Supplement 1. Detailed description of hydrodynamic model

S1.1. Model description

The current velocities and water levels for the Firth of Thames (FoT) were computed using the primitive equation hydrodynamical ROMS (Regional Ocean Modeling System) model version 3.7 over a 27-year period (1989-2015). This ocean model has been used widely in the scientific community and industry for a range of ocean basin, regional and coastal scales. ROMS has a curvilinear horizontal coordinate system and solves the hydrostatic, primitive equations subject to a free-surface condition. Its terrain-following vertical coordinate system results in accurate modelling of areas of variable bathymetry, allowing the vertical resolution to be inversely proportional to the local depth.

The 2D ROMS hindcast setup was configured with a nesting approach to adequately and gradually transfer energy from larger to smaller scales, and properly resolve flow and sea surface anomalies associated with local and remote forcing, both essential for the resultant currents and sea surface elevation in the nearshore area of interest. Along the production run both regional and high resolution domains undergo a spin-up phase of 7 and 3 days, respectively, occurring under a time frequency of 6 months. This procedure ensures the long term hindcast is produced in methodologically identical and reproducible blocks, along with minimization of undesired long term trends in currents and elevations fields.

S1.2 Model grids

The regional ROMS domain (Figure S1a) encompasses New Zealand's continental shelf and open ocean surroundings and has a spatial resolution of 0.05° by 0.05° (approximately 5 km) over the region delimited by 165.025°E to 179.975°E and 48.081°S to 33.018°S, while the highest resolution domain encompasses the Hauraki Gulf area delimited by 174.678°E to 175.531°E and 37.232°S to 36.267°S (Figure S1b) with a spatial grid resolution of 0.0025° by 0.0025° (approximately 250 m). Bathymetry was sourced from a combination of several surveys.
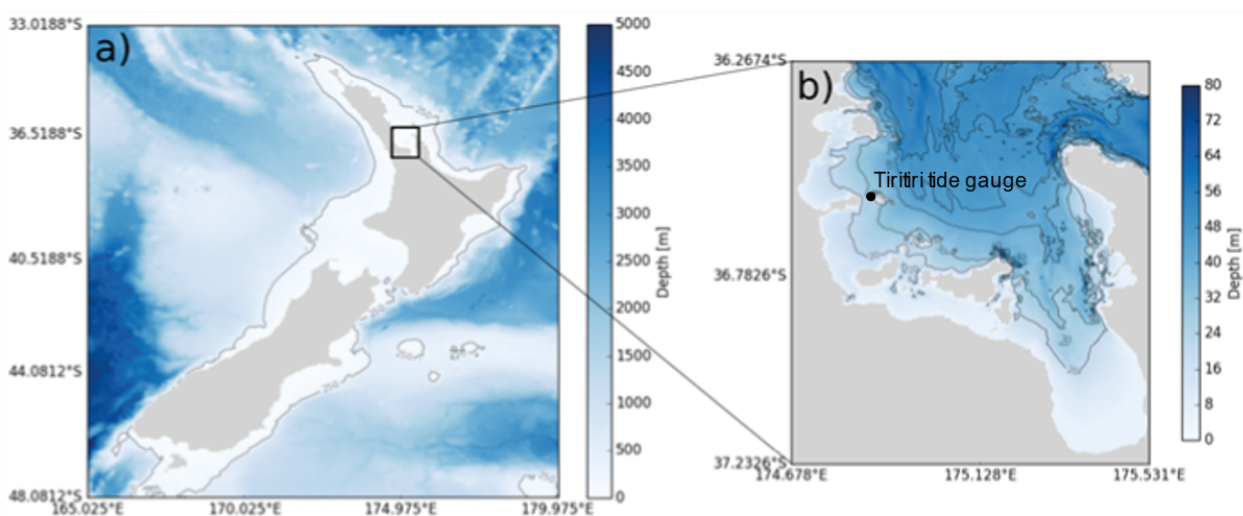
Figure S1.Bathymetry maps of the a) regional and b) high-resolution ROMS domains. Tide gauge at Tiritiri is shown.

S1.3 Atmospheric forcing

The spatially varying atmospheric forcing fields were extracted from a 36-year regional atmospheric hindcast constructed by MetOcean Solutions Ltd. The hindcast was generated using the Weather Research and Forecasting model (WRF) nested within the Climate Forecast System Reanalysis (CFSR) data set from NOAA.

S1.4. Tidal Forcing

Tidal forcing via tidal elevations and currents constituents was applied at the open boundaries. The tidal dataset used in this study was extracted from a 34-year regional oceanic hindcast constructed by MetOcean Solutions Ltd using the Princeton Ocean Model (POM), applied for the Hauraki Gulf and its open ocean surroundings with spatial resolution of 0.008° by 0.008° (approximately 800 m).

The use of the referred dataset and the location of its open boundaries (see Figure S1) ensures that stable open ocean tidal ellipses are used to force the model at the boundaries, avoiding noise introduction and volume conservation inconsistencies derived from complex and uncertain spatial variations in tidal currents/elevations amplitudes and phases in the inner Gulf and the area of interest. The model then propagates the tidal wave within the domain representing tidal currents and elevations successfully due to the accurate bathymetry and refined spatial resolution.

S1.5. ROMS Validation

Modelled sea surface elevations were validated (Figure S2) against a measured elevation timeseries obtained from a tide gauge located at Tiritiri, 174.888°E, 36.605°S (Figure S1). Tidal elevations were derived from the time series using a translated Python version of Ttide MATLAB toolbox2, while residual (non-tidal) elevations were obtained applying a 40-hour low-pass (IIR Butterworth) filter for an optimal response in removing supra-tidal signals from the total elevation time series.

The comparison statistics are summarized in Table S1 showing good agreement between modelled and measured sea surface elevations.

Table S1. Summary of the accuracy measures MAE Mean Absolute Error, and RMSE Root Mean Squared Error between modelled and observed sea surface elevations at a tide-gauge site Tiritiri from 28/08/2015 to 22/09/2015.

	Total [m]	Tidal [m]	Non-tidal [m]
MAE	0.18	0.18	0.05
RMSE	0.22	0.21	0.06
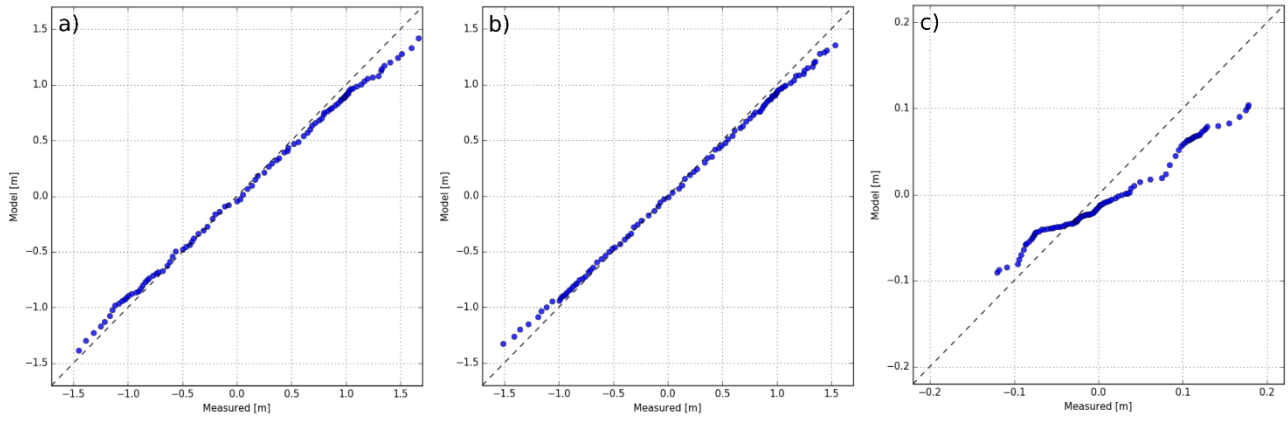
Figure S2.Quantile-quantile plots of a) total, b) tidal and c) non-tidal sea surface elevations from 28/08/2015 to 22/09/2015.

Supplement 2. Laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) operating conditions and detection limits

Table S2. The LA-ICP-MS operating parameters used in this study

Tuning

Tuning standard	NIST 610
Ablation mode	Rastering (2 µm s^{-1}) beneath a 100 µm spot
Monitored isotopes	^{7}Li, ^{59}Co, ^{88}Sr, ^{140}Ce, ^{208}Pb, ^{238}U
Carrier gas (Ar)	0.85 L min $^{-1}$
Ablation gas (He)	80%-90%
RF power	1500 W
RF matching	1.72 V
Repetition rate	5 Hz
Laser power	45%
Fluence	7.0-7.5 Jcm-1

Standards and calibration

Calibration standard	NIST 610
Ablation mode	50 µm spot
Repetition rate	5 Hz
Laser power	45 percent
Background acquisition	20 s
Sample data acquisition	40 s
Washout time	30 s
Measured isotopes	^{7}Li, ^{11}B, ^{25}Mg, ^{27}Al, ^{43}Ca, ^{47}Ti, ^{51}V, ^{55}Mn, ^{57}Fe, ^{59}Co, ^{60}Ni, ^{63}Cu, ^{66}Zn, ^{88}Sr, ^{89}Y, ^{138}Ba, ^{139}La, ^{140}Ce, ^{208}Pb, ^{238}U.
Fluence	7.0-7.5 Jcm-1

***P. canaliculus* method**

Repetition rate	5 Hz
Ablation mode	100 µm spot
Laser power	65%
Background acquisition	30 s
Sample data acquisition	45 s
Washout time	30 s
Measured isotopes	^{7}Li, ^{11}B, ^{25}Mg, ^{27}Al, ^{43}Ca, ^{47}Ti, ^{51}V, ^{55}Mn, ^{57}Fe, ^{59}Co, ^{60}Ni, ^{63}Cu, ^{66}Zn, ^{88}Sr, ^{89}Y, ^{138}Ba, ^{139}La, ^{140}Ce, ^{208}Pb, ^{238}U
Fluence	7.0-7.5 Jcm-1

Table S3. Detection limits of LA-ICP-MS of elements investigated in this study. Limits were calculated as 3 x SD of background/NIST610 value

TE:Ca ratio	Internal Precision (2% RSD)	Detection Limit (µmol:mol)
Li:Ca	0.098	0.2
B:Ca	0.629	0.2
Mg:Ca	0.250	0.6
Al:Ca	0.072	0.7
Ti:Ca	0.213	1.2
Mn:Ca	0.049	1.3
Co:Ca	0.078	1.4
Ni:Ca	0.080	1.4
Cu:Ca	0.081	1.6
Zn:Ca	0.142	1.6
Sr:Ca	0.120	2.1
Ba:Ca	0.176	3.3

Supplement 3. Experiment to determine if in situ culturing containers affected the trace elemental composition of mussel shell

In order to determine if *in situ* culturing containers influenced the trace elemental composition of *Perna canaliculus* a laboratory culturing experiment was conducted. Seaweed was collected from Muriwai Beach (-36.837249, 174.427382) on the 27th of February 2017and was transferred to the University of Auckland School of Biological Sciences. 180 early juvenile mussel spat were removed from the seaweed and 10 individuals placed into each of a total of 9 in situ culturing containers (ICCs). Three ICCs were placed into each of three high-density polyethylene HDPE tanks with flow through water ($n_{(ICC)}$ = 9). The remaining 90 juvenile mussels were placed into each of three identical tanks without ICCs. Every two days they were fed 400 ml of *Isochrisis spp.* microalgae. Juvenile mussels were allowed to grow for seven weeks at which time they were removed from the ICCs and tanks and frozen at -20 C until analysis. Shells were defrosted prior to analysis, and the shell deposited after harvest was identified visually based on differences in shell colour. LA-ICP-MS analyses were conducted to determine the trace elemental composition of shell Laser spots were performed 200 μm from the most recently formed shell edge. The concentration of trace elements in shell material illustrate similarities in trace elemental composition of ICC and tank shells (Table S4).

A linear mixed model analysis was undertaken in R v3.3.3 (R core team). The effect of tanks was taken as a fixed factor and the ICC was treated as a random effect. This analysis was performed on all 12 of the elements which were analysed (Table S5).

Table S4. Concentrations of trace elements (in *Perna canaliculus* cultured in in situ culturing containers placed inside HDPE tanks or grown outside the culturing containers in the HDPE tanks for seven weeks.

	TE:Ca ratio (μmol:mol)	
TE:Ca	Tank	ICC
Li:Ca	0.37 (±0.02)	0.46 (± 0.02)
B:Ca	38.34 (±3.4)	103.4 (± 14.54)
Mg:Ca	1995.5 (±193.79)	2281.3 (± 165.88)
Al:Ca	1.55 (±0.21)	11.6 (± 7.15)
Ti:Ca	4.72 (±0.06)	5.11 (± 0.19)
Mn:Ca	3.75 (±0.53)	4.26 (± 0.54)
Co:Ca	0.12 (±0)	0.09 (± 0.01)
Ni:Ca	0.64 (±0.05)	0.71 (± 0.06)
Cu:Ca	3.59 (±0.35)	6.72 (± 0.47)
Sr:Ca	296.78 (±14.4)	269.66 (± 8.32)
Ba:Ca	0.67 (±0.02)	0.71 (± 0.03)
Pb:Ca	0.45 (±0.03)	0.52 (± 0.02)

Table S5. Results of the linear mixed model comparing *Perna canaliculus* grown in HDPE tanks and those grown in culturing containers placed into these tanks. Note: Bold values indicated significant differences existed between the two culturing methods.

TE:Ca	p value
Li:Ca	**0.023**
B:Ca	**0.036**
Mg:Ca	0.386
Al:Ca	0.38
Ti:Ca	0.29
Mn:Ca	0.802
Co:Ca	0.253
NI:Ca	0.57
Cu:Ca	**0.012**
Sr:Ca	0.155
Ba:Ca	0.445
Pb:Ca	0.231