

MICB475

THE SIMULATED SPACE RESEARCH STATION, HI-SEAS, IS A POOR MICROBIAL MODEL FOR THE INTERNATIONAL SPACE STATION (ISS)

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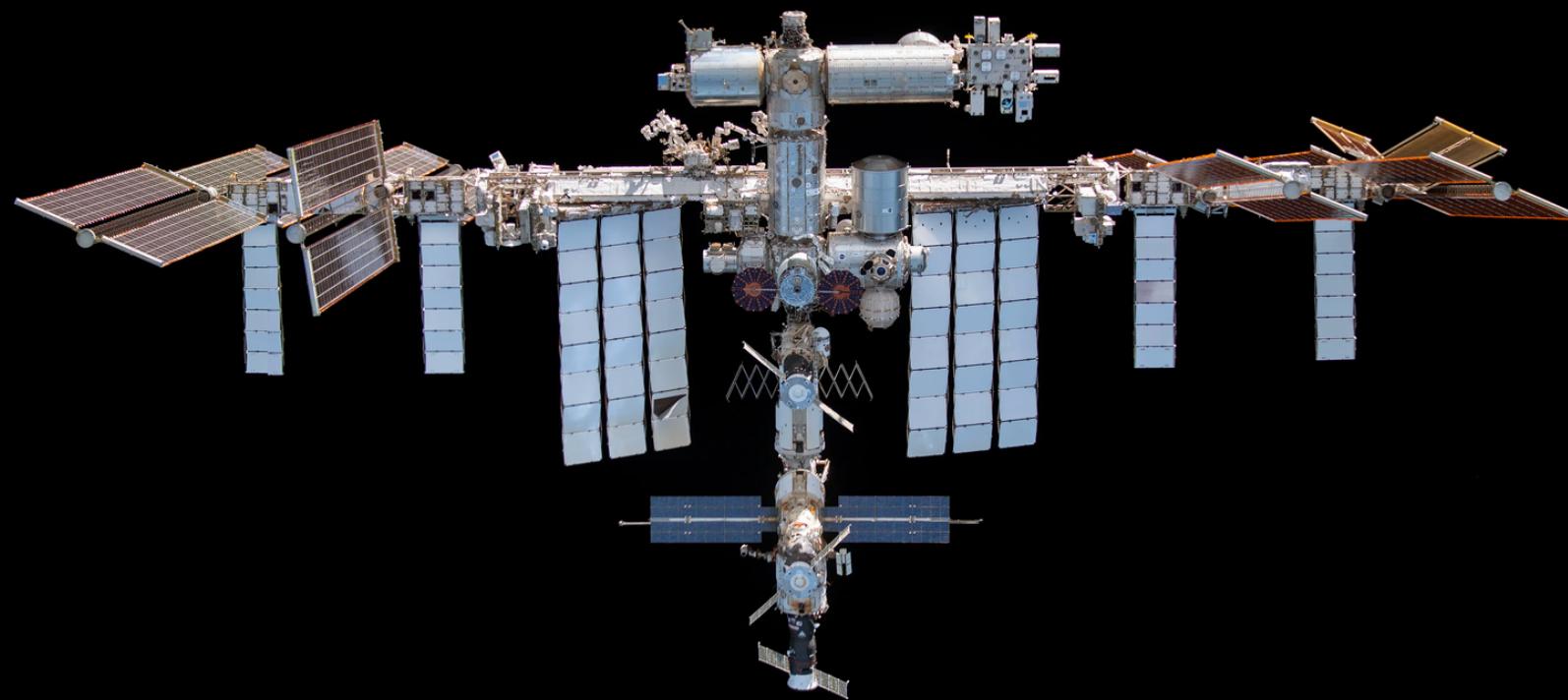


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ISS

- First station module launched in 1998
- Spacecraft that orbits Earth, serving as a habitable artificial satellite
- Continuous human presence, with a rotating crew living aboard
- As of 2023, 270+ astronauts visit



HI-SEAS

- The Hawaii Space Exploration Analog and Simulation
- Situated on Mauna Loa volcano, Hawaii
- Aims to replicate the challenges of space missions (limited resources, communication delays, and confined spaces)
- Crews live in isolation for extended periods



WHY IS MICROBIAL STUDY IMPORTANT?

- Crew health and equipment function
- **Effects on crew health:**
 - Increased risk of pathogen infection
 - Close confinement of crews
 - Impaired immunoregulatory function
 - Microgravity
- **Effects on equipment:**
 - Biodeterioration of polymeric materials by technophilic microorganisms

**ACCURATE MICROBIOME ANALYSIS NEEDED AS
PREVENTATIVE MEASURE FOR FUTURE LONG-TERM MISSIONS**

RESEARCH QUESTION

Is the microbial composition of abiotic surfaces in the HI-SEAS comparable to those in the ISS, and can it serve as a reliable Earth-based analog for studying ISS microbiota?

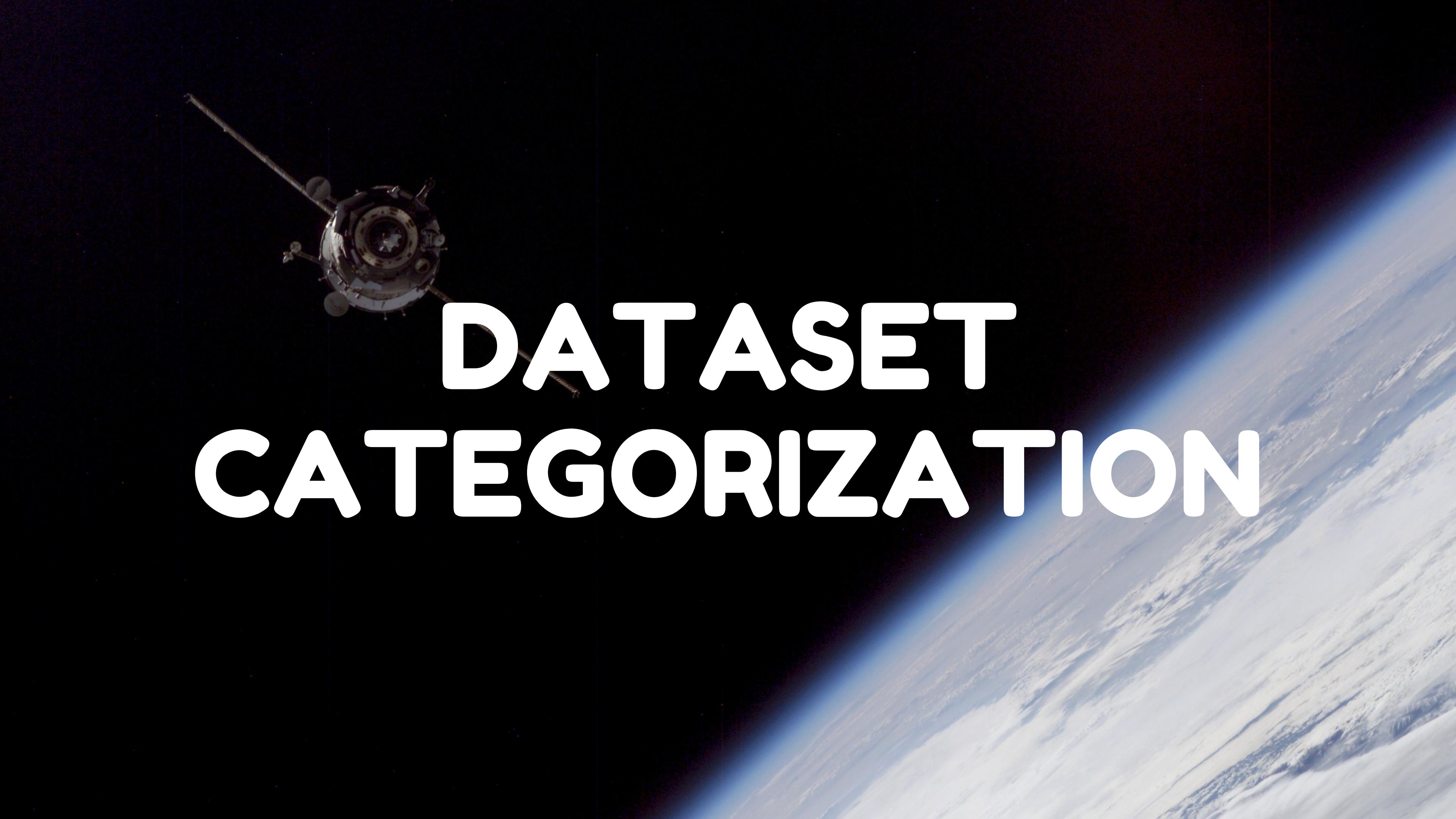
RESEARCH AIMS

1

To compare the abiotic surface-specific microbial diversity between the HI-SEAS and ISS datasets and the locations within ISS and HI-SEAS using alpha and beta diversity metrics.

2

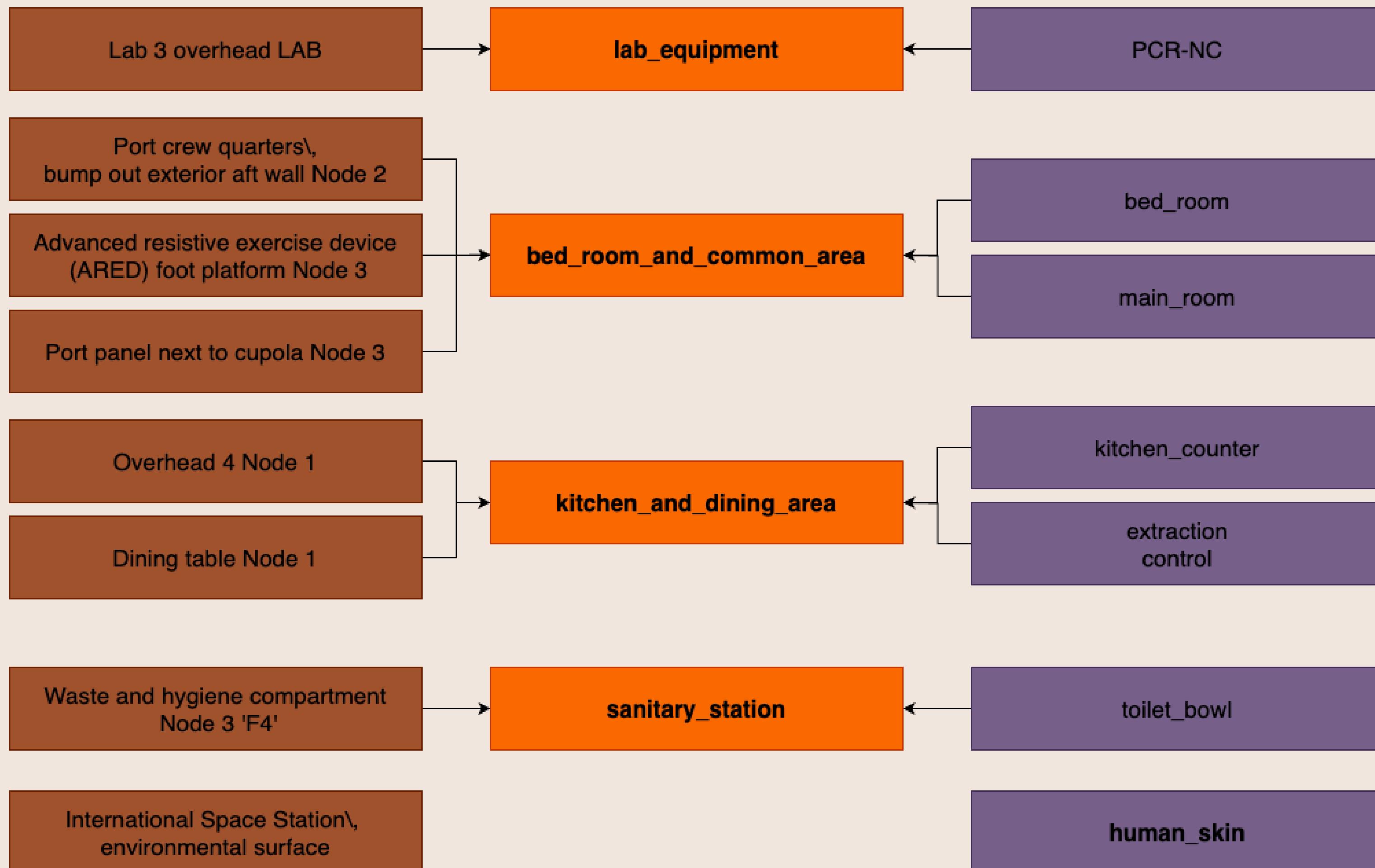
To assess and compare microbial taxonomic composition on abiotic surfaces in HI-SEAS and ISS by performing taxonomic analyses



DATASET CATEGORIZATION

ISS

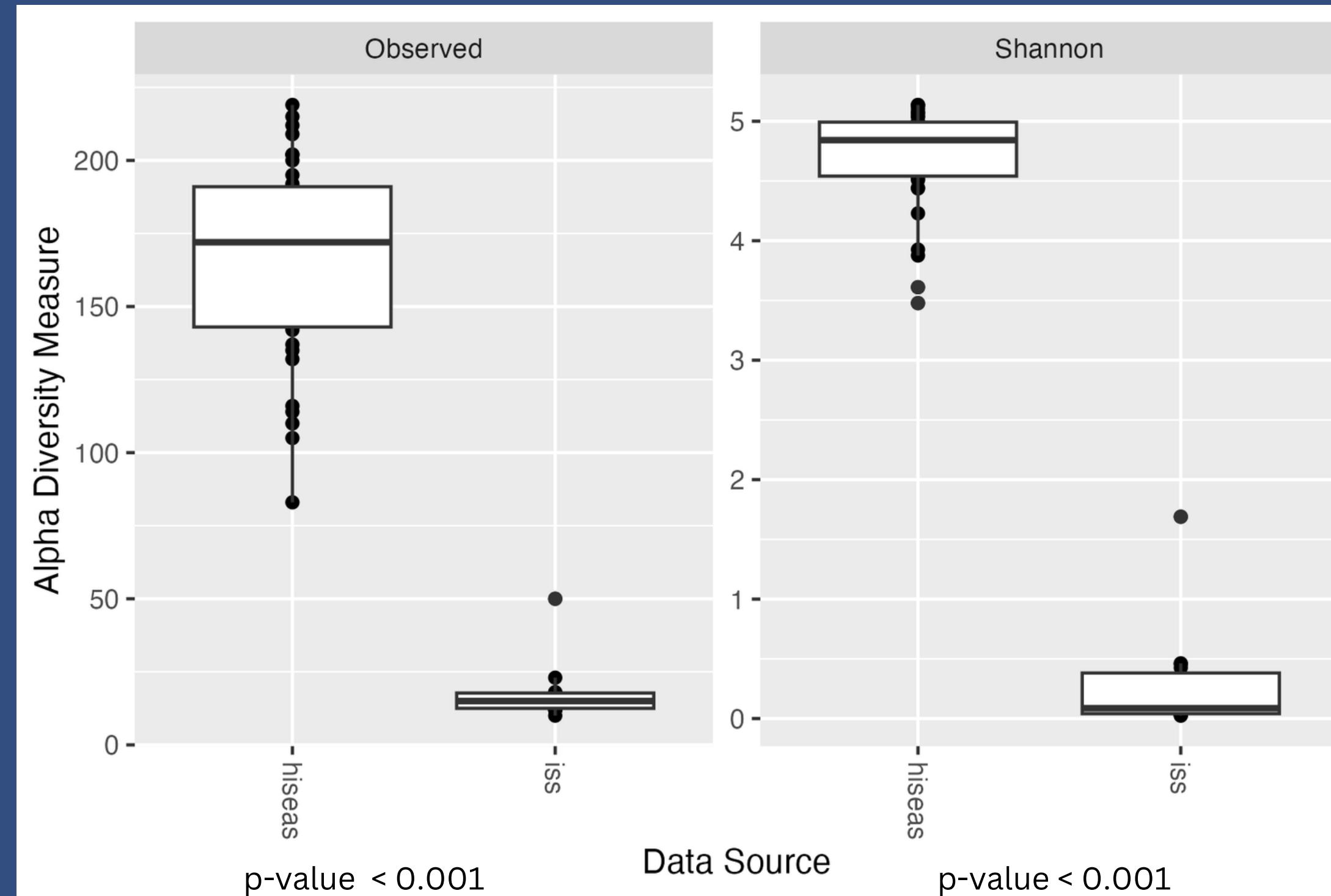
HI-SEAS



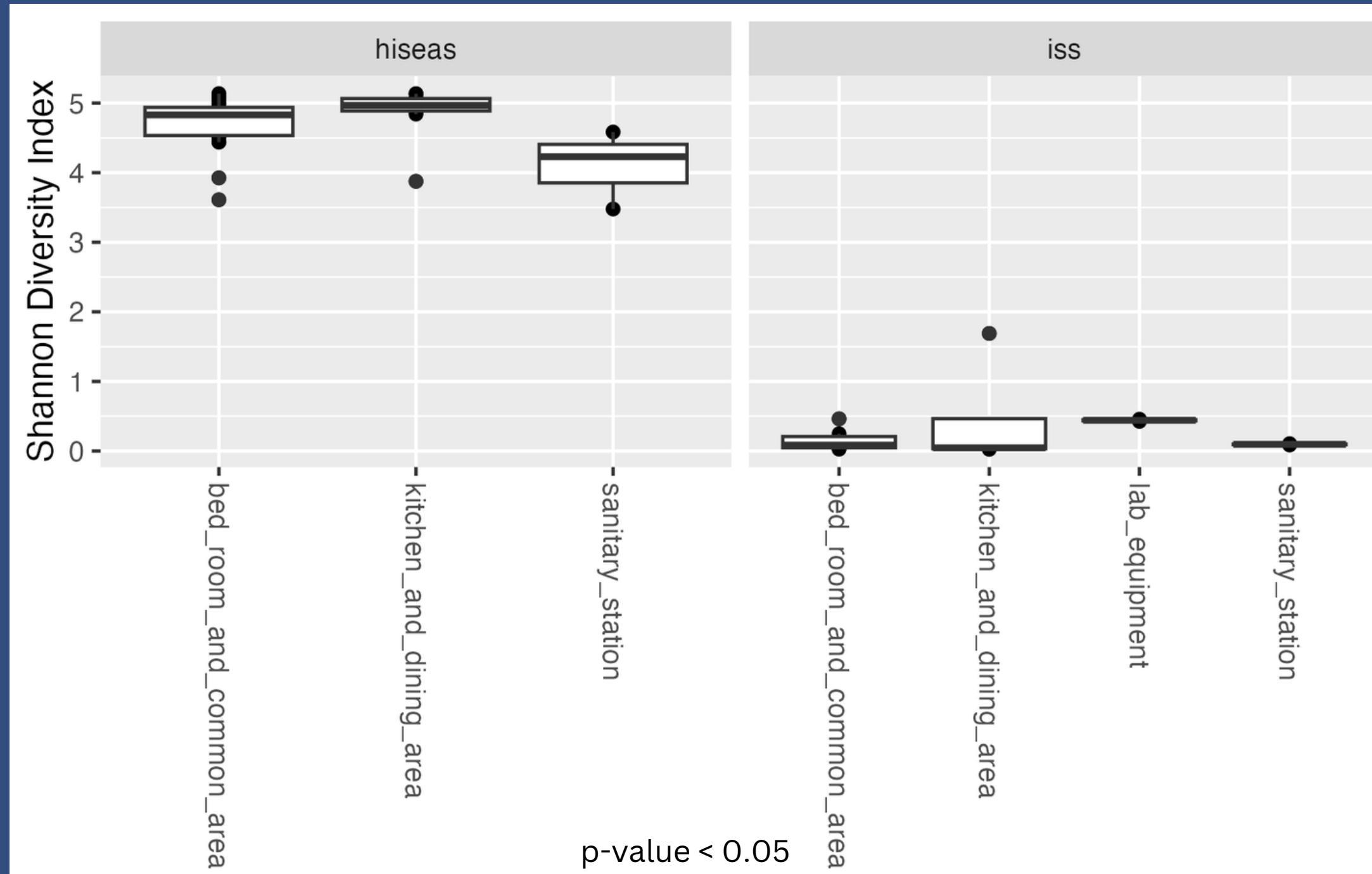
ALPHA DIVERSITY ANALYSIS



SIGNIFICANTLY MORE VARIATION OF MICROBES WITHIN HI-SEAS COMPARED TO THE ISS



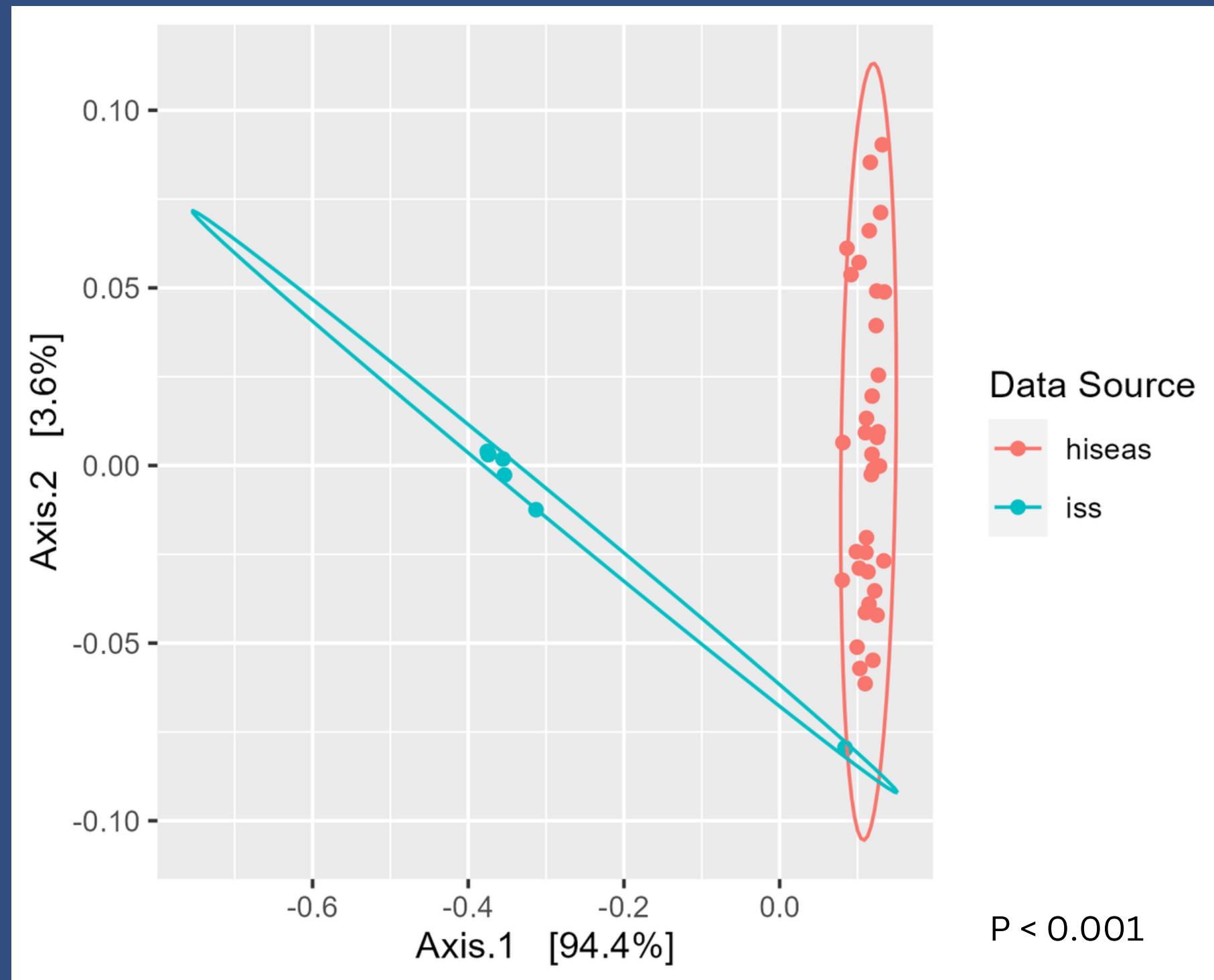
EACH LOCATION WITHIN THE HI-SEAS HAD GREATER COMMUNITY RICHNESS AND ABUNDANCE THAN THE ISS



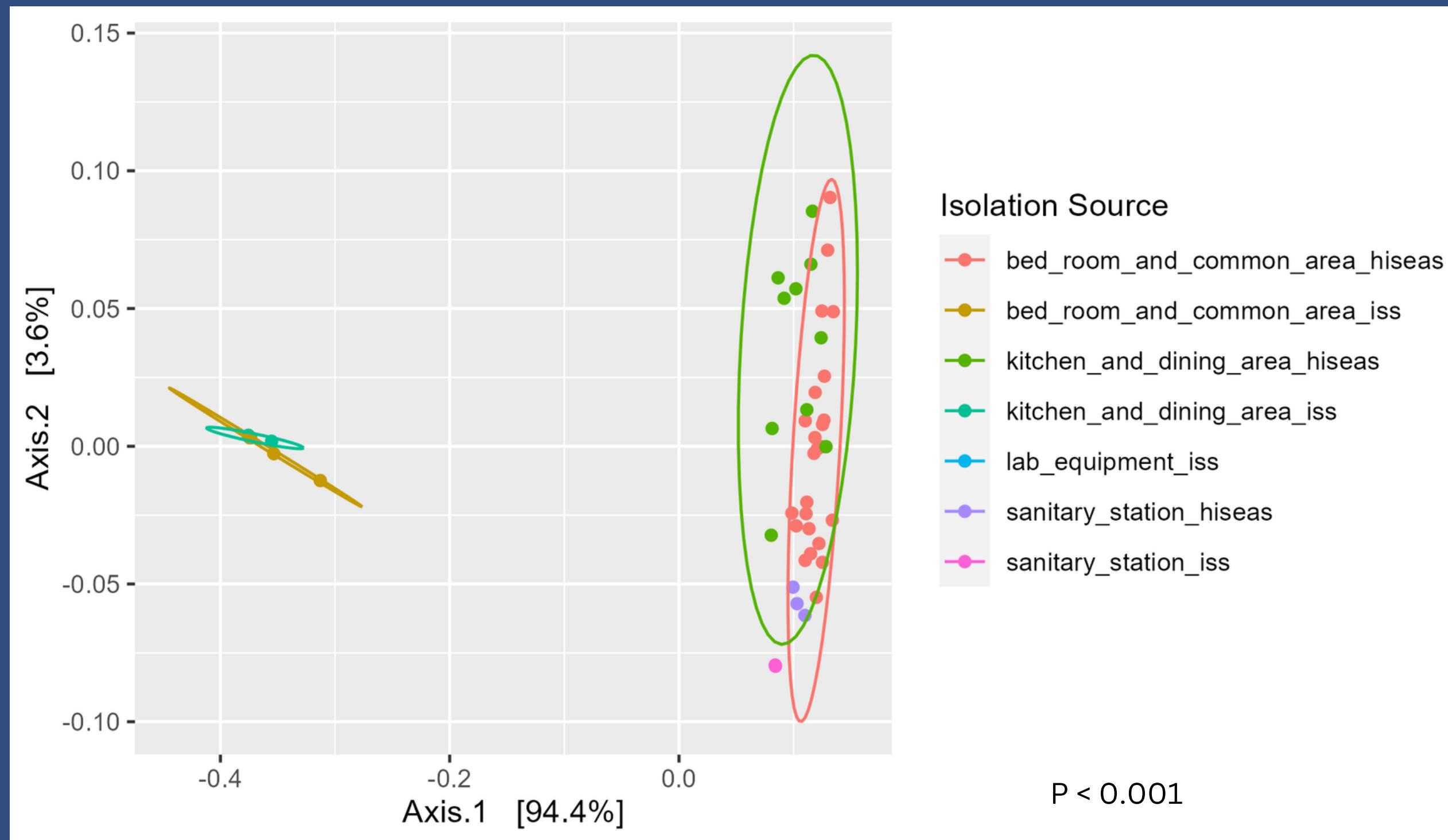
BETA DIVERSITY ANALYSIS



WEIGHTED UNIFRAC PCA INDICATED SIGNIFICANT MICROBIAL DIVERSITY BETWEEN HI-SEAS AND ISS DATASETS



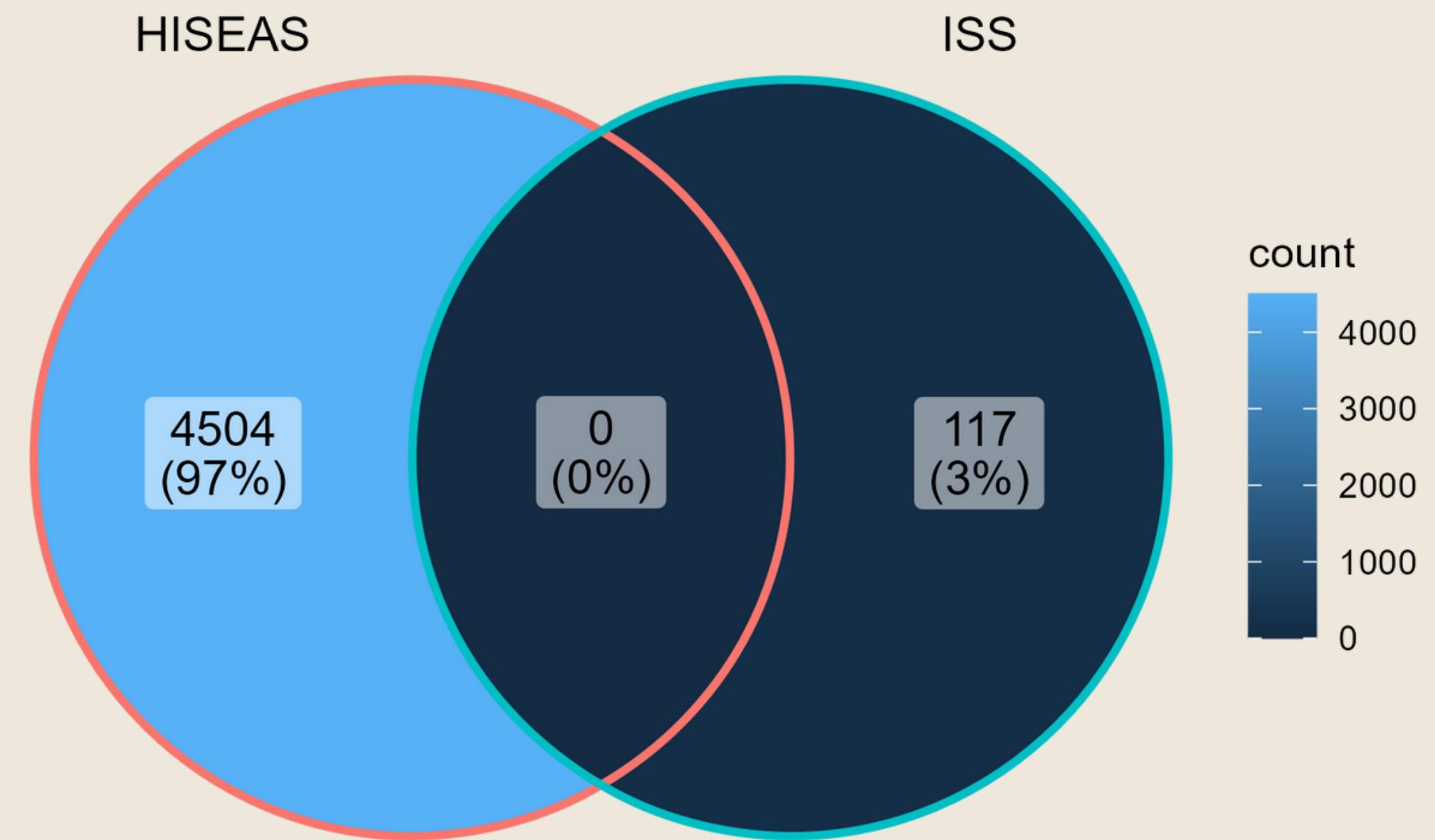
LOCATIONS WITHIN HI-SEAS AND ISS EXHIBITED UNIQUE MICROBIAL PROFILES



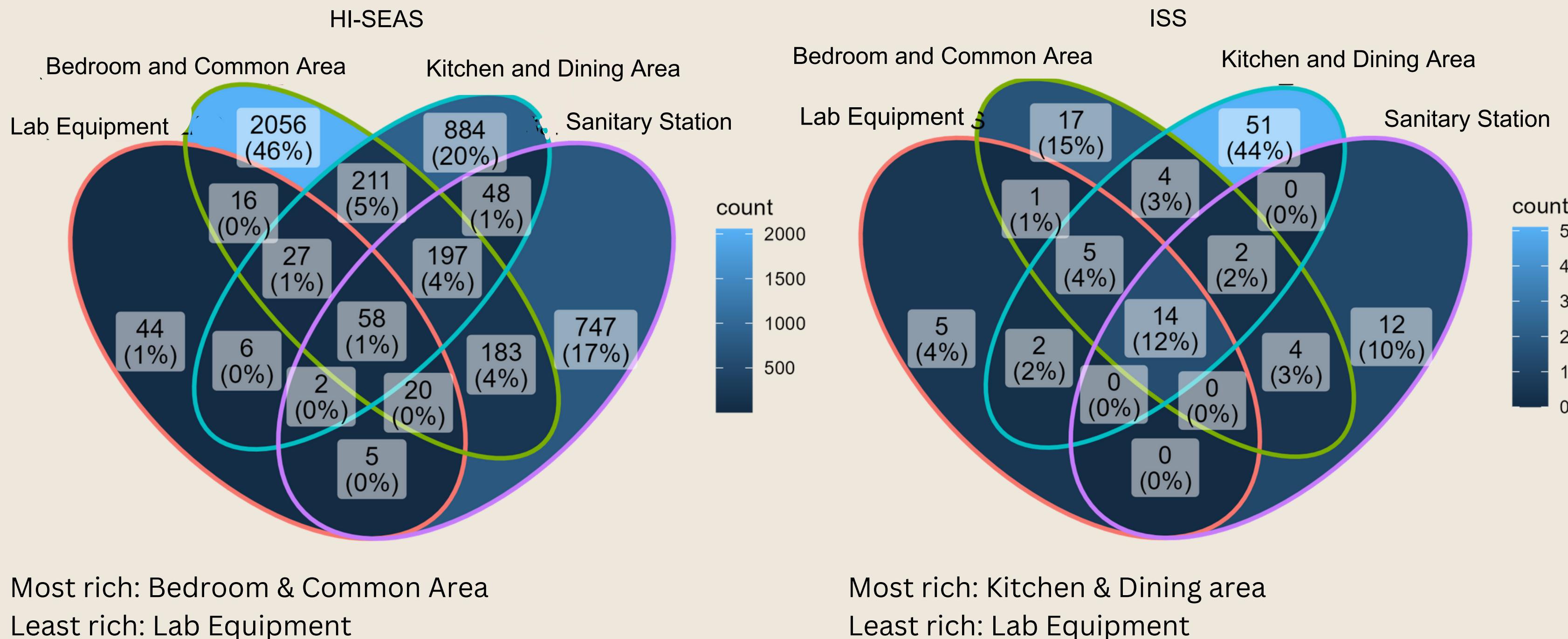
CORE MICROBIOME ANALYSIS



NO SHARED ASVS BETWEEN THE HI-SEAS AND ISS DATASETS



DISTRIBUTION TRENDS IN ASV RICHNESS DIFFER BETWEEN DATA SOURCE LOCATIONS



INDICATOR TAXA ANALYSIS



TWO SHARED ASVS BETWEEN HI-SEAS AND ISS, WITH HI-SEAS EXHIBITING 17 UNIQUE ASVS AND ISS FEATURING 5 ASVS

Dataset	Bedroom and Common Area	Kitchen and Dining Area	Lab Equipment	Sanitary Station
HI-SEAS	✓	✓	✓	✓
HI-SEAS	✓	✓	✓	✓
HI-SEAS	✓	✓		✓
HI-SEAS	✓	✓	✓	
HI-SEAS	✓		✓	✓
HI-SEAS	✓		✓	
HI-SEAS	✓			✓
HI-SEAS	✓			
ISS	✓	✓	✓	✓
ISS				✓
ISS				✓
ISS			✓	✓
ISS			✓	
HI-SEAS & ISS	✓	✓		✓
HI-SEAS & ISS				✓

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HI-SEAS	✓	✓	✓	✓
HI-SEAS	✓	✓		✓
HI-SEAS	✓	✓	✓	
HI-SEAS	✓		✓	✓
HI-SEAS	✓		✓	✓
HI-SEAS	✓			✓
HI-SEAS	✓		✓	
HI-SEAS		✓		
HI-SEAS		✓		✓
HI-SEAS		✓		✓
HI-SEAS		✓		✓
HI-SEAS		✓	✓	
HI-SEAS		✓	✓	✓
HI-SEAS		✓	✓	✓
HI-SEAS		✓	✓	✓
HI-SEAS		✓	✓	✓
ISS	✓	✓	✓	✓
ISS				✓
ISS				✓
ISS			✓	✓
ISS			✓	✓
HI-SEAS & ISS	✓	✓		✓
HI-SEAS & ISS				✓

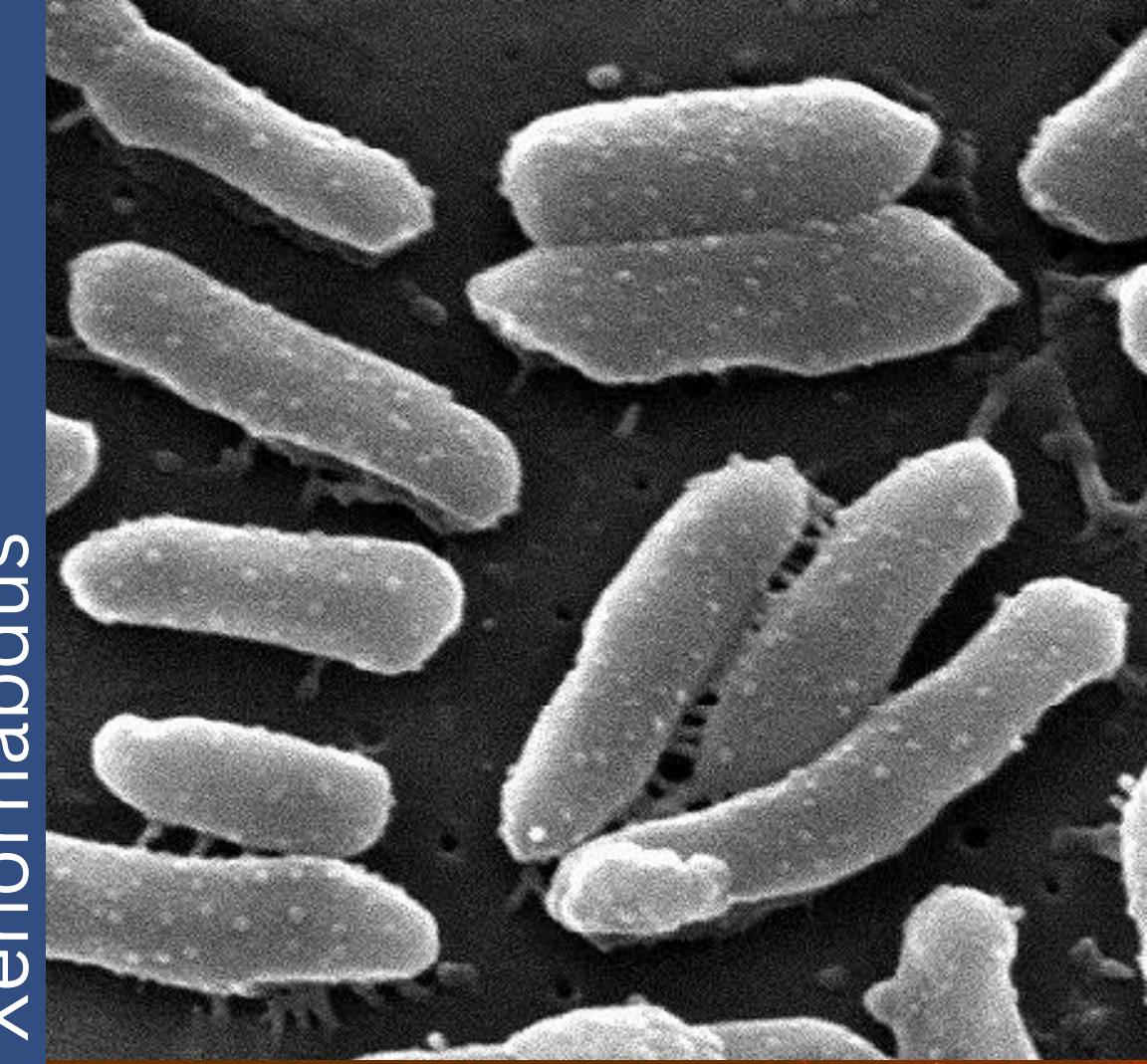
TWO SHARED ASVS BETWEEN HI-SEAS AND ISS, WITH HI-SEAS EXHIBITING 17 UNIQUE ASVS AND ISS FEATURING 5 ASVS

Dataset	Bedroom and Common Area	Kitchen and Dining Area	Lab Equipment	Sanitary Station
HI-SEAS	✓	✓	✓	✓
HI-SEAS	✓	✓	✓	✓
HI-SEAS	✓	✓		✓
HI-SEAS	✓	✓	✓	
HI-SEAS	✓		✓	✓
HI-SEAS	✓		✓	
HI-SEAS	✓			✓
HI-SEAS	✓			
ISS	✓	✓	✓	✓
ISS				✓
ISS				✓
ISS			✓	✓
ISS			✓	
HI-SEAS & ISS	✓	✓		✓
HI-SEAS & ISS				✓

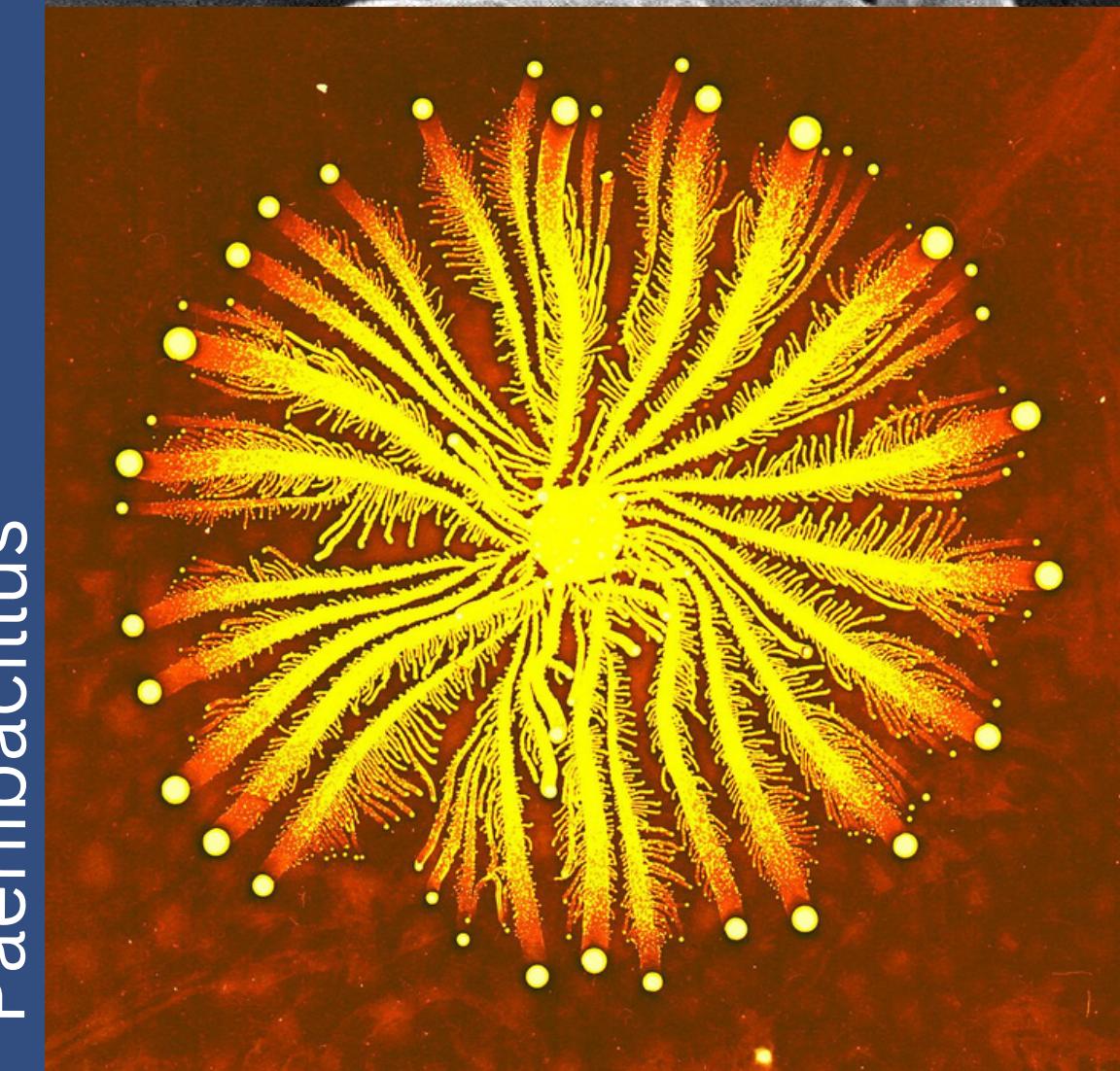
2 ASV'S SHARED BETWEEN HI-SEAS AND ISS

Location: sanitary station

- Family: Morganellaceae;
 - Genus: *Xenorhabdus*
- Family: Paenibacillaceae;
 - Genus: *Paenibacillus*



Xenorhabdus



Paenibacillus

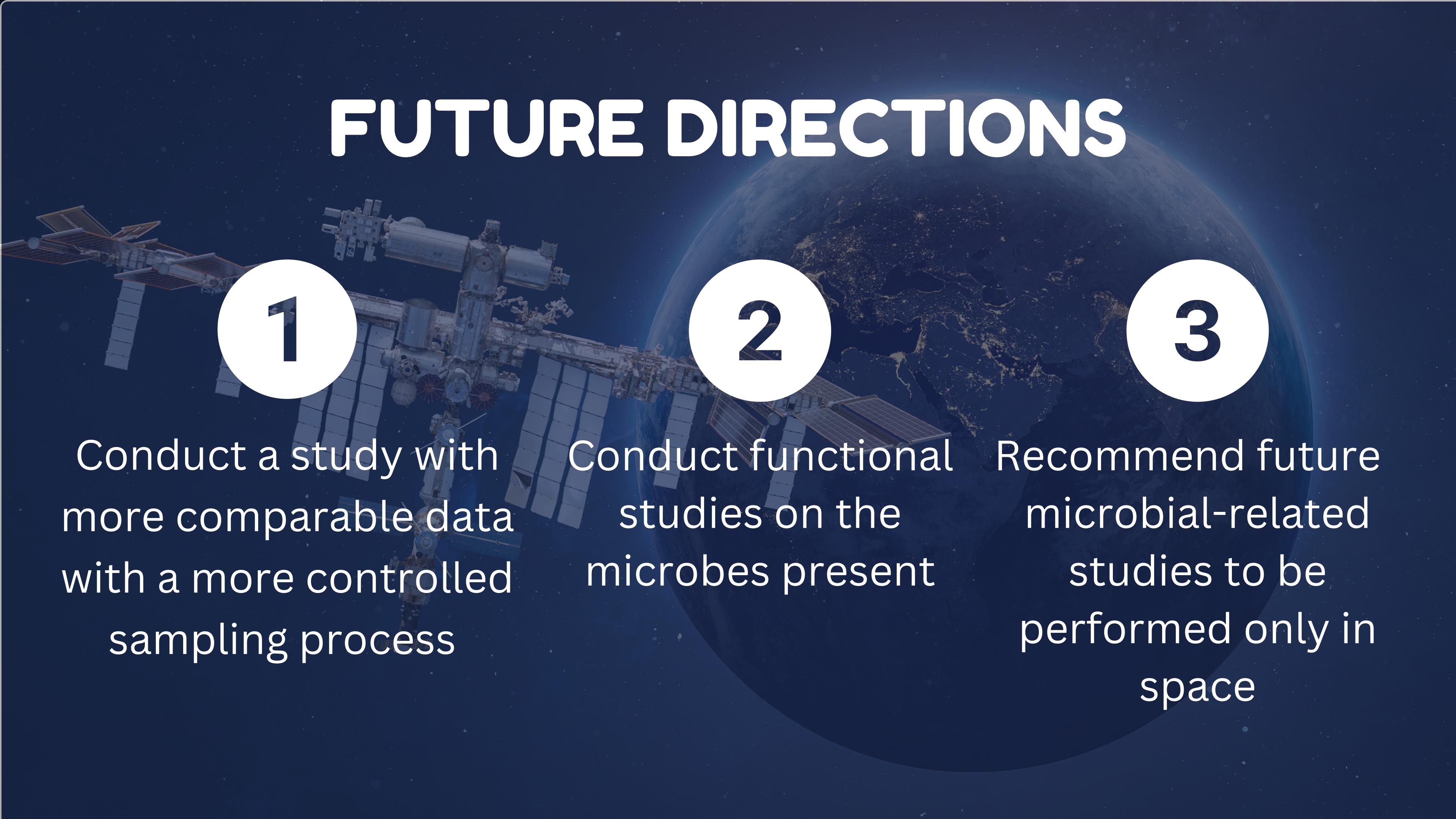
CONCLUSION

- Microbial composition and diversity on abiotic surfaces in the HI-SEAS are **NOT COMPARABLE** to those in the ISS.
- Another study (Chi et al., 2023, to be published) discovered soil microbial contamination in the HI-SEAS profile
 - **NOT** a fully isolated environment
- Other factors affecting composition and diversity including:
 - Gender
 - Number of crews
 - Diet

Limitations

1. Huge difference in sample size
2. Different sample collection and sequencing process
3. Time and duration of study

FUTURE DIRECTIONS

A photograph of the International Space Station (ISS) against the dark void of space. The station's complex structure of white modules, blue solar panels, and various scientific instruments is visible. It is positioned in front of the planet Earth, which shows a bright blue ocean and white clouds from its atmosphere. The background is filled with the small, white dots of distant stars.

1

Conduct a study with
more comparable data
with a more controlled
sampling process

2

Conduct functional
studies on the
microbes present

3

Recommend future
microbial-related
studies to be
performed only in
space

Acknowledgements

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HI-SEAS Research Team

Alexander Mahnert and Team

MICB 475 W23 Team 3

Chi et al.



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**THANK
YOU VERY
MUCH!**

