Metabarcoding Insights into Coral Microbiome Structure Across Bleaching States and Restoration Strategies in Shimoni, Kenya

Salome Chemutai
SG26/PU/36129/23
MSc Microbiology

Dr. Sammy Wambua | Dr. Ewout Knoester

Background Information

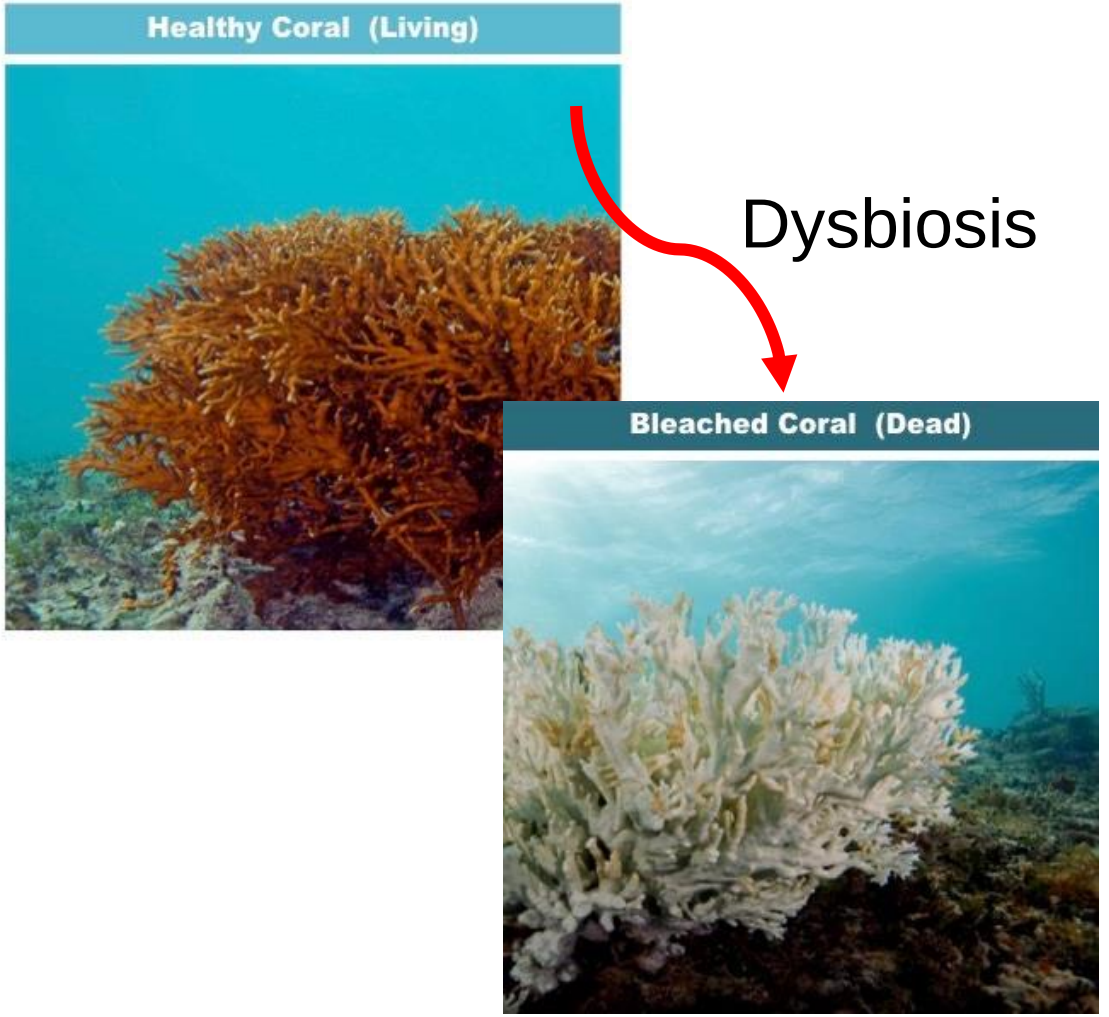
- Corals are important both ecologically and economically
- Ecologically: home to ~25% marine organisms (Nama et al., 2023)
- Economically: support ~6 million – income and food (Gan et al., 2021)

Background Information

- Corals rely on symbionts:
  - Bacteria
  - Algae

- Corals are under threat

- 50% of corals have been lost globally (Rivera-Sosa et al., 2025)
- Coral restoration initiatives: coral gardening



Problem Statement

- Coral reefs face multiple threats leading to bleaching and mortality
- Microbial contributions to coral bleaching tolerance remain unclear
- Effects of restoration on coral–microbe symbioses are unknown in the WIO region

Justification

- Symbionts are essential for coral health and resilience
- Microbes act as biomarkers – early stress detection
- Enhances selective breeding for resilient corals
- Microbes could be used as probiotics to improve nursery outcomes

Research Questions

i. Do microbial community composition underpin bleaching resilience in *Acropora tenuis* and *Acropora verweyi* coral species cultivated in Shimoni?

ii. Do relocations between intertidal and subtidal zones affect the composition of *Acropora tenuis* and *Stylophora pistillata*-associated bacterial symbionts?

iii. Are *Acropora tenuis* and *Stylophora pistillata* microbiome under nursery experiments different from those associated with naturally growing conspecifics?

Objectives

Overall Objective

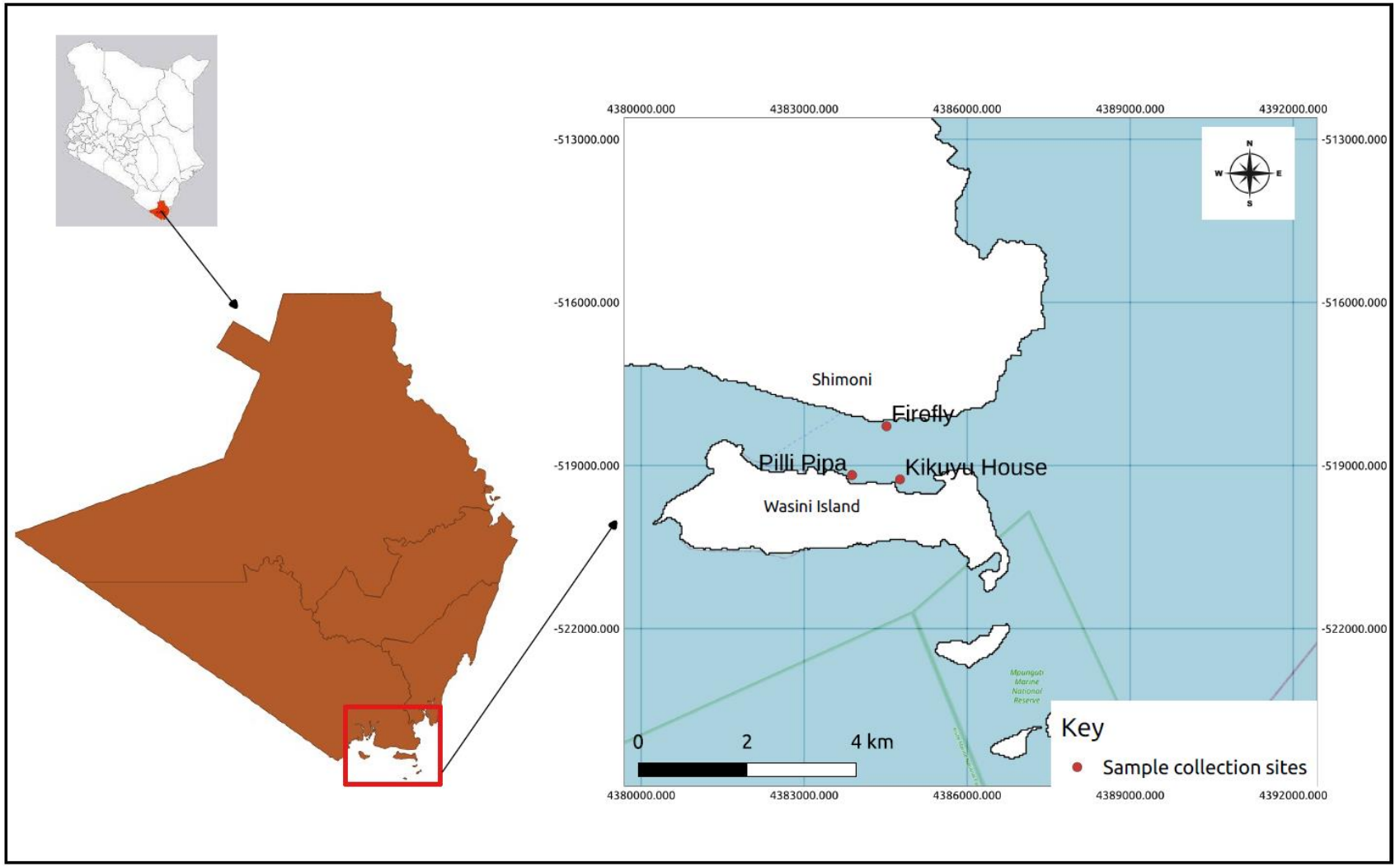
- To assess the coral microbiome composition across bleaching states and restoration strategies in Shimoni, Kenya using 16S rRNA metabarcoding

Specific Objectives

1. To characterize the physicochemical and biological variables of the coral nurseries and habitat under study
2. To compare bacterial composition between non-bleached and bleached *A. tenuis, and A. verweyi*
3. To describe the bacterial assemblage of *Acropora tenuis* and *Stylophora pistillata* relocated between intertidal and subtidal zones
4. To assess the impact of nursery strategies on the composition of *Acropora tenuis* and *Stylophora pistillata*-associated bacteria

Methods

Study Site: Shimoni



Treatments

- **Natural:**

Intertidal

Subtidal

- **Nursery:**

Intertidal → Intertidal

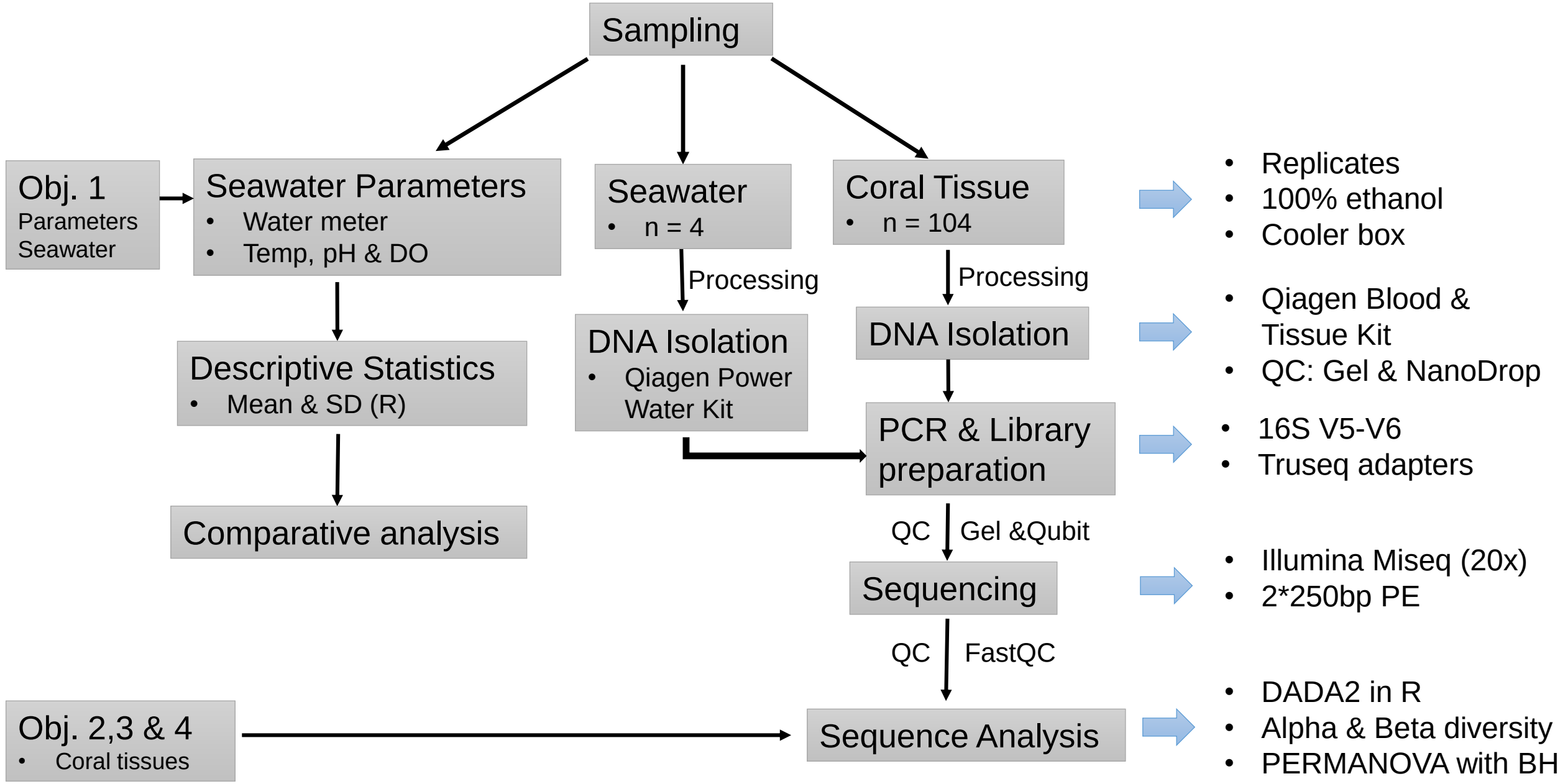
Intertidal → Subtidal

Subtidal → Subtidal

Subtidal → Intertidal

- **Bleached & Non-bleached**

Methods


Sampling
Obj. 1
Parameters Seawater
Seawater Parameters
• Water meter
• Temp, pH & DO
Descriptive Statistics
• Mean & SD (R)
Comparative analysis
Seawater
• n = 4
Processing
DNA Isolation
• Qiagen Power Water Kit
Coral Tissue
• n = 104
Processing
DNA Isolation
PCR & Library preparation
QC
Gel &Qubit
Sequencing
QC
FastQC
Obj. 2,3 & 4
• Coral tissues
Sequence Analysis
• Replicates
• 100% ethanol
• Cooler box
• Qiagen Blood & Tissue Kit
• QC: Gel & NanoDrop
• 16S V5-V6
• Truseq adapters
• Illumina Miseq (20x)
• 2*250bp PE
• DADA2 in R
• Alpha & Beta diversity
• PERMANOVA with BH

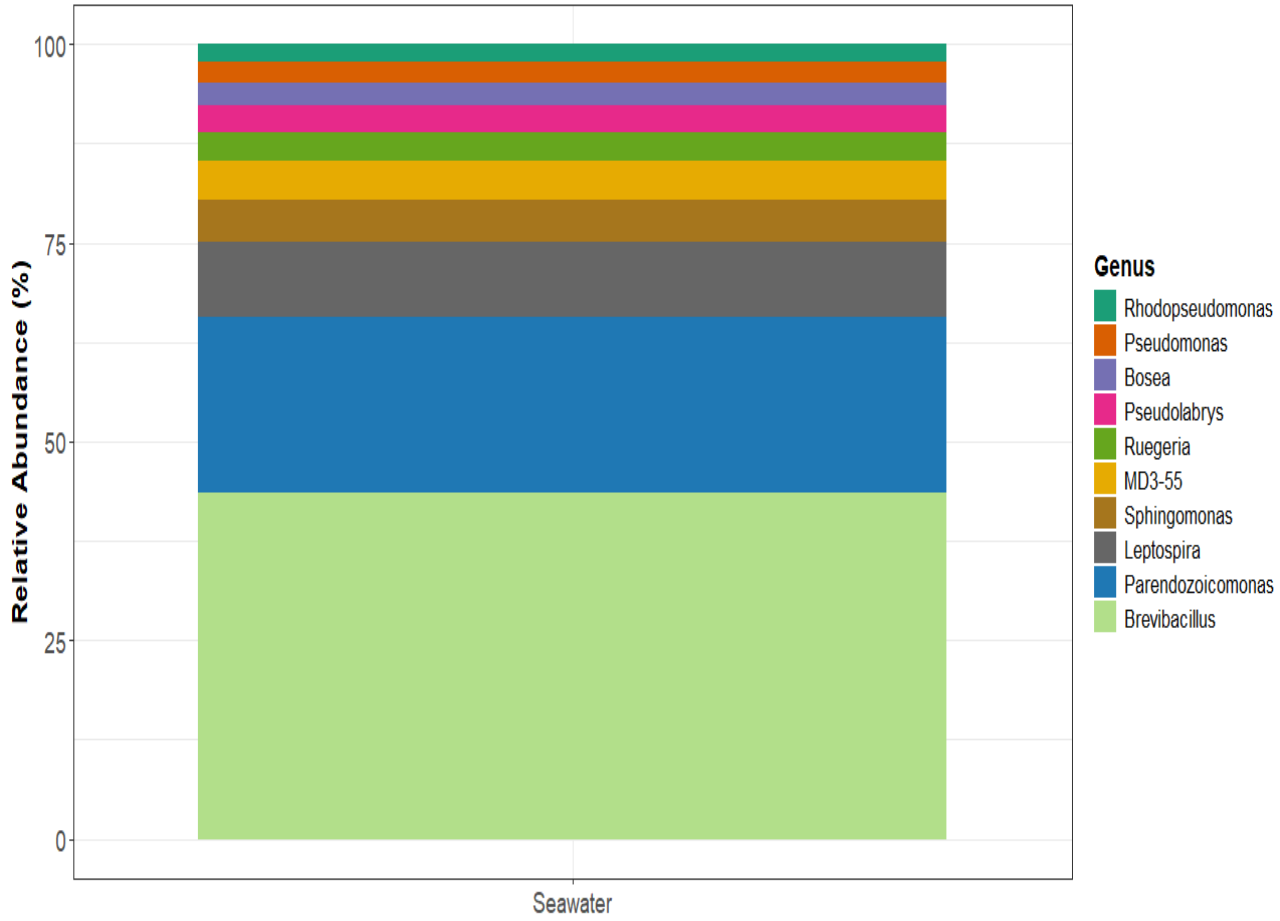
Results and Discussion

Objective 1: Physicochemical Parameters

PARAMETER	MEAN (SD)
DO (mg/L)	7.0 (1.1)
Temperature (°C)	29 (0.93)
pH	8.1 (0.14)

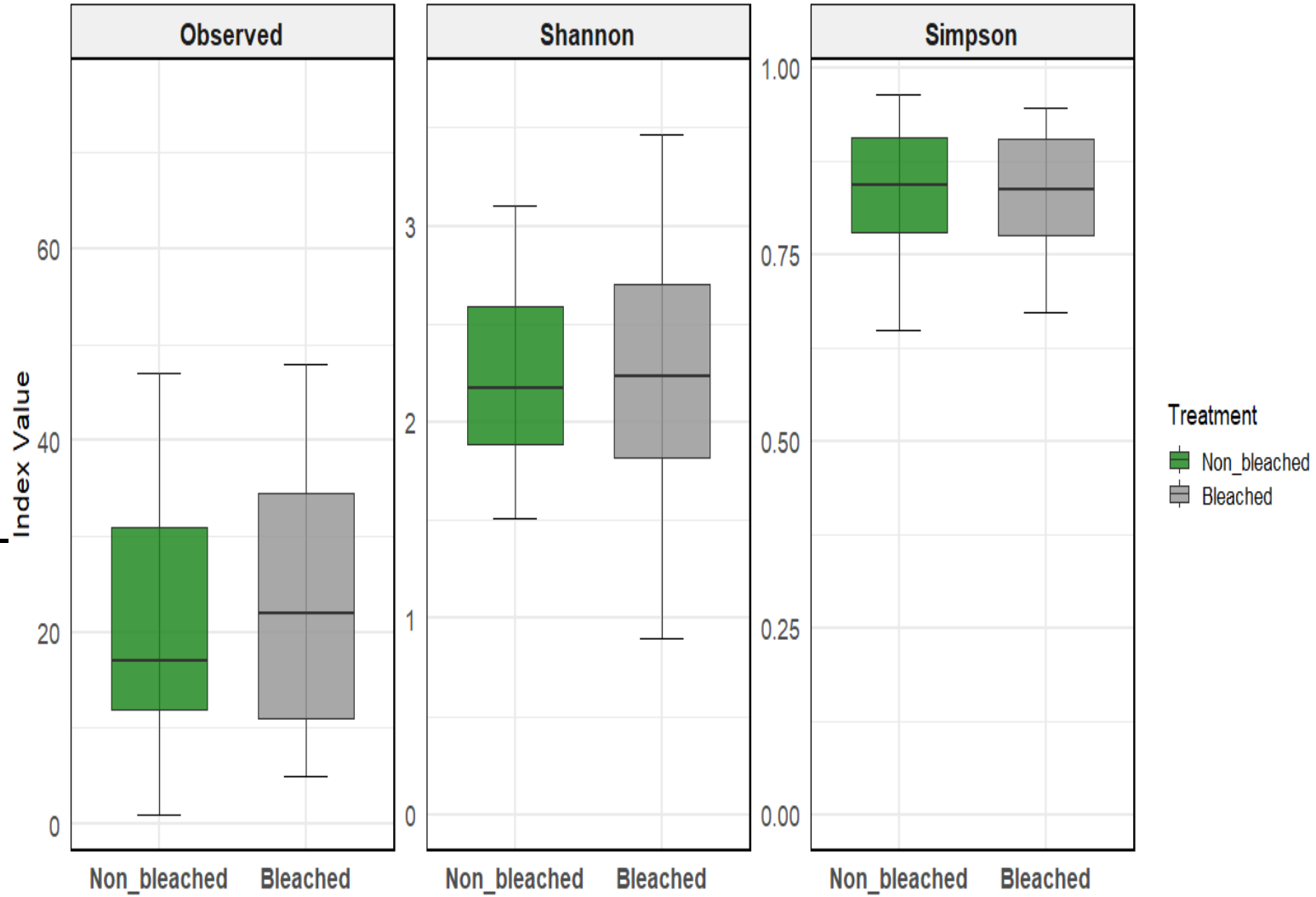
Objective 1:Biological Variables

- Dominance of *Brevibacillus* and *Parendozoicomonas* – produce antimicrobials & recycle nutrients
- *Ruegeria & MD3-55* – coral specific symbionts
- *Leptospira* – terrestrial microorganisms



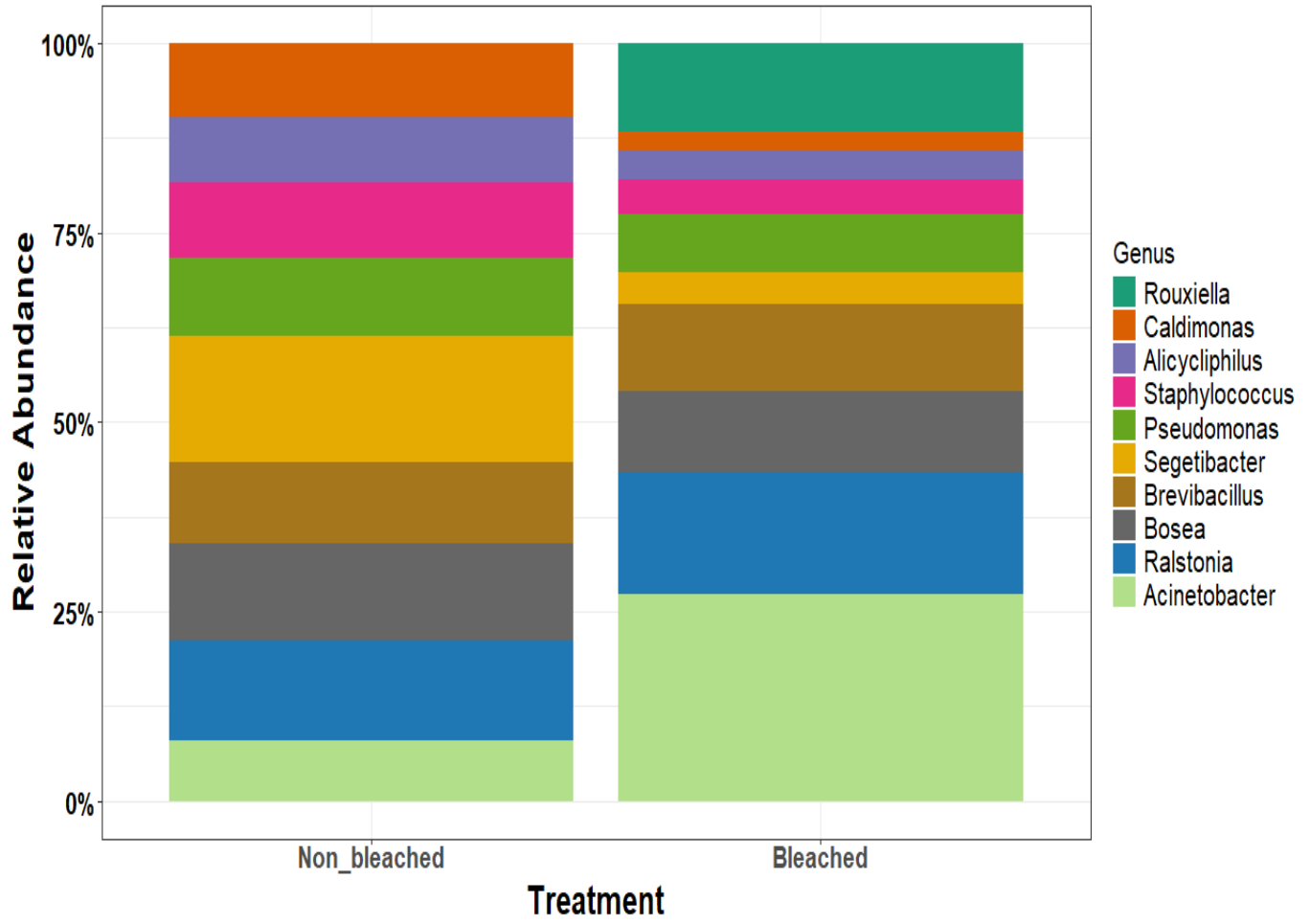
Obj. 2: Bacterial Diversity for Non_bleached vs Bleached

- High richness in bleached – loss of coral's selectivity
- More even bacterial communities in non-bleached – stable communities



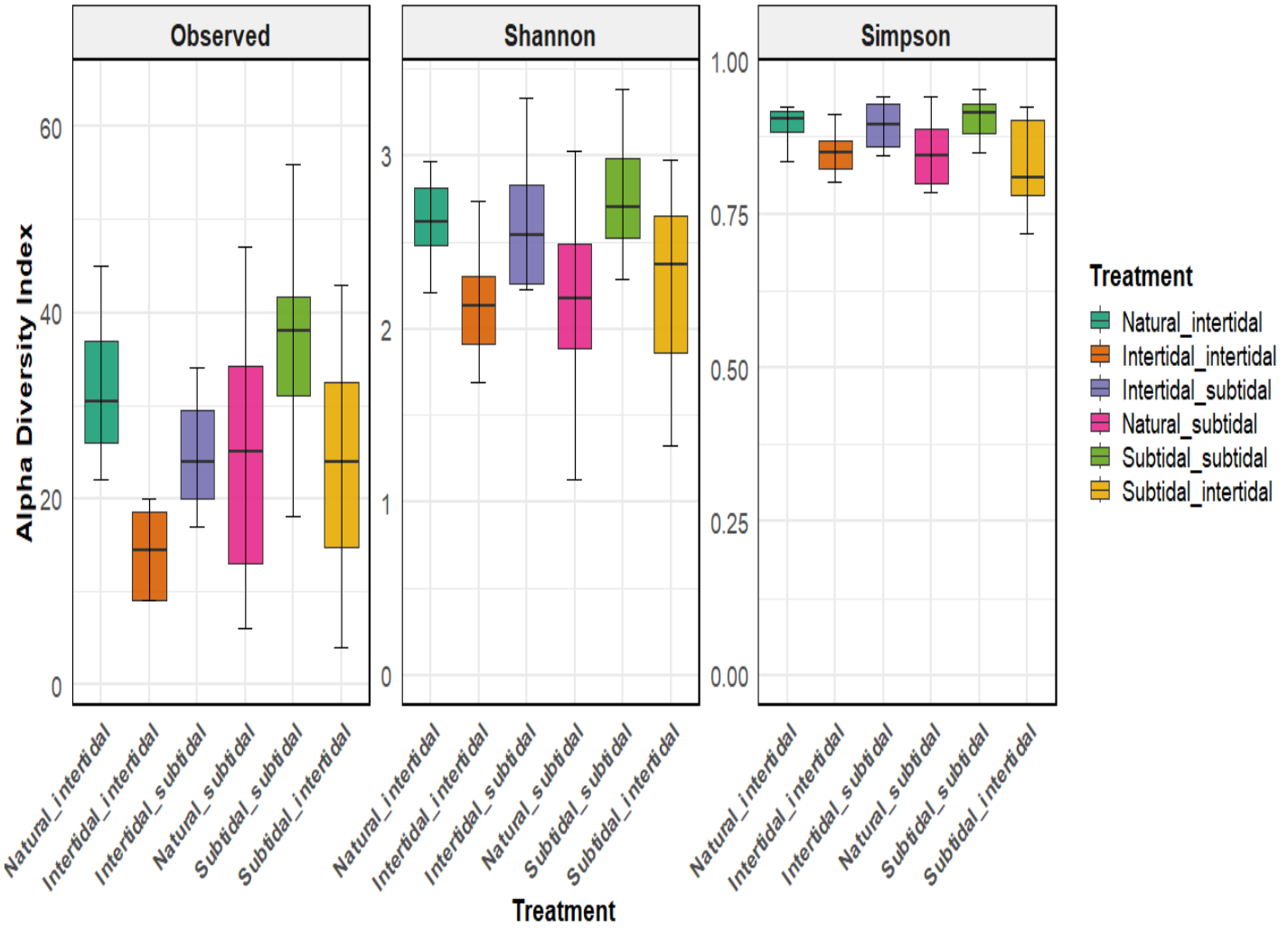
Obj. 2: Bacterial Composition in Non-bleached vs Bleached

- Bleaching led to microbial dysbiosis (Bourne et al 2016)
- Significant difference in bacterial composition (p = 0.003)
- *Rouxiella* could be used as a stress biomarker



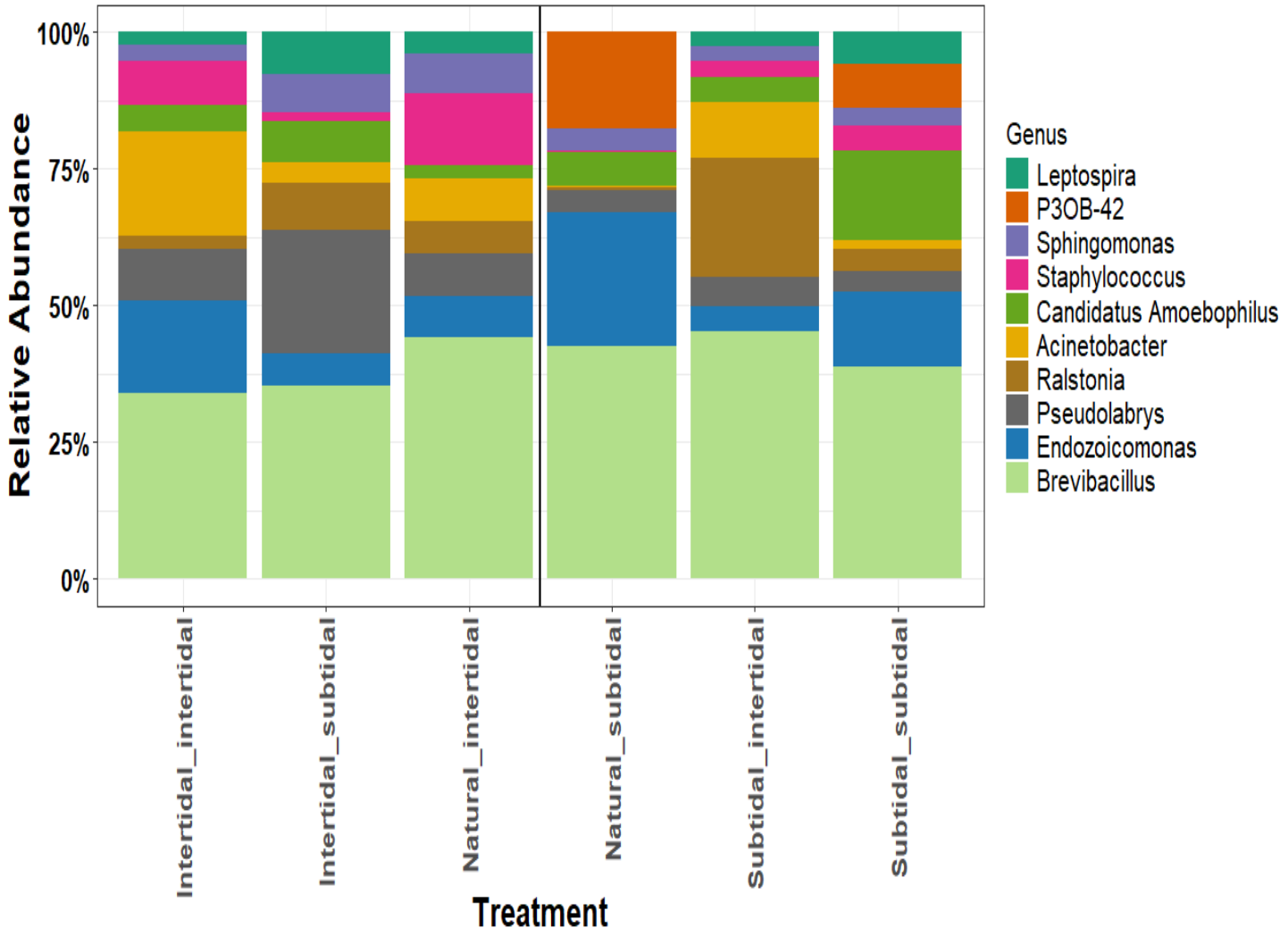
Obj. 3: Bacterial diversity for Intertidal Experiment

- Subtidal – subtidal showed high richness (~38 ASVs)
- Intertidal – intertidal had lower richness (~15 ASVs)
- High evenness in all treatments (>0.75)



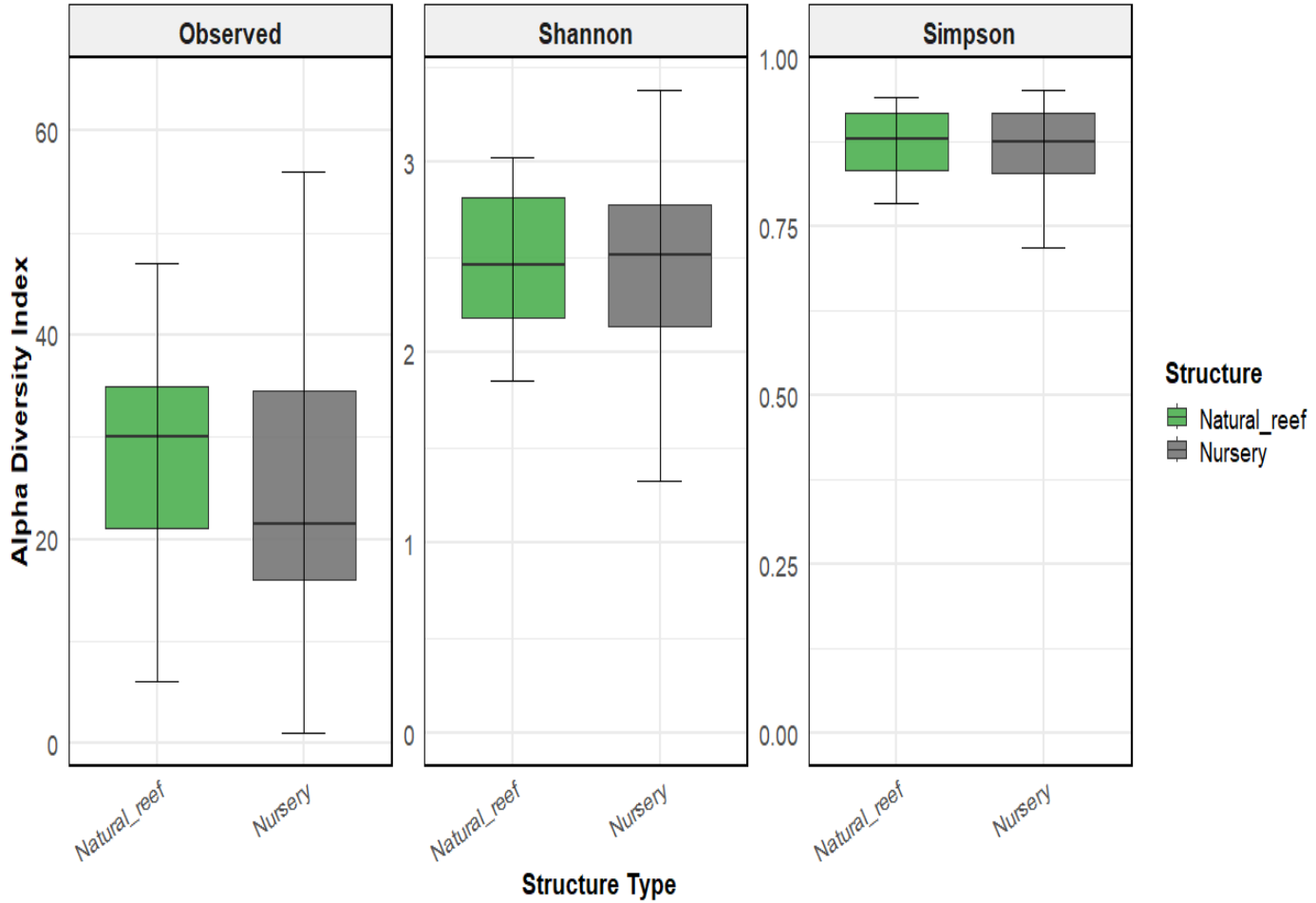
Obj. 3: Bacterial Composition in Intertidal Experiment

- *Brevibacillus* was detected in all treatments (>25%)
- Relocated corals show evidence of stress
- No significant difference in bacterial composition (p = 0.138)



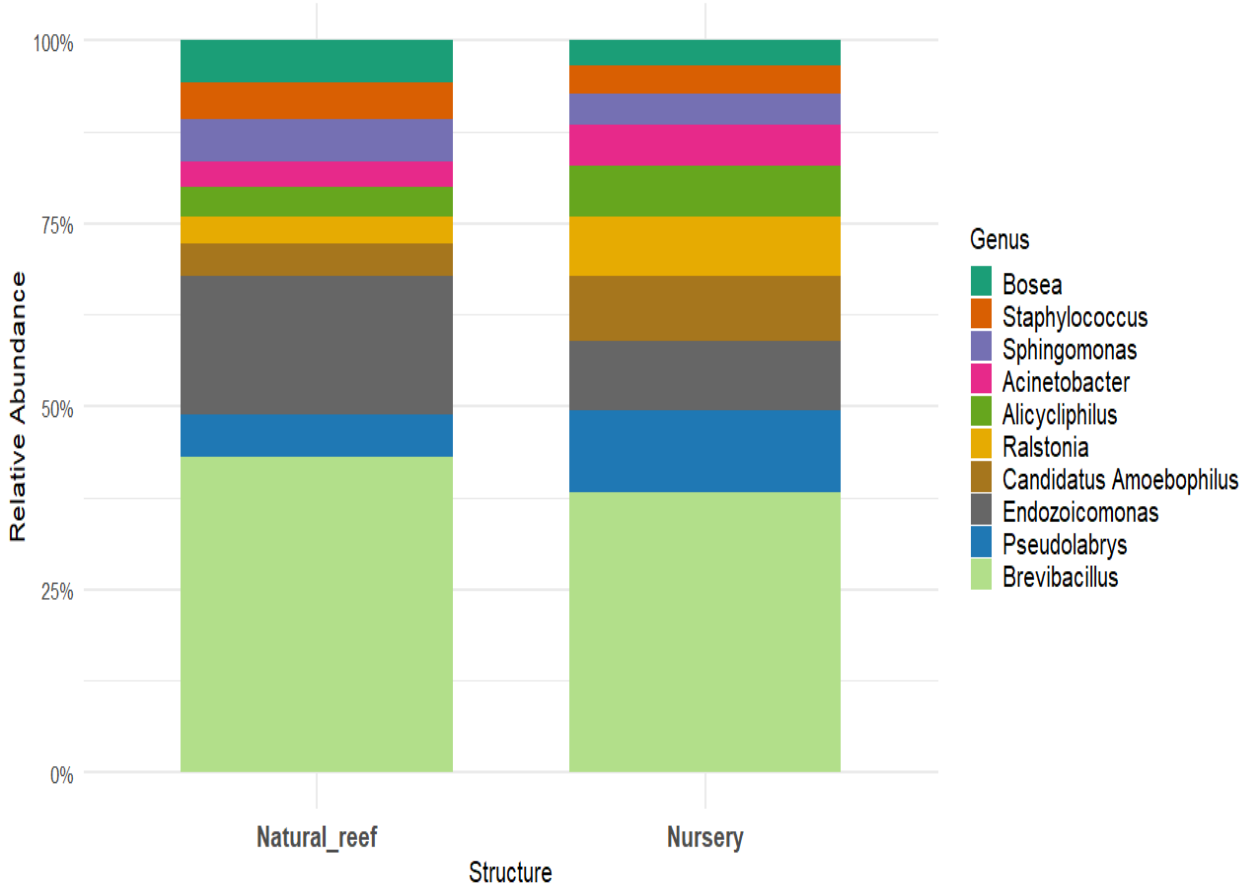
Obj. 4: Bacterial diversity for Nursery vs Natural Reef

- High ASV richness in natural reef (~30)
- More substrates, hence more microbes
- Environmental stability
- Comparable evenness



Obj. 4: Bacterial Composition in Natural vs Artificial Reef

- *Brevibacillus* was more dominant across treatments (>30%)
- *Endozoicomonas* abundance in natural reef
- No significant difference in bacterial composition (p = 0.371)



Conclusion

- Bleaching results in bacterial dysbiosis
- Relocated corals showed a reduction in beneficial taxa
- Nursery treatments may unintentionally disrupt coral-microbe symbiosis
- It’s important to monitor microbial shifts in restoration contexts

Study Limitations

i. Short-term study, hence no temporal dynamics

Recommendations

i. Use of microbial biomarkers for coral health monitoring

ii. Longitudinal study across seasons

iii. Include multi-omics such as metagenomics and metatranscriptomics

iv. Test probiotic inoculations to enhance nursery outcomes

Acknowledgements

Almighty God

Supervisors:

1. Dr. Sammy Wambua
2. Dr. Ewout Knoester

Support/Funding bodies

Colleagues & Family