Soil characterisation (biological, physical and chemical) of highly productive New Zealand avocado orchards.

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New Zealand Avocado

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Introduction - Motivation

- Growers' interest in soil health and how it influences productivity and the environment.
- General interest in the top-growers soil profile.
- An increasing number of products claiming to modify soil for productivity.

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Introduction

- **Primary objective: Characterized soil of orchards achieving ≥ 15 t/ha.**

- This is our **first step** into avocado soil microbiology. We selected three well-known labs that our grower are familiar with to test our samples (replicability).

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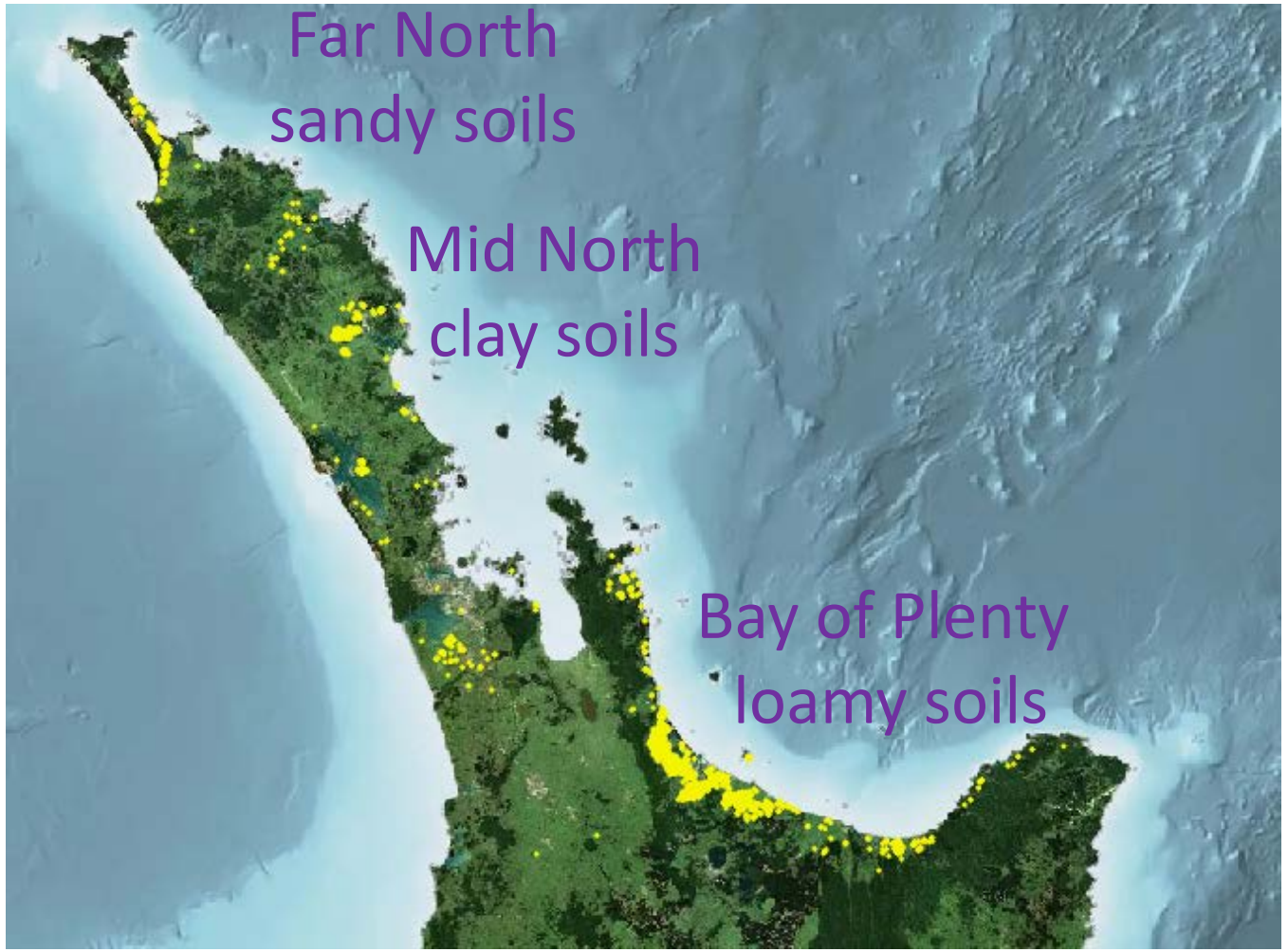
Introduction – Regional differences



Created with QGIS 3.22.16 and LINZ .

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Methodology - Project

Orchard selection

Tree selection

14 orchards ≥ 15 t/ha

13 orchards < 15 t/ha

10 x

20 soil cores

15 cm depth

BIOAGRINOMICS
Agricultural consultancy - Soil/Plant/Animal Health

Physical

Hill Laboratories
TRIED, TESTED AND TRUSTED

Chemical

Soil Foodweb
NEW ZEALAND

Biological

linnaeus
LABORATORY

Biological

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Results - Outputs

BIOAGRINOMICS
Agricultural consultancy - Soil/Plant/Animal Health

Hill Laboratories
TRIED, TESTED AND TRUSTED

linnaeus
LABORATORY

Soil Foodweb
NEW ZEALAND

8 variables + 39 variables + 32 variables + 15 variables = 94 soil attributes

Every grower received their two biological reports.

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Physical results

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Physical results - Soil Quality index

Soil Quality index = 8 indicators

Far North - sand

Mid North - clay

Bay of Plenty - loam

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Soil Quality Assessment	Soil Quality index
Poor	< 14
Moderate	14–28
Good	> 28

Chemical results

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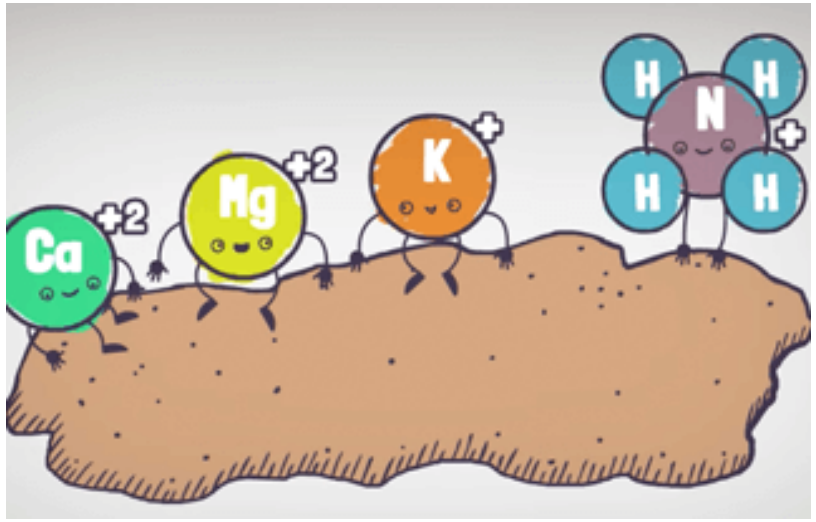
Chemical results - Total carbon

- Water holding capacity
- Cation exchange capacity



(*Cation Exchange - Science of Agriculture*, n.d.)

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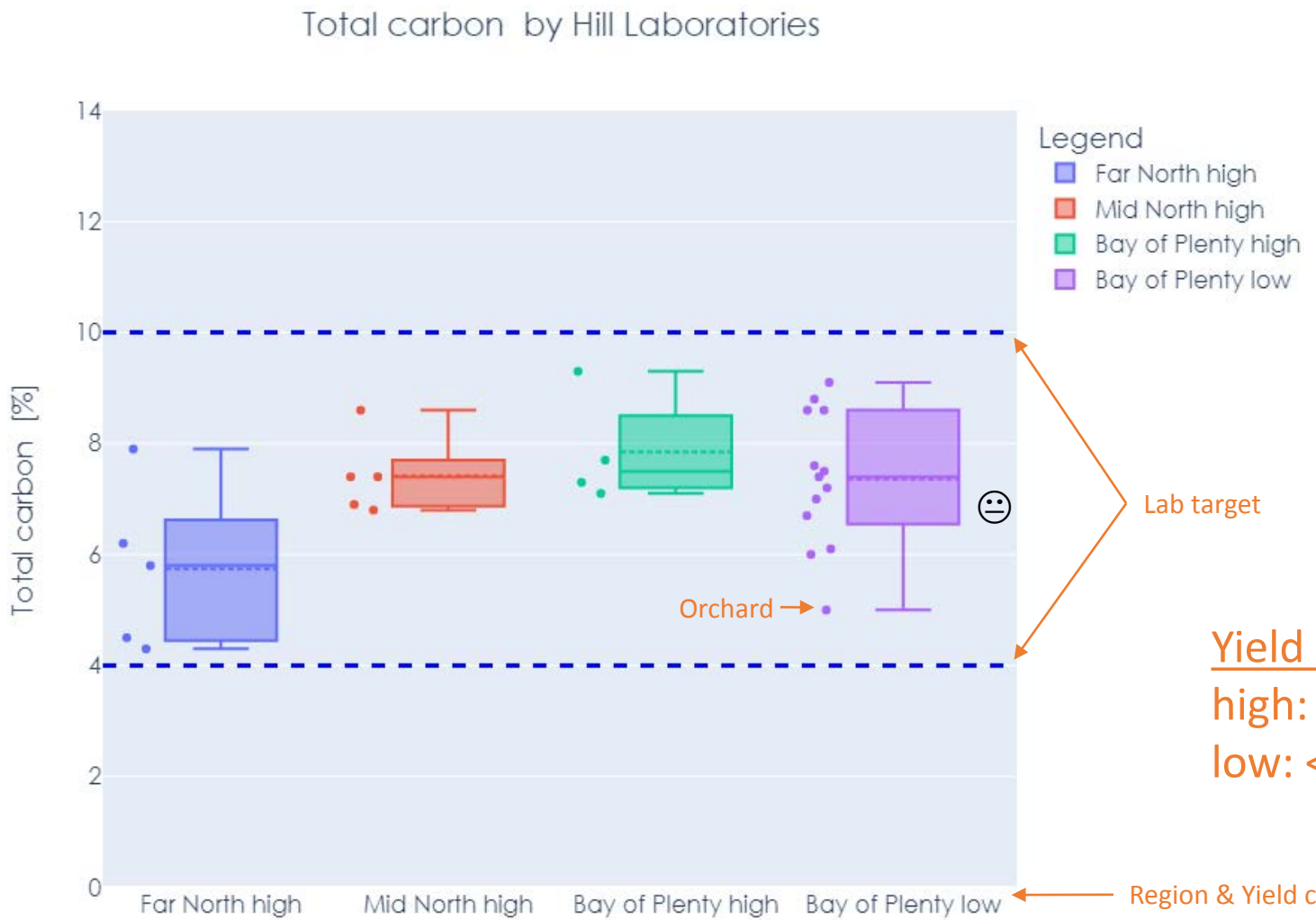
Chemical results - Total carbon



Yield class
high: ≥ 15 t/ha
low: < 15 t/ha

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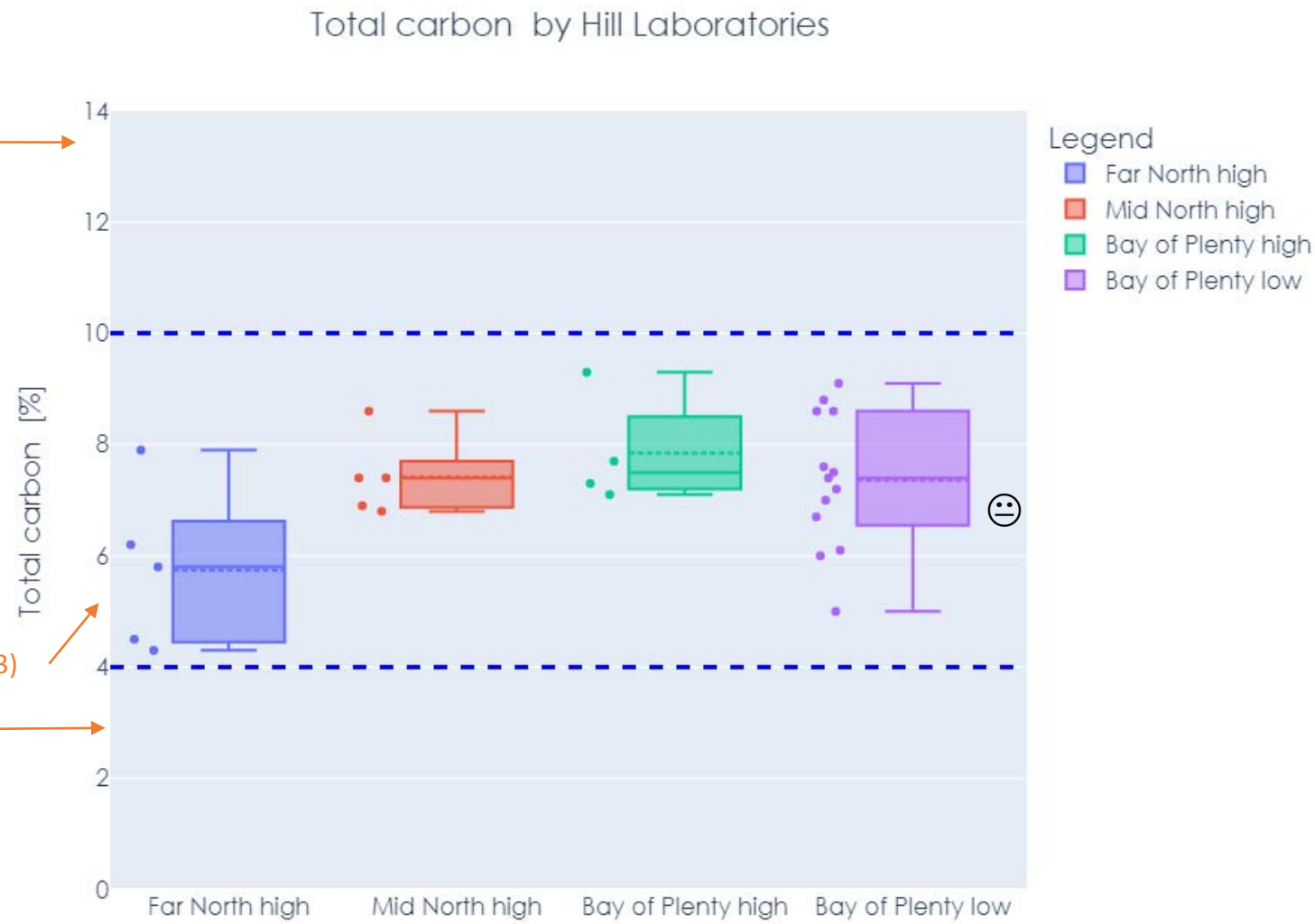
Chemical results - Total carbon

NZ native (Ghani et al,. 2003)

Maize & sweetcorn (Ghani et al,. 2003)

NZ average (LCR, 2023)



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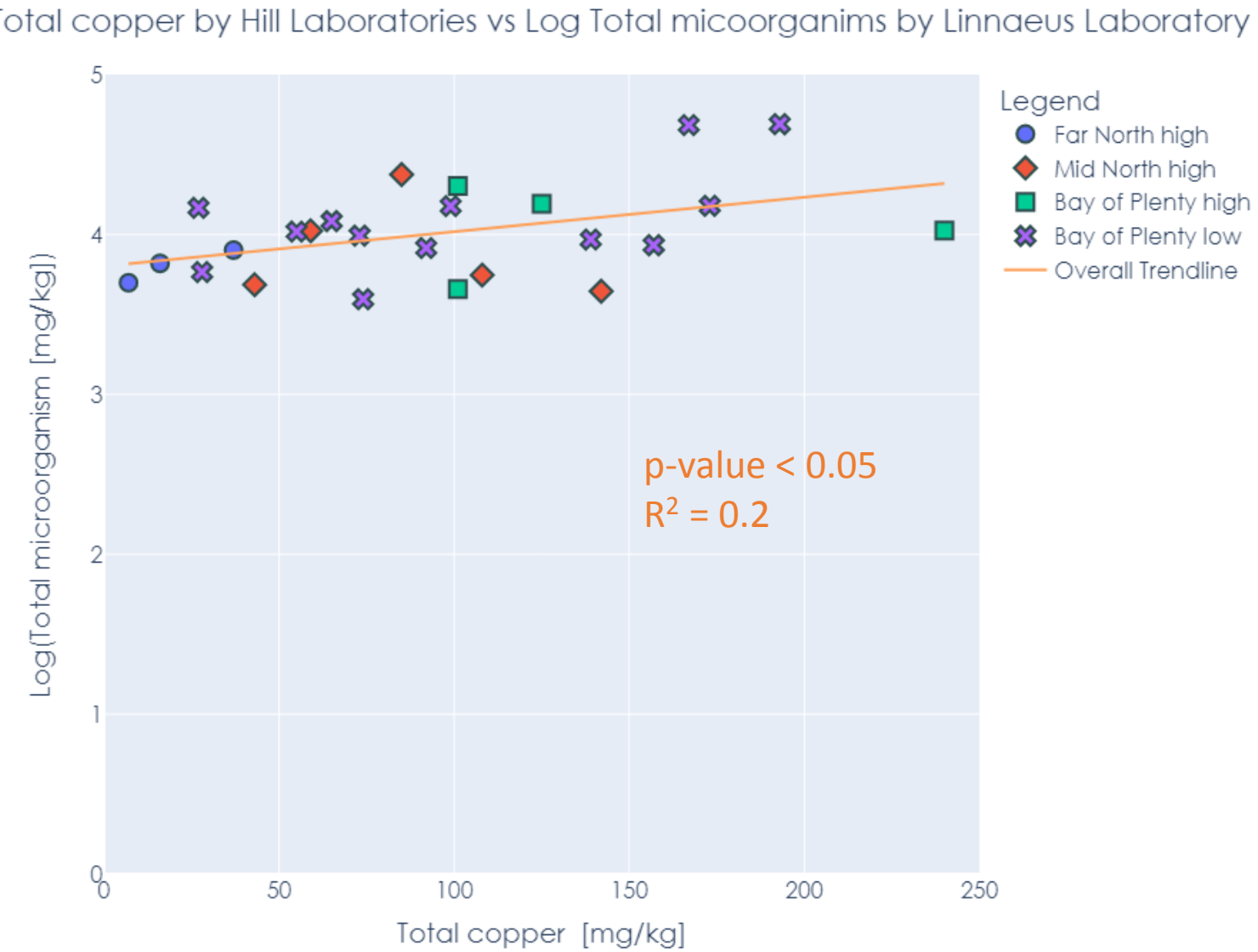
Chemical results – Total copper



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Biological results

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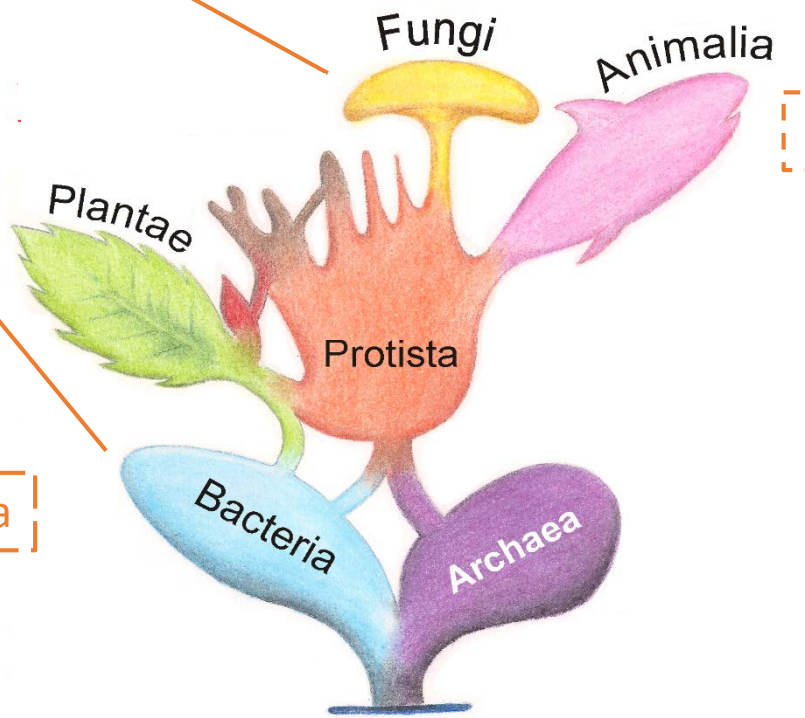
Biological results

Total fungi to bacteria ratio

Total fungi
Mycorrhiza

Earthworms count

Anaerobic bacteria



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Biological results - Earthworms

Count number of worms per species
12 replicates per orchard

Lumbricus rubellus (surface litter), *Aporectodea caliginosa* (topsoil dwelling), *Aporectodea longa* (deep burrowing) and *Octolasion cyaneum* (Shepherd, 2009).

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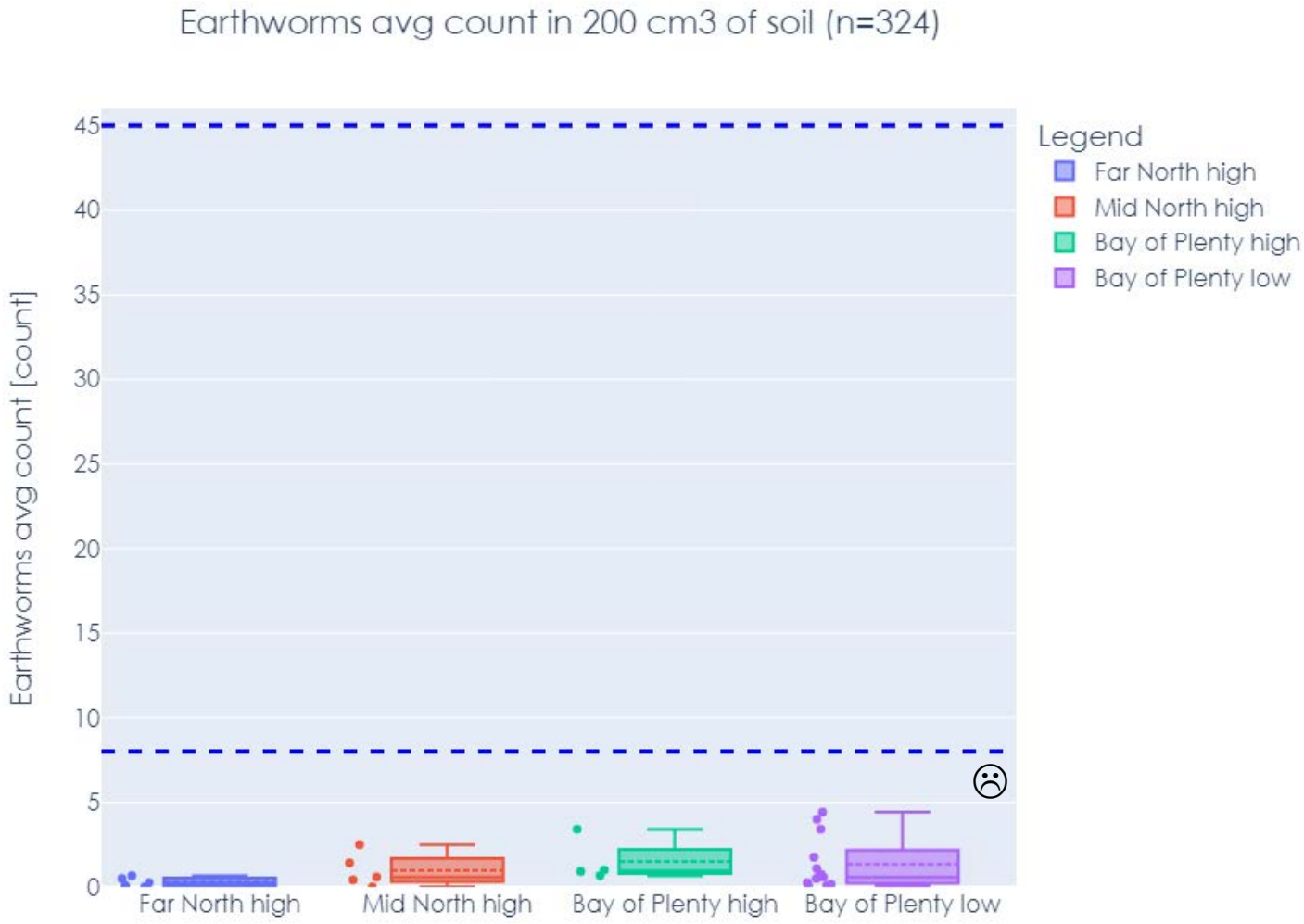
Biological results - Earthworms



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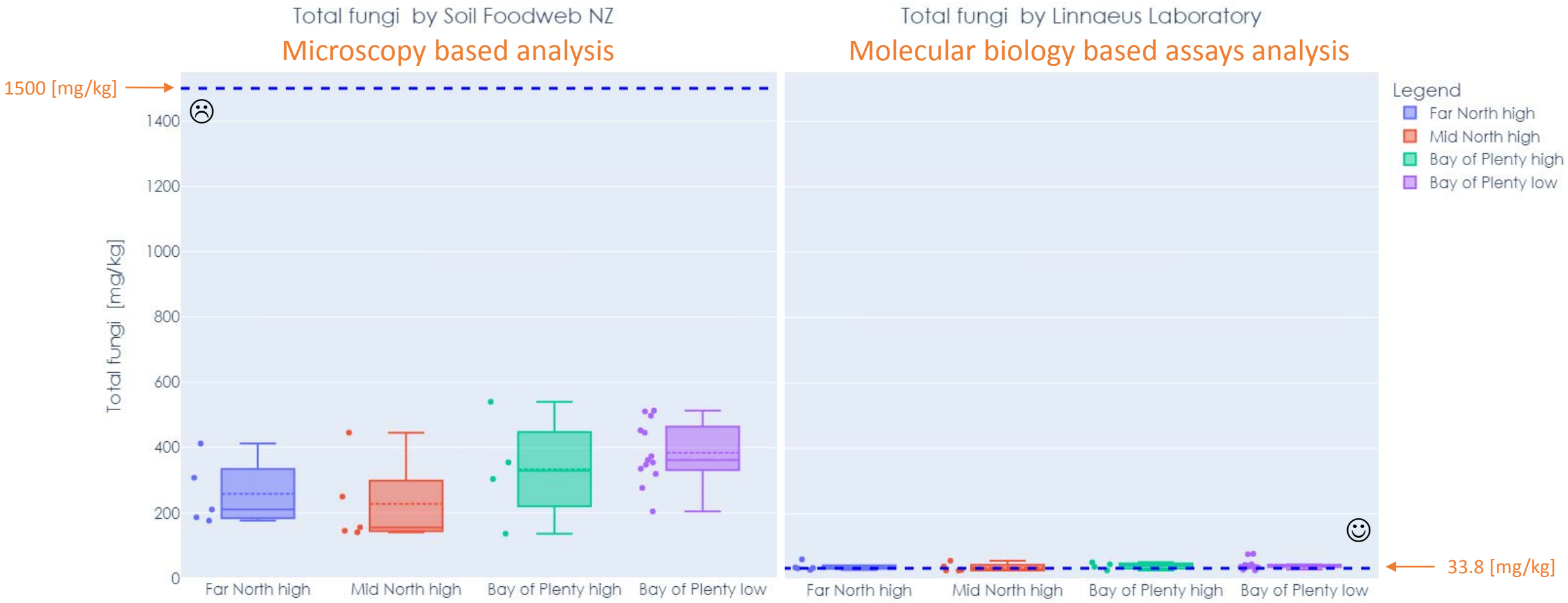
Biological results - Total fungi



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Biological results - Total fungi to bacteria ratio

$$\frac{Total\ fungi}{Total\ bacteria} = 1$$

Fungal dominance ☺

Bacterial dominance ☹

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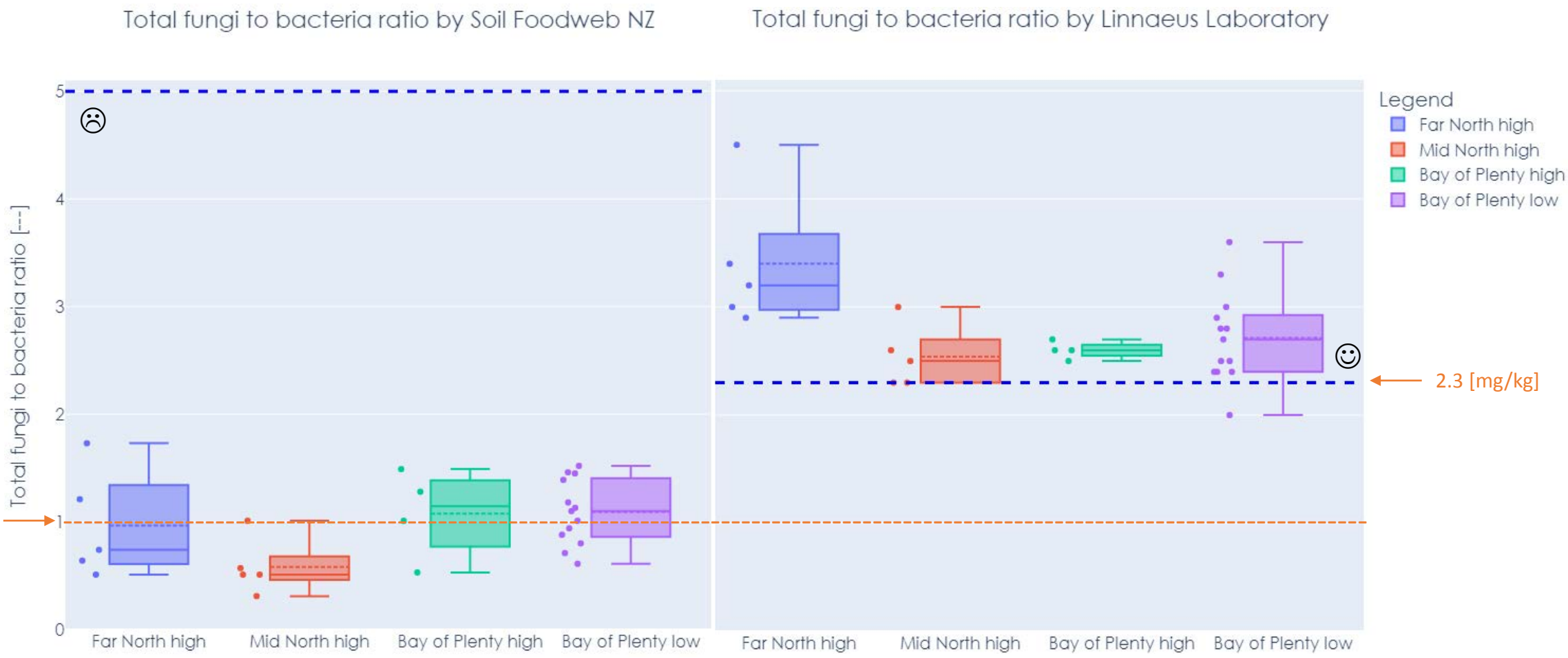
Biological results - Total fungi to bacteria ratio



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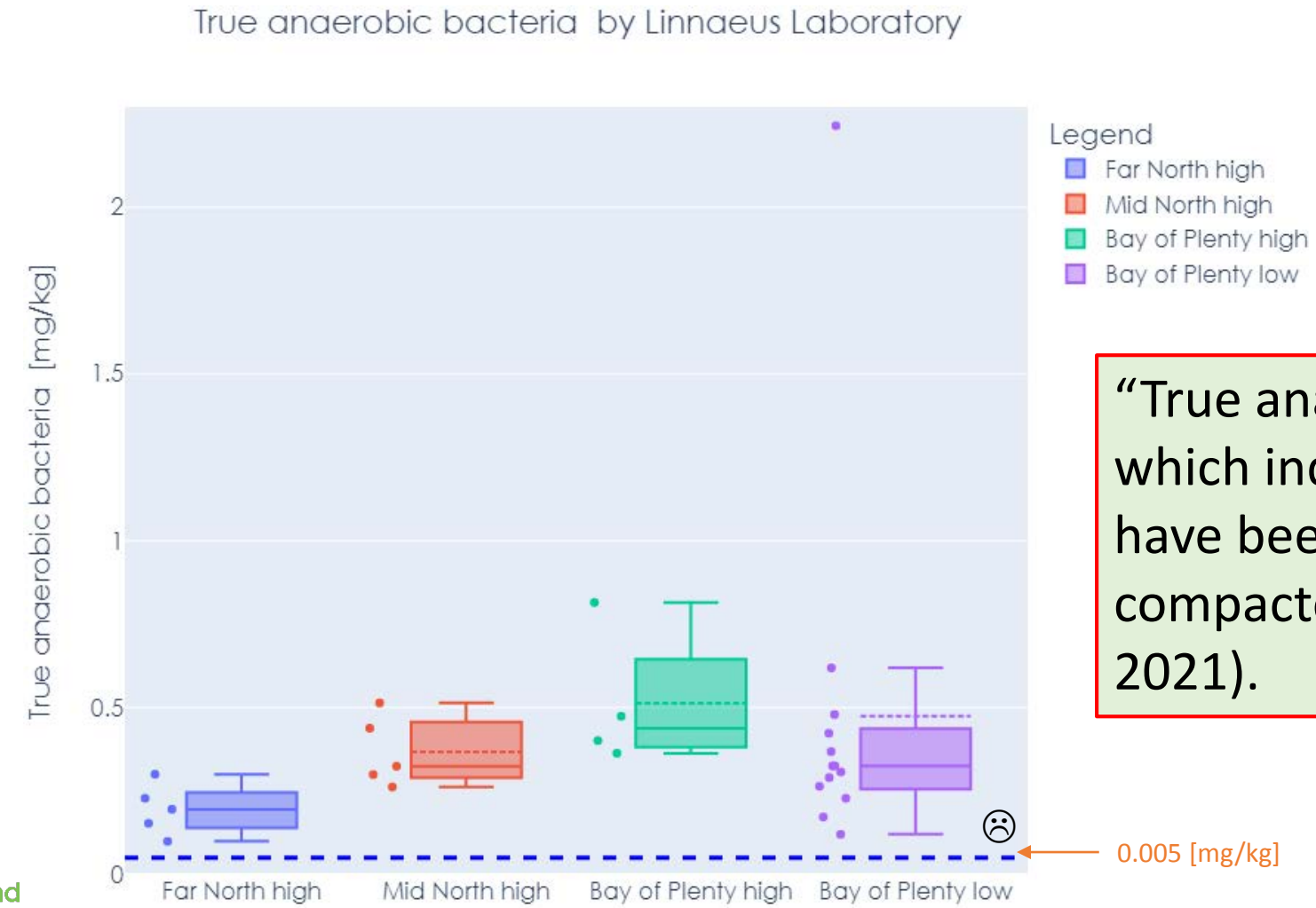
Biological results - True anaerobic bacteria



"True anaerobes were elevated, which indicates that this soil may have been recently waterlogged, or compacted" (Linnaeus Laboratory , 2021).

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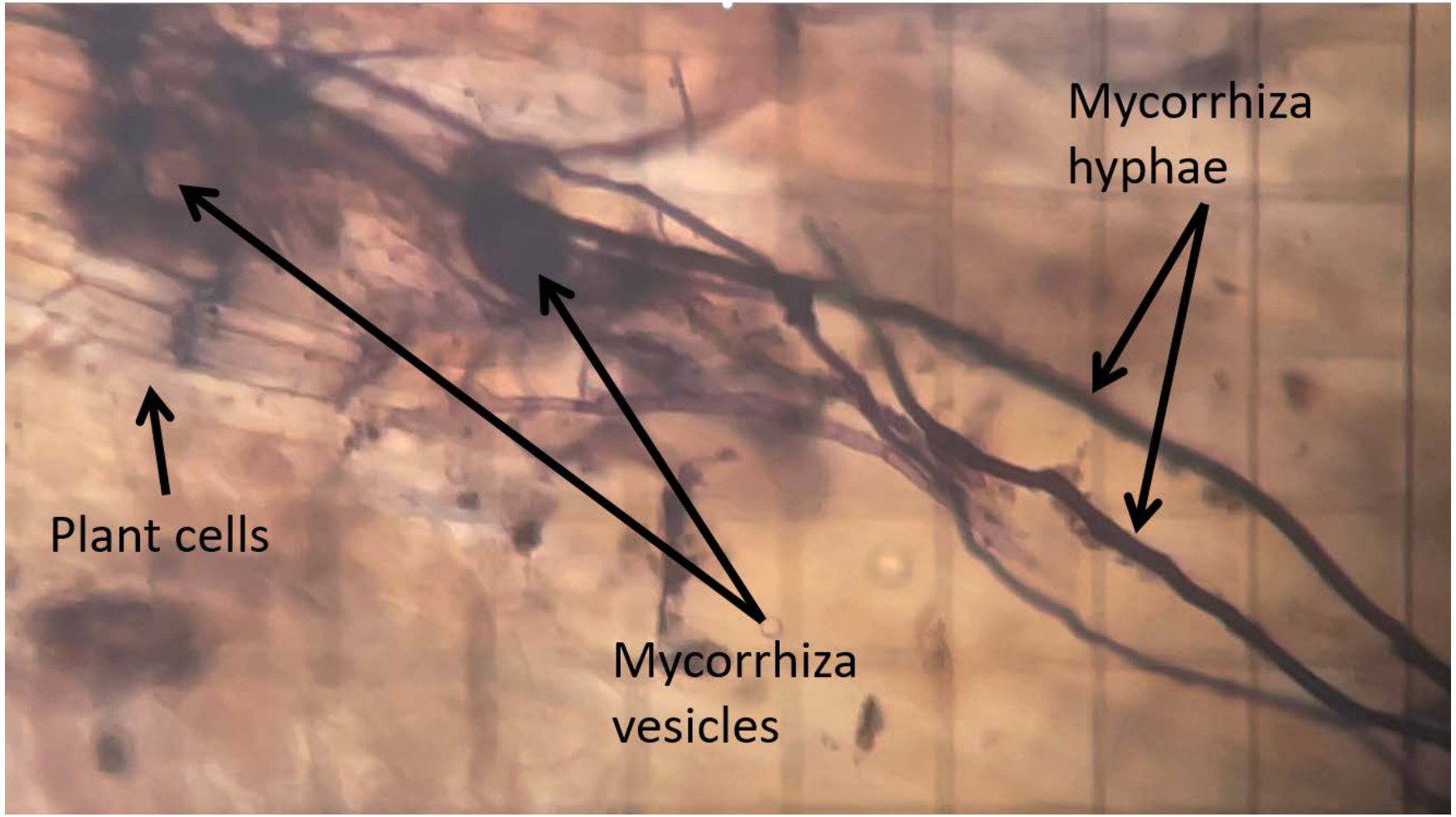
Biological results - Mycorrhiza



(Courtesy of Cherryle Prew, Soil Foodweb NZ, 2021)

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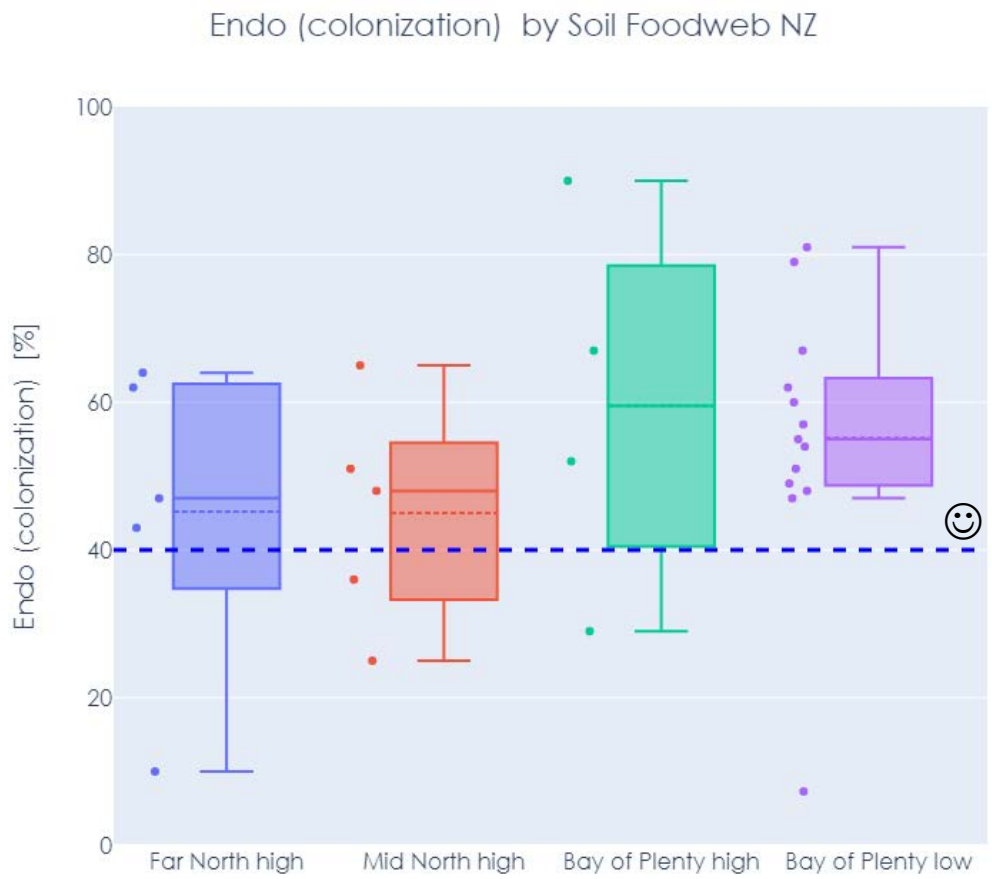
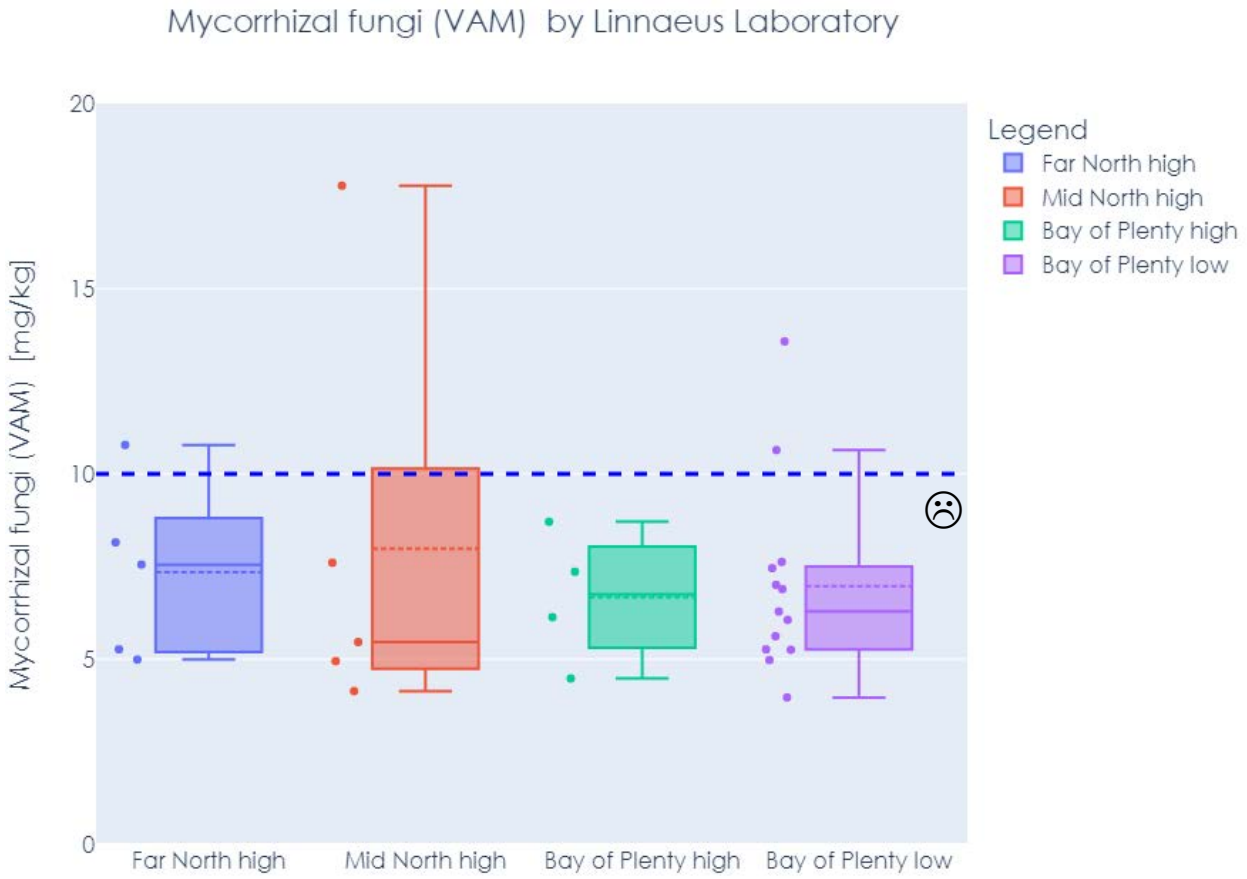
Biological results - Mycorrhiza



Microscopy based analysis



Molecular biology based assays analysis

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Biological reports outcome

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Results - Grower reports

Every grower received their two biological reports.

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Results - Grower reports

Soil attribute	Soil Foodweb NZ result	Linnaeus Laboratory result	Conclusion
Total fungi [mg/kg]	498	27	Opposite
Total bacteria [mg/kg]	357	7.5	Opposite
TF:TB	1.4	3.6	Opposite
Mycorrhizal fungi	48 (*)	5.6 (**)	Opposite
True anaerobic [mg/kg]		0.1	

(*) Endo [%].
(**) Mycorrhizal fungi (VAM) [mg/kg]

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Results - Grower reports

How to navigate this?

What to do?

Corrective actions = $

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Summary

Biological test results from **different methods** are **not interchangeable**.

Different lab recommendations could lead to **inappropriate corrective actions**.

There is a need to develop **specific biological targets for NZ avocado orchards.**

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Summary

Interim solution: NZ Avocado has released a small data set of growers achieving ≥15 t/ha (objective).

Ideal scenario: Build dataset with ongoing monitoring across seasons in collaboration with the labs to **refine the targets.**

Machine learning is a valuable tool for studying an extensive dataset.

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Acknowledgments

Phillip West[1], *Sarah Sorensen*[1], *Cherryle Prew*[2], *Will Kerner*[3], Sarun Saju[3], *Caroline Hill*[4], Graham Shepherd[5], Maryam Alavi[6] and **all our growers** give us access to take samples and work in their orchards.

[1] New Zealand Avocado Industry Limited, [2] Soil Foodweb NZ, [3] Linnaeus Laboratory, and [4] Hill Laboratories, BioAgriNomics Ltd, and [6]Plant & Food Research.

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¡Muchas gracias!
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