



University  
of Glasgow



# Gill Health in Scottish Farmed Salmon

## Microbiome Study



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# Longitudinal Analysis of Gill Mucosal Microbiome of farmed Atlantic Salmon in Scotland

## Aim

To **characterise** the mucosal gill microbiome of farmed Atlantic salmon through the seawater production phase

## Why

- The microbiome is thought to influence host health
- The Gill microbiome and possible associations with CGD are currently understudied

## HATCHERY 1



A

NOV 18-FEB 19  
EVERY TWO WEEKS  
20% CGD, 38% AGD  
264 FISH



= Gill Swab Sample

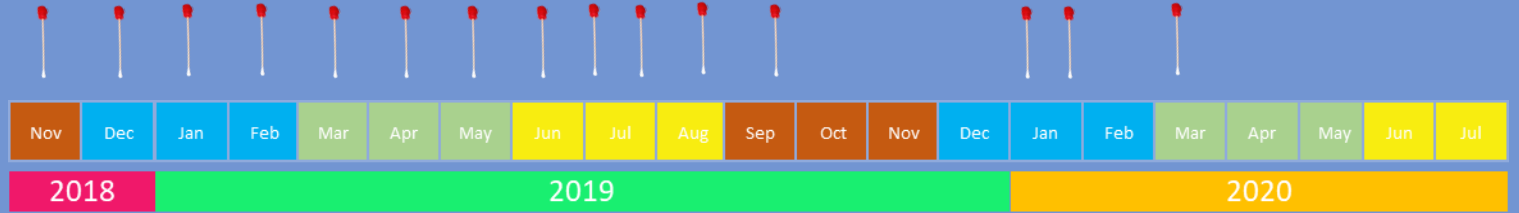
S0

## HATCHERY 3



B

NOV 18- MAR 20  
EVERY MONTH  
11% CGD, 74% AGD  
116 FISH



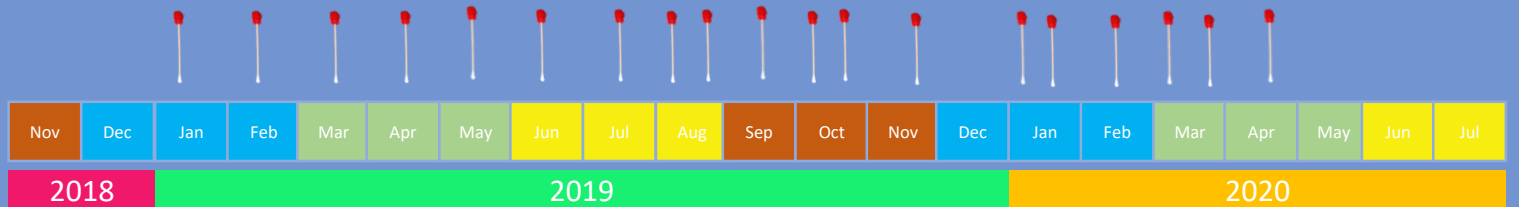
S0

## HATCHERY 4



G

JAN 19- APR 20  
EVERY TWO WEEKS  
13% CGD, 35% AGD  
152 FISH



S1

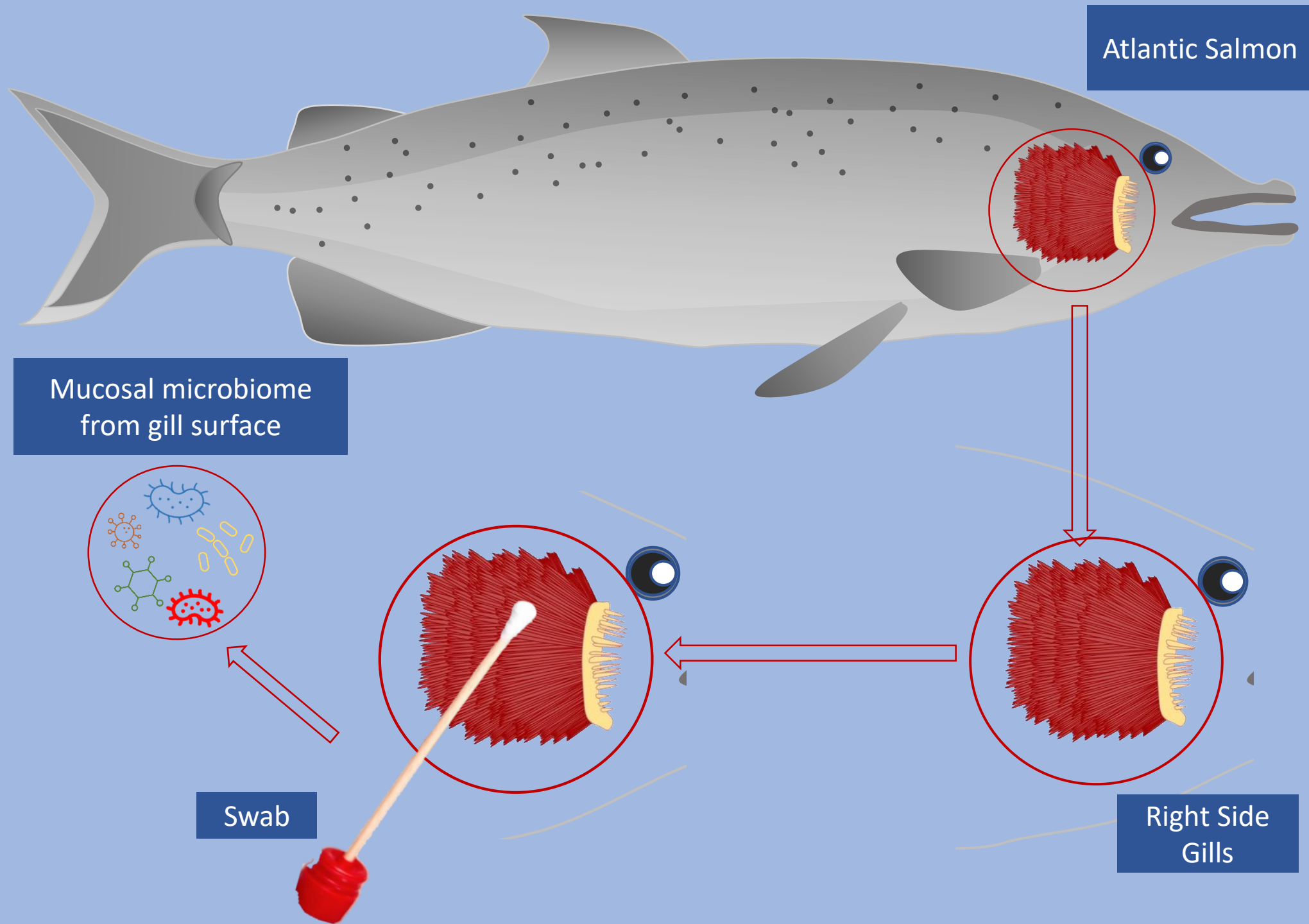
TOTAL SAMPLED: 636 FISH

SITES A,B,C & G GEOGRAPHICALLY DISTINCT

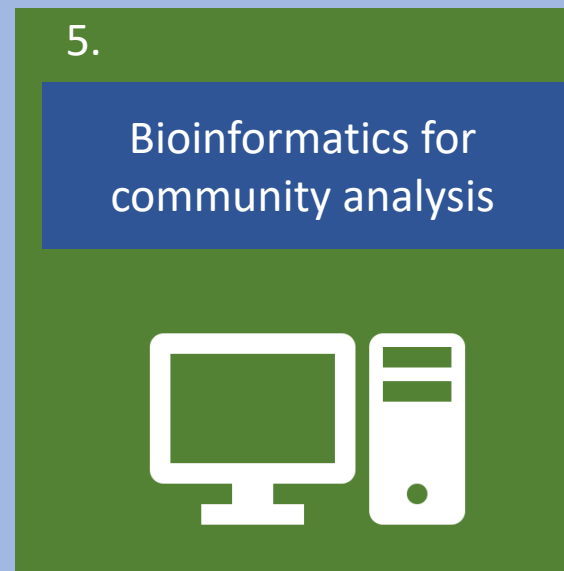
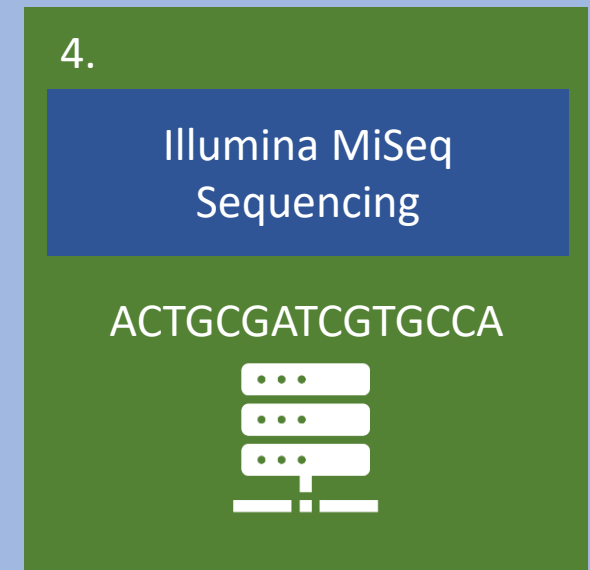
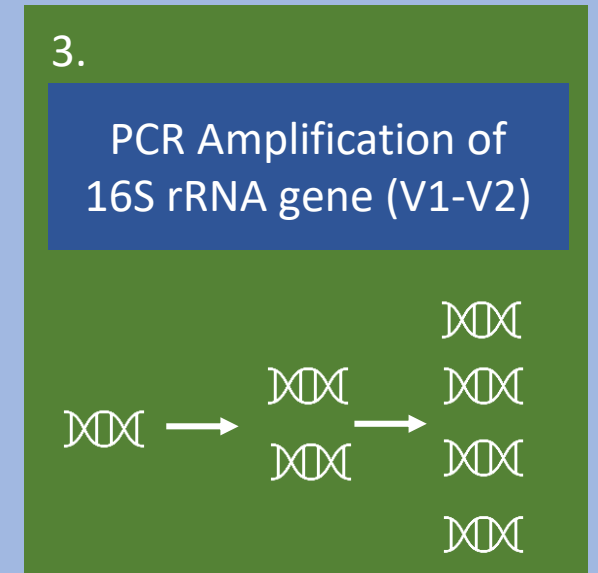
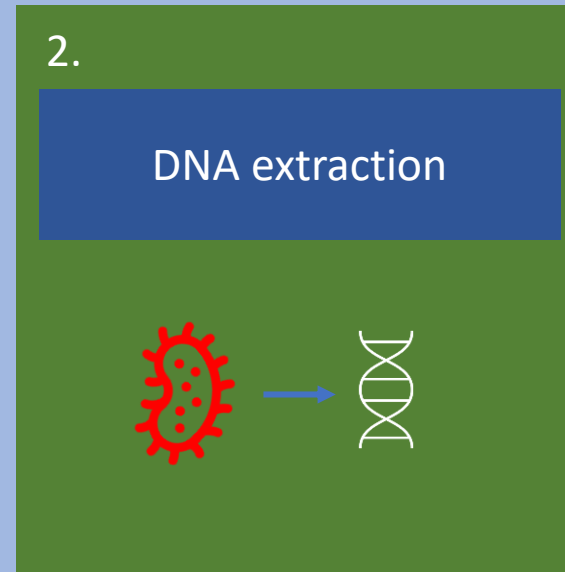
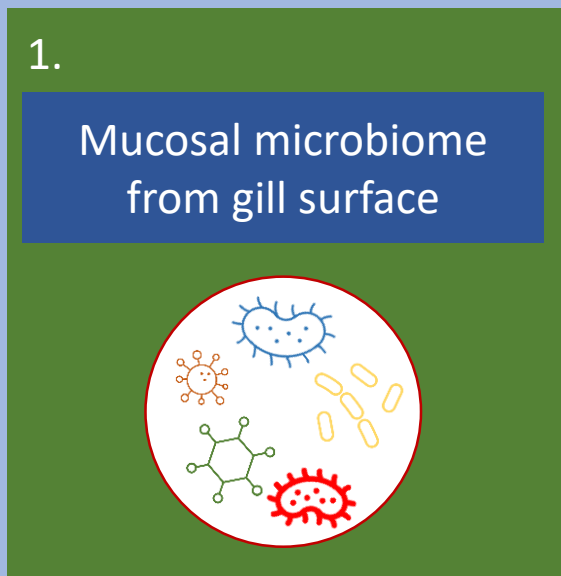
HATCHERY 3 SUPPLIED SMOLTS FOR SITES B & C

## Sampling Method

Swabs collected from right side arches 1, 3



# Workflow



# Bacterial Alpha Diversity: the biodiversity within a given sample

Richness: absolute count of present taxa

A  
S0

NOV 18-FEB 19  
EVERY TWO WEEKS  
20% CGD, 38% AGD  
264 FISH

B  
S0

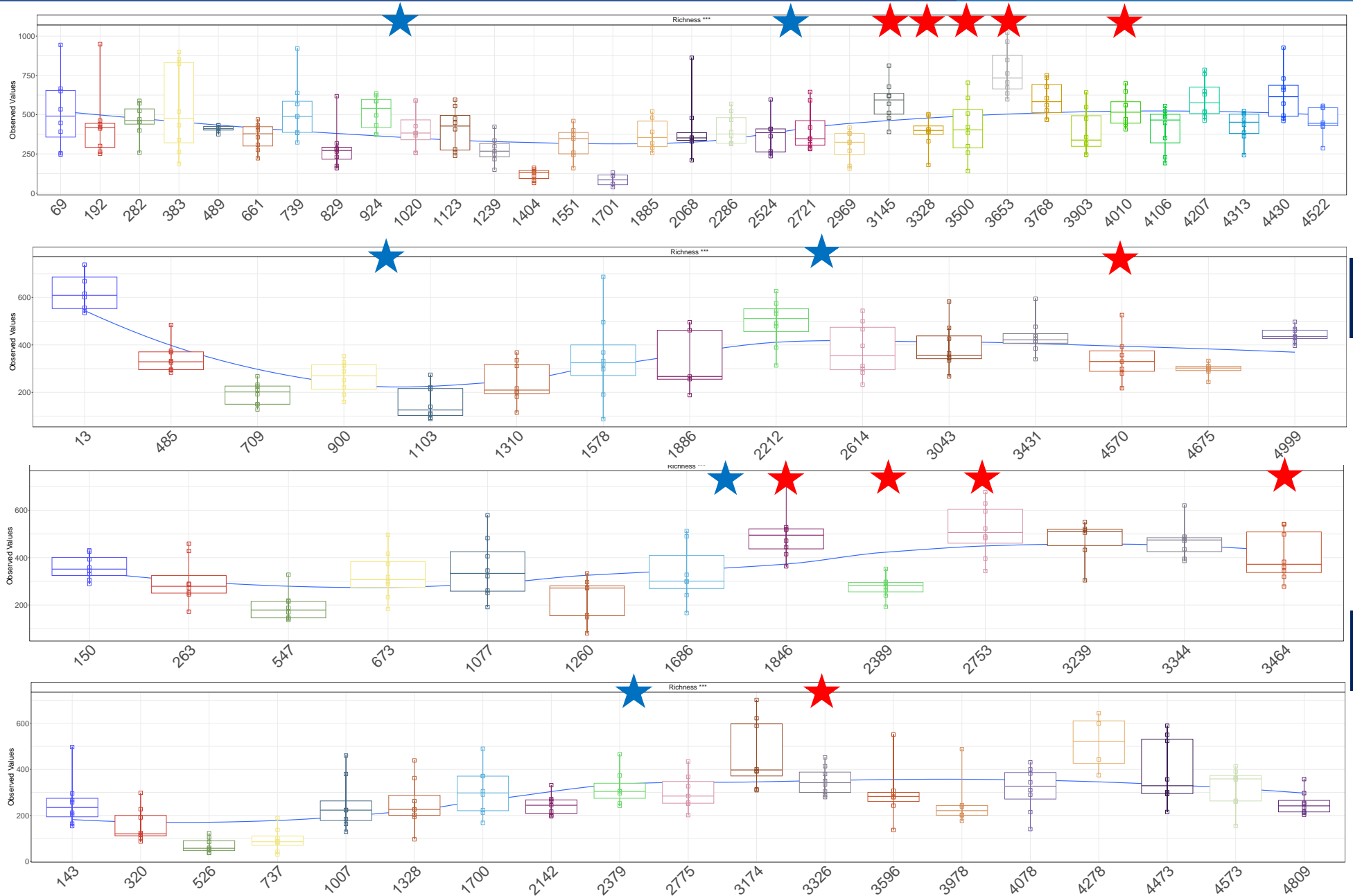
NOV 18- MAR 20  
EVERY MONTH  
11% CGD, 74% AGD  
116 FISH

C  
S1

APR 19- FEB 20  
EVERY MONTH  
24% CGD, 37% AGD  
104 FISH

G  
S1

JAN 19- APR 20  
EVERY TWO WEEKS  
13% CGD, 35% AGD  
152 FISH



>50%  
CGD



Hyd  
Peroxide

# Bacterial Alpha Diversity: the biodiversity within a given sample

Evenness: how balanced a community is . Simpson Index.

A  
S0

NOV 18-FEB 19  
EVERY TWO WEEKS  
20% CGD, 38% AGD  
264 FISH

B  
S0

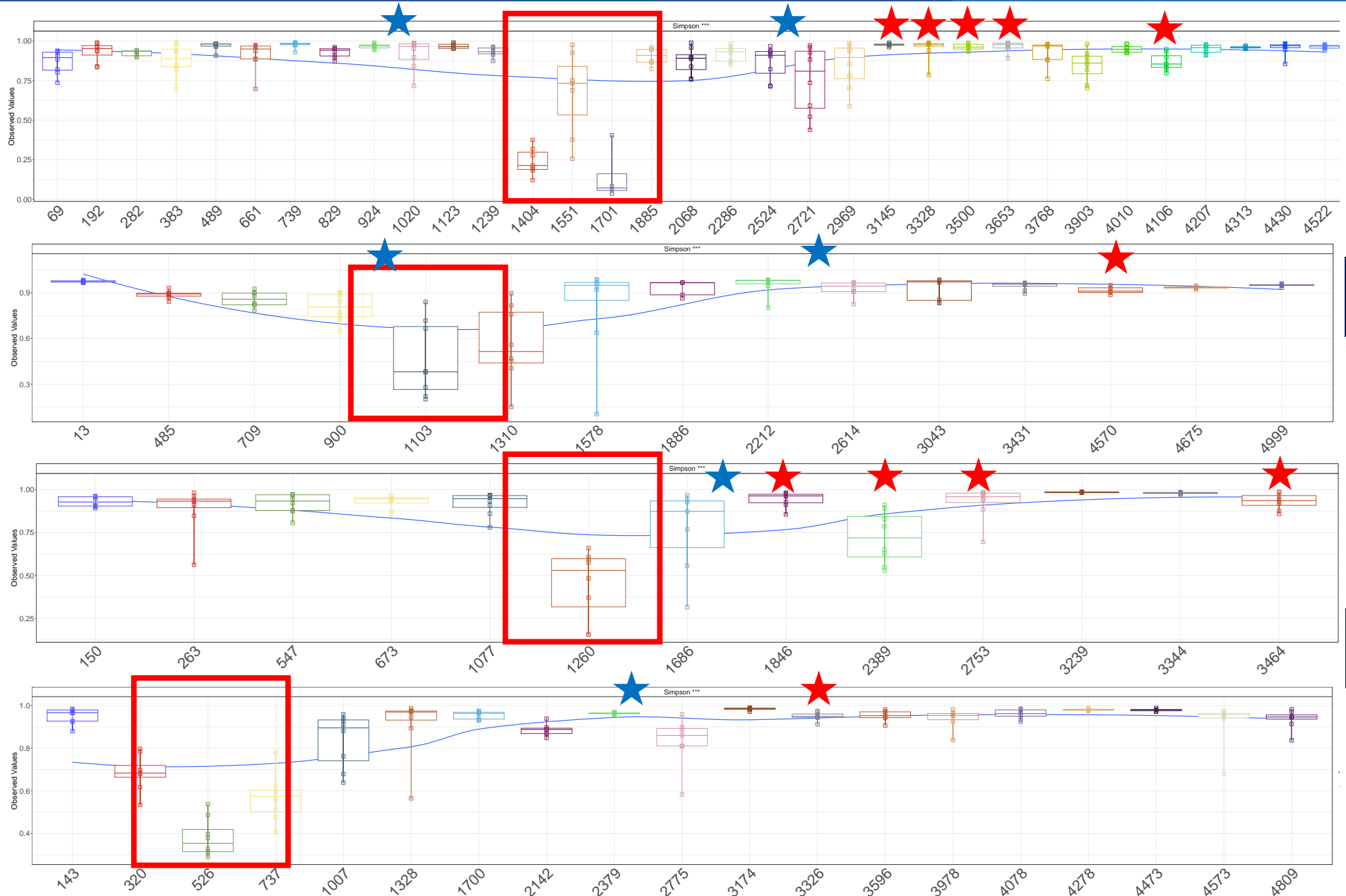
NOV 18- MAR 20  
EVERY MONTH  
11% CGD, 74% AGD  
116 FISH

C  
S1

APR 19- FEB 20  
EVERY MONTH  
24% CGD, 37% AGD  
104 FISH

G  
S1

JAN 19- APR 20  
EVERY TWO WEEKS  
13% CGD, 35% AGD  
152 FISH



>50%  
CGD

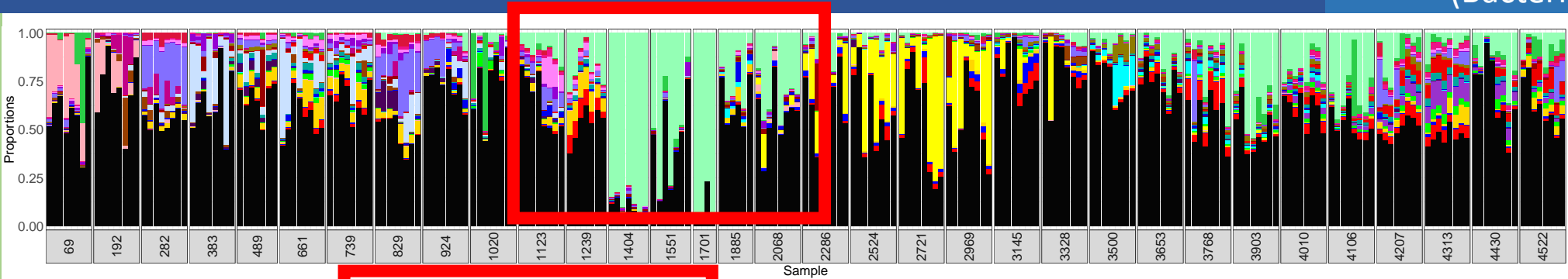


Hyd  
Peroxide

Top 25 Most abundant ASVs

ASV: amplicon sequence variant  
(Bacterial Phylotype)

A  
S0

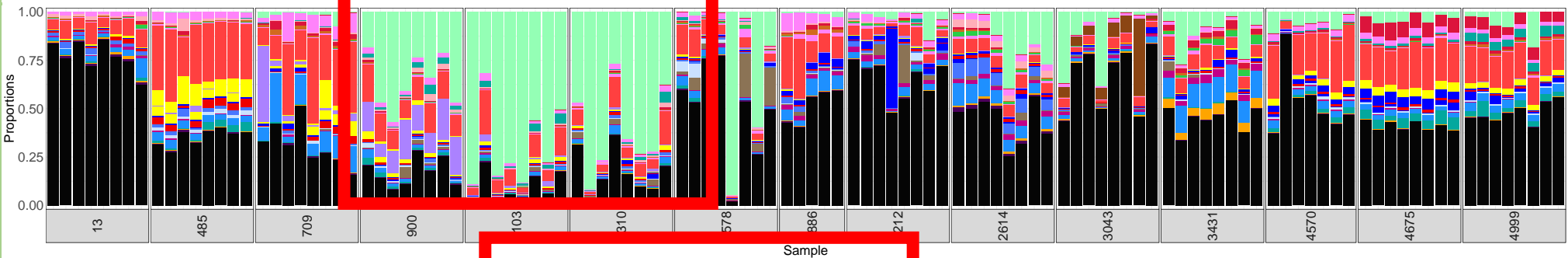


ASV 1  
Gammaproteobacteria

ASV 30

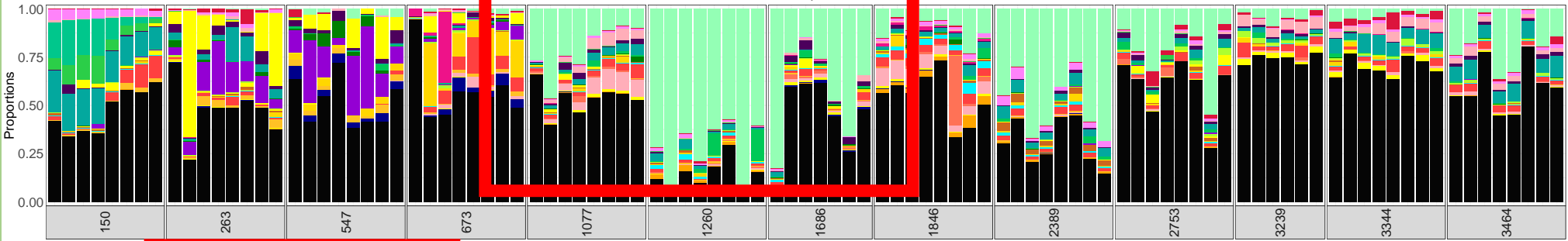
Candidatus Branchiomonas

B  
S0



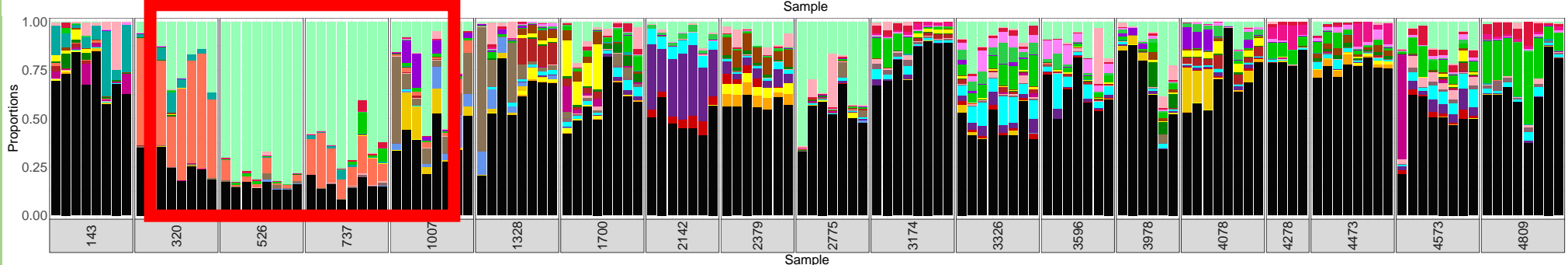
ASV 2  
Pseudoalteromonas

C  
S0



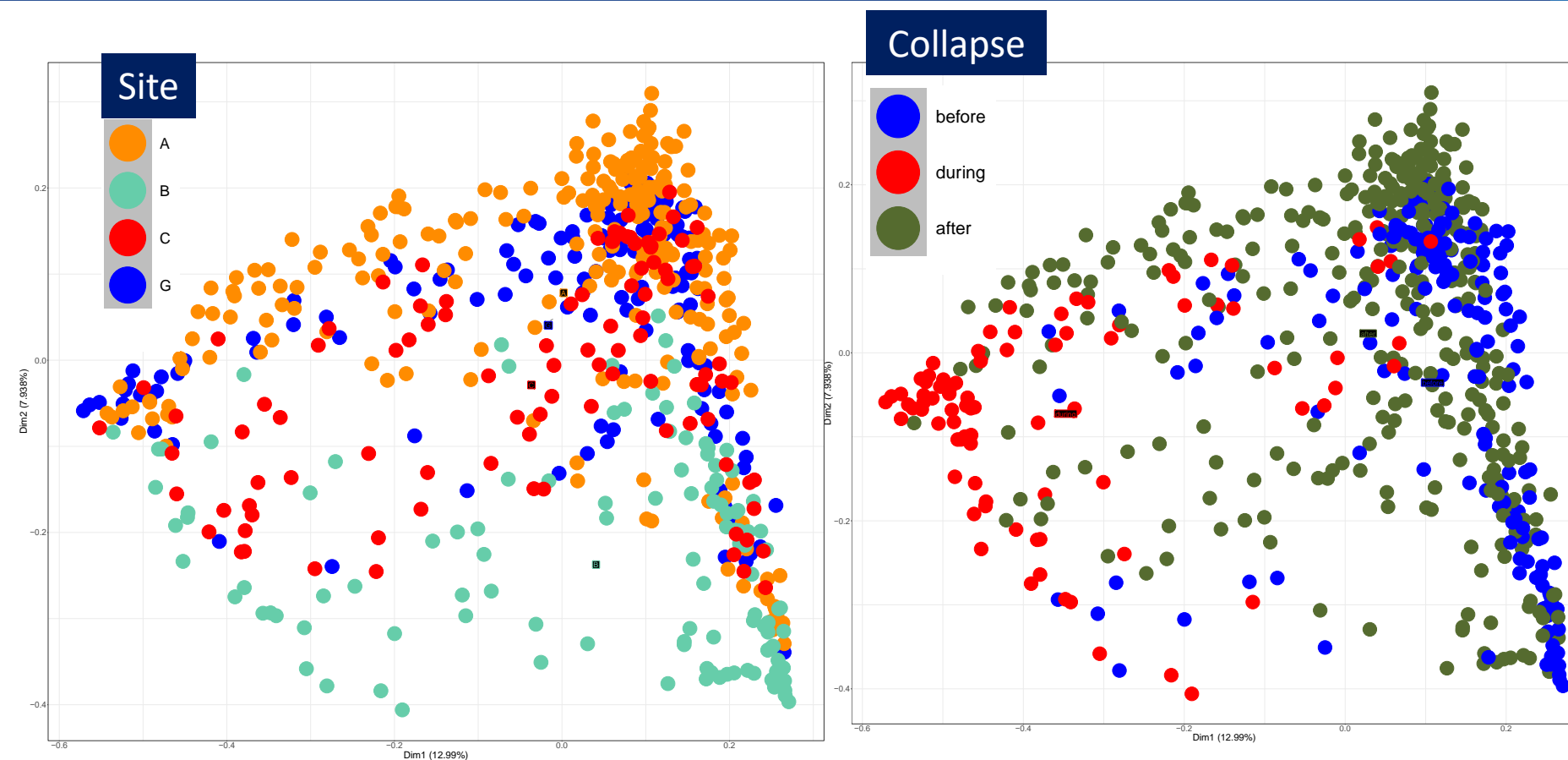
ASV 55  
Tenacibaculum dicentrarchi

G  
S0



ASV 79  
Tenacibaculum maritimum





Plot interpretation

Each dot = microbiome

Closer dots = more similar

Both **Site** and **Season** are drivers of difference  
PERMANOVA

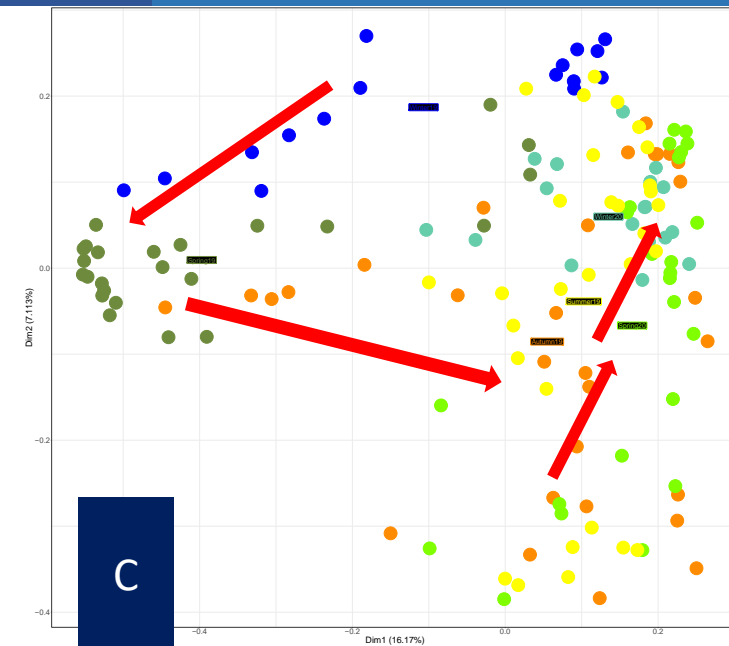
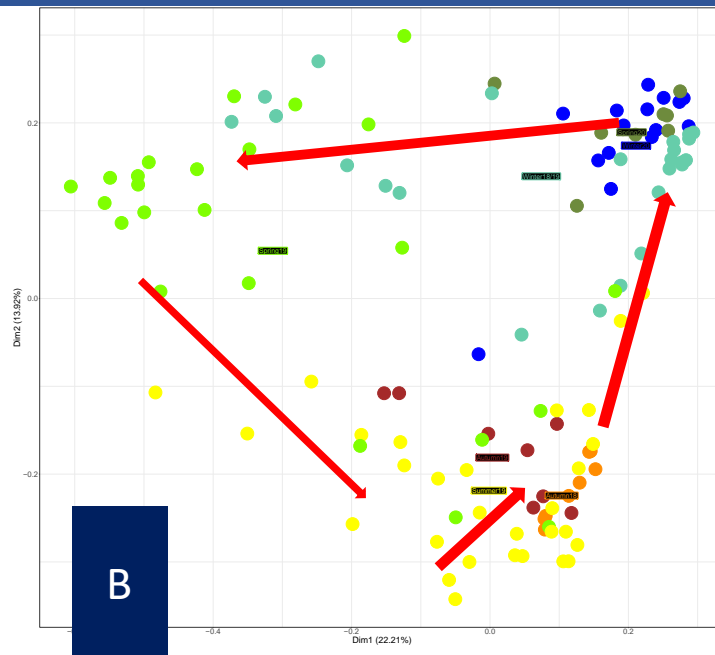
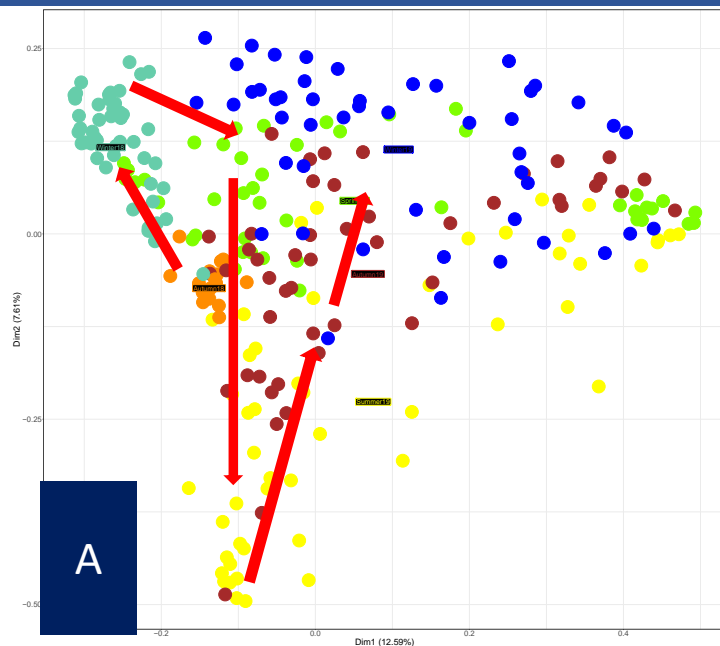
**Site** –  $R^2 = 0.072$   $P = 0.001$

**Season** –  $R^2 = 0.099$ ,  $P = 0.001$

**Evenness Collapse Group**  $R^2 = 0.08401$ ,  $P = 0.001$

# Bacterial Beta Diversity: comparing the biodiversity between samples

Bray-Curtis: Presence absence with  
Abundance



## PERMANOVA - Season

Site A –  $R^2=0.20$ ,  $P=0.001$

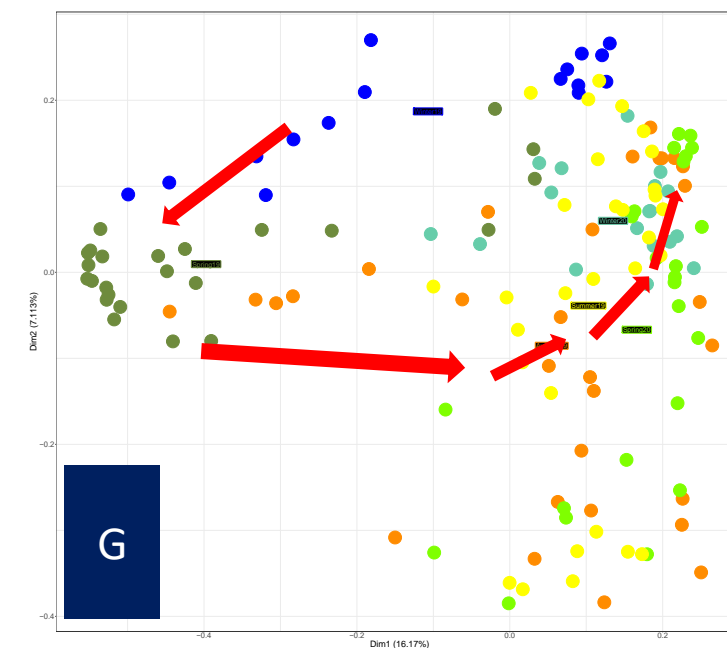
Site B –  $R^2=0.40$ ,  $P=0.001$

Site C –  $R^2=0.22$ ,  $P=0.001$

Site G –  $R^2=0.23$ ,  $P=0.001$

## Key message

We see clustering by  
season at each site



80%

ASV\_1:Gammaproteobacteria

ASV\_2:Pseudoalteromonas

ASV\_6:Psychrobacter

90%

ASV\_2:Pseudoalteromonas

ASV\_6:Psychrobacter

### **Pseudoalteromonas**

Heterotrophic, often produce  
bioactive secondary  
metabolites

### **Psychrobacter**

Nutrient cycling in cold  
environments, contributing to  
carbon and nitrogen cycling.

Two ASVs found in **90%** of Samples  
Three ASVs found in **80%** of Samples

### **Key Message**

Despite seasonal and  
geographic differences  
certain ASVs persist  
throughout

## Take Home Messages

- Differences observed between site and through the seasons
- Despite this we see some taxa consistently across the sample set



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