# Strategic Science Investment Fund Contract

# 2022/23 Financial Year

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| Project Name | Crop Forecasting |
| Project Manager | David Plew |
| Programme | Aquaculture/Environment Interactions |
| Centre | Coasts & Estuaries |
| Budget | $185,000 |
| Code | CEEE2303 |
| Expected co-funding | In-kind support from Kono via installation of NIWA-supplied temperature sensors on marine farms. In-kind support from NZ King Salmon in the form of daily water temperature data from salmon farms. In-kind support from Marlborough District Council in the form of monthly CTD profiles from 22 locations in Queen Charlotte and Pelorus Sound. |
| External collaborators | Kono, New Zealand King Salmon |
| Critical kit/infrastructure | Access to the Copernicus data hub for climate data forecasts. |

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| Delivery of NIWA Science Strategy | |
| National Outcome, Suboutcome | Sustainable economy/advancing sustainability and diversifying aquaculture |
| How Programme contributes to Outcome | The Aquaculture/Environment Interactions programme promotes sustainability and diversifying aquaculture by linking environmental conditions to aquaculture production. The programme aligns with the NZ Governments (2019) Aqauculture Strategy – particularly the outcomes relating to: (a) environmental sustainability, (b) maximizing farm productivity and (c) developing an industry which is resilient against environmental fluctuations and trend. Parts of the programme also align with the Aquaculture New Zealand Spat Strategy. |
| How Project contributes to Programme | This project will provide farmers with means of mitigating financial risk from year-to-year fluctuations in crop-performance and risk to stock by providing seasonal-scale forecasts of sea-surface temperature and mussel condition in Pelorus Sound. Therefore, it aligns especially closely with the resilience outcome of the NZ Govt (2019) Aquaculture Strategy |
| National Centre KPIs | Data analyses of mussel growth relative to environmental factors are available for development of models to forecast mussel crop performance in Pelorus Sound by June 2023 |
| Integration within NIWA | This project relies on climate forecast data compilation and analysis from the Climate, Atmosphere, and Hazards Centre, with input from the Forecasting Services and Climate and Environmental Applications teams. The research paper outputs, specifically the validation of climate model projections of sea surface temperature, will be useful to both the Transforming Aquaculture and Predicting Climate Variability and Change programmes. Furthermore, the methods behind the downscaling work undertaken in this project has synergies across NIWA (e.g., climate change projections and sub-seasonal to seasonal forecasting). |

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| *Project Rationale*  *Describe the proposed research, in the context of existing knowledge and how/why it will contribute to achieving the programme's science directions and knowledge transfer activities (Maximum of 30 lines)* |
| This is the second year of a project that will likely last three years. One of the work-streams relies upon substantial in-kind support from Konon LLC (their staff are responsible for deploying and recovering temperature sensors from about 20 farms around the Marlborough Sounds and returning those instruments to us).  The New Zealand Government’s Aquaculture Strategy (2019) seeks to enable sustainable growth of the industry to to $3b in sales by 2035. It identifies four target outcomes: (a) an environmentally sustainable industry, (b) a productive industry that supports regional economies, (c) an industry that is resilient against biological harm and the challenges of climate change, (d) inclusive – utilizing partnerships with Māori and communities to generate meaningful jobs, prosperity and well-being.  Global warming is causing sea-temperatures to rise at around 0.2–0.3 degrees /decade around New Zealand. ENSO oscillations and weather-events induce fluctuations about the decadal-scale averages for any given time of year. Sea-surface temperatures (SST) during the summer of 2021/2022 were around 2 degrees warmer than average for the time of year around much of New Zealand. New Zealand King Salmon Ltd reported a loss of $78M and attributed much of this to crop-losses arising from heat-stress. Losses of juvenile crop mussels have also been anomalously high in some regions during recent marine heatwave events and some in the industry attribute those losses to heat-stress. Environmental factors also play a demonstrable role in mussel crop performance. Mussel crop condition at harvest (loosely, flesh-weight:live weight) is an important determinant of the crop’s value. This varies from year to year, creating a financial risk for farmers. The aquaculture industry requires forecasts of environmental drivers of crop performance on time-scales adequate for management interventions to be implemented (at least 3-6 months).    During the 2021/22 FY, NIWA developed tools to forecast SST and mussel condition on seasonal timescales. The SST forecasts derive from models that have approx. 1°x1° spatial resolution. The condition forecasts apply to mussels in Pelorus Sound. We are delivering these to industry via the NIWA website, but the analyses that underpin the forecasts are neither fully complete nor formally documented.  This project aims to:   1. Iteratively refine our comparison of past forecast SST data and past observations of SST with a view to further improving the quality of our future forecasts for offshore waters adjacent to marine-farming zones 2. Complete, and formally document the methods and analyses that underlie the forecasts 3. Provide regularly updated seasonal forecasts of SST and mussel condition to the aquaculture industry (and other interested parties) via NIWA website 4. Deploy a set of temperature loggers in marine farms in the Marlborough Sounds region to collect temperature data that will enable us to better extrapolate from forecasts of SST in the Cook Strait region into the sheltered inshore waters where most marine farms of the Marlborough region are found (i.e. downscale SST forecasts).   Whilst this project focusses on forecasting temperature and mussel condition on seasonal-scales, it may also have relevance to disease and pest forecasting if the likelihood or prevalence of either were to prove to be correlated with temperature or crop nutritional status. |

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| *Objective—What science advances will be achieved this year?* |
| To enable the marine farming industry mitigate the risks that environmental fluctuations present to financial performance by delivering fully documented and iteratively improved seasonal-scale forecasts of:   1. sea-surface temperature for oceanic-waters adjacent to NZ marine farming regions, and 2. mussel condition (at harvest) for Pelorus Sound. |

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| *Work programme—What activities will be done?* |
| **Task 1:**  Via NIWA’s website:   * on a monthly basis, over the period July 2022 and June 2023: delivery updated forecasts of SST for oceanic waters adjacent to/containing NZ major NZ marine farming zones [Output 1]. * On a monthly basis, over the period July 2022 and June 2023: deliver updated forecasts of and the condition of harvested, harvest size mussels in Pelorus Sound   In addition:   * Continue analyses of the forecast SST data upon which we draw in order to better understand the merits of the various international SST forecast models to further improving the quality of the forecasts which we can deliver to industry. Any insights that lead to improved forecasts are to be incorporated into the routine monthly forecasts before June 30, 2023 * Document the methods and forecast analyses for publication on the NIWA website and for submission to a Scientific Journal before June 30, 2023 [Outputs 2 and 3].   **Task 2:**  In collaboration with Kono LLC and New Zealand King Salmon Ltd., maintain the existing network of temperature loggers associated with marine farms in the Marlborough Sounds region. Sensors will be (re-) deployed before end July 2022 and to remain in the water until at least May 2023 (barring brief turn-around intervals for downloading/servicing). Sensor data will be compiled into a readily accessible and properly documented electronic form (e.g. excel spreadsheet or similar) following each instrument turn-around. The data will be vetted (assessed for quality with ‘bad data’ clearly marked or explicitly deleted). The in-situ observations of water-temperature at the marine farms have been compared with from satellite observations of SST and forecasted SST (subject to availability of corresponding satellite-sensed and forecast SST data). [Output 4]  In the longer term (beyond the 22/23 FY), we believe that these data will enable us to more reliably extrapolate from coarse spatial-scale forecasts of SST to bay-specific forecasts. |

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| *Outputs—List expected outputs for each component of the Work programme this year. This will form the basis for reporting the progress of the project.* | |
| *Description (outputs to be produced)* | *Comment (value of the outputs and their intended audience)* |
| 1. New forecasts of water temperature and mussel condition have been issued via NIWA’s website at monthly intervals. | Industry has been directed towards these forecasts via appropriate means (eg mention in Marine Farmers Associate AGM, Marine Farmers Association Research, Development & Technology sub-committee, engage NIWA’s C&E comms person to run comms on the product) |
| 1. One scientific manuscript describing the temperature-forecasting analyses and outcomes submitted by March 2023 | Analogous material has also been incorporated into the relevant part of NIWA’s website |
| 1. One scientific manuscript describing the condition-forecasting analyses and outcomes submitted by June 2023. | Analogous material has also been incorporated into the relevant part of NIWA’s website |
| 1. Temperature logger data from Marlborough farms are available in a well-documented, electronic form (e.g. excel spreadsheet or similar). An early-stage draft paper describes the observed in-situ observations in the context of historical in-situ observations and compares the recent in-situ observations with corresponding contemporaneous satellite-sensed SST observations and forecasts of SST (by year-end) | Data collected with support from Kono to deploy loggers on farms they own or operate. |