

Evaluating Constructed Wetland Treatment Performance and Links with Seasonal Microbial Dynamics

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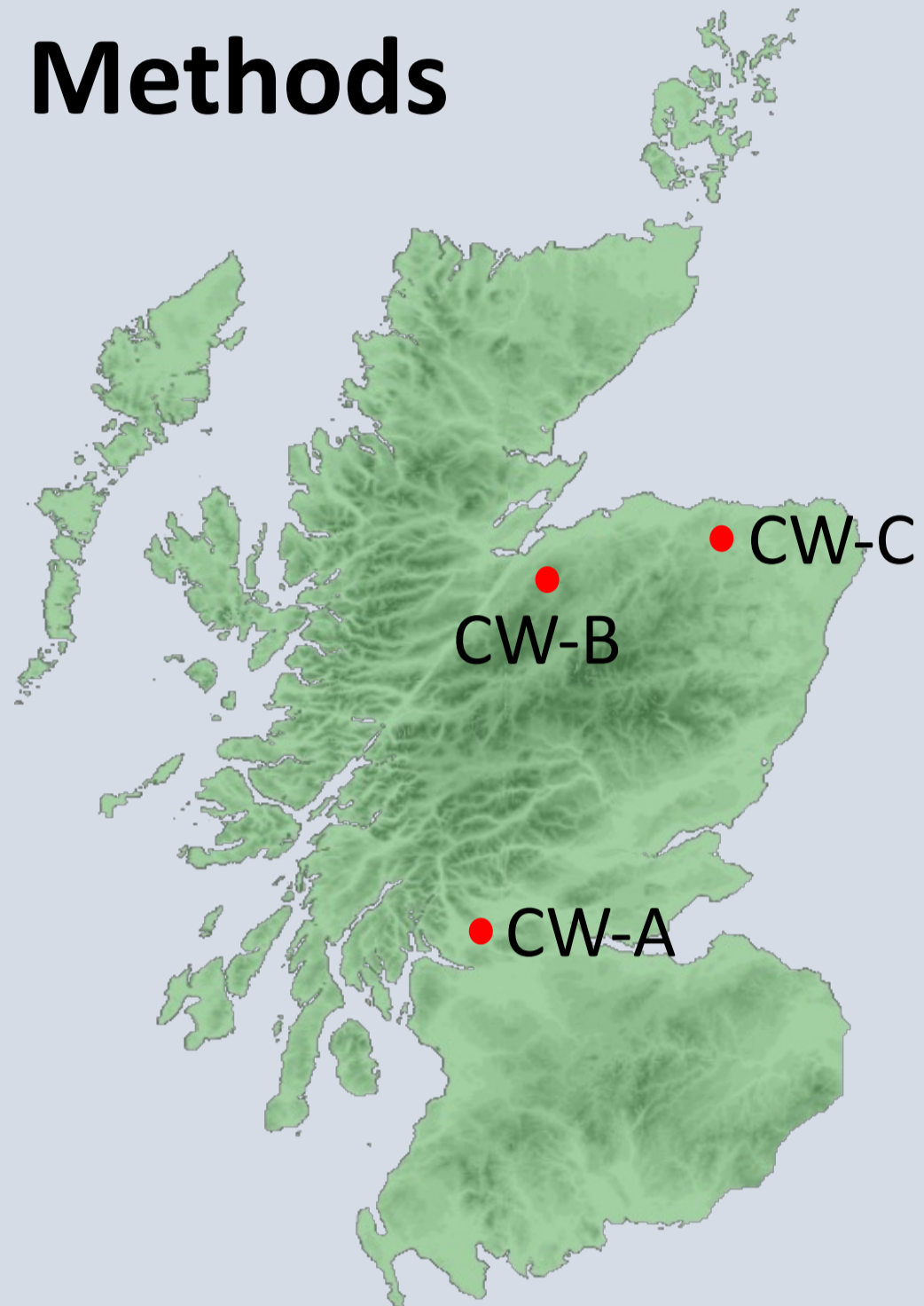
Introduction

Constructed wetland systems (CWs) can be used to treat 'spent lees', a distillation by-product of whisky manufacturing. Despite the many advantages of such systems, a key challenge is their potential inability to maintain stable performance throughout the year due to the negative impact of colder temperatures on microbial community and plant metabolism.

Aims

- To examine the treatment performance of different CWs at whisky distilleries in Scotland on a seasonal basis.
- To characterise the effluent of distilleries over seasons.
- To observe the seasonality of microbial communities at these CWs.
- To identify the effect of microbial community on treatment performance.

Methods



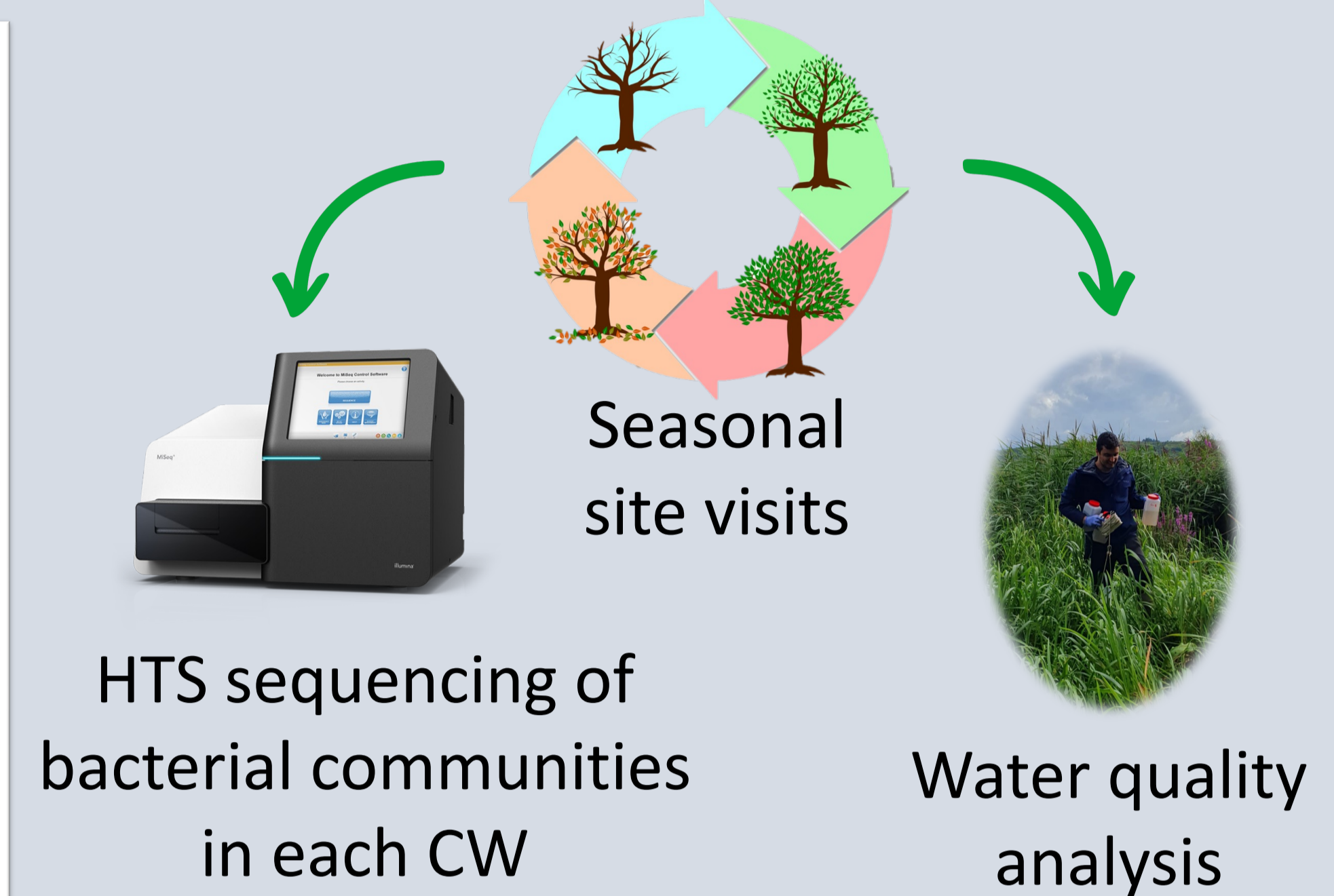
CW-A



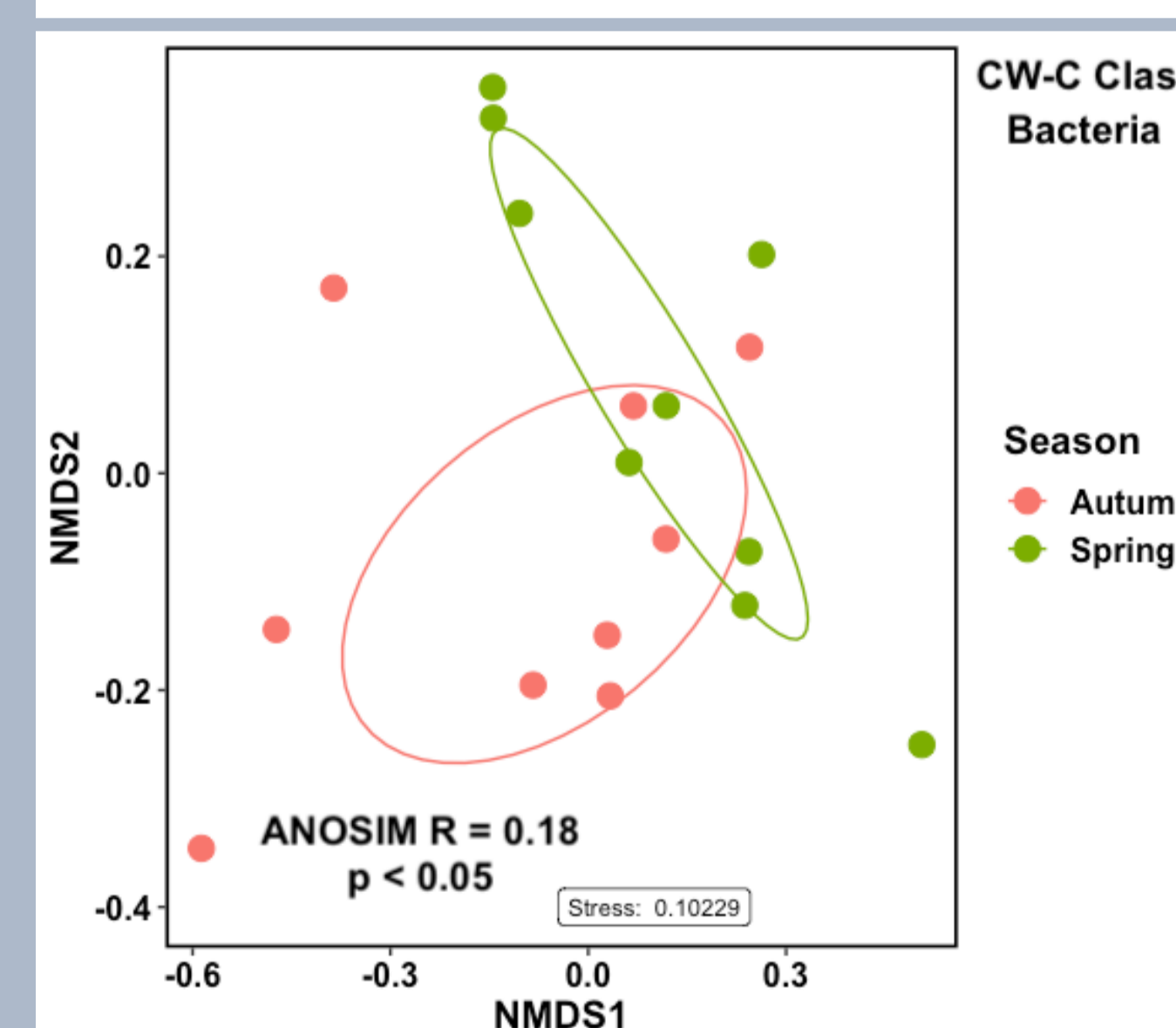
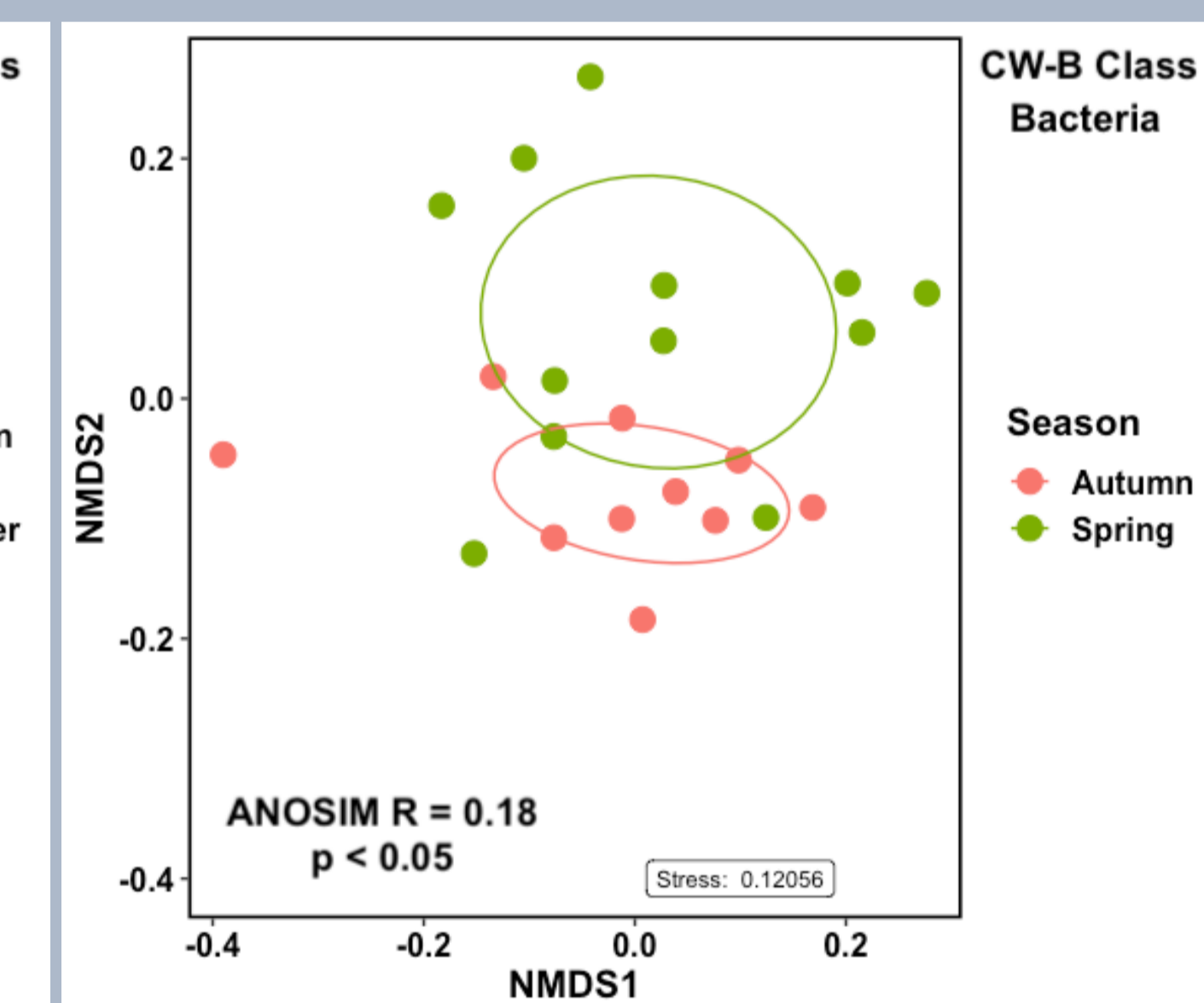
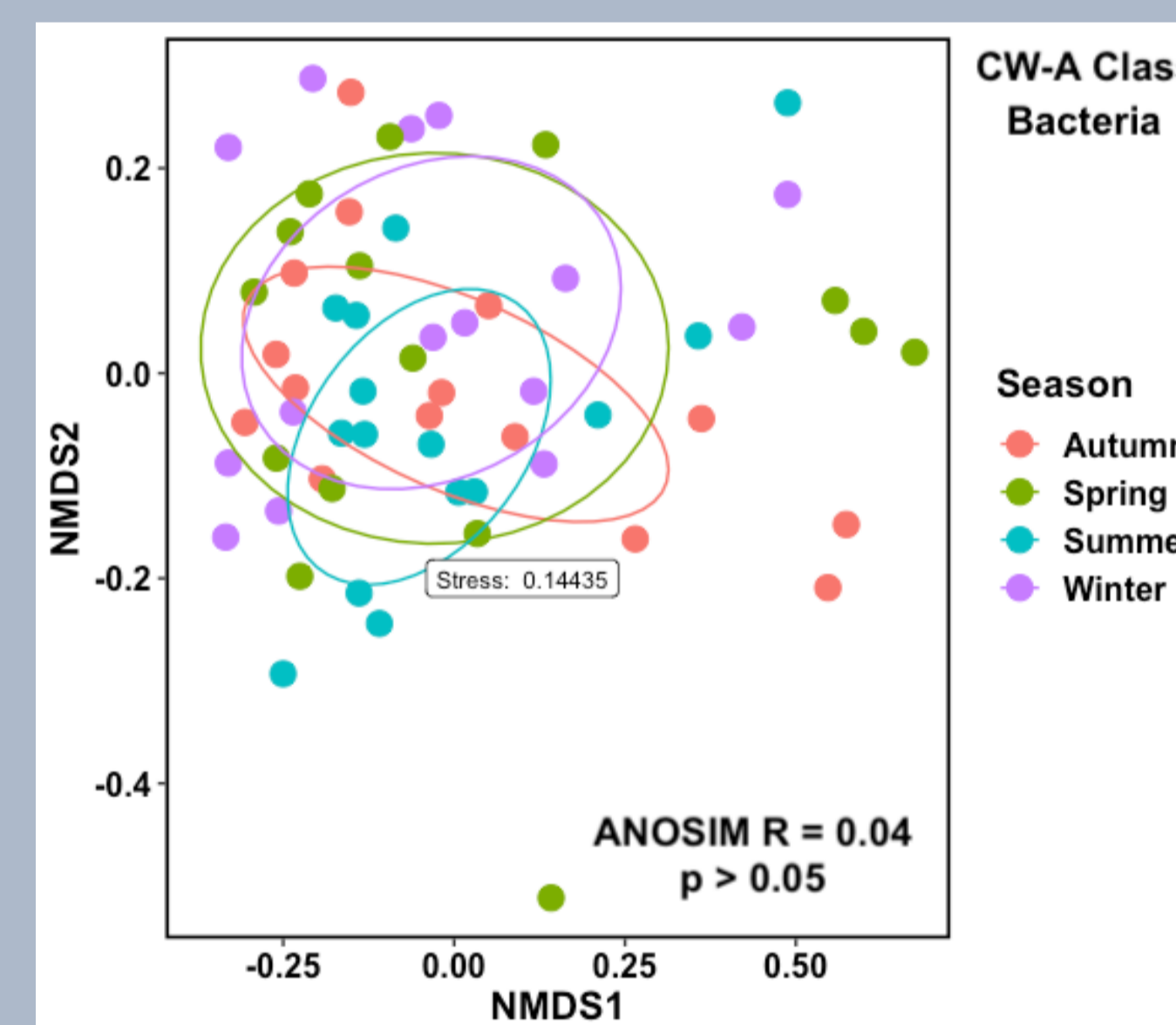
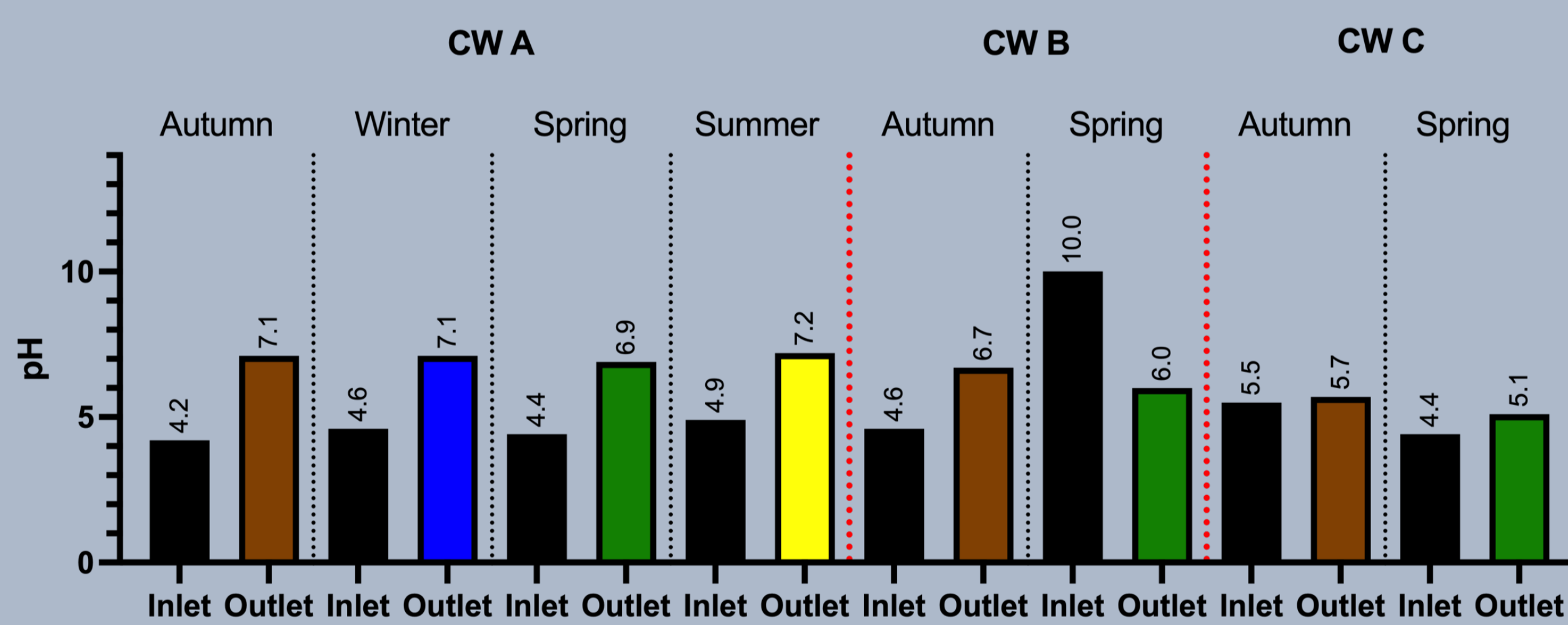
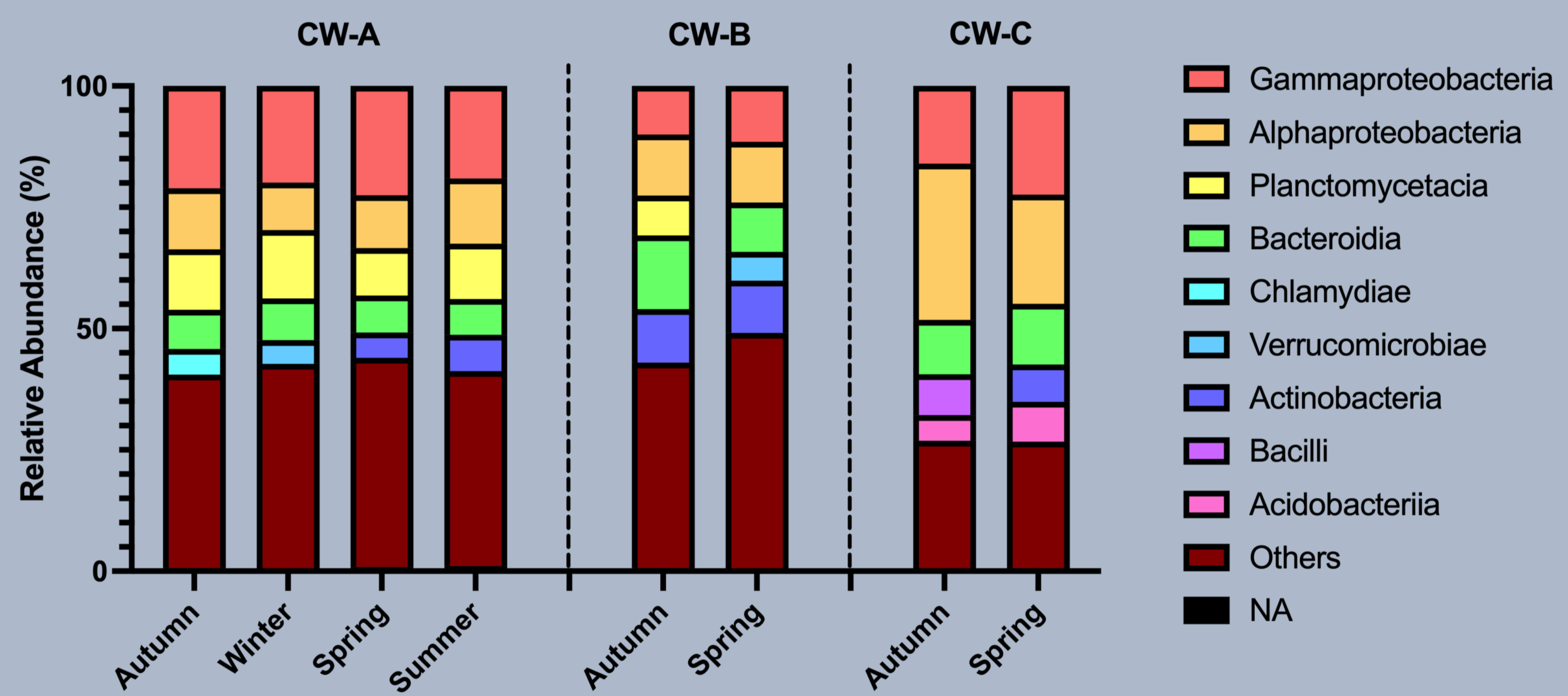
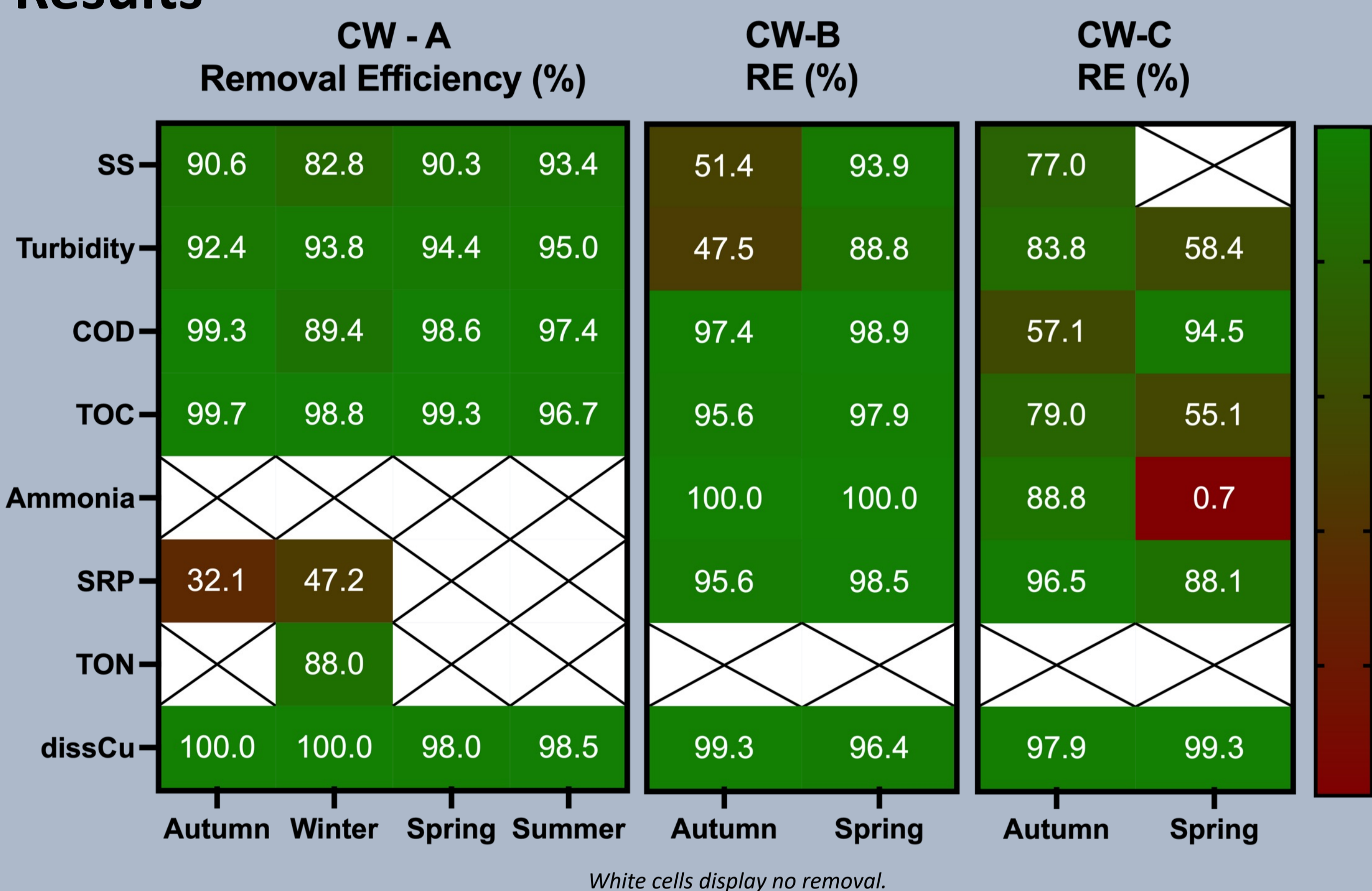
CW-B



CW-C



Results



In CW-A, active year-round performance declined slightly for suspended solids (SS) and chemical oxygen demand (COD) removal during winter.

All CWs consistently achieved high dissCu removal performance in all seasons.

Across all three sites, the bacterial relative abundance profiles at the class level remained remarkably similar across different seasons. The influence of seasonality on the bacterial community profile was found to be either insignificant or negligible at the class level.

Indicator Taxa Analysis

Site	Kingdom	Taxonomy	Name	Relative Abundance	Associated with	Indicator Value	p-value
CW-B	Bacteria	Class	Bacteroidia	15.30%	Autumn	0.651	0.0015 **
			Planctomycetacia	8.20%	Autumn	0.508	0.0038 **
			Saccharimonadia	2.10%	Spring	0.625	0.0001 ***
CW-C	Bacteria	Class	Alphaproteobacteria	32.20%	Autumn	0.624	0.0039 **
			Actinobacteria	7.70%	Spring	0.565	0.0146 *

In CW-C, the effect of higher Alphaproteobacteria presence in Autumn versus Spring improved TOC and ammonia removal performance.