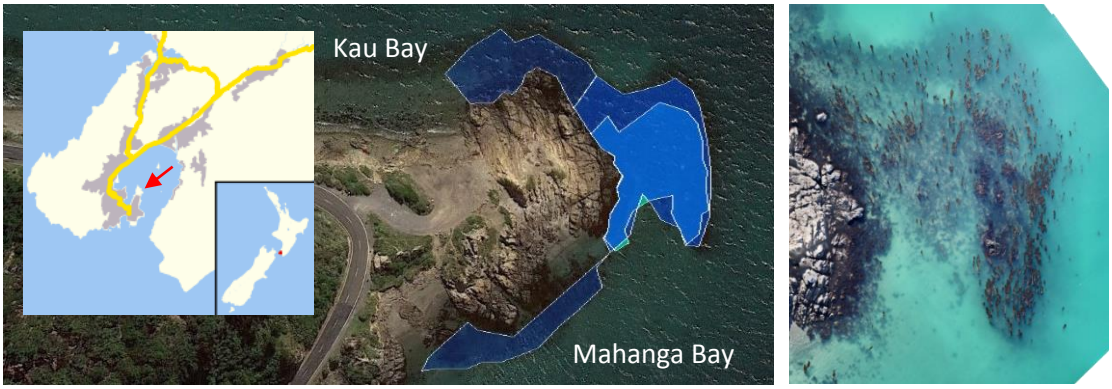
Summary - Monitoring Giant Kelp in Wellington Harbour

Giant kelp (*macrocysits pyrifera*) plays an important role in the marine ecosystem,[1] similar to the tall canopy-building trees in rainforests. Diving in healthy kelp beds is an amazing experience and we are lucky to have giant kelp at its northern-most limit in the Wellington harbour and coast. Native seaweeds are the basis for highly diverse and productive ecosystems, they act as natural shore protection and provide food for residents. Many stressors impact on the health of the local kelp beds, i.e. water temperature, wave action (storms), and reduced water quality caused by sedimentation, pollution and land reclamation and coast modification. We have measured the area covered by giant kelp between Kau Bay and Mahanga Bay 6-monthly since June 2016 using underwater surveys, drone footage and gps technology to delimit the kelp bed extent and its density.

Kelp bed with thick coverage in Nov/Dec 2017.

Water temperatures seem to have the biggest impact on the size of the kelp bed.[2] In the 2015/16 season leading up to the first monitoring temperatures reached 20-21°C and the area observed in June 2016 was relatively small. In the 2017/18 summer season the water temperatures reached nearly 22°C, and a significant decrease of the size of the kelp bed was observed in June 2018, while the kelp bed size was observed to increase after summers with lower water temperatures.



Left: Smallest and largest extent of giant kelp recorded since Jun 2016: Smallest - Dec 2016 (lighter blue / green bottom layer), largest - Nov 2017 (darker blue). **Right**: Drone image of the giant kelp bed from Jun 2018 depicting the reduced coverageand sparse growth of kelp after a summer season with warm water temperature readings.

We observed a strong correlation between water temperature and the subsequent growth and size of kelp beds.[3] Our project has limited data to conclude if the reduction in kelp bed size results from short spikes of 'hot' water or longer exposure to water above a critical temperature tolerance. Other variables to investigate are the influence of sedimentation, pollution, storms impacts or the Hutt River outflow and nutrient levels. To protect the extremely important seaweed ecosystems in the face of warming oceans, assessing and mitigating the potential negative impacts of coastal and harbour developments need to be a priority for organisations charged with maintaining the health of the region's ecosystems.

1) Read about **importance & functions of seaweed** on the WUC website: https://wuc.org.nz/index.php/wuc-projects/loveseaweed/cornerstone-of-life; 2) **Cameron H. Hay**, Journal of the Royal Society of New Zealand, 1990, 20:4, 313-336; 3) As the seas around NZ warm up, the range of giant kelp can be expected to move south. Giant kelp could be an effective indicator for evaluating ecosystem responses to climate change.

Project Baseline Wellington Giant Kelp Survey: June 2016 - June 2019

Our Project Area and Monitoring Regime

Monitoring data for giant kelp (*macrocysits pyrifera*) growing between Kau Bay and Mahanga Bay is collected biannually to account for seasonal changes in growth rates. GPS data is available for June & December 2016, June & November 2017, June & December 2018, and June 2019. An additional data point was acquired in February 2018. Drone images are available from June 2018 and January & June 2019.

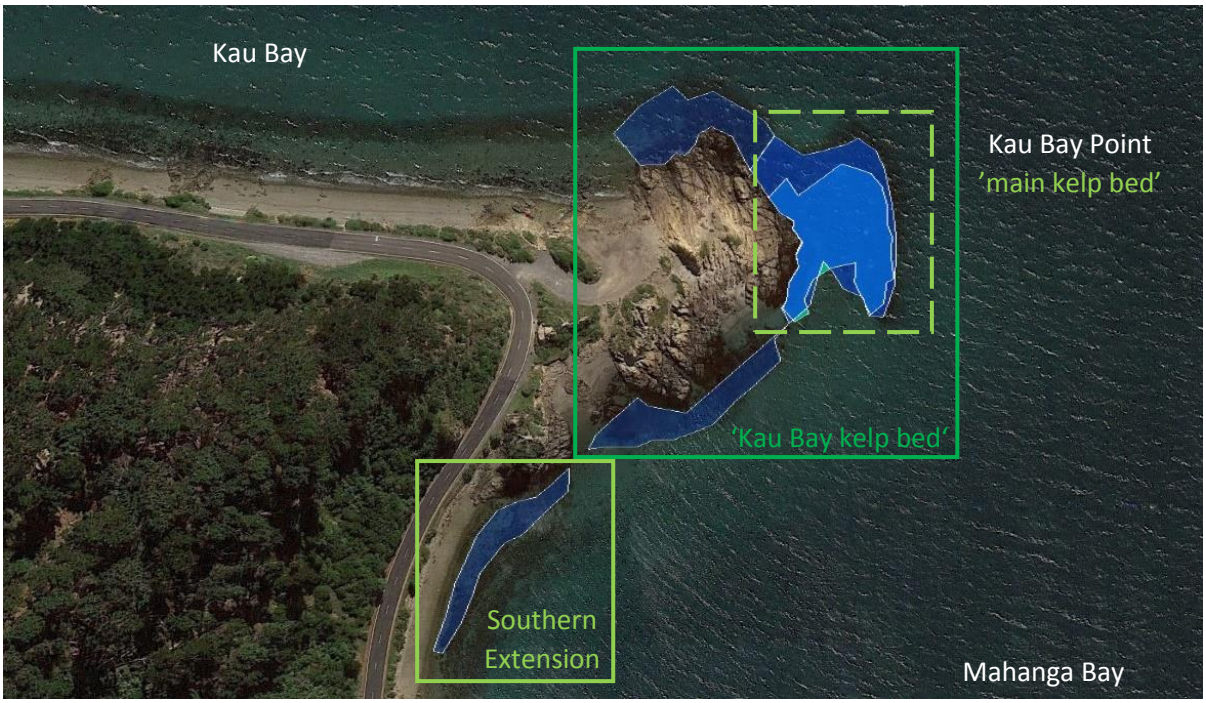


Figure 1: Smallest and largest extent of giant kelp recorded between June 2016 and June 2019 at the project site. Smallest: December 2016 (green bottom layer **1,377m²**), largest: November 2017 (darker blue, **3,619m²**, plus southern extension **553m²**). Area covered: 1,377m² vs 4,172m² (ratio 1:3!).

The area referred to as 'Kau Bay kelp bed' (dark green square) is shown in **Figure 1**. In November 2017 giant kelp was prolific close to shore on both sides outside the core project area. We recorded the area covered by kelp from the project site into Mahanga Bay (referred to as 'southern extension'). The area of the main kelp bed at the point between Kau Bay and Mahanga Bay is shown in **Figure 1** as light green, dashed square (see drone images on page 3).

Images of the giant kelp bed with thick coverage in Nov/Dec 2017

Project Monitoring Data

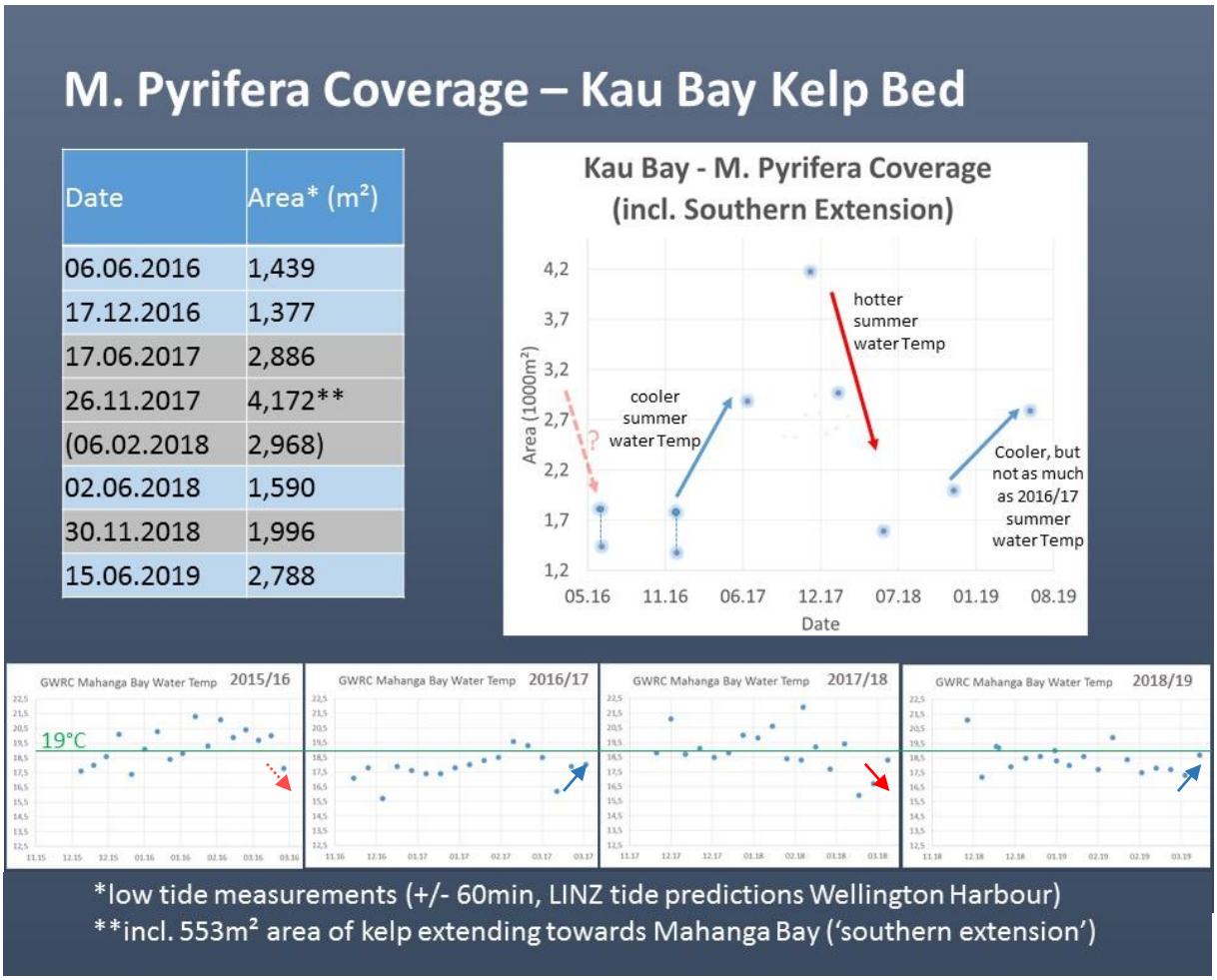


Figure 2: Project monitoring data and Wellington Harbour water temperature readings.

Comments

Giant kelp beds are known to fluctuate considerably in size in the Wellington region, close to its northern-most distribution boundary. Water temperatures seem to have the biggest impact on the size of the kelp bed (see also C. H. Hay, 1990). The hot 2017/18 summer showed water temperatures up to 21.9°C resulting in significant decrease of the size of the kelp bed in the June 2018 measurement. The 2015/16 season leading up the first monitoring also showed temperatures over 20-21°C. The size of the kelp bed increased after summer seasons with lower water temperatures.

Season	Date	Max Water Temp °C
2015/16	08.02.2016	21.3
2016/17	20.02.2017	19.6
2017/18	13.02.2018	21.9
2018/19	03.12.2018	21.1
	11.02.2019	19.9

Table 1: Maximum water temperatures as recorded by Greater Wellington Regional Council at Mahanga Bay over the summer seasons from 2015/16.

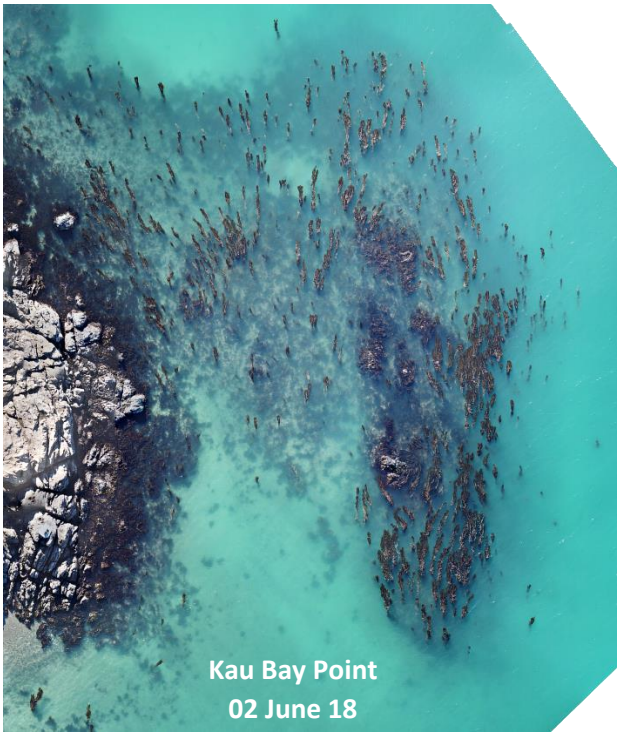
Our project monitoring data wasn't aquired frequently enough to conclude if the reduction in kelp bed size results from shorter spikes of 'hot' water or cumulative effect of exposure to warm temperatures above a critical temperature and length of time above that (see C. H. Hay for references to studies on temperature exposure). Cumulative temperature effects are well documented in other ecosystems (i.e. for coral species).

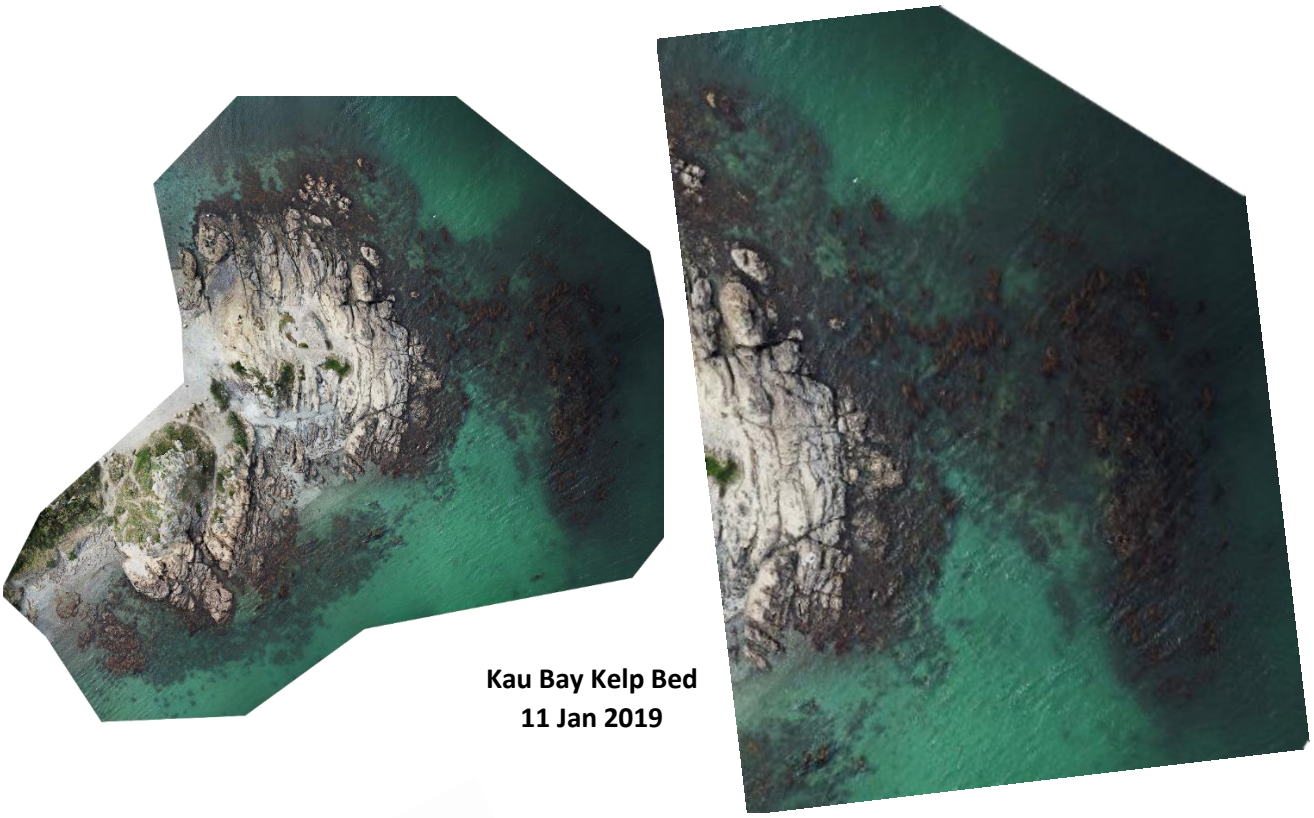
Sedimentation has a considerable influence on kelp productivity. Unfortunately, we don't have the data to further investigate the influence of sedimentation and pollution at our project site. However, no extraordinary events were recorded over the project time to date (i.e. dredging or significant pollution events covered in the news over prolonged duration). Strong storms and resulting near shore swells impact on giant kelp beds as well and research into wave height and wind directions might provide further insights of possible impacts over the project duration. Hutt River flow and nutrient levels in the harbour are other variables that might have an impact on the growth and helath of giant kelp at the project site.

Drone monitoring

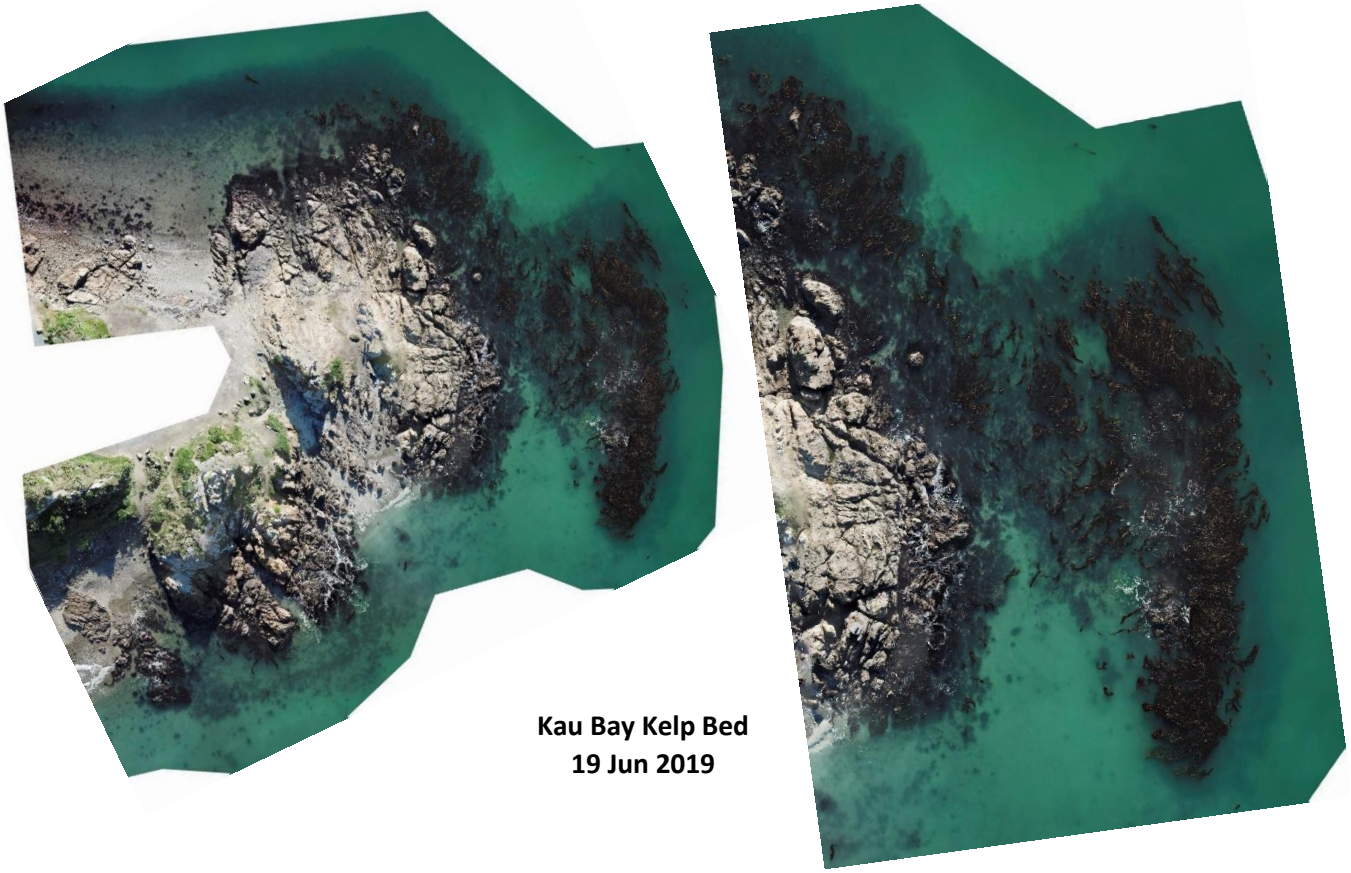
The surface area measured by GPS is an indication of kelp coverage, but it doesn't reflect the thickness of the kelp strands. Drone images (low tide, 30m flight height) can be used to give more detailed views of the kelp bed.

Below photosmosaics were assembled from drone images taken on 02 June 2018, 11 January and 19 June 2019:





Kau Bay Kelp Bed
11 Jan 2019



Kau Bay Kelp Bed
19 Jun 2019

Key references and resources

Cameron H. Hay (*1990*) The distribution of Macrocystis (Phaeophyta: Laminariales) as a biological indicator of cool sea surface temperature, with special reference to New Zealand waters, Journal of the Royal Society of New Zealand, 20:4, 313-336, DOI: 10.1080/03036758.1990.10426716:

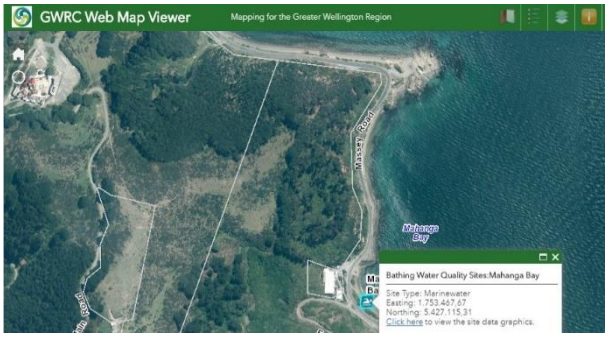
From the Abstract:

… In New Zealand, *M. pyrifera* does not persist in areas where maximum temperatures exceed 18-19°C for several days, and where the warmest monthly isothere does not exceed 16-17°C. An apparent easterly retraction of Macrocystis distribution within Cook Strait since 1942 is described, and the possibility that this may reflect slight warming in ambient sea surface temperature over the last forty years is discussed. The intolerance of the kelp to extreme temperatures above 18-19°C was confirmed by experimental transplantation of kelp plants within Queen Charlotte Sound…

From the Discussion section:

… Although *Macrocystis* fronds are short lived, with a life span rarely exceeding 6 months and on average 2-3 months, the holdfasts, from which new fronds sprout, are perennial. Holdfasts of Californian *M. pyrifera* have a half-life ranging from 2 to 68 months depending on location and depth. The plant thus effectively integrates sea surface temperatures over at least several years… These observations show that in New Zealand M. pyrifera is confined to open coasts where the highest monthly mean temperature is cooler than 16-17°C, and there is little likelihood of summer maxima exceeding 18-19°C… The inner embayments of Wellington Harbour are clearly at the very limits of growth for Macrocystis, as the summer deterioration of some inner harbour beds shows. Despite abundant rocky substrata inside Evans Bay, the paucity of the kelp and the brief survival of many young sporelings appearing in spring inside the Bay indicates that temperatures in late summer and autumn are usually too warm. The mean summer maxima at Mahanga Bay and Evans Bay are 1.5-2.0°C warmer than at Lyall Bay on the outer coast...

Greater Wellington Regional Council GIS Viewer and Environmental Monitoring Database:
Mobile Web Map: https://mapping.gw.govt.nz/GW/GWpublicMap_Mobile/
Monitoring Data Mahanga Bay:
http://graphs.gw.govt.nz/?siteName=Mahanga%20Bay&dataSource=Water%20Temperature%20(X)



Sustainable Seas National Science Challenge Webinar: Using drones to monitor marine ecosystems
Dr Leigh Tait from NIWA describes his research on monitoring kelp and seaweed biodiversity of coastal marine ecosystems using drones (6 June 2019): https://youtu.be/-A83VI2xWk4

Acknowledgements

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