ENVSCI 708: Research Plan

Canopy and habitat effects on understory light and microclimate across fixed forest–grassland points

Names & IDs:
Michael Myers 398913404
Yuehan Luo 169890290
Lachlan Reid 881758357
Peter Yue 714291302

Background:
Microclimate directly influences ecological processes and captures subtle changes in ecosystem function and landscape structure across scales. The role of microclimate in shaping ecological processes has become an essential focus of contemporary ecological research[1].

Despite the high relevance of forest microclimates to numerous ecosystem processes, a functional and quantitative understanding of how key variables within these ecosystems interact with the understory microclimate remains elusive[2].

Forest structure serves as a primary driver of near-surface microclimates, cooling hot days and warming cold nights beneath canopies compared with adjacent open areas[3]. Forest canopies reduce incoming radiation, buffer temperature extremes and often maintain higher humidity relative to open habitats[4]. Consequently, changes in canopy structure can either amplify or dampen plant responses to broader macroclimate warming[5].

At the plot scale, canopy cover and closure exert strong control over understory light (PAR) and modulate soil moisture and temperature through interception, shading, and evapotranspiration [6]. Spatial variation in microclimates across forests and open habitats emerges from the interplay of vegetation structure, topography, soil characteristics, water balance, and prevailing meteorological conditions[7] [8]. Compared with woodlands, grasslands experience higher solar loading and greater diurnal thermal amplitude, leading to consistently higher daily maxima and lower minima, as well as elevated vapour-pressure deficits[4].

A standard approach to quantifying these contrasts involves reliable, repeatable point measurements using handheld sensors (for PAR, air temperature/relative humidity, and soil temperature/moisture) at fixed locations. These measurements are then correlated with canopy metrics derived from tools like densiometers or hemispherical photographs[9]. In urban settings, structural characteristics such as canopy cover, tree species density, and richness determine the degree of microclimate buffering[10].

Our research quantifies how canopy cover and habitat type relate to microclimate by using six fixed points with repeated measurements by all groups. The results will provide valuable insights for restoration and management.

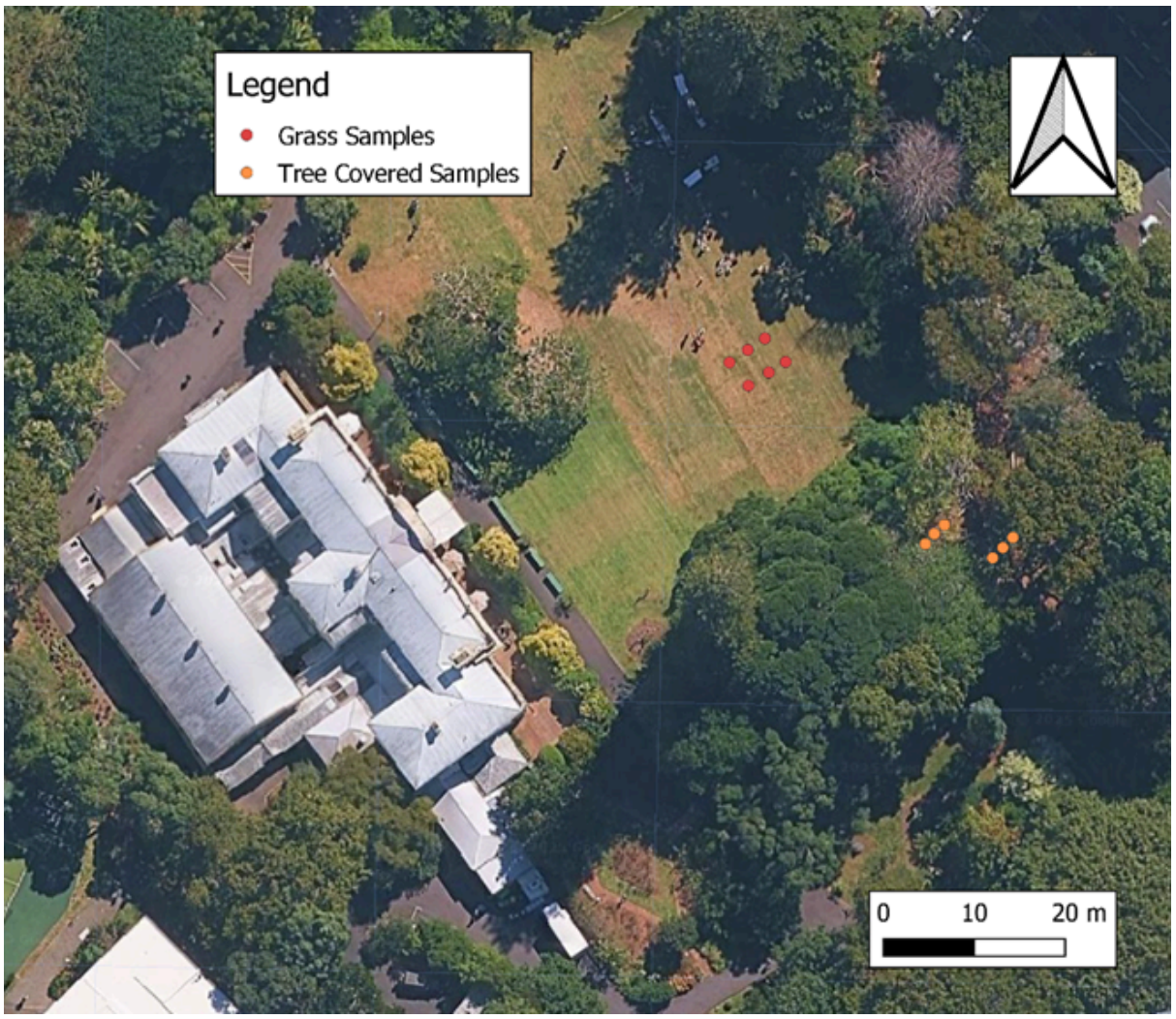


Figure 1. Distribution of sampling points in the grassland (red dots) and the tree-covered (orange dots) ecosystems.

Vision Mātauranga:
This project aligns with the Taiao theme, supporting environmental sustainability through improved understanding of forest ecosystems. Māori iwi and hapū have long practised kaitiakitanga (guardianship) over native forests, integrating knowledge of canopy structure and seasonal changes. The findings from this research may support indigenous-led restoration initiatives by providing quantitative evidence of how canopy conditions influence microclimate stability, thereby aiding the protection of taonga species and habitats. Collaboration with mana whenua ensures that the research respects and incorporates mātauranga Māori alongside Western science.

Research Question:
How do trees and their canopies affect light intensity, temperatures, and humidity, creating a gradient of microclimate

Hypotheses:
(1)Tree canopies are an essential aspect in defining outcomes of tree and forest microclimate characteristics by modulating radiative energy and increasing humidity.

(2) Temperatures and light intensity will be elevated at lawn sites, and will show decreased relative humidity.

Method:

Canopy cover to be measured alongside light intensity and relative humidity in forest-grassland microclimates to examine how the two categories are related. Soil Temperature and moisture content are to be measured for soil microclimate changes.

Study Location: City Campus Sector 100, Auckland, NZ. Sites will represent a gradient from open canopy to dense canopy within native forest areas.

Design & Sites: Six fixed points were established in each habitat type, forest (closed canopy) and grassland (canopy ≈ 0%), located in the park behind the school. Measurements were generally conducted between 11:00 and 14:00 to minimise diurnal variation. Each variable was measured twice at every point, and the mean value of the two measurements was used for analysis. Sampling was performed under clear or uniform conditions to reduce sky-condition bias.

Data Collection:

Microclimate Variables: Air temperature and relative humidity were measured using HOBO loggers or equivalent sensors inserted into the soil at each point. A digital thermometer was inserted into the soil to measure temperature, and a Hydrosense II (model number 4933) was used to directly measure soil moisture. Light intensity (PAR) was measured at ground level using a LI-250A placed directly on the soil surface, and the 15-second average was taken.

Canopy Cover: Hemispherical photographs were taken at each point and analysed with software to quantify canopy cover percentage and leaf area index (LAI). Canopy average Diameter and height of the edge will be taken for reference.

Sensor data were downloaded in CSV format with complete metadata. Quality control included removal of erroneous values, cross-validation with hand-held measurements, and correction where necessary.

Data Analysis:
Descriptive Statistics: Daily and diurnal means, variances, and extremes were calculated for each variable.

Statistical Tests: Relationships between canopy cover and microclimatic variables (light intensity, relative humidity, temperature) were evaluated using Pearson correlation and linear mixed-effects models with site as a random effect.

Visualisation: Time-series plots, boxplots, and canopy–microclimate response curves were generated to illustrate patterns and trends.

Equipment list: HOBO, temperature/relative humidity loggers (digital thermometer, Hydrosense II, LI-250A), Canopy measurement app, GPS device, field sheet.

Roles:

Michael Myers: Background in environmental science, broad-based and mixed with earth, climate, and marine/coastal sciences Will assist with data collection and analysis.

Yuehan Luo: Background in environmental physics and GIS. Will focus on microclimate data analysis, including modelling, spatial analysis.

Lachlan Reid: Background in earth science and GIS. Will assist with further data collection and analysis.

Peter Yue: Background in environmental science and GIS. Assist with data collection and data analysis.

Timetable:

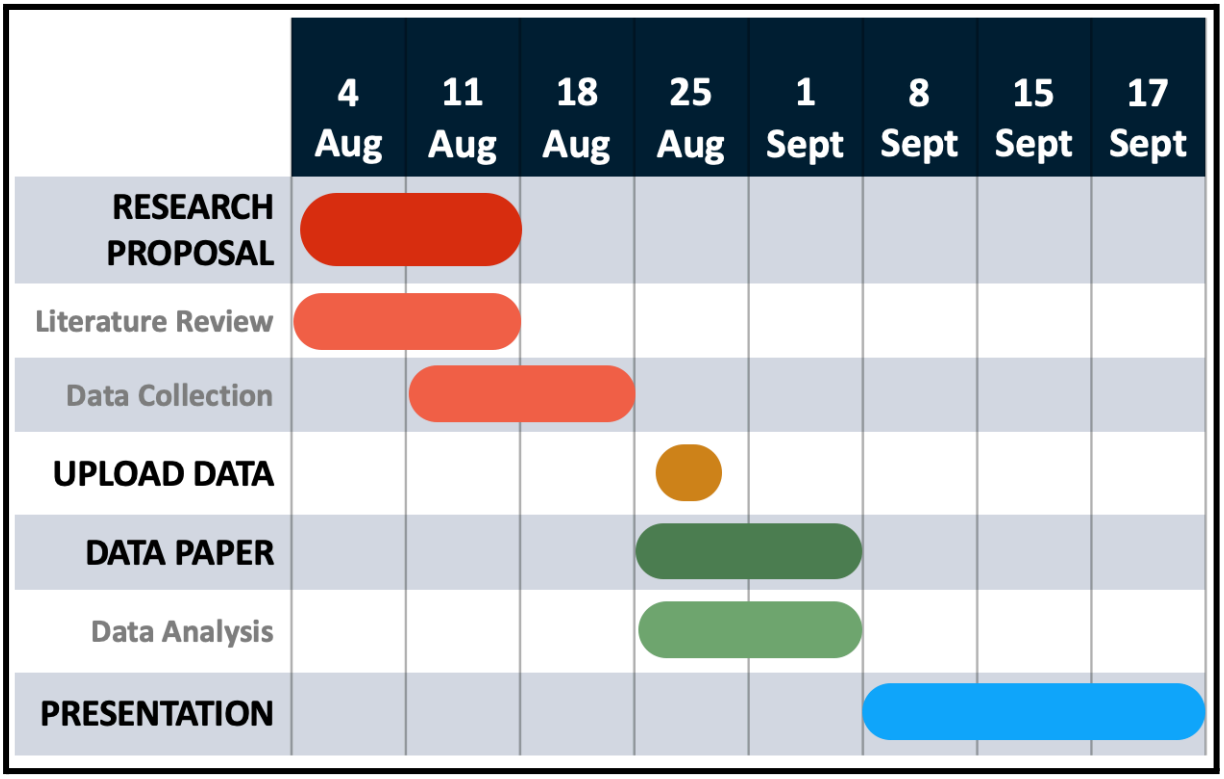


Figure 2. Timetable indicating research composed of individual assignments in bold with assignment components in grey.

Reference List:

1. Chen, J. *et al.* Variationsin local climate can be used to monitor and compare the effects of different management regimes.

2. Von Arx, G., Graf Pannatier, E., Thimonier, A. & Rebetez, M. Microclimate in forests with varying leaf area index and soil moisture: potential implications for seedling establishment in a changing climate. *J. Ecol.* **101**, 1201–1213 (2013).

3. De Frenne, P. *et al.* Global buffering of temperatures under forest canopies. *Nat. Ecol. Evol.* **3**, 744–749 (2019).

4. Senior, R. A., Hill, J. K., Benedick, S. & Edwards, D. P. Tropical forests are thermally buffered despite intensive selective logging. *Glob. Change Biol.* **24**, 1267–1278 (2018).

5. Zellweger, F. *et al.* Forest microclimate dynamics drive plant responses to warming. *Science* **368**, 772–775 (2020).

6. Suggitt, A. J. *et al.* Habitat microclimates drive fine‐scale variation in extreme temperatures. *Oikos* **120**, 1–8 (2011).

7. Lembrechts, J. J. *et al.* SoilTemp: A global database of near‐surface temperature. *Glob. Change Biol.* **26**, 6616–6629 (2020).

8. De Frenne, P. *et al.* Forest microclimates and climate change: Importance, drivers and future research agenda. *Glob. Change Biol.* **27**, 2279–2297 (2021).

9. Jennings, S. Assessing forest canopies and understorey illumination: canopy closure, canopy cover and other measures. *Forestry* **72**, 59–74 (1999).

10. De Pauw, K. *et al.* Urban forest microclimates across temperate Europe are shaped by deep edge effects and forest structure. *Agric. For. Meteorol.* **341**, 109632 (2023).

Field Activity Planning Guide

Field activity is defined as any off-campus work carried out for the purpose of teaching, research or representing the University off-site, including site visits and reconnaissance trips. It does not include working from home. Any time you wish to undertake field work or a site visit you need to complete a Field Activity Plan and have it approved by your Supervisor/PI/Line Manager. For site visits, a Field Activity Plan is required whenever participants health and safety is not managed by another institution. The University has a responsibility under legislation to ensure that health and safety is a key consideration in the planning and operation of field activities, and that such activities are carried out in an environmentally responsible manner.

The Health and Safety at Work Act 2015, recognises that participation, leadership, and accountability are essential to ensuring that everyone gets home safe. In cases of serious negligence or recklessness the HSWA allows for penalties of up to five years imprisonment or fines of up to $3M (information here). Field activity leaders and approving supervisors are responsible for ensuring the health, safety and wellbeing of participants is maintained at all times while on a field activity as well as guaranteeing compliance with legislation and University policy.

Your plan must be assessed by the Technical Manager (or delegate) before being passed on to your Supervisor/PI/Line Manager for final approval. The Technical Manager will either accept the plan or return it to you with recommendations for improvement. When assigning your University contact, you must remember to ask the person first and check they are available. The use of private vehicles for University work is only approved in exceptional circumstances, and the vehicle must have current full/comprehensive insurance cover, warrant of fitness etc. Please discuss this with the Technical Manager ahead of time. Generally private vehicles are not approved for field activity outside of Auckland.

Some field activities are inherently high risk due to the work environment or the nature of the work undertaken. The University takes a risk-based approach to the management of such activities, expecting that planning is thorough and robust, appropriate procedures and equipment are used, and participants are fully briefed and/or trained in advance.

University of Auckland Code of Conduct

University of Auckland field activity information

University of Auckland Field Activity Planning Guide

University of Auckland Field Operations Guide

Examples of field activity include:

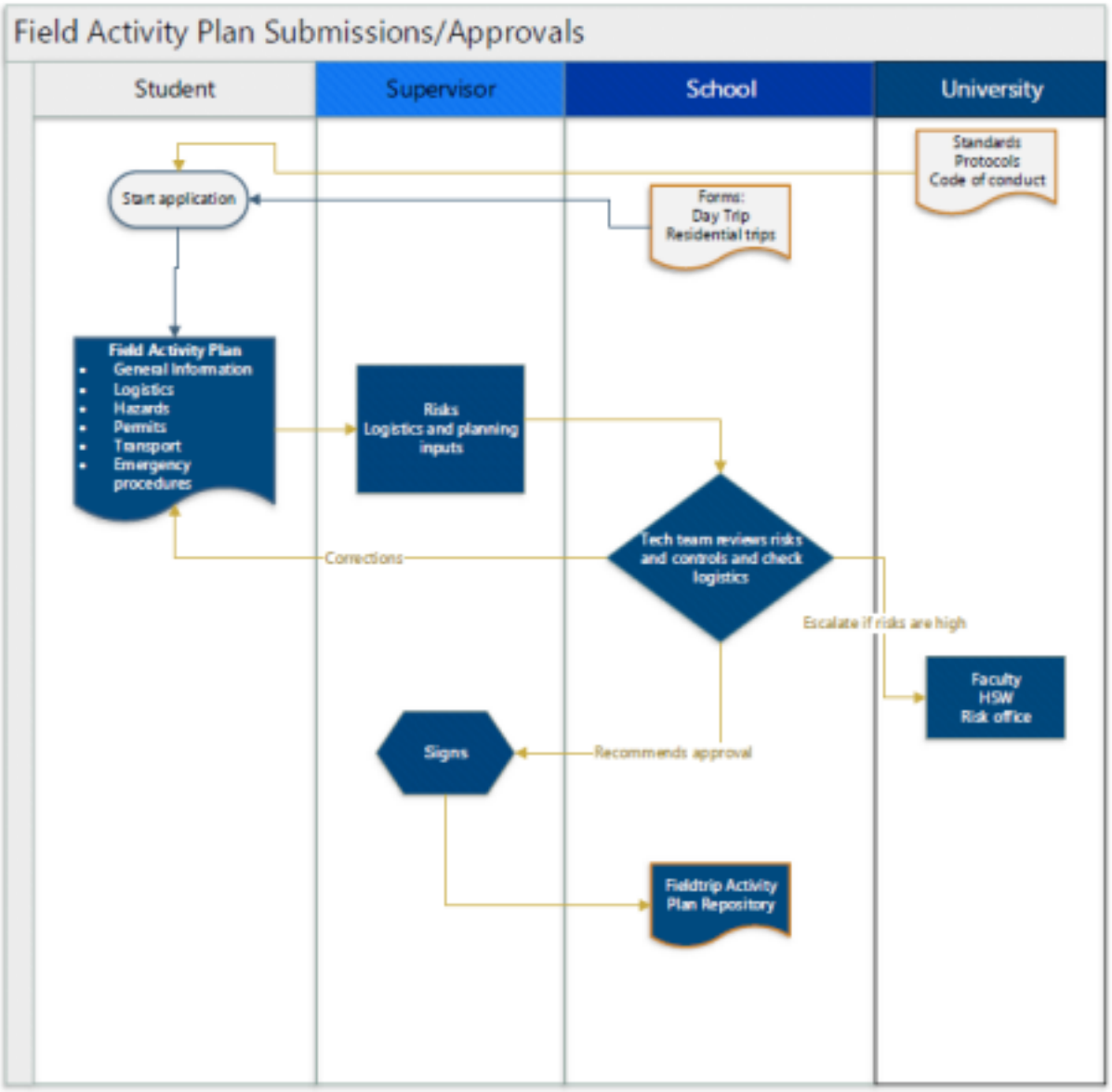
ξ Groups of staff, students and contractors who travel off campus as part of a University course of study (undergraduate or postgraduate)

ξ Groups of staff, students and contractors who travel off campus as part of a University research project, and are intending to visit or work at locations that are not governed by University of Auckland health and

safety policies and controls
ξ Staff and students engaged in research off campus

Field activity does not include:

- ξ Approved travel to conferences (with University travel insurance coverage) where participants can be expected to be responsible for their own wellbeing
- ξ Activities based at established University facilities, which are covered by the University Health and Safety Policy
- ξ Study that is part of a University of Auckland Study Abroad programme or elective courses taken at other institutions
- ξ Local and international off-campus placements of students and staff
- ξ Placements and work experience



Medical Emergency Procedure

1. Administer initial first aid.
2. Make the patient as comfortable as possible.
3. Decide whether the patient can walk to the recovery point agreed for that day, or whether the patient needs assisted evacuation.
4. If necessary, two persons should walk to the recovery point agreed for that day and raise the alarm. If necessary, use the satellite phone/mobile/EPIRB to call 111 (or other local emergency

number) for help. Note that someone must always stay with the injured person.
5. Call the University security hotline in the event of any critical incident (0800 373 7550).

Extreme Weather Event Procedure

Field activity leader to check long range and daily weather forecasts. If extreme weather is noted, carry out the following actions.
1. Consider cancellation/postponement if you have not yet set out.
2. If in the field, inform University contact that a weather system has developed, and provide daily communication for the duration of the event.
3. Inform all field trip participants of the situation and provide regular communications to them. 4. If safe to do so, evacuate all persons on the field trip to a safe location. Stay there until it is safe to move on.
5. Monitor the weather via the CDM or MetService website, or National radio. Assess the situation, and if the risk of serious flooding or snowfall seems possible the field trip may need to be abandoned. 6. University contact to inform the head of department (or equivalent) of the situation and provide at least daily updates.

Non-contact / Missed Check-in Procedure

1. Alert other participants in the vicinity (they may be able to investigate without placing themselves at risk). Enquire with accommodation to see if the person has returned there.
2. Mobilise a vehicle to search a wider area while field activity leader continuously attempts to contact the missing person through normal communication channels for three hours (as well as checking for messages on phone message bank).
3. If after three hours the person is still missing, contact their next of kin to check if contact has been made with them.
4. Contact station owner or ranger in search area to assist in search.

Missing Persons Procedure

1. Advise local authorities / emergency services of the situation and respond to their advice or instructions. Once informed, police will take charge of search.
2. If local authorities implement search and rescue, the field activity leader is to liaise with emergency services and advise the University emergency contact.
3. The University contact is to alert the head of school and UoA Health, Safety and Wellbeing Service. 4. If the missing person is found / contacted and a remote area emergency reported, the following procedure must be observed. Record:

a. Location and time of incident
b. Nature of the incident
c. Number of casualties (if any)
d. Action undertaken by field crew
e. What future action response is required by field crew
f. Any additional information

5. Once missing persons are located, contact emergency services and the University contact and notify that emergency is over.

ENV Field Activity Plan

Technical HSW Advice Provided	Supervisor/PI Final Approval
	† Approve † Decline † Approve † Decline
Name:	Name:
Date:	Date:
Signature:	Signature:

What is the date of your trip?
If multiple day trips then please list each date.

14th August, 21st August

Summary of field activity

Field activity as a part of Envsci 708 course in which our group of 4 is to take a range of air and soil samples.
Field activity is low risk and takes place on city campus grounds.

ENV Field Activity Plan

Project Supervisor / Manager Name

Luitgard Schwndenmann

Participant details

	Name	Phone number
Field activity leader	Lachlan Reid	0273591069
Deputy field activity leader	Peter Yue	0274663836
UoA Staff Contact (check-ins and emergencies)	Luitgard Schwndenmann	84301

Other UoA participant details

No	Name	Phone number
1.	Yuehan Luo	0221021012
2.	Michael Myers	0221019394
3.		
4.		
5.		

If there are more than 5 additional participants, then please upload their details here.

Upload Details

Do any of the UoA participants have disabilities or medical conditions that you need to make appropriate provisions for? † Yes † No If yes, then provide details

Details of participants from other organisations involved

No	Name	Phone number	Organisation
1.			
2.			
3.			
4.			
5.			

ENV Field Activity Plan

Is this a single-day trip or a residential trip?

† Single-day (or multiple single days)
✔

† Residential

Accommodation details (if residential)
Information for where you are staying; name, address, contact number.

Level of inherent risk for this field activity

Before controls are applied.

Note that any work in, around or near water is inherently high risk.

† Low † Moderate † High † Extreme
✔

What are the most significant risks that participants should be aware of and how are the managed/mitigated?

Lone working, time of day, tides, security (theft), environment, terrain, weather, covid-19, driving, people, animals, equipment etc.

Info on common risks can be found here
More information on risks can be found here

environment, terrain, people, weather.

Level of residual risk for this field activity

After controls are applied.

† Low † Moderate † High † Extreme
✔

If high or extreme risk have you discussed this with the Technical Manager and what was the decision?

Any work that is identified as high or extreme risk AFTER controls are applied will require approval from the ENV Technical Manager and central HSW.

Provide a description of the daily field plan

Preparation – What do you need to prepare in advance?

Bring adequate footwear and clothing

Travel– How are you getting there?

Walking

Activities – what will you be doing, what equipment do you need for this activity, who will be operating equipment, do you have the right training, personal protective equipment required, food, water, hygiene, estimated timings?

We will be operating We have adequate food, water, hygeine.

Return – how will you get home safely?

Walking back to university.

Check-ins

Location, date and time you will check in.

No	Date	Time	Location
1.	14/08/25	11:00	302-140
2.	21/08/25	11:00	302-140
3.			
4.			
5.			

Have you received relevant consents/permits/access permissions to undertake this activity, and have the appropriate agencies/Iwi been notified? Are there any cultural considerations you need to be mindful of?

† Yes † No
✔

Transport

† Commercial operator † Private vehicle † Rental vehicle † University vehicle

All ENV vehicles have current WOFs, Licensing, RUCs and carry vehicle first aid kits.

Vehicles can be booked through https://carscience.fos.auckland.ac.nz/

† Mitsubishi Outlander † Toyota Hiace † Toyota Highlander † Toyota Hilux

Provide details of commercial operator(s) or rental vehicles

N/A

Provide details of private vehicle

N/A

(Private vehicles cannot be used for field work outside of Auckland. If you require an exception to this protocol you must discuss it in advance with the Technical Manager).

Private vehicles must have comprehensive insurance.

Private vehicles must be road worthy, have a current WOF (or COF), licensing and RUCs if applicable.

Are there any specialist vehicle requirements?

- ξ Must have a trained and certified operator
- ξ Special licences - provide details
- ξ Will hazardous substances be required to be carried?
- ξ Will boat or aircraft operators be engaged?
- ξ 4WD or off-road driving required

N/A

Emergency contacts

	Name	Phone number

University emergency contact	Luitgard Schwndenmann	84301
Next of kin (field leader only)		

Communication equipment

† ENV Garmin Comms † EPIRB † Mobile phone (will have full coverage) ✔

† PLB † Radio † Satellite phone (rented or owned)

Response plans

Details of planned responses to scenarios you could encounter such as; vehicle accident, eruption, unable to leave area, severe weather, flooding.

Head to university designated emergency/evacuation areas.

If someone becomes sick during your trip what is the plan?

Cease field activity and head to university health centre if necessary.

Where will you meet in an emergency.

In the middle of the government house field.

Is first aid help is less than 30 minutes away?

If yes then a first aider is not required.
If no then a first aider is required.

† Yes, help is less than 30 mins away † No, help is more than 30 mins away ✔

First aider details

	Name	Certificate type and expiry
Current first aider		
Current first aider		
Current first aider		

First aid kits

† ENV Large † ENV Standard † Vehicle

ENV Field Activity Plan

List the emergency and safety equipment you will have.

PFDs, throw-lines, high-vis vests, safety glasses, hard hats, footwear, hearing protection etc.

Covered shoes, suitable clothes for the weather.

This plan has been discussed with all participants and they have been made aware of the hazards, risks and controls in place to make this activity safe. All information is accurate, up-to-date and if there are any changes I will notify the ENV Technical Manager as soon as possible.