipment.

# 5. Address the misconceptions and misunderstanding of the 'Keep it Clean' campaign.

Reconsider the 'Keep it Clean' slogan and add direct reference to trees and diseases in the slogan headline.

#### 6. Provide information through sources and organisations people already use.

People get information about the environment and about plants and trees online. Conservation organisations were mentioned as trusted sources they use to find out about trees and plants.

#### 7. Provide biosecurity information where people say it would be useful.

Respondents wanted to see information at the start of trails, along trails, at carparks and places such as the Rowardennan toilet block. They also wanted information to be online and in the press.

#### 8. Tailor messages to different 'stages' of peoples' walks.

Tell people what actions to take before setting off, what actions to take along the route, and what actions to take at the end of the walk.

# 9. Avoid adding biosecurity messages at locations where multiple posters, signs and messages are on display.

Messages will get lost amongst other messages and signs.

# **10.** Use online information sources aimed at overseas visitors to Scotland as communication vehicles.

Accessible walking locations such as Rowardennan are popular with overseas visitors and they are keen to know about issues such as this when they visit, particularly as information about pest and disease threats may not exist at their home locations.

#### 12. Provide biosecurity equipment where people say it would be useful.

People stated that they want to be able to access cleaning equipment (for boots etc) at carparks. They also want equipment at the start of routes, at points along hiking routes, at visitor centres and locations like the toilet block building at Rowardennan.

#### **13.** Remember the importance of social norms.

People are positively influenced by the opinions and actions of their friends and families, and by seeing other people performing behaviours.

#### 14. Businesses and organisations have an important role to play.

Businesses and organisations would welcome more information to help them inform their customers and visitors about issues around biosecurity.

There was willingness to provide the necessary biosecurity equipment for hikers, such as brushes, boot scrapers and taps. In a number of cases, such facilities are already



provided and it was felt important to be able to add information and interpretation in order to raise awareness and encourage use.

Businesses and organisations provided a range of suggestions for how to disseminate information about biosecurity to their customers and visitors, including through existing correspondence with customers, their website, marketing publications, and strategically placed signs and posters.



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# Appendix 1: Questionnaire with hikers at Rowardennan, 2018

#### INTRODUCTION

Hello. I work for Forest Research. Do you have about 5-10 minutes to do a short questionnaire about environmental issues and threats to the countryside?

This questionnaire is part of a project that Forest Research is doing for Forestry Commission Scotland to find out what walkers think about threats to the countryside.

#### First of all I just need to say that:

We don't ask for your name or any contact details so all of the data we collect is anonymous. Ok?

#### SECTION ONE: First we have some questions about your visit here today.

#### 1. Today, are you walking...

A	The Ben Lomond Path (note: out or return?)	С	Doing something else? Please add details
В	The West Highland Way		

#### 2. What are the main reasons you're here today? Select up to three. (SEE SHEET)

А	To spend time with other people	
В	To get some exercise	
С	To see the scenery	
D	To see wildlife	
Е	For a personal challenge	
F	For charity	
G	For health reasons	
Н	To visit somewhere new	
Ι	Something else -	
	Please provide details	

#### 3. Who are you here with? Select one.

Α	Family / partner / friends (circle which one)	
В	Club / membership group / group with a tour guide	
С	On my own	
D	Some other answer.	
	Please provide details.	

#### 4. How many adults are in your group today, including yourself? How many under 16s?

А	Adults		В	Under 16s	
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5. In the last 12 months how often have you visited the countryside for walking? (Stress - not just here but anywhere) Select one. (SEE SHEET)

А	Every week	
В	Once or twice a month	
С	Once every 2-3 months	
D	Once or twice through the year	
Е	Never	
F	Don't know / can't remember	

**SECTION TWO** Next, I'd like to ask you some questions about the environment.

#### 6. What do you think are the biggest threats to the countryside here where we are today? Select up to three. (SEE SHEET)

	•									
Α	Climate	change								
В	Extreme	e weather	events							
С	Loss of	biodiversit	y (plants, ir	sects, bird	s, wildlife)					
D	Visitor i	mpacts (eg	g erosion, li	tter, noise)						
Е	Non-na	tive / invas	ive species							
F	Forestry	/ activities	(eg plantin	g, felling)						
G	Water p	ollution								
Н	Develop	oment (eg	constructio	n of buildir	igs, roads)					
Ι	Pests ar	nd diseases	s in the env	ironment						
J	Agricult	ural practi	ces							
К	Other –									
	Please p	provide det	tails							
7. Trees, forests and woodlands are threatened by a range of pests and diseases.         What is your level of knowledge of this problem? Select one.         No knowledge       Small amount         8. Can you name any tree pests or diseases?         Yes       No         If yes, what?										
9. Have you heard of Phytophthora ramorum?         Yes       No         10. How concerned are you about the threat to trees from pests and diseases - on a scale from 1 to 10 where 1 is 'Not at all concerned' and 10 is 'Extremely concerned' (Circle one number)										
No	t at all									Extremely
cor	ncerned		2	4	-	6	-	0	0	concerned
	1	2	5	4	5	6	/	8	9	10



SECTION THREE: Next are some questions about information on trees and the environment.

#### 11. Where do you get information about environmental issues? Select all the apply. (SEE SHEET)

Α	Online (websites) (inc. online	newspapers, magazines)					
В	Through the post (leaflets, le	tters etc)					
С	On posters						
D	Social media						
Е	Friends/family/neighbours/c	olleagues					
F	TV						
G	Radio						
Н	Newspapers (paper copies)						
Ι	Magazines (paper copies)						
J	At events						
К	Something else?						
	Please provide details						
L	Don't know						
Μ	I'm not interested in environ	mental issues					
12.	For information about plants	and trees which organisatio	ns would you go to? Who would you ask?				
А	Please add details						
В	Don't know						
С	Not applicable to me.						
<b>13.</b> Yes If y	13. Have you seen any signs, posters or information about tree pests and diseases today?         Yes       No         If yes, what can you remember about what they said?						
<b>14.</b> Yes If y adv	14. Have you heard of the campaign 'Keep it Clean'?         Yes       No         If yes, what do you remember about the advice it gives for actions to take?						
<b>SE(</b> cou	<b>SECTION FOUR:</b> We have some questions about actions you might do, connected to walking in the countryside.						
<b>15.</b> Yes	Did you clean the footwear t	hat you're wearing today bei	fore setting out? (If no, go straight to Q17)				

16. If yes, why did you do that?



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<b>17.</b> I al	How often do you clean footw ways do	wear after walking in c	one lo	ocation before walking elsewhere?
(Sp	ace for comments here)			
18.	Have you seen any mats for c	leaning footwear toda	ay?	
Yes		No		(If no, go straight to Q21)
<b>19.</b> Yes	If yes, have you used them?	No		(If yes, go straight to Q21)
<b>20.</b> (SF	If you have seen the mats bu	t not used them, why o	did y	ou not use them? Select all responses that apply.
A	Didn't know what they were	for		
В	Didn't think it was necessary	-		
С	My boots / shoes were clean			
D	Didn't want to			
Е	The mats were too dirty			
F	Didn't think they were useful			
G	Didn't have time			
Н	Someone else was using it		[	
Т	I was distracted (by other peo	ople or dogs or other		
	things going on around me)			
J	Some other reason.			
	Please provide details.			
К	Don't know			

# 21. We need walkers to play a part in stopping the spread of tree pests and diseases through the countryside, for example by cleaning boots and other equipment.

What would help or encourage you to take action?	<b>Select up to three.</b> (SEE SHEET)
--	--

А	Information about the problem of tree and plant pests and diseases				
В	Equipment for cleaning	washing footwear provided at carparks			
С	Equipment for cleaning	washing footwear provided at accommodation and catering outlets			
D	Advice about what hiker	s should be doing and should not be doing			
Е	Evidence of the role of h	ikers in spreading pests and diseases in the countryside			
F	Help finding information about biosecurity at particular locations I might want to visit				
G	Seeing other people taki	ng action to clean their boots, bikes, vehicles, dogs, equipment			
Н	Something else. Please				
	provide details.				
Ι	I won't be doing anythin	g.			
J	Don't know				

#### 22. If more information and advice would help, where would you want to see this information?

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# **SECTION FIVE:** And finally there are a few questions about yourself **23. Where do you live?**

А	If <b>UK</b> , what is the first part of your postcode,	
	for example, EH15, LA5, SW19?	
В	If overseas, which country?	
С	Prefer not to say	

#### 24. Which age range are you? (SEE SHEET)

А	16-35	
В	36-55	
С	56-75	
D	76+	
Е	Prefer not to say	

#### 25. Finally, are you? (SEE SHEET)

А	Working full time (30+ hrs per week)	
В	Working part time (less than 30 hrs per week)	
С	Retired	
D	Parent, carer or home maker	
Е	In full time education	
F	Unemployed	
G	Unable to work because of illness/disability	
Н	Self employed	
I	Other (specify)	
J	Prefer not to say	

#### Please tick the relevant box for gender, and note the date and time of day.

26.	Male	Female	Date	Time of	
				 day	

#### THANK YOU VERY MUCH FOR YOUR TIME. GOOD BYE.



# Appendix 2: Interview schedule – businesses and organisations

Interviewer name	
Interviewee name	
Date and time	
Telephone number	
Organisation of	
interviewee	

#### **Introduction**

Forest Research is conducting research on behalf of Forestry Commission Scotland with hikers and businesses in and around Rowardennan on the topic of tree diseases and biosecurity. We are currently interviewing people from different businesses and organisations who work in and around Rowardennan and have some connection to the hikers in the area.

[Check that the consent form has been completed and returned. If not, then make the interviewee aware that all results from the interviews will be anonymised and there will be nothing in the write up that will identify them or their organisation.]

[Repeat that the interview will be recorded. It should take between 30-40 minutes.]

[Check that they can hear ok. Ask if they have any questions before beginning.]

#### Note for interviewee:

Will need to decide which term is best to use for which interviewee: Guest, visitor or customer, depending on which organisation is being interviewed.

#### Section one: Introduction to business/ organisation and employee's role

1. How long has your organisation or business been in operation in the Rowardennan area?]

2. Approximately how many customers / guests / visitors does the organisation / business have (per year?) Could you say approximately what percentage of those are walkers / hikers?

3. What is your own role in the organisation or business? [And how long have you been in that role? What are your main day to day tasks in that role? Does your own role involve direct contact with hikers? If so can you provide some detail about that aspect of your work?]

#### Section two: Knowledge / attitudes / experience of tree diseases



4. What environmental issues concern you the most in the area around Rowardennan?

5. Do you know anything (or what have you heard) about tree pests and diseases in the area? If so, can you elaborate?

6. Have you heard of Phytophthora ramorum? What do you know about the disease? [What do you know about how it is spread? And about what can be done to prevent it spreading?]

7. Are you aware of the 'Keep it Clean' campaign? Are you aware of the information it provides and the actions it describes?

#### **Section three: Biosecurity**

Biosecurity is the term used to describe the measures and actions we can all take to try to protect the natural environment against pests and diseases.

8. Is biosecurity an issue of any interest or relevance to you and your organisation? [Why/ why not? How? Has anything related to tree health or biosecurity impacted you, your organisation, your work/role at all? Can you provide details?]

9. Whose responsibility do you think it should be to address issues relating to tree health and biosecurity? [What do you think should be the role of government and government agencies, private businesses, landowners, NGOs, the general public, local residents?]

#### Section four: Customers / guests / visitors - Information

10. Do guests/visitors/customers ask about anything to do with environmental issues in the area? [What do they ask? Any examples?]

11. Do guests/visitors/customers ask about anything to do with tree diseases & biosecurity? What do they ask? Any examples?

12. Do you have any information materials about trees diseases and biosecurity available for guests /visitors /customers?

13. If yes, what information? Where and how is this provided? Where did the materials / publications come from? Who supplied them to you? Or did you produce them in-house?

14. Is there anything that would help you to continue providing information and advice about biosecurity and maybe to offer more?

15. If not already provided: Would you be able to provide information and advice for hikers about tree health and biosecurity? If not, why not? If yes, what could you provide? (information on your website, postcards, posters, leaflets, banners?)

16. Thinking about the practicalities, do you have suitable locations to place information materials such as postcards, posters, leaflets, banners? Where might this be?



17. What would help you to offer information and advice about tree health and biosecurity to your customers / guests / visitors?

#### **Section five: Practical actions**

As you may be aware, (or as you know) one of the key pieces of biosecurity advice given to hikers is to keep their boots clean to avoid spreading tree diseases from one location to another.

18. Do you provide any facilities /equipment for cleaning boots etc (for washing, brushing, disinfecting etc)? Boot scrapers, brushes, water, tap, spray?

19. What do you provide? Do people use them? What are the barriers to use?

20. If nothing currently provided: Would you be in a position to provide brushes for cleaning? [and/or washing facilities for boots, pets, vehicles, equipment? mats / bootscrapers? disinfectant for cleaning (spray or mats)? If not, why not?]

21. If yes, where / how would you provide the equipment?

22. What problems or barriers do you think there might be for you and your organisation to providing any of the equipment / washing facilities mentioned? [Maintenance? Space? Cost?] How could these be overcome or avoided?

23. What support might you need to provide facilities/equipment for biosecurity?

24. Do you think your customers would use the cleaning eqiupment if it were to be provided? What might be the barriers to use?

#### Section six: Networks and information

25. Is your organisation / business part of any local networks? [These might be business forums or environmental networks] If so, are tree diseases and biosecurity likely to be issues of interest to the network?

#### Section seven: Final

26. Do you have any suggestions for how businesses / organisations like your own could be supported or encouraged to engage with tree health issues, and in turn help their customers / visitors / guests be more aware and engaged with biosecurity behaviours?

27. Is there anything else you would like to say about this topic?

#### Thank and close



# Appendix 3: Comments about the 'Keep it Clean' campaign

 Remember\_keepitclean

 Correct (6)

 Clean shoes, bike, dogs

 Clean your shoes and pets

 I think I saw signs saying to brush shoes

 Keep boots, paws clean- saw signs at Sallochy campsite

 Today. Remove mud

 Wash dogs, shoes etc to avoid spreading the mud

#### Litter (25)

Associates keep it clean with litter Bin it. Use bins Dispose of all trash. Don't litter countryside Do not litter. Saw signs on Ben Nevis day before Don't leave litter Don't leave rubbish Dustbin in city Leave no trace. Leave as it is. No litter Litter. Keep forest clean. No fires. Stay on paths Litter. Look after environment No litter. Don't leave human traces No litter. No fires. Take it with you. Pack everything and take it out (away with you). Leave only footprints. Poster. Don't leave rubbish. No fires Put rubbish in bin Putting litter in bin Signs on litter bins in city. Associated with waste/ litter Take litter home Take litter home. Don't leave anything. Take rubbish home Take trash back home Take your rubbish with you Taking litter home. Don't make fire. Today. Seen the poster. Don't litter or urinate Website/blog. Don't leave waste / rubbish



## Hikers and biosecurity

#### Can't remember (9)

Can't think where He says no. But his girlfriend says yes and then talks about doing water sports yesterday. Saw signs at lake about water biosecurity. Also talk about take rubbish with you. Saw the sign. Just remember the name and logo. Just recall slogan No No can't remember Nothing Read the signs on the road Today



# Appendix 4: Where do people look for information about plants and trees?

Plants & trees_information_source	
Forestry Commission.	8
Google.	8
Online.	5
Bund. German organisation for plants and nature. "German Federation for the Environment and	5
Nature Conservation". NGO. Bund. German organisation for plants and nature. "German	
Federation for the Environment and Nature Conservation". NGO.	
Daughter . Mum. A friend who has great knowledge. A friend.	4 (people they
	know)
WWF. WNF - WNF is World Nature Fund in Dutch and is actually WWF.	4
Books. Peterson field guides. ID books	3
Nabu. NABU (Nature And Biodiversity Conservation Union), is one of the oldest and largest	3
environment associations in Germany.	
National Trust .	3
RHS	3
Greenpeace.	2
Australia National Park foundation and local councils. Australian National Parks	2
Some sort of Farming support organisation. Bauernkammer - organisation for farmers	2 regional
	farming
	organisations
Munich - Green City (Sustainability organisation) . Sustainability organisation called City Tree.	2 sustainable city
(in Israel)	initiatives
Delachaux - Online field guides	1
An ID app - unsure whether FC or Woodland Trust	1
Forest Stewardship Council	1
Kew gardens	1
Mountaineering Ireland	1
SNH	1
South West Lakes Trust	1
VisitScotland.	1
Woodland Trust.	1
German bird protection	1
Scientific papers	1
Wikipedia.	1
Lions Club.	1



# Appendix 5: Where do people want to see more information about tree health and biosecurity?

Where\_more\_information

ALONG TRAILS, AT START OF TRAILS (19) Along long distance routes at checkpoints Along the route At entrance, start of hike At beginning and end of path Start of trails. On the trail at beginning Starts of walks. Strategic points along walks. Rescue points along walks. For people doing reverse of Ben Lomond Path - i.e. going up the Ptarmigan path In entry points to trails At the start of the track. Information boards at start. Signs along the path. Put on trail posts. Needs to be front and centre. Between carpark and start of walk. On the trail. Posters on site. Before going on walk. Seeing management in action and reasons and effects Signs at start of WHW - really "in your face". Start of the walk Throughout- when doing the walk. AT CARPARK, TOILET BLOCK (19) At carpark and visitor centre. Leaflets and maps. In this centre (The Rowardennan toilet block) Signage at carpark Car park .. Carpark Carpark. Carpark / loos. Set-off points Carpark. Toilets. On panel in carpark

On site. Starting point at carpark



Posters. In the carpark Signpost. Car park Displayed in carparks Starting and finishing points. Carpark This place (Rowardennan carpark building). Like this place. We are wild campers so places like this (the toilet block / shelter at Rowardennan. When entering a certain area. At small spots inside the park. Location like this (the toilet block at Rowardennan). Information - at points where you stay/stop - eg toilet block, campsite. Need big sign with a "good for nature" message ONLINE / SOCIAL MEDIA (16) Social media. Social media.

Wants information on social media. Information - online, social media. website, Dedicated website Information online Internet Make information available online On the WHW website. And NP website WHW website Online. Info on walking websites, travel websites On walk descriptions - online and in books In the travel guide for WHW

IN THE PRESS / MEDIA (10) Newspapers. Sunday newspapers. Magazines - Scottish magazines. Local newspapers. Radio. Radio Scotland "out of doors" TV for locals. TV adverts. Not posters articles Adverts etc - don't see much about it. That's what's needed. Advertisements for general knowledge. Media - so problem is more talked about.



#### AT ACCOMMODATION (9)

At campsite. At cottage (accommodation) At the hotel Campsites, posters Information, soaps etc at campsites At campsites Signs at B&B Camping sites Information - at points where you stay/stop - eg toilet block, campsite. Need big sign with a "good for nature" message

#### **INFORMATION CENTRES (7)**

Access to info in visitor centres. Spread awareness. In visitor centre. When you ask at the desk about walks to do. Information at visitor centre National Park visitor centre at Balmaha. Information centres, At information points. At carpark and visitor centre. Leaflets and maps.

ON MAPS (2) Pop ups on OS maps On maps.

OTHER PHYSICAL LOCATIONS (6) Info at towns/villages Village centres and shops In outdoor gear shops. Cafes. A small poster, bright and colourful In schools At airport (like NZ).



# Appendix 6: What other suggestions do people have about what would encourage biosecurity action?

Something_else_to_encourage_action			
Boot cleaning station at entrance			
Cleaning equipment and signs along the route			
Equipment at visitor centre			
Equipment before trails.			
Equipment e.g. basin to clean, at carpark			
Equipment on trail itself			
Need equipment on paths			
More mats and more obvious mats. Cleaning shoes is new to me. Not so muddy where I live.			
Want brushes etc. at beginning of path, along the path			
Wants to see equipment on trails but knows can't lay mats everywhere			
Would like equipment so don't have to think about it. Cleaning station and sign			
Wants equipment at campsites.			
At start of walk. Mats. Want disinfectant mats. They talked about the RhineSteig where lots of people walk. Need to			
provide mats and brushes there.			
Equipment at start of walks			
Equipment at starting points			
Equipment (mat) at path junction or fences			
Wants equipment before the start of the hike			
Want equipment at start of walk			



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### Executive summary

The trees of Britain face increasing challenges from a range of potentially damaging pests and diseases, most of which have come from overseas. One such disease is Phytophthora ramorum (P. ramorum) which impacts many woodland species including the commercially important Larch (Larix species) in the United Kingdom (UK). A growing recognition of the impact of introduced tree pests and diseases highlights the need to explore all means of dispersal, and measures to limit such 'pathways' where possible. One potential means of dispersal through the countryside is the presence and movement of recreationists, including hikers. Hence there is a need to engage these groups in positive biosecurity behaviours for tree health. Forest Research conducted a social science study at Rowardennan on the shores of Loch Lomond in Scotland in 2018 to investigate the awareness, attitudes, actions and intentions of hikers in relation to biosecurity behaviours (reported elsewhere). To inform the design of that study, and to add to the available literature on the role of recreationists in spreading pest, diseases and other non-native species through the environment, Forest Research has also completed this literature review. The research team reviewed existing literature relating to four topics.

# **<u>1. The role of recreationists in the introduction and spread of pests, pathogens, seeds, weeds, and other non-native invasive species.</u>**

There are a number of studies that have found a connection between recreationists and tourists, and the presence of pests, pathogens, non-native invasive species, seeds, and weeds in the environment. What these studies have in common is that they provide the evidence demonstrating how recreationists, such as hikers, can be instrumental, through their outdoor activities, in spreading unwanted species that can be damaging to environments such as forests. This highlights the importance of engaging with hikers about biosecurity for preventing the spread of P. ramorum.

# 2. The public, tree health and biosecurity: Knowledge, attitudes, perceptions, willingness to engage, and behaviours.

The reviewed studies generally demonstrate three key points:

- Levels of knowledge amongst the public are generally low this applies to tree pests and diseases, and non-native invasive species. However, there are exceptions, and self-reported awareness in some specific cases can be high. Generally, this occurs when information campaigns have been highly targeted and sustained across years, and where their effectiveness has been evaluated.
- Levels of concern and perceptions of risk are high again, this applies to tree pests and diseases, and non-native invasive species. Again, there are exceptions, for example, in places where the introduction of exotic species is perceived as contributing to sense of place, concern is low. The nature of the non-native species and how it is viewed by those being questioned, is therefore important, i.e. is it viewed as negative or positive?
- Expressed willingness to take action related to biosecurity is high however, this is likely to be dependent on good levels of awareness and understanding, a degree of concern, and a lack of personal cost (time, effort and financial), such that the perceived benefits of action outweigh the perceived costs.



# 3. Principles of stakeholder communication and engagement for behavioural change.

A number of recurring principles for stakeholder engagement are found in the literature:

- Build engagement programmes around the interests and motivations of the stakeholder target group.
- Where necessary utilise trusted information sources and organisations to communicate the programme to the intended stakeholders.
- Ensure that any required behavioural change or adoption of new behaviours is supported by the necessary infrastructure so that stakeholders feel able to adopt the required actions without signicant additional cost (time, effort or financial) to themselves.
- Evaluation of engagement campaigns is important to learn what does and does not work.

#### 4. Effectiveness of behavioural change interventions relating to biosecurity.

The studies reviewed present a mixed picture in terms of the effectiveness of biosecurity engagement campaigns aimed at raising awareness and encouraging new behaviours. However, some evidence demonstrates that the engagement programmes have not increased knowledge or changed behaviours, even when people have been exposed to the campaign information. This suggests that information campaigns need to be better designed and disseminated, drawing on the key principles for engagement outlined above. There are exceptions and some evidence of successful campaigns. Campaigns aimed at USA campers regarding the movement of firewood seem to have had some success at reducing the numbers of campers transporting firewood from home and other places outside of campsites into the areas where they camp. Also, the 'Check, Clean, Dry' campaign in New Zealand is another apparently successful example of an engagement programme. Evaluations of this programme indicate high levels of awareness and self-reported engagement with key biosecurity behaviours promoted by the campaign. A number of conclusions from the 'Check Clean Dry' evaluations about its strengths and reasons for success, are presented here:

- The campaign used regional partnerships but with over-arching national (government) support.
- There were integrated regional invasive species management strategies.
- The campaign used multiple different communications channels with a focus on signs at key recreational sites.
- Biosecurity messaging about actions to take were simple and consistent across sites.
- Cleaning stations were provided at high-risk sites.
- Biosecurity awareness was monitored on an annual basis.
- Evaluation of engagement programmes was key to understanding what worked and what did not work.



# 1. Introduction

#### 1.1 Background

The trees of Britain face increasing challenges from a range of potentially damaging plant pests and diseases, most of which have come from overseas. In their native habitats and ecosystems in other parts of the world these pests and diseases may cause few problems, as they have a natural niche in their established environments and are in balance with other species around them. However, in new environments such as here in the United Kingdom (UK), some of these imported organisms can be fast-spreading and damaging to native and established species and habitats as there are none of the same environmental or biological controls which are found in their native environments elsewhere in the world. One such introduced disease is *Phytophthora ramorum* (*P. ramorum*).

P. ramorum is a fungus-like pathogen which is particularly damaging to economically important larch trees (*Larix* species) and some other species associated with woodlands. Larches can succumb very quickly to P. ramorum, and produce extremely high levels of infective spores, which can be spread widely from tall trees by wind and moist air currents. Where they fall to the ground they can then be further dispersed in mud and soil on footwear, tyres and animals.

A growing recognition of the impact of introduced tree pests and diseases highlights the need to explore all possible means of dispersal, and measures to limit or prevent such 'pathways' where possible. Much of the literature on the spread of tree pests and diseases addresses how new pests and pathogens are introduced to the country. Commonly discussed pathways include the global trade in potted trees and plants, and insects, larvae and eggs that 'hitchhike' in wooden packaging and on vehicles. Another method of spread across borders and into new countries can be wind dispersal. However, the interest in this review is in the spread and dispersal of pests and diseases through the countryside once they have established. One potential means of dispersal through the countryside is the presence and movement of recreationists, including hikers. Hence there is a need to engage these groups in positive biosecurity behaviours for tree health.

Forest Research conducted a social science study at Rowardennan on the shores of Loch Lomond in Scotland in 2018 to investigate the awareness, attitudes, actions and intentions of hikers in relation to biosecurity behaviours (reported elsewhere). Rowardennan is a particularly relelvant location for such a study because of the identification of P. ramorum in larch trees at the site in 2017. Ultimately the aim of the social science study will be to inform interventions designed to encourage positive biosecurity behaviours for tree health among visitors to the countryside. To inform the design of that study, and to add to the available literature on the role of recreationists in spreading pest, diseases and other non-native species through the environment, Forest Research has also completed this literature review. This review therefore informs and complements the empirical research carried out with hikers and local businesses at the study site.



#### 1.2 The review topics

The research team reviewed existing literature relating to the following four topics:

1. The role of recreationists in the introduction and spread of pests, pathogens, seeds, weeds, and other non-native invasive species.

2. The public, tree health and biosecurity: Knowledge, attitudes, perceptions, willingness to engage, and behaviours.

- 3. Principles of stakeholder communication and engagement for behavioural change.
- 4. Effectiveness of behavioural change interventions relating to biosecurity.

The review extends beyond pests and diseases to include the spread of seeds, weeds and non-native invasive species, due to the paucity of available evidence relating specifically to recreationists and tree health. Significant evidence and lessons may be learnt from literature on the role of recreationists in the spread of seeds, weeds and non-native species, particularly in the context of their activities, actions, required behaviours, impacts and approaches to messaging and engagement.

Reviewing literature on these four topics will:

- Demonstrate the role of recreationists in the spread of pests, diseases, seeds, weeds and non-native invasive species in both terrestrial and marine environments.
- Present a snapshot of existing literature that has investigated what the 'public' understand and think about biosecurity and issues around tree health and invasive species.
- Provide a summary of some key principles of stakeholder engagement for behavioural change, thereby helping to inform the social science study design.
- Highlight whether existing behavioural change interventions for biosecurity have achieved the desired changes, and what lessons can be learnt for the current study.

## 2. Method

#### 2.1 Approach used

To search for peer-reviewed and grey literature, the following key words were used in multiple combinations in online literature searches using Google, Google Scholar, ScienceDirect and Researchgate:

- Biosecurity, tree health, tree diseases, tree pests, invasive species, non-native species, alien species, weeds.
- Public, stakeholders, tourists, visitors, recreationists, hikers, tourism.
- Engagement, intervention, programme, 'Keep it clean', 'Check, Clean, Dry'.
- Evaluation.

In addition, the review authors utilised knowledge from within Forest Research and Forestry Commission, and reference lists of relevant papers and reports, to identify further sources.



#### 2.2 Summary of studies reviewed

Table one lists the studies reviewed for each topic, which together total 28 studies. Note that some studies were relevant for more than one of the review topics.

Review topic	Number of studies	Which studies
1. The role of	9 studies including 3	Anderson et al, 2015
recreationists in the	reviews (the 3	Buckley et al, 2004
introduction and spread	reviews covered 247	Cushman & Meentemeyer, 2008
of pests, pathogens,	studies in total)	Gower, 2008
seeds, weeds, and non-		Marzano & Dandy 2012
native invasive species.		Pickering & Mount, 2010
		Rooney, 2005
		Torn et al, 2009
		Turton, 2005
2. The public, tree	8 studies	Anderson et al, 2014
health and biosecurity:		Bardsley & Edwards-Jones, 2006
Knowledge, attitudes,		Fuller et al, 2016
perceptions, willingness		P&A and Auckland Council's Research,
to engage, behaviours.		Consultation and Engagement Team, 2013
		Runberg, 2011
		Urquhart et al, 2017
		Verbrugge et al, 2014
		Young, 2006
3. Principles of	/ studies	Ambrose-Oji et al, 2011
stakeholder		Christmas et al, 2013
communication and		Crompton 2010
engagement for		Kruger et al, 2012
benavioural change.		Lakon, 2010
		Marzano et al. 2013
4 Effectiveness of	Zatudiaa	O brien et al. 2017
4. Effectiveness of	7 studies	Anderson et al. 2014
interventions relating to		Compbell et al. 2017
hiosocurity		Disc-Torrance et al. 2018
Diosecurity.		National Social Marketing Centre, no data
		Runberg 2011
		Verbrugge et al. 2014
		verbrugge et al, 2014

#### **Table 1: Studies reviewed**



# 3. The role of recreationists in the introduction and spread of pests, pathogens, non-native invasive species, seeds, and weeds

#### 3.1 Introduction

There are a number of studies that have found a connection between recreationists and tourists, and the presence of pests, pathogens, non-native invasive species, seeds, and weeds in the environment. What these studies have in common is that they provide the evidence demonstrating how recreationists, such as hikers, can be instrumental, through their outdoor activities, in spreading unwanted species that can be damaging to environments such as forests. This highlights the importance of engaging with hikers about biosecurity for preventing the spread of P. ramorum.

#### 3.2 The studies

Nine studies were identified and reviewed. Three were reviews of evidence and between them they drew on a further 247 studies.

The nine studies covered activities in:

- Terrestrial,
- Marine and
- Freshwater environments.

They refer to:

- Walkers,
- Campers,
- Horse riders,
- Visitor vehicles,
- Cyclists, and
- Water based recreationists such as canoeists and anglers.

The studies are from:

- North America,
- Australia,
- UK,
- Finland, and
- Global reviews.

The inclusion of other recreational activities besides hiking and walking is considered relevant to the current review as it demonstrates how recreational users may contribute to the spread of unwanted plant and pest species into areas where they can cause damage.


# 3.3 Global reviews

Global reviews (Marzano & Dandy 2012; Anderson et al, 2015; Pickering & Mount, 2010) that consider the role of recreation and tourism in spreading pathogens, non-native species, and plant seeds have established that there is evidence of a relationship. In many cases data reveal that the presence of tourists and recreationists corresponds with greater abundance of pathogens, invasive species, and plant seeds. This applies across ecosystems and is found to be the case in forest, other terrestrial, freshwater, and marine environments.

A report from 2012 provided an overview of impacts related to recreational activities in UK forests and woodlands (Marzano & Dandy, 2012). The review found that some activities can introduce harmful species or pathogens into forests via footwear, vehicles and bicycle tyres. The review also revealed that horses can potentially contribute to the spread of invasive or non-native plants or pathogens on their hooves, coat, or via their digestive tract. Some of the studies featured in the review are included in more detail below.

In a systematic literature review published in 2015 authors investigated the potential relationship between tourism and outdoor recreation, and the abundance and richness of non-native species (NNS) (Anderson et al, 2015). They reviewed 32 studies covering terrestrial, freshwater and marine environments. They found that both abundance and richness of non-native species were significantly higher in sites where tourist activities took place than in control sites. This was the case across terrestrial, freshwater and marine environments; across a variety of vectors (e.g. hikers, horses, yachts); and across a range of taxonomic groups of NNS. The majority of the terrestrial studies that they reviewed focused on plants. However, they did include one study which showed that the prevalence of P. ramorum was higher on trails in a Californian National Park than in areas where the vegetation was undisturbed. They concluded that the impact of terrestrial-based recreational activities such as hiking, on other types of non-native species besides plants (such as pathogens and invertebrates), needed further attention.

In another global review of 32 studies from Australia, Europe, North and Central America, and Africa, authors reviewed data on seed dispersal via clothes, cars, horses and donkeys (Pickering & Mount, 2010). They established a global database of records of terrestrial seeds carried on equipment, clothing or animals that might be used for tourism and recreation. The database drew on studies that included seeds of species that were non-native to the continent, seeds from species included in 'A Global Compendium of Weeds' (Randall, 2007, 2009), and seeds from plants that were identified as major invasive plant species internationally by Weber (2003). The data they found demonstrated that seeds from 754 species of terrestrial plants had been collected from the vectors considered. More than 200 seed species had been collected from clothing and equipment (228), and from horse dung (216), and more than 500 seed species had been collected from vehicles (505). A further 42 seed species had been collected from the fur of donkeys and horses. They found eight studies that had focused specifically on tourists, and between them these tourist studies had found 12 species of seed on clothing, 133 seed species in horse dung, and 26 species on vehicles. They concluded that some tourism activities and destinations needed to be subject to control methods to



minimise the risk of tourists acting as dispersal agents. They suggested "simple measures such as cleaning cars, boots and other equipment prior to travelling and before leaving a destination are likely to reduce risks" (p252).

## 3.4 Other studies

In addition to the reviews referenced above there are other relevant studies that are more specific to particular places and contexts, including rainforests and protected areas of Australia, waterways and waterbodies across the UK, a range of recreational activities including hiking in a number of states in the United States of America (USA), and horse riding trails in Finland. Some of these studies addressed the spread and impact of specific pathogens, including *P. ramorum*, but also *Phytophthora cinnamomi* dieback.

#### 3.4.1 Hikers and other recreationists

P. ramorum is not only a threat to larch trees in the UK, but is an invasive pathogen of world-wide concern, which also causes Sudden Oak Death in the USA. Authors have examined the influence of humans and a range of environmental factors on the distribution of P. ramorum in California (Cushman & Meentemeyer, 2008). They found that P. ramorum was more common in soil on hiking trails than in soil from areas away from the trails. They also found that forests on public land open to recreation had a higher prevalence of the disease than forests on private lands that were not open for public recreation. They concluded that it was possible that humans inadvertently tracked P. ramorum on the soles of their shoes and dispersed the pathogen along hiking trails. They noted that there is ample opportunity for the pathogen to be dispersed by hikers along trails, and possibly contribute to long-distance spread.

One paper investigated environmental impacts of tourism and recreation activities in the world heritage listed rainforests of northeast Australia (Turton, 2005). The author described how visitor use in the area was mostly associated with walking tracks, camping areas, picnic and barbeque areas, and off-road vehicle use of old forestry roads and tracks. He identified a wide range of environmental impacts associated with these activities. Impacts included the spread of soil pathogens and weeds, particularly along networks of old forestry tracks and roads, no longer used for forestry work but accessible for recreationists. He reported that the spread of soil pathogens by hikers along walking trails, and by vehicle tyres on old forestry roads, poses a threat to the Wet Tropics World Heritage Area. Of particular concern was the spread of the root rotting fungus, P. cinnamomi, known to cause forest dieback affecting a wide range of species in Australia including eucalyptus. He found a strong association between distributions of P. cinnamomi and the location of old forestry tracks and roads used by recreationists in the area. He concluded that use of long distance walking tracks by hikers, and old logging tracks by off-road enthusiasts, had the potential to spread the P. cinnamomi fungus spores to susceptible areas previously unaffected by dieback.

In a book chapter from a publication about the environmental impact of ecotourism, authors also described the role of tourism and recreation in the dispersal of *P. cinnamomi* dieback in protected areas of Australia (Buckley et al, 2004). They stated that tourism contributes to the dispersal of *P.cinnamomi* dieback by spreading spores,



mycelium and infected plant material, and by changing environmental conditions in ways that increase plant stress. They pointed out that, off-road, spores may be carried on footwear, trail bikes, mountain bikes, horses and four wheel drive vehicles. The authors described how spores can be carried into backcountry and wilderness areas on hikers' boots and camping equipment. In addition, they noted that spores can be carried in mud, soil and water on vehicles belonging to commercial tour operators and private individuals, and can be dispersed along roads and tracks by tourist buses. However, they did not specify the likelihood of these different dispersal methods occurring or the relative severity of impact. Overall, this book chapter discussed how tourism broadly can impact on the spread of a tree disease but did not focus on the particular role of hikers.

#### 3.4.2 Horse-riding

Other types of recreation can also contribute to the spread of pathogens, pests, weeds and seeds. Considering the impact of horse riding on the spread of non-native grass seeds, a study in the USA collected horse hay, manure, and hoof debris samples at horse riding events in North Carolina, Kentucky, Illinois, Wisconsin, and Michigan (Gower, 2008). One sub-sample of material from each horse was sown in pots to determine if they contained seeds from non-native species. A second sub-sample of material from each horse was placed back on the riding trail to determine whether seeds would germinate and become established on the trail. They found that while horse hay and manure did contain seeds of non-native plant species, these rarely became established on horse trails because of the environmental conditions. Horse trails are a highly disturbed system and the frequent disturbance of the soil along heavily used horse trails made it difficult for seedlings to become established.

Another study looking at the impacts of horse riding on trail characteristics and vegetation was carried out in northern Finland (Torn et al, 2009). Widths and depths of trails, and vegetation on trails and in the neighbouring forests, were monitored at two sites during 2001 and 2002. Horse riding trail plots were found to have more forbs (herbaceous flowering plants) and grasses, many of which did not grow naturally in the forest. The authors concluded that these introduced species appearing along the riding trails could change the structure of adjacent plant communities in the long term.

#### 3.4.3 Off-road vehicles

By combining field surveys for seven invasive plant species along two off-road vehicle (ORV) trails, and seed surveys via soil samples taken from the undercarriage of ORVs, one researcher in the USA was able to investigate the impact of recreational vehicles on the spread of invasive species (Rooney, 2005). Vegetation surveys found that four of the seven invasive species occurred along 88% of the 100 m trail sections surveyed. The author concluded that some ORVs dispersed seeds, and because many invasive species have seed traits that predispose them for vehicular dispersal, ORVs can contribute to long-distance dispersal events.

## 3.5 Section summary

The nine studies reviewed here demonstrate how recreationists and tourists across a wide range of activities and in multiple settings can contribute to the introduction and



spread of pathogens and invasive species. While all of this evidence is relevant to the central issue of the associated social science study, this section of the review report is particularly relevant where evidence is presented from the impact of hikers on the spread of pathogens such as Phytophthora. There were three such studies from elsewhere in the world. Overall, the evidence tells us that unintentional pathogen dispersal by tourists including hikers is likely, but further infection and establishment in new areas does not necessarily follow in all cases.

# 4. The public, tree health and biosecurity: Knowledge, attitudes, perceptions, willingness to engage, and behaviours

#### 4.1 Introduction

This section focusses on the small number of studies that have considered the knowledge, views, perceptions and behaviours of the public relating to invasive tree pathogens, forest pests, and non-native invasive species in terrestrial and aquatic environments, in the UK, the Netherlands, Mediterranean islands, north America and New Zealand.

Overall, these studies showed that people have variable levels of awareness of tree pests and diseases, and of terrestrial and water-based invasive species, depending on context, location and issue. Likewise, although levels of concern about introduced species was generally high, there were some instances where the opposite was true, and exotic species introductions were considered in a positive light. Thus levels of concern are strongly related to the nature of the introduced species. A few studies included questions about biosecurity behaviours. Most often these behaviours were cleaning footwear before or after visits to forests, woodland and other rural areas, but also, less commonly, cleaning bike tyres after visits to forests and woodland areas, not bringing plants and wood products into the country from overseas, and buying plants from trusted local sources that are certified as grown in the country. In the few studies that did consider such behaviours there was willingness expressed to engage in positive biosecurity actions, or there already was a good level of reported engagement with biosecure behaviours. However, none of the studies that reported engagement with biosecure behaviours were based on observation of actual behaviours. All relied on self-reported behaviours which might contain a degree of social desirability bias or incorrect recall.

The most relevant studies are those that report results relating specifically to trees pests and diseases, or the behaviours of recreationists in forested areas, and their attitudes to biosecurity (Urquhart et al, 2017; Fuller et al, 2016; BP&A and Auckland Council's Research, Consultation and Engagement Team, 2013; Young, 2006; Runberg, 2011). There are other studies reviewed here which address other groups of recreationists and their attitudes and behaviours towards invasive species in different settings, including non-forested and marine environments (Bardsley & Edwards-Jones, 2006; Verbrugge et al, 2014; Anderson et al, 2014). These are also included as they provide potentially



useful transferable lessons from different contexts, given that the role of recreationists and the mechanisms of dispersal are common across settings and activities, and the need for engagement and communication applies equally in all scenarios.

# 4.2 The UK public, biosecurity, and tree pests and diseases

In a paper based on a British study, authors presented findings from an online questionnaire of 1334 respondents representative of the British public to investigate their awareness and concern in relation to tree pests and biosecurity, and their willingness to adopt biosecure behaviours (Urguhart et al, 2017). They found low levels of awareness and knowledge about tree pests and pathogens, but high levels of concern about the health of trees, forests and woodland. Another nationally representative survey of 2000 people in the UK conducted in 2014 also discovered low public awareness of tree pest and disease threats (Fuller et al, 2016). Respondents to the study reported by Urguhart et al (2017) expressed moderate levels of willingness to adopt biosecure behaviours to help protect tree health including adopting measures to reduce the spread of tree pests and diseases. This involved cleaning footwear and bike tyres after visits to forests and woodland areas, not bringing plants and wood products into the UK from overseas, and buying plants from trusted local sources which were certified as grown in the UK. However, paying more for accredited plants was the biosecure behaviour with the lowest level of willingness to engage, suggesting that cost could be a barrier to action in some situations. Although cost in this instance was financial, it could apply equally to cost in terms of time, effort and perceived inconvenience.

## 4.3 The New Zealand public, biosecurity and tree diseases

Kauri dieback is a fatal disease caused by Phytophthora agathidicida that affects the New Zealand kauri tree (Agathis australis). Auckland Council wanted to find out how much Aucklanders knew about kauri dieback disease, how they thought it should be managed, and how information about it should be communicated by the council (BP&A and Auckland Council's Research, Consultation and Engagement Team, 2013). In total 2,983 completed surveys were received from People's Panellists and there were an additional 94 public responses to the survey. Overall, 82% of survey participants were aware of the disease. When asked about biosecure behaviours, just over half (55%) said they always used cleaning stations when entering a track in a kauri area, and half said they used them when leaving the track. The reason people gave most often for not using the stations was that they had already cleaned their shoes or planned to do so at home. Around one in five said they did not use them because they were not going to be visiting other kauri areas in the near future or they said their shoes already looked clean. In addition to the use of cleaning stations, other behaviours were investigated. Just over half of visitors to these areas said they had stayed off kauri roots (54%) and a third said they cleaned their gear at home (34%) and/or told friends about kauri dieback (32%).

# 4.4 Hikers and biosecurity in Australia

A study in Australia focused on two long distance trails in North Queensland to consider the experience and opinions of hikers on the trails (Young, 2006). The researcher conducted questionnaires, and the hikers were asked, among other things, whether they would use wash-down facilities to prevent the spread of soil-borne diseases if track



management introduced them. Respondents from both tracks were strongly supportive of this. More than 80% of respondents from both tracks agreed that they would use them.

# 4.5 Campers and biosecurity in USA forests

Many insects and diseases that are a threat to forests can be transported inside firewood. A USA study analysed Pacific Northwest campers' practices, values, and knowledge regarding invasive species and firewood. This was conducted through a mixed-method study in 2010 and included two surveys (Runberg, 2011). There were 331 respondents to the first survey, and 308 respondents to the second survey. When presented with multiple definitions, the majority (66%) of respondents to the first survey were able to correctly identify the definition of an invasive species. The majority of survey respondents perceived invasive species as a serious threat to ecosystem functions and more generally to the region as a whole.

## 4.6 Residents on Mediterranean islands and invasive plants

In a paper from 2006, authors reported results from semi-structured interviews with stakeholders about their perceptions of the impacts of invasive plant species on the islands of Mallorca, Sardinia and Crete (Bardsley & Edwards-Jones, 2006). They found substantial levels of concern about the impacts. However, they also found some positive perceptions about species turnover (new species introduction) as it was viewed as being connected to a sense of place. Some respondents were unwilling to support control programs for invasive exotic plants. The authors concluded that this could be because respondents did not recognise the negative impacts of invasive species or because they considered the introduction of exotic species to be an important process on their island. Such a position could represent a barrier to biosecure behaviours, hence the authors emphasise the need to understand stakeholder perceptions before designing any engagement programme.

# 4.7 UK water-based recreationists and invasive species

In another study from the UK researchers conducted an online survey with water based recreationists to investigate their activities and recreational behaviours that could potentially contribute to the spread of invasive non-native species (INNS) (Anderson et al, 2014). They found that 78% of canoeists and 64% of anglers used their equipment or boat in more than one catchment within a fortnight, and that 50% of canoeists and 12% of anglers did so without either cleaning or drying their kit between uses. Furthermore, 28% of canoeists and 8% of anglers had used their equipment overseas without cleaning or drying it after each use. All of these self-reported behaviours could facilitate the introduction and/or secondary spread of INNS in the UK.

# 4.8 Dutch aquarists and non-native species

Researchers interviewed aquarists and water gardeners at garden centres and pet stores in the Netherlands (Verbrugge et al, 2014). Respondents were asked questions regarding their knowledge of, and attitudes towards, non-native species and potential impacts, and about behaviours such as disposal of plant material. They found that the



percentage of respondents who were able to give a correct definition of non-native species was low. An understanding of the role of humans in the introduction of non-native species was also generally lacking. However, about 70% of respondents could give examples of impacts of aquatic invasive plants, including loss of native species, ecological damage and disturbance, and disease risk. Also, there was a high level of concern about the loss of native species or loss of diversity in an area due to the introduction of a non-native species. This, therefore, is another study showing gaps in awareness but a high degree of concern, suggesting the need for appropriately designed engagement programmes that tap into levels of concern and are effective at raising awareness. Section five of this review will provide more detail about how this could be achieved.

#### 4.9 Section summary

Overall, the reviewed studies generally demonstrate three key areas of relevance to the current study.

- Levels of knowledge amongst the public are generally low this applies to tree pests and diseases, and non-native invasive species. However, there are exceptions, and self-reported awareness in some specific cases can be high (for example, BP&A and Auckland Council's Research, Consultation and Engagement Team, 2013). Generally, this occurs when information campaigns have been highly targeted and sustained across years.
- Levels of concern and perceptions of risk are high again, this applies to tree pests and diseases, and non-native invasive species. Again, there are exceptions, for example in places where the introduction of exotic species is perceived as contributing to sense of place concern is low. The nature of the non-native species and how it is viewed by those being questioned is therefore important, i.e. is it viewed as negative or positive?
- Expressed willingness to take action related to biosecurity is high however, this is likely to be dependent on good levels of awareness and understanding, a degree of concern, and a lack of personal cost (time, effort and financial), such that the perceived benefits of action outweigh the perceived costs.

# 5. Principles of stakeholder engagement for behavioural change

# 5.1 Introduction

There is literature on principles relating to stakeholder engagement and interventions designed to facilitate behavioural change that can be of value to this study. These should help to inform the design of engagement processes such as those being implemented at Rowardennan.

Overall, a number of recurring principles are found in the literature:

• Build engagement programmes around the interests and motivations of the stakeholder target group.



- Where necessary utilise trusted information sources and organisations to communicate the programme to the intended stakeholders.
- Ensure that any required behavioural change or adoption of new behaviours is supported by the necessary infrastructure so that stakeholders feel able to adopt the required actions without additional cost (time, effort or financial) to themselves.

These require understanding what the interests and motivations are of the target stakeholder group, where they look for information and who they talk to and trust, and what infrastructure and facilities they would require to engage with the required actions.

# 5.2 Principles from the reviewed studies

Forest Research produced guidelines in 2011 for public engagement in the management of woodlands (Ambrose-Oji et al). The guidelines included some points to be addressed before a campaign can be initiated:

- Establish the reasons for engaging with people (for example, awareness raising, information provision or behavioural change).
- Identify those who have a stake in the programme or those who are the target of it.
- Consider how best to engage each stakeholder or stakeholder group.
- Identify issues and potential conflicts that might affect engagement.

Having clarified the above points an engagement campaign should be designed using a number of key principles found in exisiting literature. The key engagement principles from the reviewed studies that are of most relevance to this study are presented in table two. The text in the following paragraph briefly describes the studies referred to in table two.

One study was found that focused specifically on engaging members of the public in activities related to tree health (Marzano et al, 2013). They identified a number of relevant lessons from other sectors that are included in table two. Forest Research (O'Brien et al, 2017) developed key principles that could be used to guide forestry interventions aimed at achieving behavioural change. Forestry behaviours are diverse and range from activities such as felling and timber harvesting to social, recreational and cultural activities conducted in a woodland or forest setting. They could also include biosecurity behaviours. The Forest Research publication (O'Brien et al, 2017) considered policy interventions in other sectors including health, energy and transport that focused on behaviour and behaviour change, to look for transferable lessons for the forestry sector. This could include those interventions aimed at facilitating positive biosecurity behaviours. Some of the lessons they described are also included in table two. An Australian project called 'Engaging in Biosecurity' developed guidelines for engaging communities in biosecurity for agriculture (Kruger et al, 2012). The project aimed to develop an engagement framework that identified what enables and hinders effective community engagement about biosecurity issues. This was done by profiling six existing biosecurity engagement programmes and conducting four biosecurity engagement trials. A number of principles that address the enablers and barriers identifed through their profiling work and trials are also included in table two. Another review considered literature relating to engaging people in biodiversity issues (Christmas et al, 2013). The review identified a number of factors which could explain different levels of engagement,



and that could therefore be relevant when designing engagement programmes for biosecurity issues. Again, some of these factors feature in table two.

Headline principle for		Points from reviewed studies	References				
en	engagement						
•	Understand the interests, motivations, values and perceptions of those to be engaged. Design engagement programme and communication materials around those motivations etc.	<ul> <li>Messaging should reflect the diverse contexts and interests of the target audience.</li> <li>Tailor messages for each stakeholder group based on their needs and interests so they can understand, 'what's in it for me?'.</li> <li>Understand motivations and values and the things people care about.</li> <li>Understand peoples' risk perceptions.</li> </ul>	O'Brien et al, 2017 Marzano et al, 2013 Kruger et al, 2012 Christmas et al, 2013				
• •	Understand the social and physical contexts of those to be engaged. Design engagement programme, communcation materials, and necessary infrastructure around those contexts.	<ul> <li>Relate to the wider social and physical context of target groups.</li> <li>Social context plays a role in shaping, modifying or driving the individual factors above.</li> <li>Physical context plays a role in behaviour, by prompting or inhibiting certain types of action. For example, how easy is it for hikers to clean their boots in different situations, such as at carparks, hostels, or train stations before setting off on a walk or before heading home?</li> </ul>	O'Brien et al, 2017 Christmas et al, 2013				
•	Understand where and how the target group currently access information relating to related topics such as environmental issues, trees, plants and biodiversity. Design engagement programme around that understanding and utilise multiple communication channels if required.	<ul> <li>Adopt a multifaceted approach at various scales.</li> <li>Effective public engagement will likely involve multiple methods and will require collaboration and coordination across multiple partners.</li> <li>Identify engagement activities and communication tools that will resonate with the stakeholder group.</li> </ul>	O'Brien et al, 2017 Marzano et al, 2013 Kruger et al, 2012				
•	Understand which organisations and information sources the target audience trust, rely on and utilise when seeking information on related topics. Investigate feasilbility of using these trusted intermediaries in communication and engagement.	<ul> <li>Sources providing information and advice need to be trusted by those receiving the information.</li> <li>Channel information through the most appropriate person or organisation that has the respect and trust of the stakeholder group. This might require intermediaries to be involved so these need to be identified.</li> <li>Those seeking to engage the public</li> </ul>	Marzano et al, 2013 Kruger et al, 2012 Marzano et al				
-	programme uses consistent	need to ensure that messages are	2013				



	and persistent messaging.		consistent and that engagement processes have legitimacy with the intended stakeholders.	
•	Be clear about the positive impacts that the required actions will have.	•	Make sure people know what to do, how to do it, and believe they have the ability to do it. Make sure people believe that what they are being asked to do will have an impact. People need a sense of personal responsibility, or a feeling of personal obligation to take action.	Christmas et al, 2013

#### Table 2: Principles for stakeholder engagement

# 5.3 Framing the issue

Framing - the way in which the issue is presented - can be crucial for successful engagement (Christmas et al, 2013). Suitable framing works by tapping into peoples' motivations and values, as well as the other individual and contextual factors referred to in table two. To effectively frame an issue within an engagement programme there is a need to understand and reflect the frames that people have in their own minds. Frames are mental structures through which people understand the world (Crompton 2010). Frames thereby entail a set of values, and work with peoples' values and language. They structure ideas and concepts, shape thinking, and influence perception and actions. Environmental frames are the (typically unconscious) conceptual structures that people have in their minds to understand environmental issues such as biosecurity (Lakoff, 2010). The reason that frames are important for engagement programmes are because words can be chosen to activate frames. This is what effective communicators do. In order to communicate a complex issue, words must be chosen carefully to activate the right frames so that the issue can be understood. Where people lack the necessary background frames, constant effort is required to build up the background frames needed to understand the environmental issue in question (in this case, tree health and biosecurity behaviours). However, that is not a simple, short-term task to be done by a few words or slogans (Lakoff, 2010), but requires in-depth understanding of the motivations, values, attitudes and understanding that lead to the mental frames people utilise.

#### 5.4 Section summary

Key points are:

- An engagement programme must be designed based on an understanding of peoples' motivations, risk perceptions, values, unconscious mental frames, and social and physical contexts.
- People need to understand that the actions required will be useful, valuable, achievable and practicable.
- The engagement programme should be communicated through trusted organisations, individuals and media sources.



# 6. Effectiveness of behavioural change interventions relating to biosecurity

# 6.1 Introduction

There is very little evidence evaluating programmes that have sought to engage with recreationists and other stakeholders about tree health and plant biosecurity in order to increase awareness and change behaviours. The only literature that was identified for this review that related to tree pests and diseases included two studies on the movement of firewood by USA campers, and a study with recreationists in Australia about the spread of a root rotting fungus. There are some lessons to be learned from literatures on invasive species in marine environments, and with aquarists, and specific examples such as an evaluation of the New Zealand version of the 'Check, Clean, Dry' campaign aimed at water users.

The studies reviewed here present a mixed picture in terms of the effectiveness of biosecurity engagement campaigns aimed at raising awareness and encouraging new behaviours. However, some evidence demonstrates that the engagement programmes have not increased knowledge or changed behaviours, even when people have been exposed to the campaign information. This suggests that information campaigns need to be better designed and disseminated, drawing on the key points from section 5 of this review. There are exceptions to this where campaigns have had some success. Campaigns aimed at USA campers regarding the movement of firewood seem to have had some success at reducing the numbers of campers transporting firewood from home and other places outside of campsites into the areas where they camp. Also, the 'Check, Clean, Dry' campaign in New Zealand is another apparently successful example of an engagement programme. Evaluations of this programme indicate high levels of awareness and self-reported engagement with key biosecurity behaviours promoted by the campaign.

# 6.2 Biosecurity engagement in terrestrial environments

An Australian study reported results from research designed to assess the effectiveness of an education programme about an introduced pathogen aimed at recreationists in a national park (Boon et al, 2008). Recreationists were surveyed in 1993 and 2003 to assess the effectiveness of the education programme relating to *P. cinnamomi* (cinnamon fungus), a root rotting pathogen that kills a range of native plants in Australia. The authors reported that over 10 years the percentage of those surveyed who were not aware of the fungus was largely unchanged. They concluded that the education programme was therefore not effective even though people had noticed and read information boards or visitor guides with information about the disease and its impacts. People were found to be supportive of biosecurity quarantine measures when informed of the impacts of the pathogen. However, being exposed to information about a biosecurity issue did not translate into large numbers of people gaining new knowledge and changing behaviours. They stated that the materials that had been provided included good factual information in an easy to read and non-technical way, and were



designed to appeal mostly to reason and intellect. This, they claimed, omitted any attempt to link any emotional component into the messaging, or any cognitive element which might cause the visitor to think about their own role in the problem. They pointed out that the ideas being communicated needed to be important to the recreationists and not merely factual.

Many insects and diseases that are a threat to forests can be transported inside firewood. In the USA it is not uncommon for campers to take their own firewood when they go camping. When campers transport their firewood across borders and ecosystems they can spread invasive species into campgrounds and parks. In response to this risk, the 'Tri-State firewood campaign' was developed to inform campers in three USA states about the risk of invasive species being transported through firewood. The campaign strategy was composed of three communication mediums, which included materials at campgrounds (posters, flyers, playing cards, and Frisbees), roadside billboards, and online materials (www.dontmovefirewood.org, website warnings, and electronic campsite reservation notifications). An evaluation of this campaign was subsequently carried out with campers through surveys conducted before and after the campaign (Runberg, 2011). The objective of this evaluation project was to measure how effective the campaign was at informing campers about the risk of invasive species being transported in firewood. The results indicated that there was an increase in campers' exposure to information about invasive species in firewood as a result of the campaign. However, several knowledge gaps and misconceptions by campers were identified. Exposure to information through the campaign appeared to have no effect on campers' ability to define invasive species, or on their ability to identify specific invasive species, such as Emerald Ash Borer (EAB). It also appeared not to have had any impact on their views about invasive species as a threat to the area, or their beliefs about the impact of invasive species on the environment, recreation, health, economy, or beauty. Nevertheless, nearly two thirds of post-campaign respondents (61%) who had seen information about invasive species in firewood stated that they would change their camping or firewood practices based on the information they had seen. Of the campers who had already changed their camping practices, the majority had adopted new practices highlighted by the messaging from the firewood campaign. For instance, 75% of those campers who stated they had changed their camping practices reported that they bought their firewood where they were going to burn it, which was the slogan of the campaign. The author of the study concluded that, among other things, campaign effectiveness could be improved by providing campers with a list of suitable alternative firewood sources or local firewood dealers in popular camping areas. This point demonstrates the importance of making the biosecurity behaviours easy for people to carry out by providing them with the resources or facilities needed.

In a similar study, another paper focussed on regulator efforts to address challenges presented by dispersal of forest diseases and invasive pests in firewood by campers in the USA (Diss-Torrance et al, 2018). In 2006, in response to the rapid spread of EAB and other invasive forest pests, the Wisconsin Department of Natural Resources (Wisconsin DNR) began regulating firewood allowed by state campgrounds. This regulation was linked to an education campaign designed to dissuade the public from moving firewood for any purpose and to "Buy it where you burn it", as the campaign stated. Postal questionnaires were carried out from 2006 to 2015 at two year intervals.



Their results showed an increase in camper awareness of EAB, from 77% in 2006 to 96% in 2014. There was also an increase in average camper ratings of the threat of invasive species, from 5 in 2006 to 5.73 in 2014 (using a 7 point scale from 1 - 'no threat' to 7 - 'a huge threat'). Likewise campers rated the importance of stopping firewood movement using a 7 point scale (where 1 = not at all important' and 7 ='extremely important'). Average scores in 2006 were 5.53 and in 2014 were 6.29. Overall, this study demonstrated positive change in peoples' stated awareness of an important tree pest, perception of threat of invasive species, and opinions about the importance of stopping movement of firewood. The survey also asked about behaviours. In 2006, 33% of respondents indicated that they took wood from home to use as firewood when camping because they had it at home and wanted to use it. By 2014, the percentage doing so was 10.5%. These results suggest that the Wisconsin DNR had been successful in persuading campers not to bring firewood from home, not to stock firewood at home for use in camping, or both. Campers were also asked "Where do you typically get the firewood you use for camping?". Campers were considered to be compliant with the regulations if they obtained firewood exclusively inside or near the places they camped, or brought only scrap timber left over from home or work projects, an allowable alternative. Data demonstrated that camper compliance with firewood movement rules increased steadily over the study period. The percentage of campers, all of whose sources of wood were compliant, was 44.5% in 2006 and 77.8% in 2014. Results suggested that efforts to reduce firewood movement had been effective. Results from the five questionnaires revealed that compliance improved dramatically in early programme years and then levelled off, suggesting that it may be unrealistic and cost ineffective to strive for 100% compliance and to try to stop all non-compliant firewood movement. It also revealed that persistence in messaging is important in building awareness and motivation. They recommended that managers and educators should refresh the core message periodically to maintain effectiveness.

#### 6.3 Biosecurity engagement in aquatic environments

In a report from New Zealand, authors presented results from research that had investigated aquatic biosecurity (Anderson et al, 2014). They carried out questionnaires with water users and interviews with stakeholders at the Rotorua Lakes on North Island. Questions were asked about biosecurity awareness and actions. They found that public awareness of biosecurity was high in their case study region with 71% of water users having heard of the regional biosecurity campaign. This converted into between 50-60% of recreational water users carrying out three key biosecurity behaviours (check kit, clean kit, dry kit, all after every use). The study authors received a lot of positive feedback about staff at boat ramps providing biosecurity information, and their presence was perceived as having a positive influence on people's awareness of invasive species. This finding suggests that a place-based biosecurity champion might be an effective vehicle for biosecurity programmes.

The National Social Marketing Centre (NSMC) in New Zealand carried out an evaluation of the same 'Check Clean Dry' campaign aimed at recreational water users (NSMC, no date). The annual evaluation survey of the campaign aimed to measure changes in attitudes and self-reported behaviour. The NSMC found that a large percentage of those surveyed (88%) were able to identify an action they had taken to help stop the spread



of an invasive algae (didymosphenia geminata, also known as didymo). They also found that there was a correlation between the campaign outputs and self-reported 'Check, Clean, Dry' behaviours. Most of the people who said they 'always' 'Check, Clean, Dry' (98%), as well as most of the people who said they 'sometimes' 'Check, Clean, Dry' (95%), reported having seen promotional items or received information from the campaign. A wide range of resources, tools and promotional giveaways were developed for the campaign so people could have been exposed to it via many different items and sources. These included biosecurity resources such as leaflets, cleaning station signage, detergent sachets and spray bottles. The branded promotional items designed to increase exposure to the campaign slogan included stickers, pens, water bottles, car bumper stickers, key rings, jelly beans and sunscreen. The evaluation study found a significant improvement in people reporting that they do 'Check, Clean, Dry', with 22% of respondents stating that they were more vigilant than they had been a year ago. The authors reported increases year on year from 2006 to 2009 in the proportions of highrisk freshwater users who stated the following three things: They think about how they can personally stop the spread of didymo; they have taken actions to do so, and; they always make an effort to 'Check, Clean, Dry'. The apparent success of this campaign may be due to the high profile and widespread nature of exposure to the campaign slogan and messages, as well as the provision of practical resources.

In a paper about biosecurity messaging for marine recreationists, authors reported results from a questionnaire carried out in Tasmania (Campbell et al, 2017). They found that exposure to biosecurity messages through education campaigns and material had created awareness of non-indigenous marine species. However, the respondents seemed not to have assimilated this information. They often reported awareness of non-indigenous marine species but were then unable to correctly identify invasive species, indicating a mistaken confidence in their own knowledge. The authors concluded that educational campaigns and messages had not been effective and could result in a false sense of security on the part of the authorities who might believe that marine recreationists were educated about the topic when in fact they could still be contributing to the problem through their actions. This emphasises the importance of evaluating biosecurity engagement programmes.

In another study, researchers interviewed aquarists and water gardeners at garden centres and pet stores in the Netherlands (Verbrugge et al, 2014). Interviewees were asked about the familiarity of a government campaign which used flyers and posters with information about non-native species and the harmful effects of them. Familiarity with the campaign was found to be low, and only a minority recognised the campaign slogan and warning logo about the disposal of invasive species. The authors concluded that the results emphasise that education of the public in relation to biosecurity is not straightforward, and that it is a long term process, especially when it concerns behavioural change. They also reported that part of the apparent failure of the campaign was possibly due to the low visibility of flyers and warning labels.

## 6.4 Section summary

Overall, this section looking at evaluations of biosecurity engagement campaigns tells two stories. On the one hand, a number of campaigns in different countries in both



terrestrial and aquatic environments have not succeeded in raising awareness and changing self-reported behaviours, even when people have been exposed to information. On the other hand, USA campaigns aimed at campers to stop the movement of firewood report some positive achievements, and the 'Check, Clean Dry' campaign in New Zealand appears to have increased awareness and engagement with positive biosecurity actions by water-based recreationists. A number of conclusions from the 'Check Clean Dry' evaluations about its strengths and reasons for success, are presented here as they have relevance for all biosecurity engagement campaigns:

- The campaign used regional partnerships but with over-arching national (government) support.
- There were integrated regional (invasive species) management strategies.
- Tour operators from unaffected areas were given the opportunity to visit areas impacted by invasive species.
- The campaign used multiple different communications channels with a focus on signs at key recreational sites.
- Biosecurity messaging about actions to take were simple and consistent across sites.
- Cleaning stations were provided at high-risk sites.
- Biosecurity awareness was monitored on an annual basis.
- Evaluation of engagement programmes was key to understanding what worked and what did not work.

# 7. Conclusions

This final conclusions section of the review report draws together some of the key points from the preceding chapters. There are a number of lessons that can be applied to understanding hiker awareness and attitudes to biosecurity behaviours along the West Highland Way and on the Ben Lomond track.

- Studies demonstrate how recreationists and tourists across a wide range of activities including hiking and walking, and in multiple settings including forest and other terrestrial and aquatic environments, can contribute to the introduction and spread of pathogens and invasive species.
- Studies showed that people have variable awareness levels depending on context, location and issue but that generally awareness is low.
- Although levels of concern about introduced species was generally high, there were some instances where the opposite was true and exotic species introductions was considered in a positive light. This could act as a barrier to action and shows that perceptions of the pest or disease in question need to be investigated and understood before designing engagement programmes.
- In the few studies that considered whether people would be prepared to engage in biosecurity behaviours, there was strong willingness expressed, or there already was a good level of engagement with biosecure behaviours. However, none of the studies that reported engagement with biosecure behaviours were based on observation of actual behaviours. All relied on self-reported behaviours which might contain a degree of social desirability bias or incorrect recall.
- A number of recurring principles for stakeholder engagement were found in the literature:



- Build engagement programmes on the interests and motivations of the stakeholder target group.
- Where necessary utilise trusted information sources and organisations to communicate the programme to the intended stakeholders.
- Ensure that any required behavioural change or adoption of new behaviours is supported by the necessary infrastructure so that stakeholders feel able to adopt the required actions, without incurring additional costs in terms of time, effort or money. In other words the behaviour needs to be easy for people to engage in.
- The studies reviewed present a mixed picture in terms of the effectiveness of biosecurity engagement campaigns at raising awareness and encouraging new behaviours.
- Evidence generally demonstrates that the engagement programmes have not increased knowledge or changed behaviours, even when people have been exposed to the campaign information.
- It is likely that the apparently unsuccessful engagement campaigns failed to utilise the principles for stakeholder engagement, for example, by relying on information posters that contained factual messaging without appealing to peoples' motivations or interests, and without demonstrating their potential role in helping avoid or solve a problem. This suggests that in many cases programmes that rely on providing information without first understanding how, where and when people want to receive that information, and from whom, and how it needs to be framed for different groups, are unlikely to lead to widespread and lasting behavioural change.
- The 'Check, Clean, Dry' campaign in New Zealand appears to be one example of a successful biosecurity engagement programme. As detailed above, this campaign:
  - Used regional partnerships who developed integrated regional invasive species management strategies;
  - Used multiple communication channels with a focus on signs at key recreational sites;
  - Provided simple and consistent biosecurity messaging across sites;
  - Provided cleaning stations at high-risk sites; and
  - $_{\odot}$   $\,$  Was subject to evaluation to understand what worked and what did not work.

For the current study, where the focus is on hikers at Rowardennan in the Loch Lomond and Trossachs National Park in Scotland, all of the above provides important lessons to inform the social science study on site, and future biosecurity engagement programmes.

- First, the literature provides evidence of the role of recreationists in the spread of pathogens and invasive species, thus serving to justify the focus of the study, and demonstrating the need for greater engagement by recreationists in biosecure behaviours such as habitual boot cleaning between hikes.
- Second, the review demonstrates there are generally low levels of awareness but high levels of concern, illustrating the need for more information and awareness raising, that takes advantage of the levels of concern people have about potential environmental damage.
- Third, engagement principles help to inform both the social science study questionnaire design, and the recommendations that will follow for engagement programme design.

• Fourth, the programme evaluations add to the stakeholder engagement principles by providing some understanding of what has worked and what has not worked, when seeking to engage with recreationists about biosecurity issues and actions. These can be used to further inform recommendations for future engagement programme design.



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