Why are oysters dying … and can we vaccinate them?

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Acknowledgements to material prepared for this presentation by E/Prof Richard Whittington

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NSW Oyster Conference, Merimbula

THE UNIVERSITY OF SYDNEY

Celebrating 175 years

Meet Domi

History collection

- Signalment: species, breed, age
- Presenting complaint
- Environment & lifestyle
- Medications & allergies

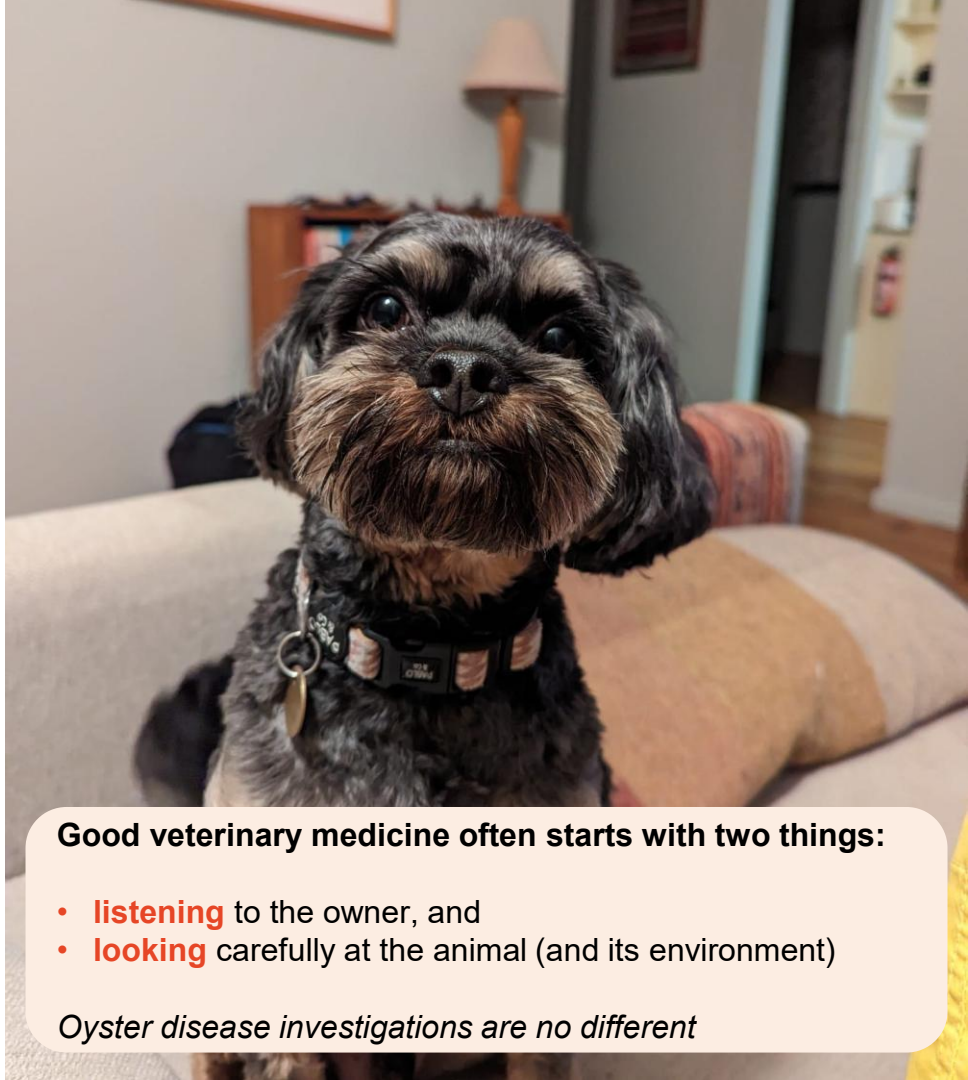
Anamnesis

*Helps us understand **possible causes** and **risk factors***

Physical examination

- Is Domi bright or depressed?
- Losing weight?
- Pain?
- Breathing normally?
- Signs of infection or inflammation?

The *Helps us understand how sick the animal is*



Good veterinary medicine often starts with two things:

- **listening** to the owner, and
- **looking** carefully at the animal (and its environment)

Oyster disease investigations are no different

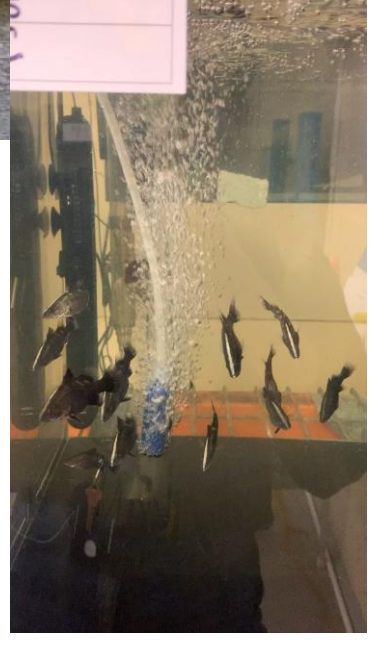
Early clinical signs in oysters can we hard to spot

Dogs / terrestrial animals

- stop eating
- limp
- cough
- vomit
- act quiet
- reduced mobility

Oysters & aquatic animals

- often no obvious signs
- disease may already be advanced
- dead oysters disappear quickly
- environment changes fast
- By the time the vet arrives, it might already be too late



Investigating unexplained mortality events in oysters

Getting the right samples at the right time

Summer 2025-2026

1. **Regular checks** – active surveillance
- Sentinel oysters at Porto Bay & Mullet creek
- "Canary in the coal mine"

2. **Grower reporting** – passive surveillance
- Farmers notify unusual mortality events
- Sampling kits provided

What we looked at & what we did:

- Mortality patterns
- Environment (water quality)
- Histology ("microscope exam")
- Bacteria & viruses

↓

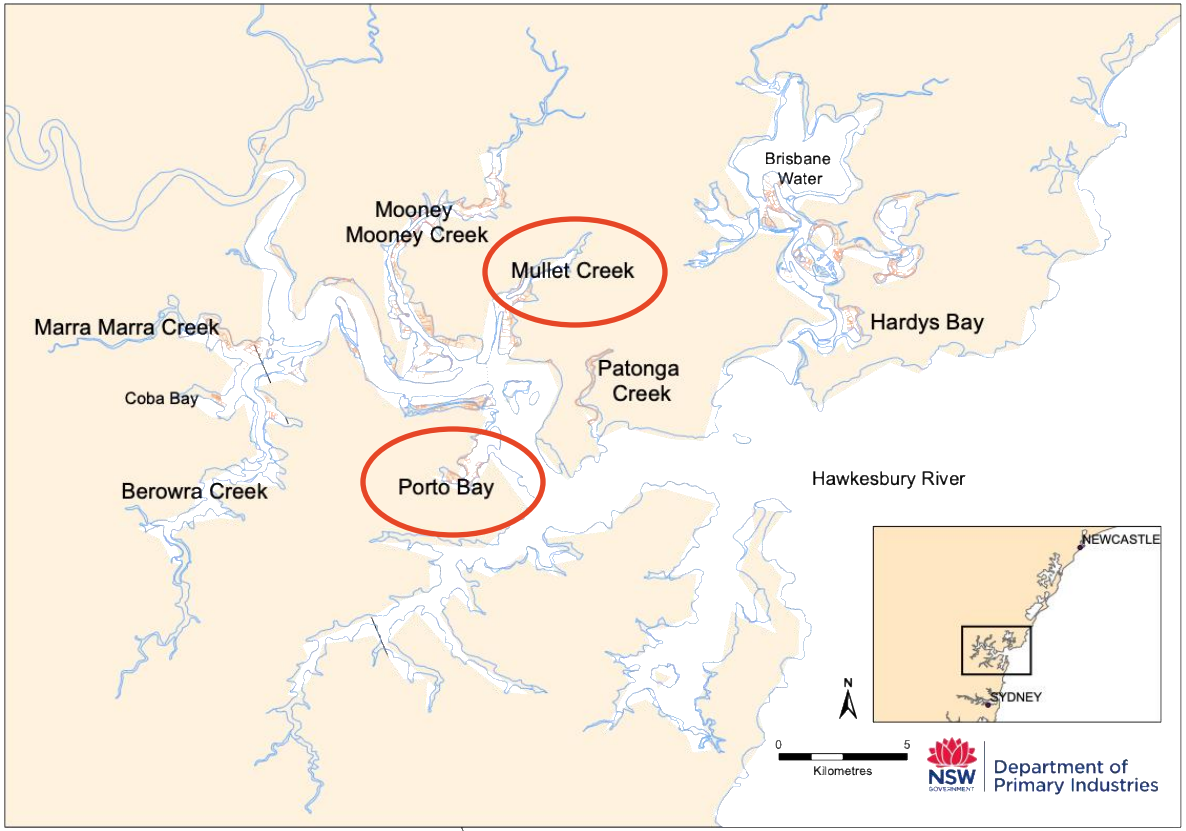
- Describe the disease
- (Case definitions)
- Identify risk factors

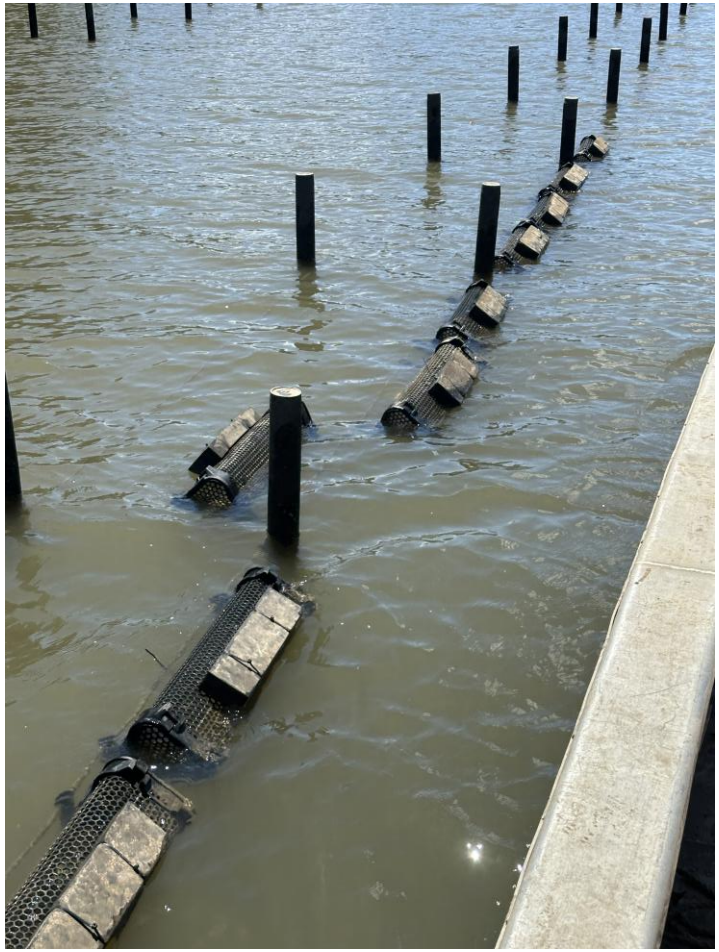
FRDC Delivering impact for fishing & aquaculture

The University of Sydney

Compare results with 2024 - 2025
- *in kind* investigation
- contributed into this FRDC project

Location of sentinel oyster baskets

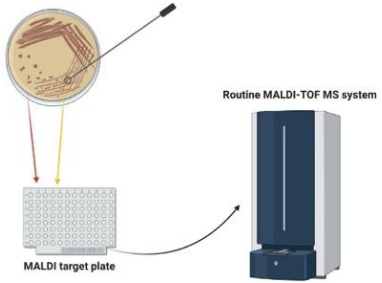




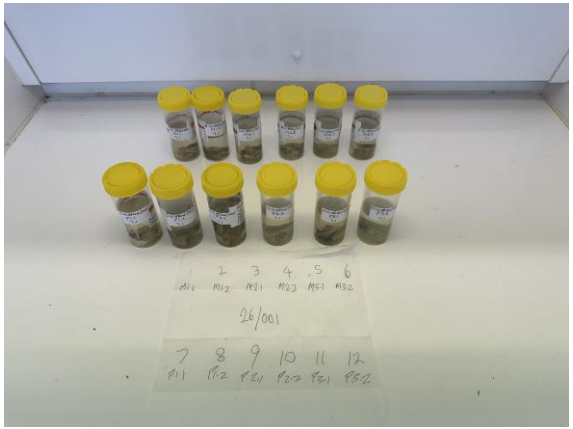
A very powerful & low-tech tool:

counting dead & alive

Image credit: Richard Whittington



samples for histology, bacteriology and virology were collected on site to avoid changes during transport



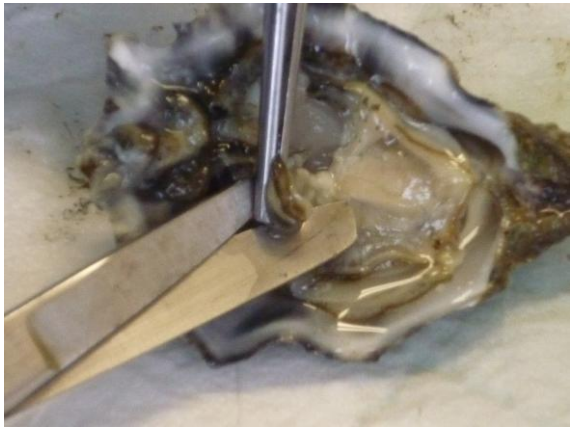


Image credit: Richard Whittington

Disease timeline 2025 – 2026

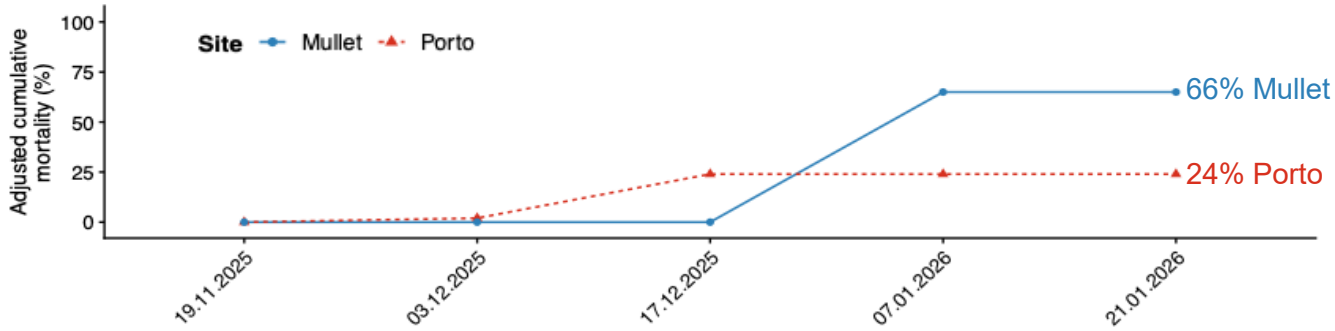
Mortality occurred over less than 2-3 weeks at each site
Mortality began earlier at Porto

12 Nov 2025
Clyde River to Hawkesbury

2 weeks | 3 weeks

	13 Nov 2025	19 Nov 2025	3 Dec 2025	17 Dec 2025	7 Jan 2026	21 Jan 2026
Mortality at Porto:		0%	**2%**	24%	24%	24%
Mortality at Mullet:		0%	0%	0%	**66%**	66%

samples



Disease timeline 2024 – 2025

Mortality event probably lasted for 2 months

Earlier 2024	2 Dec 2024*	11 Dec 2024	19 Dec 2024	8 Jan 2025	20 Jan 2025
Mortality at Mullet: 0%	0%	started	31% to 60%		88% salvage harvests

*mortality at Porto

samples
SVC24-034

Comparison of mortality pattern

2024 – 2025	progressive-slow
2025 – 2026	acute-sudden

Mortalities occurred first at Porto in both summers

Environmental monitoring (2025 – 2026)

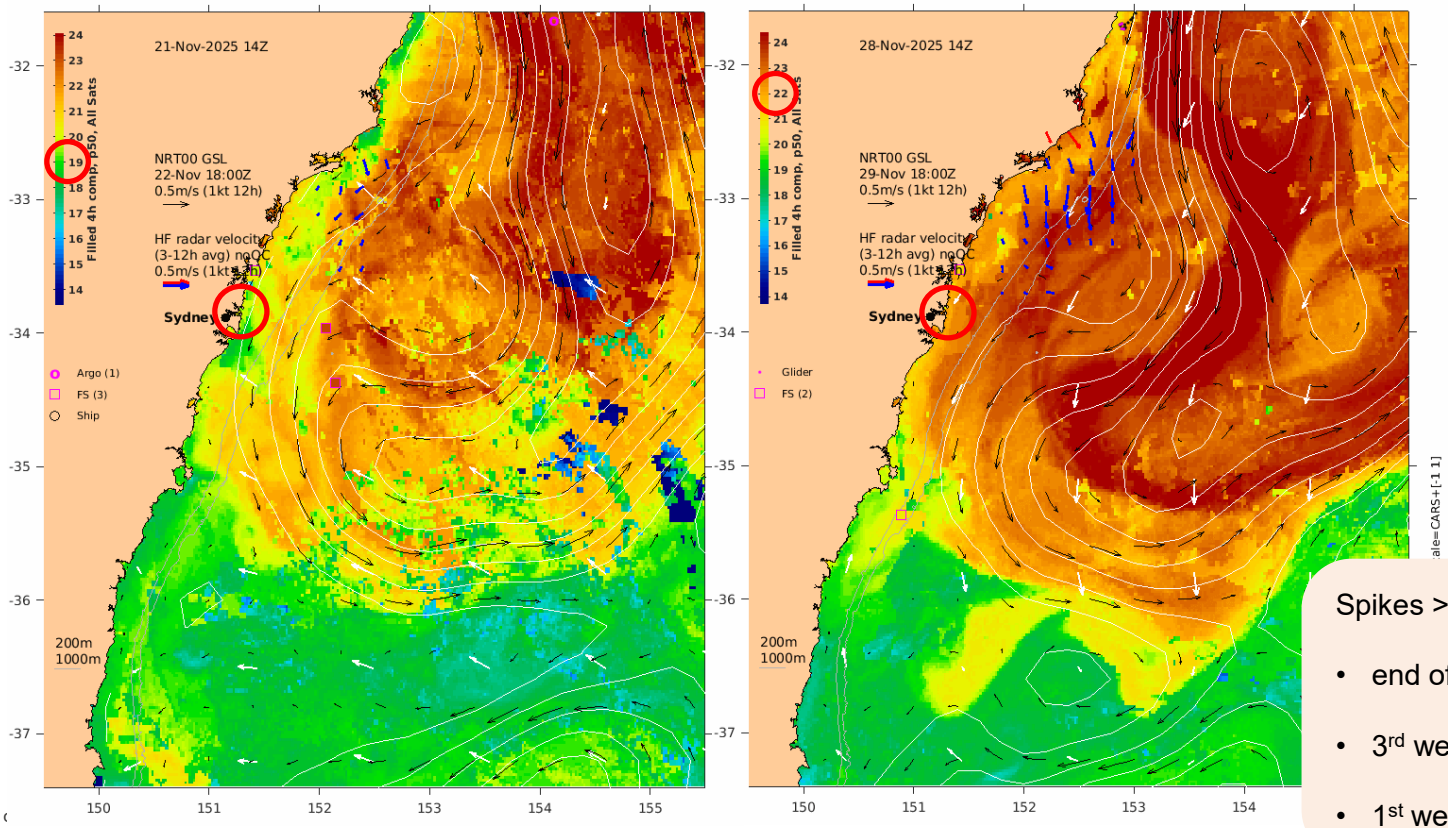
Hornsby Council Probe at Mullet

ICT-DPI Probe at Porto
+ USYD oxygen, salinity and bar pressure probes

USYD temp probes in baskets

- Hornsby Council Gunyah probe
- Bureau of Meteorology rainfall and air temp
- Satellite telemetry – sea surface temp

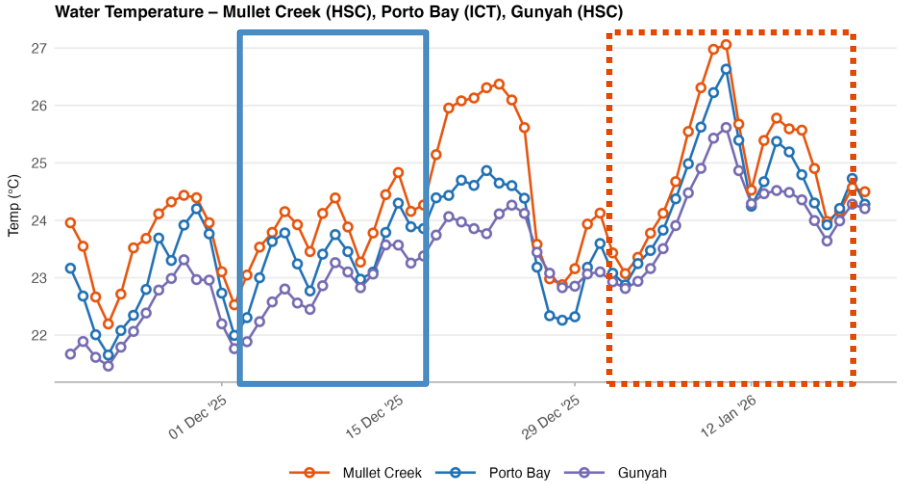
Sea surface temperature (2025 – 2026)

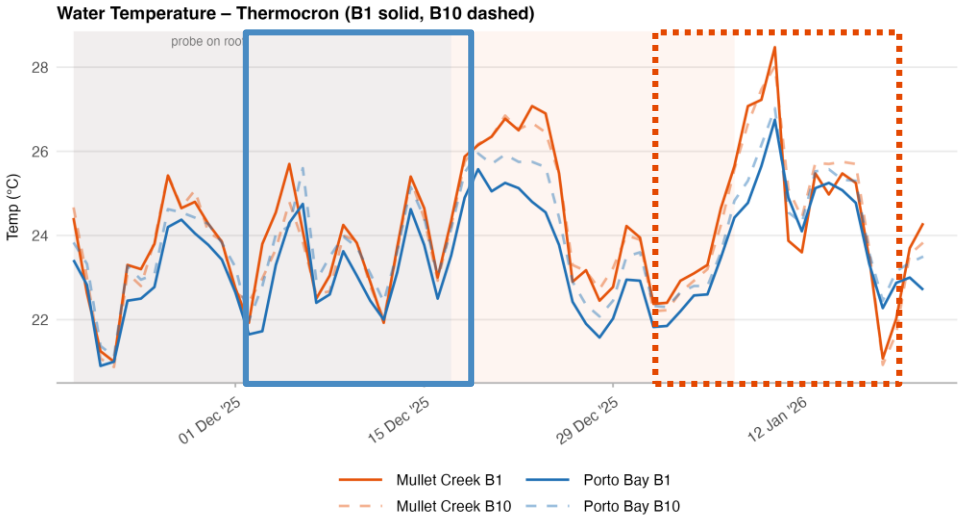


Spikes >23°C

- end of Nov 2025
- 3rd week Dec 2025
- 1st week Jan 2026

Water temperature (2025 – 2026)

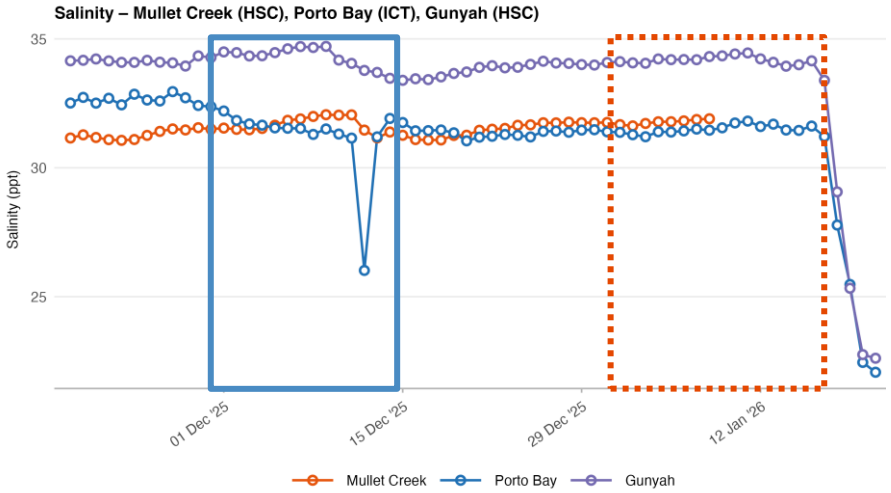


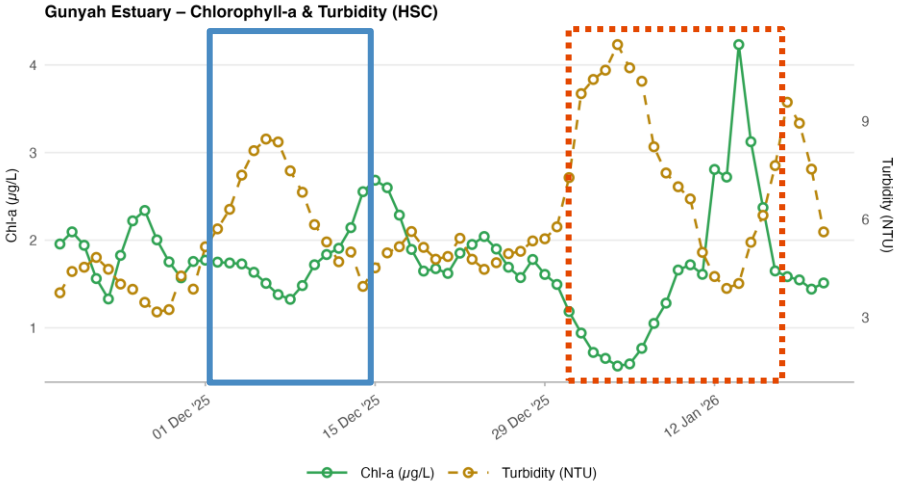


Temperature inside the basket 1 – 2 °C higher

Credit: Joshua Tu

Salinity and Chlorophyl-A (2025 – 2026)



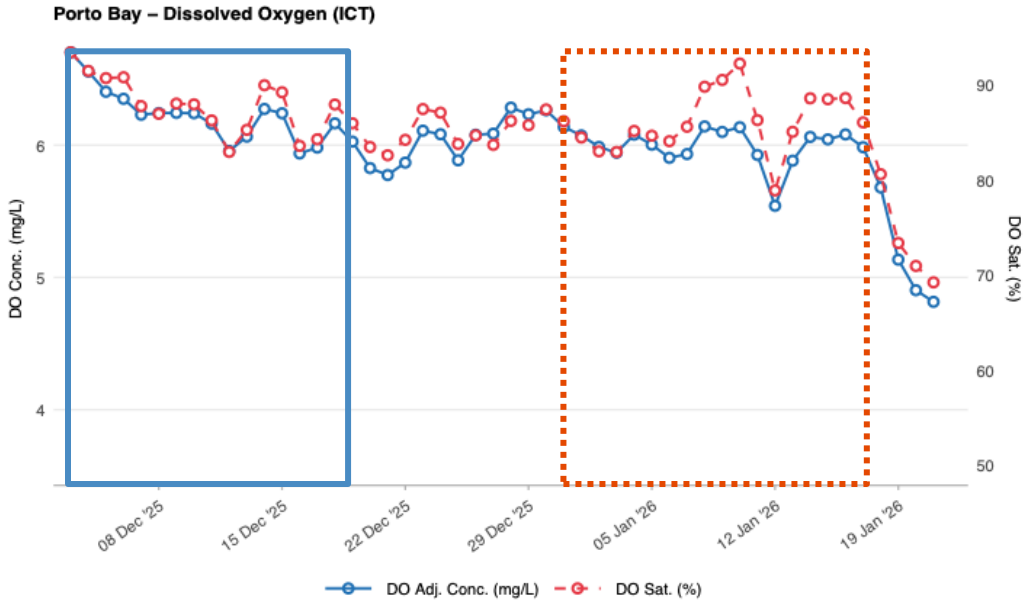


salinity mostly stable and high

spikes in chlorophyll-a and turbidity considered low to moderate

Credit: Joshua Tu

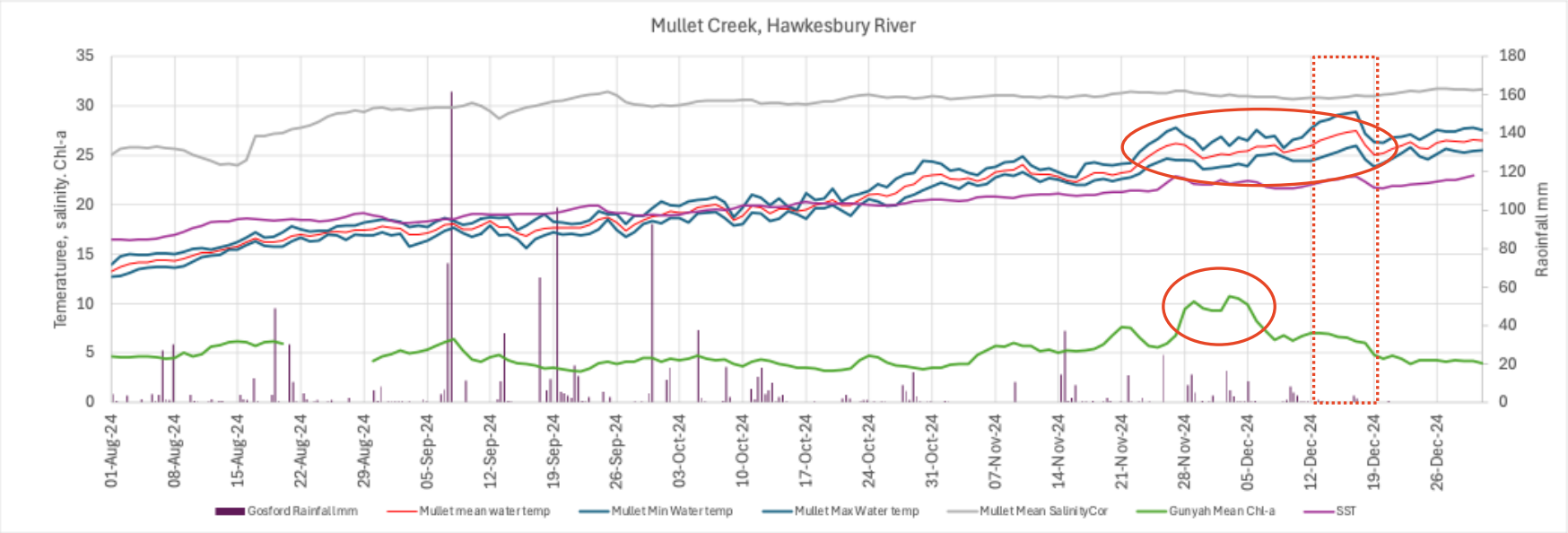
Dissolved oxygen (2025 – 2026)



good level of dissolved oxygen

Credit: Joshua Tu

Environmental data - Mullet Creek Aug-Dec 2024



- Salinity relatively stable and high
- Av daily temperature >25 °C from end November
- Max daily temp ~30 degrees around the time mortalities were noticed at Mullet
- Spike in chlorophyll 1-2 weeks before mortality started

Temp, salinity – Mullet probe
ChlA- Gunyah probe
SST- satellite data

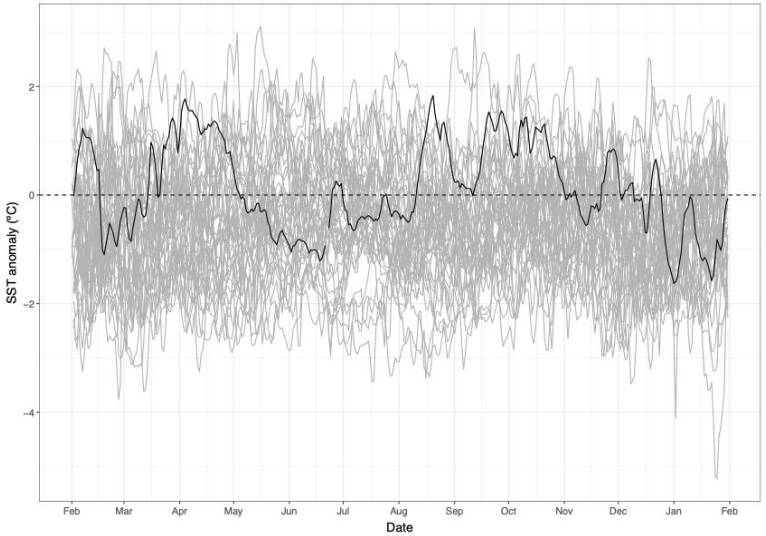
Acknowledgements: Lachy Ingram, Ana Rubio

Summary of environmental conditions

temperature >25 ^{o}C before mortalities in 2024 – 25 and 2025 – 26
But not unusual - 45 years of historical data

chlorophyll-A spiked before mortality in 2024
harmful algae?

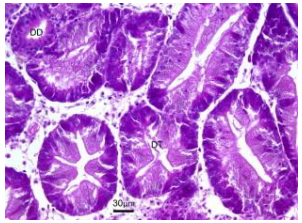
turbidity spikes on spring tides - every month
pollutants mobilised from sediment?

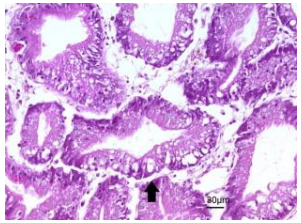


Comparison of environment 2024 and 2025
High temperatures recorded on leases both years
(Mortalities tend to occur in summer all over the world)

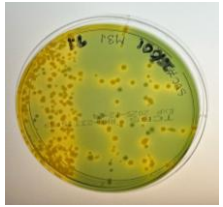
Back to Domi – now the vet will need to run some tests …

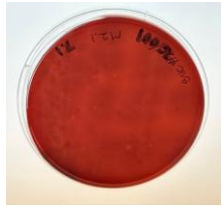
Histopathology



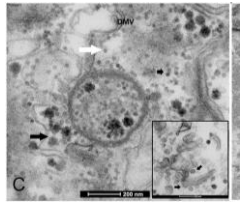


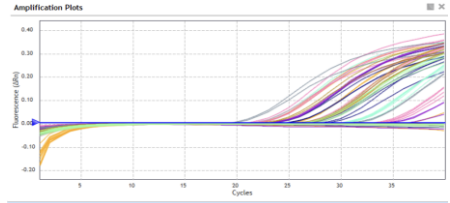
Bacteriology





Virology





Knowles et al. 2014; Carella et al. 2023

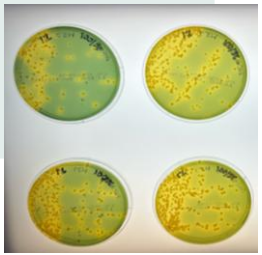
Bacteriology

2025

High bacterial counts

- in sick oysters at Porto 3 Dec 2025
- in live oysters at Mullet on 7 Jan 2026

Vibrios present and probably played a role in the mortality

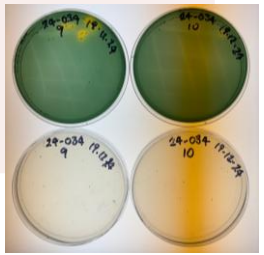


2024

Low bacterial counts in sick oysters

Vibrios present (normal)

Mortality was not caused by bacteria



Comparison of bacteriology 2024 and 2025
Significant bacterial infection in 2025 but not in 2024

Virology

2025

POMS negative
- All samples collected 13-Nov-25 – 21-Jan-26
- DPI samples following notification by farmers

PoSV-1 positive but low viral loads

2024

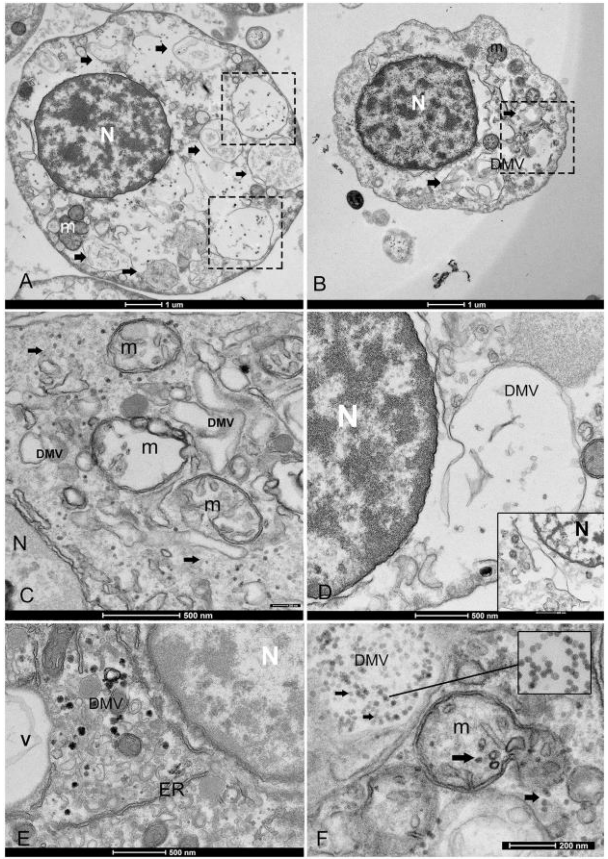
POMS negative
- All samples collected on 19 Dec 2024
- DPI samples following notification by farmers

PoSV-1 positive and high viral loads
- PCR developed in collaboration with EMAI

Comparison of virology 2024 and 2025
No evidence of POMS
Possible role of PoSV-1

What is PoSV-1

- Previously unknown picorna-like virus
- Discovered through metatranscriptomics in 2024
- Related virus associated with mass mortality events in shellfish in the Mediterranean



Credit: Vince Costa

Carella et al. 2023

Histopathology

Comparison of histopathology 2025 and 2024
Inflammation more severe in 2024 than 2025
Bacterial septicaemia only 2025
Other lesions present both years

2025

Inflammation
- Began two weeks after deployment
- Worsen over time from low grade to marked

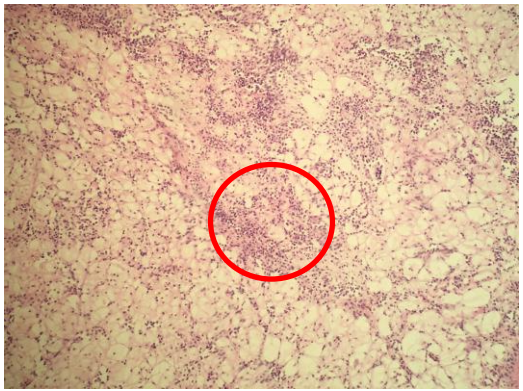
Bacterial septicaemia in diseased oysters

2024

Inflammation
- Severe
- Persistent (still present in January 2025)

No bacterial septicaemia

Connective tissue
Diffuse inflammation (3)
SVC26-001-3 Mullet



Connective tissue
Diffuse inflammation (4)
SVC24-034-4 Mullet

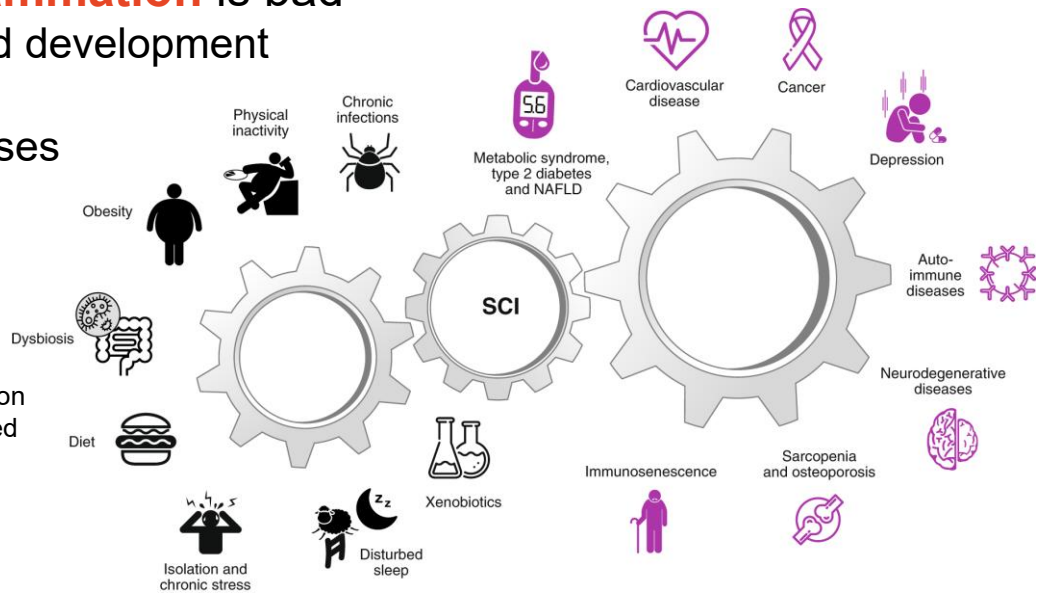
Credit: Richard Whittington

Is inflammation harmful?

Inflammation is part of the normal healing process

But **persistent (chronic) inflammation** is bad

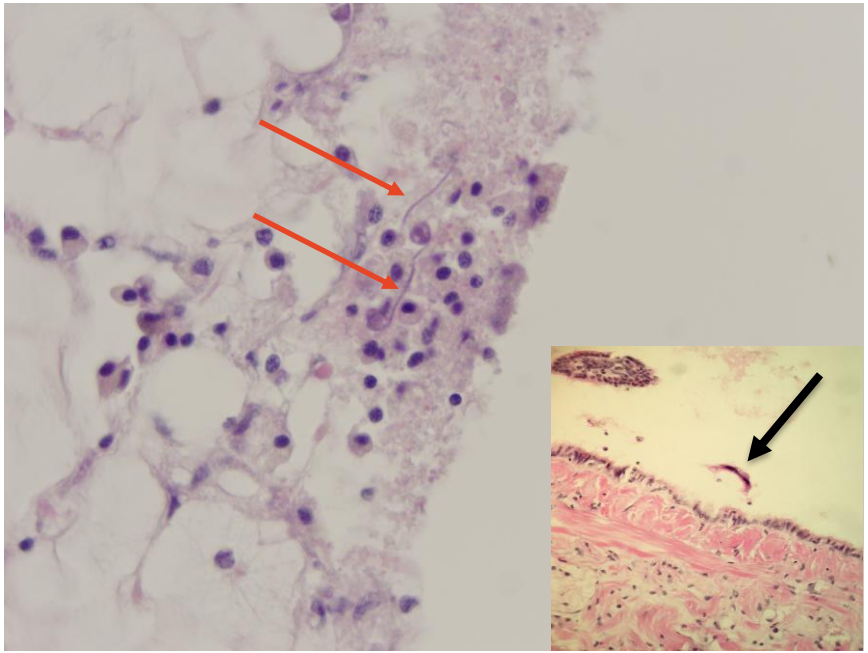
- Diverts energy from growth and development
- Can damage organs
- Can predispose to many diseases



Several causes of low-grade systemic chronic inflammation (SCI) and their consequences have been identified

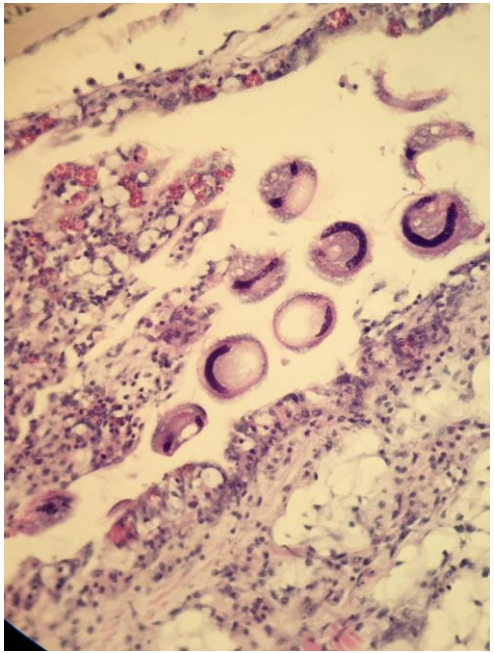
Furman et al. 2019

Other histological lesions



Credit: Richard Whittington

Mantle
Trichodina ulcer with secondary bacterial invasion
SVC24-034-5 Mullet



Gill
Trichodina
SVC25-024-5
Clyde River

***Trichodina* parasites**
- present in 2025 and 2024,
- also present in Clyde River

Conclusions – so far

Pattern of mortality	Sudden to progressive; starts in Porto followed by Mullet	2024 - multisystemic organ failure 2025 - bacterial septicaemia
Risk factors	Risk factors • water temperature >25 °C • inflammatory disorder	toxins, pollutants, other factors immune deficiency, possible role of PoSV-1
Secondary diseases	Often opportunistic	Bacterial agents (Vibrios) Parasites (Trichodina sp.)
Revised case definition	**HUMIS**	Hawkesbury unexplained mortality and inflammatory syndrome Further R&D is required

What causes HUMIS disease?

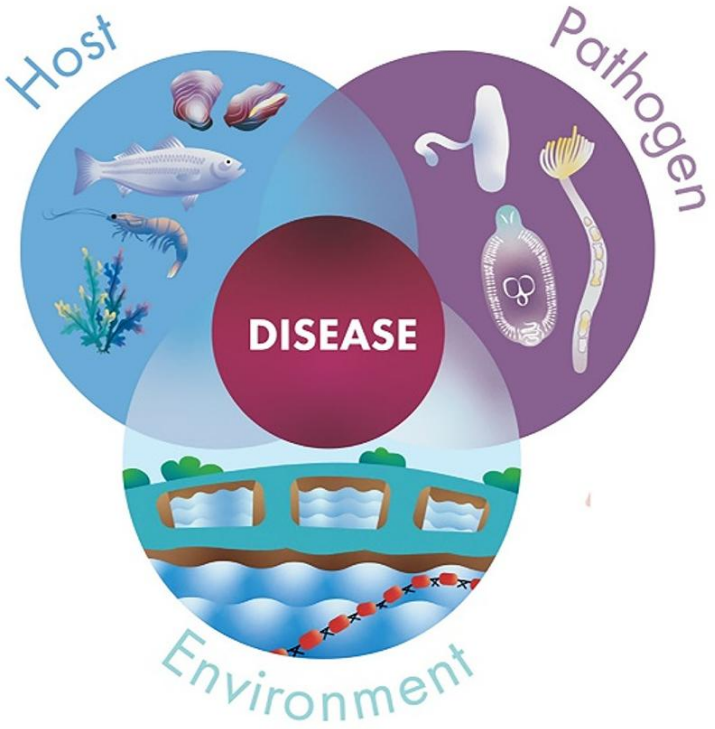
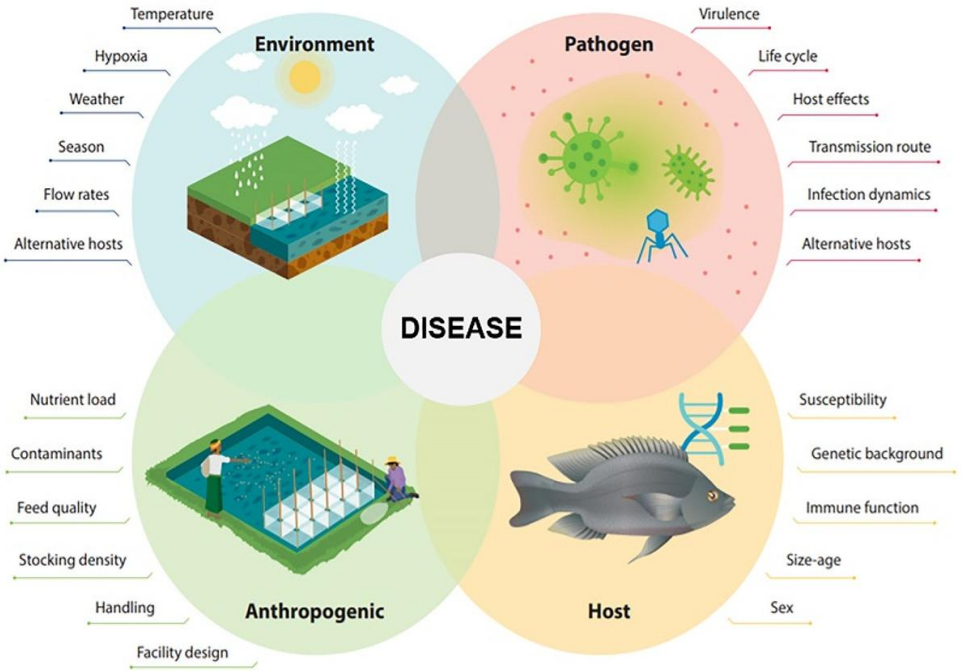


Image by Barnes and Delamare-Debouteville
Dong *et al.* 2023

What causes HUMIS disease?

water temperature >25°C

pollutants?



PoSV-1? opportunistic agents?

chronic inflammation

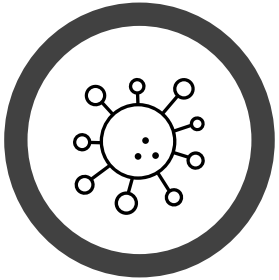
Image by Barnes and Delamare-Debouteville
Dong *et al.* 2023

Recommendations

Improve **early detection** and rapid-response sampling

Expand **environmental and toxicological** investigations

Data integration and long-term monitoring of production data



Further investigate the **role of viral agent PoSV-1**

Develop baseline health datasets for Australian oyster populations

What does a happy oyster look like?

Laverty Pathology

IRON STUDIES

Specimen Type: Serum			
Serum Iron	24	umol/L	(10-30)
Transferrin	31*	umol/L	(32-48)
Transferrin Saturation	40	%	(13-45)
Serum Ferritin	16*	ug/L	(30-165)

Although the transferrin saturation is normal, the mildly reduced ferritin suggests iron deficiency.

During the reproductive years, iron deficiency in women is usually due to multiparity or heavy menstrual losses. Investigation of the gastrointestinal tract for a source of blood loss may be indicated.

Credit: Phil Barry-Cotter and Jeff Go

Histology | Microbiome | Virome

Can we vaccinate them?

Domi 10 years ago …

We recommend the following vaccination schedule for your puppy:

Age	Vaccination
6-8 weeks	1st vaccination, C3 vaccine
10-12 weeks	2nd vaccination, C3 + Bronchi-Shield III vaccines
14-16 weeks	3rd vaccination, C3 vaccine
16 weeks of age (if 3rd vaccination given at 14-weeks of age)	4th vaccination, C3 vaccine

We recommend giving a **C3 booster** to your puppy at **6-months** of age to ensure complete protection. After this, they will need a C3 booster **every 3-years**. Your puppy will need their first **Bronchi-Shield III annual booster** at **15-month**s of age, with a booster needed **every 12-months.**

We made a groundbreaking discovery … oysters can also be vaccinated

Oyster vaccine for POMS

Refurbished PC2 oyster challenge room

Recruited a fantastic PhD student

Developed vaccine candidates

Results after a live POMS (OsHV-1) challenge

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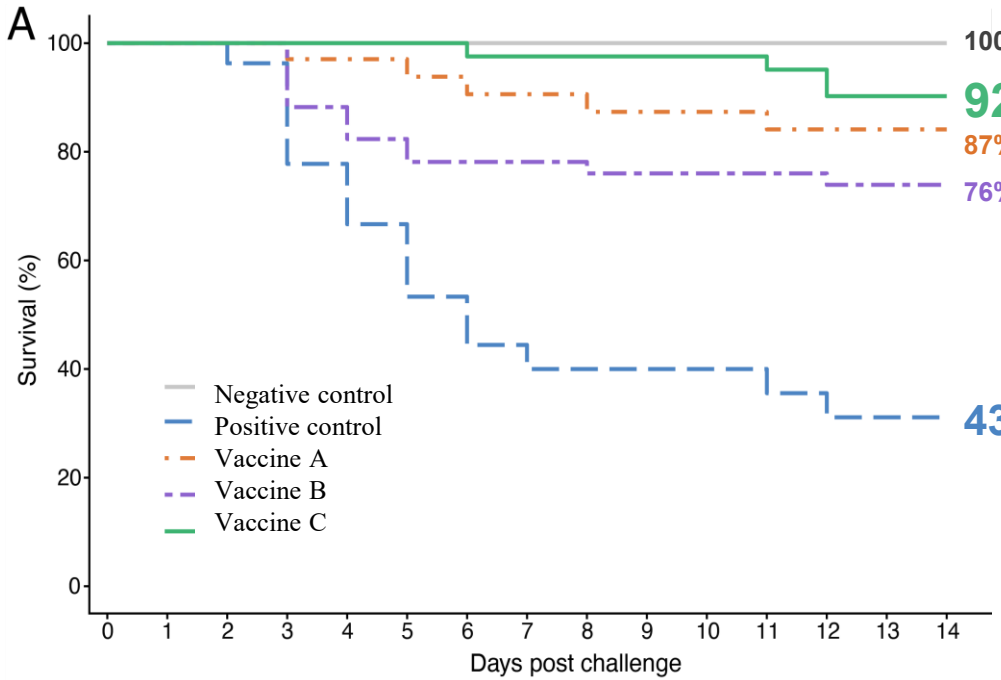

100% survival with no viral challenge

92% survival with Vaccine C

87% survival with Vaccine A

76% survival with Vaccine B

43% survival with no vaccine

~ **60% mortality in the lab**, which is the gold standard for vaccine development

Filing a patent & seeking for funding

- Optimise delivery
- Determine duration of protection

Credit: Arman Hossain

A flexible vaccine platform for oyster health

- Not just a solution for POMS
- Can be quickly adapted to new targets
- Similar concept to autogenous vaccines used in livestock and finfish industries

Wrapping up – most of veterinary medicine comes down to:

Listening

history collection with those on the ground

Looking

animal and its environment

Preventing

husbandry practices to improve health

Acknowledgments

- **Josh Stubbs, Ben Ralston, Luke Stubbs** and **all the team at Hawkesbury River Oyster co**
- **Hawkesbury River Growers**
- **The research team:** Vincenzo Costa, Richard Whittington, Joshua Tu, Arman Hossain, Jane Williams, Kerrie Wiley, Victoria Brookes, Jefffrey Go and Cheryl Jenkins
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