

MUSSEL FARMING IN A WARMING OCEAN

Greenshell mussel | *Perna canaliculus*

PHYSIOLOGICAL RESPONSES INVESTIGATED

The following factors influence heat tolerance:

- Integrated thermal history (e.g. the thermal environment experienced in the recent past)
- Genetics & parent's experiences
- Feeding (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 $\geq 22\text{C}$, for example:

- Heat-shock proteins \uparrow
- Antioxidant response \uparrow
- Oxidative damage \uparrow
- Energy available for growth \downarrow
- Investment in reproduction/conditioning \downarrow

LAB STUDIES:

ACUTE

Mussels exhibit extreme physiological stress at seawater temperatures $> 28^{\circ}\text{C}$ & temperatures $> 30^{\circ}\text{C}$ are lethal if mussels are exposed for more than a few hours.

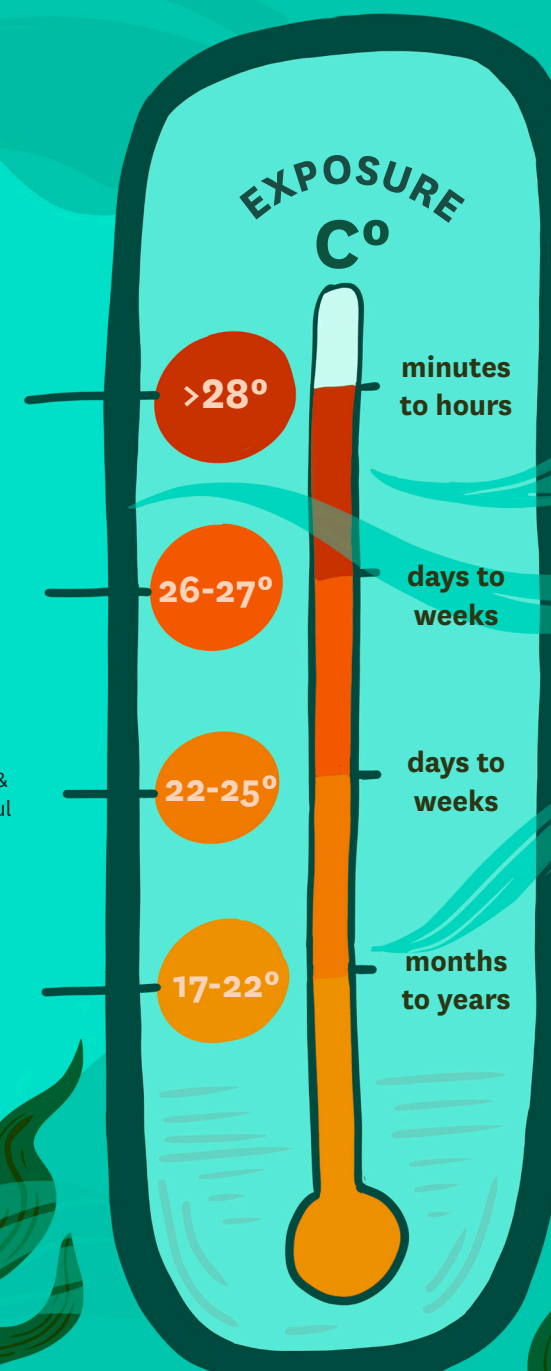
SUBCHRONIC

A tipping point temperature 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 by breeders 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 to these temperatures for long periods (e.g. for many months).



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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.

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 & mitigate these wherever possible

4

REGION SPECIFIC VULNERABILITIES

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

3

THERMAL HISTORY & RECOVERY

Exposure to 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.