

Environmental DNA surveys on the Isle of Man

Dr. Rachel Glover

Taxa Genomics

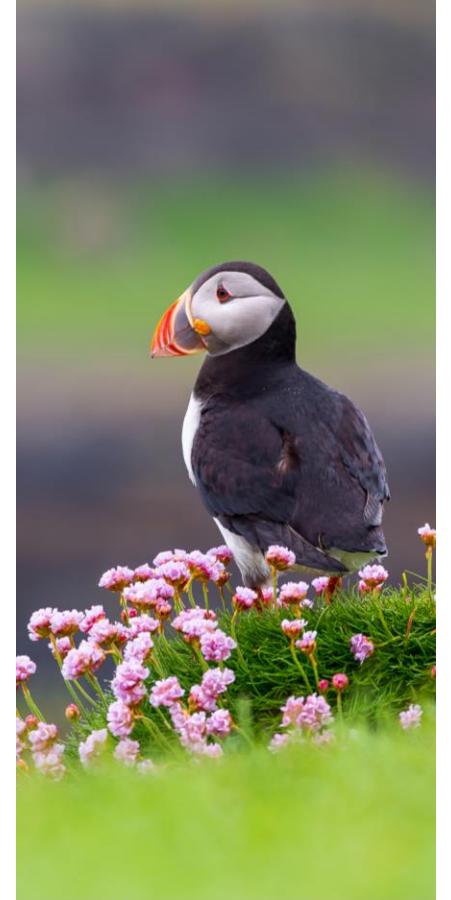
What are biomonitoring and biosurveillance?

- Biomonitoring

- The regular measurement of biodiversity or specific taxa in an environment to understand ecological health, species richness, or long-term trends
- Detects changes in community composition, presence/absence of species, and overall ecosystem status

- Biosurveillance

- The targeted, early detection and tracking of specific species or pathogens to enable rapid management action.
- Acts as an early warning system for threats to biodiversity, food security, or public health



Consistent measurement is vital



Without knowing the current state of biodiversity, it's impossible to determine whether ecosystems are improving or declining over time.

There's a whole universe of biodiversity we can't easily see but which is easily detected with eDNA

Traditional surveys

- Fish surveys often involve electrofishing, seine netting, or trapping
 - invasive
 - labour-intensive
 - seasonal
- Macroinvertebrate surveys
 - Kick sampling
 - Physical identification and sorting of species
 - Relies on microscopy and visual taxonomic expertise

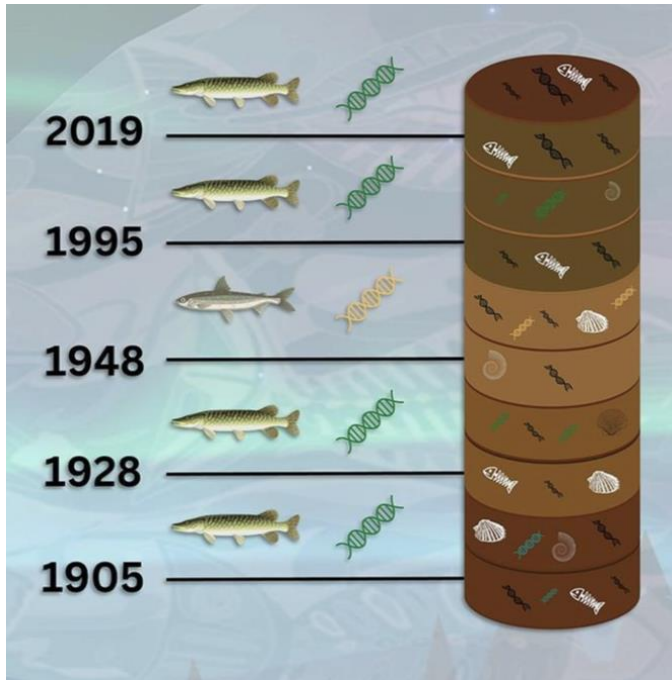


Environmental DNA (eDNA)

- eDNA is the DNA left behind in an environment by organisms
 - epithelial cells
 - mucous
 - gametes
 - faeces
- eDNA can be broken down by UV light, microbes and DNases over time
- Temporal resolution
 - typically, days-weeks
 - Isle of Man rivers likely hours



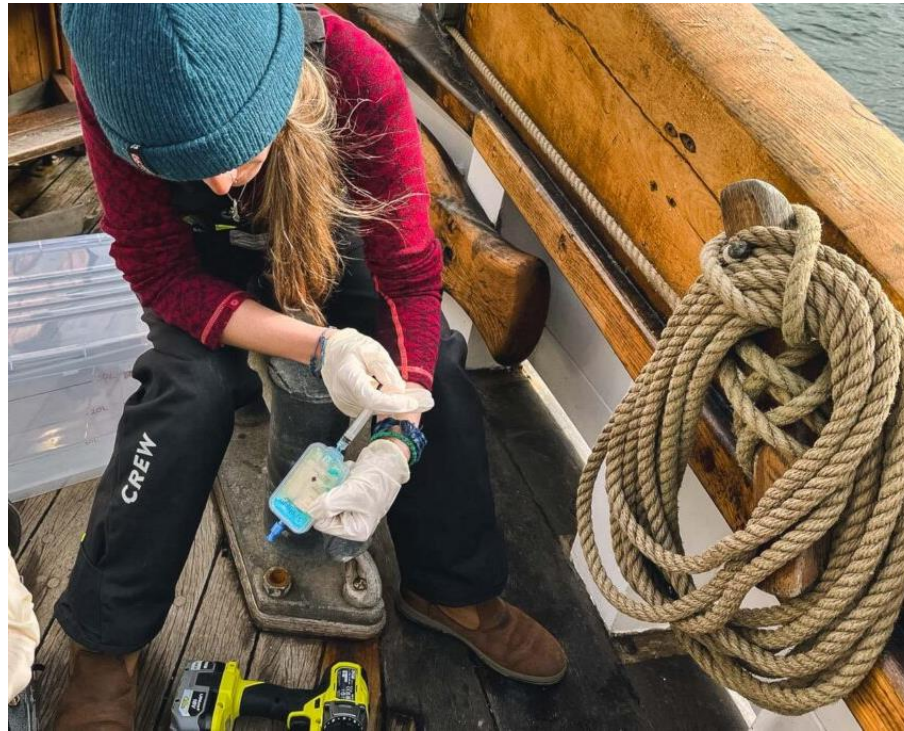
eDNA soil/sediment/surface sampling



eDNA air sampling



eDNA water sampling



2024 Freshwater IoM

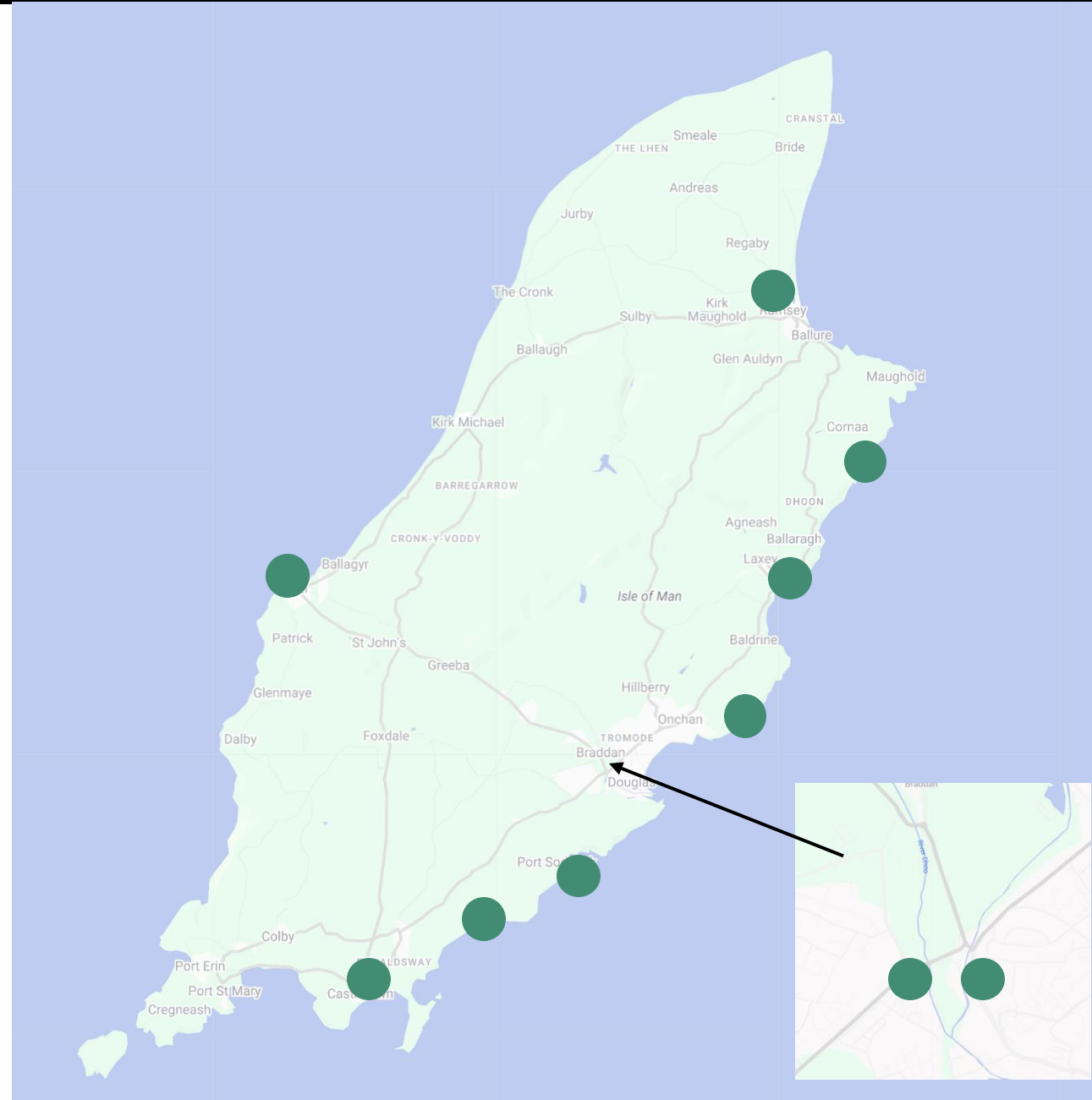
** A collection of samples taken for internal R&D purposes**

Freshwater samples

Rivers:

- Sulby
- Cornaa
- Laxey
- Groudle
- Dhoo
- Glass
- Port Soderick
- Port Grenaugh
- Silverburn
- Neb

DISCLAIMER! These samples were taken for internal R&D purposes not a designed and executed survey of Manx rivers.



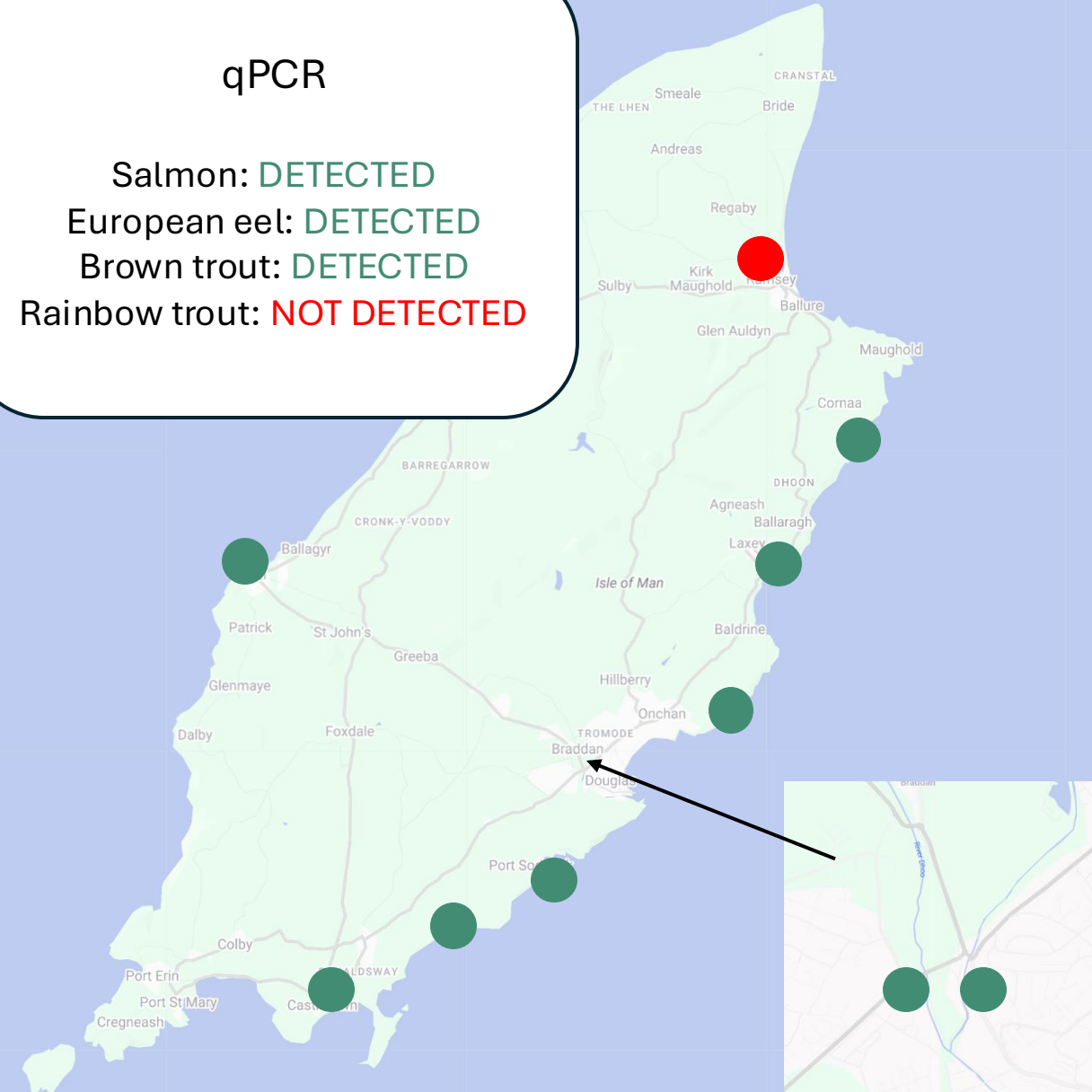
Sulby River

Metabarcoding detected:

- *Homo sapiens* (Human)
- *Salmo salar* (Atlantic salmon)
- *Anguilla Anguilla* (European eel)
- *Pomatoschistus microps* (Goby)
- *Salmo trutta* (Brown trout)
- *Felis catus* (cat)

qPCR

Salmon: **DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **NOT DETECTED**



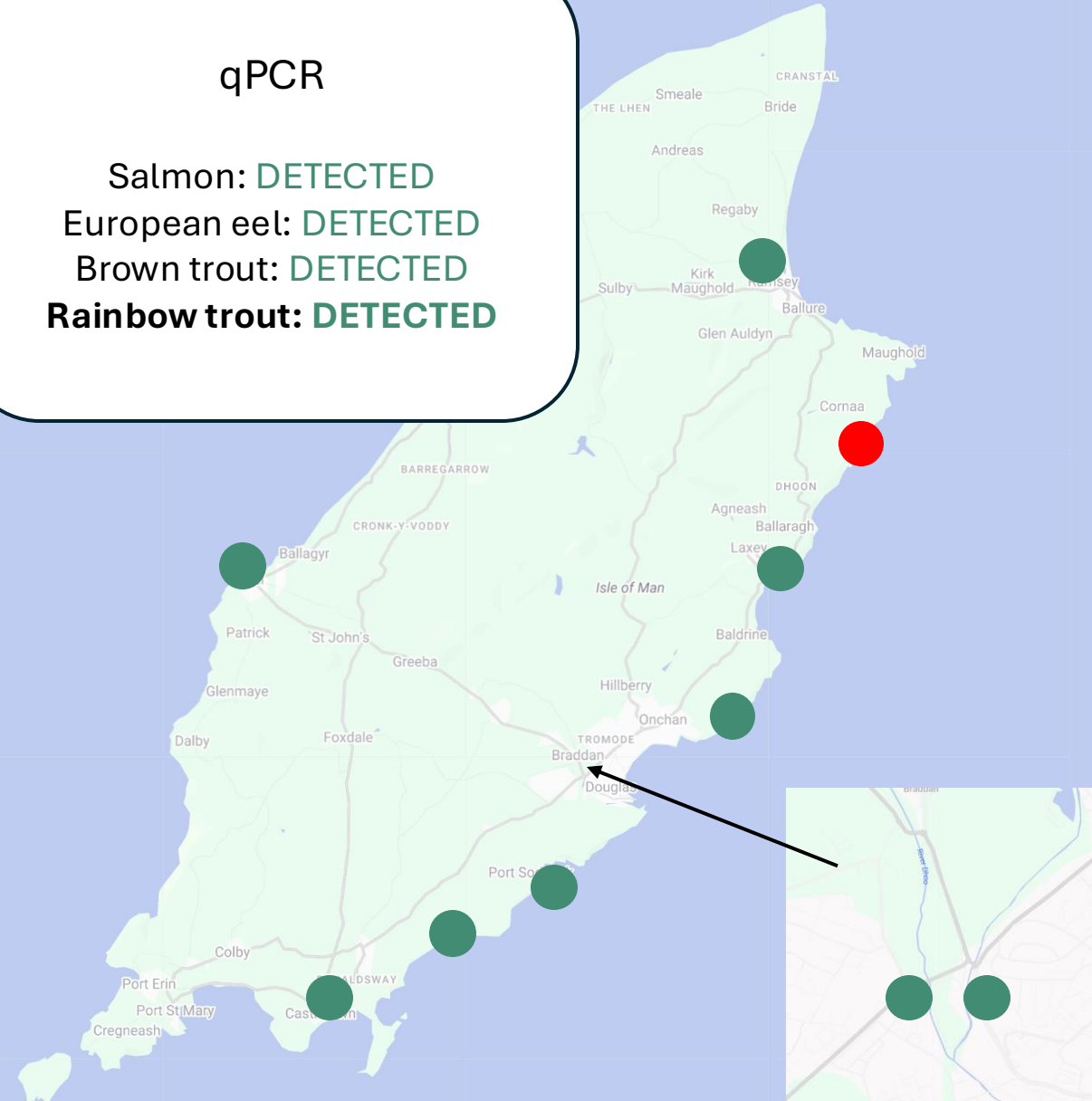
Cornaa River

Metabarcoding detected:

- *Onchorhynchus mykiss* (Rainbow trout)
- *Mareca sp.* (ducks)
- *Spatula clypeata* (northern shoveler)
- *Salmo salar* (Atlantic salmon)
- *Anguilla Anguilla* (European eel)
- *Pomatoschistus microps* (Goby)
- *Salmo trutta* (Brown trout)
- *Homo sapiens* (Human)

qPCR

Salmon: **DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: DETECTED



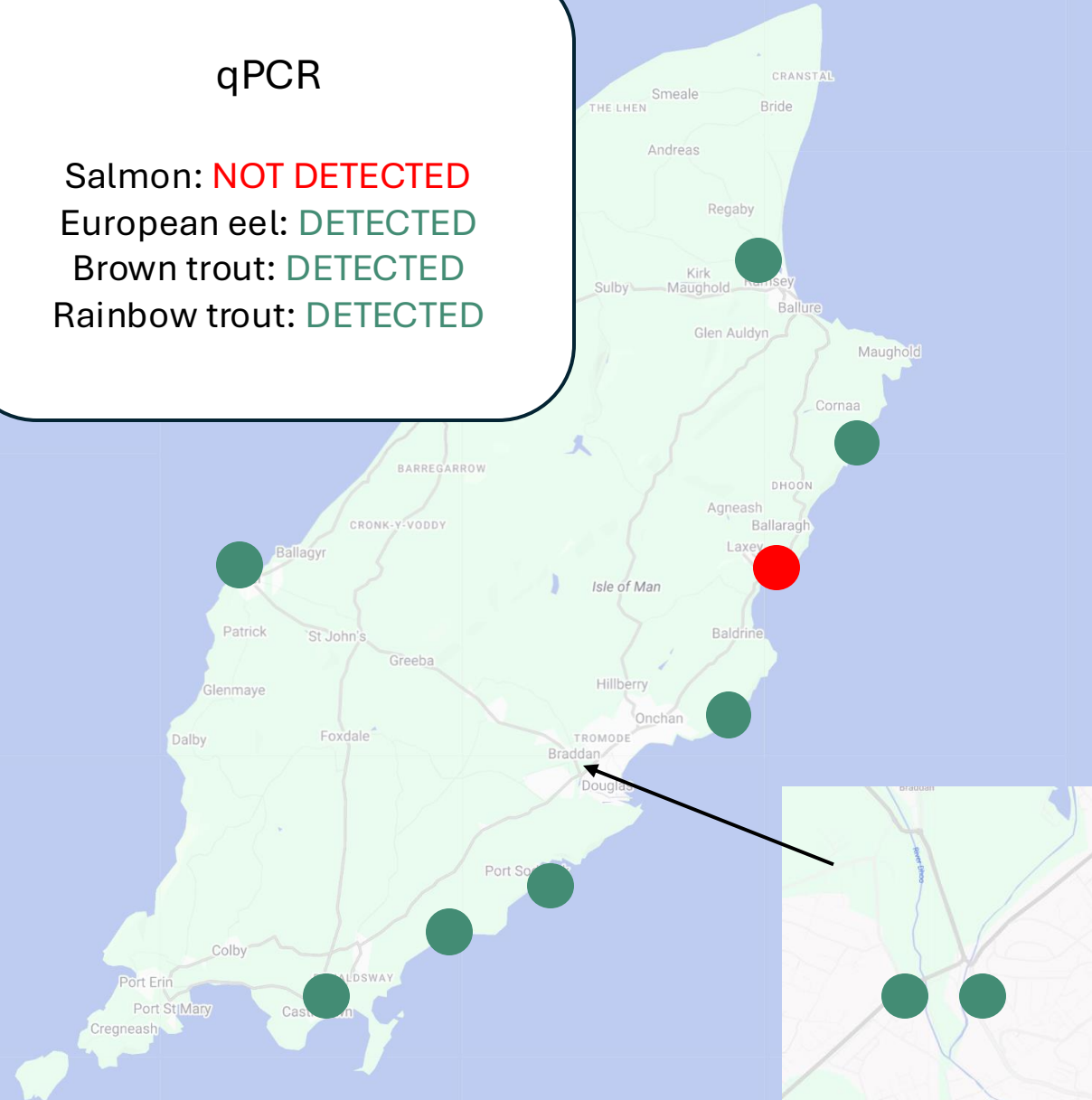
Laxey River

Metabarcoding detected:

- **Homo sapiens (Human)**
- *Salmo trutta* (Brown trout)
- *Salmo salar* (Rainbow trout)
- *Oncorhynchus mykiss*
(Rainbow trout)
- *Pomatoschistus microps*
(Goby)

qPCR

Salmon: **NOT DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **DETECTED**



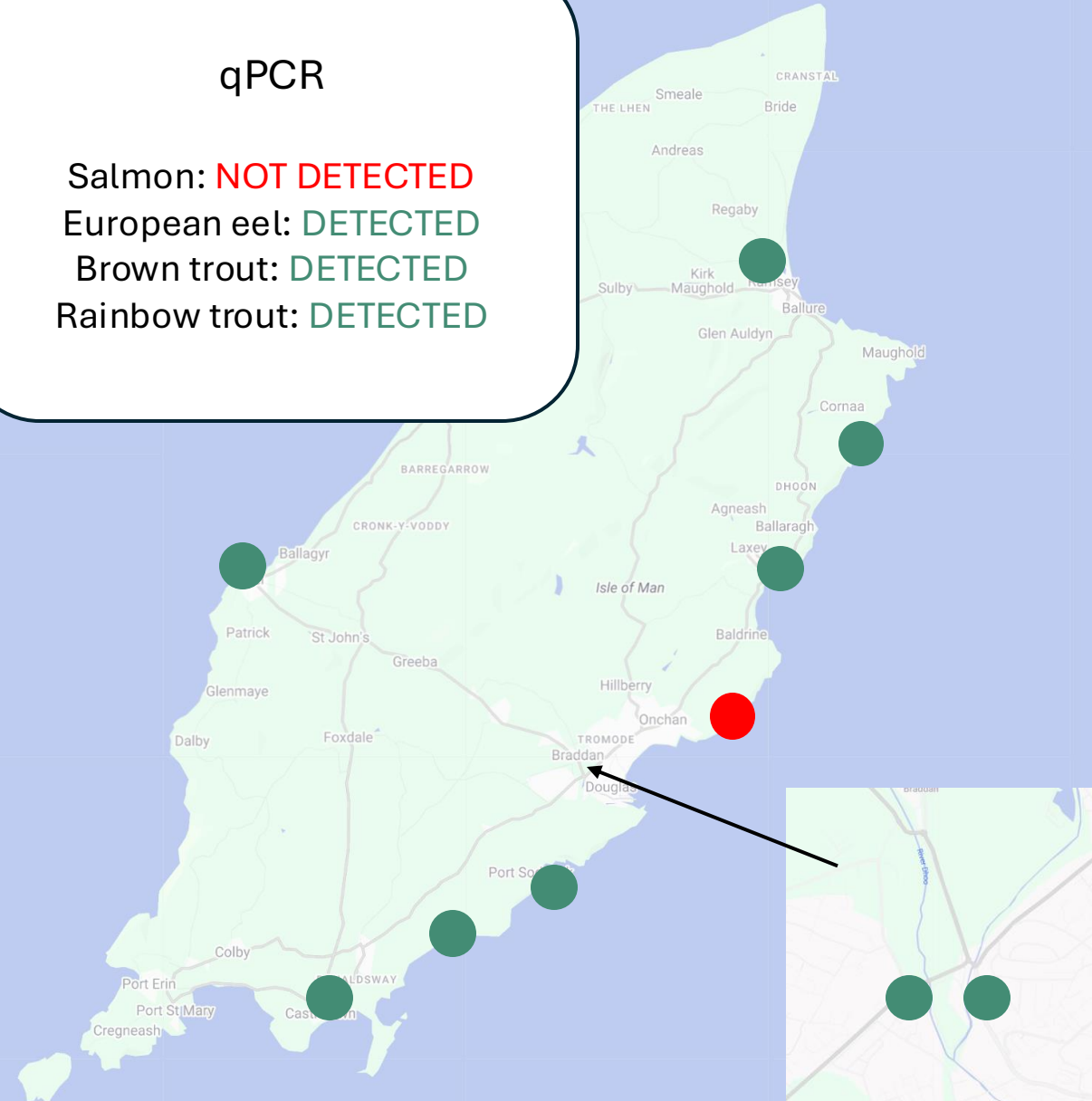
Groudle River

Metabarcoding detected:

- *Homo sapiens* (Human)
- *Anguilla Anguilla* (European eel)
- *Salmo trutta* (Brown trout)
- *Onchorynchus mykiss* (Rainbow trout)
- *Felis catus* (Cat)
- *Sorex minutus* (Shrew)
- *Bos taurus* (Cow)
- *Canis lupus familiaris* (Dog)

qPCR

Salmon: **NOT DETECTED**
 European eel: **DETECTED**
 Brown trout: **DETECTED**
 Rainbow trout: **DETECTED**

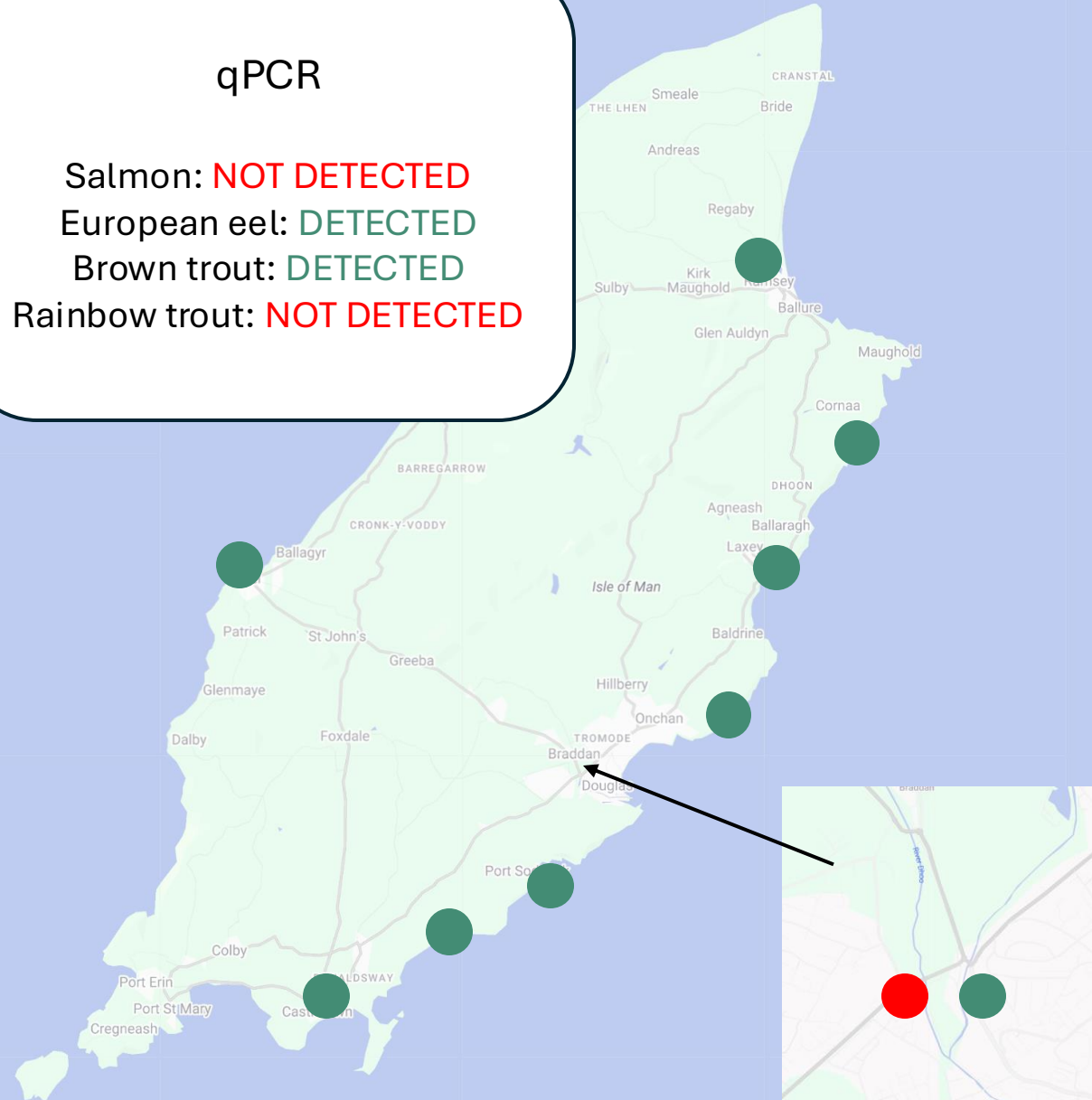


River Dhoo

No metabarcoding data

qPCR

Salmon: **NOT DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **NOT DETECTED**

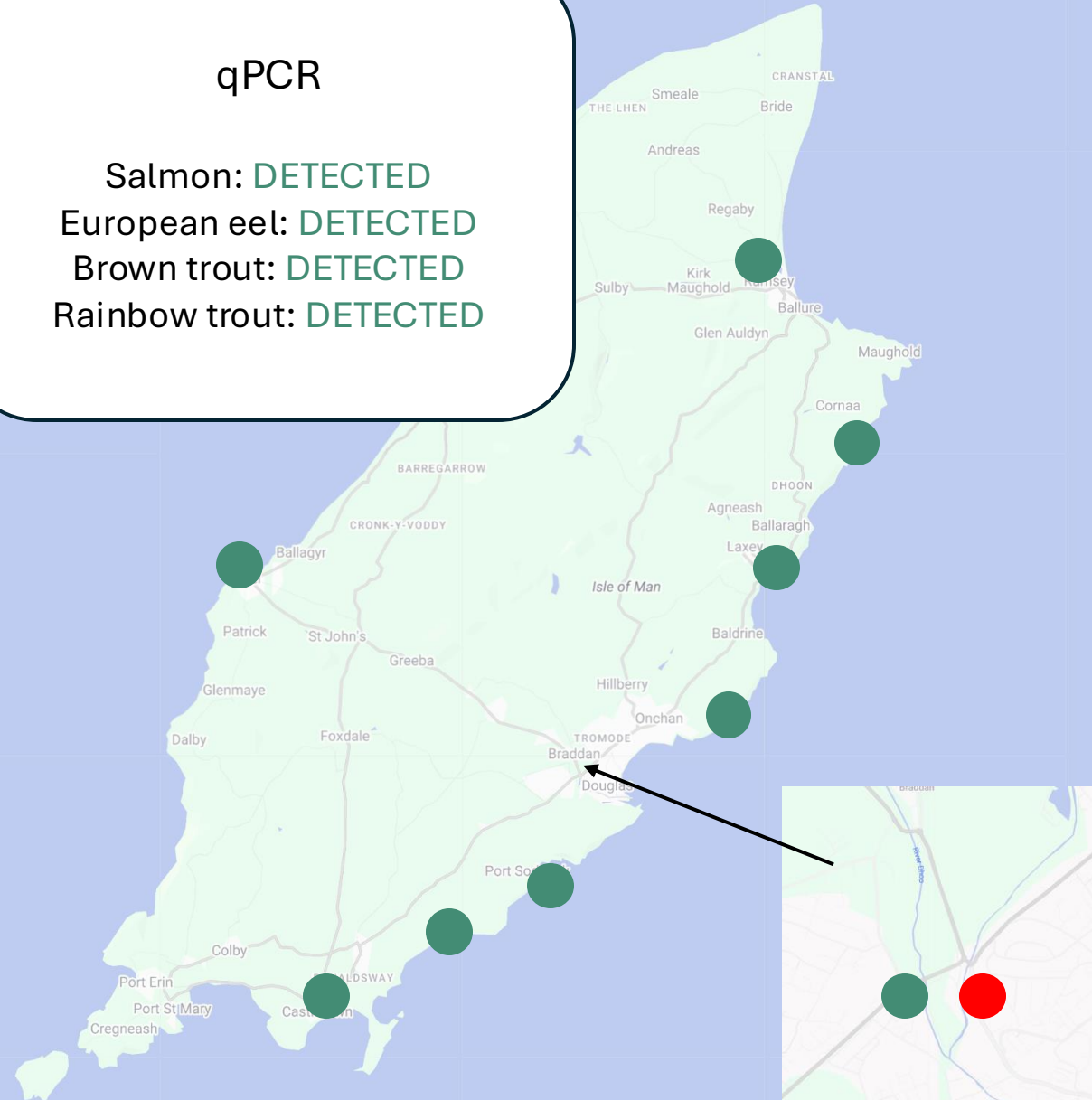


River Glass

No metabarcoding data

qPCR

Salmon: DETECTED
European eel: DETECTED
Brown trout: DETECTED
Rainbow trout: DETECTED

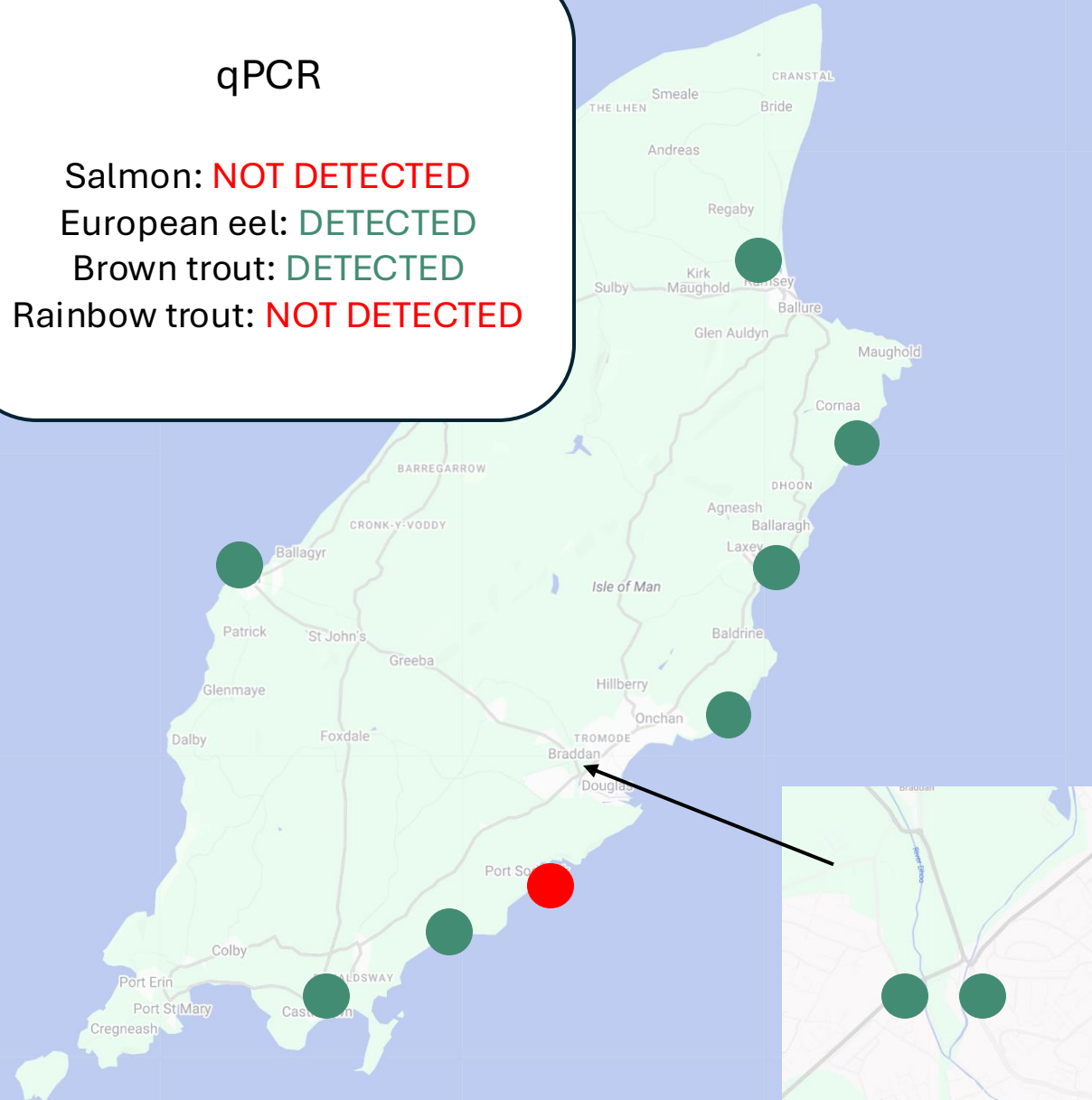


Port Soderick

No metabarcoding data

qPCR

Salmon: **NOT DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **NOT DETECTED**

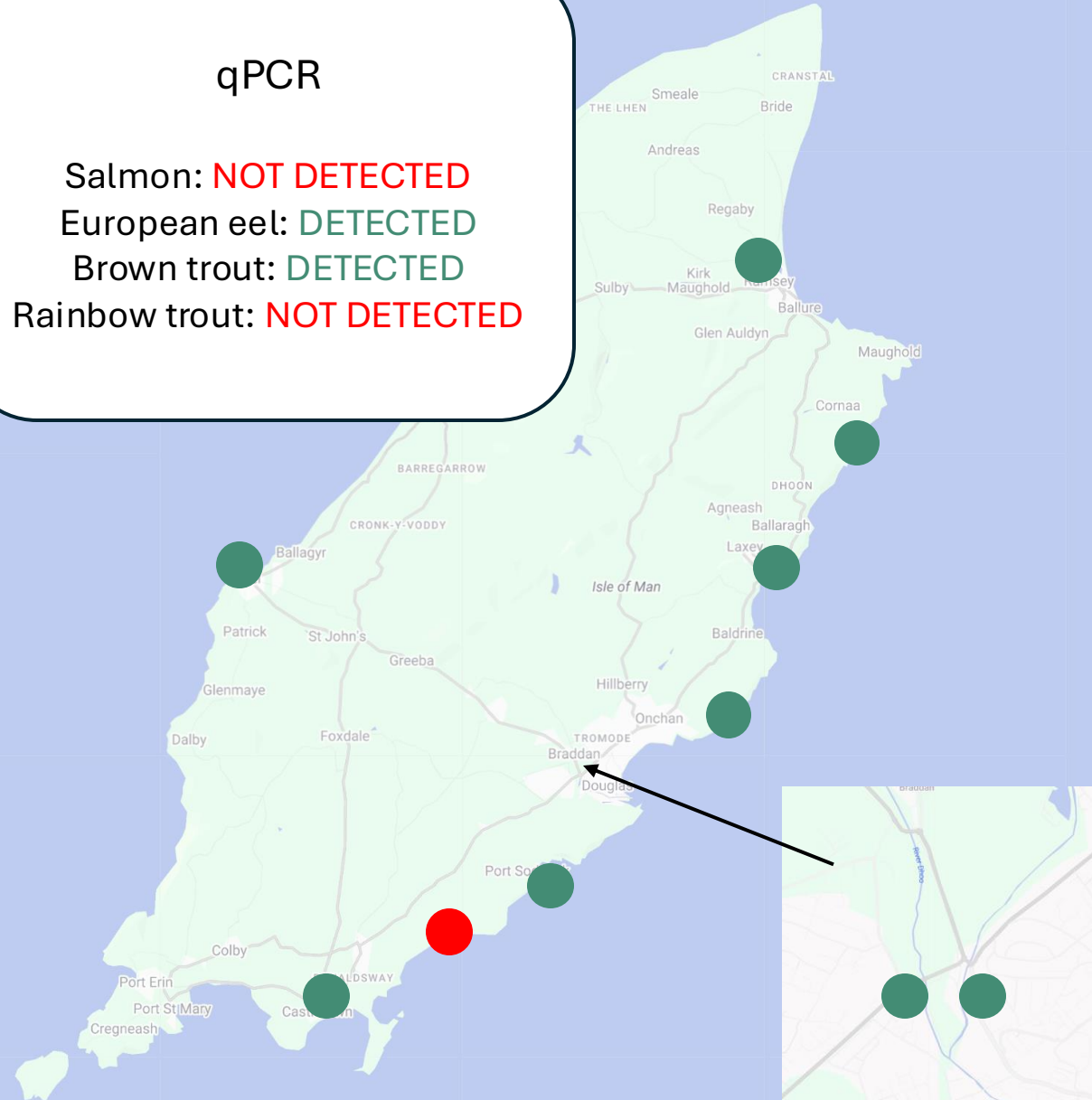


Port Grenaugh

No metabarcoding data

qPCR

Salmon: **NOT DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **NOT DETECTED**

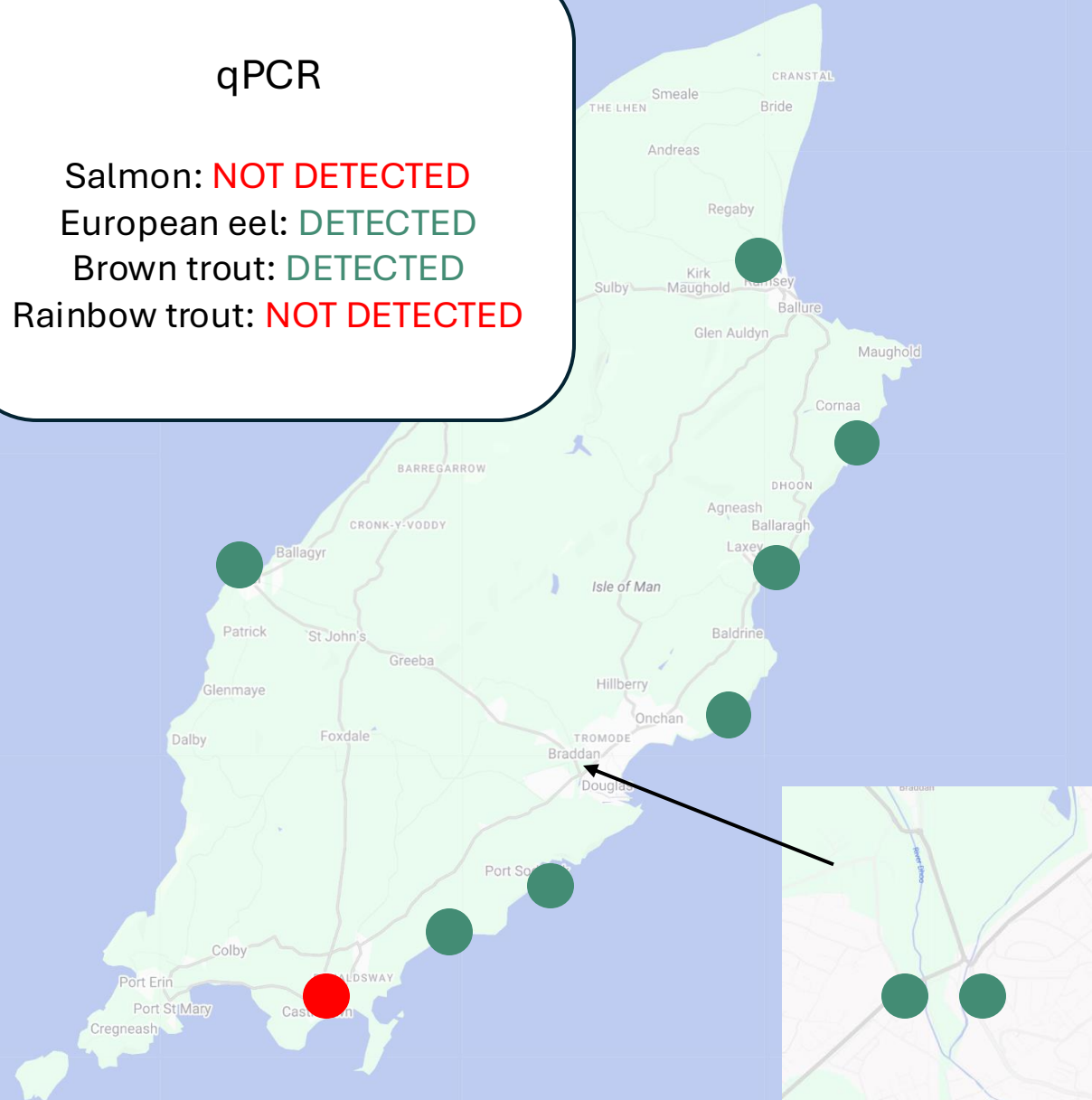


Silverburn river

No metabarcoding data

qPCR

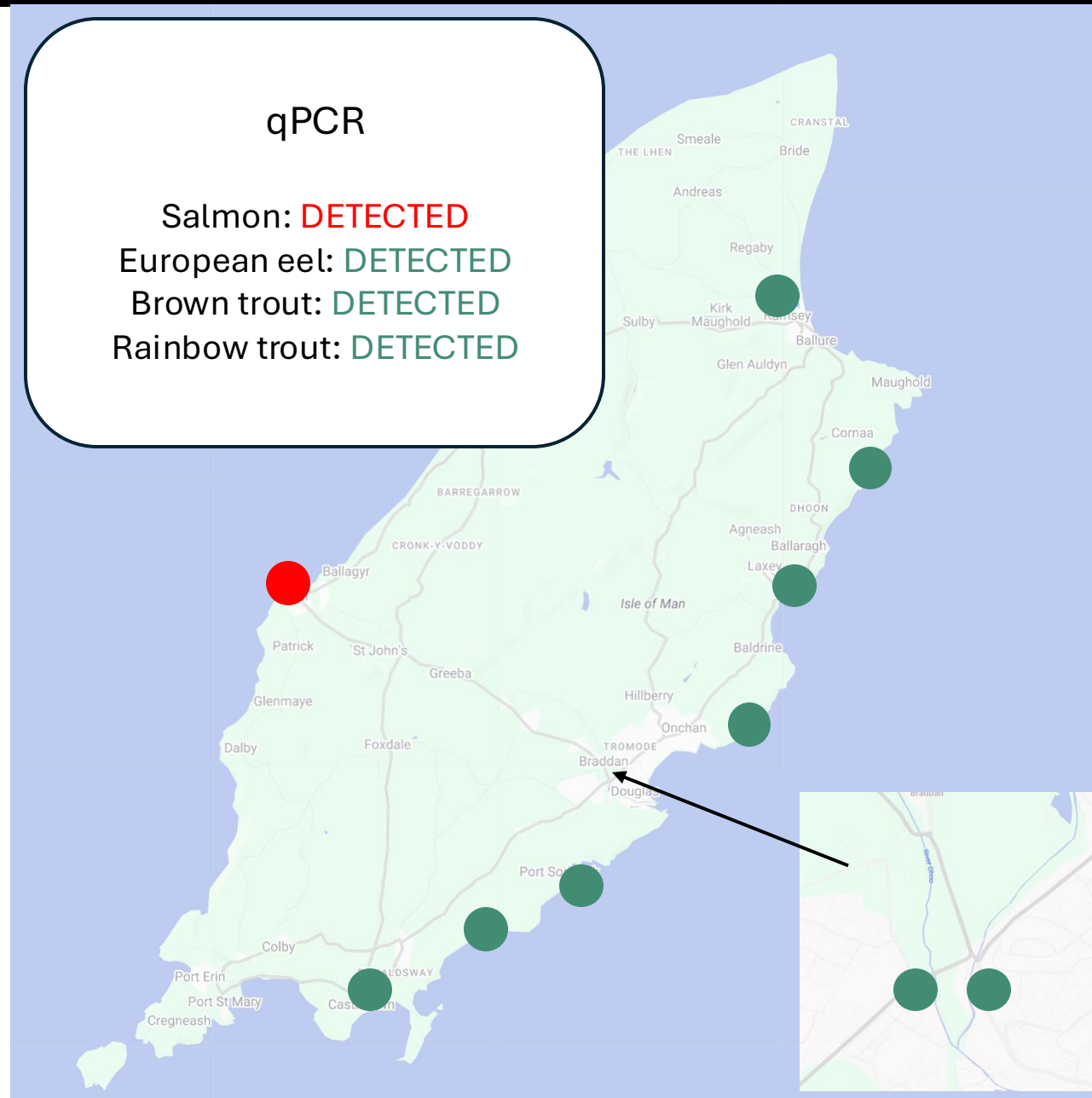
Salmon: **NOT DETECTED**
European eel: **DETECTED**
Brown trout: **DETECTED**
Rainbow trout: **NOT DETECTED**



River Neb**

Metabarcoding detected:

- *Salmo trutta* (Brown trout)
- *Anguilla anguilla* (European eel)
- *Salmo salar* (Atlantic salmon)
- *Pomatoschistus microps* (goby)
- *Clupea harengus* (herring)
- *Sprattus sprattus* (brisling)
- *Scomber scombrus* (mackerel)
- *Thymallus thymallus* (grayling)
- *Larus argentatus* (herring gull)



Findings

- The red-listed endangered European eel appears to be extremely abundant in rivers on the Isle of Man
 - **This finding warrants further investigation**
- Brown trout is also abundant in Isle of Man rivers
- Rainbow trout and Atlantic salmon were also detected
- No detections of the invasive Pink salmon were detected.
 - **HOWEVER!**
 - We did not test for this specifically for this species with qPCR, the most sensitive method.
 - The metabarcoding experiments were not designed to carry out “deep sequencing” to detect rare species.

Peel: August 2023

Bacterial survey

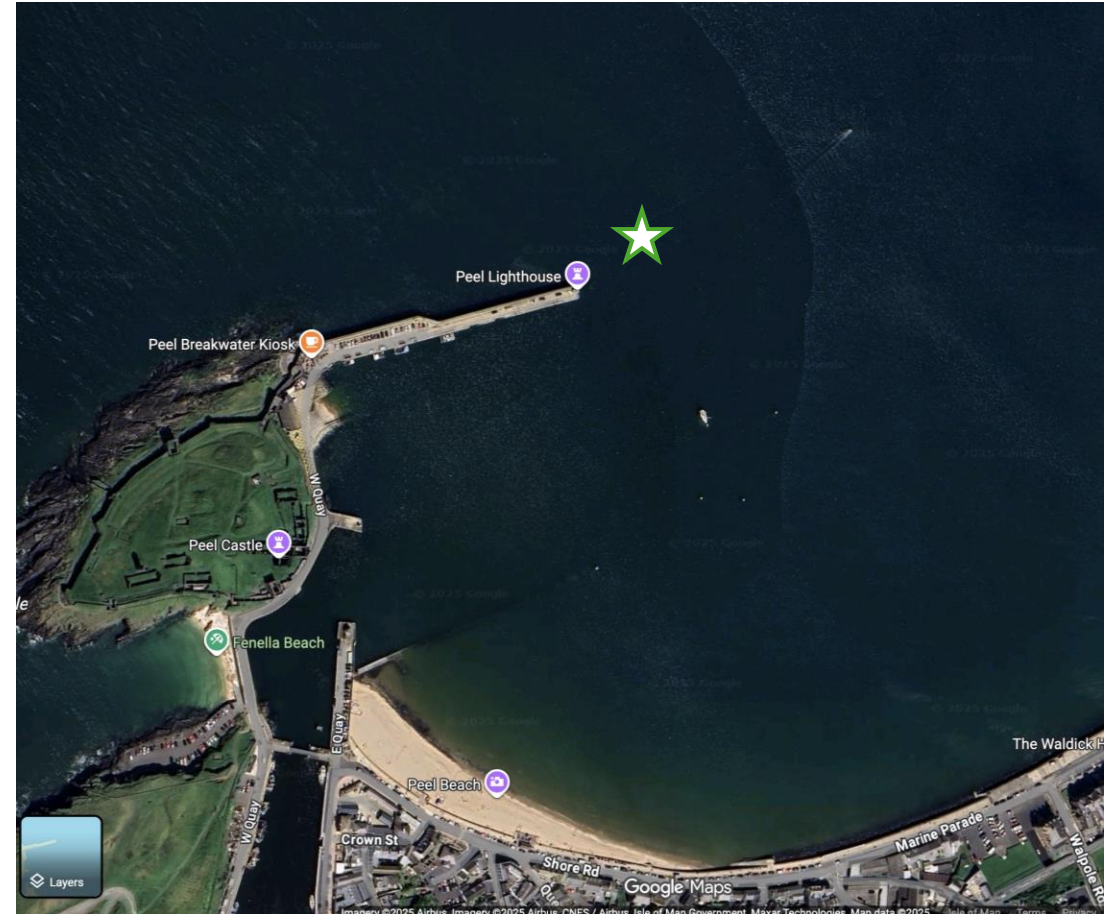
Aims

- Survey Peel bay and marina for bacterial species
- Collect a large number of samples to be used for internal eDNA R&D and method development
- High tide and low tide on the same day



Sewage in marine environments: sources

- Sewage outfall, sewer overflows, storm water discharges
- River discharges, possible run-off from agricultural activities
- Diffuse discharges from birds, bathers, marine sediments, companion animals



Sewage in marine environments



Health risks

- Direct contact with sewage-contaminated water can lead to serious infections of the skin, eyes, ears, and gastrointestinal tract

Foodborne illness

- The presence of pathogens like *Vibrio* spp. in shellfish from contaminated waters can cause foodborne illness

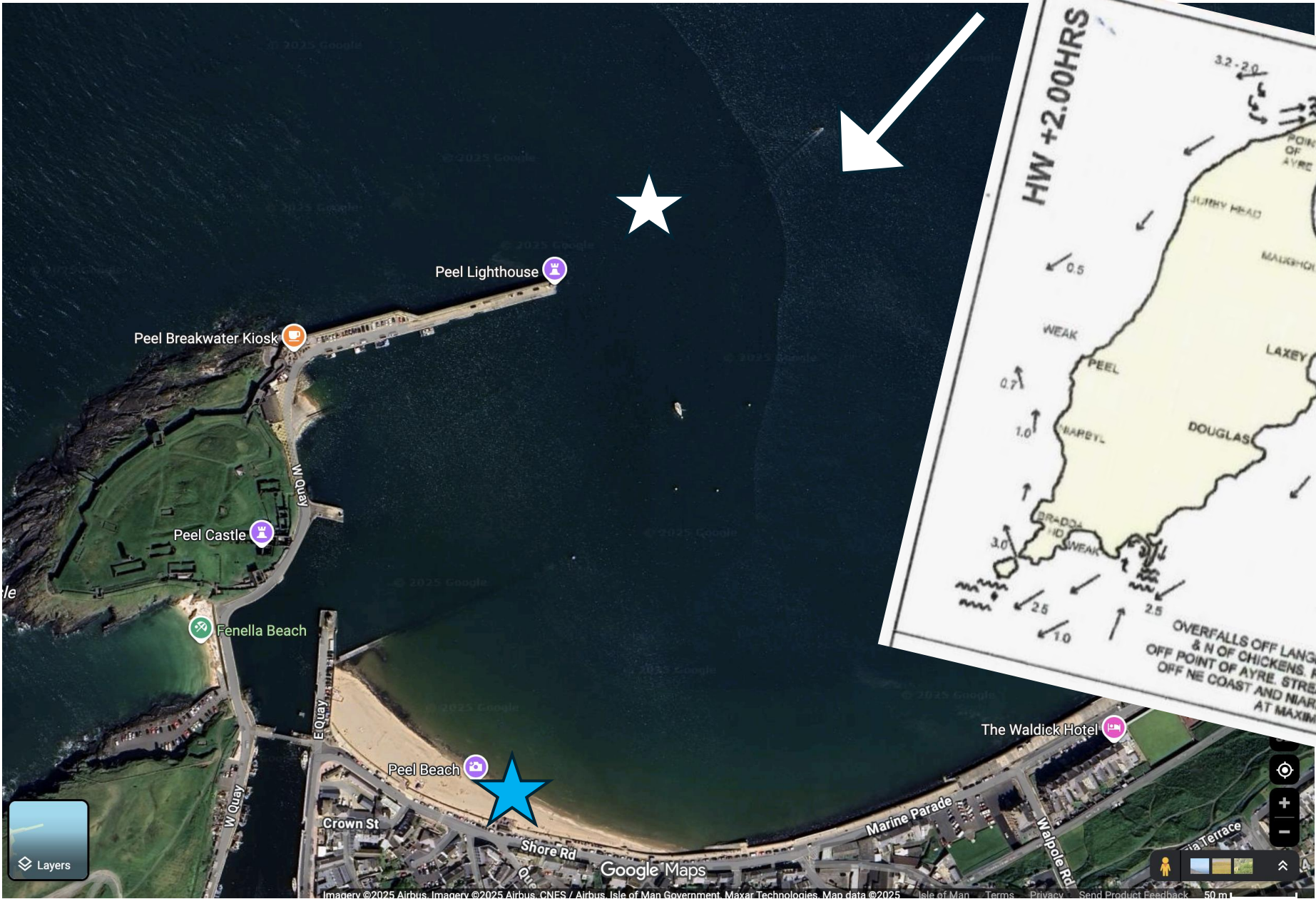
Environmental persistence

- Bacteria and other microbes can persist in marine sediments, becoming a long-term source of contamination to the water column

Antimicrobial resistance (AMR) “superbugs”

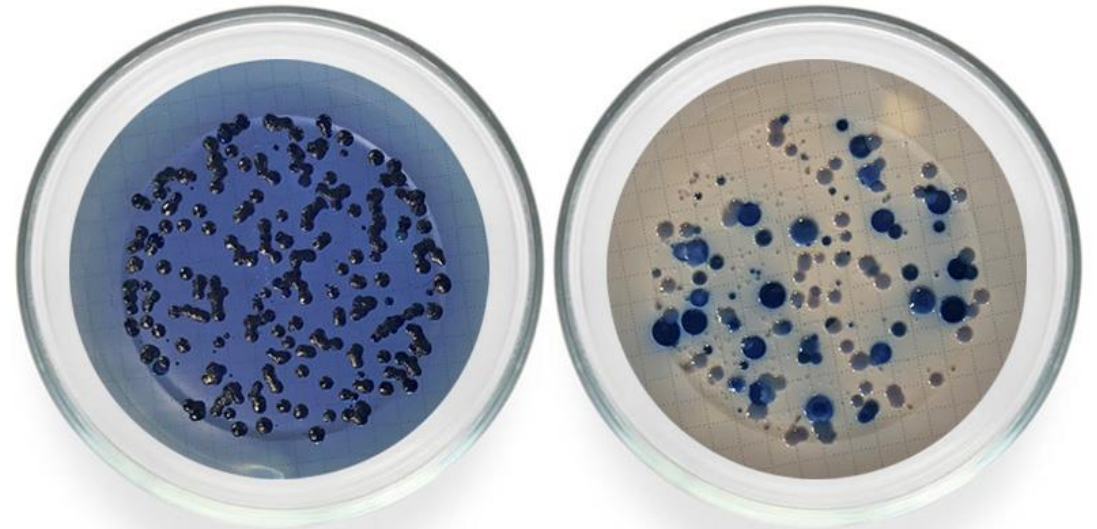
- Pollution from sewage, especially untreated raw sewage, contributes to the spread of AMR in marine environments, posing a threat to human and animal health

...also a source of nutrients!

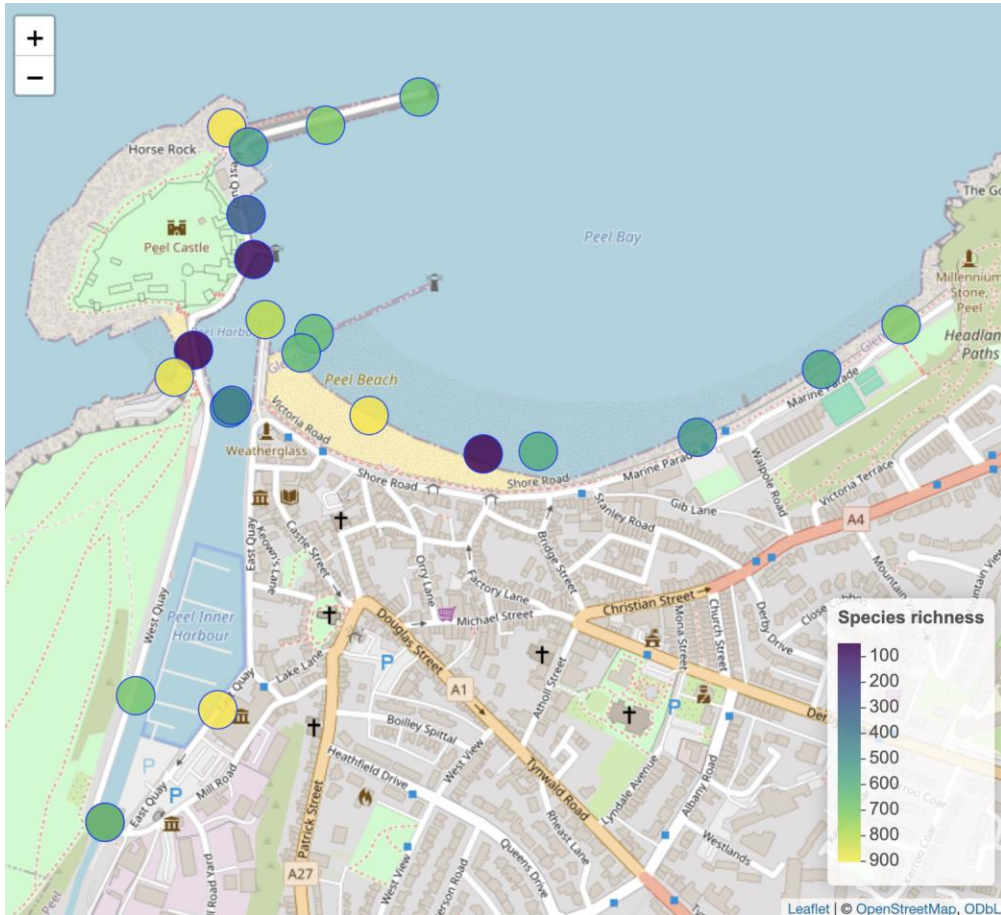


Sewage contamination: traditional assessment

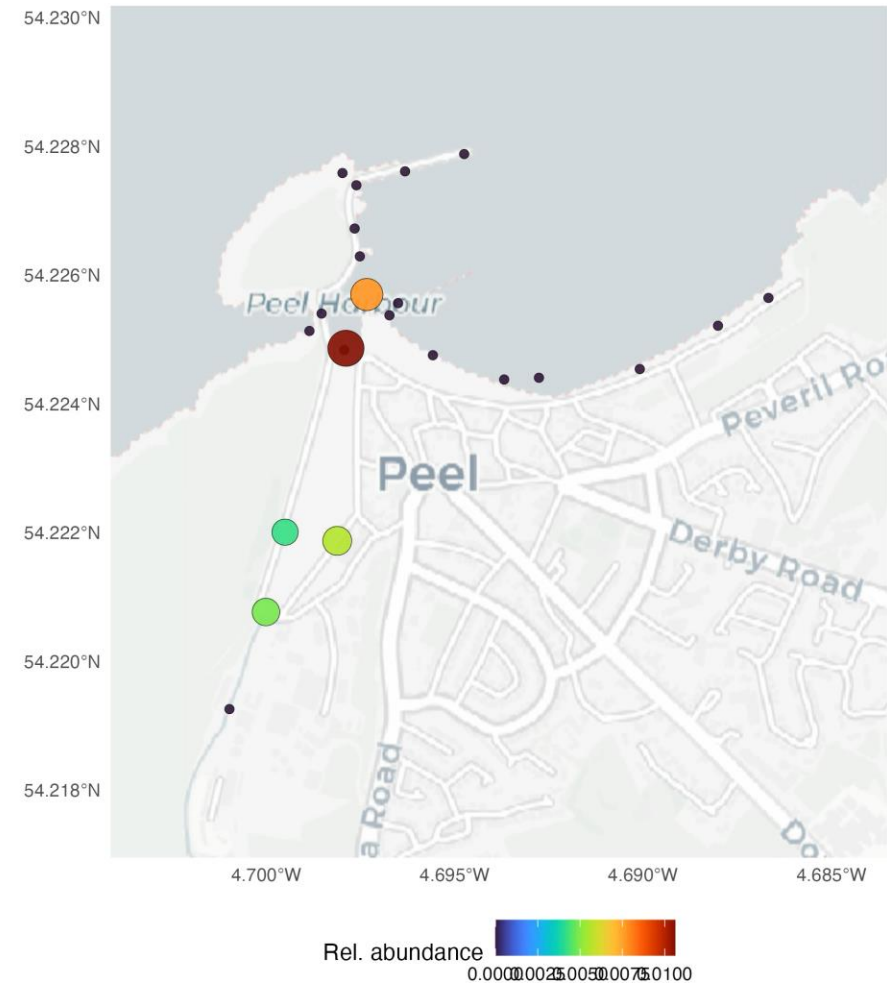
- Faecal Indicator Bacteria (FIB)
- Total coliforms
 - Large group of bacteria present in the environment and faeces of humans and animals
- Faecal coliforms
 - Sub-group of total coliforms that are found in faeces
- *E. coli*
 - Bacterial species found in faeces



eDNA water sampling locations



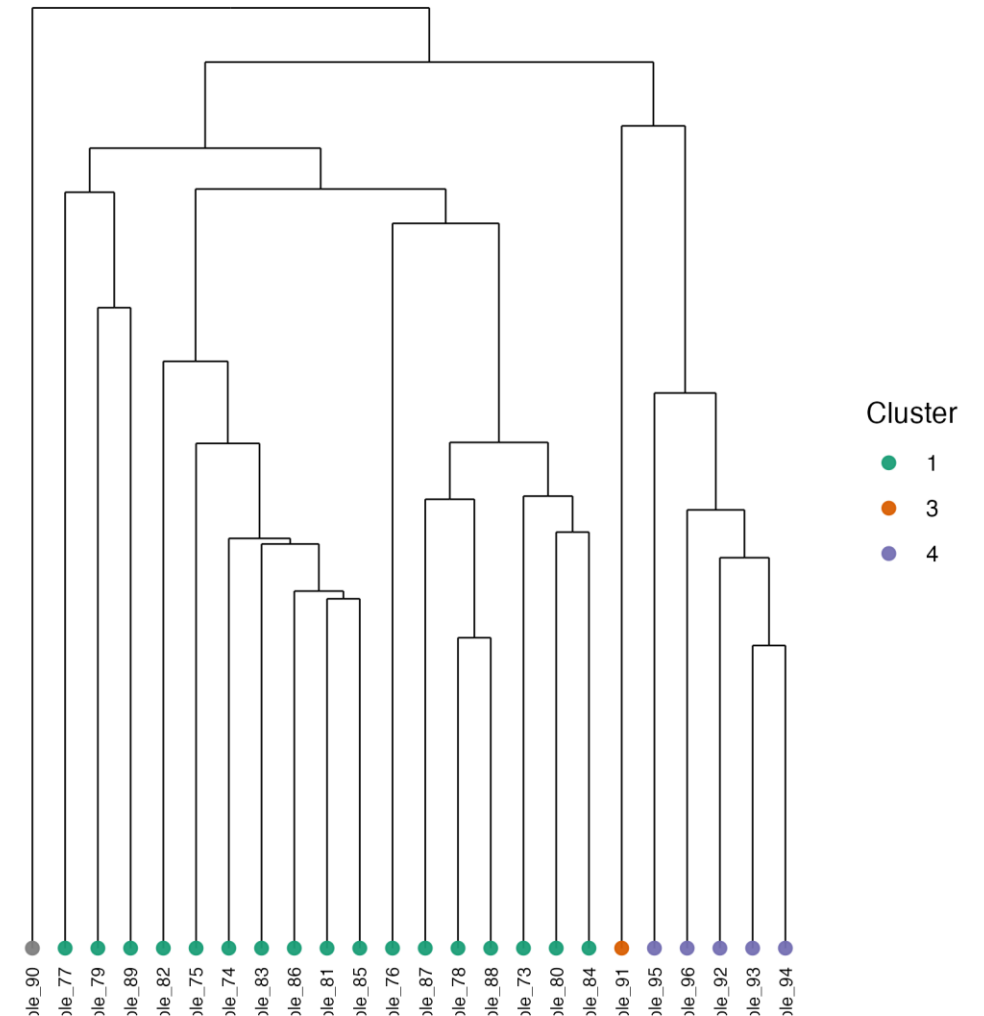
Relative abundance of '*Novosphingobium aquaticum*' Singh et al. 2015



Mantel coefficient



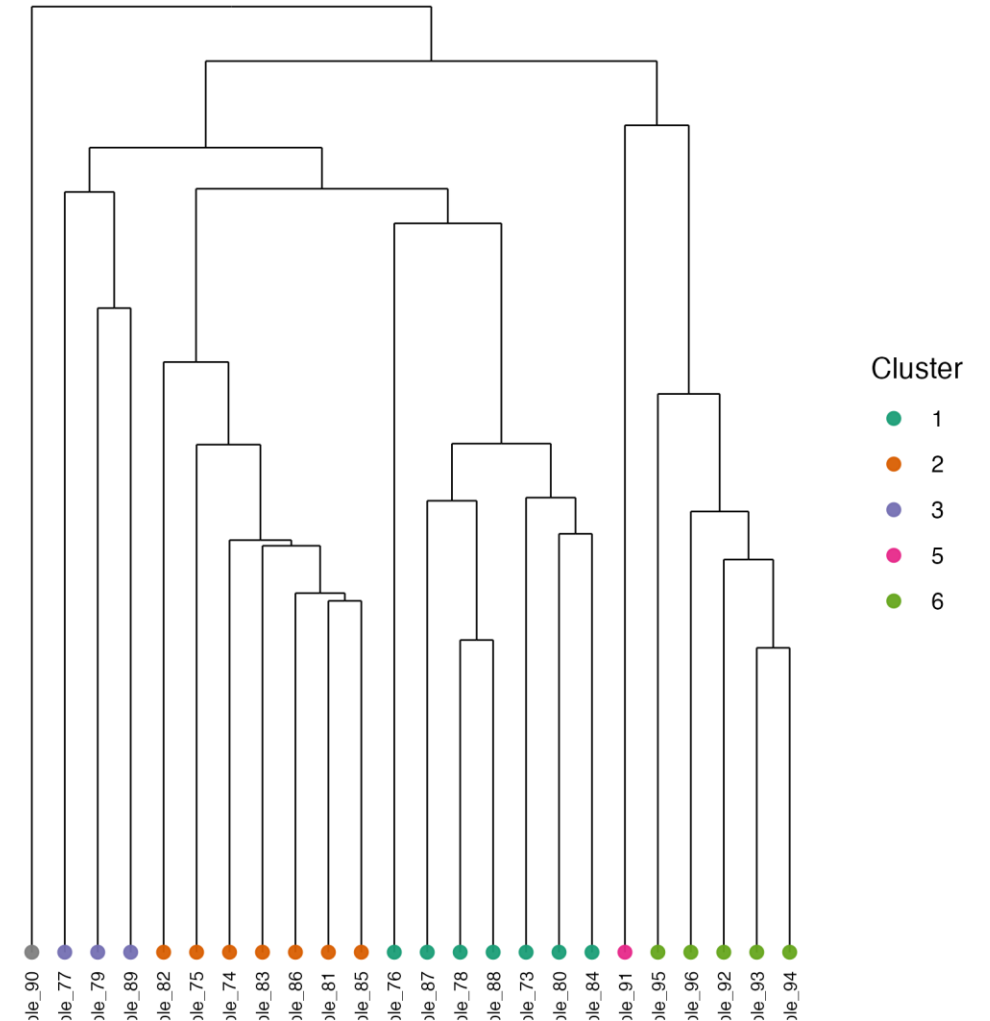
Bray–Curtis hierarchical clustering (UPGMA)



Mantel coefficient: HiRes

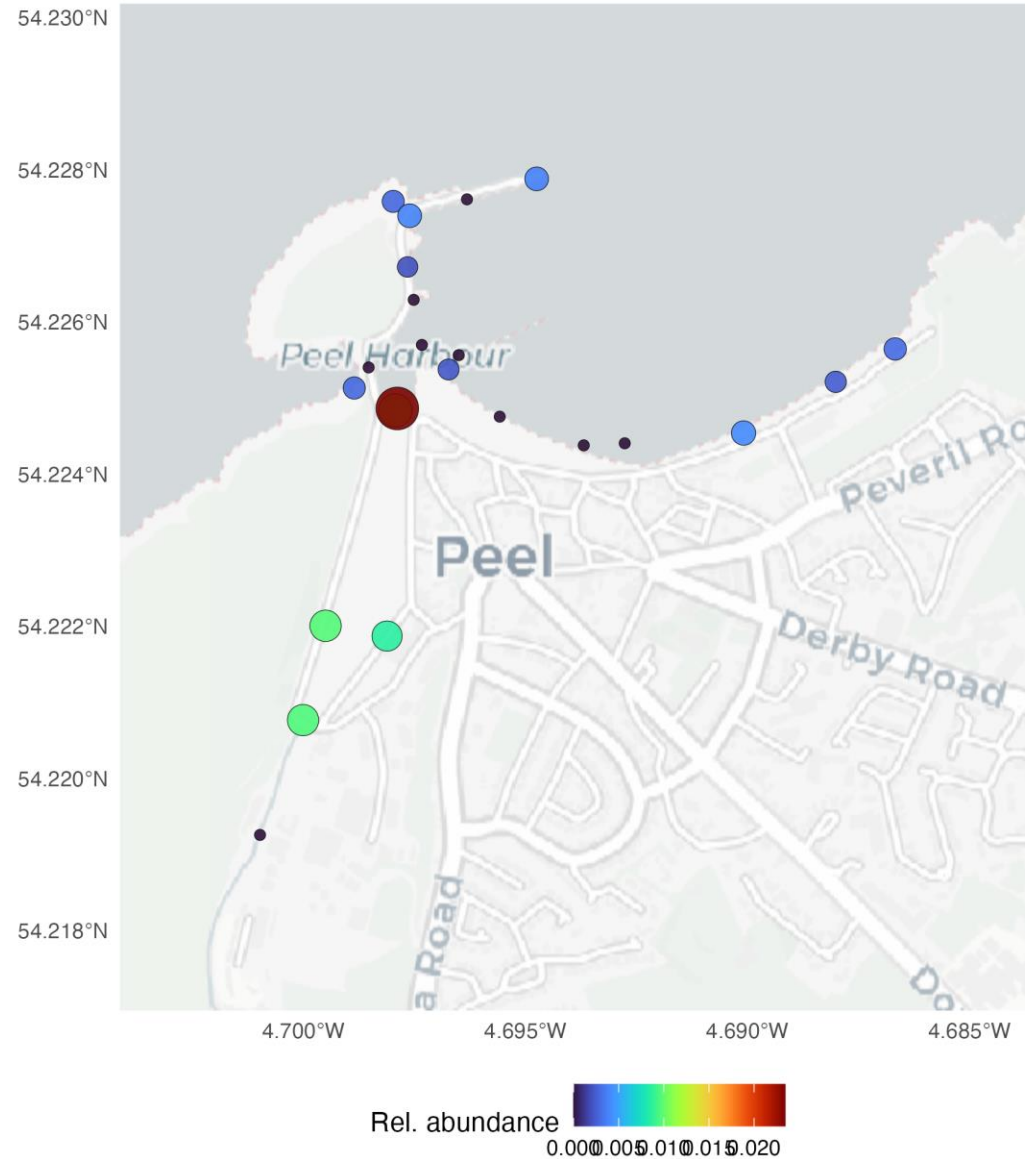


Bray–Curtis hierarchical clustering (UPGMA)



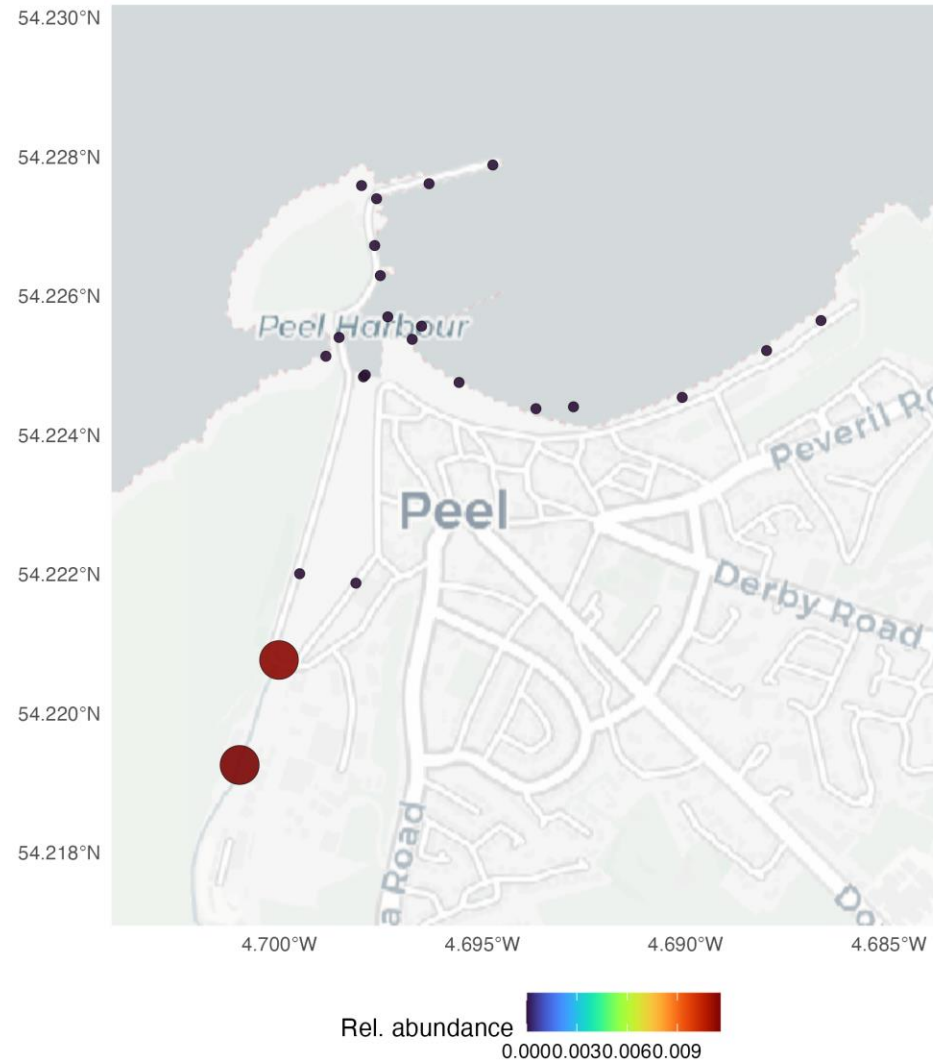
Pathogens

Relative abundance of Escherichia coli



Pathogens

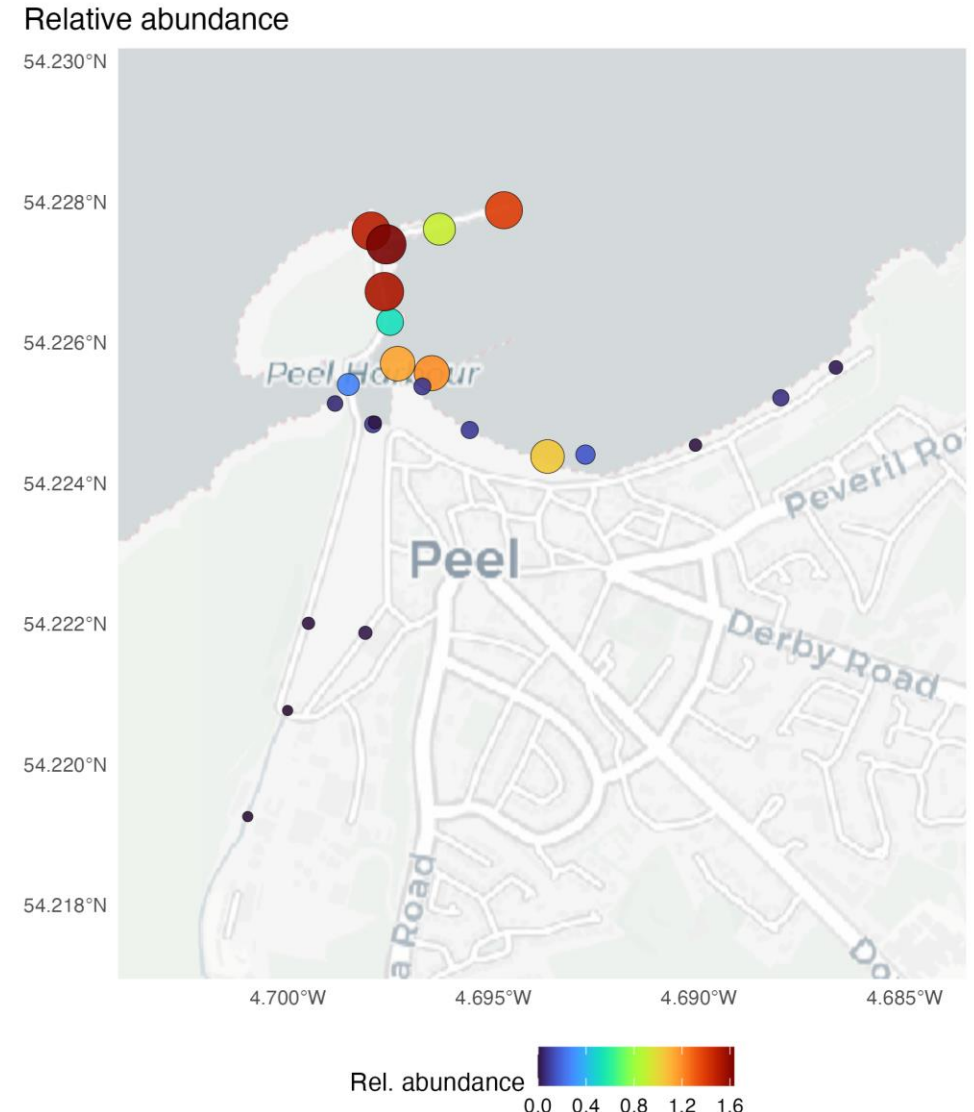
Relative abundance of *Campylobacter jejuni*





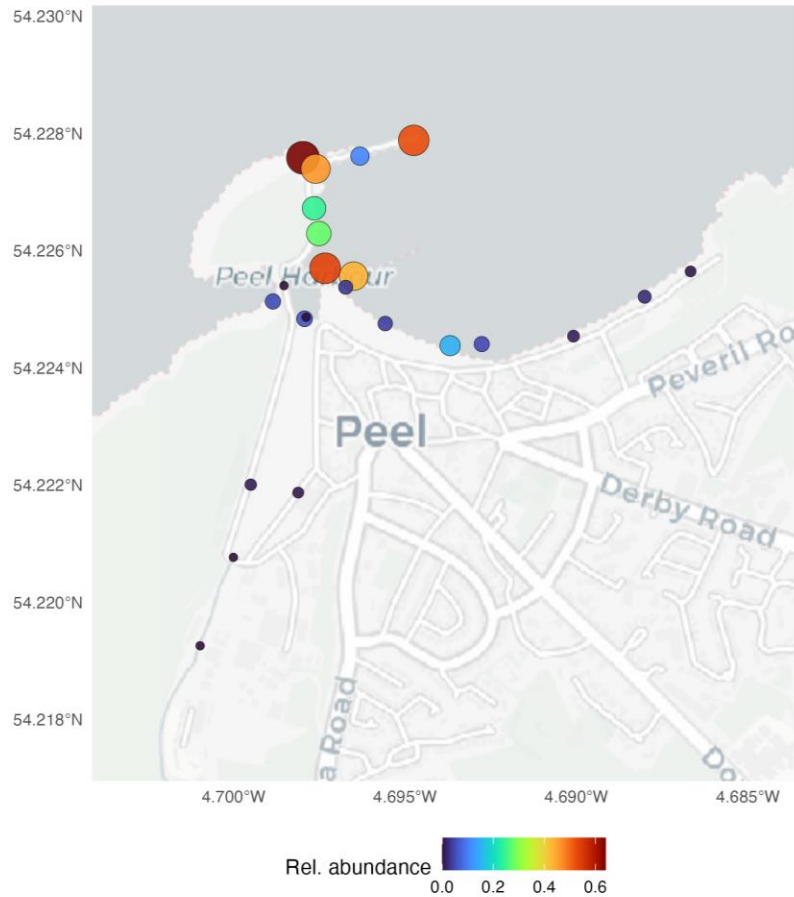
Candidatus Pelagibacter sp. FZCC0015

- Pelagibacter species are extremely abundant worldwide
- Recycles dissolved organic carbon
- Proxy for where the sewage going



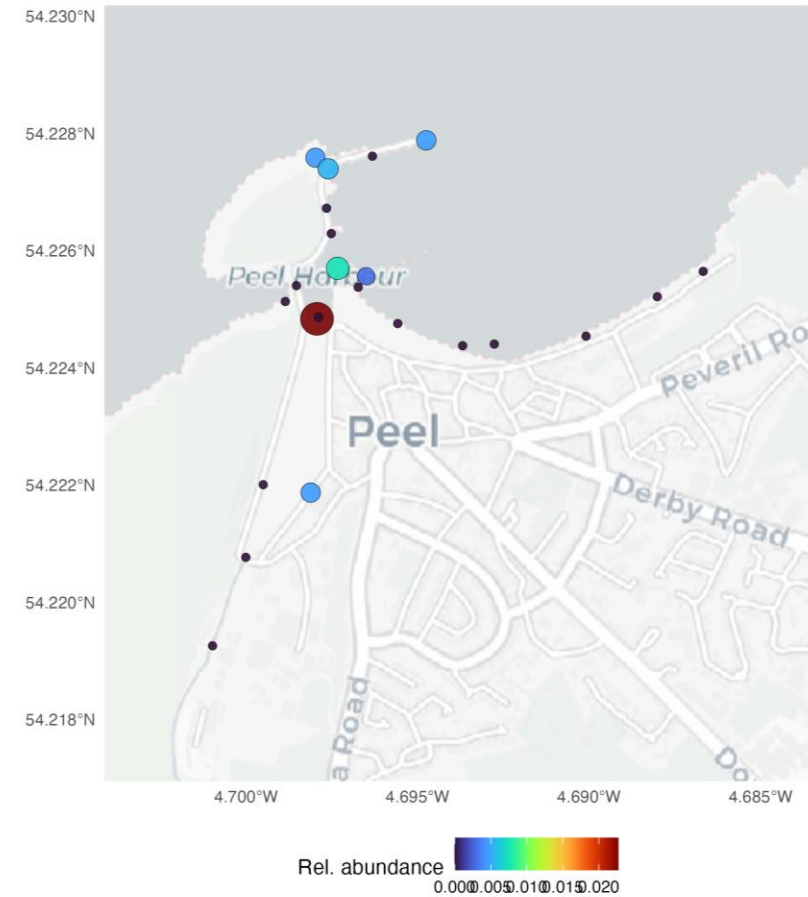
Neptunomonas spp

Relative abundance of *Neptunomonas antarctica*



Associated with nutrient rich sediments

Relative abundance of *Neptunomonas naphthovorans*



Associated with breaking down oil/hydrocarbons

Aeromonas salmonicida

Relative abundance of *Aeromonas salmonicida*

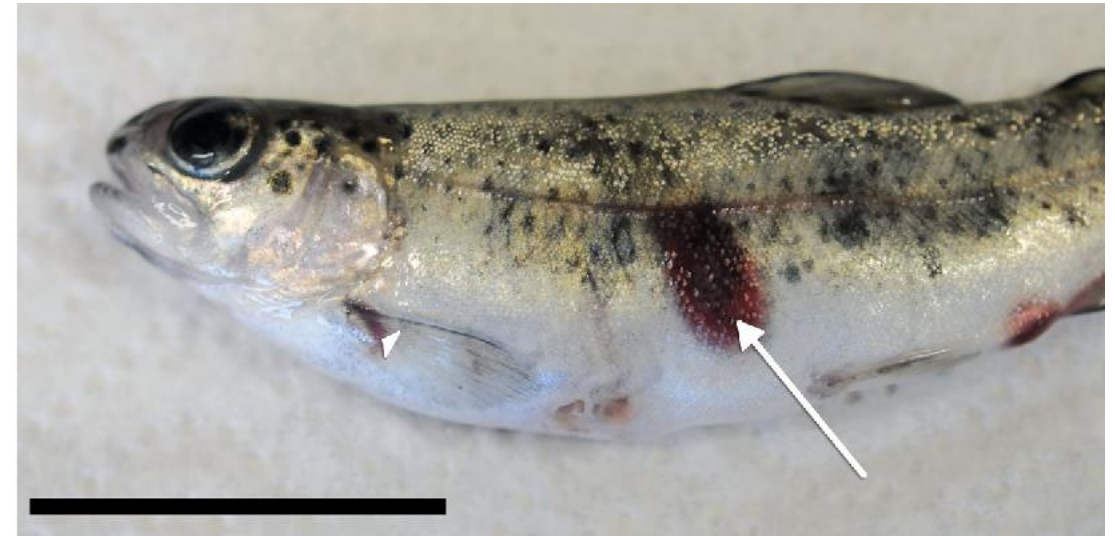
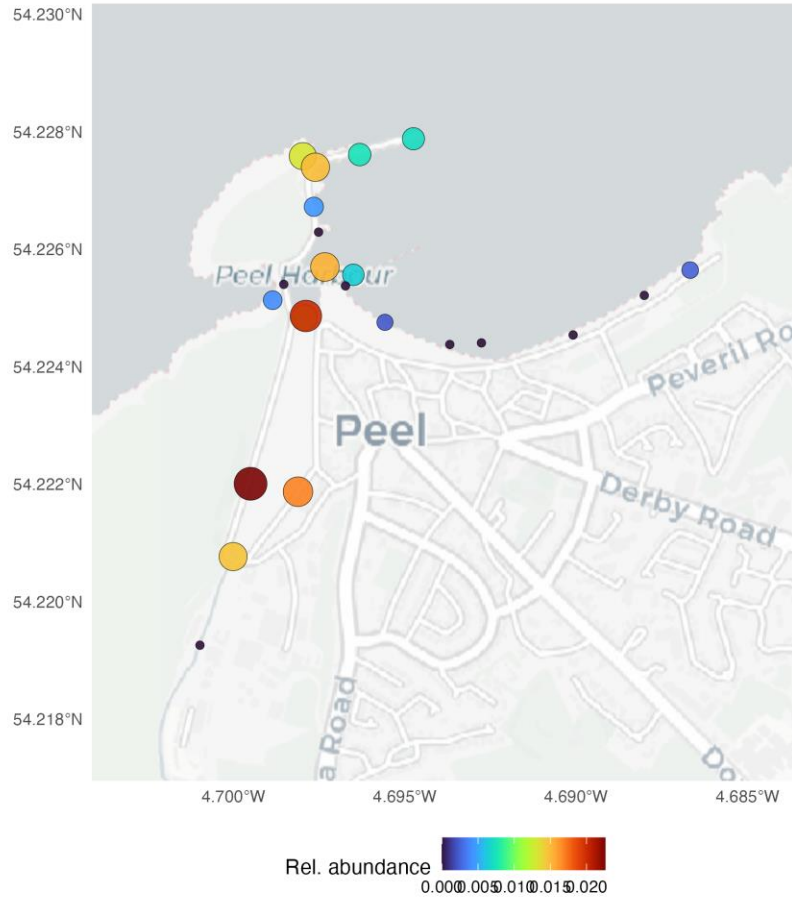
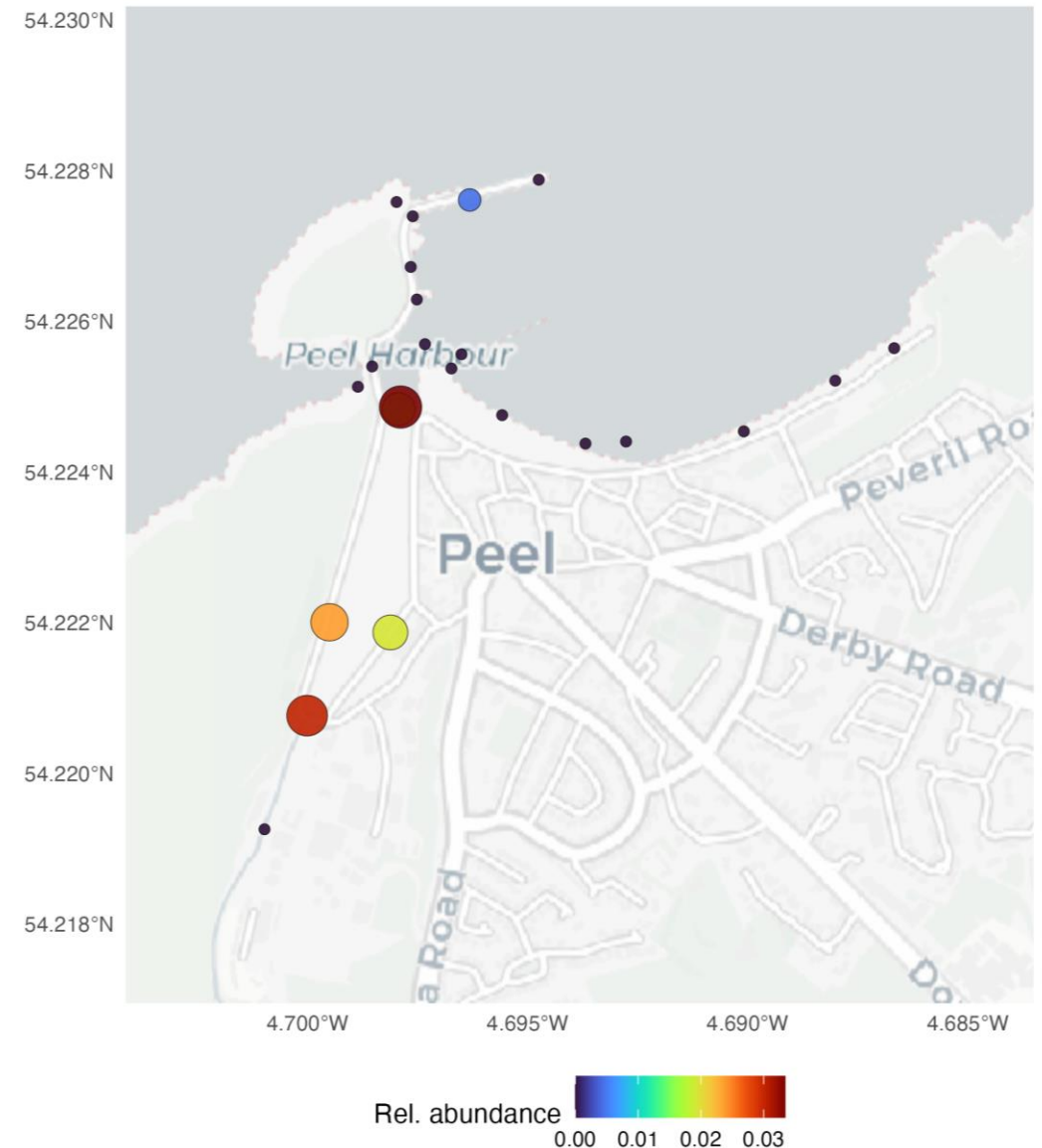


Figure 1: Clinical signs of *Aeromonas salmonicida* infection in salmon.

Agricultural Soil inoculant

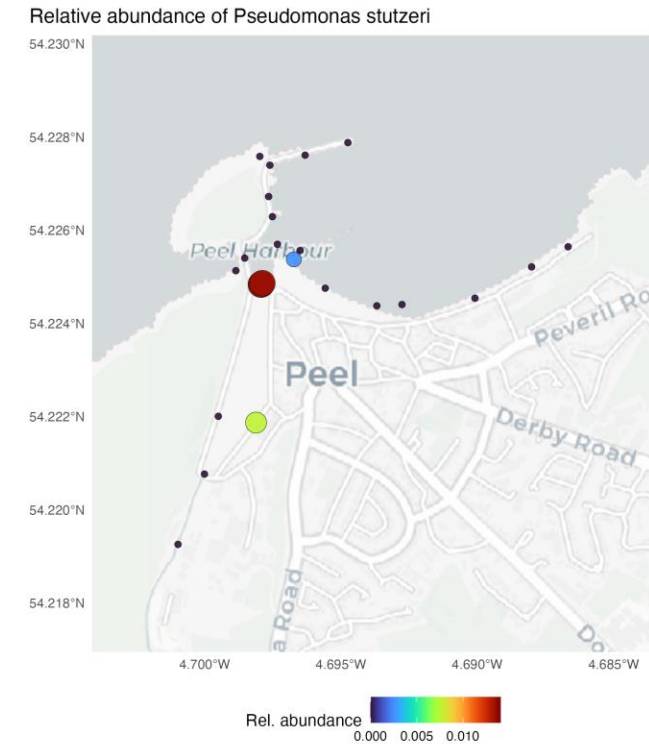
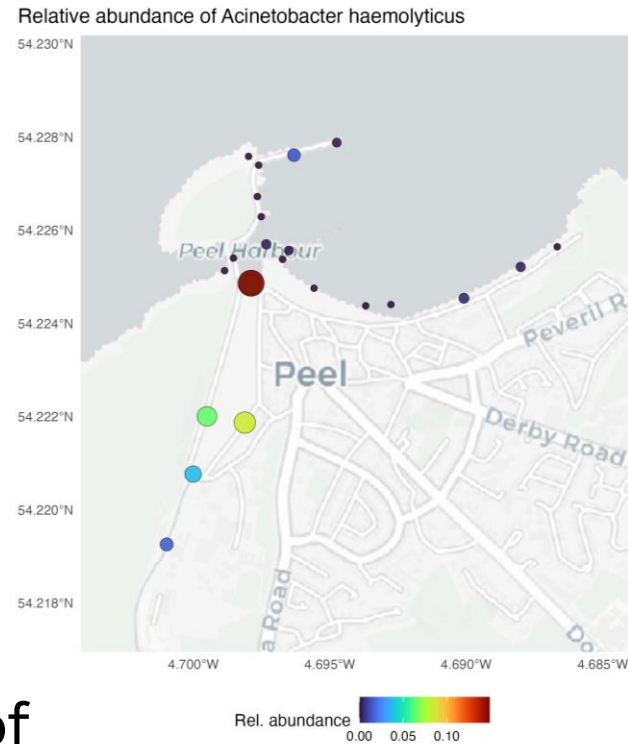
- Soil additive used to improve plant growth
- accumulation in the marina silt?
- run off from agricultural uses upstream in the Neb?

Relative abundance of *Acidovorax facilis*



Heavy-metal contamination associated species

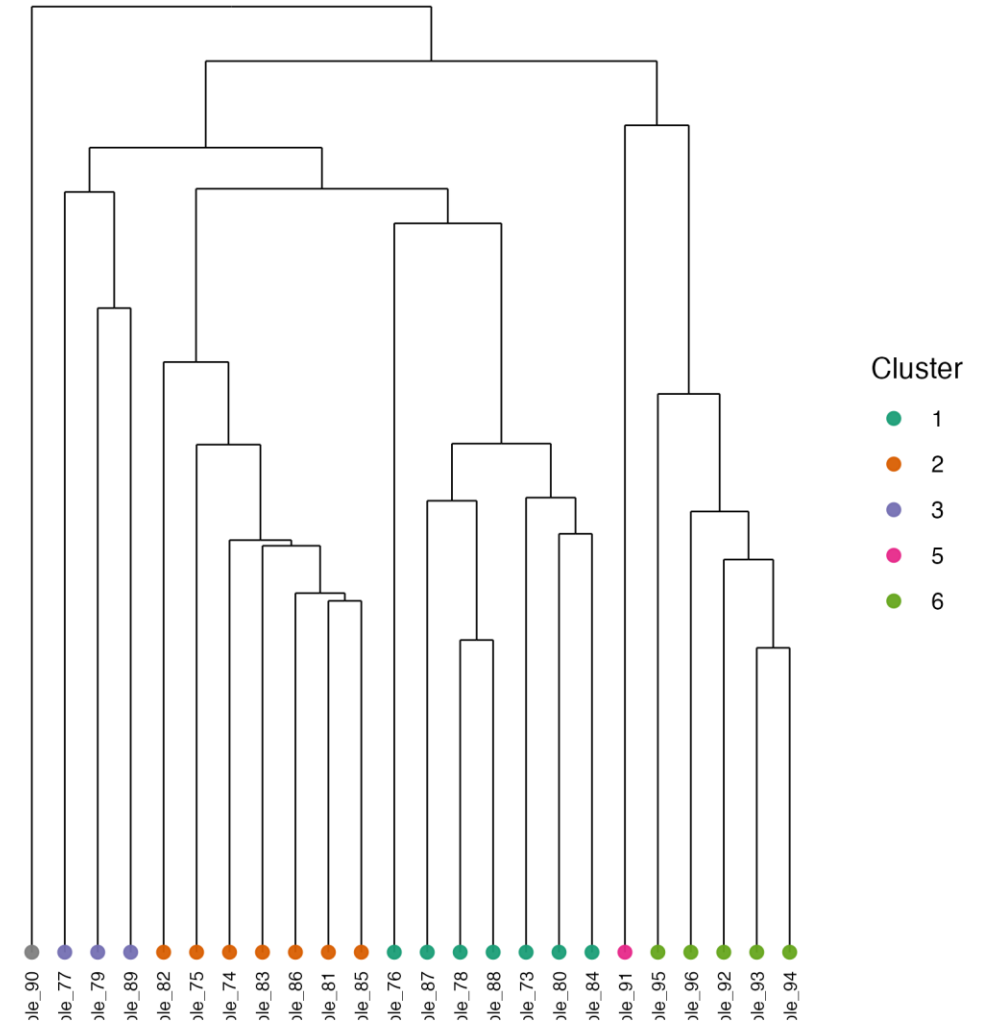
- *Acinetobacter spp.*
 - hydrocarbon contaminated areas
 - activated sludge
 - sewage
 - dump sites
- *Pseudomonas stutzeri*
 - implicated in bioremediation of heavy metals

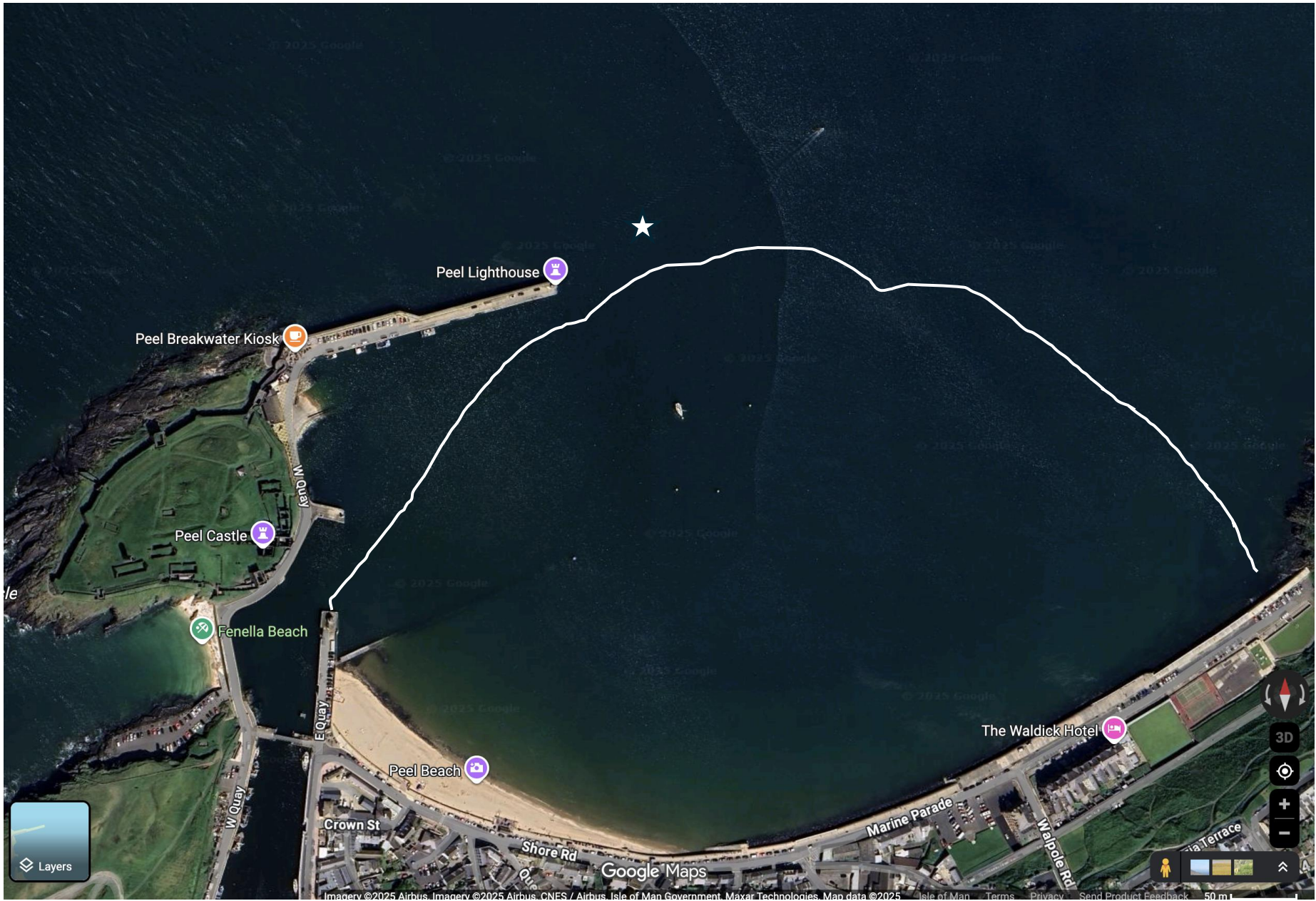


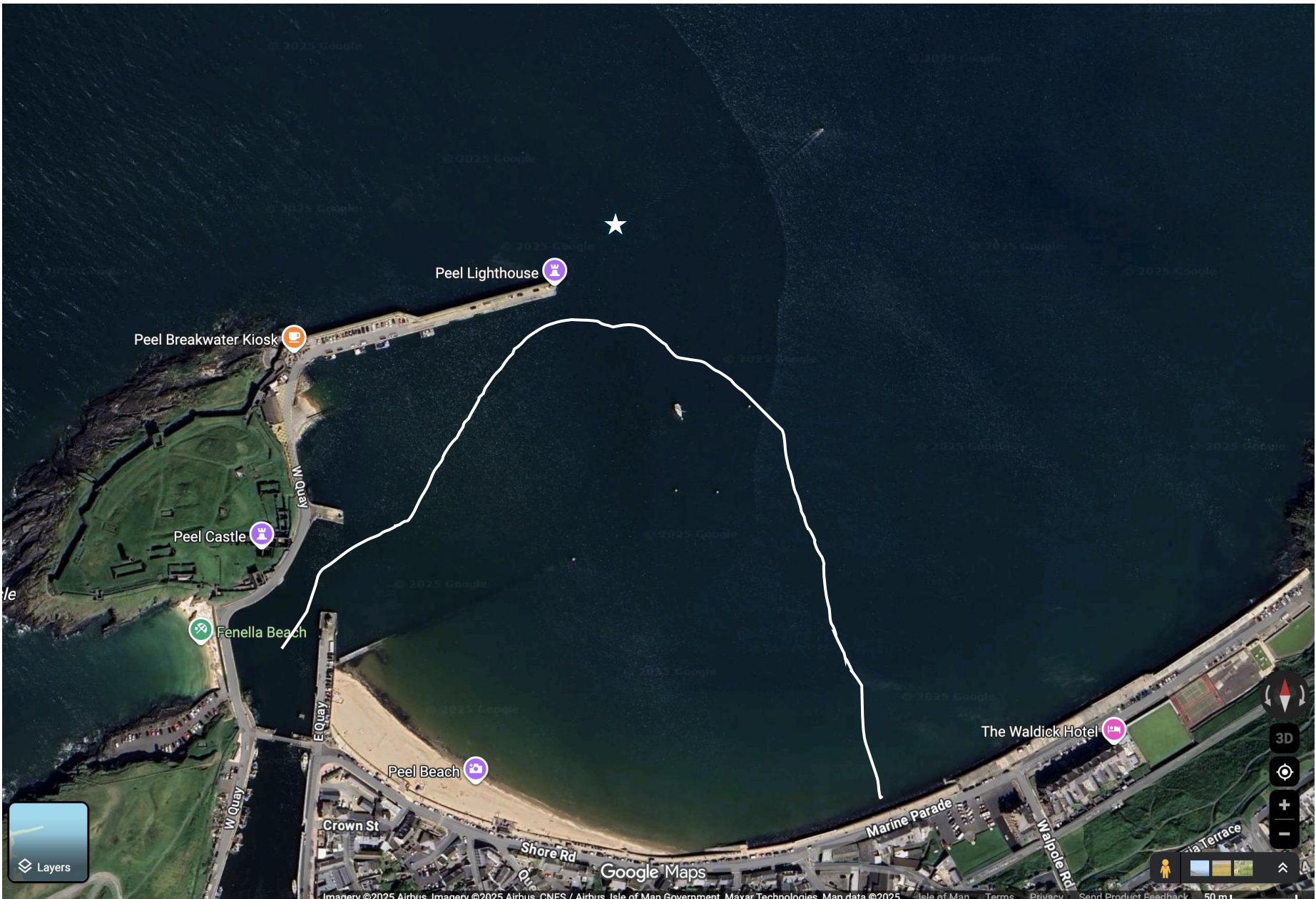
Mantel coefficient: HiRes



Bray–Curtis hierarchical clustering (UPGMA)







Where does Peel go from here?

- It's not all doom and gloom
 - Sewage treatment works from 2027
- The questions for the future:
 - How will the sewage treatment works change the microbial diversity of Peel bay?
 - If anyone would like to fund this research....!
 - If some of the FIB are from agricultural run-off, will the treatment works change the locations of FIB present in the bay?
 - Should more FIB sites be considered for Peel in the interim?

An unusual stranding

Glen Maye beach, 2024

with Dr. Peter Duncan (DEFA) and Dr. Lara Howe (MWT)



ZooKeys 365: 5–24 (2013)
doi: 10.3897/zookeys.365.5873
www.zookeys.org

RESEARCH ARTICLE



The use of DNA barcoding to monitor the marine mammal biodiversity along the French Atlantic coast

Eric Alfonsi^{1,2*}, Eleonore Méheust^{1,2*}, Sandra Fuchs², François-Gilles Carpentier¹,
Yann Quillivic², Amélia Virice^{3,4}, Sami Hassani², Jean-Luc Jung¹

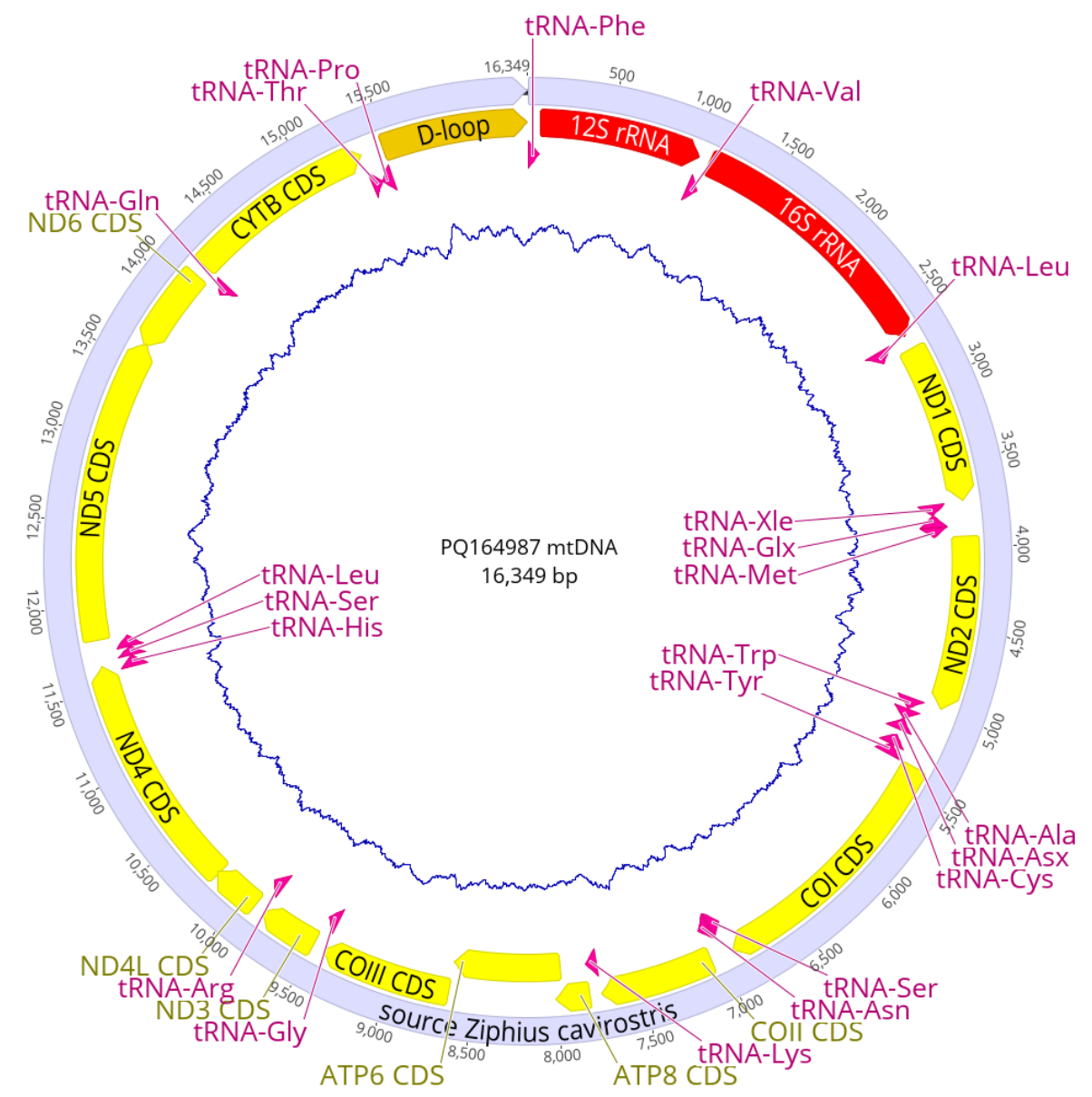
DNA IN THE DEEP: COMPARATIVE MOLECULAR ECOLOGY FOR THE CONSERVATION OF BEAKED WHALES

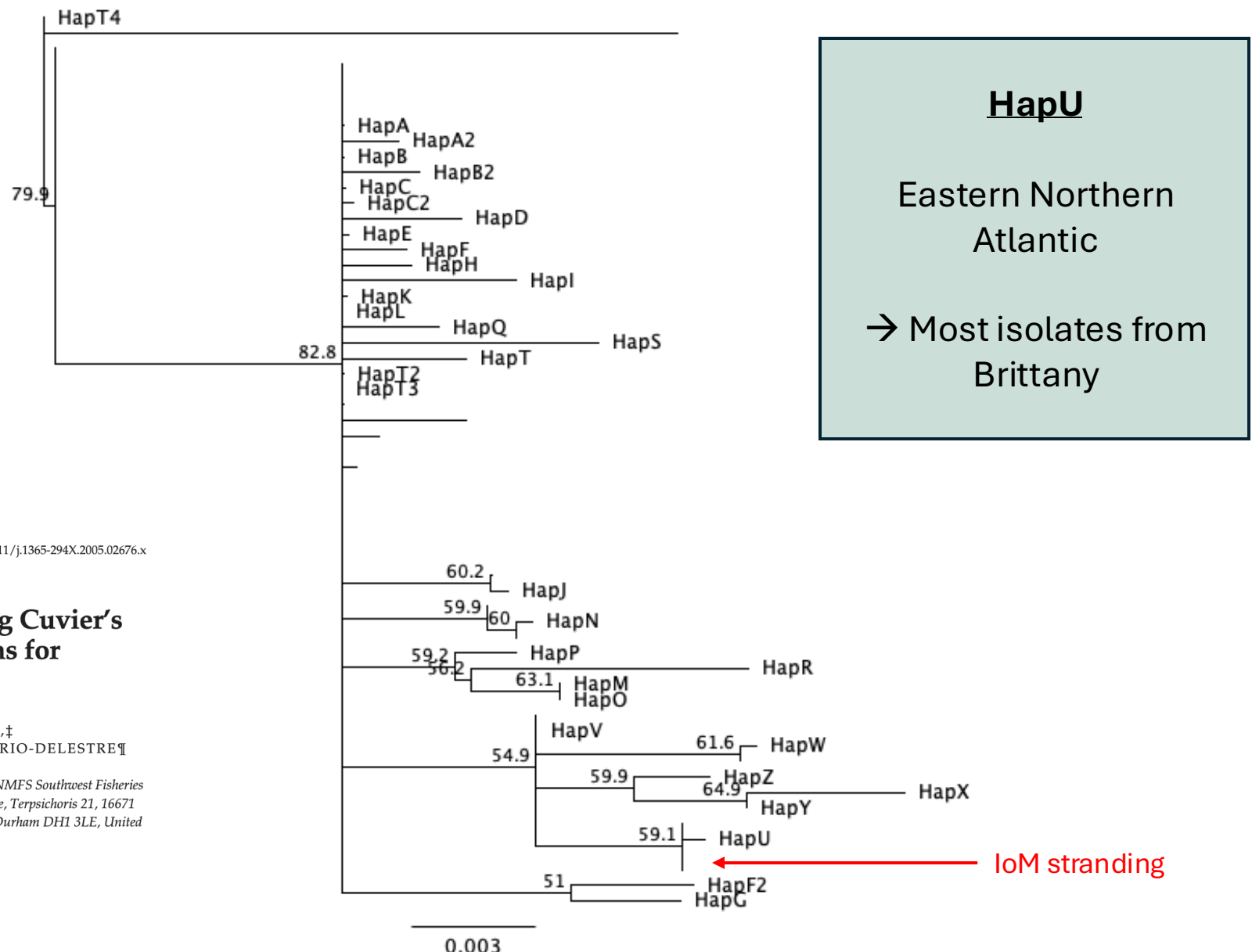
Aubrie Booth Onoufriou

A Thesis Submitted for the Degree of PhD
at the
University of St Andrews



2023





Molecular Ecology (2005) 14, 3353–3371

doi: 10.1111/j.1365-294X.2005.02676.x

Worldwide structure of mtDNA diversity among Cuvier’s beaked whales (*Ziphius cavirostris*): implications for threatened populations

MEREL L. DALEBOUT,* KELLY M. ROBERTSON,† ALEXANDROS FRANTZIS,‡ DAN ENGELHAUPT,§ ANTONIO A. MIGNUCCI-GIANNONI,¶ RAUL J. ROSARIO-DELESTRE¶ and C. SCOTT BAKER*

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Ziphius cavirostris isolate S-2407-73 mitochondrion, complete genome

GenBank: PQ164987.1

[FASTA](#) [Graphics](#)

[Go to:](#) ☐

LOCUS PQ164987 16349 bp DNA circular MAM 16-FEB-2025

DEFINITION Ziphius cavirostris isolate S-2407-73 mitochondrion, complete genome.

ACCESSION PQ164987

VERSION PQ164987.1

KEYWORDS .

SOURCE mitochondrion Ziphius cavirostris (Cuvier's beaked whale)

ORGANISM [Ziphius cavirostris](#)
Eukaryota; Metazoa; Chordata; Craniata; Vertebrata; Euteleostomi; Mammalia; Eutheria; Laurasiatheria; Artiodactyla; Whippomorpha; Cetacea; Odontoceti; Ziphiidae; Ziphius.

REFERENCE 1 (bases 1 to 16349)

AUTHORS Glover,R.H. and Duncan,P.

TITLE An unusual stranding of Cuvier's beaked whale (Ziphius cavirostris) on the Isle of Man

JOURNAL Unpublished

REFERENCE 2 (bases 1 to 16349)

AUTHORS Glover,R.H. and Duncan,P.

TITLE Direct Submission

JOURNAL Submitted (09-AUG-2024) Environmental Genomics, Taxa Genomics, Eden Business Park, Braddan IM4 2AY, Isle of Man

COMMENT ##Assembly-Data-START##
Assembly Method :: MiniMap2 v. 2.2.0
Sequencing Technology :: Oxford Nanopore
##Assembly-Data-END##

FEATURES

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/product="tRNA-Phe"

[rRNA](#) 75..1046

Thank you!



@Taxa Genomics

Jennie Fantham
Kelly Weston-Ford
Helen Ley
Niamh Rowe
Rhys Burrell
David Williams
Lina-Elvira Bäck

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