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Otago Regional Council's Response to Lake Snow: A Planner's Evaluation

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ABSTRACT

Regional Council ability to respond to invasive species under the Biosecurity Act 1993 is essential to protecting New Zealand's economy, environment and society. Otago Regional Council's response to lake snow is investigated as a case study. The findings highlight the implementation 'gaps' and challenges encountered by the regional council through identification, researching and managing the nuisance algae.

Keywords: Biosecurity, framing, lake snot/snow, Lake Wanaka, Ministry for Primary Industries, Otago Regional Council, risk, uncertainty.

1. INTRODUCTION

For 80 million years, New Zealand has evolved in isolation, resulting in a biodiversity richness with many endemic species. New Zealand's economy, environment and community are increasingly threatened by invasive species. An 'Invasive species' is defined as a non-native organism, whose introduction causes harm to society or the environment (NISIC, 2016). New Zealand's relative isolation and high endemism has meant that it is more dependent on biosecurity measures to address invasive species than many other developed countries. In New Zealand, the Biosecurity Act 1993 (BSA) sets out the law relating to the exclusion, eradication, and effective management of pests and unwanted organisms. Under the BSA every Chief Technical Officer (appointed by relevant central government departments) has the power to determine whether pests are unwanted organisms. Regional councils can provide further surveillance of pests, and any action required to manage and control pests in their region.

Otago Regional Council (ORC) is currently addressing an invasive gelatinous algae, called "Lake Snow", that was originally discovered in Lake Wanaka in the early 2000's and has now become widespread throughout North and South Islands. Lake snow can be regarded as a biofilm, slime or flocculent that binds together biological and physical particles (Ryder, 2017). The process of concentrating nutrients and aquatic life (e.g., bacteria, phytoplankton and zooplankton) to produce the lake snow slime has potential environmental effects on the lake ecosystem. The potential environmental impacts include: shortening the lake food chain, shifting the species composition, changing the sinking rate of biological materials and changing how nutrients are cycled through the lake (Ryder, 2017). The environmental impacts are affecting water users' recreational enjoyment of the Alpine lakes in Otago - the slime sticks to skin, hair and fishing lines.

Lake snow was not originally regarded as invasive, or a nuisance until algae began to produce in other Central Otago Lakes in 2016. In that year, media reports raised the question "Why did Otago Regional Council take so long to address lake snow?" (Otago Regional Council, 2016). This paper seeks to identify the potential 'implementation gaps' that influence the overall effectiveness of the biosecurity framework in New Zealand. It presents an analysis of the challenges that arise within an institutional body's ability to form frames and framing, due to the risk and uncertainty that invasive species pose.

2. BIOSECURITY MANAGEMENT FRAMEWORK

The biosecurity risk framework covers: pre-border risk management, border management, readiness and response, and long-term pest management to ensure that biological risk and threats are managed throughout New Zealand. Pre-border management imposes health standards, risk assessments and international trade agreements to reduce risk of invasive pests coming into New Zealand, through shipping, passengers or packaging, for example fresh fruit. Border management, assesses the potential risk of organisms (Biosecurity New Zealand, 2006). The Ministry for Primary Industries (MPI), is responsible for informing biosecurity clearance and surveillance activities at airports of pests that are a high risk to New Zealand. Sniffer dogs and passenger inspections [MPI, 2017]) are examples of activities used at airports to prevent the entry of pests. Readiness and response actions deal with biosecurity emergencies. Under the BSA, agencies may be given access to powers (to enter properties, impose controls, destroy infected properties and give direction) to deal with harmful organisms once these pests get past the border (MPI, 2017). The last line of defence is long-term pest management, that is, preparation and review of both national and regional pest-management plans[1]. The MPI is responsible for updating national plans. Regional councils may be responsible for developing and implementing Regional Pest-Management Plans (PMP) under the BSA. Both plans contain rules and principal measures to be used to achieve objectives aimed to control the introduction, spread and use of organisms.

Pre-border and border control stages are the strongest defence for biological invasions, because once invasive species become established it can be more difficult to identify the pest and apply appropriate strategies to eradicate and manage the organism. Under the BSA Chief Technical Officers (CTOs) are responsible for determining whether a new organism is an unwanted organism (Parliamentary Commissioner of Environment, 2002). CTO are appointed by any central department with biosecurity responsibility (including the Department of Conservation [DOC] and the Ministry for Primary Industries). Under the HSNO Act, a new organism is identified as a pest or a disease that has newly invaded New Zealand, whereas MPI identify an unwanted organism as any organism that is capable of harming natural and physical resources (e.g., forests and waterways) or human health; this is not necessarily a new organism. Once unwanted organisms have been identified, the pest is placed on an Unwanted Organism Register. This is an on-line register essential to ensuring that all regional councils in New Zealand have clarity about which organisms are unwanted. Regional councils are responsible for managing and controlling unwanted pests identified in the national register if they become established within their region (Teulon, Boyd Wilson, Holton and Ridley, 2012).

3. THEORETICAL FRAMEWORK

Scientific advice can help institutional bodies to identify, prioritise and guide decisions on biosecurity management (Parliamentary Commissioner for the

[1] In the Biosecurity Law Reform Act 2012 (BLRA) pest management plans replaced the previous pest management strategies (which had been introduced into the BSA in 1997). Pest management strategies, whether national or regional, operative at the commencement of the BLRA were deemed to be plans and remained operative, some are yet to be replaced by plans prepared under the amended legislation.

Environment, 2002). However, there is considerable uncertainty and risk surrounding invasive pests, affecting how biosecurity department and local authorities can respond and eradicate pests. Wynne (1992) believes that the shift towards a preventative approach has influenced how environmental and technological policies are used to assess risk.

3.1 Precautionary Approach

The precautionary approach seeks to prevent environmental effects before they occur. The approach draws on anticipatory knowledge from scientific evidence to understand complex systems. Wynne (1992) argues that science can only define risk, or uncertainties by artificially "freezing" a surrounding context, which may or may not represent reality. All knowledge is conditional, it is impossible to identify, control and understand all the components of a complex system.

3.2 Uncertainty

It is essential that these limitations and uncertainties are acknowledged. Wynne (1992) presents a useful framework for understanding multiple layers of uncertainty: risk, uncertainty, ignorance and indeterminacy. Risk, you may 'know the odds', means you can identify and quantify the probability of the outcome occurring. Uncertainty, when the parameters are known but the odds are not', means that the probability of an outcome occurring cannot be calculated. Ignorance, relates to ontology 'we don't know what we don't know', and forms a deep uncertainty that cannot be predicted or reduced by further research due to the complexity of the system. Lastly determinacy, is embedded into risk and uncertainty. It refers to how social institutions and practices adapt scientific knowledge to fit into current paradigms of society. In this process of simplification, the true meaning and cause can be lost in translation between regional councils and scientists.

3.3 Framing

Society constructs frames to understand the elements and processes of the external world. Frames and framing are constantly being used in decision making to guide the strategies and actions to address an environmental problem, such as a biosecurity threat. Dewulf et al. (2004) identified the nature of frames using two different approaches – the interactive approach and the cognitive approach. The interactive approach resembles Bateson's (1955) work on metacommunication, frames are communication devices that can be used to understand the interactions, negotiation and perceptions between different parties. In addition, the cognitive frame theory formulated by Minsky (1975), frames are knowledge structures that help organise and interpret data that fits into current paradigms, beliefs and values of society. In this paper, the cognitive and interactional approaches are used to identify and understand how Otago Regional Council framed lake snow as an issue.

4. METHODS

This research used a qualitative singe-case study approach, desk top study and semi structured interviews. A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context (Yin, 2013). The study provided a systematic way of observing the management processes used by one regional council over a period of time. The interview followed a semi-structured approach with pre-circulated questions to help lead the discussion. These questions focused on key issues and events, surrounding the discovery, the research and management challenges and the threat lake snow poses to society and the environment**.** Three scientists and one community group chairperson were interviewed for the purposes of this research. Desktop study and the semi structured interviews were used with a triangulation method to construct the case study. Triangulation methods were used for cross-checking multiple sources and collection procedures to help strengthen the validity of this study. Documents were analysed for two

purposes. Firstly, to understand the implementation of the Biosecurity Act 1993. Secondly, the document analysis has allowed the Otago Regional Council approach under the biosecurity framework to be evaluated.

5. ANALYSIS

Analysing the frames and framing of lake snow contributes to understanding how Otago Regional Council responds to invasive pests in Otago. There are three key events: Firstly, the discovery of lake snow. Secondly, the spread of lake snow which lead to lake snow becoming a research priority. Lastly, evidence of lake snow as an introduced pest to New Zealand.

5.1 Discovery

In the early 2000s, a fisherman discovered an unfamiliar slime sticking to fishing line and reel, while fishing in Lake Wanaka. This unknown phenomenon was later identified by Marc Schallenberg an Otago University Professor, as lake snow (Shallenberg, 2016). In later years, *Lindavia intermedia* would be recognised as a diatom, a group of algae, that produces mucus known as lake snow. Since, the discovery of lake snow Schellenberg has been involved in supervising students in researching lake snow. By 2010, Schallenberg had become vocal in the media and had notified ORC, trying to raise concerns surrounding lake snow. However, ORC perceived lake snow as "no point of concern", because of the lack of supporting evidence and therefore was not on the "council's' radar", no requests for follow up were made on lake snow (Adam Uytendaal, former ORC scientist, personal communication, 2017).

5.2 Spread of lake snow

In 2016, lake snow was confirmed in Lake Wakatipu, and Lake Hawea (Schallenberg, 2016). It was at this point that many organisations began to change their perception and approach towards lake snow. The spread of lake snow and its appearance on fishing lines and domestic water filters led to the vernacular term "lake snot" coined by Schallenberg and Novis. This was because of its similarity to didymo, an invasive diatom in New Zealand rivers that is sometimes known as "rock snot" (Novis, Mitchell, & Podolyan, 2017). Schallenberg expressed in the media "much remains unknown about lake snot" (Mitchell, 2017) and "we have had little success attracting research funding from any level of government" (Mitchell, 2017). Schallenberg was articulating his concern and frustration at the lack of progress that had been made towards finding answers about the production of lake snow.

The uncertainty and the research gaps led ORC to organise a technical workshop to discuss current knowledge, sampling methods and research prioritisation of lake snow. The technical workshop was held on 20 December 2016. Many organisations were invited to present at the workshop including: Landcare Research, Cawthron Institute, NIWA, University of Waikato, University of Otago, MPI, Queenstown Lakes District Council, Environment Canterbury, and Environment Southland (Ryder, 2017) The primary objectives of the workshop were:

I. Develop and prioritise research questions
II. Scope the methodology, timeframe and resource requirements for each research question.

The research questions were divided into 5 main areas:

(1) Is *Lindavia intermedia* native or non-native to New Zealand,
(2) What are the environmental drivers,
(3) Development of effective sampling and monitoring technologies,
(4) how to reduce the growth and lastly
(5) Supporting citizen science (Ryder, 2017).

In promoting the workshop, Otago Regional Council stated that they could become "world leaders in analysing lake snow" (ORC, 2016)

5.3 Discovery of an Invasive pest

Otago Regional Council has made headway on many of these research priorities. One of the biggest discoveries is the identification of lake snow as an introduced pest to New

Zealand. In 2016, ORC signed a $30, 000 contract with Phil Novis from Landcare (Ryder, 2017). The results were released in the *Otago Daily Times* on the 14th of September 2017 by journalist Tim Miller (Waterworth, 2017d). The report confirmed that lake snow is highly likely to have been introduced in New Zealand from Lake Young, Washington (Novis, Mitchell, and Podolyan, 2017). ORC revealed that "no immediate measures would be taken to stop the potential spread of lake snow"; however, a more intensive research programme would get underway to understand the organism and work towards solutions to minimise the effects of lake snow (Waterworth, 2017d). ORC has continued to make progress with the other research priorities.

Monitoring is one of ORC's key responsibilities under the BSA and Resource Management Act 1991 (RMA). Under Part 4 of the BSA, regional councils must monitor unwanted organisms, provide information and inform the Ministry if unknown organism are detected. Under s.35 of the RMA, local authorities have a duty to gather information, monitor and keep records. ORC has been concentrating on developing and reviewing the effectiveness of monitoring tools such as Monitoring Buoys (Waterworth, 2017c). However, ORC wish to ensure that adequate viable solutions are researched thoroughly to ensure money is not wasted and effective monitoring can be achieved (Waterworth, 2017c). In the meantime, to reduce lake snow, ORC commissioned MPI to engage with NIWA to review the effectiveness of a 'Check, Clean, Dry' programme (to persuade recreational lake users to clean their equipment) on *Lindavia intermedia* (Ryder, 2017). The resultant 2017 report concluded that one minute of dishwashing liquid, bleach, freezing and drying at room temperature was the most effective treatment. Hot water and salt water were not recommended without future testing (Kilroy and Robinson, 2017). ORC will continue to promote the Check, Clean, Dry concept between waterways as recommended treatment for lake snow.

To support citizen science ORC have signed a $10, 000 contract with a community-based group, Aspiring Environmental Ltd run by Chris Arbuckle (Ryder, 2017). Aspiring Environmental established 'The Touchstone Project' in early 2017 as a direct initiative to support those concerned with lake water quality, raise awareness of the impacts and demonstrate how to make a positive change on the lake (Chris Arbuckle, personal communication, 2018).

Researching the environmental drivers is ongoing. The University of Otago and the Ministry of Business, Innovation and Employment are studying the relationship between diatoms with overseas situations, and the effect of nutrient availability, climate warming and grazing pressure of water fleas on the algae. In 2016, Schallenberg believed that nutrient, climate warming and grazing pressure may be encouraging the growth of lake snow. Many Central Otago lakes have very low Trophic Level Index (TLI) values, which indicate low levels of nutrients and algae, a good sign of water quality. The land use changes may be causing a very slight increase in nutrients, which may impact on the algae community. Changes to the climate, for instance increases in temperature, may favour the growth of a different species of algae. Lastly, North American introduced water flea (Daphnia spp.) graze on an alga that competes with lake snow algae, allowing lake snow to be produced (Otago Regional Council, 2018). Further research on environmental drivers is crucial. This work will be intensive and is seen as best delivered through Universities, and a number of post graduate and post-doctoral research programmes (Ryder, 2017). ORC will continue to coordinate with Land care, University of Otago, MPI, Aspiring Environmental Ltd and other regional councils to understand the phenomenon and find viable solutions to combat lake snow.

6. DISCUSSION

There are a number of challenges that arise over biosecurity management and the potential 'implementation gaps' that are evident in this case study. This research has shown that understanding how an issue is framed can play an essential role in biosecurity management. There are many challenges in framing environmental problems which have

impacted on ORC's ability to respond to lake snow. The framing and defining of an issue require building an understanding of the problem: a problem cannot be fully defined if there is limited knowledge and understanding surrounding the topic (Bardwell, 1991). The ORC's slow response to lake snow may have been as a result of limited knowledge and understanding of the lake snow issue, which was exacerbated by the costs of obtaining information through research and the geographical challenges of doing so, given the size of the lake. Since lake snow has become a 'national issue', coordination, co-management and communication between institutional bodies have become crucial to pest management. Challenges within the institutional bodies such as: MPI, local government and non-government organisations have occurred.

6.1 Institutional Arrangements

MPI is responsible for providing money, and support, and setting up programmes for regional councils to implement (e.g., the Check, Clean, Dry programme aimed at reducing the spread of invasive pests). MPI could not provide crucial funding for scientific research until lake snow was confirmed as a "new organism" under the HSNO Act 1996, and as an invasive pest (Ryder, 2017). However, once a Landcare Scientist (Phil Novis) confirmed that lake snow was most likely an invasive pest, MPI was unwilling to identify lake snow as an unwanted organism on the national register. MPI have not provided reasoning for their decision. In Otago, under the BSA the local government (including ORC and Queenstown Lakes District Council [QLDC]) is responsible for managing lake snow in coordination with other councils (Environment Southland and Environment Canterbury) and non-government organisations. Councils contract non-governmental organisations to undertake research in biosecurity management. Non-governmental organisations include community trusts and groups such as the Lake Wanaka Trust, Guardians of Lake Wanaka and Guardians of Lake Hawea. The Guardians have provided and offered to support ORC in identifying and managing lake snow; however, the ORC, according to Robertson (Chairperson of Guardians of Lake Wanaka, personal communication, 2017), has not been forthcoming in accepting the Guardians' help. This has been frustrating for the Guardians. However, ORC have contracted another non-government group, Aspiring Environmental Ltd, to carry out citizen science, to increase community involvement in monitoring of lake snow.

There is lack of understanding and common foundation between the different organisations—central government, regional and district councils and non-governmental organisations (Drage & Cheyne, 2016). Therefore, there is a lack of understanding of the threat that lake snow poses to the community and environment, due to the limited funding for scientific research, as well as a lack of transparency and support between groups.

6.2 Risk and Uncertainty

Research on lake snow has been undertaken by national research institutes (such as Landcare Research, the University of Otago and NIWA) over the last eight years, especially in 2017 and 2018. The depth of understanding of lake snow has increased. Research is a slow process. It can be difficult to identify the biosecurity risk and, according to Wynne (1992), science is based on conditional knowledge that may not represent reality. Wynne's (1992) four uncertainty concepts; risk, uncertainty, ignorance and indeterminacy can be used to understand the challenges of identifying and researching the threat that invasive species pose to New Zealand. With regard to risk, freshwater scientists were able to understand that the odds of invasive species being introduced were high, due to high numbers of domestic and international travel. However, there was uncertainty surrounding the types of species that would be a risk of establishing in New Zealand. In the earlier years of discovery, freshwater scientists could not predict whether lake snow would become a problem, because *Lindavia Intermedia* is an unusual diatom that may be present in waterways but does not always produce the

mucus that is identified as lake snow (Shallenberg, personal communication, 2018). There still remains a deep uncertainty surrounding the environmental drivers and the full impact lake snow will have on the composition of the lakes. This can be classified as ignorance under Wynne's framework (1992). In terms of biosecurity, freshwater is an indeterminate system; there are gaps within scientific knowledge and understanding of invasive species. Social institutions, scientist and policy makers seek to understand or to formulate assumptions surrounding lake snow, through creating and forging connection between current environmental issues and water quality issues that have been affected by land use and climate change. The freshwater scientists recognise the complexity of the freshwater ecosystem, and the limitation of scientific research. However, policy makers used the uncertainty of lake snow as a reason not to act, which is counter to the precautionary principle.

It is important to note that, since the introduction of lake snow the problem has got much worse and therefore, much more difficult to manage. Once the severity of lake snow was recognised, the central government, local government, research institutes and non-government organisations are now doing their best to work together to overcome challenges and increase the understanding of the lake snow phenomenon, how it can be managed (monitoring) and whether there is potential (biological controls) to eradicate lake snow. The management process is more effective and beneficial if the organisations are on common ground and, engaged openly with one another and support each other through the process of dealing with unidentified organisms. This management process can be used as a prime example for tackling invasive species, to ensure that the environment, community and economy are protected within New Zealand.

7. CONCLUSION

Otago Regional Council's response to lake snow was used in a single case-study analysis to provide useful insights into pest management. This research found that how a biosecurity threat such as lake snow is framed can strongly influence regional council's ability to respond and approach invasive pests. A biological risk identified as an occurrence that may have adverse consequences, can be framed in a variety of ways due to different scientific, community knowledge, social institutions, and challenges incorporated in understanding the phenomenon. This research identified that Otago Regional Council's uncertainty surrounding lake snow and indeterminate freshwater system and the Ministry of Primary Industries' lack of support has led to a slow response towards lake snow. In their eyes, there was no evidence suggesting that lake snow would become a problem for the community. Council formulated naïve assumptions surrounding scientific analysis, and assumed that more scientific research would be key to managing lake snow. However, it was difficult for research to be undertaken due to the lack of support from the central government. MPI refused to identify lake snow as an invasive species on the national invasive register or provide appropriate funding for scientific research to be undertaken. In this case, by the time that lake snow was identified as a freshwater invasive pest, it was too late to effectively manage and control as it had already become established in too many lakes in Otago and other lakes in New Zealand.

Overall, this research demonstrates that the biosecurity framework is difficult to implement at regional planning level, therefore key recommendations and future research have been proposed. More support and better collaboration between different levels of governance and non-government organisation in terms of information sharing and providing funding is crucial. Information sharing can be improved through the development of national and international species databases. The introduction of a precautionary invasive pests fund for local government in New Zealand can be used to support research projects. Development of national guidelines on identification and regional management regimes that seek to understand and overcome the uncertainties, risk and challenges of managing biological invasions in New Zealand are needed. Action

on these recommendations and further research are essential to improving the implementation of a biosecurity framework within regional planning in New Zealand. Biosecurity management is crucial to ensuring that New Zealand's unique biodiversity can be protected for future generations.

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