



Manaaki Whenua
Landcare Research

NEW ZEALAND'S
BIOLOGICAL
HERITAGE

Ngā Koiora
Tuku Iho

National
SCIENCE
Challenges

Co-designing for research impact: lessons learned from practice in Aotearoa New Zealand

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Co-designing for research impact: lessons learned from practice in Aotearoa New Zealand

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Summary

Aotearoa New Zealand's mission-led National Science Challenges are expected to deliver research impact by connecting researchers, Māori partners, stakeholders and end users to co-design and co-create research to respond to the country's biggest and most complex issues. This report contributes to collaborative research theory and practice by examining key aspects of the co-design scoping process undertaken by New Zealand's Biological Heritage National Science Challenge, Ngā Koiora Tuku Iho (the Challenge), to establish the foundations of its *Strategy 2019–2024*. Drawing on Challenge leadership and process participants' reflections and experiences through 25 interviews, the research identifies what worked well and what did not work so well from multiple perspectives.

This report identifies the practicalities, opportunities, and challenges of doing co-design and nine foundations for giving co-design the best chances of success, namely:

1. leadership commitment
2. financial resources
3. a realistic timeframe
4. organisational capacity
5. diverse, knowledgeable and experienced participants across researcher, tangata whenua and stakeholder/end user groups
6. clear values, rules of engagement and output expectations
7. power sharing
8. skilled facilitation
9. a well-designed process.

Strengths of the process are identified as varying degrees of successful implementation of these foundations of co-design. Weaknesses are linked to governance of the Challenge which had substantive ramifications for its organisational capacity to undertake the co-design process and how it did so. While the Challenge was committed to taking a collaborative and strategic path to establish the foundations of its *Strategy 2019-2014*, it was doing so in the midst of unrealistic expectations about what it actually takes to meaningfully, respectfully and effectively do codesign and the flexibility required to shore up both internal and external credibility and legitimacy for the process, its inputs and outputs.

This research raises important questions about the consequences of research policy reforms that are changing the rules of the game but not the governance structures that directly shape how, when, where and why co-design (and co-creation) are done. The report concludes with recommendations for both governing and doing co-design as well as further research to examine questions raised by this study.

1 Introduction

The imperative for research institutions and researchers to more closely and clearly link the work they do with decision-making and on-the-ground action is embodied in recent changes to New Zealand's research funding performance criteria, which require these institutions and actors to monitor and tangibly demonstrate both academic and societal impact from research. The focus on impact as well as science excellence is an international trend that is now formalised in Aotearoa New Zealand in the Ministry for Business, Innovation and Employment's *The Impact of Research: Position Paper*. This potentially game-changing document defines research impact as a 'change to the economy, society or environment, beyond contribution to knowledge and skills in research organisations' (MBIE 2019a, p. 1).

The increasingly loud calls for impact, both internationally and in New Zealand, have coincided with an expansion of academic literature over the past two decades in the fields of sustainability science, transdisciplinary research and practice, and science and technology studies that argue that linking knowledge to policy and action to achieve impact is necessary, but not at all straightforward (e.g. Brandt et al. 2013; Cash et al. 2003; Cash et al. 2006; Fam et al. 2017; Kates et al. 2001; Kirchhoff et al. 2013; Lang et al. 2012; Leith et al. 2017; van Kerkhoff & Pilbeam 2017; West et al. 2019; Wyborn et al. 2019).

Some reasons for difficulties relate to institutional settings, reward and recognition systems, and measures of success that have been established to advance science through disciplinary and specialised research (Fam et al. 2017; Hansson & Polk 2018, Thompson et al. 2017; Turner et al. 2016; West et al. 2019). These existing institutional structures and the norms they embody have favoured impact within research institutions (MBIE 2015; see also MBIE 2017, 2019a). Although the call for impact is now clear, and new performance criteria are crucial for signalling the need for change, just how research institutions should or could go about achieving impact in practice remains distinctly unclear (Duncan et al. 2020a).

In particular, the challenging, time-consuming and often highly political collaborative work required to equitably and respectfully bring together researchers, Māori research partners, stakeholders and end users – which is now recognised as necessary to land scientific research in the world of real life – is poorly resourced and not highly valued within research institutions (Duncan et al. 2020a, 2020b; Fam et al. 2017; Lang et al. 2012; Mark & Hagen 2020). Accordingly, *how* to meaningfully, respectfully and effectively link knowledge and action is an important question that this report contributes to addressing by reflecting on the co-design process undertaken by New Zealand's Biological Heritage National Science Challenge, Ngā Koiora Tuku Iho (the Challenge) during 2019.

With limited funds to address the profoundly complex national issues of biodiversity and biosecurity, the Challenge leadership adopted a leveraging-across-research-institutions approach in Tranche 1. In Tranche 2, the Challenge decided it was necessary to go many steps further to capitalise on what it had learned in Tranche 1, in terms not only of the biological science it funded and seeded but also what it actually takes to make a visible

and tangible difference in the world. The Challenge's *Strategy 2019–2024* seeks to overcome issues it sees as having become deeply entrenched and disabling within the nation's science system:

Our emphasis for 2019 to 2024 is to actively lead better and faster pathways from science discovery through to delivering impacts at regional or national scales. By 'impact' we mean a set of final, long term effects or benefits in a value chain. A rich array of talents are needed to better understand and manage our biological heritage and deliver impact, but many science and research efforts in New Zealand have increasingly become fragmented. For example, our Challenge Parties identified c. \$179M of research over 3 years representing >700 research projects or programmes aligned with the Mission of our Challenge. However, this diverse effort has lacked overall cohesion and focus, in part because it has never been harnessed in a strategic framework to deliver measurable benefit for New Zealand (BioHeritage, 2018, p. 4).

To remedy concerns about fragmentation, the wasteful ramifications of competition within and across science institutions, and the lack of cohesion and strategic direction, the Challenge leadership set its sights squarely on catalysing the research impact that New Zealand society has always expected and research funders are increasingly calling for. Building on Tranche 1, it was decided that a radically different and far more strategic approach to framing problems and solutions was needed, and that the Challenge could play a key role in establishing these foundations. As such, a key first step for the Challenge was to scope collaboratively-designed overarching and strategic programmes of work to support and fund.

To this end, during 2019 the Challenge embarked upon an ambitious co-design scoping process to transform its seven strategic outcomes into key goals and investment plans to catalyse co-investment and build enduring relationships. This new and ambitious approach was identified by the Challenge as necessary to achieve its mission, which is to 'reverse the decline of New Zealand's biological heritage, through a national partnership to deliver a step change in research innovation, globally leading technologies, and community and sector action'.

Its co-design process sought to extend the Challenge's connecting-up approach to science investment in Tranche 1 to include establishing new foundations in order to foster greater collaboration and on-the-ground action through identifying research gaps and opportunities, and fostering co-investment with partners willing to join the Challenge on its journey:

We have always grappled in the Challenge with this issue, if you want to call it that, that we've actually been given so little funding to do something really really big. Quite a long time ago, during tranche one, we got to the point where we thought it's not about the money. It's never been about the money, it's never been about getting funding out the door in the traditional way. We thought the only thing we can do is use the money effectively to connect up people and build those collaborative processes differently. That means then

the next logical step beyond that is to say, 'Here's a place where you could invest your time, your energy, your resources or your knowledge.' We've been quite clear, at least for us, co-investment doesn't mean money necessarily. It can mean a case study area, it can mean capability, it can mean knowledge or any of those things. That needs to be woven together to make a really strong story that will incentivise others to jump on board around priority goals or priority areas. (Challenge Co-director)

The Challenge *Strategy 2019-2014* establishes a framework to focus research and other investments across seven strategic outcomes (SOs). Initially eight scoping groups were established to work with seven SOs that aligned with the three impacts the Challenge identified with Challenge parties as essential to its mission: empower, protect, and restore (Table 1). These scoping groups brought together Māori research partners, researchers, stakeholders and end users from a range of industry organisations, levels of government and beyond to work together to co-design goals and pathways to impact, and develop an investment prospectus that would be used to inform funding decisions and encourage co-investment. During 2019 the Challenge was given surge funding by central government to address kauri dieback and myrtle rust, which instigated the creation of a ninth scoping group, referred to as Ngā Rakāu Taketake.

Table 1. Challenge structure of impacts and strategic outcomes

Impact 1 Whakamana Empower	Impact 2 Tiaki Protect	Impact 3 Whakahou Restore
<i>New Zealanders value our biological heritage, understand how it is changing and are inspired to take actions to protect it</i>	<i>New Zealand's biosecurity system is world class</i>	<i>New Zealand's natural and production ecosystems are resilient and thriving</i>
Strategic Outcome 1 We assess our progress using a biological heritage scorecard for Aotearoa	Strategic Outcome 3 We anticipate both emerging and latent biosecurity risks, and avoid new or recurring invasions	Strategic Outcome 6 We quantify social-ecological linkages for use in managing, protecting and restoring land and water ecosystems
Strategic Outcome 2 We empower New Zealanders to demand and enact environmental stewardship and kaitiakitanga	Strategic Outcome 4 We have state-of-the-art biosecurity surveillance systems	Strategic Outcome 7 We enable people to build biological heritage resilience with the right policy and governance instruments
	Strategic Outcome 5: Pre-border We deploy novel tools, technologies and strategies for control or eradication of biotic threats	
	Strategic Outcome 5: Post-border We deploy novel tools, technologies and strategies for control or eradication of biotic threats	
Ngā Rakāu Taketake Saving our iconic trees from kauri dieback and myrtle rust		

Design-thinking principles have been central to the Challenge's new approach and its ambition to fund science strategically with the right teams and with a clear line of sight to impact. The Challenge's co-design process ran from December 2018 to December 2019 (see Appendix 1 for a chronology of events). The Challenge received 237 expressions of interest to be involved in the process, from people across 64 organisations. It appointed 87 people from 34 different organisations, which were assembled into the nine design teams (see Table 1) with the following make up:

- 45% female and 55% male
- 24% self-identified as having Māori whakapapa
- 16% self-identified as being early career
- 63% were from a research organisation, 16% from a government organisation, 8% from industry, 3% from an NGO, and 9% were independent.

All up, 280 hours were spent in 25 hui. Team members engaged with around 250 people from 130 organisations to gather feedback. These people comprised representatives from a variety of groups as follows:

- 16% iwi/hapū
- 12% non-government organisations
- 12% community
- 21% industry representatives
- 21% research organisations
- 18% government organisations.

Given the intensity of the process, its design philosophy and methodology, the considerable time and resources dedicated to it, and how broadly based the process was in terms of participation of Māori partners, researchers, stakeholders and end users, this case study provides invaluable insights into the practicalities, opportunities and challenges of co-design. As such, it can make an important contribution to the fields of transdisciplinary research and practice (Botha et al. 2017; Duncan et al. 2020a, 2020b; Fam et al. 2017; Hansson & Polk 2018; Lang et al. 2012; Mitchell et al. 2015; Mobjörk 2010; Polk 2015; Robson-Williams et al. 2018; Roux et al. 2010; Thompson et al. 2017; Turner et al. 2016; Wickson et al. 2006) and the relatively new concept of knowledge governance (Miller & Wyborn 2018; Van Kerkhoff & Pilbeam 2017; Wyborn et al. 2019; see also van Kerkhoff 2014; Gerritsen et al. 2013).

2 Background

In 2013, 11 mission-led and outcome-driven National Science Challenges (NSCs) were established by the New Zealand Government's Ministry of Business, Innovation and Employment (MBIE) to address the country's biggest and most challenging issues. The NSCs focused on issues identified through public engagement as having importance to New Zealanders (e.g. health care, nutrition, biodiversity, childcare, housing, natural hazards, climate change, and natural resource management). Funding was approved for 10

years between 2014 and 2024, with a mid-term review in 2018, which approved funding for all NSCs to continue through to 2024.

In 2015 additional performance criteria for the NSCs were introduced by MBIE. These new requirements call for scientists to work collaboratively with Māori partners, stakeholders and end users to co-produce science to deliver outcomes and impact (MBIE 2015; see also Duncan et al. 2020a; MBIE 2019b). The New Zealand Government's *National Statement for Science Investment 2015–2025* defines impact as 'the direct and indirect "influence" of research or its effect on an individual, a community, or society as a whole, including benefits to our economic, social, human and natural capital' (MBIE 2015, p. 6). More recently, as discussed, *The Impact of Research: Position Paper* (MBIE 2019a, p. 1) defines research impact as a 'change to the economy, society or environment, beyond contribution to knowledge and skills in research organisations' (see also MBIE 2017). Both definitions make it very clear that research impact is expected to occur well beyond research institutions.

With the changes to their performance criteria in 2015, the expectation is now for the NSCs to work in closer partnership with Māori, collaboratively across science disciplines and institutions, as well as co-designing and co-innovating with stakeholders and end users. The performance criteria also require the NSCs to build inter- and transdisciplinary capacity within the science system. This more collaborative way of working and doing research is expected to have a greater chance of delivering outcomes and impact to ultimately deliver the NSC missions (MBIE 2019a, 2019b). However, funding policy and timelines for the NSCs have not changed with these collaboration requirements, and there has been limited direction on how to actually *do* co-design and transdisciplinary research (Duncan et al. 2020a, 2020b). Notably, the Challenge had been seeking to create more effective links between knowledge and action since its inception. For example, from the outset it created positions for knowledge brokers, and in 2019 they became part of the Challenge's Senior Leadership Group (SLG), alongside earlier career researcher representatives, and played a key role in the co-design process.

To build on the science undertaken in Tranche 1 and the partnerships it built during that phase, the Challenge set its vision for Tranche 2 on shifting the dichotomous thinking between discovery and applied science to build its funding system around an 'innovation system' and an 'innovation pathway' (Figure 1). The Challenge explains in its documentation that this approach seeks to expand the disciplines, knowledge holders, stakeholders and end users it could work with and populates the assumed gap between discovery and application with:

- discovery: new knowledge
- invention: new approaches
- innovation: new ways of doing things
- translation: more people have the required tools
- adoption and scale out: landscape-scale intervention.



Figure 1. The Challenge's representation of its innovation pathway within its innovation system approach.

The innovation pathway is for 'collective impact', which the Challenge defines as 'the commitment to a common agenda of a group of important actors from different sectors for solving specific strategic problems that will deliver enduring national benefit' (BioHeritage 2018, p. 4). The Challenge documentation provides further insights on how it plans to achieve impact using this approach:

Our 'innovation system' approach is explicitly designed not just to ensure end user 'uptake', but to remove perceived barriers and constraints across organisational boundaries, with end users and knowledge holders shaping and co-designing the research agenda to drive a paradigm shift towards impact-oriented science and research. Under our framework, all types of skills and roles – including those of end users – will be required if the Challenge is to deliver on its Mission. Our commitment to resourcing (for example) broker and translator roles is one example of what will be needed; equally, end users have indicated a strong willingness to commit time and expertise. (BioHeritage 2018, p. 25)

MBIE's additional performance criteria for the NSCs, which require 'co-design (at the outset)' and for them to 'co-develop/create (along the way)' (MBIE 2019b, Appendix One) align well with the Challenge's new Tranche 2 Strategy. However, what it actually takes to implement a strategy focused on impact through co-design (at the outset) is an enormous and time-consuming task that few have undertaken in a meaningful and large-scale way in New Zealand. At the request of the Challenge director and Kaihautū Ngātahi, I followed the scoping co-design process undertaken by the Challenge during 2019 to document key elements and provide critical reflection on the process. The purpose of doing so is to ensure experiences and lessons learned from this process are made available to others who might pursue similar aims and adopt similar processes, and to reflect on the implications of this process for research and practice in the fields of sustainability science, knowledge governance, and transdisciplinarity.

3 Defining co-design

In a review of co-design in Aotearoa New Zealand, Mark and Hagen (2020, p. 5) maintain that the term 'co-design' has become 'ubiquitous across government' over the last 5 years, as the public service has recognised the utility of co-design to develop policy, services and community-led responses that have greater relevance and legitimacy when those using services are involved in their formulation. These authors conclude that co-design is 'seen by many as providing a powerful method to connect with those using or impacted by services and products. This brings their experiences to shape a solution to a problem, and, more importantly, to define the problem itself' (Mark & Hagen 2020, p. 5). They also note that 'co-design' is often used interchangeably with other terms, such as participatory design, co-production and human-centred design.

Mark and Hagen (2020, citing Boyd 2012, p. 2) define co-design as 'a process in which targeted end users and other relevant stakeholders form a partnership with researchers and work together on all aspects of intervention development, from needs assessment to content development, pilot testing, and dissemination'. The inclusion of researchers alongside stakeholders and end users to do co-production or co-design is also referred to as 'transdisciplinary' (Hansson & Polk 2018; Lang et al. 2012; Mitchell et al. 2015; Mobjörk 2010; Polk 2015; Roux et al. 2010; Thompson et al. 2017; Wickson et al. 2006) or 'co-innovation' (Botha et al. 2017; Turner et al. 2016; Vereijssen et al. 2017; Wickson et al. 2006). In their review of transdisciplinary research in sustainability science, Brandt et al. (2013, p. 1) maintain:

Steering socio-ecological systems towards a more sustainable path is an inherently transdisciplinary problem, requiring cooperation between different scientific domains and society at large – here we define transdisciplinarity as a research approach that includes multiple scientific disciplines (interdisciplinarity) focusing on shared problems and the active input of practitioners from outside academia.

Clearly, there is a constellation of terms that involve or can be classed as 'co-design', which is both a philosophy and a methodology for developing policy, services and initiatives, as well as doing research (Mark & Hagen 2020) within a number of academic fields.

While Brandt et al. (2013, p. 1) contend that 'science needs to move beyond classical disciplinary approaches', they note that the implementation of transdisciplinary research is fraught with practical and institutional difficulties. Relatedly, Mark and Hagen (2020, p. 5) note that while co-design has considerable potential, it can pose significant risks for participants, researchers and research institutions if it is practised poorly and does not create 'time, space and structures for learning, reciprocity, and power sharing'. Another risk is a lack of follow-through on what is co-designed. Hence, setting up a co-design process and asking a range of stakeholders, end users and Māori partners to be involved cannot be taken lightly. Co-design needs to be genuine, appropriately resourced and competently conducted. This is especially important given that Mark and Hagen (2020, p. 5) have found there is increasing distrust of the term, and growing 'co-design fatigue'.

The shift to co-design, co-production, co-innovation and transdisciplinarity is challenging traditional conceptions of the scientist or researcher as the expert, and participants as research subjects. In collaborative research processes such as these, participants become experts alongside researchers (e.g. Botha et al. 2017; Fielke & Srinivasin 2018; Srinivasin & Elley 2018; Turner et al. 2016). The Crown's Treaty obligations of rangatiratanga for tangata whenua and the mātauranga held by Māori also challenge traditional conceptions of the scientist as expert. As in other colonised nations, in Aotearoa New Zealand collaborative research practices have to traverse different, if not divergent, ontologies (i.e. what we know), epistemologies (i.e. how we know) and values of both Western and indigenous knowledge systems. A 'weaving' together of knowledge systems requires 'effective engagement of actors, institutions and knowledge-sharing processes' (Tengö et al. 2017, p. 17).

While collaborative modes of research challenge the traditional conceptions and roles of researchers, it should be recognised that they do not seek to devalue or diminish science or the role of scientists in research. What is crucial is maintaining the integrity of both knowledge systems, as they both have something important to offer each other and the issues of concern. However, these are significant and difficult issues to navigate in practice (Duncan et al. 2020a; Mark & Hagen 2020; Robson-Williams et al. 2018; Tengö et al. 2017), which highlights the need to learn from genuine and well-planned co-design processes such as this one to improve practice (Mark & Hagen, 2020).

4 Methods

Qualitative social science research methods have been used in this study, including the collection and review of documents, process observation, semi-structured interviews, and a thematic analysis. Specifically, I attended both 2-day workshops for one scoping group (SO3) and either 1 or 2 days of workshop 2 for another five scoping groups (SO2, SO4, SO5 pre-border and SO5 post-border and SO6). The purpose of attending the workshops was not to directly observe participants or record what participants said, but to gain an understanding of a design-led process, its structure, and the various activities SO team members engaged with. Witnessing the process in action enabled me to ask SO team research participants relevant questions in the subsequent interviews about key aspects of the process. I also attended the two pitch days, which was invaluable for the same reasons.

Social ethics approval was obtained for the observation phase of the research. A research information sheet was emailed by the Challenge to all SO team members and placed into each team's Dropbox (Appendix 2). Also, at the beginning of each meeting I attended, I briefly introduced myself, explained the research and asked everyone if they were comfortable with my presence for the purpose of observing the process, as described above, to which I received positive acknowledgements from SO team members.

Between December 2019 and April 2020, I conducted a total of 25 semi-structured interviews with selected members of the SO teams, the SLG and the process facilitator

(Table 2). Social ethics approval was also obtained for this phase of the research (Appendix 3).

Table 2. Overview of the number of research participants and their cohorts

Strategic leadership group	6
Facilitator	1
Māori team members	6
Researchers	6
Stakeholders	6
Total	25

Selection of research participants initially sought to obtain three perspectives from each SO team (i.e. Māori participants, researchers and stakeholders). However, resources and time limitations precluded me from gathering these three perspectives for all teams, but it was possible to do so for four design teams. In any case, I was able to interview at least one person from the nine SO teams. While advice was sought from the SLG on potential participants to provide a range of perspectives, I chose who to invite, and this was not discussed with or disclosed to anyone in order to meet the confidentiality and anonymity commitments made to participants.

Interviews lasted between 30 and 60 minutes. Broadly, participants were asked about their role in the process, why they applied to be part of the process (if applicable), their experience of the various aspects of the process and reflections on what aspects of the process worked well and what aspects did not.

Twenty-three interviews were digitally recorded with the permission of participants and transcribed by a contracted transcription service provider into Word documents. Manaaki Whenua – Landcare Research has a service agreement with the transcription provider, which contains confidentiality provisions and a requirement for the immediate erasure of digital files upon completion of transcription. Once transcribed, the transcript was read through and checked with the audio file and emailed to participants for review and, if necessary, amendment. Two interviews occurred over the telephone and notes were taken. These notes were provided to the participants for approval and, if necessary, amendment.

It should be noted that naming Māori participants as ‘team members’ evolved through the process. Māori participants involved in the process were from research organisations, stakeholder organisations and there were independent Māori practitioners. It was important to understand how Māori participants experienced the process. Hence, I spoke with a number of Māori participants as a cohort to build a Māori perspective. Even though there were a number of Māori participants, to identify them as a Māori researcher or a Māori stakeholder in their quotes risked identifying them. To avoid this as far as possible, I have used the term ‘Māori team member’ to encompass their many roles. It should also be noted that apart from the Challenge Co-director, the Challenge Kaihautū Ngātahi and the facilitator, participants’ quotes have not been numbered or otherwise anonymously identified through the report as this too risked identifying them. Participants were

provided with a draft of the report with their quotes highlighted for checking accuracy and correct interpretation.

4.1 Data Analysis

The transcripts and notes from the interviews were coded using NVivo software. A deductive and inductive approach was used (Cope 2005; Merriam & Tisdell 2015). The first (deductive) step was to establish a framework for coding to organise the considerable amount of data collected through the interviews. The coding framework initially organised data into the following categories: views on the design concept; aspects of the process; views on what worked well, what did not work so well, and what could be done better; and lessons learned. These broad categories reflected key themes in the research questions, which were informed by the academic literature and observation of the process in action.

The second (inductive) step was to generate as many descriptive codes as possible from the data to explore and capture feedback from research participants. This was done by reading through the transcript and notes that had been loaded into NVivo and labelling sections of text to capture the details of why participants thought things did or did not work, reflections on what they were asked to do, what was seen as important, and what issues were raised, and to identify strategies participants used to navigate the process. These sections of text and their given code name were either assigned to categories within the overarching framework or classed as emergent themes for subsequent classification.

4.2 Report structure

Through an iterative process of describing, grouping and categorising codes and sub-codes and assigning and re-assigning codes between existing and emergent themes, the following overarching structure was developed:

- A design philosophy and methodology
- Aspects of the co-design process:
 - Convening strategic outcome teams
 - Connections between teams
 - Empathy mapping
 - Developing goals
 - Feedback between workshops
 - Impact pathways
 - Investment prospectus
 - The pitch
- What worked well
- What did not work so well

- Tensions and emergent themes

The above framework structures this report. Discussion about what worked well and what did not work so well is incorporated into each aspect of the process (numbered 1–8) and summarised at the end of the research findings section alongside tensions and emergent themes (Table 3).

4.3 Research limitations

There are clearly limitations to this research which relate to limited time and resources and the inability to talk to more people to gather more perspectives and insights. Furthermore, the research questions and research findings have been shaped by the observations of workshops I was able to attend which were not in their entirety for all SOs except SO3 and did not include SO1, SO7 and Ngā Rakāu Taketake.

I have undertaken my role as researcher to provide to the Challenge with critical reflections on key aspects of the process in the spirit of being helpful and identifying lessons learned for future co-design processes and governing co-design. I have also been tasked with linking this case study with its broader implications for theory and practice in the fields of sustainability science, transdisciplinary research and knowledge governance.

5 Research Findings: Co-design in practice

5.1 A design philosophy and methodology

The Challenge Co-director was asked why a design-led approach had been adopted for the scoping process. She explained that during meetings with Challenge partners to discuss the Challenge's plans for Tranche 2, a Challenge partner identified that the Challenge had 'a design problem'. The Challenge Co-director recounted a key conversation:

She said, 'This is about design. This is about how you design a new process and design the right teams that are fit for purpose to deliver a common goal.' It was really then that I got interested in collective impact and design thinking.

The Challenge's design-thinking facilitator explained the rationale for a design-led process as follows:

The rationale is that if you're looking for ways to innovate or if you're looking for innovation and you seek to do that by harnessing the insights, the experience, the knowledge and the networks of people from a range of different disciplines or organisations or agencies and if you're seeking to bring that disparate group together, identify innovations in a way that is efficient and yet also does justice to the nature of the challenge, design thinking offers a pathway or a mechanism to do that. In broad terms, that's how I would describe the rationale. (Facilitator)

Hence, a design approach is about bringing together expertise, experience and networks to foster innovation.

While some participants were familiar with design thinking (and some had been involved in design-led processes), many were not. Some participants thought that the close involvement of stakeholders was a design-led process, which highlighted the need to clarify with participants what was different about a process led by 'design-thinking', compared to others that might ordinarily be identified in New Zealand as co-design, co-innovation and/or transdisciplinary.

Two defining features of design thinking as well as the various modes of collaborative research discussed earlier are opening up knowledge production to stakeholders and/or end users and a problem focus. The idea is that multiple perspectives on a problem can lead to more relevant framing of the problem and consequent innovative solutions. Including stakeholders, mana whenua and/or end users in a co-design or co-innovation process can occur in a number of ways (e.g. see Botha et al. 2017; Fielke 2018; Turner et al. 2017; Vereijssen et al. 2017). Using design thinking as a methodology is one of them, but design thinking has further defining features that made this process different.

Design thinking (Sheppard et al. 2018; Liedtka 2018) has been described as a 'human-centred approach to problem-solving' (Hoolohan & Browne 2020, p. 106). Empathy is central to design thinking, which compels the designer to walk in the shoes of who he or she is designing for to understand their context, world view, issues and challenges. In this way, rather than assuming one knows what is important for tangata whenua, a stakeholder or end user and going ahead and creating a policy, product or service for them, one finds out first what is needed and wanted and then goes about designing it. Hence, knowing who one is designing for is crucial.

Other features of this design-led approach that were presented to SO team workshops were as follows.

- *Divergent and convergent thinking*: These are two interconnected phases. The former encourages blue-sky, unconstrained thinking, while the latter narrows things down. A divergent and convergent thinking phase structured each workshop and were represented as a 'double diamond' for the two workshops.

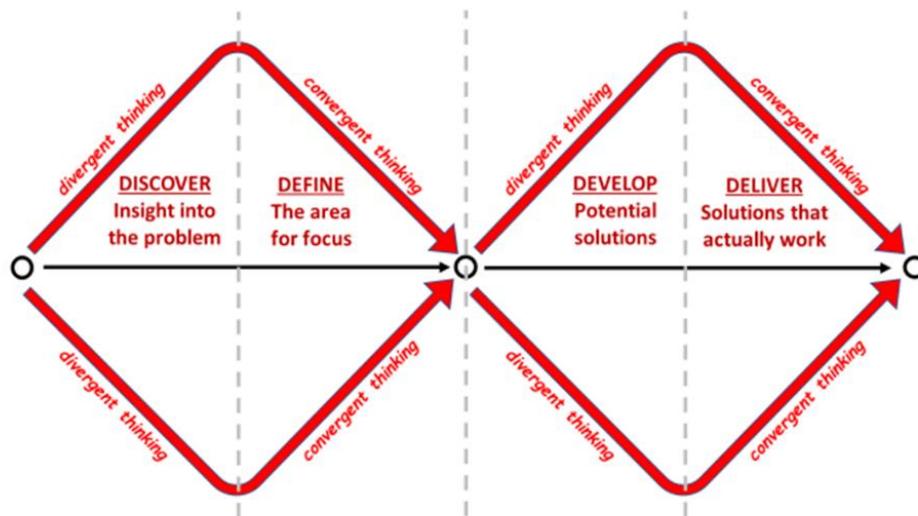


Figure 2. The 'double diamond' of divergent and convergent thinking phases used in workshops (Source: Phil Morrison citing British Design Council's Double Diamond Model for Human Centred Design).

- *Taking the expert hat on and off:* Related to this, the divergent thinking phase encourages people to take off their expert hat and not be constrained by the bounds of their discipline or institution, and the convergent thinking phase is when one puts one's expert hat back on again to be discerning about what is being proposed, to narrow down options.
- *Creating a minimum viable product:* This is about having permission to create something that is not fully formed or final when it is presented for feedback. Indeed, finality is counter to the design and innovation process that is expected to be driven by stakeholder or end-user needs. A minimum viable product has just enough features to be recognisable to those who need to use it and to give them something to work with in developing it further with a designer to produce the needed product in the most efficient way. This is a challenging concept for researchers, in particular, who are accustomed to having their success measured on the basis of fully formed ideas, reports and publications.

Having reminded participants about these aspects of the design-led process, which the facilitator covered in the workshops, research participants were asked if they thought the design process they experienced was appropriate for developing a science research agenda, given that the issues we are dealing with are complex, conflicted and uncertain.

While it was recognised there is no perfect way, participants felt that this design-led process certainly was appropriate. In explaining why, the following attributes were identified. The design-led process:

- brought a lot of knowledge and experience into one room
- fostered creativity, blue-sky thinking and thinking as a group
- subdued personal agendas and biases
- embraced complexity

- forced crucial questions to be asked (e.g. is this appropriate, where does it fit, does it actually add value, who can I partner with, can we co-design this, can we bring in other researchers?)
- encouraged innovative and interdisciplinary outcomes
- provided a safe space for different voices and ideas to be put forward *and* heard
- managed different personalities (e.g. introverts and extroverts)
- encouraged people to speak about things they were not an expert on
- encouraged listening and learning from others
- generated good ideas
- allowed time for conversations rather than meeting agendas
- allowed time for considered dialogue rather than rushed interactions, which are the usual these days
- did not feel prescriptively forced
- encouraged integrative thinking
- pushed people outside their comfort zone, which was seen as a good thing
- gave a voice to mana whenua and levelled out hierarchies
- allowed assumptions to be challenged
- was interesting, engaging and structured
- fostered inclusiveness
- helped identify what was important
- brought together different sources of knowledge and talents
- encouraged respect for each other and each other's ideas
- encouraged putting oneself in the shoes of others
- fostered learning between researchers, Māori team members and stakeholders
- avoided preconceived ideas
- broke down barriers between institutions and disciplines
- ensured conversations were collective but not homogenised.

The uniqueness of the process experienced by participants is conveyed in the following reflections:

People with diverse thinking and often in competition with each other over funding were brought together to think about one thing and build a consensus around that and then work out what to do about it. Because there is so much going on, it is hard to do this and find out where there are commonalities and gaps. (Māori team member)

I didn't get the sense that people were feathering their own nests or that kind of thing. To be honest, I expected everyone to turn up with their pet project and then, like how bills go through parliament, adding their little amendments, their little piece in. I felt like it didn't really go like that, which was good. I think the team worked together well. (Researcher)

5.1.1 What worked well?

Research participants were then asked what aspects of the process contributed to the above positive attributes. They identified:

- the facilitator
- the outward-focused (i.e. towards stakeholders and mana whenua needs and aspirations) process, which fostered outward thinking
- it was problem- rather than solution-focused at the outset
- the scoping group selection process, which got the right people with the right expertise in the room
- the Challenge values
- the diversity of people in the room (which extended to career stage)
- convergent and divergent thinking exercises, which involved taking the expert hat off then putting it back on
- working in small *and* larger groups
- empathy mapping.

How participants encountered these different aspects of the process is elaborated in the following reflections, which highlight the key role of the facilitator and the design principles he used:

I liked the facilitation. I thought that overall Phil did a good job of making sure that different people's voices came out in different ways. I was impressed by some of the techniques, like the empathy mapping. I can't even really put my finger on it but just the way, particularly in that first workshop, where you went from feeling like there was just so much unstructured complexity and somehow miraculously converging on something. (Stakeholder)

Actually, you need to be able to listen and learn from each other as well. I did like that idea of taking off your expert hat. Then, there were times when you put it back on and you go actually, 'That's all great, now let me just think and scrutinise that a little bit, think how could that work and how might we make that work with my experience.' I think there are times for that and I think that's why Phil did a good job of steering people through those spaces. (Researcher)

The double diamond design was a revelation to me, it was fabulous, so outlining that right from the start was really good. That was really surprising, so surprising a lot of that stuff that I took photos, thinking about how I can incorporate them into my [work]. (Researcher)

It kept breaking up into groups and brainstorming stuff and then coming back together and that was quite productive. It allowed different viewpoints to come forward and then be challenged, which then sparked fresh ideas. That expansion, contraction, expansion, contraction. (Stakeholder)

Reassurance was identified as important for helping SO teams to 'go with the flow' of the design process and was built in to some extent with the SLG doing a first iteration of a design-led workshop. This experience with the process meant that SLG members who

regularly attended the SO workshops were able to speak from experience to reassure SO team members to have 'trust in the process', which the facilitator maintained was a very important success factor:

often in the first workshop, people were a little confronted by the process and what really helped was having members from the senior leadership team or the knowledge brokers there to provide that reassurance of 'we've been through this, trust the process ... it'll be all right'. That was so helpful to me that the Challenge had invested upfront in taking the senior leadership team and the knowledge brokers through an iteration, to give them familiarity with it. (Facilitator)

As is the case with any collaborative process, having leadership support and leaders championing the process is vital to success. In this case, the Challenge leaders supported and championed the process. Indeed, whenever it was possible, one or both of the Challenge directors introduced and/or attended at least part of the workshops:

I've also learned that it's important that the leaders, in this case, the Challenge leaders, were fully committed and were championing the design process. They were champions of it, as well as champions of co-design and co-governance. If you had directors, leaders or senior members of an organisation who were lukewarm in respect of design, I'm not sure we could've achieved what we achieved. It was only really the 110% commitment of Andrea and Mel that I think allowed us, within the timeframe available and the resources, to perhaps deliver on what we were able to deliver. That's consistent with what the research also indicates elsewhere, is that you need leaders who commit to the design process. (Facilitator)

From observing the process, a useful strategy was having a poster of the double diamond on the wall at the back of the room so that everyone could see what stage the process was at (e.g. convergent or divergent thinking) and how the team was tracking.

5.1.2 What did not work so well?

While there was broad agreement that the design-led process was most welcome and appropriate, it was recognised that some SO team members struggled with it. An important reflection came from a Māori team member who thought the design language was 'strange' and thus was not helpful for communicating with whānau about the process and what it was trying to achieve. Another Māori team member explained it was a matter of 'going with the flow' until the 'method in the madness' became visible.

Not having preconceived ideas about solutions or where the process might end up is a key part of the design *modus operandi*, but it was unsettling for some. A member of the SLG reflected on what some SO team members were saying in the early stages: 'people would say, "I'm scheduled to do four days of this, this feels like a waste of time to me."' People couldn't see where it was going to end necessarily. Phil was very clear about that'. It was also observed that '[s]ome people just embraced the process and could just let go

and go for it and others, I think, fought it the whole way and really felt like a fish out of water'. (SLG member)

Some participants were concerned that the design methodology did not go far enough and the process required a further step to test and critique ideas:

I really liked the design thinking workshop and process but we need a bit more science process on the end of it. I think if you're trying to design something for a business and Phil says this, when you're going through the process, it's great for fast fails. Actually, what we were trying to get out was some solid, robust, long term programmes and plans. (SLG member)

Related to this, a researcher participant saw the design-led process as useful for generating ideas but not necessarily for winnowing them. 'I think it's a good strategy for fast-fail, generation – of putting ideas on the table. I'm not quite convinced that it's good for taking ideas off the table and settling on the final ones'. The concern here is that the process, as it was structured, could not adequately test ideas to decide whether they should be on or off the table. An SLG member felt the design process needed to be more iterative, so going back to make sure things had not got lost:

you didn't always know at which stage in the process things were getting filtered out; in other words, that this would be your last opportunity to include an idea. I know in some situations I was in, we actually went back and we pulled some ideas through that had fallen out because they added something, an idea that had not made it through. I think for the design process to work well in this space, I think it needs to be a little bit more iterative than just the double diamond.

These reflections draw attention to how the divergent and convergent thinking aspects of the process worked. Suggestions that the process does not go far enough and perhaps did not involve sufficient scientific expertise to assess the various proposed ideas raises a question about whether science programmes should be treated differently to product design, which these design principles have typically been applied to, given the somewhat different end-point, which ultimately needs to be more than a minimum viable product or a fast fail.

5.2 Convening strategic outcome teams

While the SO teams and the design-focused outputs they produced with a considerable number of Post-it notes are highly visible artefacts of the process, it is the somewhat invisible but carefully crafted administrative aspects that were critical for convening the SO teams and establishing the foundations for this new process.

5.2.1 What worked well?

These indispensable administrative aspects included a letter of offer (Appendix 4), which explained the expectation of 5–8 days' work over the ensuing 3–4 months, which would include two 2-day face-to-face meetings and the likelihood of one other face-to-face

meeting. The letter explained that SO team members would be paid an honorarium of NZ\$1,200 per day (excluding GST), plus actual and reasonable expenses.

The letter also directed recipients to links to the following documentation and required signed acceptance of the offer, which represented an agreement by SO team members to comply with this documentation (Appendix 3). This documentation provides important insights on how the Challenge envisaged the scoping groups process should work, what the Challenge required of SO team members, and how these expectations fitted into the overall mission:

1. **The 38-page Strategy 2019–2024 for Tranche 2.** This provides a comprehensive explanation of the Challenge mission, its achievements in Tranche 1 and lessons learned, engagement undertaken to refresh the Strategy, investment priorities, an overview of the new strategy and approach and what it would require in terms of investment strategies and priorities, guidance on potential actions across the innovation system, how the Challenge intended to give effect to the Vision Mātauranga policy and its innovation system approach through co-design focused on impact while also delivering on commitments to science excellence and much more (<https://bioheritage.nz/wp-content/uploads/2019/05/STRATEGY-FINAL-JULY092018.pdf>).
2. An **abridged version of the Strategy** in an easy-to-carry small booklet, which was highlighted by participants as extremely useful.
3. **Terms of Reference (TOR).** The TOR state an expectation that Stage 1 of the scoping and design process would take 3–4 months and that individuals involved in Stage 1 ‘may have the opportunity to remain involved in Stage 2’. It also explains that Stage 1 would involve ‘building networks of relevant expertise that could contribute to the delivery of the SO’. The TOR goes on to explain that the intention of the Stage 1 scoping and design process would be three-fold:
 - a. to ensure that a wide range of solution-focused perspectives and novel research approaches are built into Tranche 2 of the Challenge, in order to drive transformational change
 - b. to be as inclusive of all relevant research expertise, aligned disciplines, and knowledge systems as practicable
 - c. to drive added value from all relevant capability, skills, and current investments, and to ensure that these are better connected, so as to present a more cohesive, ‘joined up’, and compelling narrative that will incentivise investment in environmental outcomes for the benefit of Aotearoa.

The TOR emphasise that ‘the Challenge does not intend to invest in research projects per se’ and that ‘Contracts will be focused on overall delivery of each SO, with Challenge investments targeted to high-priority research, innovation, and translation gaps and potential barriers to delivering overall benefit for Aotearoa New Zealand’. In other words, funding will seek to catalyse research and actions across the innovation pathway as programmes of work.

The TOR state that design teams will be required to 'construct a complete innovation pathway ... focusing contributions from a wide range of co-investors, to deliver step change towards the Mission by 2024', with the main deliverable being the investment prospectus and that Stage 1 groups 'have been established to scope and design an Investment Prospectus for each SO'.

Importantly, the TOR explain that Stage 2 would be for laying out detailed plans for research investments. (Appendix 5)

4. **A non-disclosure agreement** to 'create a safe environment' for the exchange of confidential and sensitive information, which SO team members were required to sign (Appendix 6).
5. **An interest register** to ensure transparency of the process and record any conflicts of interest (real or potential).

These administrative documents established some important rules of engagement. For example, the letter of offer established a foundation for exchange between the Challenge and each SO team member: payment for time and commitment to the tasks outlined in the Strategy. This payment for time and expenses opened up the process to many people who would not otherwise have been able to participate. The non-disclosure agreement made the contributions of all SO team members (including ideas and concepts, information, data, mātauranga Māori, know-how, whether technical or not) 'confidential information', which could not be disclosed or published by others without consent. Hence, everyone was bound by 'certain duties of confidentiality and non-use in respect of the Confidential Information in both written and verbal form'. The strategy and terms of reference provided considerable guidance on what was expected, and that the deliverable of the Stage 1 process was the investment prospectus.

Participants were asked why they applied to be involved in the Challenge's scoping groups. In answering this question, a number of participants recounted negative experiences in Tranche 1 with this and other NSCs. Several participants recalled what they described as seemingly endless workshops, where they were divided into groups of researchers, sometimes with stakeholders, who were tasked with working out what research should be done. These meetings were clearly memorable. I was told by several researcher participants how meetings tended to descend into arguments between people from different institutions, with those with the loudest voices taking control and, ultimately, ending up with the money:

I guess from my experience [with another NSC] ... it was the big dogs got in. They were just reproducing the same work and the same behaviour that is negative. If you're slightly outside of the clique or outside of the traditional way of how science is meant to be undertaken, then it's quite a negative experience. (Māori team member)

I was told that experiences such as these made researcher participants reluctant to be involved with NSCs and similar processes. When asked what overcame their reluctance in this case, it was the values of the Challenge and its commitment to do something quite different that were critical. Other participants explained they were encouraged to apply by

their organisation or the Challenge to ensure needed experience from stakeholder organisations or expertise gaps were filled. Some participants had been involved in Tranche 1 and applied to maintain continuity, while another wanted to ensure issues they considered were not fully addressed in Tranche 1 were addressed in Tranche 2. Some also talked about involvement as an opportunity to see how high-level decision-making was done, or to make sure the Challenge and researchers understood the practical end of the use of science.

Māori participants were encouraged by the Challenge's commitment to co-leadership, mana whenua engagement and the opportunity to rectify a lack of Māori involvement in managing kauri dieback. For Māori participants, co-leadership demonstrated that the Challenge was serious about partnering with Māori, doing things differently, and recognising mātauranga Māori as a legitimate knowledge system alongside Western science. These commitments were seen as supported with real decision-making power (i.e. Māori co-leadership of the Challenge and Māori co-leadership of some SO teams) and resources made available for Māori team members to be involved across the scoping groups. The Challenge was also recognised for uniquely providing institutional safeguards for mātauranga Māori.

Through my discussions with participants it was clear that the process deeply changed some of them. For two participants, this related to gaining a deeper understanding and appreciation of issues of concern for Māori that had not been fully appreciated. The process and convening of these groups created a safe space for close encounters and important conversations:

just the incorporation of mātauranga Māori and where we got to and other groups as well. It was just how we worked. It wasn't a separate objective, it was just how we operated. That's a big cultural shift we're going through, I think, in New Zealand. It's great that it's seeping into all aspects of what we do. Personally, it challenged me to do better, learn more about that. I've enrolled already to do a Te Reo course next year. That's driven from that stuff. I was embarrassed. I didn't really know anything about it and I actually said on the first day, 'All this stuff, guys, is just fluff, how you get to your outcome because that's really what we're trying to do. There's no time to waste. We've just got to get there as fast and as hard as we can.' Actually, how we get there is probably more important in some cases. It definitely changed my thinking. I was wrong. (Stakeholder)

An important aspect of convening the SO teams was the application and selection process. It was noted by participants that the Challenge application was not the usual format (e.g. focused on credentials and/or the number of publications). It was more about why you wanted to be involved, where you saw yourself fitting in, and what you could offer the Challenge (see Appendix 7). According to the Kaihautū Ngātahi, the application sought to elicit people's commitment to the values of the Challenge, which enabled the selection of people committed to those values alongside what they could offer:

I think the way we picked the SO teams worked really well. Having an EOI [expression of interest] process that was focussed on values, what you brought to the team and the like was a really good process that got us the right people.

Overall, participants were very positive about the diversity of views, skills and knowledge of the people in their respective groups:

I was pleasantly surprised to be honest. There was a good diverse team of ages and gender. There was good Māori representation. There was a decent focus on allowing minority positions to come forward, which was new. I hadn't seen that done in other Challenges, so I was reasonably impressed ... I'm not the person for diversity's sake. I think people have to be there because of their competency as well and experience and so on. I think there's just quite a good mix of competency, diversity and experience, which made us a pretty good team. (Researcher)

I thought it was fantastic. At least our group, I thought was a really good mix from early career researchers to old grey heads ... The cultural mix as well, the mix of science and end users. I thought if you were to encapsulate a cross section of the research world in just six or eight people, I thought the Challenge did really well, at least in our group. (Researcher)

Participants were also surprised by the openness of everyone to the views of others, which was in stark contrast to past experiences of developing research ideas and agendas in other research settings.

As discussed, the knowledge brokers assigned to various teams were recognised as immensely helpful through providing advice on direction and expectations, as communication lines to the SLG, answering queries and insights on what was occurring in other SGs, and generally helping.

Having Māori members in all but one group and with more than one Māori member in some groups was recognised as highly unusual and was seen (not only by Māori participants) as demonstrating the Challenge's commitment to the inclusion of mana whenua and valuing their input. Some Māori members noted that they started the process feeling wary but by the end they were very comfortable:

by the end of the second workshop, I was quite happy to engage with any of the team. I wouldn't have been like that going into the workshop. There were some that I knew, some that I didn't know prior to the first workshop. I was really comfortable talking to anyone and everyone by the end of the second workshop. (Māori team member)

Māori participants maintained that the process provided a rare opportunity for them to engage and express views on an equal footing with researchers and stakeholders such as the Department of Conservation and Ministry for Primary Industries. Māori participants had an opportunity to question researchers and stakeholders, provide their Māori

perspective, and propose responses that had the potential to put Māori needs and knowledge at the centre of research projects.

As mentioned, teams nominated leads and, in most cases, co-leads. These leadership roles were open and taken up by Māori members. It was clear from Māori team members that co-leadership roles at the head of the Challenge and across the teams built credibility and legitimacy for Māori members as well as their wider whānau and networks, whom Māori members were interacting with during the process:

That [co-everything] allowed for relationship building, and for me, that's the key underpinning thing that makes the difference, building that relationship, building that trust and sharing the learning as a part of that, so the process of co-everything, building relationships and the values [worked well]. (Māori team member)

Including early career people within the SO teams was also recognised as invaluable, in particular in terms of the energy, enthusiasm, and capability created. The Challenge's commitment to the inclusion of early career researchers within SLG and SO teams led to the realisation that the 'early career' label needed to be extended beyond researchers to early career people in regional councils, industry and government organisations. However, having stakeholders and people with experience in the room provided important reality checks:

We did have one or two people that were quite, really reticent, quite anti and cynical, burned after years of trying to do this sort of stuff ... and seeing things get worse. ... They were needed as well because they were telling us a bit of a story about the nature of things and the way things were. (Researcher)

What was also recognised as invaluable was the amount of time SG members were able to spend with each other over 4 days of workshops, with a considerable amount of social interaction time in between. I was told that workshop exercises helped understand one's own capabilities and strengths of others. Tea and meal breaks allowed people to get to know one another and build rapport. Some participants mentioned that these gatherings were invaluable networking and bonding moments.

Hence, the application and selection process were validated by the reports of rapport and the willingness to work together created within SO teams groups, and the profound change the process instilled in some. The process enabled the Challenge to convene the 'right teams' based on expertise, but also demonstrated a commitment to the Challenge values, as well as the effort dedicated to the workshops to bring people together face-to-face for a considerable period of time.

5.2.2 What did not work so well?

As set out above, there was broad agreement that the groups were inclusive, diverse, competent and affable. For Māori members they were empowering. However, there were tensions. For example, although participants were happy with the diversity of views, expertise and experience in their respective groups, reflections on what did not work so well revealed concerns about a lack of different types of research expertise. For example,

concerns about a lack of social scientists, a lack of scientific expertise for the needed step-change, and a lack of interdisciplinary capacity were raised. For example, the following reflection highlights a researcher's concern that she/he was expected to cover all of the science:

There was not really a modeller in the room or someone who knew that sort of side of it, so it does make me nervous. We might have the right team in terms of personalities and complementary skills but not enough in certain areas ... I felt nervous that we were relying on my knowledge of what's out there ... Of course, I can't be aware of all of the stuff that's going on out there, and is this actually the right approach? There could be many approaches scientifically to take to that problem. (Researcher)

There were also concerns about a lack of expertise to assess what should and should not be on the table (to be discussed). The issue of absent stakeholders in some groups was also raised (e.g. a regional council representative in one and a Department of Conservation representative in another).

In terms of team leadership, the point was also raised that leaders are busy people and did not have time to follow up team members, many of whom went back to focusing entirely on their day jobs once they left the workshops. It was also mentioned there was some hesitation from leaders in some groups to delegate tasks, as this was not seen as their role. It was suggested that what was needed was more of a coordination role, with a Challenge coordinator for each team being the responsible person dedicated to this role and delegating tasks, following up, chasing people and keeping track.

As discussed, various members of the SLG sat around the tables with SO team members at various times throughout the scoping groups process. It appears their role was not entirely clear, with some SLG members conveying that they felt slightly conflicted about whether to contribute to SO team discussions or not. This tension related to an important issue that had been raised in the formative stages of the scoping groups process, which was that the SLG should not attempt to drive the scoping groups' process in any particular direction, and that SO teams should own the process, which could be jeopardised if the SLG intervened or was perceived to be intervening. Hence, '[t]here was a bit of a balancing act, where I might feel like I had something to contribute in terms of where I thought it should go but really felt it wasn't my role to do that' (SLG member). However, it would appear SO team participants were not aware of this tension, and in their contributions they recognised the considerable value of having members of the SLG at the meetings, in particular the knowledge brokers, to provide guidance, answer questions and give feedback across the SO teams.

It was also recognised that the process and what it arrived at was 'hugely dependent on the people in the room and the voices that are there' (researcher), implying that the outcomes would be different if different people were involved. Another felt that large groups tended to 'arrive at the average', and that creativity is usually fostered by small groups working on particular tasks that can take things to a new level, which are then brought back to the larger group so that everyone is on the same page and learning from

each other (researcher). Group size was also raised by the facilitator, who found, overall, it was easier for groups to build a consensus on their goals when the groups were smaller.

5.3 Connections between teams

The Challenge created its design teams around the SOs. The Challenge Co-director explained that integration would be done by the Challenge at the end of the process once the investment prospectuses had been completed, i.e. when all the pieces of the puzzle were most visible. Nevertheless, a range of opportunities were created to create connections between teams and for cross-fertilisation to occur.

5.3.1 What worked well?

There was a range of ways to connect across SO teams. For example, there was a Friday Skype meeting with leaders of SO teams, which provided information and feedback opportunities between SO teams and the knowledge brokers within SLG. Also, with several staff involved, regional council members and SO members from at least one Crown Research Institute held meetings outside their group meetings to catch up and compare notes. There was also a network of early career people that video-conferenced regularly, and Māori members connected at different times.

As discussed, the Challenge's knowledge brokers played a key role in cross-fertilising among the teams they were involved with (some were involved with two or three), and they would link up via SLG meetings. Also, in some cases SO team members attended the meetings of other SOs where SOs thought they could or should be linked to others. While not through formal arrangements, SO team members were free to link up with others, and some reported that they did so.

Some participants referred to the half-day get-together in Christchurch for SO team leaders and the SLG, which occurred after the first round of workshops. It was recognised as very important for making connections across the SOs and finding out what others were planning. This meeting presented everyone's draft goals and to some extent included feedback SO teams had obtained on those draft goals from stakeholders, researchers and Māori networks. This helped SO leaders see what others were doing, where there were crossovers, and where there appeared to be gaps. This meeting instigated Skype conversations between some SO team leaders.

5.3.2 What did not work so well?

Although the Challenge intended to do the necessary integrating across the SOs once the investment prospectuses had been completed (Challenge Co-director), research participants felt that a more integrated approach could have helped make their jobs easier. Hence, while it was acknowledged that some interaction occurred and that some SOs needed more interconnection than others, it was observed by participants that there was a lack of connection between SO teams because they were developed in isolation.

It was noted that this absence of connection was occurring out of necessity, as teams were so busy working with their own SO or doing their day jobs there was limited time to

connect with others. The implications for groups working in isolation were that participants experienced confusion about who was proposing what and how the outcomes of one SO group could, or should, ultimately feed into another and when. The following reflections highlight these concerns:

I think that there are some quite critical interdependencies and for it to work as a cohesive whole, you do need to be able to know whether these things are fitting together, and while it might make sense for this group to be developing this if this is the case, but if that's not the case then maybe it would make more sense for them to be doing something else or whatever. I think some way of being less siloed about that would be useful. (Stakeholder)

The Friday things allowed a bit of cross fertilisation but most of it was mechanics. I think there was a bit of a sense of 'we didn't get the ability to join up'. Obviously, as soon as I saw a couple of the presentations [at the pitch days], I thought well good, we won't have to fund that one because that's over there. Ultimately, when those drafts are finalised, hopefully there'll be a little bit more synergy between them. I don't think the process really allowed that to happen very well. I think that's because everyone was on a day job, so you tried to minimise the amount of time that you were putting into it, to balance all your other bits and pieces. (Stakeholder)

It was also recognised that a number of SOs needed to interact because a lot of the goals they designed were 'social goals':

at the end of the day, a lot of the goals that the SOs would like to see achieved were really social goals, as opposed to more concrete things. There were very few things like build a better trap, but there were a lot [of goals] around empower people, enable people, motivate people and engage people. As an aside, we were definitely short of social researchers. That was an ongoing thing. A lot of people had those same goals. However, there was one SO, which was SO2, I think, which was primarily directed at those social goals: 'We empower New Zealanders to demand stewardship and kaitiakitanga.' That reflected what a lot of SOs wanted to do, in terms of empowering, enabling and motivating. (SLG member)

The point was also raised that it was not clear who had (or could have) a complete picture of what was going on across all the groups, except perhaps the facilitator, but he was busy facilitating. 'Having that overview and seeing how the different parts of the puzzle were developing and actually where the SOs haven't got up to speed, I think that could've just equalised things a bit more' (researcher). Another participant was concerned the structure was not holistic:

I didn't like the structure – it was all divided up. I'm used to looking at the whole and the big picture – the process seemed odd. I would talk about one thing and be told that was being dealt with by this group and I'd talk about another thing and was told that was being dealt with by another group. It's hard to focus on bits. (Māori team member)

5.4 Empathy mapping

As discussed, empathy is central to design thinking. Empathy was built into the process in a number of ways. Workshop exercises encouraged interaction and conversations that built understanding and respect for the knowledge and perspectives of others. In addition, empathy mapping and personas (to be discussed) were used to bring into view the contexts, world views, issues and challenges of stakeholders, tangata whenua and other potential end users already in the room and those outside it.

What is referred to as *empathy mapping* was introduced to SO teams in the first workshop. They were told it involves in-depth conversations to build a detailed picture of what a person in a particular role is seeing, hearing, saying and doing, in order to develop an understanding of their 'pains' and where they are seeing potential 'gains'. In a product design context, these insights are imperative for designers seeking to create something that is relevant, useful and compelling. However, gathering detailed information can be time consuming and time is usually limited. Also, the extent of the detail gathered through empathy mapping can be challenging for a design team to work with. Hence, another approach is to develop a *persona*, which involves asking a person in a relevant role more specific questions about positive and negative trends, headaches and opportunities, hopes and fears (Phil Morrison, pers. comm.).

5.4.1 What worked well?

During the first workshop SO team members learned about empathy mapping and personas and practised doing them with SO team members who volunteered. Between workshops, to build up the bank of empathy maps and personas, SO team members were asked to do more empathy mapping and develop more personas to build up the information needed to write an investment prospectus that embodied the pains and gains of relevant people and organisations, and that was sufficiently tailored to encourage co-investment. In all, over 60 empathy maps and personas were developed through the scoping groups process. The idea was that even though these artefacts were created by different groups, they would form a bank of insights that could be used by all teams.

Participants were asked what role the empathy mapping played in the work they did. It was found that empathy mapping and personas were new to many participants, although some felt it was something they did all the time, which is about finding out who your audience is. One participant found it highly useful when applied:

I did one of the empathy maps ... and it was such an easy conversation to have and just the amazing information that dropped out after an hour's conversation over coffee was just incredible. It gives you some really easy things that you can see how you can implement some projects or whatever to solve a whole lot of problems. (Researcher)

Another could see its potential value in their own working environment:

I think that [personas] were useful, particularly in the design part of the process. I'd not come across them before as a thing and I thought they were really interesting and actually brought that idea back to something that we

were working on here, which was quite gnarly and involved some quite conflicting value positions ... with care, this is possibly quite an interesting way of eliciting a better understanding of different perspectives. I was quite impressed by that as a concept. (Stakeholder)

Another was surprised at how empathy mapping illuminated unexpected insights into what really goes on in large organisations, which helped explain observed challenges and barriers (researcher).

5.4.2 What did not work so well?

Another participant felt that the empathy mapping questions were too rigid to fully understand where people were really coming from (researcher). Another felt its utility would vary with how empathetic a person is and it lacked rigour:

I get the impression that the value of empathy mapping is on a person-by-person basis, so from the person who's doing the empathy mapping, because some people are more empathetic than others. People who wouldn't normally perhaps think about things from the perspective of another person, they might get more out of the empathy mapping. I know people who are just completely selfless and are always thinking about what's that other person thinking. They might be quite good at empathy mapping, they're doing it all the time anyway. I got the feeling that as a tool, it's a tool that's probably more useful for some people than others. Personally, from my ... scientist perspective, I thought it was a bit wishy-washy. I'm supportive of social science and everything but I'm still a little cynical of the fuzzy edges of it. It seemed to me that that part was right in the fuzzy edges of what I'm comfortable with for a science process. (Researcher)

5.5 Developing goals

The purpose of the goals was to break down the Challenge's high-level strategic outcomes (or problems that needed to be addressed) into more tangible aims. A considerable amount of time was spent by SO teams developing the goals over the two workshops. The goals were to be negotiated and agreed upon by researchers, stakeholders and Māori research partners inside the room, and to some extent outside the room, through seeking feedback (to be discussed). In effect, the draft goals were the minimum viable product of the first workshop. It was envisaged that the finalised goals would enable the SO teams to tell a compelling story about what was needed in terms of research and pathways to impact in their investment prospectus to encourage partnerships and co-investment.

5.5.1 What worked well?

Development of the goals occurred in two stages. In workshop 1, divergent and convergent thinking exercises (e.g. context and stakeholder mapping, empathy mapping and personas) were the building blocks for teams to begin developing their goals. Through a range of activities and the development of canvasses that captured ideas on Post-it notes, and considerable wordsmithing, the draft goals emerged for each group by

the end of workshop 1, with most groups feeling comfortable with their goals at this stage. Through this process, and given their siloed development, a number of questions arose about the goals and whether other teams were or might be addressing particular aspects. These questions were parked on a separate canvass to be taken back to the SLG for answers and to feed back to the teams. This approach allowed conversations to continue while knowing the questions were not going to be lost and answers would be forthcoming.

5.5.2 What did not work so well?

While each group came up with their goals, it was quicker for some compared to others. A researcher commented that some of the strategic outcomes were just too big, which made deriving goals very hard and time consuming:

people got stuck on lots of these conversations that would go around and around. Some really valuable stuff would come out of them but they would take a long time. That, I think, is partly about ... the wording of that strategic outcome. It's huge. It is absolutely huge. (Researcher)

While not suggesting SO1's mandate for a scorecard was in any way easy, it was noted by some participants that this team at least had something tangible to focus on and work with. For other groups, a scorecard could have been one of 50 or more ideas that the teams proposed in their divergent thinking process in workshop 2 (to be discussed).

The next step was to take the goals to stakeholders, the research community, Māori groups and organisations, and mana whenua.

5.6 Feedback between workshops

At the end of workshop 1, SO teams identified and prioritised the organisations and people that were not in the room but with whom the team needed to engage before the second workshop. Teams were encouraged to draw on their own knowledge and experience, but also the stakeholder mapping exercise they had done in workshop 1 to ensure they prioritised who to talk to for gauging interest in the goals, prospects for co-investment and/or going back to for further conversations down the track.

There was also an expectation that partially developed personas (i.e. personas built on assumptions) would be either validated or updated with real rather than assumed perspectives, and that further empathy mapping would be done to build up the bank of information and personas that everyone would have access to and be able to refer to in the development of their investment prospectuses. The activities of team members in undertaking these tasks and feedback were to be entered into a spreadsheet, which enabled contacts to be tracked by a contact's name and their organisation.

Team members were also expected to gather information to map out the 'lay of the land' or the existing 'portfolio of effort in a given area' (Investment Prospectus Guidelines, p. 1) (e.g. what research is being done, who is doing what, what partnerships already exist, who is making what contribution related to the topic, where are the gaps and what more is

needed?). This information was needed to develop an innovation pathway for each SO, to help decide what gaps needed to be filled, and to see where there were opportunities and prospects for partnership and/or co-investment.

5.6.1 What worked well?

Participants were asked for their impressions on this feedback process and what came back into workshop 2. It was widely recognised that this feedback process was invaluable. It provided an opportunity for SO teams to:

- make new contacts
- understand what was and was not being done by various individuals and groups, mana whenua, stakeholders and researchers
- gather different perspectives on their draft goals
- do empathy mapping
- identify research and implementation gaps
- identify who might be interested in working together in the future
- gather information about issues to consider when revisiting the goals in workshop 2
- see the big picture and where all the parts were.

This outreach and feedback process occurred in a variety of ways. Some asked about co-investment while others did not. Some sought feedback on the goals and some used empathy mapping, while others were more comfortable telling people about the process and what the Challenge was trying to achieve. It appears not everyone was comfortable with what was expected of them. Nevertheless, the process provided key information for the teams to move forward:

I think it was variable. Again, going back to people's comfort level in having those conversations with those people, some people were more comfortable than others. Some people were uncomfortable to begin with and then got better at it and loved doing it. In the end, though, I think the quality of the information that came back was good quality information and useful information. I think it did helpfully inform the process. You can see that the goals changed. Almost all the goals for all the groups changed over time, as people absorbed that information. (SLG member)

The tracking spreadsheet shows that over 200 people were contacted. Importantly, the spreadsheet under-reports the already very high level of engagement that was done by SO teams, because not everyone used the spreadsheet. Also, as noted in the quote above, all SO teams changed their goals when they came back to workshop 2 in response to the feedback they had received on their draft goals. It was clearly an important part of the process that allowed teams to reflect on where they were heading and to find ways to better navigate the pains and gains of the multiple voices they had heard from.

5.6.2 What did not work so well?

For some participants, while recognising that this feedback aspect of the process was important and useful, there were some important reflections on what did not work so well. It appears it was not entirely clear to some SLG members working with the SO teams what the purpose of the feedback was:

When groups completed the first workshop my take-home was to 'socialise' the 2024 goals and to ensure that Tranche 1 researchers who weren't part of the scoping process were in on those conversations. It was less clear to me that this period was about seeking co-investment. And yet that was where teams were expected to be before the dragon's den [i.e. the mock investment pitch]. It just seemed like a too bigger leap for most teams. (SGL member)

Concerns also related to SO team participants feeling uncomfortable about taking the goals out to others because there had been insufficient time to reflect on them at the end of workshop 1: 'they had been developed in the last hour of the first workshop ... There wasn't time for us to really go back and think about those draft goals before we had to take them out to the world' (researcher). It was also felt that the team 'didn't have enough to take out for testing' at that stage of the process (stakeholder).

Another participant conveyed that it was a somewhat overwhelming task trying to bring feedback from all of New Zealand into the room:

Talking to stakeholders was a big one because we were a group of x people or something, trying to represent the whole of New Zealand and all the complexity of the government and private and with the cultural aspects of that, so that was quite challenging. (Researcher)

Another felt uncomfortable doing what felt like social science, which was not this person's area of expertise and, in any case, they thought it was too soon for anyone to be able to make much of a commitment on co-investment. This participant also encountered reticence from some researchers:

I think a lot of people ... were feeling really burned by the first tranche. When we went to talk to people, particularly science people, it was very hard to get them over their cynical attitude about the Challenge and how all they do is workshops, workshops, workshops and here's another workshop they're having sort of thing. I felt that we weren't in a position to be able to convey the end goal to them and that there would be some concrete things, so we were kind of going, 'We're preparing an investment prospectus.' 'What's that?' 'I don't know what's going to happen with that' 'Is it like an RFP?' 'I don't know'. It's that cynical nature that scientists have, it was really hard to get them on board. (Researcher)

At a SO team meeting in Christchurch, the Challenge Co-director reminded SO team members that talking with and seeking feedback from the research community was a priority. She was concerned that a lot of feedback had been gathered, but that the research community was somewhat missing with everyone so focused on tangata whenua, stakeholders and/or end-users. These reflections indicate the difficulties SO team

members had when they went to researchers, in that there was cynicism and SO team members had little to offer at the time they went out to people.

As discussed, the expectation was that through this feedback process SO teams would also be able to build a picture of the 'lay of the land' for each SO. This was a key task that was necessary for teams to sketch out their innovation pathway. However, it was recognised within the SLG that this was not adequately achieved through the feedback process:

[I was hearing] 'We don't even know what's going on, we don't know what communities are doing We don't know.' I guess that's what we were hoping they would do. That's why we funded them. We kept saying to them, 'It's your job to reach out and find out what's going on.' I guess, again, that's where we didn't help enough ... We just underestimated the confidence of a lot of the people to go do that. (SLG member)

At the beginning of workshop 2, SO team members were asked to share their feedback by writing key themes onto Post-it notes (i.e. the learning download). As discussed, this was to help SO teams gain an understanding of where different partners, stakeholders and end-users were coming from, what their expectations were, where there were gaps and what was needed to fill them.

While this was also recognised as an invaluable part of the process, some useful reflections were made. One participant felt that the stakeholder feedback was not shared in the workshop in a way that capitalised on the insights people had obtained. It was suggested that this aspect of the process could have used the stakeholder mapping work done in workshop 1 to see where information had come from and where there were gaps. Indeed, it was thought that more talking and fewer Post-it notes would have been more helpful:

I remember us putting up the Post-it notes. I don't remember much of a discussion or at least not all of them, because everyone talked to maybe five stakeholders or so, and I didn't get a sense that everyone in the SO team got a handle on 50 stakeholders worth of ideas. Maybe that's because it's 50 stakeholders and that's too hard to summarise. I, at least out of the people I talked to, I could have said, 'I talked to these people. They were fitted across this area of stakeholder space and the common themes that were coming from all of them were this, this and this.' I felt like Post-it notes weren't necessarily the best way to communicate that. (Researcher)

Another thought was that there needed to be more diverse feedback and there could have been feedback bias:

Potentially, it would have been good to have a bigger mix of feedback. The other thing is people who had really negative feedback probably would have just deleted the e-mail or not responded. It was a little bit self-selecting in that way. That's just how people work. (Researcher)

Following the learning download, teams substantially revised their goals with the new insights they had obtained and collective reflections. In the groups I observed, revising the

goals was an incredibly fruitful but challenging process, and it took some groups longer than others. Importantly, the time taken to revise the goals had knock-on effects for the draft investment prospectus, because once the goals had been finalised, they had to be translated into impact pathways. The problem for the facilitator was that it was difficult to move on from the goals unless everyone was happy with them, but time was ticking away. Hence, for some groups, a considerable period of time was spent litigating the wording and structure of the goals, which meant 'not so much time translating them into more tangible things' (researcher).

5.7 Impact pathways

Translating the finalised goals into 'tangible things' (i.e. possible impact pathways) occurred through a divergent thinking 'headlines' exercise and then a convergent thinking process to narrow things down. SO teams were given 2 or 3 minutes to think up and write down a media headline with an accompanying rough sketch of an action or idea that could be done or used to deliver the team's goals. The idea with this exercise is that with a short period of time to do it, 'sometimes you get the best ideas when people don't have a lot of time to think about it. It's the first thing that pops into your head' (Kaihautū Ngātahi). This design principle underpins the minimal viable product concept: developing ideas needs to be efficient, and a potential product needs to be recognisable, not complete; if it is complete it can be too hard to modify. This avoids people overthinking things and coming to the table with preconceived ideas.

The many headline contributions were subsequently viewed by the group and aligned with the team's goals or put aside if they were deemed out of scope or not feasible. Opportunities from the various contributions for building links with mātauranga Māori, social science and early career contributors were identified through a dotocracy process (i.e. ideas with the highest number of coloured sticky dots) and, if identified as within scope, were pulled through to the next stage of the process alongside other contributions. From this point, these ideas and the other work the SO teams had done through their workshops were reflected upon and assembled to populate a draft investment prospectus.

5.7.1 What worked well?

Participants were asked about their experience of the headlines process. Some recognised its purpose was to ensure people did not overthink ideas and to encourage people to boil things down (SLG member). Another saw it as a good starting point for further ideas to be developed (Māori team member). Others saw it as a fun exercise, a good way to get ideas down quickly and, although it surfaced lots of weird ideas, it was felt that the groups ended up with 'not so weird ideas' (researcher). Another saw it as a very useful way to distil ideas and backcast from the desired outcome rather than allow a process to determine the outcome:

The headlines process, that was, again, good because it's that outcomes-driven process. It's saying, assuming all this works well, what do you want to see. Sometimes people don't think about the outcomes, they just think about the process and maybe just let the process determine what the outcome's

going to be. It's interesting to put yourself in and say, 'Actually, this is what I want to see and this is the headline I want to read about.' Then, it does allow you to backcast from there. I think again that is useful because it can, very immediately, distil what your desired outcome is. What is it that you want to see from this process? The headlines were quite useful for doing that. (Māori team member)

5.7.2 What did not work so well?

Others were challenged by this aspect of the process and talked about struggling under the pressure, which meant they were 'spewing out garbage' (stakeholder) or they 'lost the plot' (Māori team member) and felt 'pretty stupid' in the midst of the process (stakeholder). There was also concern that although it was a divergent thinking exercise, it was divergent in particular directions:

the questions for that were reasonably prescriptive. They weren't, say, what headline would you like to see out of this project but more what do you think this group [e.g. social scientists or early career researchers] would like said within a topic. I felt like that limited the parameter space of ideas, I suppose, that we were able to explore. (Researcher)

This researcher also felt that the exercise was constrained by the assumed audience of newspapers – the general public. Hence, the ideas one could think of had to appeal to that audience. A further reflection was that the exercise did not capitalise on the expertise in the room:

I struggled a bit [with the headlines exercise] to pull stuff out in that pressure situation and a lot of what I saw come out of other people's heads probably wasn't their best. [Xyz] is a case in point. I think a lot of [xyz's] headlines, from memory, were very much in the app or computer game type thing or whatever, but actually there's so much rich science thinking in [xyz's] head that of all the value that we could pull out of [xyz's] brain, that's really not the thing. (Stakeholder)

Relatedly, another researcher was concerned that while this exercise might have been able to address 'known unknowns' it could not get to 'the solutions we haven't imagined yet'. As such, it 'missed more of that upstream [i.e. discovery focused] thinking as a result of that process' and focused attention on the right-hand side of the innovation pathway (see Figure 1), which addresses translation and adoption. It was observed by several participants that many of the ideas coming from the headlines process were predominantly seeking to overcome social barriers (SLG members, researcher, stakeholder).

It was also raised that some SO team members were not aware that the headlines exercise would be the last opportunity they had to propose priorities and ideas, and that what was selected from that exercise would be used to populate the investment prospectus:

we were told to stick Post-it notes about things and brainstorm and be creative, so we did that. Then, the next thing was to take a selection of those

Post-it notes and write newspaper headlines and a little picture. That was a lot of fun and everything. Then suddenly, they turned into our priorities and we had no idea that that was coming, so we probably would have chosen a little differently or in a more informed way at least from an earlier step if we'd seen where the process was going a little more. (Researcher)

As already discussed, it was observed by SLG members that SO team members were concerned about not knowing what was coming next and a lack of critical reflection on the ideas that transpired from this exercise:

they did a news article [exercise] but it goes through a real harsh filter and most people are being a bit facetious and joking around with the news article. A lot of people were really frustrated at the end because they were like, 'I just wish we knew when we were going to go through a harsh filter so that we would spend a bit more time thinking about it or arguing over it.' I think a lot of people got to the end of those workshops and were not really sold on what we'd decided on. (SLG member)

5.8 The investment prospectus

Following the headlines process, SO teams progressed to working on developing an investment prospectus canvas to generate thinking and inputs for writing their draft investment prospectus. From a design thinking perspective, the investment prospectus was to be the minimum viable product of the Stage 1 process. Importantly, the investment prospectuses the groups developed were never intended to be a final product, but something that could be modified after receiving feedback from the mock investment pitch process, but also in response to feedback from the Challenge and its various stakeholders and governance bodies.

Although they were intended to be 'draft' at the end of the process and for the pitch, the investment prospectuses still needed to be sufficiently developed to enable a coherent and compelling pitch to be made to the mock investment panel as well as other SO teams, and a range of Challenge stakeholders that had been invited to attend the pitch days. The investment prospectus in its final form would be used to foster partnerships and co-investment now and into the future. SO teams were presented with a template for the investment prospectus at the end of workshop 2, into which they were asked to aggregate the information and ideas they had gathered and developed through the workshop process (Appendix 8). The template indicated the prospectus should be no longer than 20 pages, which surprised a number of SO team members.

5.8.1 What worked well?

Extensive and clear guidelines were written by the Challenge for SO teams to explain the why of the investment prospectus, what it needed to do (e.g. tell a compelling story), how it would be used for encouraging co-investment, that it was not a research plan, how it linked to the pitch, and the activities that were needed to draft to it (Appendix 9). The guidelines also set out the assessment process the Challenge would use for the

investment prospectus and the Challenge's assessment criteria that would be used to assess whether the SOs were investment-ready. Taken from the guidelines, these criteria are:

- Clearly demonstrate the right team and pathway to impact to achieve the Challenge Mission;
- Demonstrate scale and critical mass (i.e. will likely represent several million dollars of effort across each innovation pathway), and/or be scalable in future as new opportunities and new connections come to light;
- Develop a narrative about overall portfolio of effort, and include storytellers and/or translators in the team;
- Critical knowledge gaps, potential risks, and barriers to delivery must be clearly identified and plans to target Challenge investment to overcome these clearly articulated.
- Demonstrate a balance of skill sets, disciplines and career pathways including (but not limited to) project management, conceptual science leadership, interdisciplinary researchers, stakeholders and communities, and how each will be resourced;
- Clear lines of accountability will need to be indicated in terms of delivery of metrics to evaluate success;
- The Investment Prospectus will need to demonstrate processes that will be used to cease investment if a pivot is required;
- Challenge resourcing should be allocated with an overall focus on successfully delivering 2024 Goals (delivery of which will depend on substantial investment in addition to direct Challenge resourcing);
- Co-leadership, including consideration of succession planning for postdocs, early career researchers and/or Māori leaders, will be strongly encouraged;
- Each Investment Prospectus will be expected to identify international connections and collaborations according to the Challenge's strategic guidelines, and to resource these

(Investment Prospectus Guidelines, p. 2).

The guidelines state that 'Characterising the innovation system around each of [the] Strategic Outcomes in order to incentivise investment is the aim of the Investment Prospectus'. It goes on to state that:

Only after we have mapped the overall portfolio of effort in a given area, brought essential partners on board, and identified critical gaps and opportunities can we drive transformative change: leveraging existing investments and investing in the right places to create impact ... [t]he intention of the IP is to outline how we will create impact.

The key to a good investment prospectus was identified as 'thinking like an impact investor – selling them on how we will create impact and transformational change in each of the ... Strategic Outcome areas' (Investment Prospectus Guidelines, p. 1).

As the culmination of the scoping process, each team developed and wrote an investment prospectus, which was submitted to the Challenge prior to the pitch days (to be discussed).

5.8.2 What did not work so well?

Interviews confirmed that some SO teams and team members struggled with the concept of the investment prospectus and writing it, for a range of reasons. A researcher was concerned it was a commercial world idea that was not really appropriate for science institutions, which operate differently to corporations in terms of where the ideas come from (from the bottom up in science organisations and from the top down in corporations) and how those ideas are put into practice. Another researcher was not entirely clear on the audience of the investment prospectus, nor what the investment prospectus was for:

I felt that who the audience is or was with the investment prospectus was very unclear and the term 'investment prospectus' was also quite unclear, so writing up basically a proposal was fine but who is this for? Is this what we are going to do with our funding and who we want to work with to make the biggest impact, or is it something that we are going to try to sell to others to become involved? I thought that those two concepts were very murky and not clarified. They actually were critical for us to do a good job on that. Is it, this is how we're going to invest our money, or this is how we would like you to invest your money? That is not clarified in the name. (Researcher)

This participant also raised the concern that the concept of investment too readily implied money, which people were reluctant to talk about, and did not sufficiently capture what was needed in many instances to address some of the goals, such as better and more targeted coordination.

The internal dilemmas that arose from confusion about what needed to be included in the investment prospectus are illustrated by these comments from another researcher, who thought there needed to be more science but realised that was not its purpose:

This definitely wasn't business as usual but I'm not sure we got fantastic research ideas. I'm not sure that was the purpose but certainly wasn't fantastic research ideas. I think they have to perhaps come in response to the prospectus but then I felt the prospectus tried to be too specific then. It felt like I was saying, actually in my opinion, I think you would probably do this as the only [science discipline] in this area in this room, but if you had had more people besides me, someone could have come up with something, an amazingly brilliant way of approaching it. Now, in a prospectus, it says to do it my way. (Researcher)

Another group also grappled with whether or not they needed to include research ideas:

I think we struggled as a group to narrow down to the research questions. Obviously, we're looking at [a] high-level portfolio of questions. I don't know if we tested those enough. We came through with our goals, we came about

that, but I'm not sure how much we really sat down and said, 'Where are our research areas?' (Stakeholder)

A lack of time dominated reflections on the investment prospectus. This was due to several factors. First, as discussed, finalising the goals dominated the second workshop for some, which had flow-on effects. A researcher participant was concerned that this meant there was not enough time to critically assess the priorities that were identified to deliver the goals:

There wasn't enough time to really critically assess those [i.e. ideas that went into the investment prospectus], because we were so pressed for time. It was really in the last three hours of the second workshop that we said, 'This will be the set of priorities that will form the prospectus.' Then, we had such a short turn-around time to submit the prospectus ... which was another thing, I think, that surprised me. There wasn't really any time to critically evaluate what we'd done and step back and say, 'These were some ideas that came up. Are these the best ideas or in the cold, harsh, light of day, would we go back and look at some of them and say, "Actually, that sounded like a good idea when we wrote it on a Post-it note but now, I'm not so convinced it's robust"', or something like that. If I was writing a grant application, for example, I would usually put some ideas together but then walk away from it a bit and then come back and look at it with fresh eyes and kick it a little bit and see if it still stands up. (Researcher)

Some teams had only 2 weeks to finalise their investment prospectuses. For some groups it meant that developing and writing the investment prospectus fell to only a few or was predominantly done by a single person. The short timeframe also created availability issues for team members to meaningfully contribute. This situation placed a considerable burden on those left to manage their day-job work and finalise the investment prospectus. It also meant that, for some, the collaborative approach that had been cultivated in the workshops was replaced by a more authoritarian work approach:

What would be another thing critical about that [i.e. the investment prospectus writing process] was the timing of it, the amount of time that we had to do it. 'Hey, you get to do this by the end of next week.' 'What?' 'We've got this many people to work through.' Everybody's busy and the amount of time that we were given for that, that meant, I think, that there were some people that went, 'I'm leading this, I've gotta do it, I'm gonna do it and I'm gonna do it my way. Okay, I'll get some feedback, I might be able to incorporate it, I might not,' that sort of thing. The timing was an issue. (Researcher)

Given the short timeframe, getting feedback across institutions within such short periods of time was recognised as challenging at the best of times and helps explain the more authoritarian approach:

it's always difficult when you're working across institutions and across systems ... you could ask a question or send an e-mail out to get contributions and responses and there'd be some that would respond straight away but others

would take more time. That's understandable because this wasn't part of their everyday role. (Māori team member)

The point was also raised that much more time was required than was expected, which, again, was difficult to juggle with day-job commitments and deadlines:

We'd been told, during the second two-day workshop, that everything that we were doing there would basically populate the prospectus for us, so we didn't worry too much about that. Then, when we got down to the nitty gritty, it contributed to maybe half of the prospectus but there was a whole lot more that we never expected and never had a chance to actually discuss as a group at the workshop. We had a lot of meetings outside the workshop, just our little team, where we had Skype meetings and things, trying to fill in some of the gaps. (Researcher)

As reflected in the quote above, several participants were concerned about the detail required by the investment prospectus and its absence in what had been worked up in the workshop. This meant those left writing the investment prospectus felt that they did not have what was needed to populate it. It will be recalled that some groups became jammed for time because they spent so much time finalising their goals that working on the investment prospectus steps had to be rushed. Hence, a stakeholder explained it was difficult to shift from Post-it notes to the detail required for the investment prospectus, and they were concerned about what occurred through the very rushed writing process:

It's a very big jump to go from broad concepts on post-it notes on the board to a written, detailed investment prospectus. I still don't feel confident that those ideas are accurately reflected in that document. It's just a bit of a rush and the way it was a couple of people writing. (Stakeholder)

A researcher participant in another group was also concerned that the building blocks for the investment prospectus were too high level. It was noted that the level of detail required a high level of knowledge and experience:

[there were many positive elements of the process but] I thought the negative element was that we only worked at a very high level. You could come up with very distinct high-level strategies, positions and perspectives, which is quite good. I mean, you want to come in with that high-level agreement of where to head, but there was often-times implementation of something in practice [that] requires a lot of detail of actually how you're going to do it. That's another layer of complexity, and that's where people with a lot of experience and knowledge come to the fore. (Researcher)

For this team, that detail got worked out in the process of writing the investment prospectus. Concerns were also raised that participants felt like they were 'plucking figures out of the air' to complete the investment prospectus (researcher and Māori team member).

A stakeholder participant was also concerned about a 'lack of science' and how the headlines process shaped what came through, which was that ideas tended to focus on

translation and adoption. This participant also explains the challenges the short timeframe presented, as well as implications of the process not occurring when it was originally planned:

I think my biggest concern [about the investment prospectus] is the relative balance of content. It is far too long in places – especially the delivery pathways section, and conversely, I think there's insufficient detail about the actual science that needs to be done. I think this is a result of a couple of things – partly, the prospectus content was really primed by that newspaper headlines, which, as we discussed, was in my view one of the least useful exercises of the workshops. Secondly, I think the prospectus template itself led us down that pathway somewhat as well. In addition, it was pretty challenging in terms of the timeframes we were given to work with, both in terms of the turnaround times, but also because it came much later in the year than originally forecast, so was hard to plan for in my work plan anyway. If I'd had more time I certainly would've got stuck in more to editing. (Stakeholder)

According to the Challenge Kaihautū Ngātahi, the process produced 'a lot of research plans' with empathy mapping not used as much as intended or expected:

I don't necessarily see a lot of that [insights from empathy mapping] translated through to all of the SOs. I think some did a really good job of understanding what the pressure points were and what the bottlenecks were for people, so understanding via the empathy maps what was going on. I don't know if they utilised them as well as they could have, especially not in the pitches. In the pitch day, they should have been using those empathy maps, they should have been using examples. Example: 'Person A, Melanie, has this problem and this is how we're going to fix it.' They didn't do that. (Kaihautū Ngātahi)

For at least one participant involved in writing an investment prospectus, the empathy mapping did not resonate and did not shift the conventional research-focused approach:

I wrote the prospectus in the same way that I'd write any science application really. We spent a bit of time in our team, trying to make it look nice and a little bit polished to try and sell it that way as well. Me, personally, I don't think I got a lot out of the empathy mapping stuff. I can't speak for others in the group. (Researcher)

Given the short timeframe, it would appear that participants did what they knew best.

5.9 The pitch

The final activity for the SO teams was to pitch the ideas mapped out in their investment prospectus to a mock investment panel. The purpose of the pitch was to challenge the thinking of the SO teams and for them to get feedback from neutral and independent observers to help further develop their investment prospectuses. In other words, it was intended to be a learning tool. It was expected that the compelling narrative around the goals and priorities developed in the investment prospectus that would encourage co-

investment would be tested with the investment panel and those who attended the pitch days. While the pitch was a learning exercise and a presentation of the draft investment prospectus (i.e. their minimum viable product), the stakes were perceived by participants to be high, as, ultimately, the content of the investment prospectus and feedback from the pitch would be assessed by the Challenge and its governance bodies and the International Science Advisory Panel for decisions on funding.

5.9.1 What worked well?

To help teams focus on what was required for their pitch, the Challenge provided 'Top 10 Tips for a Good Investment Pitch' (Appendix 10). The pitch days were a success for all teams, notwithstanding the crunched timeframe for several groups. All completed their investment prospectuses and developed a pitch presentation and presented it to the investment panel. SLG members were pleased that teams had delivered their investment prospectuses, that there were some amazing pitches and really good ideas, and that the Q&A at the end of each pitch had gone so well. Some participants found the pitch experience 'enjoyable' (researcher). Another described it this way:

I'm not a public speaker at the best of times. It was a daunting thing to go through at the start, but we just had confidence in the material that we had and the presentation team. The experience across our team was perfect, in that we had the right people there for the presentation. It was good. We had good confidence in our team to present and be able to answer the questions. (Māori team member)

Arguably, as a means of reviewing and testing what the SO teams had designed, the pitch saved a lot of time compared to what might have been required if the teams went back to the people they engaged with during the feedback process between workshops. However, the pitch was not conceived in this way.

5.9.2 What did not work so well?

Reflections on this aspect of the process reveal mixed feelings:

The pitching process, in reflection, I loved it. I thought it was great and I thought that the questions were the most valuable part of it. They really drilled down into an essence of what people were trying to get at but I don't think we'd given the teams enough support or help to be able to pitch really well, if that makes sense. So, I thought there were some really good nuggets that came out of it but there was still lots that could be done. (SLG member)

A phrase that was often used to refer to the pitch was a 'dragon's den', which appears to have conjured up unnecessarily scary and daunting imagery for some:

the Dragon's Den thing, I have very mixed feelings about that. On one hand, I applaud the ballsyness of it and the chutzpah to actually make that happen and to find people from outside the research world to give feedback and input and stuff. On the other hand, I think the process was quite intimidating to a lot of people. (Researcher)

Also, it appears that the room, which was a deep-sided medical school lecture theatre in Wellington, contributed to the intimidation – it potentially felt like a dragon’s den. ‘I get the feeling that some of the people who were presenting weren’t at their best because of the environment and the fact that there were these dragons that we were addressing’ (researcher). (It should be noted that the venue was a last-minute change as there were concerns that the original Rydges Wellington Airport meeting rooms would not be able to accommodate everyone who indicated they would attend.)

Participants were also daunted by expectations of selling their ideas to these ‘dragons’, who would not have the usual reference points of fellow scientists and were potentially expected to tear apart presented ideas.

[of concern was] that you are presenting science to potentially non-scientists and trying to convince them of its worth, so that they’ll make it possible. It’s easy to convince your peers because they have a background in that field, so when you talk about it, they have a point of reference. When you’re going to people that don’t have a point of reference and are potentially critical of your ideas but are ultimately responsible for their funding, that is quite daunting.
(Stakeholder)

This stakeholder also raised the point that what SO teams were asked to present (i.e. the pitch) was ‘a different product to what we were asked to develop [i.e. the investment prospectus]’.

There were also mixed feelings within the SLG. There was disappointment and frustration that the Challenge had not provided enough support for everyone or given sufficient reassurance about what the pitch involved. It was recognised that for some groups the short period of time to develop the investment prospectus between the completion of workshop 2 and pitch day contributed to the unexpected nervousness of some presenters.

It was also recognised within the SLG that the format for the pitch days turned out to be problematic. It was felt, in retrospect, that the 2-day structure, with nearly 2-hour-long sessions for each SO spread across the 2 days, was far too long. However, once the decision had been made and everyone had been told how things would run, it was not possible to change the format. This format meant there were limited opportunities for discussion across the SOs. It was suggested the presentations could have been shorter and sharper, perhaps presented in a mock pitch day on day one and then, with feedback and coaching, redone on the second day. Of course, this would have required all presenters to be present for the full 2 days and overnight, which would have required significant time commitments and resources that were already limited and stretched.

Although the pitch process was intended to be a low-stakes exercise to help teams finalise their investment prospectus, the nervousness of some presenters and the concerns raised reflected that there was considerable pressure, and that this had built up around the pitches as the final step of the process. When asked if the pitch was built up to be something bigger than it turned out to be, a participant felt the team would be more light hearted if they did it again rather than seeing it as a ‘heavy sales type pitch’ (Māori team member). Asked about the pressure, this participant certainly felt it:

Yeah, there's always pressure, because coming into the room, you didn't know what to expect. You didn't know who you'd be presenting to and you didn't know what the outcome would be. All of that did weigh quite heavily on the presenters' shoulders. I think it was after our presentation, Andrea, one of her comments was we need to relax a bit more. That's quite difficult when you're doing a pitch like that. (Māori team member)

A member of the SLG was asked about this pressure, and had this to say:

I think partly we kept talking about them [the pitches] a lot. We, being the leadership group. We kept talking about them as being the culmination of the SO process. But in fact, that was not the initial intent. The initial intent was [that] the culmination [of] the SO process was the written document [i.e. the investment prospectus]. We didn't choose people during the expression of interest process quite a while ago, we didn't consciously say, 'Those people would be good presenters.' That never came up, that they would be good pitchers. There were other criteria, but not that. Then, by the end, we had put a lot of weight on that and made a lot of fuss around it. We had also invited outsiders, so initially, it was a mock panel and then we invited people like MBIE and other challenge partners I don't necessarily think that was bad, but it did add an element of stress about it.

An observation shared by another SLG member from observing the pitches was that 'all the things that came out of this weren't science, they were just big game-changing, system-changing things. There was very little black and white science projects that came out in the traditional sense'. This observation indicates the pitches landed exactly where they were intended, i.e. as strategic overarching programmes of research. However, as was the case for others, there was a sense of unease about these big ideas not being linked to projects, which is the expectation in funding processes, and increasing recognition that these pitches (and the co-design process more broadly) marked quite a shift in the focus of research planning.

Themes that emerged from the interviews that run across all of the above aspects of the process were time, communication and peer review to which I now turn.

5.10 Time

Everyone talked about time. Importantly, it was acknowledged by all participants that the co-design process had *created* invaluable time for meaningful and important conversations. This was clearly a highly unusual experience for many. The time the process opened up had created space for conversations that deeply changed some people. It also created unexpected new connections and networks. Time was made possible by the Challenge funding people to be physically present for a significant period of time and conducting a process focused on designing things together.

However, time was also a pressure for the process, from every angle. SO team members were told they should expect to be involved in the process in the first half of 2019 over a

period of 3–4 months, but the workshops did not start until the middle of the year. In any case, it was always going to be ambitious to coordinate the diaries of well over 80 people to allow sufficient time for the four critical stages of the process (workshop 1, feedback, workshop 2, investment prospectus and pitch).

Within the workshops, for some groups, the long length of conversations to settle on the goals had knock-on effects for the time available within workshop 2 to work on the building blocks of the investment prospectus. The investment prospectus investment assessment criteria set out above (see also Appendix 9) show there were many areas and issues the teams were expected to have answers on that went well beyond the goals. It would appear that for some, what was required was unexpected and, accordingly, not planned for:

I guess signing up and coming in, I didn't expect how much work it ended up being. We were led to believe there'd be four or five days of workshops and a bit of stuff in between. That was fine but the bit of stuff in between turned out to be a lot of stuff in between. I personally wasn't prepared for that and it did come as a bit of a shock. It has set me back on my other work. I'll absorb it over the next six months but it has impacted. (Researcher)

Hence, SO team member time, although funded by the Challenge for most (noting MPI and DOC cannot be funded by the Challenge), had limits outside the workshops where SO team members could not be quarantined from day-job and other priorities and commitments.

A lack of time between workshop 2 and pitch day also meant that some teams did not have sufficient time to go back to stakeholders and research partners to retest their goals and impact pathways before putting them into the investment prospectus and presenting them before the investment panel. A number of participants felt that they needed to have done that. Notably, it was at this point (i.e. at the end of workshop 2) that teams finally had some more tangible and compelling things to talk about with potential partners and co-investors.

Limited time also meant limited interaction between SOs throughout the process, but in particular after workshop 2, which, again, is when the groups finally had some tangible ideas about what ground they were covering, what impact pathways they were or were not developing, and the ideas they had settled on. Ultimately the process ran out of time. It would appear that this put large expectations for connection, clarity and resolution onto the pitch days.

However, this is not entirely how things turned out. Presenters attended on the day of their pitch, with people coming and going at different times and working on finessing and/or finalising their pitches outside the lecture theatre at various times rather than watching the pitches of other SOs. While this was understandable and necessary given the short timeframes, it was observed by a researcher as a lost opportunity. This researcher suggested that having the SO team leads stay on after the pitches for another day could have been useful for working through the connections across investment prospectuses together.

5.11 Communication

Reflections on a lack of time also raised issues about a lack of communication from and within the Challenge. These issues were linked to a lack of organisational infrastructure within the Challenge, which was acknowledged as arising from both developing and implementing the co-design process at the same time; or, in the words of the Kaihautū Ngātahi, 'trying to lay the train tracks in front of the train as you go'. This immediacy, which meant there was a lack of time to look too far ahead, influenced the sequence of workshops (i.e. completing the first workshops for all groups before doing the second set of workshops). It was felt that if there had been more time to have the details of all the steps planned out and materials prepared before the process began, workshops 1 and 2 could have been held closer together and staggered (Kaihautū Ngātahi) or some SOs could have been progressed before others with funding staggered and/or slightly different processes that could have allowed some SOs teams to build off the work of others, thus providing more integration and better connections between SOs (Challenge Co-director).

Time and communication were factors in other ways. While it was acknowledged that communication from the Challenge got better as time went on, and that issues identified through Friday Skype meetings between the SLG and team leaders were being responded to as they arose, there were concerns about decision-making bottlenecks that impeded timely communication from the Challenge to SO team members. It was observed by SLG members that the co-directors were extremely busy and that there was a lack of decision-making structures through which to delegate tasks and decision-making:

I think everyone in the Challenge and the Challenge core admin team is stretched ridiculously thin, but if we were to go through this process again, that communication is something I think just would change everything. Even the people that were in the scoping groups were waiting for a long time, wondering when they were going to be contracted, what the time commitments were going to be. A lot more [communication] and a lot clearer would be helpful. (SLG member)

It was observed by another SLG member that a consequence of everyone being 'stretched ridiculously thin' was that that communication from the Challenge came in bursts with short deadlines, and that a lack of delegation meant decisions requiring attention floated to the top, which created delays.

Concerns about a lack of communication also related to keeping in touch with scientists who had been involved in Tranche 1, and letting them know what was happening and how and when they might be able to contribute:

there were some amazing scientists and project leaders in scoping groups in Tranche 1 who just kind of fell off the radar of the people trying to get feedback. I think people did probably the best they could in the time that they had but how long is a piece of string? There's definitely more that could be done. I still think there is. Communication, in general, from the Challenge through this process could have been more transparent. (SLG member)

Another communication issue was Dropbox, through which team documentation (e.g. templates, guidelines, correspondence and workshop outputs) was provided to SO team members by the Challenge. It was conveyed that this was not a user-friendly interface because it was time consuming to access the correct files and because some people could not access it through their workplace systems due to security concerns (e.g. Ministry for Primary Industries staff).

5.12 Peer review

Another key theme that emerged from the analysis relates to peer review. It has been raised several times in this report that some researchers felt that the design process needed an extra step to provide a process of peer review or some way of allowing scientists to decide what was worth backing and what was not. The following reflection presents a further articulation of this concern from a researcher who is aware that things have changed and need to change further in an impact-focused research context, but struggles to see how that can occur given that the topics under consideration require considerable scientific expertise:

scientists like me are thinking scientists like me are the best thing since sliced cheese. Those are the sort of people, especially on a science Challenge ... should be viewing [proposals] to say yay or nay or get a perspective on and that sort of stuff. I also appreciate that we've got to move beyond scientists like me out there and have different perspectives and all that sort of stuff. Having the judges [at the pitch days] and that sort of thing, I could see that there would be benefits there. The other side of that coin is we're after a step change ... which is heavily science driven. (Researcher)

This participant was concerned that adjudication on the science was potentially being left to people who might not have the necessary scientific expertise to make informed decisions that could deliver the step-change called for by the Challenge.

It should be noted that the Challenge carried out this extra step, and that the investment prospectuses were also reviewed by the Challenge's International Science Advisory Panel. I understand this was always the Challenge's plan. Scoping was to be a (very important) first part of a multiple-step process. Nevertheless, the concerns raised by these researchers highlight the importance of clear and multiple lines of communication from the Challenge about how all the pieces of the puzzle are envisioned to ultimately fit together which was not clear to some.

This research has canvassed multiple perspectives and reflections from many of the more than 80 people involved in New Zealand's Biological Heritage National Science Challenge's co-design scoping groups process. Participants are clearly of the view that the Challenge embarked upon an ambitious and worthwhile process and succeeded. In the spirit of learning lessons from this experiment, participants have provided their candid reflections on what worked well and what did not work so well. Their insights are summarised in Table 3, alongside tensions and themes these reflections on different aspects of the process raise for the discussion of this report and further research beyond this report.

Table 3. Summary of research findings

	Reflections on what worked well	Reflections on what did not work so well	Tensions and emergent themes
A design-led approach	<ul style="list-style-type: none"> • Design principles and a well-designed process • Facilitator providing skilled and effective facilitation • Involvement of SLG (including knowledge brokers) in meetings • Co-directors supporting and championing design process • Co-directors opening and/or attending workshops • SLG reassurance about sticking with the design process from their first-hand experience • Time created for meaningful conversations 	<ul style="list-style-type: none"> • Unfamiliar 'design' language was alienating for some • Not knowing what was coming next • Double diamond needs to be more iterative 	<ul style="list-style-type: none"> • What should be the role of SLG in SO team deliberations? • Is the process useful for taking ideas off the table? Process needed another step? • 'Fast fail' might work for products, but is it adequate for science programmes? • Required reassurance to trust the design-based process: should it require this? • Group size: large group needed for inclusivity but makes achieving a consensus challenging and time-consuming • Outputs and outcomes dependent upon voices in the room • Encouraged meaningful, respectful and effective communication
Convening SO teams	<ul style="list-style-type: none"> • Administrative documentation established the foundations of the process and rules of engagement (see Appendices) • Inclusivity and recognition of expertise through resourcing to attend meetings • Promise of a new approach overcame researchers' past bad experiences of research design workshops • Expression of interest and selection process • Challenge values were important to participants that applied • Diversity of people, ideas, values, knowledges, expertise and experience in the room 	<ul style="list-style-type: none"> • A lack of social scientists • Key stakeholders missing from some groups • Not having Māori members in all teams • So much expertise but still not enough? • Lack of a coordinator role to follow up team members, coordinate activities outside workshops 	<ul style="list-style-type: none"> • Was the Challenge documentation fully read and understood by SO team members? • Concerns that consensus decisions tend to arrive at the average • Outcomes of collaboration are dependent upon who is in the room • Agendas motivated participation of some team members • Was a leadership and/or coordinator role required? • Different people in the room would arrive

	Reflections on what worked well	Reflections on what did not work so well	Tensions and emergent themes
Convening SO teams (cont.)	<ul style="list-style-type: none"> • Co-everything empowered Māori and demonstrated legitimacy with mana whenua • More than one Māori member in some teams • Inclusion of early career people in teams • New relations, relationships and networks created • Institutional safeguards for mātauranga Māori • People were changed by the process • Contributions of knowledge brokers • Leadership roles for Māori team members • Face-to-face interaction and time to build relationships 		<ul style="list-style-type: none"> • at different outcomes • A lack of interdisciplinary capacity
Connections between SO teams	<ul style="list-style-type: none"> • Skype meetings • Cross SO attendance • Cross SO meeting with team leaders • Knowledge brokers 	<ul style="list-style-type: none"> • Skype meetings mainly about mechanics • Siloed SOs • Coordination of what each SO was proposing to do and address 	<ul style="list-style-type: none"> • Who had an overview of all SOs? • Limited time for interaction between SO teams • Lack of communication about ideas and proposals across SOs • Staggering SO teams and funding could have improved integration?
Empathy mapping	<ul style="list-style-type: none"> • Revealed important and unexpected insights about stakeholders, knowledge holders and end-users • Reached people outside the room • Building a bank of empathy maps and personas for all to access 	<ul style="list-style-type: none"> • Questions too rigid • Potentially influenced by perspective of researcher • Pushed some team members beyond their comfort zone 	<ul style="list-style-type: none"> • Limited time • Lack of social science skills • Concerns about rigour
Development of goals	<ul style="list-style-type: none"> • Design principles • Focused attention on the vision and outcomes rather than agendas or pet projects 	<ul style="list-style-type: none"> • Not enough time for teams to reflect on draft goals • Strategic outcomes so large it made development of goals difficult • Goals too broad for obtaining useful feedback • Teams could not move on until they had settled on 	<ul style="list-style-type: none"> • Timing – too soon to take goals out for feedback? • Goals too broad to seek useful feedback? • SO teams developed social goals which had implications for impact pathways and

	Reflections on what worked well	Reflections on what did not work so well	Tensions and emergent themes
		<p>final goals</p> <ul style="list-style-type: none"> • Time on goals had knock-on effects for developing impact pathways and ultimately investment prospectus 	<p>expertise to adjudicate</p>
Feedback between workshops	<ul style="list-style-type: none"> • Stakeholder mapping and prioritisation • Making contacts and building networks • Identification of potential collaborators • Engagement tracker spreadsheet • Learning download to share feedback within team 	<ul style="list-style-type: none"> • Took longer than anticipated • Pushed some beyond their comfort zone • Outreach process highly variable • Lack of focus on co-investment • Insufficient gathering of 'lay of the land' or 'portfolio of effort' information • Reticence from researchers when feedback sought • Not everyone used the tracker spreadsheet • Confidence of teams to do outreach tasks over-estimated • Learning download provided too much unstructured feedback • Bringing feedback from all of New Zealand into the room • Potential feedback bias, with those critical of goals likely to have ignored request for feedback 	<ul style="list-style-type: none"> • Feedback process was time intensive, which was unexpected • Lack of communication about expectations? • What are realistic expectations of participants even if they are being paid?
Impact pathways	<ul style="list-style-type: none"> • Headlines exercise generated lots of ideas • Allowed back-casting from outcome rather than the process determining the outcome • Ideas that would appeal to Māori partners, social scientists and early career researchers were prioritised 	<ul style="list-style-type: none"> • Headlines exercise made people feel uncomfortable • Headlines exercise pushed people in a particular direction (e.g. to appeal to general public) • Insufficient time to reflect on what came from this process • Misinterpreted and not recognised as the building blocks for the investment prospectus • Focused people's attention on the right-hand side of the weave diagram (see Figure 1) 	<ul style="list-style-type: none"> • Concerns about a lack of expertise to adjudicate on what should go through to the investment prospectus • Encouraged front-of-mind thinking?

	Reflections on what worked well	Reflections on what did not work so well	Tensions and emergent themes
		<ul style="list-style-type: none"> • Exercise became a 'harsh filter' 	
Investment prospectus	<ul style="list-style-type: none"> • A way to present elements of co-design process • Guidelines provided by the Challenge 	<ul style="list-style-type: none"> • Confusion over what the investment prospectus was and what was to be included • Affected by insufficient time for development and writing • Insufficient time to seek feedback • Affected by availability issues • Insufficient focus on co-investment • Insufficient use of empathy mapping • Concerns it was a 'commercial world' idea • Going from Post-it notes to the detail was difficult and time-consuming • Implied money, which people were reluctant to talk about • Collaborative approach reverted to authoritarian • Largely written as research plans rather than high-level strategic programmes of work 	<ul style="list-style-type: none"> • Timeframe created availability issues and conflicts with day-job commitments • Outside workshops, people went back to their day jobs • Limited timeframes meant people had little choice but to do what they knew best • Lack of recognition that co-investment did not just relate to money • Lack of communication from the Challenge about how all the bits fitted together and what role the Challenge would play in adjudication
Pitch days	<ul style="list-style-type: none"> • 'Top 10 Tips for a Good Investment Pitch' guidelines provided by the Challenge • Investment panel • Questions and conversations following each pitch • The experience • Having confidence in the material being presented 	<ul style="list-style-type: none"> • Dragon's den terminology conjured up daunting imagery • The den-like venue • Pitch day format • Pitch hype • Insufficient time for preparation • Investment prospectus and pitch were two different things rather than the latter being a mere presentation of the former 	<ul style="list-style-type: none"> • Concerns that the Challenge did not provide enough support for teams and presenters, but would this have helped given the time issues? • Did the 'dragons' have the expertise to adjudicate on the science needed to address the Challenge's mission?

6 Discussion

Co-design and other modes of collaborative research are characterised by the involvement of multiple disciplines of science (i.e. interdisciplinarity) alongside end users and stakeholders to address real-world sustainability issues (i.e. transdisciplinarity) (Lang et al. 2012; Mitchell et al. 2015). It is these features that are increasingly recognised by research funders, policymakers and research institutions as necessary for delivering impact, and that are essential for addressing the complex issues societies now face (Cash et al. 2003; Cash et al. 2006; Gibbons 1994; Hansson & Polk 2018; Roux et al. 2010; Schneider et al. 2019).

During 2019, New Zealand's Biological Heritage National Science Challenge embarked upon a co-design process to collaboratively scope programmes of work around its seven strategic outcomes and Ngā Rakāu Taketake. Participants in this study applauded the Challenge's bravery to do something radically different, the large-scale design process it orchestrated, and its commitment to establish meaningful collaborations between researchers, Māori partners, stakeholders and end users through the process and beyond. The Challenge established sizeable groups that brought together a diversity of people with high levels of knowledge, experience and capability across the biodiversity and biosecurity sectors. It was broadly agreed by participants that the right people were in each design team. Through the provision of funding to attend, clear rules of engagement and a well-designed step-by-step process, the Challenge created a setting conducive for many people (over 80 in all) to focus on the Challenge's mission and its aims for at least 4 days. The building blocks of their investment prospectuses were canvassed in a range of ways with hundreds of people after the first workshop, then revised and refined in response to feedback and developed further in a second workshop. Their investment prospectuses were then road-tested before a mock investment panel to enable further development.

The investment prospectuses, the outputs of this process, now form the basis of a number of programmes of work that have been further developed by the Challenge and its partners in line with its intention to be more strategic by funding research programmes rather than stand-alone research projects, and to fund these programmes via a collaborative design process rather than a contestable one. The SO teams' investment prospectuses are now referred to as scoping panel reports and are available on the Challenge's website (<https://bioheritage.nz/resources/research-and-bioheritage-reports/>). Importantly, the investment prospectuses developed through the co-design process are, and were always intended to be, starting points for Tranche 2 research and broader activities.

While some participants were confronted by the design philosophy and methodology used in the process, and some found the process was not for them, 'going with the flow' paid off for most. The process was described as brave, enjoyable, exceeding expectations, and pleasantly surprising. There was considerable support for design thinking, and participants recognised its many valuable attributes they saw as unattainable through other apparently co-design or workshop-based processes they had been involved in.

Although there were challenges and there is much to learn from this process, the following words capture the often intangible and invisible aspects of collaborative processes and the success of this process in particular:

Overall ... to get a group of people, many of whom had never even heard of each other before, to work together on something and produce something at the end of it, to build a sense of trust and common purpose and whatever (which you don't always see happening) – I don't underestimate that that takes some skill to make that happen. I've been to workshops where one person dominates it all or there's just no focus and you're just meandering all over the place and everyone starts getting frustrated. I think the process was good in that it kept people on task. It wasn't allowed to get derailed and it produced something. I think all of those were positive. (Researcher)

6.1 Co-design foundations

This research has identified a number of pre-conditions or foundations that are needed to give co-design processes the best chance of success in not only fostering meaningful conversations and learning between researchers, Māori research partners, stakeholders and end users, but also delivering credible and usable outputs to enable follow-through (Mark & Hagen, 2020). These are:

- leadership commitment
- financial resources
- a realistic timeframe
- organisational capacity
- diverse, knowledgeable and experienced participants across researcher, tangata whenua, stakeholder and end-user groups
- clear values, rules of engagement and output expectations
- power sharing
- skilled facilitation
- a well-designed process.

The first four foundations can be directly influenced by government, given its control over policy and funding, and have already been met in New Zealand to some extent. For example, while there was strong leadership commitment for co-design within the Challenge SLG, this commitment existed at the very top with changes to the NSC performance framework in 2015 and research policy in 2019 that have made co-design and a focus on impact a measure of success. Arguably, the second foundation has been met, given that the Challenge was able to fund the process, participants' face-to-face attendance and their time. However, whether funders fully recognise the actual cost involved in doing co-design and what the implications are for subsequent research

programme funding as a consequence of dedicating significant funds to the co-design process is a question the Challenge and MBIE should address.

The lack of the third foundation, a realistic timeframe, had profound ramifications for the process, SO teams, process outputs, and Challenge leadership. A lack of time at the end of the process created stress, pressure and regret for a number of participants, as well as for SLG members, who were concerned they had let SO teams down by not being able to provide them with sufficient guidance at the critical moments of the process and the time they needed to do the job they were tasked to do. Importantly, right through the process, considerable pressure was felt by the Challenge leadership to 'get the research funding out the door' (Challenge Co-director).

While the process was commended for the time it opened up, the lack of time on many fronts dominated participants' reflections on the process. The extended and then unexpectedly crunched timeline experienced by several groups created availability issues, work pressures, confusion and frantic investment prospectus and pitch writing. Time pressure is a difficult issue to grapple with under any circumstances. In this case, SO teams were involved in unfamiliar tasks, and so there were enormous expectations and nervousness around the pitch, for understandable reasons. It also meant that participants resorted to behaviours such as writing the investment prospectus like any other research plan and becoming authoritarian rather than collaborative. We can see that creating the foundations for co-design is one thing; allowing time for it to happen and evolve as it needs to is quite another. Hence, this case study shows that to do co-design requires a reset in thinking about funding models and timelines, as well as the need to build greater flexibility into budgets, work plans, research metrics and measures of success.

The fourth foundation, organisational capacity, relates to what capacity NSCs have (or not) to fund staff to enable coordination, delegation and oversight. It was not fully foreseen by the Challenge what would be required organisationally to orchestrate a process such as this in terms of coordination, delegation, decision-making, feedback loops, evaluation and communication. While these issues were managed by the Challenge along the way, it was observed by SLG members that the Challenge leaders and the Challenge's small administration team were 'stretched ridiculously thin'. Concerns about a lack of communication or delayed communication from the Challenge appear to have arisen from too few people with far too much to do. Given what we now know about this co-design process and what meaningful, respectful and effective co-design requires, an important question to be asked is whether the NSC organisational structures that were put in place to achieve pre-2015 performance criteria (i.e. without co-design, collaborative research and building inter- and transdisciplinary capacity), and post-2019 changes to focus research squarely on impact as well as excellence, are fit for purpose.

These four foundations are about knowledge governance (van Kerkhoff 2014; van Kerkhoff & Pilbeam 2017; Wyborn et al. 2019). The pressure 'to get money out the door' reflects the inertia of traditional research funding norms and practices, even when the rules of the game have apparently changed. This research highlights how knowledge governance can be a critical factor in the overall success or failure of research co-design and transdisciplinary processes. In particular, it illustrates the ramifications for participants as

well as internal and external process credibility and legitimacy of squeezing these new and ambitious processes into existing governance structures. As such, the research shows that changes in norms, institutions and practices take time and that new governance skills, mindsets, funding models, infrastructure and measures of success, for example, are needed to accompany policy changes.

6.2 Co-design process strengths

The other foundations (5–9) were clear strengths of the Challenge’s process. Having diverse representation across the different groups meant that a broad range of expertise, knowledge and experience was brought to bear on the issues of concern. It also meant there were a number of Māori team members across the teams. However, in some groups it was a case of ‘being the one Māori in the room’, with unrealistic expectations that one person could represent all Māori. This was recognised by those I spoke to as an impossible position. Even so, there was a high degree of power sharing and this was acknowledged as a key strength of the process by Māori participants. Notably, convening diverse, knowledgeable and experienced participants is not possible without solid foundations 1–4.

The articulation of the Challenge’s values clearly played a role in people’s willingness to be involved in the process, but more important was their implementation, which was visible through, for example, co-leadership roles at the Challenge and SO team levels, flexibility of timelines to allow people time to respond in culturally appropriate ways, and protocols to protect mātauranga Māori.

Rules of engagement and output expectations provided SO team members with clear information on expectations through the Strategy, Terms of Reference, contracts, guidelines and templates. Whether all of these were read by SO team members given the time constraints and access issues is not known.

Skilled facilitation is essential in any collaborative research setting. I understand the Challenge spent a considerable period of time choosing the right person for this job. There was agreement across participants that Phil Morrison, the facilitator, played a vital role in successfully navigating the teams through a complex process. Phil had a background in the defence forces, which meant he was highly organised and accustomed to working with teams to achieve outputs. It also meant that each workshop was planned with precision, but also with flexibility. Importantly, after each workshop Phil typed up the content of the canvasses each SO team had created and what was written on the hundreds of Post-it notes so the teams could refer back to these artefacts as they moved through the process and when drafting their investment prospectuses. This was a time-consuming but important task.

A well-designed process was also a key strength of the process. In this case, the design philosophy and methodology worked well. Each step had been planned and road-tested in an initial process the facilitator went through with the SLG. From participant accounts, Phil evolved with the process as it proceeded in order to respond to how the teams engaged with activities. The clear steps and required outputs kept SO teams on track.

Design principles informed the activities and underpinned the structure of the process. According to participants, the process:

- encouraged blue-sky thinking
- subdued personal agendas and biases
- encouraged innovative and interdisciplinary outcomes
- made time for meaningful conversations
- gave a voice to mana whenua
- empowered Māori participants by levelling out hierarchy
- fostered learning between researchers, Māori team members, stakeholders and/or end-users
- broke down barriers between institutions and disciplines
- avoided preconceived ideas
- fostered inclusiveness.

These are the invariably positive attributes participants experienced or observed while taking part in the scoping co-design process.

6.3 Co-design process weaknesses

In retrospect it can be seen that the Challenge's co-design process had very strong foundations, but also some weak points. First, there were unrealistic expectations by all involved about the time it actually takes to meaningfully, respectfully and effectively do co-design and what flexibility is needed. Second, there was a lack of organisational capacity within the Challenge to coordinate such a large-scale co-design process. It should be noted that this has been the experience of others (see Duncan & Robson-Williams 2018, Henley 2014, and Fenemor 2014 for experiences with water management collaborative processes in New Zealand). These weaknesses have been linked, in large part, to the knowledge governance issues set out above.

Weaknesses in the process itself are multi-faceted and link back to a potentially missing element. From observing the workshops, I could see that many SO teams got caught up with the goals that were intended to be their starting points. Spending so much time getting them to a point where there was some level of consensus on wording and meaning was important: as the facilitator noted, it would have been very hard to move on if there was not agreement on the goals. However, this had significant knock-on effects in terms of time available to develop the impact pathways that were central to the Challenge's *Strategy 2019–2024* and the investment prospectus. It will be recalled that the 'headlines' activity that helped teams develop those impact pathways was seen by some participants as 'unhelpful', and some were blindsided by it as they did not realise their headlines would pass through such a 'harsh filter' to the investment prospectus. It would appear that these concerns were addressed through the prospectus and pitch writing process, but it identifies a lesson to be learned and, to some extent, how science programmes should be treated differently to product design given the somewhat different end-point, which ultimately needs to be more than a minimum viable product or a fast fail.

The purpose of the headlines activity was to gather many ideas quickly. In this respect it was highly successful. However, it made people feel uncomfortable, and some felt like they were 'spewing out garbage'. This assessment is in stark contrast to how they felt about the process overall. The point was also raised that this exercise elicited mainly 'front-of-mind' ideas and did not sufficiently draw on the substantial depth of expertise in the room. Related to this, there was concern that it prioritised the right-hand side of the innovation pathway (i.e. translation and adoption/scale out; see Figure 1) over innovation and discovery, which took considerably longer periods of time to think through. This meant there were likely to be blue-skies ideas the process was unable to bring forward.

Furthermore, because the headlines activity cast the target audience as the general public, ideas for the impact pathways gravitated, to some extent, towards activities to better communicate with and educate the public. What is problematic here is not communicating with and/or educating the public *per se*, but that strategies to do this are often seen as a solution in itself and based on the assumption that impact uncomplicatedly follows from the provision of, for example, more engaging access to information (Duncan et al. 2018; Knook et al. 2020; Leith et al. 2017; Wynne 1996). While these are important activities that can play a useful role in raising awareness and motivating people, it is increasingly recognised that their role in behaviour change is limited given the many institutional and material barriers that often prevent people from expressing or acting on their values or best intentions (Duncan & Kirk, 2020; Spurling et al. 2013; Shove 2010; Shove et al. 2012; Strengers 2011; Strengers and Maller 2014). However, given that this activity embodies design-thinking principles that have been found to be highly effective, and that some participants thought it had merit, it can be helpful not to look directly at the problem but to look elsewhere across the process to see what might have contributed to the concerns raised by participants.

6.4 Insights from transdisciplinary theory and practice

Transdisciplinary theory and practice provide some useful insights. In their review of transdisciplinary research projects in the field of sustainability science, Brandt et al. (2013, p. 2, citing Pohl & Hirsch Hadorn 2008) set out three broad phases of transdisciplinary projects:

- i problem identification and structuring – where the problem is collaboratively identified,
- ii problem analysis – the co-creation of solution-oriented and transferable knowledge and
- iii integration and application – the implementation of the results into practice.

They also set out three types of knowledge that have been identified as 'shared between scholars and practitioners' within transdisciplinary projects:

- i system knowledge – the observation of the system
- ii target knowledge – knowledge of the desired state and

- iii transformation knowledge – the knowledge necessary for fostering transformation processes.

(Brandt et al. 2013, p. 2, citing ProClim, 1997).

Of interest for critiquing the Challenge’s co-design process are the results of their review, which links different knowledge types to the different process phases (Figure 3).

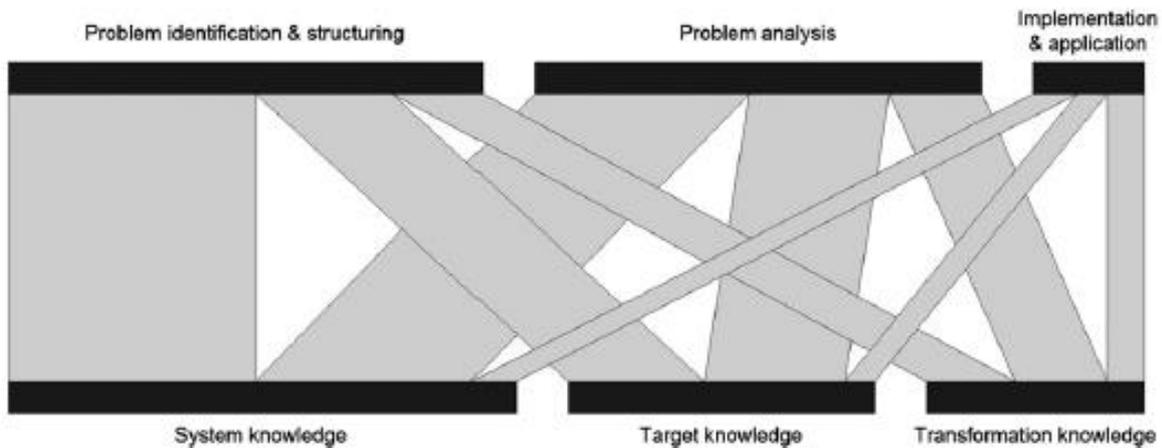


Figure 3. Relations between transdisciplinary process phases and knowledge types (source: Brandt et al. 2013, p. 6).

Relating this schematic to the Challenge’s co-design process (and noting that the Challenge’s process was focused on programmes of work rather than projects), an important question is whether the SO teams had enough collective and explicit system knowledge to work with. It can be seen from Figure 3 that problem identification and structuring and problem analysis, which the Challenge’s co-design process was substantially involved in to foster transformative knowledge, albeit at a high level, has been identified as involving a significant amount of system knowledge.

In the Challenge’s scoping process, system knowledge (i.e. understanding of the ‘lay of the land’ and the existing ‘portfolio of effort’ for each SO) was expected to have been held by those in the room. Hence, in this setting it was implicit rather than explicit and somewhat diffuse. System knowledge was also expected to be gathered through the feedback process (e.g. research underway, contributions and activities related to each SO beyond the research sphere, gaps, opportunities and potential partnerships to develop impact pathways for each SO). There were stakeholder perspectives and context mapping exercises undertaken during workshop 1 but these were broad or done to give direction to the feedback process. Even so, it will be recalled that some SO team members were raising concerns that they did not feel they had sufficient grasp of what was going on across their SO and what the many people and organisations ‘out there’ were doing. It was acknowledged by the Challenge that mapping out the ‘lay of the land’ was not done as comprehensively as had been anticipated, and that the feedback process went in many directions.

From a transdisciplinary process phases / knowledge types perspective, the absence of explicit system knowledge from the very beginning meant that the goals were very much relied on to anchor problem identification and structuring, problem analysis and ideas for implementation and application. Yet, the goals embodied what Brandt et al. (2013) identify as target knowledge (i.e. desired state). Arguably, for some groups and SO team members, a lack of explicit system knowledge (e.g. an understanding of the research and related activities and contributions along the innovation pathway within each SO topic area as well as knowing what actors are involved and existing partnerships) that everyone could work with meant they were relying almost entirely on target knowledge. A consequence appears to be that in the workshops the goals were critical but difficult to craft, the 'headlines' divergent thinking process lacked coherence through connections across the innovation pathways, and the convergent thinking process of developing the impact pathways that needed to winnow options still looked divergent. Arguably, this made the development of the investment prospectus and the pitch harder than it might have been if the anchor of the process was collectively-developed and explicit system knowledge rather than target knowledge. Hence, rather than (or as well as) an extra step suggested by several participants, I suggest that the process needed a system-focused first step.

6.5 Different experiences of the process

Importantly, SO team participants from the different cohorts (i.e. researchers, Māori team members and stakeholders) experienced the process quite differently. Specifically, the research findings show that Māori team members were empowered by the process. They had a rare opportunity to put forward their perspectives on an equal footing with both researchers, stakeholders and other end-users. Māori team members challenged their teams to think about the implications of past inequities, Treaty obligations and past research practices from the perspective of tangata whenua. They also offered different and enriching perspectives, as well as ideas on how research could be done differently. Their impact in the process is evident through the evolution of team goals, the principles SO teams developed and accounts from some participants about how they were profoundly moved and changed by the process in terms of their understanding of and future outlook towards Māori culture and their issues of concern.

The findings also show that stakeholders were encouraged by the process. They were, through necessity, focused on impact and provided invaluable insights on what was working and not working within their day-to-day experiences and realms of influence and what might work if things were done differently. They were clearly pleased to have had the opportunity to contribute, although some were concerned about the time commitment.

For researchers it was a mixed bag. For some, the process was a revelation and a refreshing change from past bad experiences, while others were more circumspect and challenged for various important reasons arising from the peculiarities of the design philosophy and methodology and how the process was challenging traditional ways of planning, developing and adjudicating research. This is not to suggest that this was the case for all researchers, or that those with concerns were not supportive of the process.

7 Conclusions

Aotearoa New Zealand's research landscape has changed considerably in recent years. Hosted by the nation's Crown Research Institutes, universities, government agencies and independent research organisations, the NSCs have become experimental collaborative research enclaves, in particular since 2015 due to changes to their performance framework that require them to also undertake 'co-design (at the outset)', to 'co-develop/create (along the way)' and build inter- and transdisciplinary capacity (MBIE 2019b; see also Duncan et al. 2020a). These changes are expected to ensure research institutions and researchers more closely and clearly link the work they do with decision-making and on-the-ground action which is an international trend now embodied in recent changes to New Zealand's research policy. Institutions and actors are now required to monitor and tangibly demonstrate research impact (MBIE 2019a; see also MBIE 2017). Consequently, requirements for consultation have shifted to collaboration for the NSCs, and within research institutions more broadly, relying on citations and peer esteem are no longer deemed sufficient for gauging the impact of research. These are significant changes.

However, as discussed by Duncan et al. (2020a), while performance criteria for the NSCs and MBIE's revised position on research impact are key to signalling the need for institutional change and a greater focus on addressing societal problems, just how research institutions should or could go about achieving impact in practice remains distinctly unclear. The development of appropriate models and frameworks to link knowledge and on-the-ground action to deliver the expected societal outcomes is still in its infancy in New Zealand and internationally (see also Fam et al. 2017; Lang et al. 2012; Mitchell et al. 2015; Mark & Hagen 2020; van Kerkhoff & Pilbeam 2017; Wyborn et al. 2019).

Hence, learning from the co-design processes undertaken by the NSCs to tease out both their strengths and weaknesses and to build a deeper understanding of the practicalities, opportunities and challenges of co-design is important for New Zealand's research funders, governance bodies and NSCs. Understanding these experiments is also internationally significant for informing theory and practice in the fields of sustainability science (Kates et al. 2001), transdisciplinary research (Fam et al. 2017; Lang et al. 2012), and knowledge governance (van Kerkhoff 2014; van Kerkhoff & Pilbeam 2018; Wyborn et al. 2019).

Insights from the co-design process undertaken by New Zealand's Biological Heritage National Science Challenge have contributed to the development of the following recommendations which have been divided in recommendations for the governance of co-design and the practice of co-design. Ideally, these recommendations should be considered in light of experiences from other NSCs and/or similar collaborative processes.

8 Recommendations

If co-design is to be conducted meaningfully, respectfully and effectively, in addition to the foundations 1-4 set out above, it is recommended that *governing* co-design requires:

- a mindset that capitalises on the ways co-design differs from traditional research processes
- skills to create governance systems, including performance measures, that foster co-design and create 'time, space and structures for learning, reciprocity, and power sharing' (Mark & Hagen, 2020, p. 5)
- recognition at all governance levels that co-design and other modes of collaborative research and practice cannot be squeezed into institutional and governance structures and reward systems that are geared to advancing disciplinary or specialised science
- sensitivity to the implications of traditional governance and funding models on potentially derailing co-design processes and diminishing the credibility and legitimacy of research institutions and actors
- commitment to co-design once a decision has been made to use it at all governance levels, including defending it when things do not go to plan and flexibility is required
- recognition of the need for different types of knowledge and knowledge systems in co-designing research programmes and projects
- *additional* funding to adequately resource co-design processes including funding to access the right people and their expertise which is appearing necessary given co-design fatigue
- realistic timeframes with flexibility built into timelines, budgets and work plans to ensure co-design runs smoothly and outputs foster credibility and legitimacy inside and outside the process
- investment in communities of practice to develop collaborative research skills and capacity
- recognition that working across institutions presents challenges and takes time and that innovation is needed to facilitate collaboration and communication
- rewards for doing co-design well.

In addition to practicalities, opportunities and challenges identified through this research and summarised in Table 3, and the foundations 5-9 set out above, it is recommended that *doing* co-design requires:

- flexibility built into the process
- a project management or a coordinator role to oversee and coordinate the process and participants
- genuine co-leadership roles for Māori and/or indigenous partners
- transparent protocols to protect mātauranga Māori and/or indigenous knowledges
- frequent and timely internal and external communication

- the establishment of decision-making roles and responsibilities at the outset
- realistic expectations about what can be asked of participants even if they are being paid for their time and expertise
- ongoing and evolving support, guidance and assistance provided to participants
- inclusion of early career researchers and practitioners
- recognition of the need for different types of knowledge and knowledge systems
- commitment and co-designed processes to weave together Western knowledge and mātauranga Māori
- the importance of explicit and collectively-developed system knowledge to anchor problem identification and structuring and problem analysis
- recognition that not all participants will read or have time to engage with the detail of guidance documentation.

It is also recommended that further research address the following questions that are opening up as a consequence of requirements to undertake co-design and research policy focused on impact:

- what new knowledge governance systems, frameworks and funding models are needed to implement impact-directed policy?
- what governing practices are needed to ensure science excellence and research impact are approached by research institutions and actors in a mutually reinforcing rather than a mutually exclusive way?
- what is to be co-designed when impact is the required outcome of research planning?
- what are the consequences for researchers and research institutions of the changing role of science in an impact-focused science system?
- what should the criteria be to assess the direction of science in an impact-oriented science system?
- who should be involved in making decisions on research criteria in an impact-oriented science system?
- how are different, if not divergent, knowledge systems to be navigated and woven together in impact-oriented research?
- what are the limits of co-design, when is it appropriate and when is it not?
- what might be required to encourage involvement given co-design fatigue?
- what other lessons can be learned from co-design and co-creation in other NSCs?

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Appendix 1 – 2019 Chronology of Events involving scoping groups facilitator

15 February: Initial meeting with BioH Directors at Manaaki Whenua Landcare Research Offices in Lincoln.

14 March: Initial one-day orientation workshop with Strategic Leadership Team and knowledge brokers – Phil facilitates a team building exercise and introduces Design Thinking (Christchurch).

15 - 16 April: First design thinking scoping workshop with Strategic Leadership Team and knowledge brokers, using plant pathogen (Kauri Dieback and Myrtle Rust) as the pilot case study (Christchurch).

5 June: Phil facilitates a two-hour empathy mapping session with Early Career Researchers – four different early career empathy maps are produced by the workshop participants (Christchurch).

10 - 11 June: First Plant Pathogen scoping workshop – an accelerated version leveraging outputs from the previous workshop and resulting in ten research investment canvases (Auckland).

18 - 19 June: Second design thinking scoping workshop with Strategic Leadership Team and knowledge brokers, drawing on insights from the previous two workshops to adapt and refine the process for use with all remaining scoping groups (Wellington).

3 - 4 July: SO5 Pre-Border Workshop 1 (Wellington).

23 - 24 July: SO2 Workshop 1 (Christchurch).

29 - 30 July: SO4 Workshop 1 (Christchurch).

30 July - 1 August: SO7 Workshop 1 (Wellington).

5 - 6 August: SO6 Workshop 1 (Christchurch).

8 - 9 August: SO1 Workshop 1 (Wellington).

12 - 13 August: SO5 Post-Border Workshop 1 (Wellington).

20 - 21 August: SO3 Workshop 1 (Wellington).

28 August: Half-day cross challenge scoping groups meeting (Christchurch).

28 August: Half-day Plant Pathogen workshop to 'tidy-up' research investment canvases (Christchurch).

9 - 10 September: SO5 Pre-Border Workshop 2 (Wellington).

16 - 17 September: SO1 Workshop 2 (Wellington).

23 September: Plant Pathogen Final Workshop - to further refine research investment concepts (Wellington).



25 - 26 September: SO3 Workshop 2 (Wellington).

30 September - 1 October: SO7 Workshop 2 (Wellington).

14 - 15 October: SO6 Workshop 2 (Christchurch).

16 - 17 October: SO5 Post-Border Workshop 2 (Christchurch).

21 - 22 October: SO2 Workshop 2 (Christchurch).

23 - 24 October: SO4 Workshop 2 (Christchurch).

11 - 12 November: Mock Investment Panel (Wellington).

Prepared by Phil Morrison, the scoping groups facilitator.

Appendix 2 – Research information sheet about attending scoping groups and observing process

Research Information Sheet

Designing research for impact: following New Zealand's Biological Heritage National Science Challenge Scoping Groups Process

The Biological Heritage National Science Challenge ('the Challenge') is conducting a unique design-led process for research development and investment. The Challenge leaders want key elements of the process documented and to obtain critical reflection on the process structure, activities and outcomes. This work will provide lessons learned for others who wish to embark upon similar processes and provide insights for science policy governance theory and practice.

To undertake this research, Ronlyn Duncan, Environmental Social Science Researcher of Manaaki Whenua – Landcare Research's Landscape Governance & Policy team, will attend a number of scoping group meetings. Ronlyn will also conduct interviews with some members of scoping groups, knowledge brokers, and the Challenge leadership.

The purpose of this Research Information Sheet is to explain that Ronlyn will attend scoping group meetings to observe the process in action. Information about how scoping group members have engaged with the process will be gathered through the interviews. She will not be observing scoping group members individually.

Ronlyn will provide a report of the research to the Challenge which will be made available to scoping group participants.

If you have any queries or wish to know more please contact Ronlyn Duncan on +64 3 321 9943, email: DuncanR@landcareresearch.co.nz. You can also contact the portfolio leader for this project, Chris Phillips, PhillipsC@landcareresearch.co.nz

This research has received social ethics approval through the Manaaki Whenua – Landcare Research social ethics process (SE 1920/09).



Appendix 3 – Research information sheet for interviews

Interview Participant Information Sheet

Designing research for impact: following New Zealand's Biological Heritage National Science Challenge Scoping Groups Process

You are invited to participate in the above research project.

This research is funded by the Biological Heritage National Science Challenge ('the Challenge') and Manaaki Whenua Landcare Research. The research is being conducted by Manaaki Whenua Landcare Research to document the Challenge's design-led approach to research development and investment and to provide critical reflection on the scoping groups process. This work will provide lessons learned for others who wish to embark upon similar co-design processes and provide insights for science policy governance theory and practice.

As a member of a scoping group, I would like to interview you to discuss:

- how you have encountered the structure and activities of the design-led scoping groups process;
- what challenges you might have faced;
- what opportunities you might have identified through the process;
- any other issues you would like to discuss about the process and its potential implications for research development and investment.

Where and when:

The interview will take between 30 and 60 minutes. I propose that we talk over the internet using zoom. I will send you an invitation and a link and we can talk if you have an internet connection.

Recording the interview

I would like to record the interview but this would only be done with your consent. Zoom's recording option can be turned off at any time. If recorded, you will be provided with a typed transcript of the recording. While it is not a requirement, I will ask you to read the transcript and let me know within two weeks if any amendments are required.

Confidentiality

Information obtained in our interview will be confidential. Transcripts and interviews will be stored on the secured computer system at Manaaki Whenua Landcare Research and password protected computers. Identifying information, transcripts, recordings and consent forms will not be accessible by the Challenge.



Public disclosure of information

Data obtained from the interview will be aggregated and analysed into themes for use in a report to the Challenge. It is likely the findings will be presented at conferences and published in journal articles. In any of these reports, forums and formats, you will not be personally identified. If you are quoted, your contribution will be anonymised as a 'scoping group member' with no reference to the name or number of your scoping group. Please note that these steps cannot guarantee anonymity. You can also waive anonymity. We will discuss these issues at the beginning of our interview.

If you agree to participate, I will ask you to sign a consent form.

I will provide you with a draft of my report to enable you to clarify and/or elaborate on its contents prior to its finalisation. You will be provided with a copy of the final report.

If you have any queries or wish to know more please contact Ronlyn Duncan on +64 3 321 9943, email: DuncanR@landcareresearch.co.nz. You can also contact the portfolio leader for this project, Chris Phillips, PhillipsC@landcareresearch.co.nz

Thank you very much for considering taking part in this important research. It would be terrific to have your contribution.

Yours sincerely

Dr Ronlyn Duncan

Senior Researcher Environmental Social Science

Landscape Governance and Policy
Manaaki Whenua Landcare Research

54 Gerald Street, PO Box 69040

Lincoln, 7640

This research has received social ethics approval via Manaaki Whenua Landcare Research
(SE 1920/09)

Appendix 4 – Template letter for SO team members confirming acceptance of position in SO team

XX June 2019

Kia ora XX

RE: Scoping Group – SO X XXX XXX

Thank you for accepting a position in this group. As mentioned in your offer letter, no-one has tried a process like this in the New Zealand science system before. The Challenge expects this scoping group to be flexible and to work closely with us as new ideas emerge, and it is envisaged that a wide range of consultations and discussions, using the group members' and the Challenge's extended networks, will be required.

We expect approximately 5-8 days' work over the next 3-4-months for this design phase to be completed, which will include two, 2-day face-to-face meetings, and likely 1 other face-to-face meeting.

For this we have budgeted to pay members an honorarium of NZ\$1,200 per day (ex gst if any) + plus actual and reasonable expenses.

More information regarding the intent and deliverables can be found in the following documentation:

- [Terms of Reference](#) for the Scoping Group, which includes information on required for the deliverable: The Investment Prospectus.
- Challenge [Strategy 2019-2024](#)
- **Non-Disclosure agreement.** While the outcomes from this scoping groups will be shared widely once complete, you may be privy to some confidential or sensitive information. To create a safe environment, members will need to sign and abide by the conditions of the non-disclosure agreement (attached).
- **Interest Register** to ensure transparency of this process, we need to record that the Challenge has been advised of any conflicts of interest (real or potential).

By accepting this offer, you are acknowledging your agreement to comply with the above documentation. Please countersign this letter and return by email to support@biologicalheritage.nz

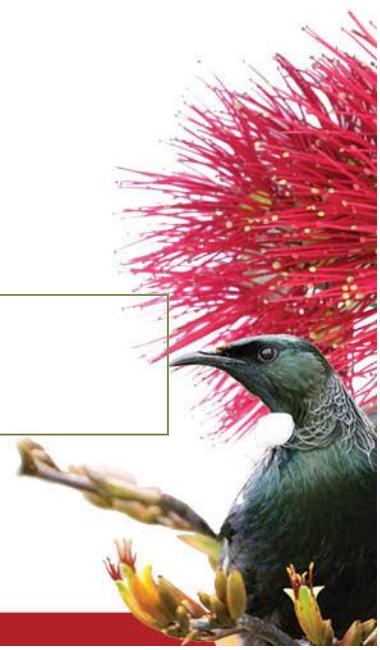
Yours sincerely

Dr Andrea Byrom
Challenge Director

Melanie Mark-Shadbolt
Director Māor

Acceptance of offer

Signature: _____



Name

Position

Date

Appendix 5 – Terms of Reference for scoping groups

Terms of Reference

Stage 1 Scoping and design of Strategic Outcomes (SOs) for the BioHeritage National Science Challenge

Background

Ngā kōiora tuku iho, the *New Zealand's Biological Heritage* National Science Challenge ('the Challenge') has been established through an investment contract between the Ministry of Business, Innovation and Employment (MBIE) and Manaaki Whenua - Landcare Research Ltd (the Challenge Host).

MBIE recently completed a mid-way review, and investment in the Challenge has been confirmed for a second five-year term (Tranche 2 (T2): 2019-2024). A refreshed [Strategy](#) for T2 was developed as part of the mid-way review process.

The Challenge's Mission is to:

Reverse the decline of New Zealand's biological heritage, through a national partnership to deliver a step change in research innovation, globally-leading technologies, and community and sector action.

The Strategy establishes a framework to focus research and other investment to achieve seven Strategic Outcomes (SOs) under three Impact areas:



The Challenge is now entering the design and planning phase of the Strategy. This involves a two-stage process, with Stage 1 being scoping and design of each SO prior to commencement of T2 in July 2019.

It is expected that Stage 1 may take 3-4 months to complete. Individuals involved in Stage 1 scoping and design may have the opportunity to remain involved in Stage 2 (including in potential leadership roles in the Challenge). The emphasis in Stage 1 is in the design process, and in building networks of relevant expertise that could contribute to delivery of the SO. At Stage 2, it is envisaged that SO teams will lay out detailed plans for research investments by the Challenge (see p. 29 of the Strategy).

These Terms of Reference set out the purpose, intended outcomes, roles and responsibilities for the **Stage 1 design process**, expected interactions with the Challenge leadership, advisory and governance groups, and deliverables from Stage 1.

Intent of the Stage 1 design process

The intent of the Stage 1 design process is three-fold:

- To ensure that a wide range of solution-focused perspectives and novel research approaches are built into Tranche 2 of the Challenge, in order to drive transformational change.
- To be as inclusive of all relevant research expertise, aligned disciplines, and knowledge systems as practicable.
- To drive added value from all relevant capability, skills, and current investments, and to ensure that these are better connected, so as to present a more cohesive, 'joined up', and compelling narrative that will incentivise investment in environmental outcomes for the benefit of Aotearoa.

In Tranche 2, the Challenge **does not intend to invest in research projects *per se***. Contracts will be focused on overall delivery of each SO, with Challenge investments targeted to high-priority research, innovation, and translation gaps and potential barriers to delivering overall benefit for Aotearoa New Zealand.

The process will require design groups to construct a complete **innovation pathway** (see pages 5-6 of the Strategy), focusing contributions from a wide range of co-investors, to deliver step change towards the Mission by 2024.

The main **deliverable** from Stage 1 should take the form of an **Investment Prospectus**. Stage 1 groups have been established to scope and design an Investment Prospectus for each SO.

Each group will be expected to work closely with the Challenge in SO design. It is envisaged that a wide range of consultations and discussions, using the group members' and the Challenge's extended networks, will be required to develop each Investment Prospectus.

The Investment Prospectus is intended to incentivise significant cohesion and focus around priority areas – integrated across disciplines, knowledge systems, and organisations – to reverse the decline of biological heritage. Each Investment Prospectus should motivate a wide range of potential capacity and capability to **complement Challenge investment**, maximising overall benefit for Aotearoa New Zealand delivered in T2 of the Challenge. To be transformational, each Investment Prospectus should be designed to influence investment focus, decision-making, and science/research delivery across our Challenge Parties, stakeholder organisations, and other potential investors.

More detail on the role and activities of Stage 1 design groups can be found on page 28 of the Strategy.

Deliverable: the Investment Prospectus

Indicative areas of Challenge investment under each Impact and SO are provided on pages 8-13 of the Strategy, but **these should be viewed as a guide only**. In addition to identifying critical issues or gaps requiring Challenge investment, each Investment Prospectus should provide detail on end-user co-investment (for example: in technology development, knowledge application and translation), and contributions of Aligned Research from Challenge Parties, in order to attract complementary and downstream investment in research and innovation.

To that end, each Investment Prospectus should include:

- A set of 3-5 Intermediate Outcomes (IOs) to be delivered by 2024 for each SO;
- Narrative (no more than 10 pages) on how the IOs will be achieved, who (individuals and organisations) will be contributing along the innovation pathway, and detail on what each will be contributing;
- Indicative level of investments required from the Challenge, and where on the innovation pathway these investments will be required to deliver the IOs;
- Quantification of contributions of aligned research investments by Challenge Parties and (where appropriate) other research organisations, and how these will be shaped year-by-year to focus on delivery of the IOs;
- Indicative cash co-investment, either in-principle or committed, from private sector or other sources;
- Indicative in-kind contributions from relevant expertise in communities, Mātauranga knowledge holders, Challenge Parties, and government agencies;
- A plan to address each of the criteria for scoping SOs, on page 25 of the Challenge [Strategy](#);
- A preliminary budget for overall delivery of the Intermediate Outcomes by 2024. Indicative Challenge investments in each SO can be found on page 34 of the Strategy.

Research detail is not expected in the Investment Prospectus.

Membership and operating principles for Stage 1 design groups

Stage 1 design groups must have a strategic, impact-oriented focus on activities that will deliver long-term outcomes for the benefit of Aotearoa New Zealand. The purpose of the Stage 1 design group is to co-design an Investment Prospectus for each SO, focusing aligned research investment and collaboration across a broad range of organisations including research, Māori, industry, government agencies, and communities.

It is expected that Stage 1 design groups will comply with the Challenge operating principles, values, code of conduct, and diversity & inclusion policy (Appendix 1) and uphold the Challenge's [values](#) at all times (see page 22 of the [Strategy](#)). The Challenge has made a purposeful commitment to embracing and embedding these values.

Membership is based on individuals' key skills and networks. Each SO group will comprise 5-10 members, chaired and facilitated by one of the group members.

It is expected that scoping and design of Strategic Outcome teams will take 3-4 months (if group members are working on design part-time). Where practicable, attendance in person at design workshops will be expected. Some travel will also be required of group members, to secure contributions from aligned research, industry, and end-user agencies.

Group members must be thoroughly familiar with the [Strategy](#), and will be expected to work closely with the Challenge leadership, advisory and Governance Groups (see below).

Stage 1 group members should not assume that they will have ongoing leadership roles in (or research investment from) the Challenge after Stage 1.

Interim SO leader roles

Work done by the Strategic Outcome groups will be a collective exercise. Each participant is expected to contribute to and take responsibility for delivery of an Investment Prospectus.

However, each SO needs designated co-leaders to manage the process and link the SO group to the Strategic Leadership Group.

SO leaders will:

- Facilitate the development of an inclusive and effective SO team
- Maintain a strategic perspective across the outcome area
- Nurture a 'whole-system' view across an innovation pathway
- Communicate effectively with the SO team and Challenge leadership
- Demonstrate the values and operating principles of the Challenge.

It is not necessary for SO leaders to be subject experts. Although their networks and knowledge will be valuable, their primary role is to chair and facilitate Stage 1 scoping. A standardized design process will be supplied by the Challenge. Other tools will be provided, as well as administrative and logistical support (see below).

Guidance and support from the Challenge

In developing the Investment Prospectus, design groups can expect strong guidance and support from the Challenge's Science Leadership Group, Governance Group, and Kāhui Māori. The Challenge will endeavour to help each group identify critical skill sets, facilitate contacts with relevant research teams across the Challenge Parties, provide contacts and networks with end users and private investors, and ensure that the Investment Prospectus gives appropriate effect to Vision Mātauranga. However, design groups will also be expected to follow up contacts, utilise their own contacts and networks, and/or facilitate new contacts and networks as part of the design process.

The [International Science Advisory Panel](#) (ISAP), or other relevant international reviewers, will peer review each Investment Prospectus. The ISAP may also be able to help identify international connections and expertise relevant to delivery of each SO. The Challenge is happy to provide introductions to ISAP members if needed.

The Challenge Support Team will provide administrative support (page 26 of the Strategy).

How the Investment Prospectus will be evaluated

Each Investment Prospectus will be evaluated according to the assessment criteria on page 25 of the Strategy. Agreement by the Challenge to proceed to Stage 2 will be based on the likelihood that a Prospectus will deliver the agreed Intermediate Outcome(s) within each SO. It is expected that evaluation of each Investment Prospectus will be an iterative process, and that some will require further refinement, identification of the right skills and roles, and/or investment commitments, before proceeding.

The Governance Group will give final approval for an Investment Prospectus for an SO to proceed to Stage 2.

Remuneration

Participants' will be paid a standard daily rate, plus travel and associated workshop costs (where practicable within the terms of the Collaboration Agreement for the BioHeritage NSC).

Appendix 1

BioHeritage operating principles, values, codes of conduct, and diversity & inclusion policies

Science and research have a major role to play in reversing the decline of our biological heritage. In our 2019-2024 strategy we sharpen the focus on how New Zealand’s research and innovation system can connect and accelerate progress to deliver enduring impact and benefit for New Zealand.

Operating Principles

- Maintaining a **strategic perspective across all relevant investments** (while not seeking to ‘control’ the direction of investments), thereby identifying gaps where investment is needed;
- **Applying a right team approach at the outset**, with a focus on inclusion of new participants who bring fresh perspectives and passion to the mission, as well as a healthy combination of Te Ao Māori and western science;
- **Taking a ‘whole-system’ view** across an innovation pathway;
- Facilitating **inclusion of independent initiatives** so they become part of a coordinated national effort, even when funded from other sources;
- Ensuring such **coordinated national effort** is informed across all priority setting initiatives;
- **Purposefully balancing** urgent/immediate deliverables with longer-term, strategic investments;
- **Capturing and using key learnings and knowledge** from national and international research;
- Investing in **Mātauranga Māori-led solutions** – and resourcing them adequately – acknowledging that there has been relative under-investment in uncovering indigenous ecological knowledge despite clear demonstration of the benefits of this approach;
- Ensuring current investments and outcomes of previous investments are **open, transparent and publicly available** (with due regard to commercially sensitive information), to prevent duplication of research effort and ensure investment is targeted to high-priority research;
- **Capturing and sharing knowledge and learnings** with everyone.

Our values

We make a purposeful commitment to embracing and embedding our values in every facet of the Challenge.

Our Values	How We Apply Our Values
<i>Mahi whaipāinga</i>	We care about making a difference for Aotearoa
<i>Ngākaunui / Uekaha / Ngakau Whakapuke</i>	We are passionate and enthusiastic about our work
<i>Whanaungatanga</i>	We work as a family We have fun together
<i>Manaakitanga</i>	We build trust and create a place that others want to be a part of We build mana in others around us to enhance the mana of the whole
<i>Mana Motuhake / Tino Rangatiratanga</i>	We recognise and empower sovereignty and autonomy
<i>Whakapapa</i>	We recognise interconnections We have an intergenerational vision
<i>Kaitiakitanga</i>	We enable stewardship of our biological and cultural heritage
<i>Mātauranga</i>	We recognise the value of blending traditional and modern knowledge
<i>Tohungatanga / Ngā tiketitanga o te pai</i>	We apply excellence to everything we do
<i>Mahi rangapū</i>	We work respectfully in partnership



<http://www.biologicalheritage.nz/about/our-values>

Equity, Diversity, Access and Inclusion Policy

To support all **members** of the **BioHeritage whanau** and to provide a **safe, inclusive** and equitable environment that enables all people to reach their potential. [Click here](#) for more information.

Code of Conduct

The Code of Conduct aims to promote a **sense of community** through the cultivation of **mutual respect** and **understanding** and ensures our collaborative research community is treated fairly and equitably. [Click here](#) for more information

Appendix 6 – Non-disclosure agreement



Non-Disclosure Agreement

BETWEEN:

Landcare Research New Zealand Limited acting on behalf of New Zealand's Biological Heritage National Science Challenge ("**Landcare Research**") of Gerald Street, Lincoln, New Zealand ("**Landcare Research**")

AND

Full legal name and **address ("the Recipient")**

.....
.....
.....

Background

- A The Recipient has been or will be provided with certain information which is either the property of Landcare Research and/or information contributed by participants, which is of a confidential and valuable nature and/or is valued mātauranga Māori, all such information should be considered ("Confidential Information").
- B Landcare Research is providing the Recipient with Confidential Information including information provided to New Zealand's Biological Heritage National Science Challenge for the purpose of mapping the research landscape and identification of research gaps and priorities.
- C The Recipient has agreed to be bound by certain duties of confidentiality and non-use in respect of the Confidential Information provided in both written and verbal form.

IT IS AGREED as follows:

1. Definition

For the purposes of this Agreement, "Confidential Information" shall mean ideas and concepts, information, data, mātauranga Māori, know-how, whether technical or not, which is disclosed to the Recipient, and which relates to research, development or business activities of Landcare Research or its collaborators and which is either marked or stated to be confidential, or is by its nature reasonably intended to be confidential. It shall not include information, data or know-how which can be established by written records to be already known to the Recipient or the public at the time of its disclosure, nor information, data or know-how which enters the public domain through no fault of the Recipient.

2. Disclosure

The Recipient agrees not to disclose or otherwise publish the Confidential Information without the prior written consent of Landcare Research.

3. Use

The Recipient agrees not to use the Confidential Information for any purpose other than that for which the information was provided. In the case of any uncertainty, the Recipient agrees to obtain prior clearance from Landcare Research.

All information that is collected or offered from Mana Whenua is deemed to be their exclusive Intellectual Property and use of that information will require prior consent from the individual from whom the information originates or their named Mātauranga Custodian. All recipients will have consideration for all relationships developed and mātauranga Māori or information offered by Mana Whenua shared during the mapping process and ensure it is handled with appropriate respect.

4. Security of Material

The Recipient shall take all reasonable care to ensure that all material in its possession which contains or incorporates the Confidential Information is securely kept by using the same degree of care, but no less than a reasonable degree of care, as is used to protect its own confidential information.

5. Return of Material

The Recipient shall return, destroy or otherwise deal with all material containing or incorporating the Confidential Information as directed by Landcare Research.

6. Term of Agreement

This Agreement will continue until the Confidential Information enters the public domain or Landcare Research and the Recipient agree that the Recipient's obligations under this Agreement may cease.

7. Disputes

Any dispute concerning this Agreement will be settled by full and frank discussion and negotiation between the parties. Should the dispute not be resolved satisfactorily for both parties, they will refer the matter(s) to mediation.

8. Execution

This Agreement may be executed by the parties exchanging signed copies by hand, post or emailed PDF.

Signed for on behalf of: Landcare Research New Zealand Limited	
Signature: _____	Date: _____
Name: Andrea Byrom	
Position: Director – Biological Heritage Challenge	

Signed by:	
Signature: _____	Date: _____
Name: _____	
Position: _____	

Appendix 7 – Expression of interest form

Strategic Outcome Design Group: Stage 1 Expression of Interest

The application form below is designed to elicit a brief summary of your personal interests and the expertise, skills and experience you can contribute to Stage 1 design groups.

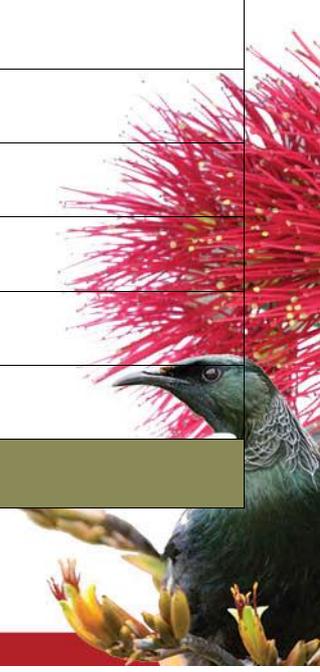
Note: The Challenge also intends to solicit EoIs from individuals and organisations. We also welcome nominations from individuals or organisations other than the applicant.

Please email EoIs using this application form to Support@biologicalheritage.nz as a word document **by 5pm on 19 December 2018**.

Please submit only the completed application form. Proposals exceeding the word limits will not be accepted. Other documents, including CVs, will not be accepted.

Any questions? Contact Support@biologicalheritage.nz

Section 1: Applicant Information and Strategic Outcome preference	
Name	
Organisation	
Postal and physical address	
E-mail	
Alignment to an SO	Indicate which of the Seven Strategic Outcome(s) you are interested in. Applications are welcome for more than one SO, up to a maximum of 3 . <i>Refer to the Challenge's Strategy for further details on each SO</i>
	SO 1: A BioHeritage scorecard for Aotearoa
	SO 2: Environmental stewardship
	SO 3: Emerging biosecurity risks
	SO 4: State-of-the-art biosecurity surveillance
	SO 5: Tools, technologies & strategies
	SO 6: Social-ecological resilience
	SO 7: Governance and policy
Section 2: Personal Capability	



Your specialty

~ 200 words.

Summarise your key skills, experience, and expertise in the areas in which you work, including research discipline (if applicable).

Describe how these could apply to the design of your chosen SO(s).

Delete text in italics

Relationship with other work

~ 200 words.

Tell us about work you have been doing that is of relevance to your chosen SO(s). Who invests in this work, and how long is the Investment for?

In design of your chosen SO(s), how will you connect with organisations or individuals that hold expertise that could contribute to delivery of the SO?

Delete text in italics

Section 3: Team fit**Fit with the team**

~ 200 words.

Tell us why you would like to be part of a BioHeritage Stage 1 design group.

Tell us why you would be a good fit for development of your chosen SO(s). What do you think you could offer? Please make a convincing argument for how and why you think you could add value to a trans-disciplinary, multi-institutional team.

Delete text in italics

Appendix 8 – New Zealand's Biological Heritage National Science Challenge Investment Prospectus: Template

Page limit: The Investment Prospectus should be no more than 20 pages in total

Section 1: Creating Impact

Vision and link to the Challenge mission

½ page

In this section you need to clearly articulate the problem, why it is critical that we solve the problem for Aotearoa, the vision for success, and what transformational impact will be delivered.

How does this relate to the Challenge mission of reversing the decline of biological heritage?

2024 Goals

½ page

State the 2024 Goals agreed during the scoping process.

Beneficiaries

1 page

Who are we doing this for? Who are the most important beneficiaries? Who is the team (institutions, individuals) who will create impact?

Delivery pathways

2-3 pages

What are the pathways by which impact will be created? Which pathways will be most decisive? Which pathways will be most costly? How do these pathways integrate with investments across the Challenge as a whole (i.e. link to work in other Strategic Outcomes)? What are the potential barriers to delivery, and how will they be overcome?

How will you build scale? What is the vision for growth? What mechanisms will be needed if the team needs to pivot in a new direction? What mechanisms will be used to introduce or refresh capability? How will you bring in new skill sets or ideas into the team? How will you ensure an element of contestability in the overall portfolio of work?

Risks

1 page

What are the perceived or actual risks inherent in your investment strategy? How might these impede progress towards creating impact? Are there potential risks or issues in working with non-traditional research organisations?

Communications and relationship management

1-2 pages

What relationships will be most decisive? How will these relationships be managed? What communication channels are essential?



Essential activities

2-3 pages

What high-level research, innovation, or translation activities are essential to delivering & sustaining impact (via the 2024 Goals)? What are the critical gaps – along the innovation pathway i.e. discovery, invention, innovation, translation, adoption and scale-out – that the Challenge should / can invest in? Are there critical gaps that parties or research involved with the Challenge should or could invest in or seek investment for?

What are gaps that the Challenge cannot cover and where others may need to invest? Include fast-fail / innovation or seed funds where needed.

Essential partnerships and relationships

2-3 pages

What relationships will be most decisive to transformation? What agreements do you have in place, or do you need, to ensure buy-in from key partners? Clearly outline who the key partners will be – research organisations, industry, Māori, government agencies, private sector. How will these partners enable the essential activities that need to be undertaken? Who are the key partners that will help create impact? What partners will be responsible for key research activities not funded via the Challenge? What partners provide access to data, infrastructure, or operational resources?

You may wish to consider Universities, Policy Agencies, CRIs & IROs, Industry, Private Sector investors, Communities, NGOs, and Iwi, Hapū & Whānau.

Essential resources

1-2 pages

What systems resources (research funding, data, infrastructure, capability etc.) are essential to delivering & sustaining impact?

Budget details and cost narrative

2-3 pages

Which essential activities are the most expensive? Which essential resources are the most expensive? Which partnerships will be costly to establish and maintain? Which are the costs inherent in delivering impact? What plans do you have to leverage co-investment from the key partners to cover some of the cost elements?

2024 Goal Metrics

1-2 pages

What are the critical steps needed to achieve the 2024 Goals? How will we measure and evaluate progress towards the desired impact (i.e. metrics)? How would investors measure success? Which outcomes will we track?

Appendix 9 – Investment prospectus guidelines

New Zealand's Biological Heritage National Science Challenge Investment Prospectus: Guidelines

Why an Investment Prospectus?

New Zealand's biological heritage is in decline. Science, research and new knowledge are needed to discover, develop and deploy in innovative ways to help reverse the decline. To address this complex issue, we need national leadership. In the BioHeritage Challenge we aim to actively lead better and faster pathways from science discovery through to creating **impacts** at regional or national scales. By 'impact' we mean a set of final, long-term effects or benefits in a value chain.

Research effort in New Zealand is fragmented, competitive, and often not collaborative. Since 2014 we have identified more than 1000 research projects or programmes aligned with the Challenge mission – millions of dollars of investment. Yet this diverse effort lacks overall cohesion and focus, in part because it has never been harnessed in a strategic framework to deliver measurable benefit for New Zealand.

In our [2019-2024 Strategy](#) we focus on the 'innovation system' as a whole, to ensure progress towards strategic, long-term goals. This requires coordination of a variety of diverse individuals and institutions, each of whom contribute different skills to different stages along a value chain from discovery science to national benefits.

Characterising the innovation system around each of 7 Strategic Outcomes in order to incentivise investment is the aim of the Investment Prospectus (IP). Only after we have mapped the overall portfolio of effort in a given area, brought essential partners on board, and identified critical gaps and opportunities can we drive transformative change: leveraging existing investments and investing in the right places to create impact.

The Investment Prospectus should tell a story

The intention of the IP is to outline how we will **create impact**. It is time-bound in the sense that it should outline the **2024 Goals** developed in each of seven Strategic Outcome areas. It should paint a picture of how we can harness knowledge, science, research, innovation and technology development across research organisations, in communities, and in government agencies. Prospectuses are a very effective tool in social enterprise and in business because they are in a format and language that investors can understand. Each Investment Prospectus needs to include narrative to characterise investment needs along the innovation pathway from Discovery Science to Adoption & Scale-Out:



The Investment Prospectus should outline how you intend to focus and prioritise research investments, clearly highlight critical gaps, and quantify the resources needed to get to the 2024 Goals. Most importantly, it is intended to **invite co-investment** and/or in-kind contributions from a wide range of knowledge holders and stakeholders. **It is not a research plan.** The key to a good prospectus is 'thinking like an impact investor' – selling them on how we will create impact and transformational change in each of seven Strategic Outcome areas. Each Investment Prospectus will be a **public document**.

The investment pitch

To encourage and strengthen the investment culture amongst science teams involved in the Challenge, we have set up a **mock panel of investors**: people who have experience with startups, philanthropy, impact investment, aid and charity sectors, tech investment, and the like. After Workshop 2, each Scoping Group will have the opportunity to present to the panel and receive feedback prior to revising their Investment Prospectus and submitting it to the Strategic Leadership Group for review. See the separate document '[Top 10 Tips for a Good Investment Pitch](#)'.

Activities you will need to undertake to draft an Investment Prospectus

By the end of Workshop 2 you will have completed a design process aimed at providing you with tools and the networks to draft the investment prospectus. Here are some of the next steps you need to undertake to complete a draft Investment Prospectus and prepare a pitch for the mock panel:

- Be thinking about how we should evaluate success (**metrics**). Preliminary Critical Steps that will form the basis of Key Performance Indicators (KPIs) have been identified via the scoping process, but more work may be needed.
- Finalise appropriate and relevant **aligned research** by speaking with researchers in Challenge Parties, and identify the capability and resources needed to connect relevant effort into an overall portfolio of work.
- Specify **current resources** (e.g. data, infrastructure, Mātauranga, germplasm etc.) that can be coordinated to achieve greater impact.
- Confirm **commitment** of meaningfully aligned effort from institutions and organisations outside of the Challenge Parties, and identify resource and/or capabilities, skills and roles needed to ensure that such connections are fit-for-purpose and will be enduring.
- Identify who/where **new capability needs** can be found – think outside the box here – we are looking to join up non-traditional capabilities to develop transformational solutions.
- Identify linkages with **Māori** communities, researchers and organisations, and plan where cultural safety agreements will be needed. The Challenge SLG can help with advice on this aspect.
- Identify strategic **international linkages** and potential international collaborators.
- Scope opportunities for **leveraging investment** from the private sector or other contestable government sources, and ensure that teams have the right mix of skills to build the required relationships.

See the [Investment Prospectus Template](#) for more detail.

Assessment process

- Scoping Groups will need to have a draft Investment Prospectus ready to 'pitch' to the panel of mock investors by the end of October 2019.
- The mock panel process will run over two days, either at the end of October or early November. Presenters are welcome to observe other groups present; indeed, integration across the Challenge will be an important aspect of the suite of investment pitches. (See separate document '[Top 10 Tips for a Good Investment Pitch](#)').
- Based on feedback from the mock investor panel, Scoping Groups will need to revise their Investment Prospectus ready for submitting to the Challenge ISAP (International Science Advisory Panel) in mid-November. Once ISAP reviews have been received, the Strategic Leadership Group will make a written recommendation to the Challenge's Mana Rangatira Governance Group.
- Note that for some investments (e.g. the *Ngā Rākau Taketake* surge investment for kauri dieback and myrtle rust) the Challenge may need to fast-track the assessment process.

Assessment criteria

The following criteria will be used to assess whether SOs are investment-ready.

- Clearly demonstrate **the right team and pathway to impact** to achieve the Challenge Mission;
- Demonstrate **scale and critical mass** (i.e. will likely represent several million dollars of effort across each innovation pathway), and/or be scalable in future as new opportunities and new connections come to light;
- Develop a narrative about the **overall portfolio of effort**, and include storytellers and/or translators in the team.
- Critical **knowledge gaps, potential risks, and barriers to delivery** must be clearly identified and plans to target Challenge investment to overcome these clearly articulated.
- Demonstrate a **balance of skill sets, disciplines and career pathways** including (but not limited to) project management, conceptual science leadership, interdisciplinary researchers, agencies, stakeholders and communities, and how each will be resourced.
- Clear **lines of accountability** will need to be indicated in terms of delivery of metrics to evaluate success.
- The Investment Prospectus will need to demonstrate **processes that will be used to cease investment** if a pivot is required.
- Challenge resourcing should be allocated with an overall focus on **successfully delivering 2024 Goals** (delivery of which will depend on substantial investment in addition to direct Challenge resourcing).
- **Co-leadership**, including consideration of succession planning for postdocs, early-career researchers and/or Māori leaders, will be strongly encouraged.
- Each Investment Prospectus will be expected to **identify international connections and collaborations** according to the Challenge's strategic guidelines, and to resource these.

Appendix 10 –10 Tips for a good pitch



New Zealand's Biological Heritage National Science Challenge Top 10 Tips for a Good Investment Pitch

What is an investment pitch?

The investment 'pitch' is an approach that is used in business and in social enterprise. For the BioHeritage Challenge, your investment pitch will be a **dragons-den-style presentation** to a panel of people with experience in startups, social enterprise, and impact investment. The investor panel has been established to help the BioHeritage Challenge build capability across the science sector to understand how investors 'think' – the questions investors will ask when assessing for impact. Panel members are not expected to provide actual investment.

You and your team will need to tell a compelling story, addressing the guidelines set out in the [Investment Prospectus Template](#) and outlining critical gaps requiring research investment. **Research details are not required.**

You will have approximately 1 hour to make the pitch and answer questions from the panel. We suggest that 2-3 people (max) from each Strategic Outcome should present the pitch. **Presenters are welcome to watch other Strategic Outcome Groups make their pitch.**

Why is the BioHeritage Challenge getting us to make an investment pitch?

Our aim with this exercise is to deepen and strengthen the focus on **impact** across all research teams involved with the Challenge, and to expose scientists (for many of whom this will be new) to the world of **impact investment**. The verbal pitch and the Investment Prospectus go hand-in-hand: the pitch should aim to give us a sense of what is contained in the draft Investment Prospectus. The investment pitch – and questions from the panel – **will help you refine your draft Investment Prospectus so that the Challenge can decide where best to focus our investment**. We need to understand critical research priorities and gaps for each [Strategic Outcome](#), and how best to connect with existing work, in order to create maximum impact and deliver on the Challenge Mission.

Around Biological Heritage, there is already significant investment in science, research and knowledge generation in Aotearoa. Your pitch should make a compelling case for how Challenge investment will connect and accelerate these aligned efforts.

This document should be read in conjunction with the [Investment Prospectus Guidelines](#) and [Template](#). If you haven't already, we recommend you familiarise yourself with the [Challenge's 2019-2024 Strategy](#).

Below we outline 10 tips for an investment pitch. Our team has seen this approach work extremely well for science and research (i.e. not just in the tech and social sectors). Organisations like CSIRO encourage researchers to focus on impact; they use **mock panels as a way of introducing them to an investor culture**. If you are interested in reading more about the 'pitch' approach, try Google. Our tips are a guideline– the more you familiarise yourself with the intent, the more successful your pitch will be.

1. Tell a compelling story (the vision)

It may sound obvious, but your pitch should not be a monologue of research ideas. We are interested in the bigger picture. What is the critical issue? Why is it important that we address the issue? What are we aiming to achieve by 2024? How will we know we have been successful? **Your narrative should focus on the **problem(s)** to be solved, the **2024 Goal(s)** to address the problems, and **critical steps** that need to be taken to get there. Your story should make the pitch compelling, unforgettable, and impart a sense of urgency. This is your theory of change.**

We suggest you weave a story around the innovation pathway outlined in the 2019-2024 Strategy.

2. Explain how you will create impact

It may be obvious to you where investment will make a difference. However, you should not assume that the panel knows this. You need to explain how the proposed investment will create impact, i.e. the benefit to Aotearoa, and contribution to the Challenge mission. You must also explain; how you have built connections with others to focus, leverage, and scale up existing efforts; decisions made in constructing the right team; any assumptions made; and key partners or relationships critical to success.

3. Understand the audience

Our mock panel of investors may not typically be involved in science investment – they are people who have experience with startups, philanthropy, impact investment, aid and charity sectors, tech investment, and the like. They want to know why you have recommended particular investment areas, the assumptions made, who the key partners are, and how risks will be managed. They will be looking for 'out of the box' ideas and will have an acute sense of what will create impact and momentum for change. Put yourself in their shoes when making the pitch.

4. Keep it simple

You need to organise your pitch around the Investment Prospectus template. However, keep it simple. Use plain language, and explain what you mean if you need to use technical language. Clearly articulate the case for investment. Practice your pitch on your kids, parents, partners, colleagues...

5. Make it time-bound

The 2024 Goals are important. The panel will want to know exactly what will be achieved by 2024, the critical steps to get there, and how that will make a difference for Aotearoa.

6. Be aspirational

Think big, not small. What should Aotearoa do to add value to current research investments, and unlock untapped potential around existing efforts to reverse the decline of biological heritage? If funding was limitless, would that change the recommendations? In an ideal world, how would you wipe the slate clean and start again if you were to design an investment strategy to create impact in this area?

7. Be clear about the investment 'landscape' (market opportunity)

Just as a corporate investor would want to know about market context, our panel of mock investors will have a similar expectation when assessing impact. In your pitch you will need to be clear about the overall landscape of research and other forms of knowledge in Aotearoa around your Strategic Outcome, and exactly how and why Challenge investment into critical gaps will make a difference.

8. Who is in the team?

One thing that any panel of investors will want to know is: who's on board? They are not interested in detail – rather an overall picture of people or organisations who have agreed to contribute in order to create impact. Provide evidence that you understand who (people, organisations) makes-up the 'right team'. Demonstrate to the panel that you have genuinely sought to connect with others and remember to include stakeholder and end user groups, and holders of traditional knowledge (Mātauranga). Where appropriate identify any relationships that you would seek to build and bring into the team as investment progresses.

9. Show scalability

The panel want to understand how and why you think this investment will build scale. You may wish to convey which critical investments should be made now, cf. those which need more work to build relationships and leverage co-investment over the next 2-3 years. You should articulate hurdles that need to be overcome to scale up.

10. Demonstrate that you have considered risk

Investors – whether for profit or for impact – vary in the degree to which they are prepared to accept risk. Perceived or actual risks should be articulated in the pitch, and more importantly, you will need to show how they will be addressed. Is a critical partner not on board? You need to show how the team will build a relationship with them. Are you recommending investment in a tool or technology that may cause public concern? You need to demonstrate how you will address the social licence issue. And so on.

Conclusion

The purpose of a successful pitch is to make the investors sit up and go 'wow' – to make the value proposition so compelling that everyone will want a piece of the action. You need to deliver what the investors want to hear – to empower, protect, and restore Aotearoa for future generations.