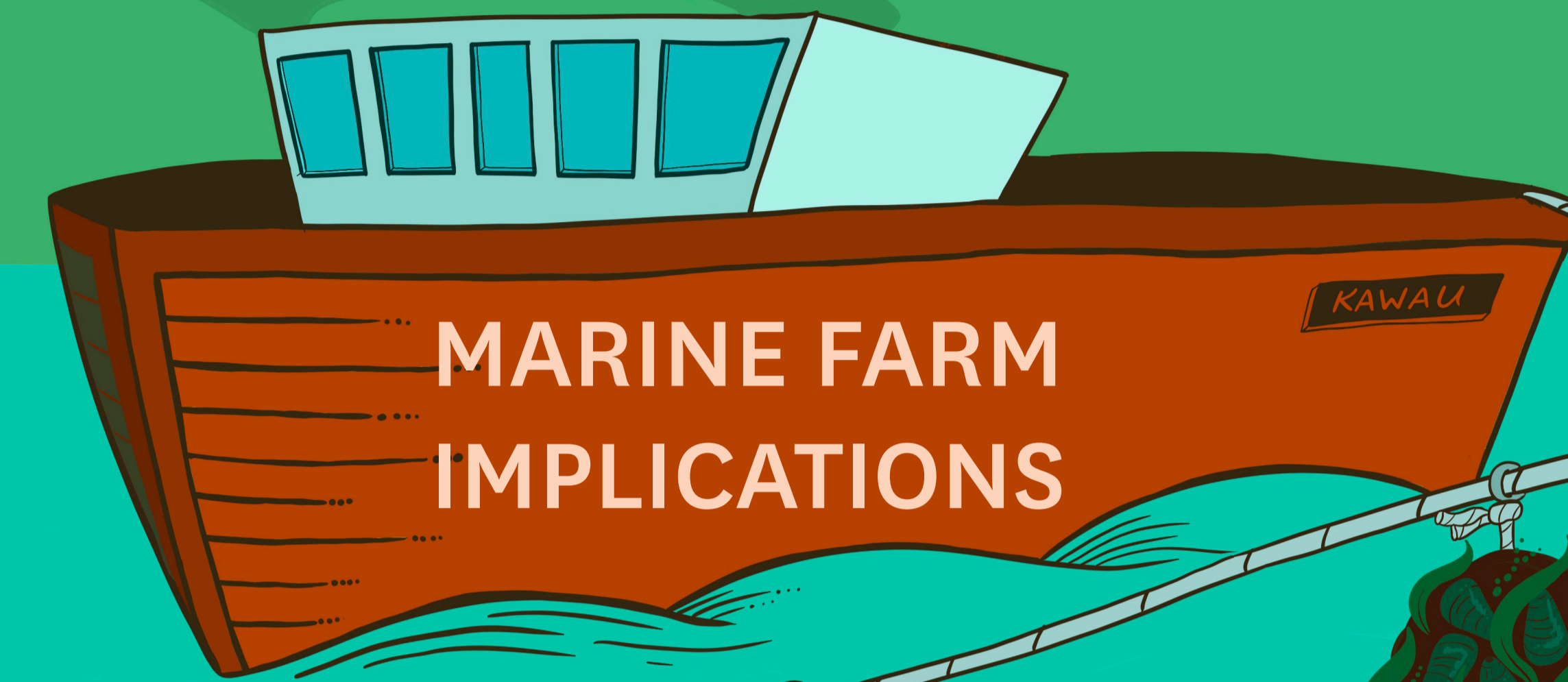


MUSSEL FARMING IN A WARMING OCEAN

Mortality & deteriorating health of Greenshell mussels on marine farms is increasing during summer. Recent laboratory studies have investigated what seawater temperatures are stressful for Greenshell mussels. These lab results provide a valuable insight into the biological mechanisms influencing thermotolerance. They help us to understand what might be causing summer mortality on mussel farms & how we might prevent it as the climate changes.



MARINE FARM IMPLICATIONS

1

SUSTAINED HEAT STRESS

Sustained seawater temperatures of 22 - 25°C may cause deteriorating health & survival of farmed Greenshell mussels especially if other stressors (e.g. pathogens) are also present. Timing of reproduction may be impacted.

2

MARINE HEAT WAVES

Marine heatwaves that result in seawater temperatures spiking to 26°C for several days are likely to cause significant mortality.

3

THERMAL HISTORY AND RECOVERY

Multiple elevated temperature events in succession will reduce the capacity of mussels to recover & increase the likelihood of stock losses. Duration of exposure & rate of temperature change will determine health outcomes for mussels.

4

REGION SPECIFIC VULNERABILITIES

Mussels on marine farms in warmer regions of NZ (e.g. the Hauraki Gulf) are particularly vulnerable to ocean warming.

5

POSSIBLE MITIGATION STRATEGIES

Mitigation measures such as moving marine farms to colder waters (e.g. into the open ocean, suspending lines deeper in the water column, moving to colder coastlines), & using land-based hatcheries to selectively breed for thermotolerance should be considered in aquaculture management plans.

Many other sources of stress can compound the effects of heat - important to understand and mitigate these wherever possible

Greenshell mussel | *Perna canaliculus*

PHYSIOLOGICAL RESPONSES INVESTIGATED

The following factors influence heat tolerance:

- Integrated thermal history (e.g. temperatures experienced in the recent past)
- Genetics & parent's experiences
- Well fed mussels are more tolerant to heat stress
- Other stressors (e.g. pollutants, microplastics, ocean acidification) are likely to lower thermotolerance.

Sublethal physiological responses are observed at temperatures ≥22C, for example:

- Heat-shock proteins ↑
- Antioxidant response ↑
- Oxidative damage ↑
- Energy available for growth ↓
- Investment in reproduction/conditioning ↓

LAB STUDIES:

ACUTE

Mussels exhibit extreme physiological stress at seawater temperatures > 28°C & temperatures > 30°C are lethal if mussels are exposed for more than a few hours.

SUBCHRONIC

A tipping point exists at 26 °C. If this temperature is maintained for several days, heavy mortality sets in. Exposure to 26 °C is likely to apply selection pressure in wild populations & could be used to identify heat-tolerant breeding lines for aquaculture.

Mussel health is likely to be compromised if mussels are exposed to these temperatures for days to weeks. Mussels elicit a stress response & become more vulnerable to pathogens & harmful algal blooms.

CHRONIC

Mussels are healthy & survival is high at these seawater temperatures, but reproduction & physiological condition are impacted if mussels are exposed for long periods (e.g. for many months).

