Science Snapshot report **2021**

Sea lettuce

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

The current sea lettuce monitoring programme has now been running for 30 years. A recent report published (Crawshaw, 2021) includes updates on a wide range of research projects relevant to sea lettuce, that have been conducted in Tauranga Harbour to try and gain greater understanding of the complex drivers of the cause of the sea lettuce blooms.

Why is this important?

Sea lettuce (*Ulva spp*) is a naturally occurring green algae, which under the right conditions can develop large problematic blooms. Blooms of sea lettuce in Te Awanui (Tauranga Harbour) have been reported anecdotally back as early as the 1940s (Park, 2011), and has continued to be a nuisance species to this day.

Effects of sea lettuce:

Blooms of sea lettuce can have detrimental effects to coastal ecosystems, such as:

- Reduction in sediment oxygen conditions
- Displacement of seagrass
- Reduced benthic biodiversity
- Fish kills
- Increased nutrient release
- Hydrogen sulphide gas release (human health concern)

Sea lettuce blooms

Sea lettuce blooms have reduced since the early 90s, in part due to climate variations and possibly due to a reduction of nutrients sourced from wastewater discharges directly into Tauranga Harbour (Figure 1). Peak blooms of sea lettuce occur over the late spring-summer period.

The worst summer coverage of sea lettuce has been measured in the southern harbour in current times, in particular Waikareao, Waimapu and Otumoetai (Figure 2). Sea lettuce blooms can be significant in the northern harbour also, and future wide spatial assessments using satellites will be a valuable new tool for monitoring. A number of sites in the northern harbour (in particular Tuapiro) are beginning to show increased coverage of the red filamentous algae *Gracilaria spp.*, which can become a nuisance species creating large mats which reduces the health of the sediment environment.

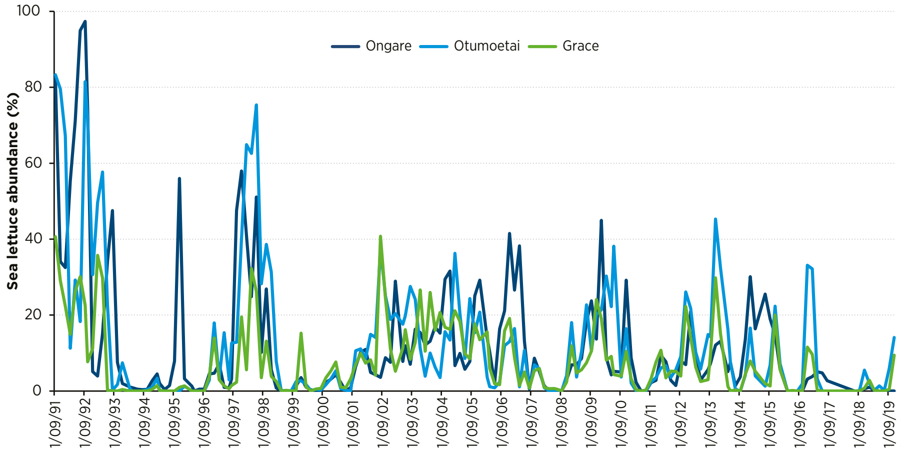

Figure 1. Abundance of sea lettuce (mean % cover of mid-lower and spring-lower tide plots) at monitoring sites in Tauranga Harbour from September 1991-January 2020.

For more information on sea lettuce monitoring undertaken by Bay of Plenty Regional Council, contact the Science Team on 0800 884 880.

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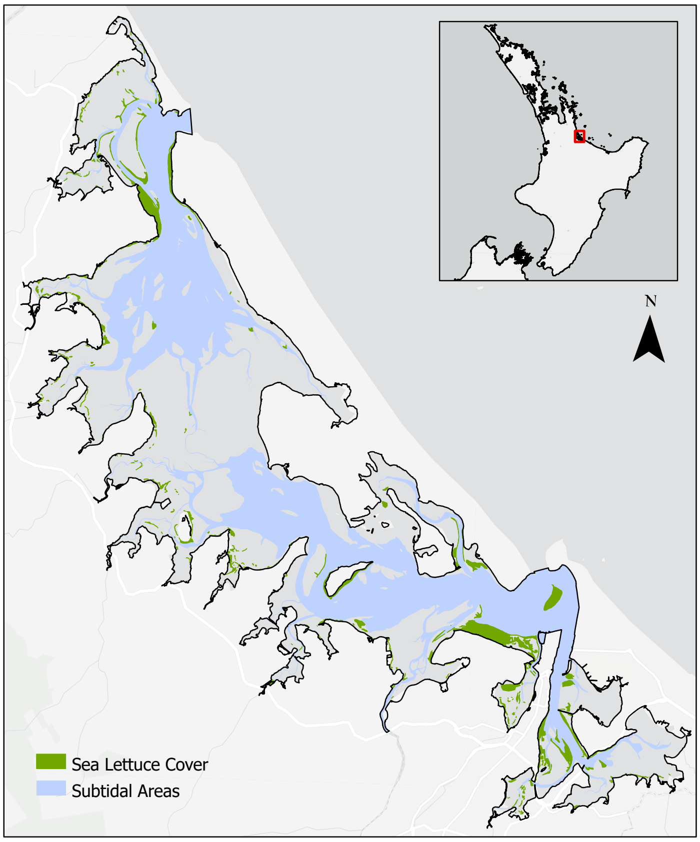

Figure 2. Macroalgae cover in Tauranga Harbour mapped from 2014 aerial photography.

Freshwater inputs

Nutrients entering Tauranga Harbour from freshwater sources have increased over time (water quality state and trends report, Hamill et al. 2020). Inputs of nutrients are greater in the southern end of the harbour compared to the north. While efforts have been made to reduce point sources of nutrients overtime, some are still evident across the harbour (storm water, on site wastewater system leakages). River nutrient inputs likely support increased nutrients within sea lettuce tissues during winter and spring, supporting greater growth of sea lettuce as temperatures increase.

Groundwater inputs

Groundwater is a significant source of nutrients into the harbour. Modelling and measurements in the southern harbour have shown submarine groundwater discharges can contribute much higher levels of nutrients than river inputs (5 times the amount of nitrogen, and 8 x phosphorus, Stewart et al. 2018). During El Nino summer conditions there is longer retention of water in the estuary and less nutrient input from surface water. During these times, nutrient loads from groundwater may be an important contributing driver of sea lettuce blooms in the upper regions of the harbour. This may account for historical observations of the largest sea lettuce blooms occurring in El Nino years.

Nutrients in sea lettuce tissues

The nutrients within sea lettuce tissues were found to vary across seasons. Changes in nitrogen content within sea lettuce were linked with changes in nitrogen levels in the environment/harbour (Figure 3). The relationship with phosphorus and sea lettuce was less clear. This is likely due to lower seasonal changes in phosphorus availability.

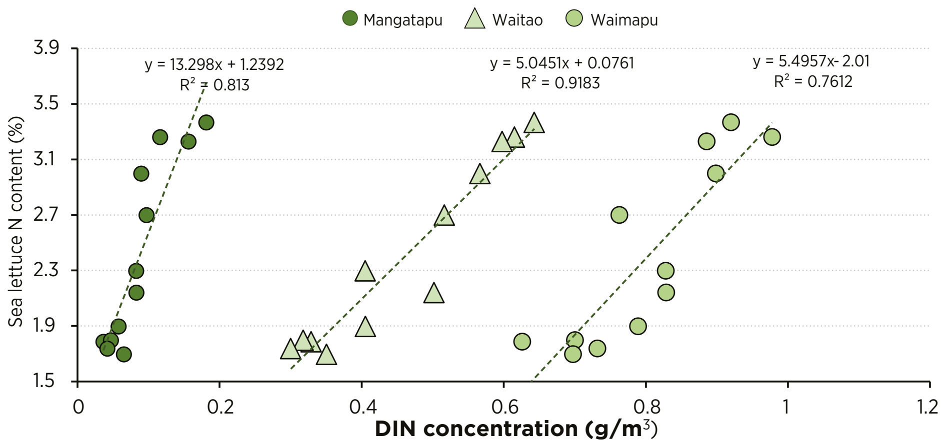

Figure 3. Grace Road average monthly sea lettuce nitrogen tissue content (%, 1991-2019) vs average monthly dissolved inorganic nitrogen concentration (g/m3) at Mangatapu Harbour site (1991-2019), and Waitao and Waimapu River sites (1990-2019).

Climatic drivers of sea lettuce

During El Nino years, multivariate analyses show that the water nutrients, temperature, and the wind conditions are significantly different to La Nina years (Figure 4). In El Nino years during incoming tides, ammonium concentrations are increased, and water temperatures are decreased, indicative of upwelled nutrients from the coast.

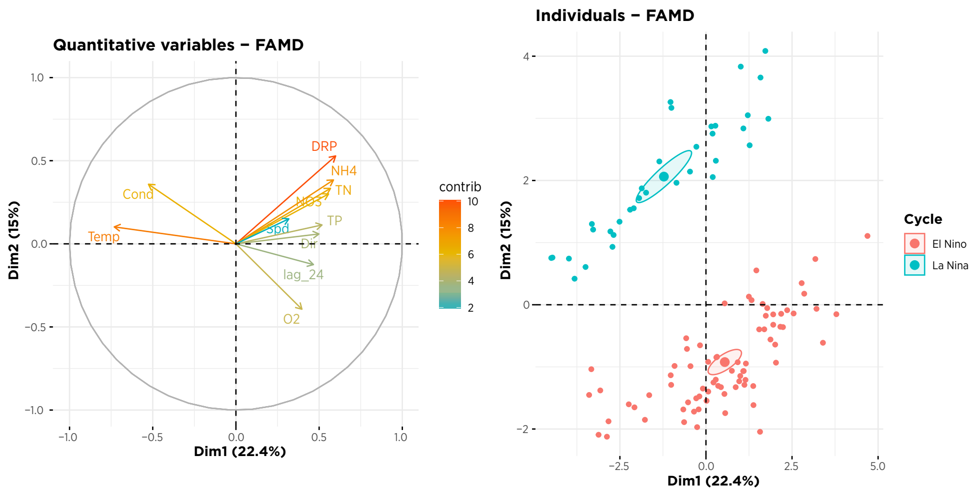

Figure 4. Factor of mixed analysis (FAMD) for climatic water quality sampling visualising the quantitative variables and their contribution to the PCA (contrib) (left) and a visualisation of the sampling points by climatic cycle (right).

Sea lettuce tissue isotopes

Isotopes can be used to identify the source of nutrients to sea lettuce. There is evidence from sea lettuce tissue isotopes of potential oceanic upwelling and or porewater/groundwater inputs influencing sea lettuce tissues. Sea lettuce tissue d15N isotope values dropped rapidly across a number of sites, following a strong westerly wind event during an El Nino year, reflecting an oceanic signature of nutrients. However, the nutrient inputs have a fast turnover in the sea lettuce tissue, and sea lettuce isotope values quickly return to normal values days after the strong westerly wind event.

Takeaway messages

- Sea lettuce blooms reduced in recent times, likely due to a reduction in nutrient discharges directly to the harbour and climatic conditions.
- Nitrogen inputs from some rivers are increasing in Tauranga Harbour, and show relationships with sea lettuce tissue nitrogen.
- Groundwater inputs may be a significant source of nutrients to sea lettuce during El Nino years.
- Oceanic upwelling during El Nino years is also an occasional source of nutrients for sea lettuce.
- Future sea lettuce blooms will likely be a mix of groundwater and river inputs, combined with high light and suitable temperatures (16-22°C).

Looking forward

The core management option to reduce future blooms of sea lettuce is to continue to work on reducing nutrient loads from rivers/land, and capturing/treating nutrients at source, and stabilise/reduce inputs of nutrients to the groundwater. Ecological modelling of Tauranga Harbour utilising the vast amount of nutrient and sea lettuce abundance data will provide scenarios of nutrient reductions to limit bioavailable nutrients for primary productivity.

For the full report, visit www.boprc.govt.nz/publications or click here

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