



Dalhousie
University

Modelling dermo and chasing MSX tolerance

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Project: Diagnosis, thermal tolerance, and risk of *Perkinsus marinus* to the oyster farming industry



Objectives

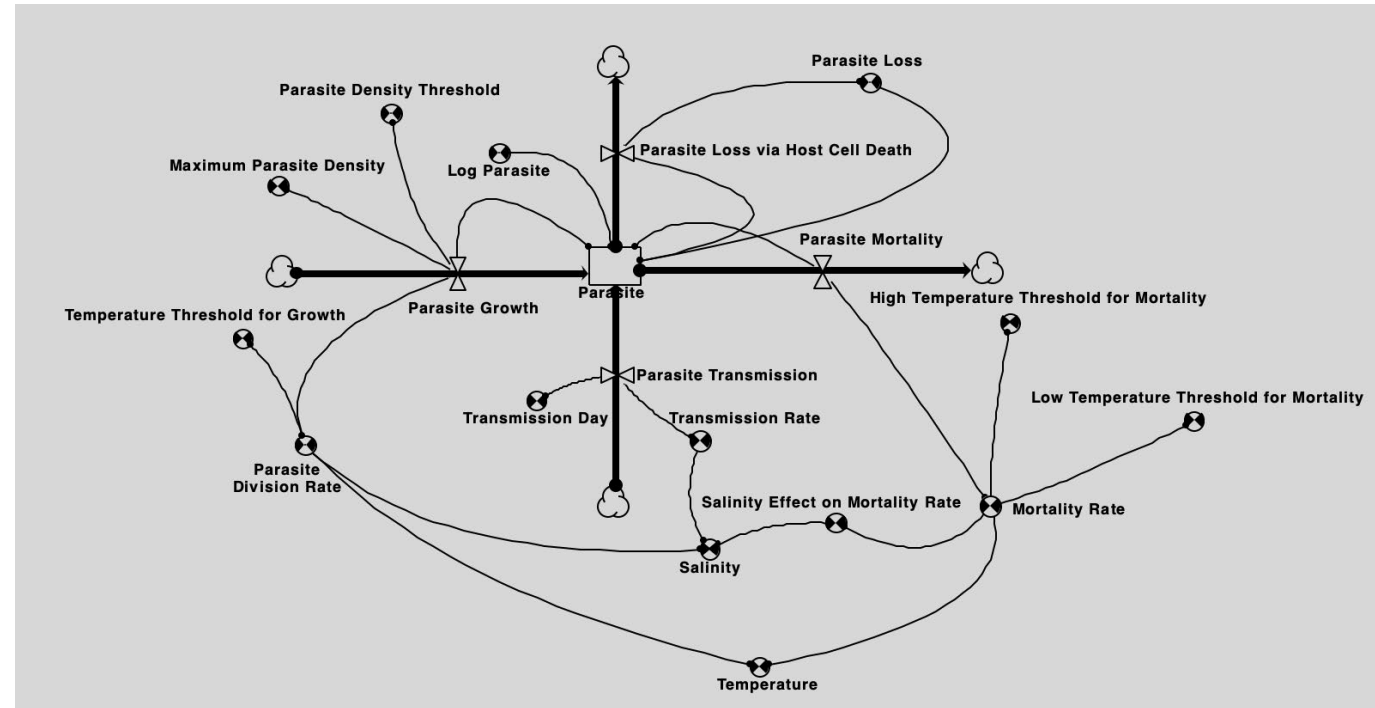
- Implement a model to simulate *Perkinsus marinus* proliferation based on temperature and salinity forcing for sites across Nova Scotia
- Identify knowledge gaps on *P. marinus* proliferation based on a sensitivity analysis
- Test different scenarios of *P. marinus* parasite proliferation and identify mass mortality risks



Model – Calvo et al. (2001)

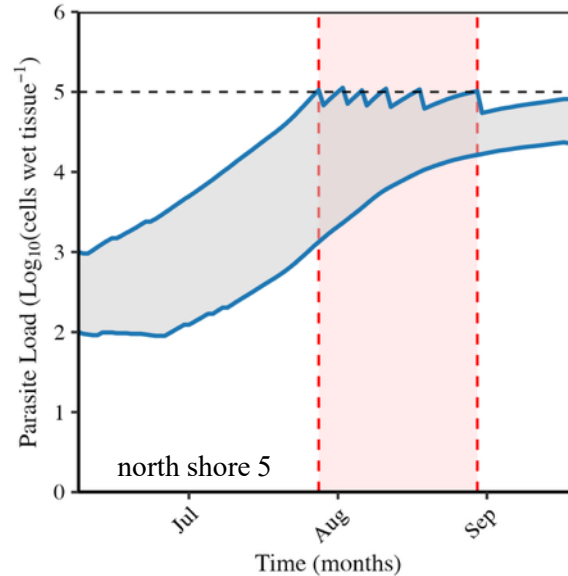
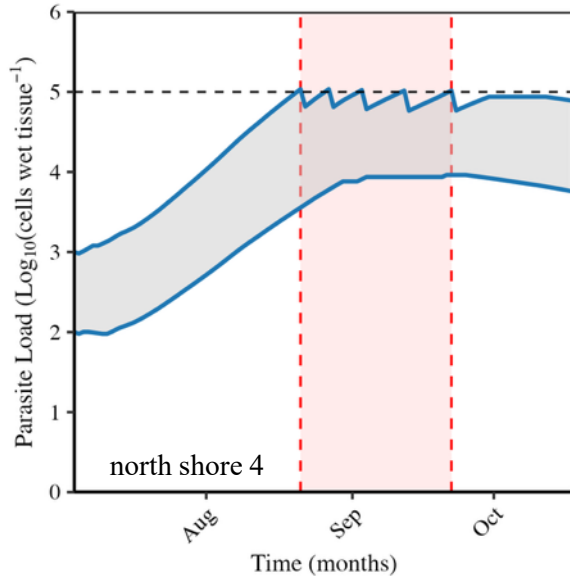
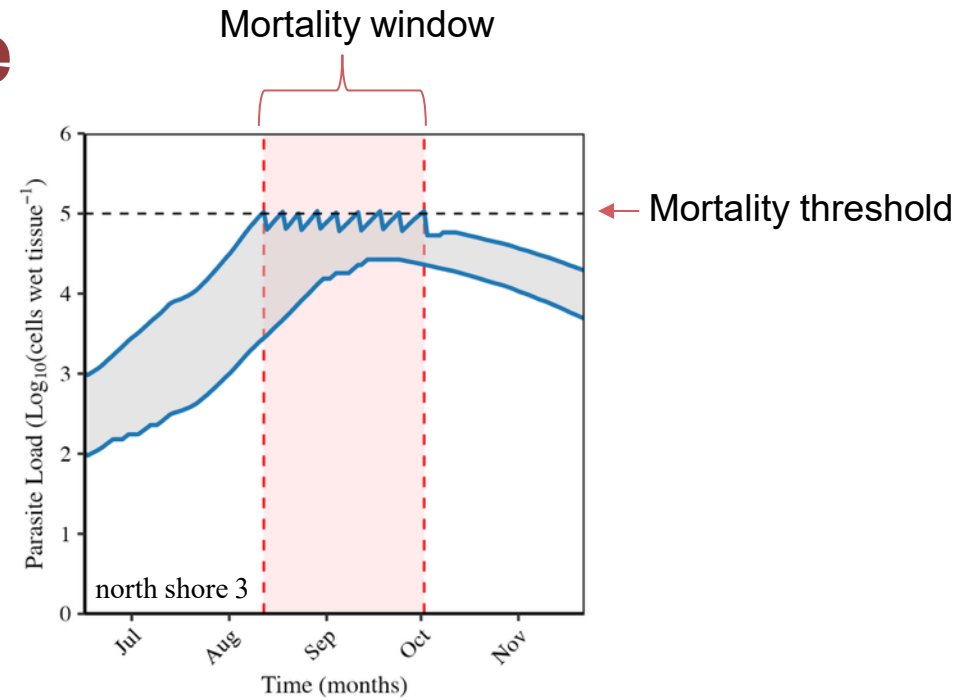
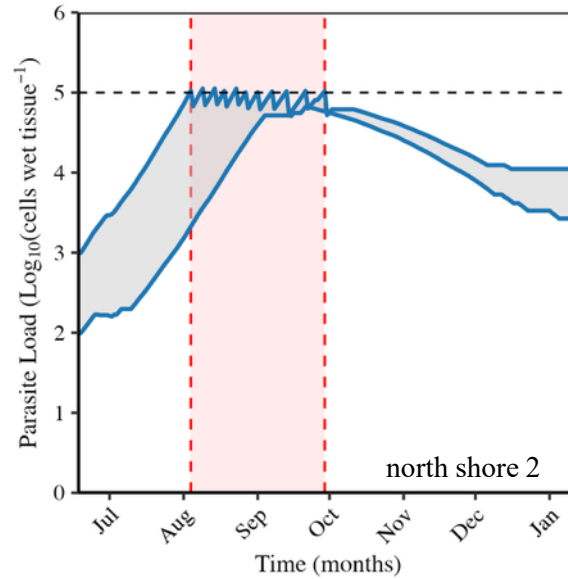
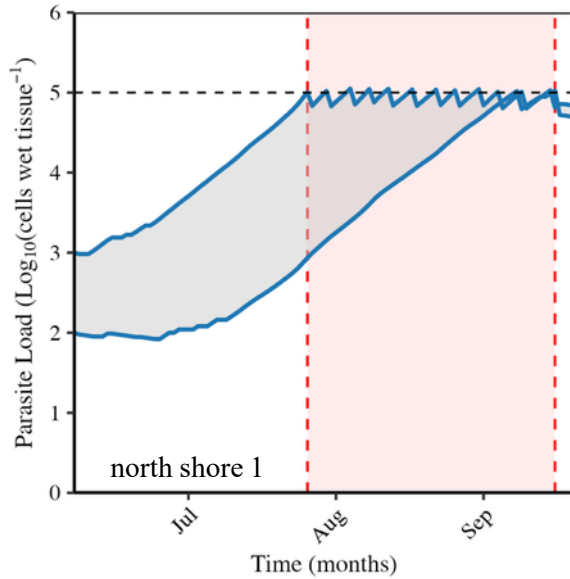
- Main processes:
 - Parasite Growth (P_G)
 - Parasite Mortality (P_M)
 - Parasite Loss via Host Cell Death (P_L)
 - Parasite Transmission (P_T)

$$dP/dt = P (P_G - P_M - P_L) + P_T$$



Results – Parasite load – North Shore

Parasite Load ($\text{Log}_{10}(\text{cells wet tissue weight}^{-1})$)

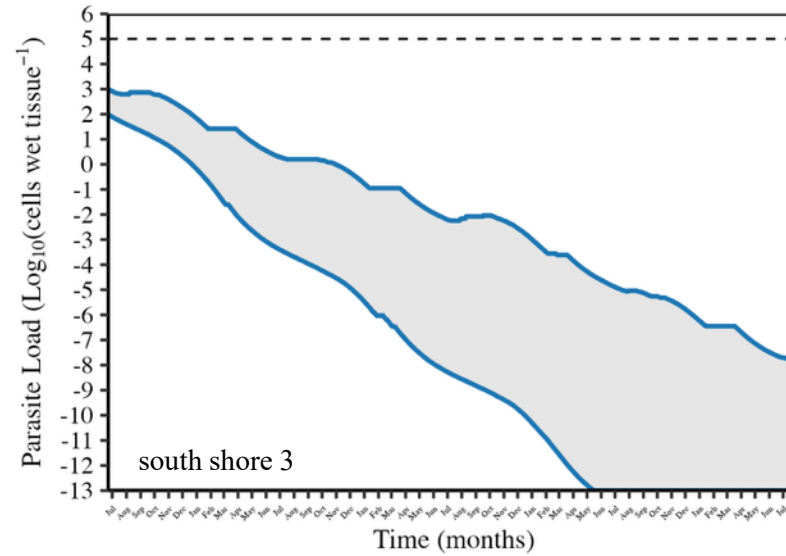
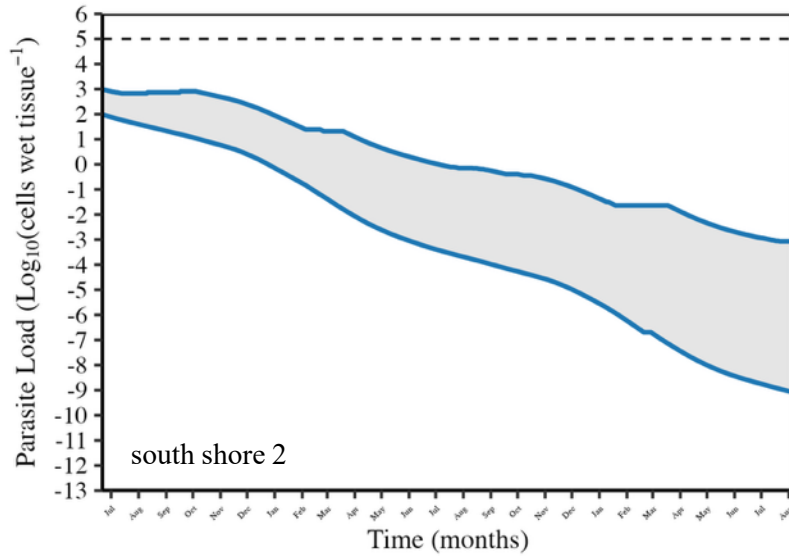
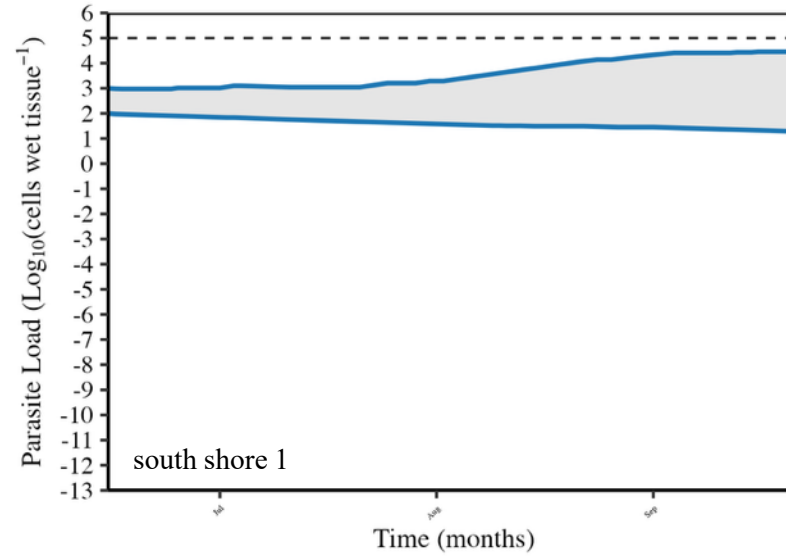
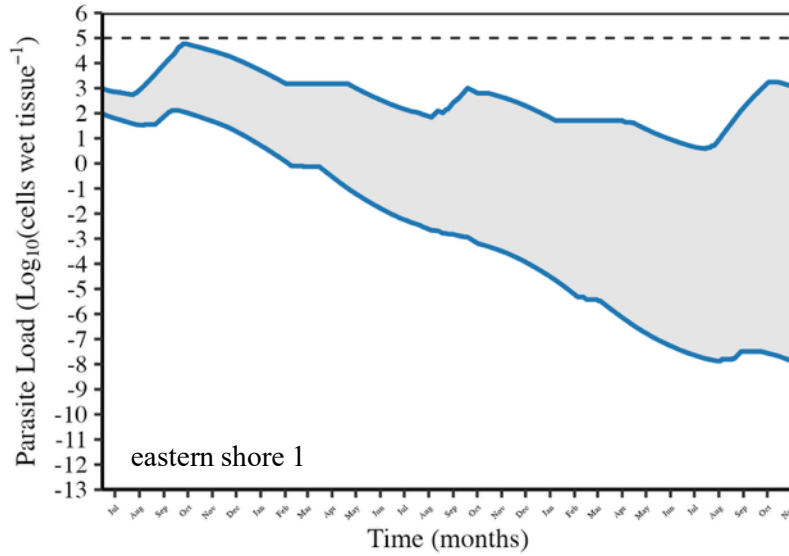


**Best and worst case
Scenarios:
Initial parasite load
is key**



Results – Parasite Load – South and Eastern Shores

Parasite Load ($\text{Log}_{10}(\text{cells wet tissue}^{-1})$)



T is key!



Next steps

- Evaluate the thermal tolerance of *Perkinsus marinus* from the North shore of NS (Culture of the parasite is ongoing at LSU!) **Temperature is key**
- Fine-tune the laboratory for *P. marinus* quantification using the Ray's fluid thioglycollate medium method
- **Seek funds** to monitor *P. marinus* using a strong quantitative approach. **Initial parasite load is also key**
- Validate the model and identify risks



Project: Charting a course forward: Evaluating oyster survival following MSX exposure to identify genetic markers of resistance



Fisheries and Oceans
Canada

Pêches et Océans
Canada

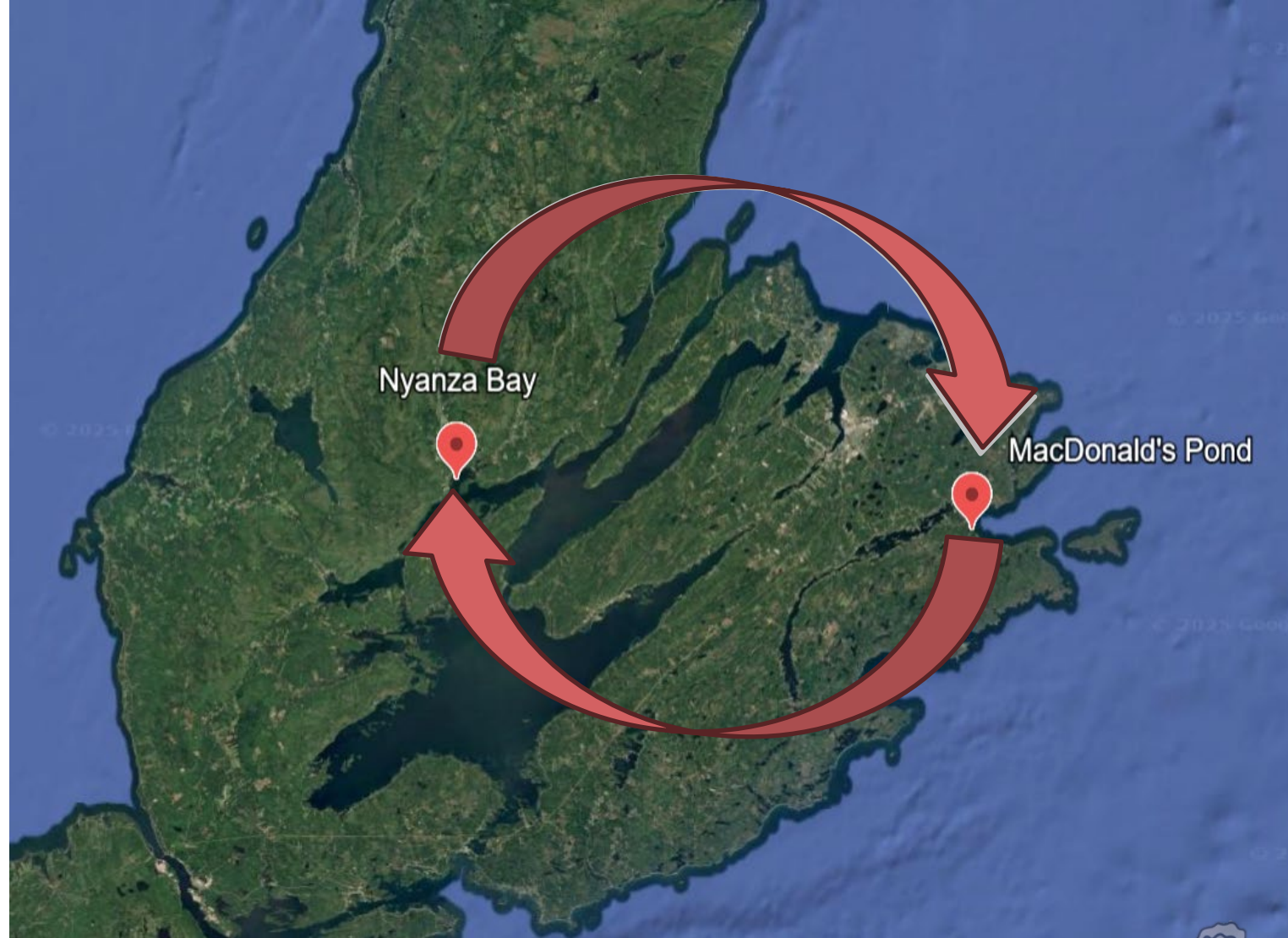
Objectives

- Determine whether the survival of MSX-infected oysters in MacDonalds Pond, NS is driven by genetic resistance or environmental factors (including depth) that diminish pathogen virulence.
- Assess whether naïve oyster survival differs between floating or bottom cage culture systems in an MSX-infected area of PEI.
- Identify potential genetic markers of MSX resistance in oysters from NS and PEI.



NS Transplant

Reciprocal Oyster
Transplant from
MacDonald's Pond to
Nyanza Bay and
Nyanza Bay



General Experimental Procedure

1

Oysters Collection
From MacDonald's
Pond



2

Non-Lethal
Sampling for
Genotyping



3

Initial Length
Measurements
and Place in Bags

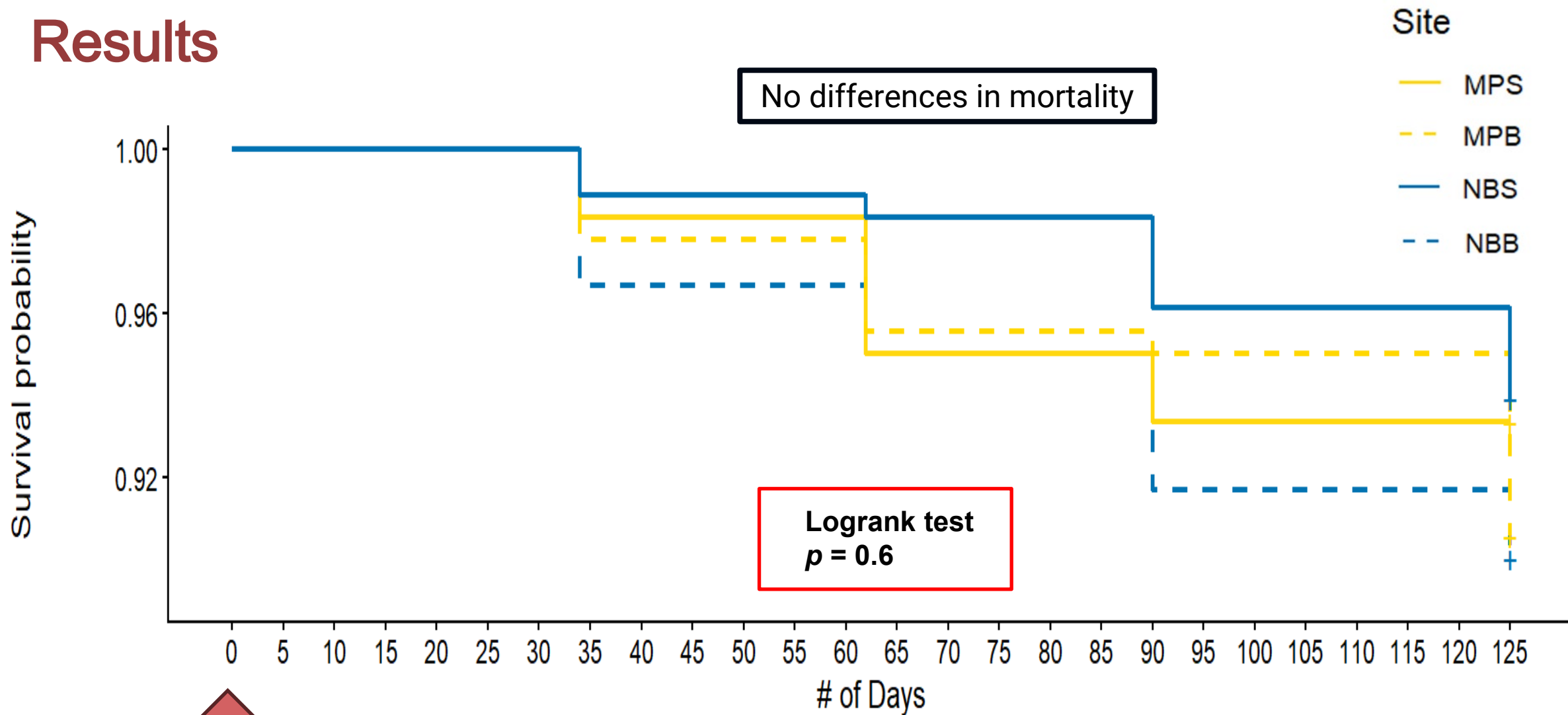


4

Deployment and
Mort. Monitoring
(inc. T and S)



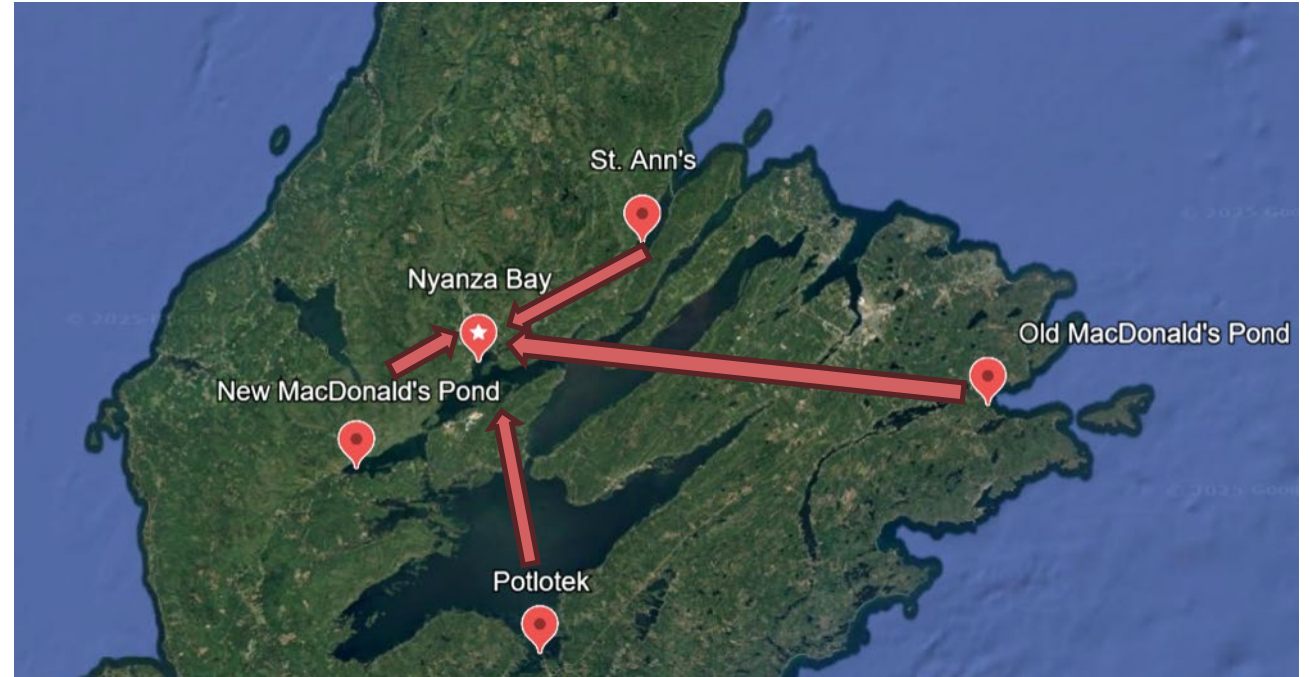
Results



63% tested positive

Tolerance? Resistance?... More Experiments!

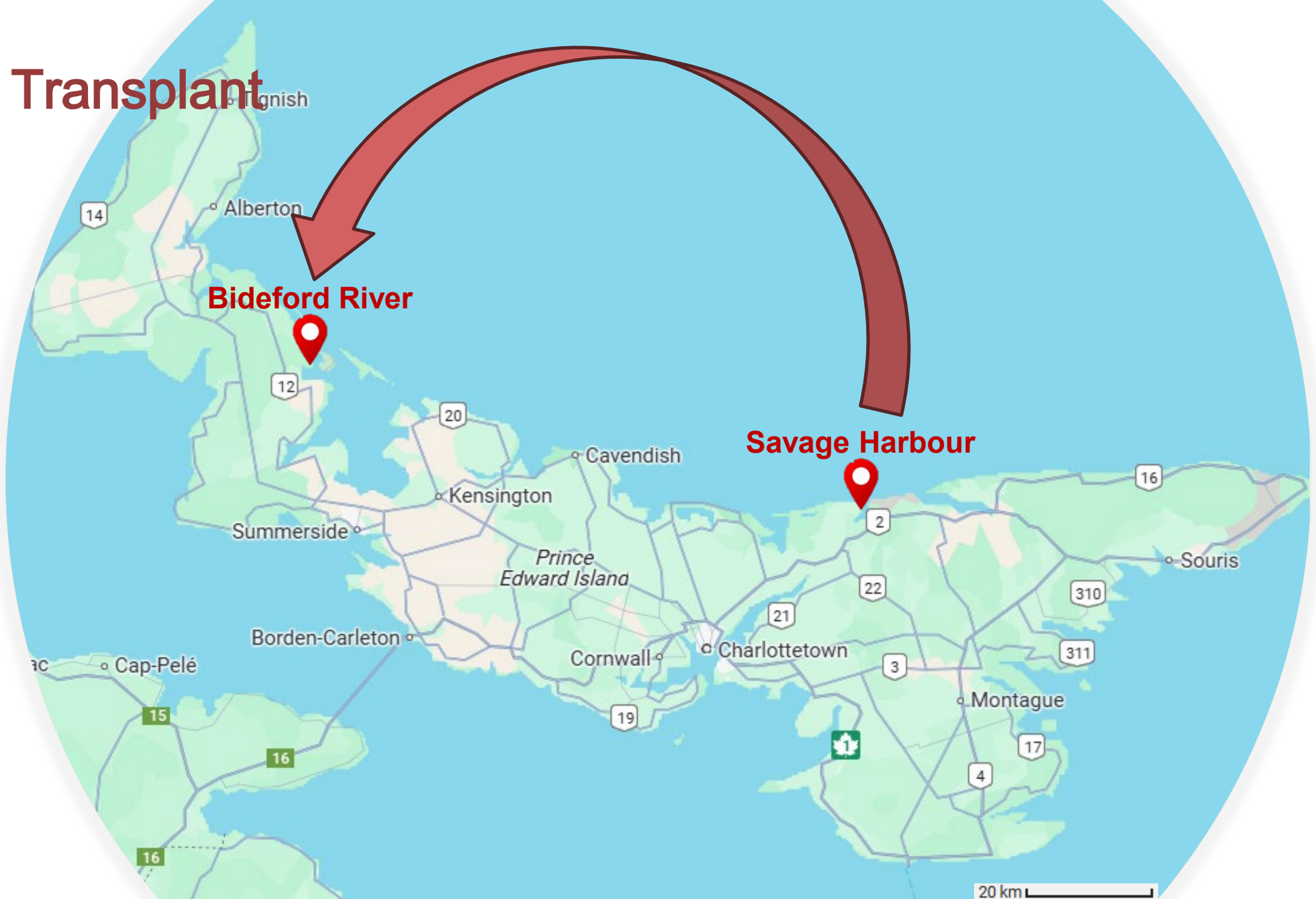
- Started in September 2025
- 4 sites:
 1. Old MacDonald's Pond → Wild Bed
 2. Potlotek → Farm
 3. St. Ann's → Wild Bed
 4. New MacDonald's Pond → Farm
- Sampled 30 oysters from each site for initial prevalence
 - Waiting for qPCR results
- **120 oysters** from each site placed in a bottom cage in Nyanza Bay



Google Earth, 2025

Stay Tuned!

PEI Transplant



General Experimental Procedure

1

Oysters Collection
From Savage H.
and Bideford R.



2

Non-Lethal
Sampling for
Genotyping



3

Initial Length
Measurements
and Place in Bags

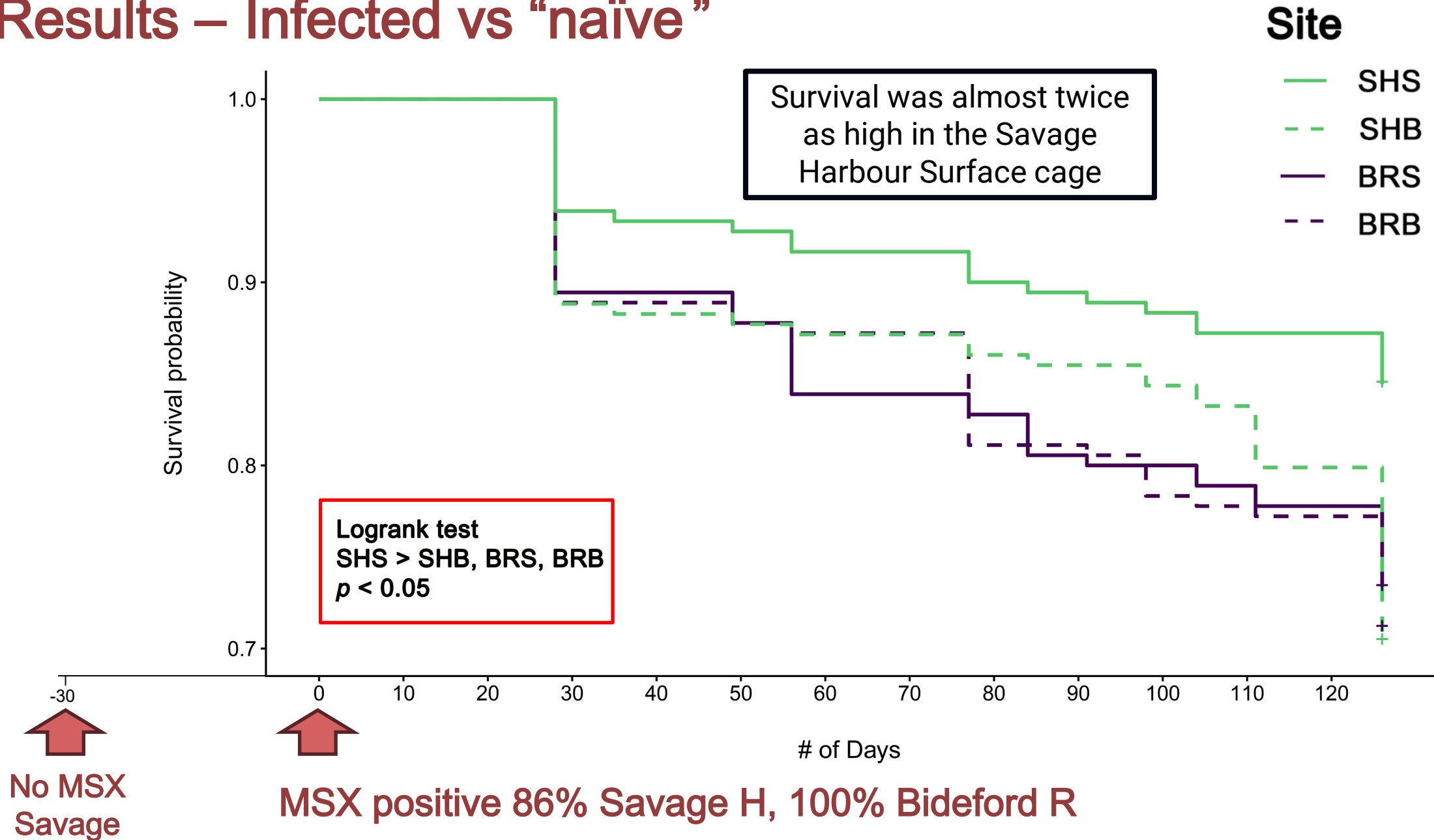


4

Deployment and
Mort. Monitoring
(inc. T and S)



Results – Infected vs “naïve”



Next steps

- **Does culture depth impact survival?**
 - Potentially, but surface culture may only benefit oysters if they are recently infected.
- **Do any oysters across CB or PEI have genetic resistance to MSX?**
 - Encouraging in CB but we need to wait for the outcome of the transplant
 - Genotyping oysters using a 60K single nucleotide polymorphism (SNP) array to conduct genome-wide association studies (GWAS).
- **How do the environmental conditions in Bideford River compare to those in Cape Breton? Are there implications for pathogen virulence?**
 - Water temperature and salinity do vary. This will be further explored.

Acknowledgements



Fisheries and Oceans
Canada
Pêches et Océans
Canada



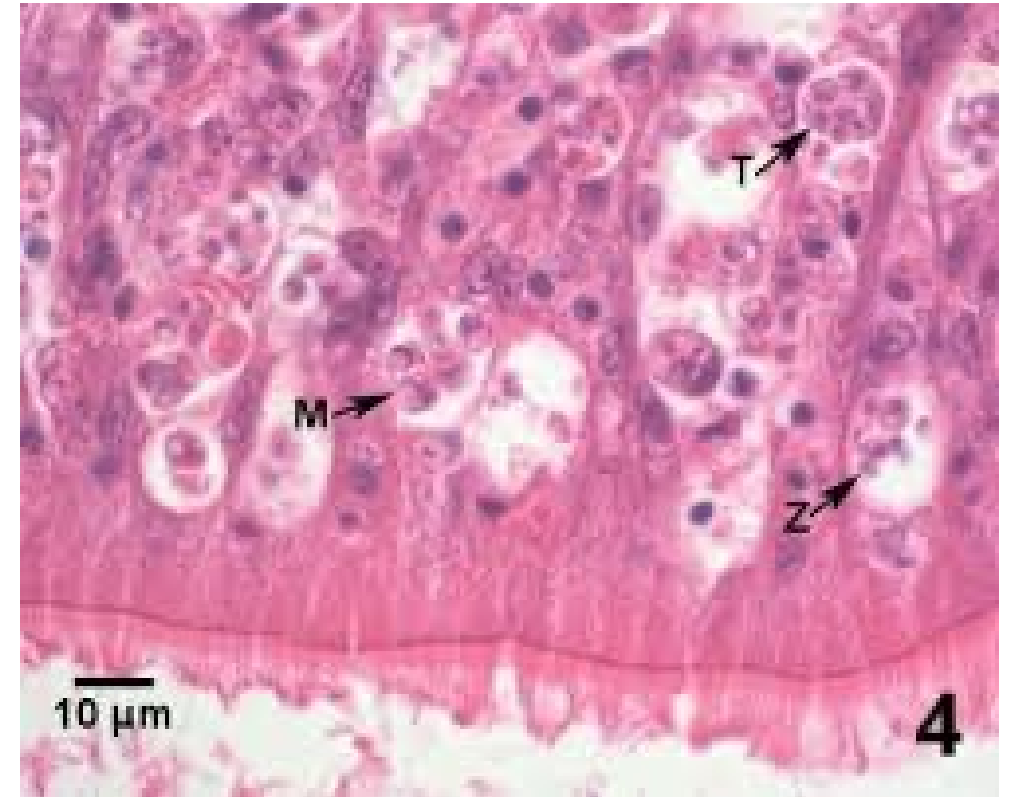
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Illustrations & Photos Courtesy of
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What is Dermo?

- *Perkinsus marinus* = pathogen known for causing dermo disease (Reece et al., 2025)
- First discovered in late 1940s (Mackin et al., 1950)
- Prominent parasite for decades in Gulf of Mexico and East Coast of the US, causing mass mortalities (Carnegie et al., 2021)
- Parasite proliferation intensifies with higher temperatures (tipping point is thought to be 20 °C) and higher salinities (above 12-15 ppt) (Calvo et al., 2001)
- Management strategies can involve:
 - movement of oysters to low salinities (La Peyre et al., 2003)
 - selectively breeding oysters that have survived repeated dermo outbreaks (Proestou et al., 2025)



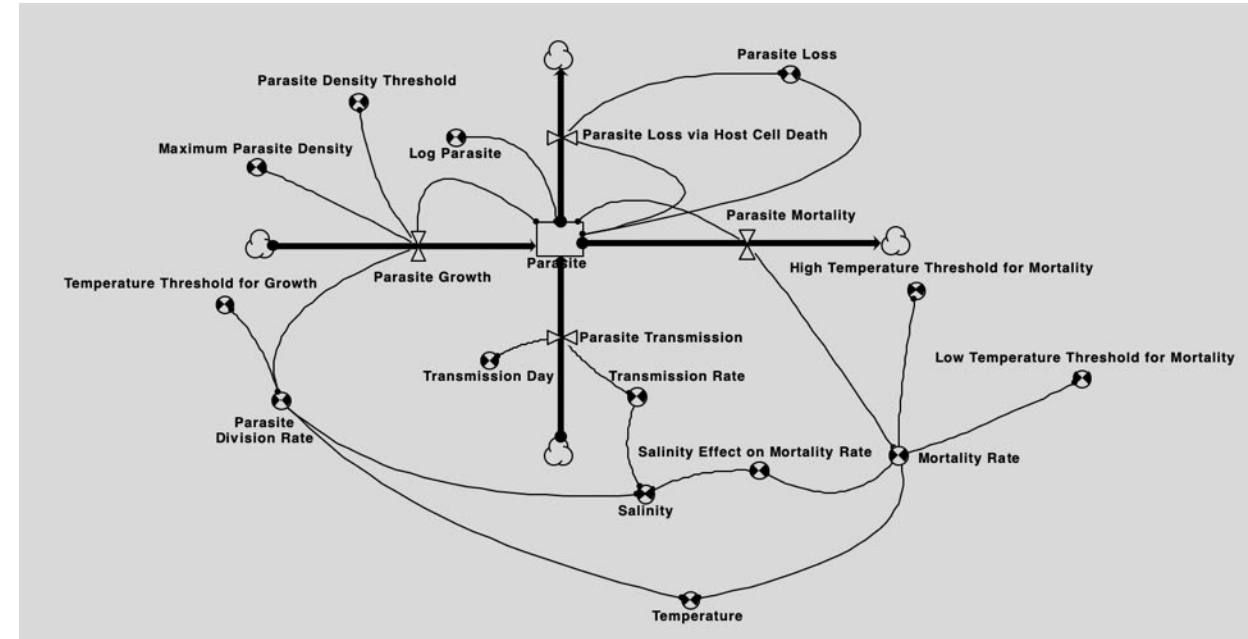
(Fisheries and Oceans Canada, 2024)

Model Description

- Parasite Growth (P_G):

$$P_G = P(t) * \mu d * (1 - ((P - A_p) / (G_p - A_p)))$$

- Triggered by the temperature threshold for growth = 20°C
- Parasite density threshold (A_p) = 10,000 parasite cells (g wet wt)⁻¹
- Maximum parasite density (G_p) = 20,000,000 parasite cells (g wet wt)⁻¹
- Salinity (S) and temperature (T) influence parasite growth through the parasite division rate (μd , d⁻¹)
 - $\mu d(t) = (-0.009 + 0.0035 * S(t)) e^{a(T(t) - 20)}$

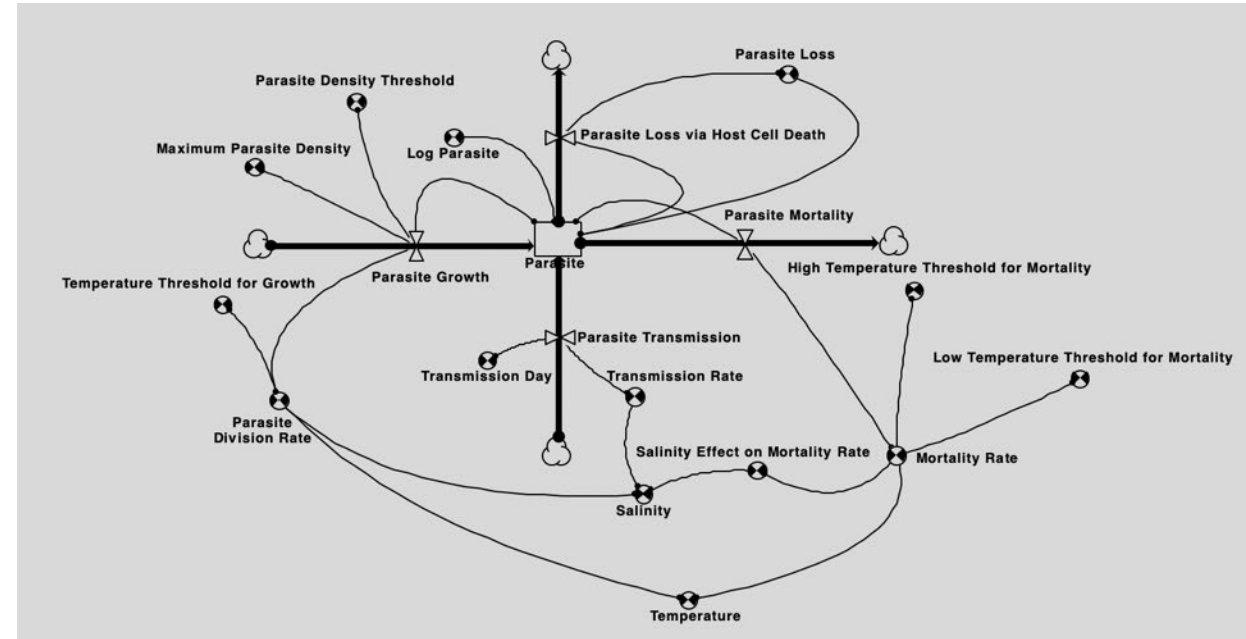


Model Description

- Parasite Mortality (P_M):

$$P_M = P(t) * \mu_m$$

- Salinity and temperature influence mortality through the parasite mortality rate (μ_m , d^{-1})
 - $\mu_m(t) = \mu_{m_{sal}} e^{a(18-T(t))}$
- Initiated at 3°C, the low temperature threshold for mortality
- Suspended at 18 °C, the high temperature threshold for mortality

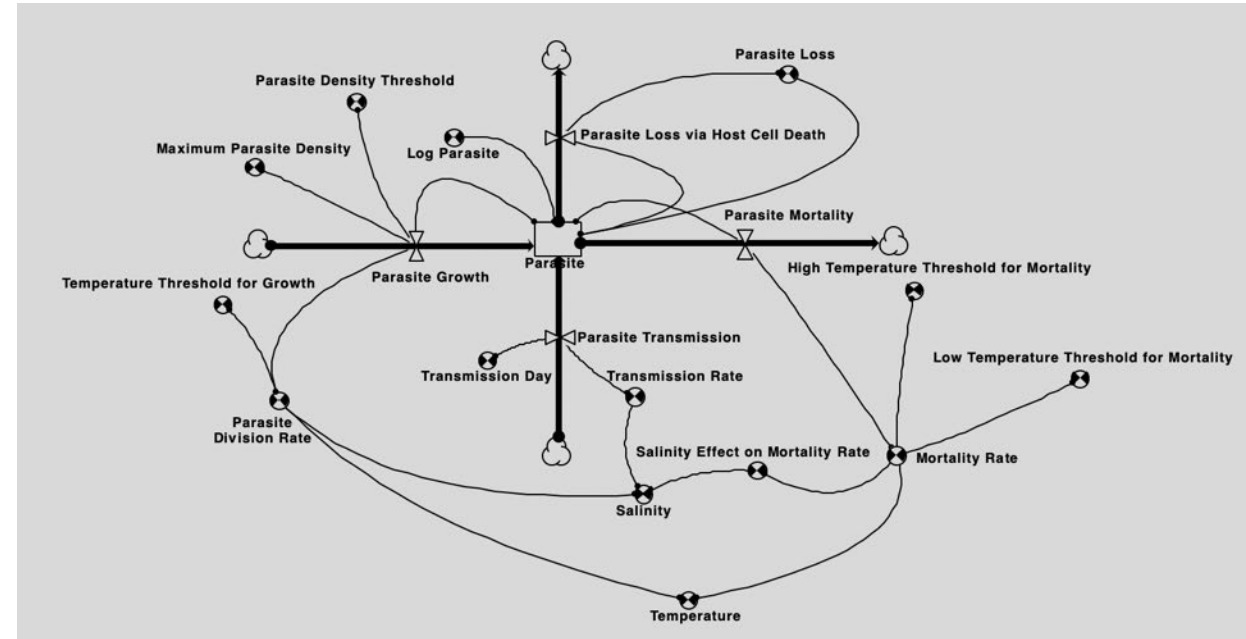


Model Description

- Parasite Transmission (P_T):

$$P_T = \mu t_{sal}$$

- Affected only by salinity through the transmission rate (μt_{sal} , cells d^{-1})
- The amount of parasite cells transmitted increases as salinity increases:
 - = 1000 cells d^{-1} at $S > 15$ ppt
 - = 500 cells d^{-1} at $15 > S > 12$ ppt
 - = 100 cells d^{-1} at $12 > S > 9$ ppt
 - = 50 cells d^{-1} at $9 > S > 6$ ppt and
 - = 0 cells d^{-1} at $S < 6$ ppt

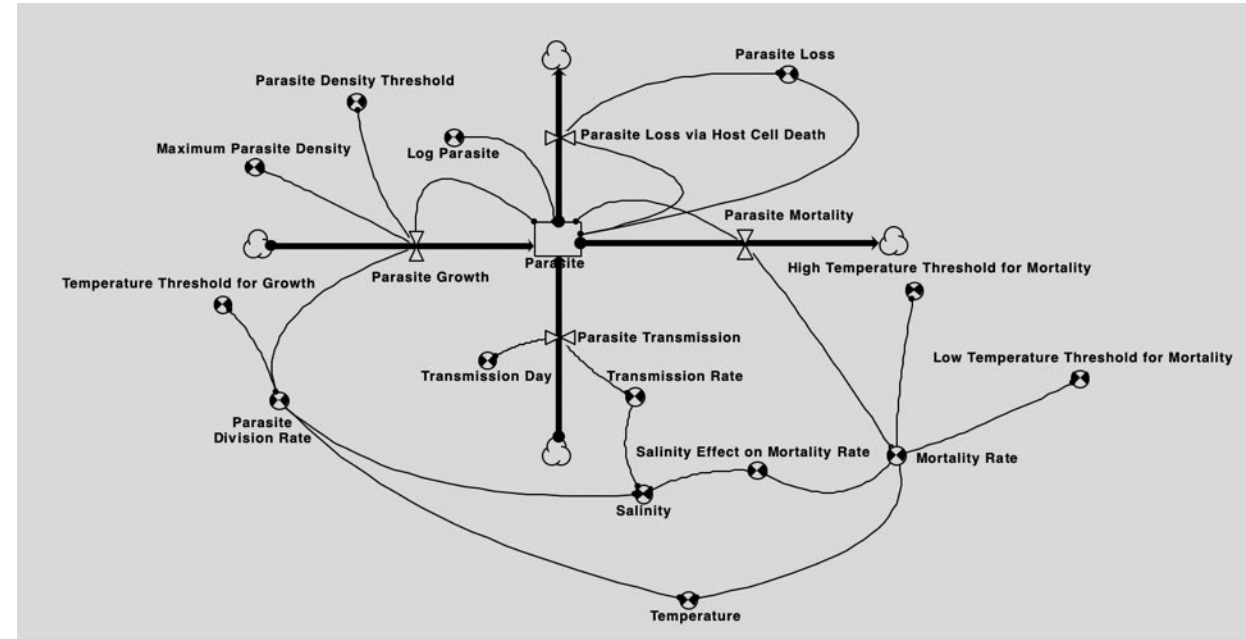


Model Description

- Parasite Loss via Host Cell Death (P_L):

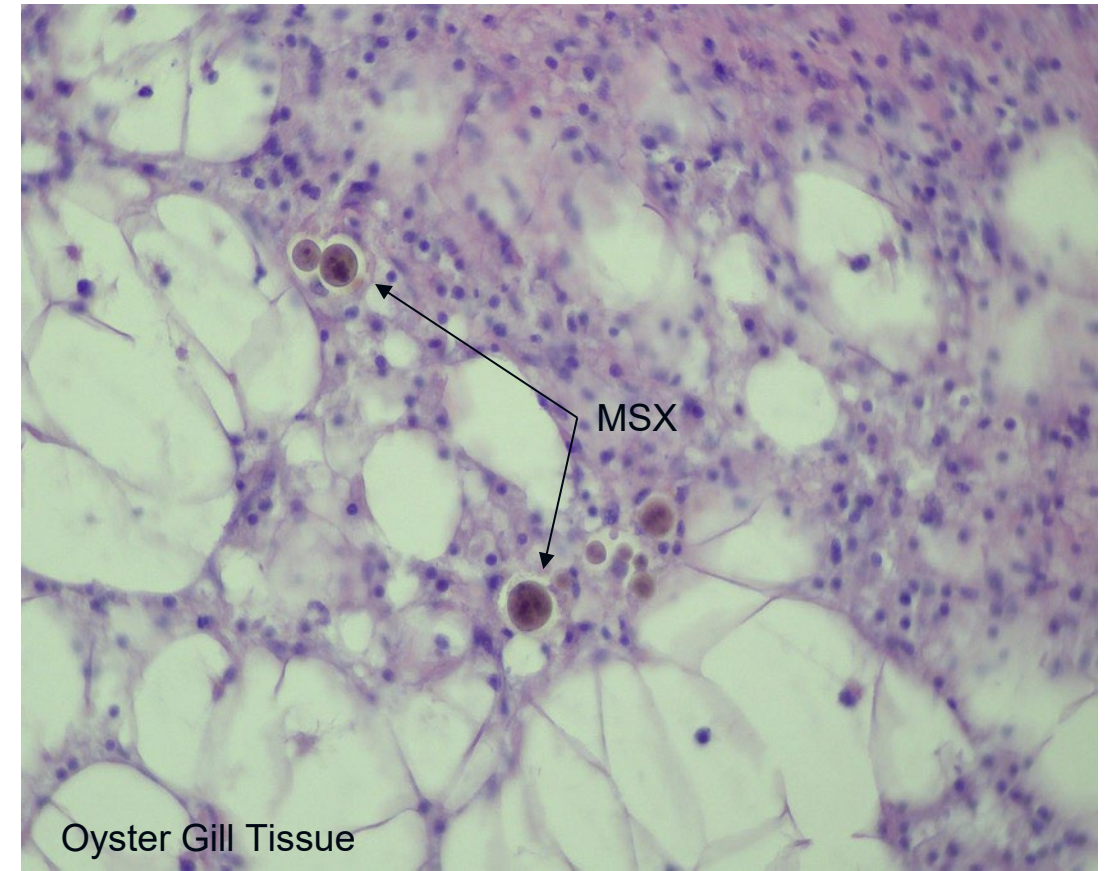
$$P_L = P(t) * \mu_l$$

- Indirect effect of salinity and temperature
- When the parasite load (P) reaches 100,000 cells (g wet wt)⁻¹, 50% of parasites die via the death of the oyster ($\mu_l = 0.5$),
- No loss of parasites unless a parasite load of 100,000 cells (g wet wt)⁻¹ is reached



What is MSX?

- *Haplosporidium nelsoni* = causative agent for Multinucleate Sphere Unknown X (MSX)
(Haskin & Andrews 1988)
- Causes mass mortality = problematic for the aquaculture industry, wild populations and wild fisheries
- Parasite thrives in warmer waters (above 20 °C) and more saline environment (above 15 PSU).
(Haskin & Andrews 1988).
- Management strategies can involve:
 - altering culture depth (Volety et al. 2000)
 - selectively breeding oysters that have survived repeated MSX outbreaks (e.g. DEBY)
(Calvo et. al 2003)



MacDonald's Pond Procedure

- 30 sampled to assess initial MSX prevalence
 - 63% tested positive
- Total = **120 oysters**
- Surface cage: 1 bag, 60 oysters
- Bottom cage: 1 bag, 60 oysters



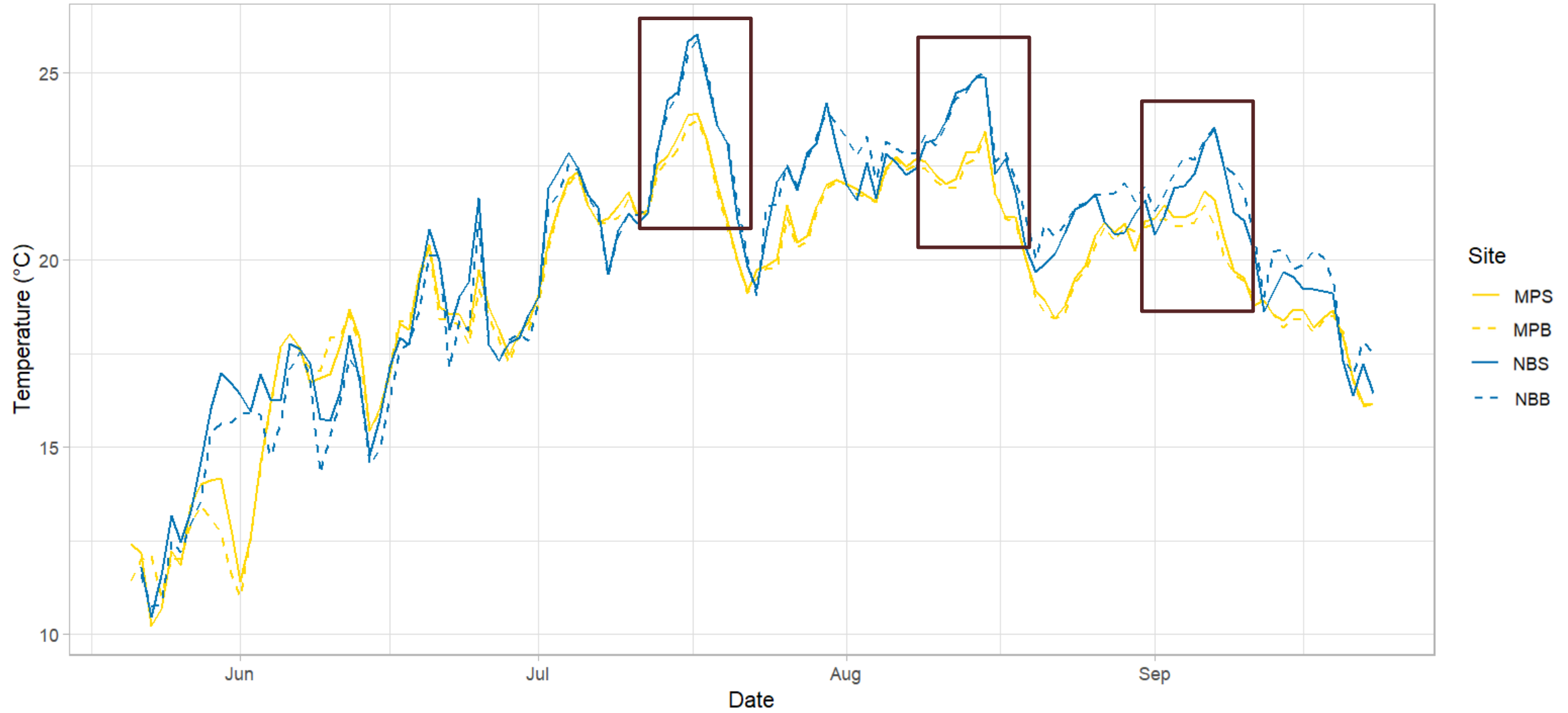
Nyanza Bay Procedure

- Total = **360 oysters**
- Surface cage: 3 bags, 180 oysters
- Bottom Cage: 3 bags, 180 oysters



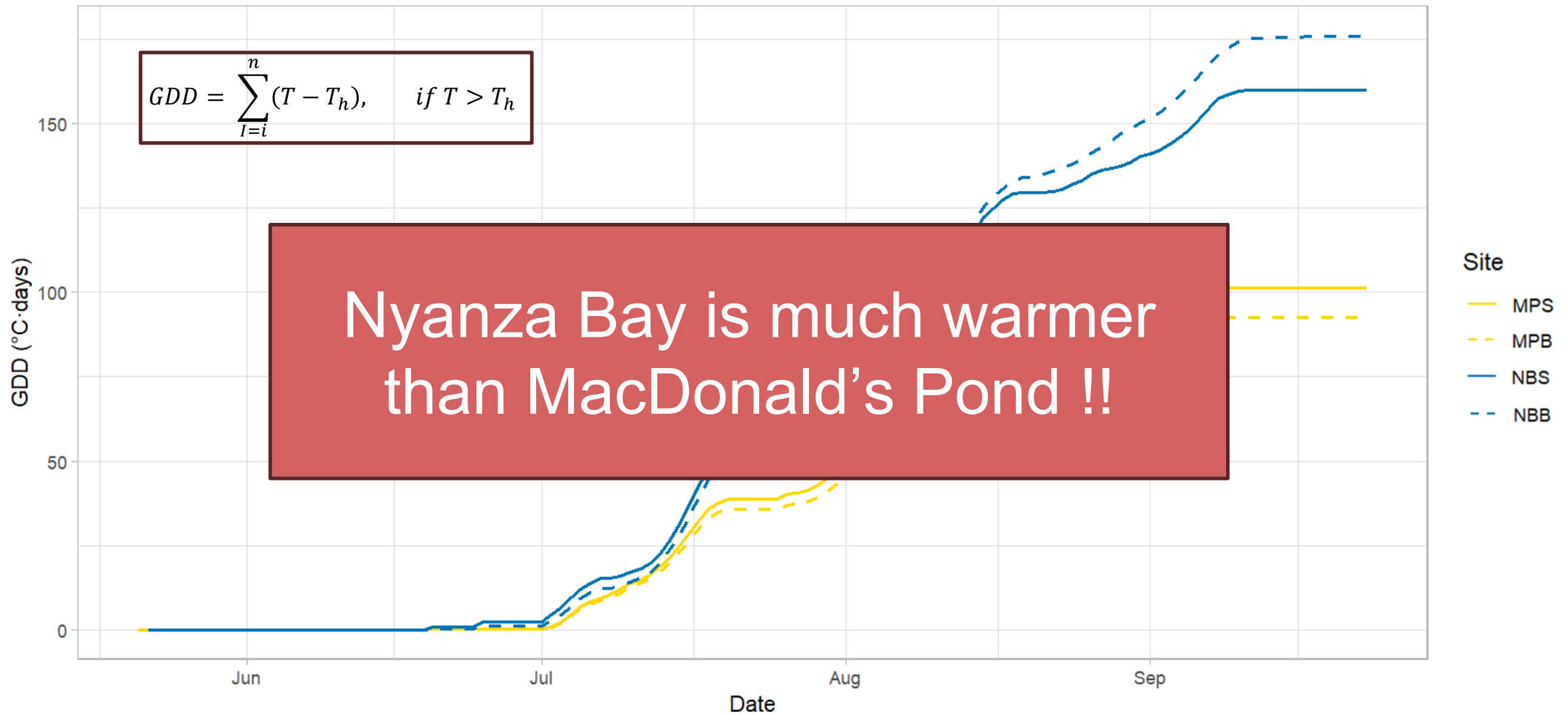
IV Results

Daily Average Temperature



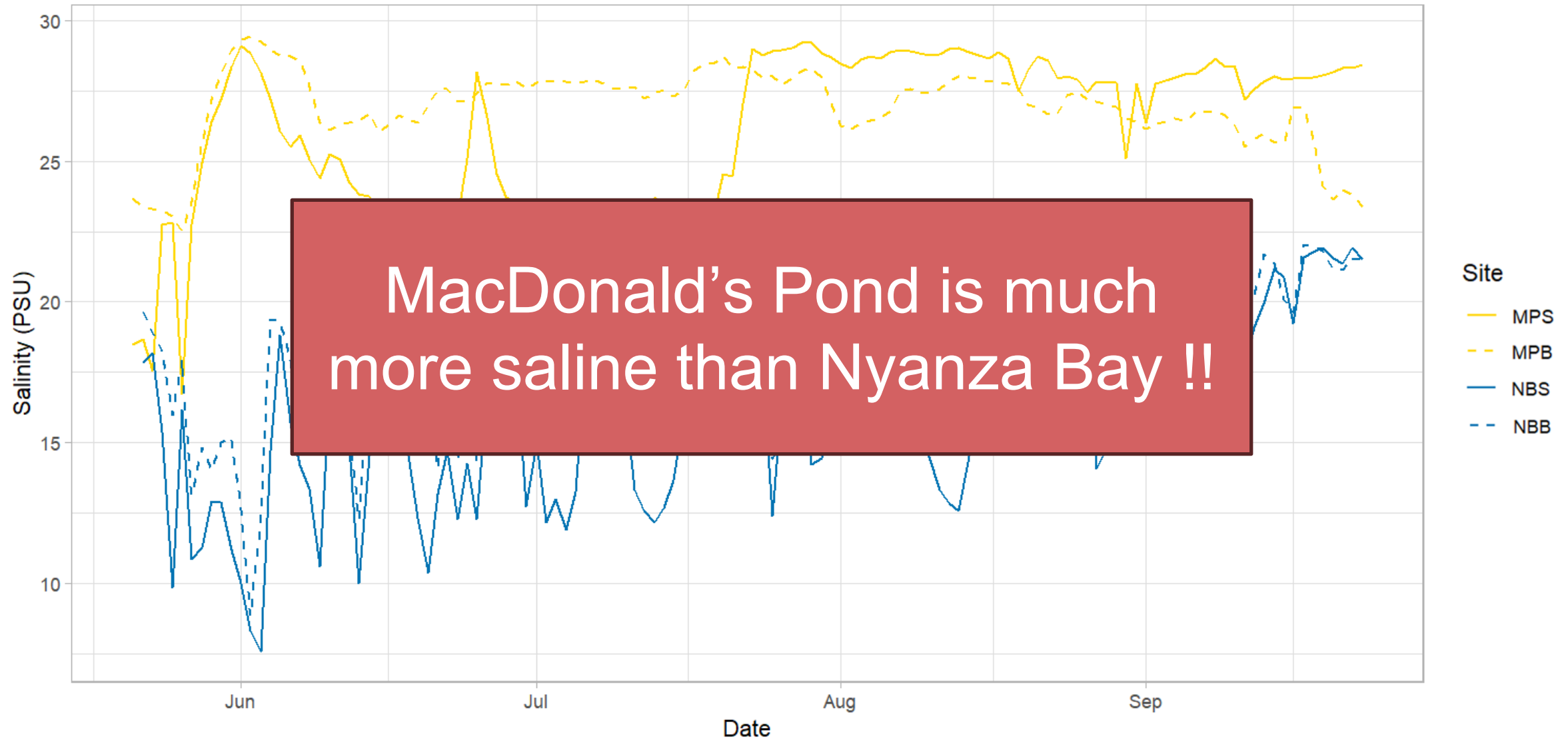
IV Results

Growing Degree Days (GDD) Above 20°C by Site

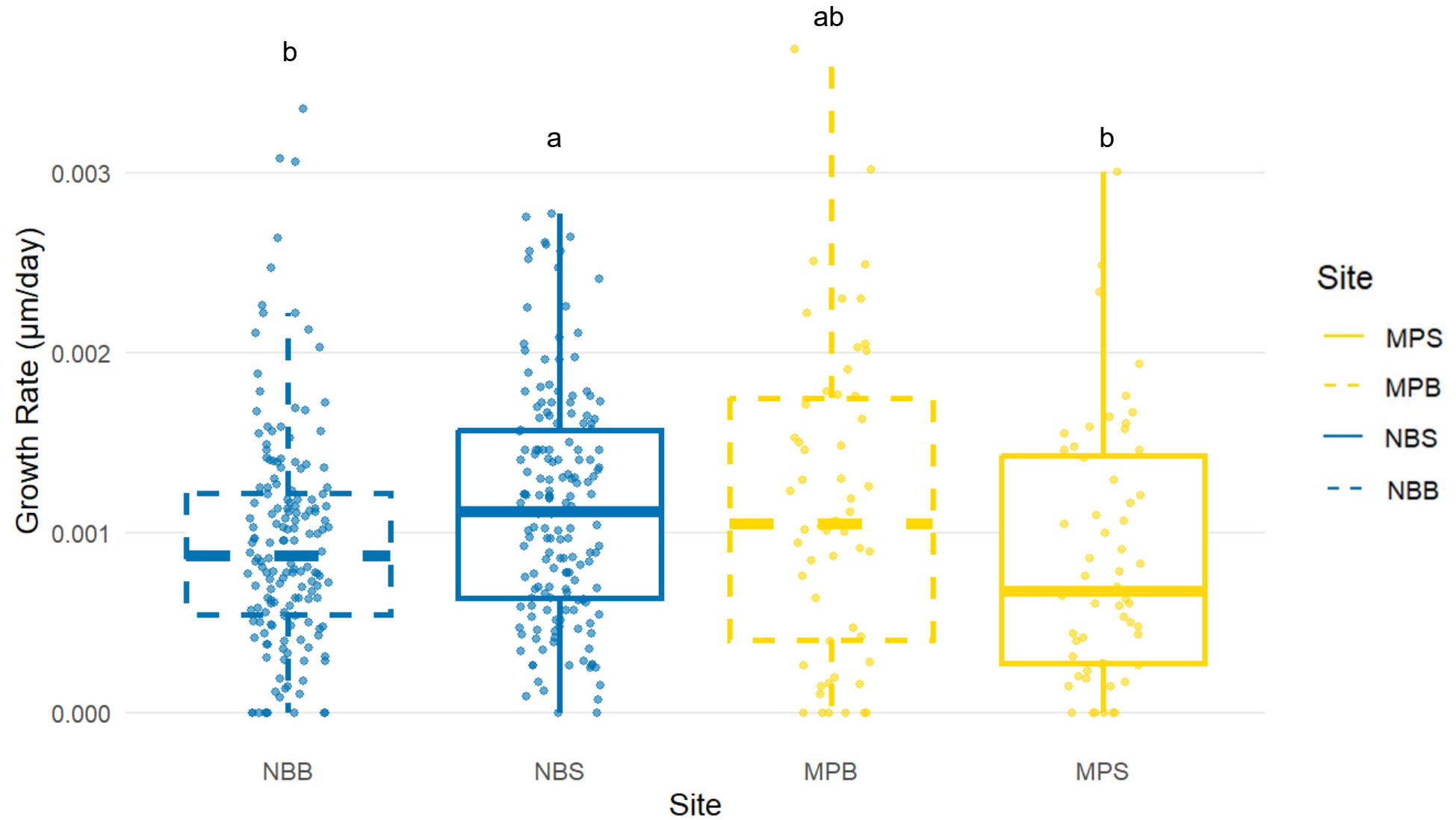


IV Results

Daily Average Salinity



IV Results



Pairwise Wilcoxon test – Nonparametric