National SCIENCE Challenges

Call for Expressions of Capability: Biosecurity Technology Research

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Illustration designed by Tyler Dixon, Waikato-Maniapoto, Ngāti Porou, Ngāi Tūhoe, Ngāi Tahu depicts a Mangopare (Hammerhead shark). It symbolises the strength in duality to be found in uniting Māori knowledge with western science.

National Science Challenges

SCIENCE FOR TECHNOLOGICAL INNOVATION

Kia kotahi mai – Te Ao Pūtaiao me Te Ao Hangarau

National Science Challenges

NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Koiora Tuku Iho

Science for Technological Innovation (SfTI) and New Zealand's Biological Heritage National Science Challenges are calling for Expressions of Capability (EoCs) from researchers to support the implementation of a new Spearhead project arising from SfTI's last Mission Lab: Biosecurity Technology.

ABOUT SPEARHEAD PROJECTS

Science for Technological Innovation (SfTI) Spearhead projects are intended to deliver specific innovative technologies to help achieve SfTI's overarching purpose of enhancing New Zealand's capacity to use physical sciences and engineering for economic growth. They should be mission-led and bring nationwide teams together to have a broad impact on this country's technology ecosystem, including capacity development for all team members.

ELIGIBILITY

The purpose of the EoC is to assemble researchers so that SfTI can form a 'best' national research team, and we welcome EoCs from researchers at New Zealand-based organisations.

BIOSECURITY TECHNOLOGY BACKGROUND

The Biosecurity Technology (Tech) Mission is one of several new topics being explored for Phase Two (2019-2024) of this National Science Challenge. Given this topic's alignment with the work of Biological Heritage NSC, SfTI is taking the opportunity to collaborate on this mission.

In essence, SfTI's Biosecurity Technology focus is on employing cutting edge physical sciences and engineering to create new technology (processes and tools) that will better protect NZ from harmful biological elements such as non-indigenous flora, pathogens, marine pests, insects, and mammalian species. In terms of benefits, best practice (through enhancing effectiveness and lowering costs) biosecurity is largely about risk mitigation, prevention and/or eradication. Additionally, any resulting biosecurity tech will likely be valuable in the international marketplace.

Early conversations have identified four potential research directions that provide a basis for further refinement:

1. Digital foundations – using software to enable specific applications that predict or detect incursions, and communicate risks and other information.

2. Sensors – developing novel sensors to detect and/or track unwanted pests or diseases to improve accuracy and lower costs.

3. Smart Traps - significantly improving smart traps for animals and insects to improve mitigation and eradication efforts in terms of both effectiveness and cost.

4. Automation and Remote Capability – developing novel automated technology that transforms our ability to inspect/surveil, mitigate and/or eradicate biosecurity incursions that come across our borders.

As with all SfTI research, in order to be funded, each new mission is required to demonstrate how it would leverage New Zealand's unique strengths, capabilities and/or resources to take a measurable, future-oriented leadership position. Incorporating Māori knowledge and cultural practices related to Biosecurity is an obvious way to do this, and it is a cornerstone of the approach that SfTI wishes to take.

Additionally, our research should identify where there is key 'stretch', and this extends beyond our borders to consider globally stretchy science, as well as 'NZ-sticky' research potential. Ultimately, this programme of work must create new knowledge leading to technological innovation resulting in long-term economic benefit to New Zealand.

THE SPEARHEAD DEVELOPMENT PROCESS

This project is at Stage 3 of the SfTI Spearhead project development process, see Appendix 1. The purpose of Stage 3 is to assemble researchers to form a 'best' research team. **You can read more detail about the Spearhead development process on our website.**

We want to develop a plan for a bold new research programme, including what might be achieved (with indicative milestones) and more detail for the first two years of the project. The plan may have three or four work streams but there must be an over-arching (longer-term) logic and internal connectivity to what is going to be attempted. A key element of the process will be the formation of a 'best NZ team', and looking for opportunities to collaborate with other organisations working in aligned areas.

Ultimately, this technology mission will meet all or most of the following criteria:

- Involves new, emerging and potentially world-leading science and/or technologies.
- Takes advantage of an opportunity or set of conditions that is unique to NZ.
- Makes good scientific sense to carry out original research in NZ.
- Is relevant to Vision Mātauranga, i.e. to unlock the innovation potential of Māori knowledge, resources and people.
- Can be applied in a unique way in NZ to generate economic growth for NZ.
- Builds capability in technology areas where NZ cannot afford to be deficient.

Please note: SfTI is not seeking investigator-led research ideas and proposals. Instead, we are interested in the expertise and experience you will bring to the research team in addressing the Biosecurity Tech Mission, and experience in multi-disciplinary/collaborative teams.

Researcher Workshops

From the Expressions of Capability, a group of researchers, together with Māori and sector and/or industry representatives, will be selected to participate in a process to establish the team that will develop a Biosecurity Tech research proposal to be considered by the SfTI Board.

The selected researchers are expected to attend a workshop in Wellington on 9 September 2020 to explore components of a research programme and organise a multidisciplinary team. It is important that the selected researchers attend the workshop with a willingness to consider a range of different ideas about the core research questions and ensure these fit with the overarching Biosecurity Tech Mission, and to work towards achieving group consensus on next steps. The workshop may focus on two or three potential research directions depending on the EoC applications received.

It is likely that only a subset of researchers attending the Wellington workshop will be selected to proceed with forming the eventual project team, and this will depend on fit of research capability and disciplines offered by the researchers to the draft research programme project developed during the workshop. SfTI will fund travel to attend the Wellington workshop, as well as any on-going costs involved in bringing the team together to further develop the spearhead research programme proposal.

The process will finish with the development of a formal spearhead research programme proposal covering a maximum of three strands of work. Given the importance of Taonga/native species, the eventual project will need to address Vision Mātauranga, and the how it will empower kaitiakitanga, protection, and partnership with Māori.

HOW TO APPLY

Register your interest by sending your completed application form and CV to:
SfTIChallenge@callaghaninnovation.govt.nz

Applications close 10 August 2020.

The application form asks for a brief summary of your experience and how it might relate to the current mission. The form is at the end of this document, or it can be downloaded from our website:
https://www.sftichallenge.govt.nz/news/biosecurity-technology-mission-calling-for-expressions-of-capability

Please note: Long applications will not be considered so please do not exceed the word limit.

Key dates and process

- Biosecurity Tech EoC released – 15 July 2020
- EoC Applications close – 10 August 2020
- Workshop invitations sent to researchers – mid-August 2020
- Researchers Workshop in Wellington – Wednesday 9 September 2020
- Spearhead research team formation and proposal development – from Sept 2020
- Spearhead proposal approved and research starts – from early-mid 2021

Funding will be a maximum of $1m per annum for up to three years.

Contact information

If you have any questions about the EoC process, email Denise Cutler, SfTI Senior Advisor Research Delivery:
denise.cutler@callaghaninnovation.govt.nz

For all other questions relating to Biosecurity Tech, expertise and capability, email SfTI Leadership Team members:

- Elspeth MacRae: **elspeth.macrae@scionresearch.com**
- Ian Woodhead: **ian.woodhead@lincolnagritech.co.nz**

REFINING THE RESEARCH PROGRAMME

Our vision for this Mission includes supporting both the identification of biohazardous incursions before they arrive in New Zealand in order to keep them out, and mitigating and/or eradicating the biological threats we already have through developing novel solutions.

Vision Mātauranga (VM)

New Zealand is uniquely positioned to combine both Māori philosophies such as kaitiakitanga (guardianship of the biosphere) and Mātauranga Māori with Western Science when developing biosecurity technology. In this way, we can capitalise on one of NZ's unique capabilities.

It is clear that partnership has a central place in developing best approaches that lead to the improved health and wellbeing of Aotearoa's people and land. Establishing and building long term relationships and growing shared understandings will support two-way knowledge and technology transfer between Western Science and Mātauranga Māori. With regard to Biosecurity Technology, this can be achieved through:

- Partnering with local communities to both draw on their knowledge of the local environment and understand its needs. Māori have been managing local environments for hundreds of years and have a great deal of important knowledge.
- Ensuring Mātauranga Māori is rightly recognised as science during the research process and is incorporated into projects from the outset. This includes valuing the in-depth knowledge and wisdom of kaumātua. One project already being undertaken in New Zealand uses existing knowledge about toxins found in native plants to develop and test alternatives to 1080.
- Understanding that any technology solutions to biosecurity problems have to be accepted and used by communities. The ongoing controversy around the use of 1080 demonstrates this point.

More generally, researchers should be mindful to: include Māori researchers in the project; ensure the researchers are skilled in working with Māori; involve Māori communities and businesses in problem/solution definition; protect Mātauranga Māori IP; and ensure the science and technology filters through to Māori communities and business.

The eventual Biosecurity Tech research will need to strongly address VM, and will likely be overseen by a governance group that supports co-leadership and co-innovation with Māori.

Duplication

A considerable breadth of work is already being undertaken within the biosecurity space, both locally and internationally, so a key consideration is to ensure against duplicating the work of others; this research must constitute novel science.

There is strong potential for this Spearhead to be aligned with work being carried out by the Biological Heritage NSC. That Challenge has already conducted a partial stocktake of relevant strategic and operational research, but a wider stocktake of current research work and industry investment will need to guide what should and should not remain in scope.

In addition, we expect the project team to actively engage with other relevant organisations and initiatives during the proposal stage. These may include: Biosecurity 2025; other NSCs such as *Our Land and Water* and *Biological Heritage*; Predator Free New Zealand; Te Tira Whakamātaki (the Maori Biosecurity Network); Te Herenga; and the Cacophony Project, among others.

Collaboration

Given the obvious potential to align this Mission with the Biological Heritage Challenge's efforts, some elements of their work stream can usefully be considered when developing SfTI's research programme. For example:

> ***Strategic Outcome 5:*** We deploy novel tools, technologies & strategies for control or eradication of biotic threats. Autonomous systems and sensors feature here as key tools for controlling and eradicating threats both for border biosecurity and in dealing with legacy pests that have established in New Zealand.
>
> ***Strategic Outcome 2:*** We empower New Zealanders to demand and enact environmental stewardship and kaitiakitanga. People who are informed, motivated and enabled will effect change.

The recently released Predator Free 2050 Strategy includes the 2025 interim goal: "By 2025 we will have developed a breakthrough science solution that would be capable of eradicating at least one small mammal predator from the New Zealand mainland." This, and other goals from the strategy, present a substantial challenge that SfTI is well-placed to support.

POTENTIAL RESEARCH DIRECTIONS

Four potential research directions have been suggested that provide a basis for subsequent refinement by researchers, Māori partners and industry/sector experts. The underpinning science/technology relates to *digital foundations* and *sensors*, while specific applications may include *smart traps* and *automated/remote capability*. These are described below.

It should be noted, however, that the researcher workshop will be an opportunity to explore other potential technologies not mentioned below.

1. Digital foundations – using software to enable specific applications that predict or detect incursions, and communicate risks and other information.

Data analytics, machine learning, novel modelling, virtual reality and other digital tools will likely underpin any application-focused science and technology within this Mission. When it comes to developing 'smart' tools, Māori values need to be integrated into the process from the outset.

One impact of better application of data science to biosecurity may be new methods for data collection, analysis and accessibility that ensure insights can be applied by any and all users to mitigate biosecurity harms. Given the significant work already happening around applying data analytics to biosecurity, ensuring any proposed project constitutes novel research will be vital.

Potential ideas include creating an open software platform that serves as a repository and analysis point for multiple data streams collected over time from multiple points around the country, or incorporating machine learning to develop predictive response models to understand how pathogens travel within New Zealand.

2. Sensors – developing novel sensors to detect and/or track unwanted pests or diseases to improve accuracy and lower costs.

While sensors constitute standalone devices as monitoring tools, they will also enable more complex applications such as smart traps, mobile traps and automated/remote biosecurity tools to be developed. Sensors that can better characterise disease/infection as well as identify the presence of target mammals, marine species, insects and plants are essential to improve biosecurity activities. Valuable potential would be released if sensors, including those in remote environments, were able to easily share data.

Potential areas for focus include: improved odour sensors; new materials (e.g. g-putty) to sense small insects such as brown marmorated stinkbug; particulate and fungus detection (e.g. to detect West Coast winds for Myrtle Rust); environmental DNA sensors and tracers; detection of human-borne pathogens arriving at entry ports; and thermal imagery (e.g. linked with machine learning for accurate species detection).

3. Smart Traps - significantly improving smart traps for animals and insects to improve mitigation and eradication efforts in terms of both effectiveness and cost.

Specifically, there is a desire for far more sophisticated traps to better identify and kill target pests while also avoiding non-target species. Further, they will ideally function remotely infield, and supply the added benefit of feeding valuable, real-time data into wider biosecurity efforts.

Smart traps could incorporate a range of technologies, including but not limited to: novel materials; sensors (using vision, sound, pheromone etc); electronics; actuation; communications; and g-putty. Ideally, improved smart traps would be self-clearing and resetting, and have remote monitoring capability for minimal human input.

4. Automation and Remote Capability – developing novel automated technology that transforms our ability to inspect/surveil, mitigate and/or eradicate biosecurity incursions that come across our borders.

New Zealand's vast borders and impenetrable forests mean that current manual methods to detect and treat invasions and infections are expensive and limited. Decisions about where and how to deploy resources at our borders are currently heavily influenced by factors such as a ship's country of origin, which is not an ideal proxy. Creating solutions that function in remote areas with limited human intervention has massive implications for this country.

Applications might include automated and remote capability robots and drones working individually or within connected networks. They may be used on land and sea, with tasks and pathways determined by predictive modelling.

Ensuring people's safety will be a key consideration, and community confidence in built-in safety features will be crucial, for example, ensuring a robot can distinguish between a possum and a small child.

APPENDIX 1 – SPEARHEAD DEVELOPMENT PROCESS