Coastal Water Quality - Monitoring 2015 - 2023

Temperature Trends

Key Points

- Council has an ongoing monitoring programme to determine water quality and temperature in the Sounds
- The past seven years show a significant increase in annual ocean temperatures for both Queen Charlotte and Pelorus Sounds
- Pelorus Sounds water temperatures have been influenced by a prolonged heat wave in the Cook Strait
- Strong tidal currents in the Tory channel may compensate for climate-induced elevated sea-surface temperatures
- Consistently high temperatures can impact species distributions and abundances.

What is Marlborough District Council doing?

The council has a state of the environment programme monitoring coastal water quality at 11 sites (Figure 1) in both the Queen Charlotte Sound/Tōtaranui (monthly since 2011) and Pelorus Sound/Te Hoiere (monthly since 2012). Long-term monitoring like this is identifies changes in water parameters over time. Monthly monitoring gives a good indication of natural seasonal changes and catchment influences, and the data enables us to identify irregularities and determine their causes. At each site, we take field measurements of water quality using an electronic sensor called a sonde. This measures biophysical parameters like temperature, salinity and Chlorophyll a throughout the water column

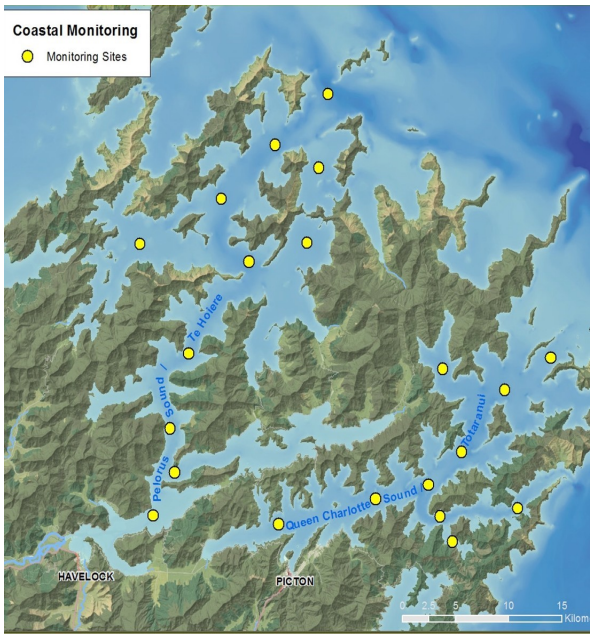

Figure 1: Map of sampling sites.

Overall temperature trends from 2015 to 2022

The past decade has witnessed an unprecedented increase in global sea surface temperatures (SST) due to human-induced climate change. As a result of several remarkably intense heatwaves in the Cook Strait (Fig. 2A), the Marlborough Sounds have experienced unusually warm ocean temperatures in recent years. Our monitoring data shows that both the Pelorus Sound and Queen Charlotte Sound exhibit record-breaking high temperatures in 2022, with annual averages reaching approximately 15.7°C (maximum: 20.4°C) for Pelorus and 14.7°C (maximum: 20.8°C) for Queen Charlotte (Fig. 2B).

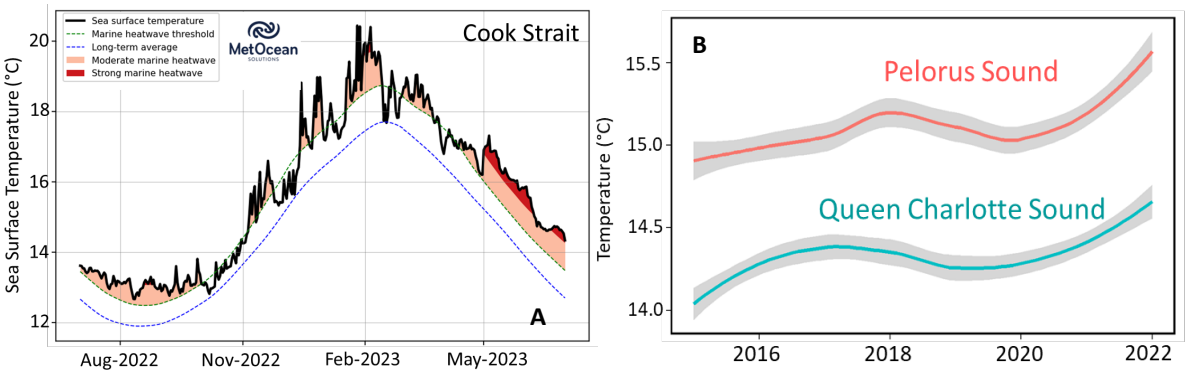

Fig 2A: Sea surface temperatures at Cook Strait over the past 12 months. Red shading appears when temperatures are above the marine heatwave threshold, e.g., seawater temperatures are warmer than the 90th percentile of the local long-term (25-year) average for at least five consecutive days. Fig **2B:** Smoothed trend line (LOESS) of annual average water temperatures from 2015 to 2022 at Pelorus Sound and Queen Charlotte Sound.

Fine-scale temperature patterns

Pelorus Sound: Outer- and mid- Pelorus Sound areas have exhibited a noteworthy upward trend in annual average water temperatures from 2015 to 2023. Due to its proximity to the Cook Strait, the Pelorus Sound is potentially more exposed to additional heat transfer from the Strait. The enduring heatwave in the Cook Strait has not only affected surface waters but has also extended its influence to deeper ocean layers in the outer reaches of Pelorus Sound (Fig 3A). A less pronounced temperature trend in the inner Pelorus sites suggests that freshwater inflows from the Te Hoiere and Kaituna catchments may counterbalance the influx of warm water into the inner Pelorus Sound (Fig 3A) It is important to note that, although there is strong evidence of greater warming in waters immediately outside the Sound, maximum temperatures still tend to be lower in comparison to the innermost and more sheltered sites (Fig 3A).

Queen Charlotte Sound: Overall, our data suggests that most sites of the Queen Charlotte Sound have warmed significantly from 2015 to 2023 (Fig. 3B). However, temperature trend magnitudes inferred from Sen-Slope estimates indicate that warming has been slower for most of these sites in comparison to the Pelorus Sound. This discrepancy is likely attributed to the strong tidal currents coursing through the Tory channel and northern entrance, which facilitate continuous interchange with deeper, cooler oceanic waters throughout the year. Maximum temperatures in the innermost and more sheltered areas are markedly higher when compared to those in the Tory channel and northern entrance sites (refer to purple and blue values in Fig. 3B).

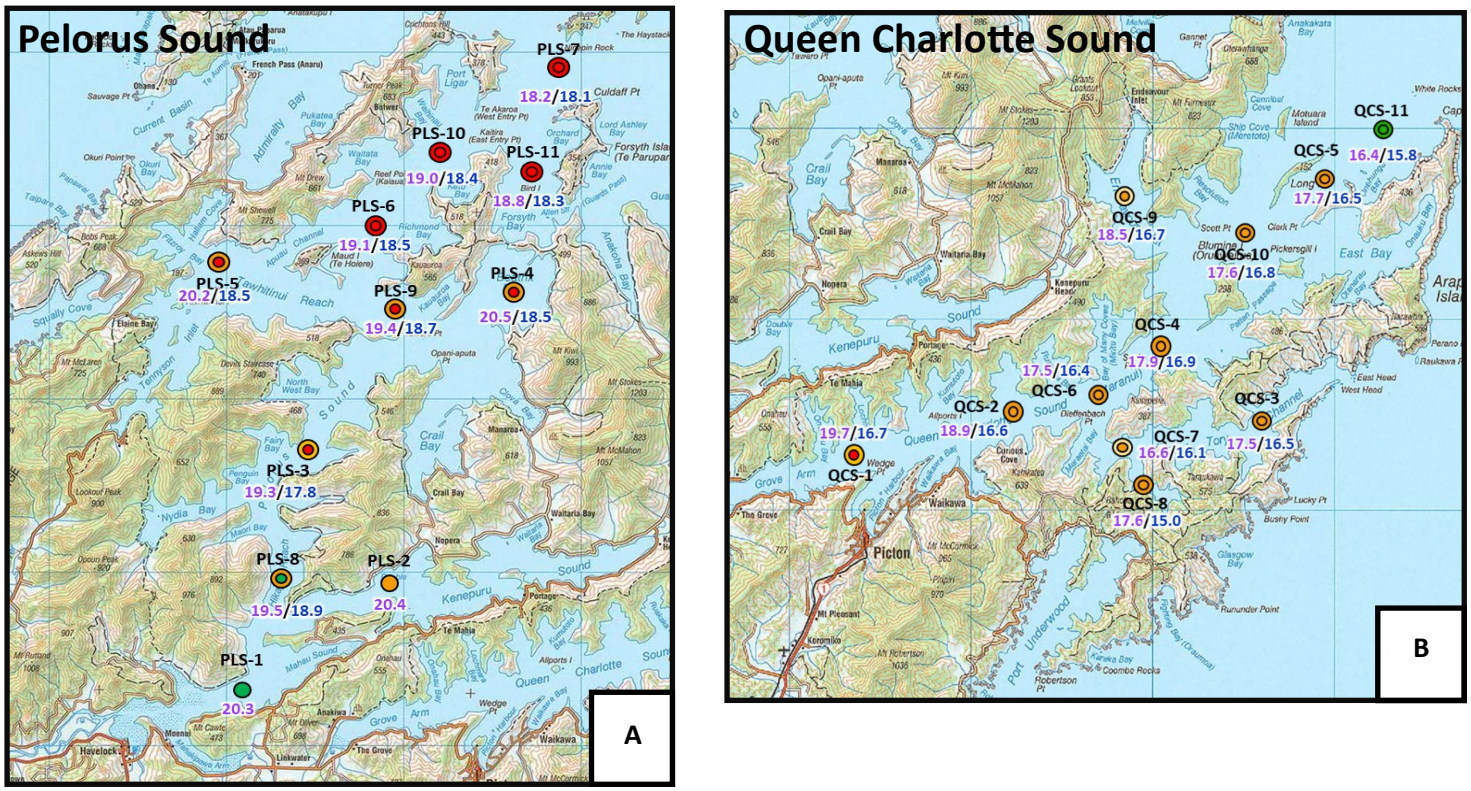

Fig 3: Sampling site locations in the Pelorus Sound (Map A) and Queen Charlotte Sound (Map B). **Red circles:** highly significant increase of temperatures from 2015 to 2023 (based on Sen-slope estimates of temperature anomalies). **Orange circles:** significant increase of temperatures from 2015 to 2023. **Green circles:** no significant change of temperatures within this time span. *Small circles:* temperature trend at 1m depth, *large circles:* temperature trend at 20m depth. Blue/ purple numbers indicate maximum temperatures measured at each site for the year 2023 at 1m and 20m depth (**purple**: 1m, **blue**: 20m)

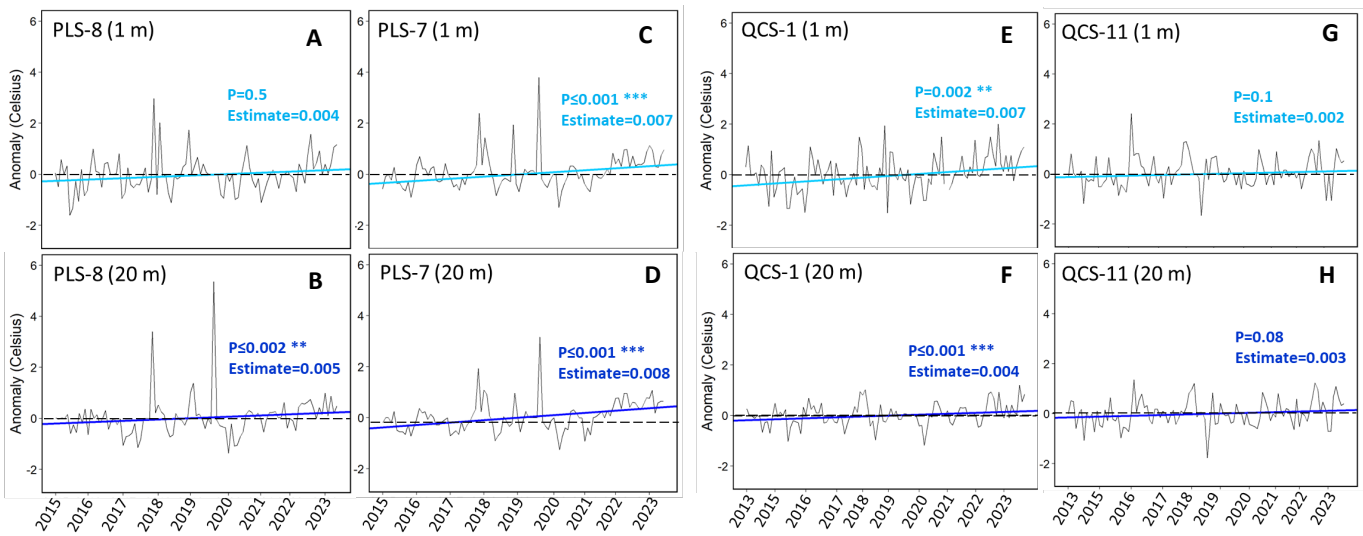

Fig 4: Temperature anomalies (i.e. differences from the long-term median of the temperature data for the calendar month) and the estimated Sen-slope trend-line with p-value and slope estimates at 1m depth (light blue line) and at 20 m depth (dark blue line) for PLS 8 (Fig 3 A+B; innermost sampling location) and PLS 7 (Fig. C+D; outermost sampling location), as well as for QCS 1 (Fig 3 E+F; innermost sampling location) and QCS 11 (Fig. G+H; outermost sampling location).

Potential effects of warming ocean temperatures on marine species and habitats in the Marlborough Sounds

- **Seaweed**: Warming waters and increased herbivory from sea urchins have caused declines of temperature -sensitive ecosystem engineers like kelp and other algae species across the Marlborough Sounds. Monitoring studies from 2022 revealed that the red algae *Adamsiella*, a formerly abundant habitat-forming species in the Queen Charlotte Sound, has almost disappeared. Ongoing high temperatures, in concert with more frequent marine heatwaves, may lead to further retreat and regional extinctions of important macroalgae species.

Image 1: Water Quality Monitoring, September 2023.

- **Fish:** The distribution and abundance of certain fish species are expected to undergo fundamental changes in the Marlborough Sounds. Fish species with narrow temperature ranges, such as blue cod and kahawai, may redistribute southwards or to deeper waters. In aquaculture, heatwaves can lead to increased mortality of fish stocks as adult feed intake can become suppressed during anomalously warm summer periods over 18 degrees.

Image 2: Algae Bloom in Double Cove, August 2023

- **Sponge communities:** Recent research has documented widespread, temperature-induced bleaching and mortality of sponge communities along New Zealand's coasts. As sponges play a crucial role in the food chain, there could be serious consequences for fish populations and other marine organisms if sponge communities start to disappear.

- **Shellfish:** Warmer waters can create favourable conditions for shellfish pathogens, leading to increased disease outbreaks and mortality among green-lip mussels and Pacific oysters. Moreover, the rising water temperatures are expected to promote proliferation of harmful algae blooms. These blooms produce toxic compounds that accumulate in the tissue of shellfish. More frequently, toxic algae blooms have caused many harvesting closures of green-lip mussel farms in the Pelorus Sound. If climatic conditions continue to change, blooms may become a substantial concern for the shellfish industry in the Marlborough Sounds .

For more information on coastal water quality go to
www.marlborough.govt.nz/environmental/coastal
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