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Memo

TO	Pim de Monchy (Bay of Plenty Regional Council)
COPY	Stephen Park (Bay of Plenty Regional Council)
FROM	Keith Hamill
DATE	16 April 2015
FILE	
SUBJECT	**Cellular nutrient content of sea lettuce in Maketū Estuary and implications for nutrient limitation**

Introduction

The Kaituna River re-diversion is expected to decrease nutrient concentrations in the upper Ongatoro / Maketū Estuary but increase nutrient concentrations in the lower-estuary. More flow from the Kaituna River is predicted to increase average nitrogen concentrations in the lower-estuary by 25 % - from 0.31 mg/L to 0.387 mg/L.[1] This will be compensated by less internal nutrient loads from estuary sediments and also by faster current speeds causing more scour of biomass. Nevertheless there is a risk that an increase in nutrient concentrations in the lower-estuary could increase the rate of sea lettuce growth.

In March 2014 the biomass and cellular nutrient content of algae was assessed from three transects in the upper and mid-estuary. The samples consisted of primarily of *Gracilaria* and to a lesser extent sea lettuce (*Ulva pertusa*) and the results indicated that the algae at these sites were likely to be replete in both nitrogen (N) and phosphorus (P). This analysis had limitations, including not sampling from channels of the lower-estuary where sea lettuce is dominant and the highest percent increases in nutrient concentrations are predicted (Hamill 2014).

This memo discusses the results of additional sampling of sea lettuce cellular nutrient content undertaken in January 2015. This was undertaken to better assess the extent to which sea lettuce is potentially nutrient limited in Ongatoro / Maketū estuary, and thus its potential sensitivity to increased nutrient concentrations.

Method

The potential nutrient limitation of sea lettuce (*Ulva pertusa*) was assessed by measuring the cellular nutrient content of sea lettuce from the mid- and lower-estuary. Sea lettuce samples were collected from channels at three locations shown in Figure 1 on 28 January 2015. At each location five replicate samples were collected. We tried to ensure that each replicate sample consisted of at least 10 health green, non-sporulating plants. This was achieved at the site at the lower estuary but it was difficult to find young healthy plants at the mid-estuary site and the sample included some mature plants.

Samples were washed in freshwater, spun dry, refrigerated and sent to Hill Laboratories for analysis of dry matter, total carbon (TC), total nitrogen (TN), and total phosphorus (TP).

The results were compared with optimum cellular nutrient concentrations found for sea lettuce in Tauranga Harbour. De Winton et al. (1998) found that the growth of sea lettuce in Tauranga harbour was limited when the cellular N and P was below about 1.5% and 0.1% (of dry weight) respectively. Intracellular N and P above 1.5% - 2% and 0.1 - 0.12 respectively did not result in additional growth.

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[1] Based on DHI model over the spring-neap tidal cycle in the lower estuary at site T5 (DHI 2014).

These values are likely to be lower for *Gracilaria* sp which can grow in lower nitrogen concentrations than sea lettuce (Lartigue et al 2003, Teichberg et al. 2008, Jenson 2007).

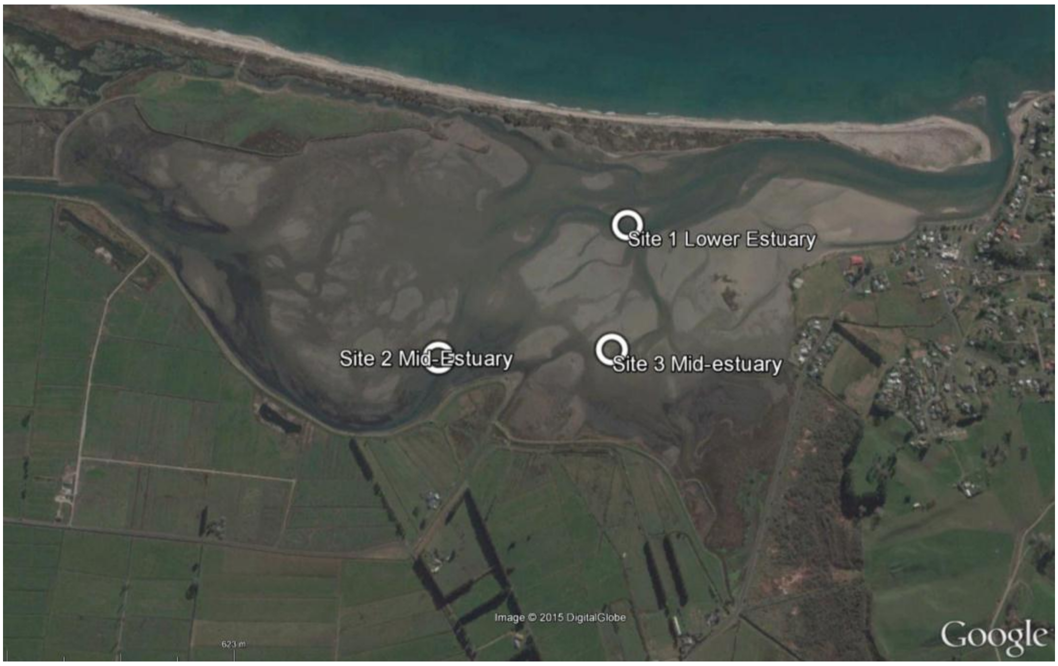

Figure 1: Location where sea lettuce samples were collected in the Ongatoro / Maketū Estuary.

Results and discussion

Sea lettuce from the lower estuary had an intracellular N and P concentration of 2.8% and 0.15% (dry wt.) respectively. Sea lettuce from the mid-estuary sites had a median intracellular N and P concentration of was 2.3% and 0.13% respectively (Table 1). These are high compared to the concentrations that limit growth (i.e. >2% for N and > 0.12 % for P). It suggests that the sea lettuce was replete in N and P and growth was not limited by these nutrients. The growth of sea lettuce at the time of sampling is likely to have been limited by factors other than nutrients.

Cellular N and P were higher in sea lettuce from the lower estuary despite water column nutrient concentrations being lower compared to the mid-estuary. This may reflect more grazing of algae at this site which is known to enhance the nutrient content of macroalgae (Hillebrand and Kahlert 2001).

The results are consistent with previous sampling of *Gracilaria* and sea lettuce in March 2014. This found the nutrient content of algae in samples was 2.68% to 4.24% for nitrogen (N), and 2.75% to 3.49% for phosphorus (P) – also suggesting the algae was replete in N and P (Hamill 2014).

Benthic macroalgae typically have a ratio of C:N:P of 215:14:1 (by weight) and a C:N ratio of 15 (Atkinson and Smith 1983). The sea lettuce from the channel in the lower estuary had relatively more nitrogen to phosphorus and relatively less carbon to nitrogen compared to optimum ratios for macroalgae and compared to other sites (Table 1). This suggests that if nutrients were to limit sea lettuce growth at this site than it would more likely be P rather than N.

Conclusion

The intracellular nutrient concentration of sea lettuce collected from the lower and mid-estuary during summer indicated that it was replete in N and P, with growth not limited by these nutrients. The results give some assurance that a small increase in N concentration as a result of the re-diversion will have little impact on algal growth rates in the lower estuary.

Table 1: Cellular nutrient content of sea lettuce from sites in Ongatoro / Maketū Estuary. Growth limitation is indicated when the cellular N and P is less than 1.5 - 2% and 0.1 – 0.12% (dry wt.) respectively.

Site name	**Replicate**	**Dry Matter (g/100g w.wt.)**	**Total Carbon (g/100g dry wt.)**	**Total Nitrogen (g/100g dry wt.)**	**Total Phosphorus (g/100g dry wt.)**	**TC:TN**	**TN:TP**	**TC:TP**
Maketu Lower 1	a	17.1	28.1	2.81	0.164	10.0	17.1	171
Maketu Lower 1	b	15	33.3	2.47	0.123	13.5	20.0	270
Maketu Lower 1	c	14	35.7	2.86	0.150	12.5	19.0	238
Maketu Lower 1	d	15.8	31.6	2.66	0.171	11.9	15.6	185
Maketu Lower 1	e	18.4	33.2	2.83	0.125	11.7	22.6	265
Maketu mid 2	a	16.8	38.7	3.10	0.119	12.5	26.0	325
Maketu mid 2	b	18.1	32.0	2.15	0.133	14.9	16.3	242
Maketu mid 2	c	16.3	33.1	2.02	0.123	16.4	16.5	270
Maketu mid 2	d	18.2	33.0	1.87	0.137	17.6	13.6	240
Maketu mid 2	e	15.8	34.8	2.15	0.146	16.2	14.8	239
Maketu South 3	a	16.2	35.8	2.41	0.110	14.9	21.8	324
Maketu South 3	b	16.8	33.3	2.02	0.125	16.5	16.2	267
Maketu South 3	c	17.3	32.4	2.20	0.133	14.7	16.5	243
Maketu South 3	d	17.6	33.0	2.39	0.142	13.8	16.8	232
Maketu South 3	e	15.9	39.6	3.02	0.132	13.1	22.9	300
Maketu lower 1	**median**	15.8	33.2	2.81	0.150	11.9	19.0	238
Maketu mid 2	**median**	16.8	33.1	2.15	0.133	16.2	16.3	242
Maketu mid 3	**median**	16.8	33.3	2.39	0.132	14.7	16.8	267
Optimum ratios (benthic macroalgae)						15:1	14:1	215:1

Note: Optimum ratio based on Atkinson and Smith 1982.

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