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Executive Summary | Spring 2025

Understanding and Mitigating Kelp Forest Losses Caused by Environmental Change in *Aotearoa* New Zealand

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Client: Cawthron Institute

The Problem

Kelp forests are rapidly declining due to climate change, threatening marine biodiversity and coastal economies (Cornwall et al., 2023). Kelp forests in New Zealand provide essential habitat for culturally and economically important species such as the rock lobster and abalone (Cornwall et al., 2023). However, rising ocean temperatures can reduce the availability of key nutrients, such as nitrogen (Cavanaugh et al., 2021) and impair kelp survival. Punctuated marine heatwaves have also led to widespread kelp forest dieback that have caused billions of dollars in economic losses (Smith et al., 2023). Understanding how ocean warming and marine heatwaves are affecting kelp is critical to preserving these ecosystems and the species they support.

In recognition of the increasing use of seaweed aquaculture for ecosystem restoration, climate mitigation, and economic growth (New Zealand Government, 2021; Cawthron Institute & EnviroStrat, 2022; Racine et al., 2021), we explored the impacts that elevated temperatures have had on kelp in both their natural habitat as well as in an aquaculture setting. We also tested various aquaculture cleaning methods to compare each of their impacts on contamination and kelp development. With rising interest in sustainable aquaculture, optimizing cultivation methods of native species is a critical step toward building a resilient seaweed sector.

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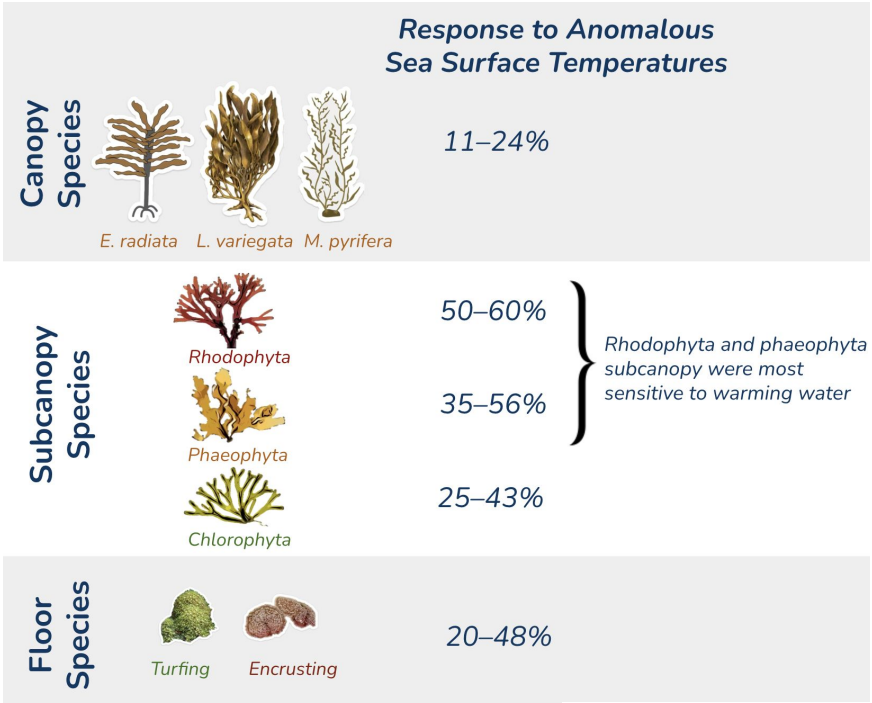
Key Findings



On the east coast of New Zealand, canopy and floor seaweed species showed resilience to anomalous sea surface temperatures (SST), whereas the *Rhodophyta* and the *Phaeophyta* subcanopy seaweeds showed the least resilience. Also, shallow sites were more sensitive to SST changes than deeper sites, with the abundance of seaweed decreasing as SST increases.

The west coast experienced both warmer and cooler SST anomalies. Floor and subcanopy seaweed species were more sensitive to these changes, whereas canopy forming species were more resilient to changing temperatures.

Overall, Betadine performed the best of the kelp aquaculture cleaning treatments, because it either had a positive or neutral effect on the critical developmental stages of kelp. Of the three canopy kelp species, *Ecklonia radiata* showed the ability to develop sporophytes at higher water temperatures (21°C), indicating this species' suitability for restoration projects in areas that experience marine heatwaves.

Which cleaning method was best for...?	 *E. radiata*	 *L. variegata*	 *M. pyrifera*
Spore Survival	*Betadine*	*Betadine & Ethanol*	*Scraping*
Decreased Contamination	*Scraping*	*Scraping*	*Scraping*
Sporophyte Development	*Betadine*	*Control*	*Ethanol*

Conclusion & Recommendations

Although the role of site-to-site variation in shaping kelp and seaweed distributions should be considered, we recommend that conservation managers and researchers focus on protecting deeper kelp forest habitats which are less sensitive to SST fluctuations and could serve as climate refugia. We also recommend *Ecklonia radiata* as a strong candidate for any restoration projects due to its resilience to warming and success in aquaculture trials. We recommend further research and application of Betadine as a cleaning agent.