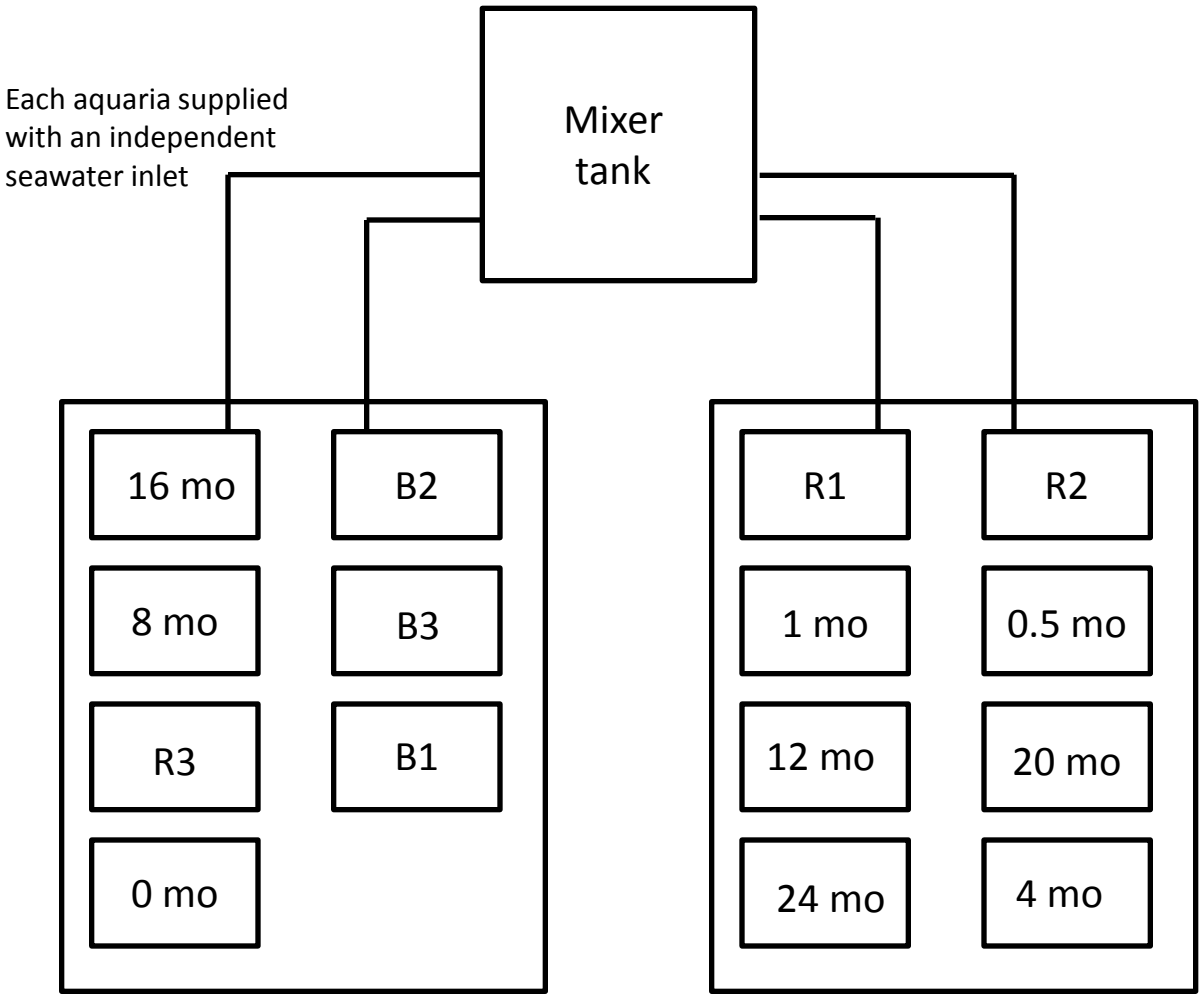
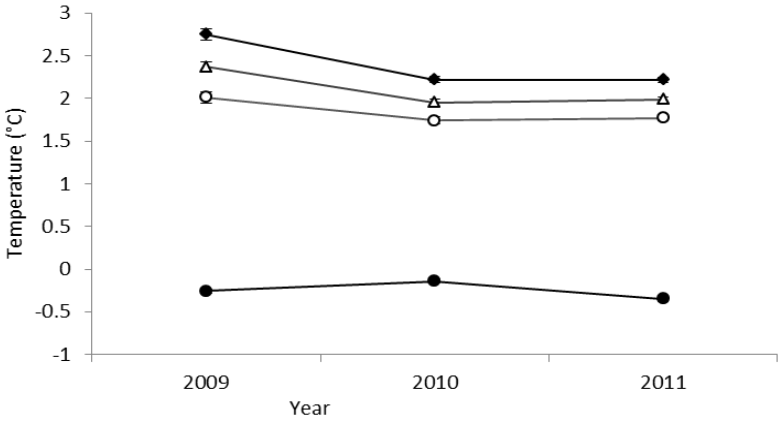
Seawater parameter	Low temperature control		High temperature control		-0.3 pH		-0.5 pH	
	6 mo	17 mo	6 mo	17 mo	6 mo	17 mo	6 mo	17 mo
pCO_2 (ppm)	439.76 ± 8.93	439.31 ± 8.65	443.92 ± 7.39	439.35 ± 5.84	956.00 ± 3.41	1017.00 ± 3.65	1569.00 ± 0.01	1568.00 ± 0.06
$pH_{(NIST)}$	7.98 ± 0.01	8.02 ± 0.01	7.98 ± 0.01	8.03 ± 0.01	7.71 ± 0.01	7.75 ± 0.01	7.53 ± 0.01	7.58 ± 0.01
Ω calcite	1.42 ± 0.03	1.49 ± 0.03	1.44 ± 0.03	1.46 ± 0.03	0.79 ± 0.02	0.85 ± 0.03	0.52 ± 0.01	0.58 ± 0.01
Ω aragonite	0.96 ± 0.02	0.94 ± 0.02	0.96 ± 0.02	0.92 ± 0.02	0.49 ± 0.01	0.53 ± 0.02	0.33 ± 0.01	0.36 ± 0.01
Temperature (°C)	-0.92 ± 0.07	-0.94 ± 0.03	-1.06 ± 0.06	-0.84 ± 0.04	-1.02 0.09	-0.81 ± 0.03	-0.94 ± 0.05	-1.02 ± 0.04
Salinity (psu)	36.00 ± 0.01	33.30 ± 0.10	36.00 ± 0.01	33.28 ± 0.10	36.00 ± 0.01	33.29 ± 0.10	36.00 ± 0.01	33.29 ± 0.10
Alkalinity (mmol L^{-1})	2012 ± 23	2078 ± 16	2032 ± 23	2009 ± 17	2051 ± 20	2072 ± 20	1995 ± 35	2085 ± 17

Supplementary Table 1: Mean (± SE) seawater parameters of the *Sterechinus neumayeri* larval cultures derived from parents pre-exposed to low temperature and high temperature seawater controls and lowered carbonate conditions. pCO_2, Ω calcite, Ω aragonite and total alkalinity values modelled from CO2SYS (Lewis & Wallace, 1998) with refitted constants (Mehrbach *et al.*, 1973; Dickson & Millero, 1987). Values represent seawater values before and after seawater exchanges. Comparisons of seawater parameters demonstrated that larval temperatures were similar ($P > 0.05$), low pH treatments were significantly lower than controls ($P<0.001$) and that salinity was significantly higher in the 6 months parental conditioning trial compared to the 17 months trial ($P<0.001$). It is possible that salinity could be contributing towards the results we see in the latter trial. However it is consistently higher across all treatments and treatment effects are still observed (and therefore comparable) thus indicating that parental conditioning affects still remain.

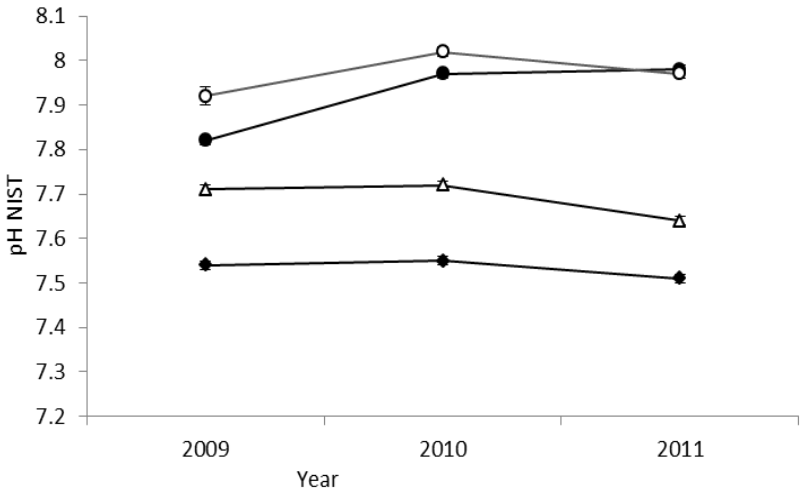


Supplementary Figure 1: Experimental set-up for each of the treatments with two tray tanks for each treatment, fed by a single mixer tank. Each tank contained 7-8 x 3L aquaria, each housing 8 urchins. The 3 tanks labelled R contained the animals for the respirometry studies. At each time point, 10 animals were taken at random from the 3 tanks and subjected to respirometry measurements. After each measurement the animals were returned to their respective aquaria and animals in a separate aquarium were used for the destructive sampling and determination of (AFDM) for each treatment at each sampling time point (n=8). The numbers refer to the months the destructive sampling was carried out. There were also three tanks containing broodstock (labelled B).

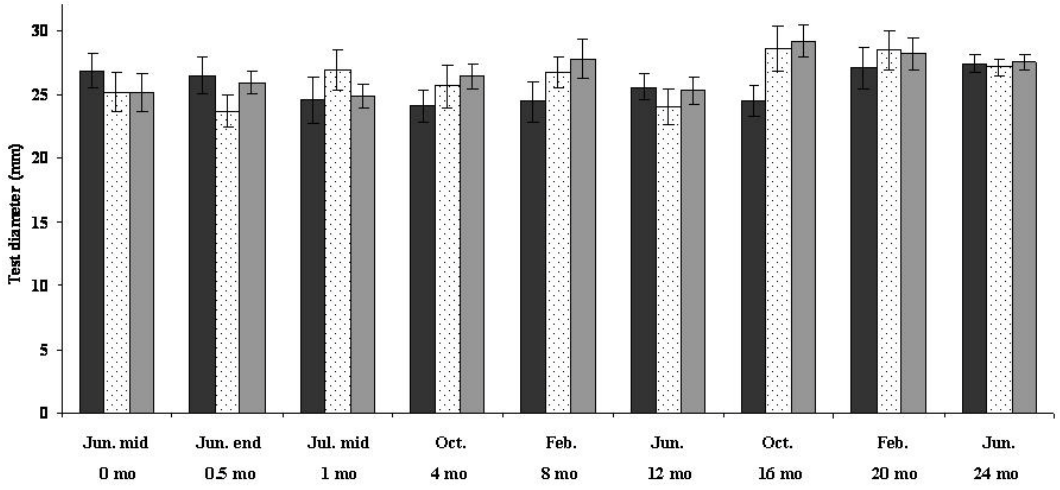
A



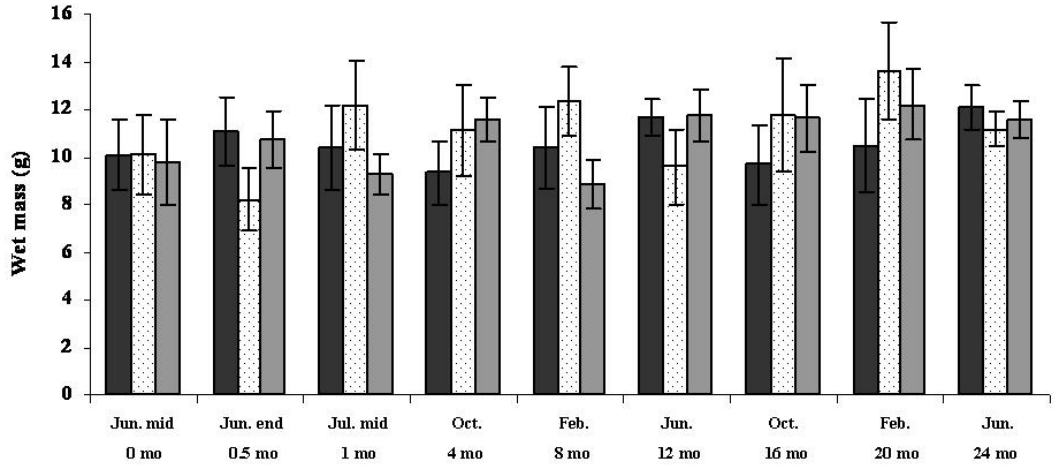
B



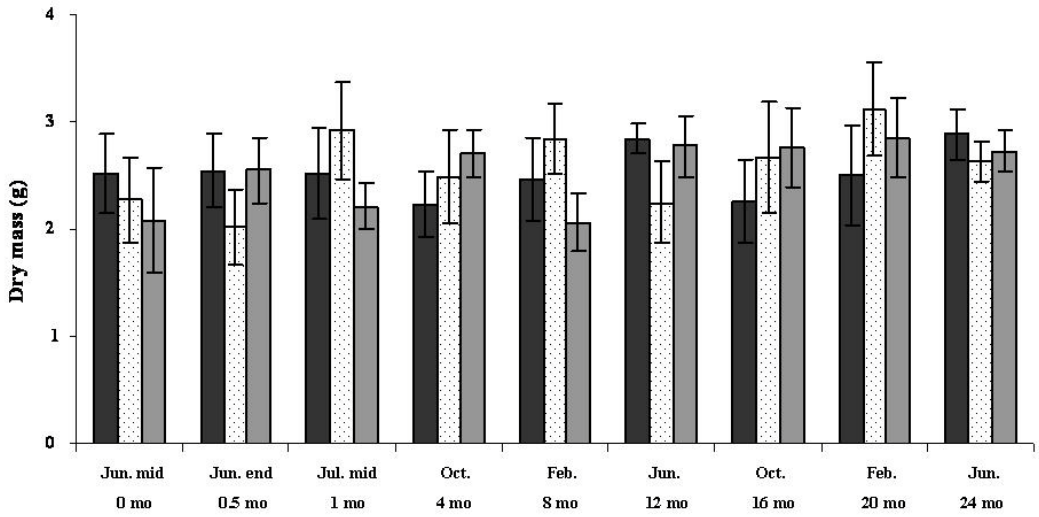
Supplementary Figure S2: Mean (± SE) seawater parameters of the *Sterechinus neumayeri* adults exposed to low temperature and high temperature (A) seawater controls and lowered carbonate conditions (B) across each year of the experimental period. = low temperature control; = high temperature control; = -0.3 and = -0.5 pH units. Comparisons of seawater parameters presented in Table 1 demonstrated that all treatments were significantly different from each other with respect to temperature and pH ($P < 0.001$). Low temperature control salinity was 1 psu lower than other treatments ($P < 0.001$).



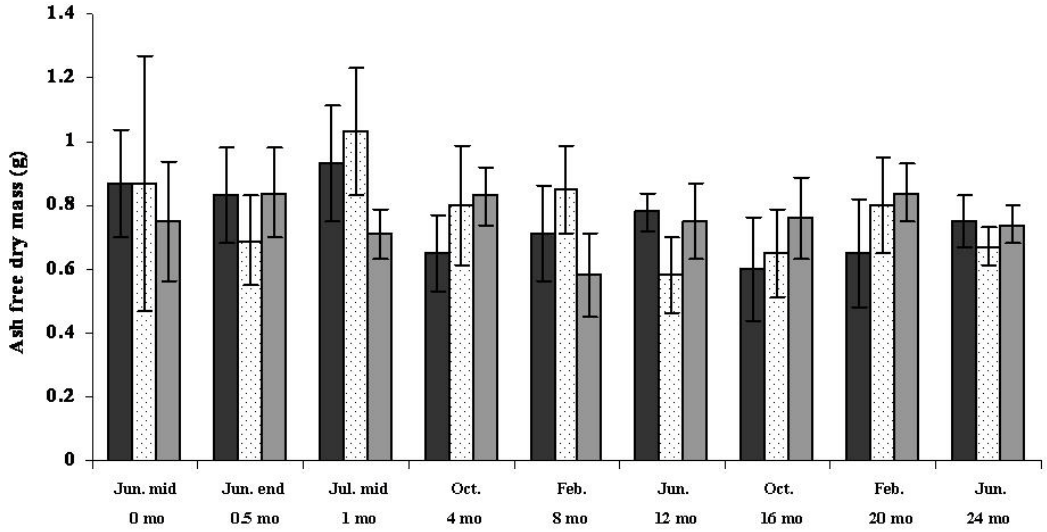
Supplementary Figure S3: Mean test diameter (mm; ± SE) of adult *S. neumayeri* exposed to control and reduced pH conditions. Test diameters were not significantly different across treatments at any given time point for the duration of the experimental period up to 24 months exposure time nor across time for any treatments (Treatment: $F_{(2,237)} = 1.52$, $P = 0.222$; Time: $F_{(8,237)} = 2.55$, $P = 0.559$;Interaction: $F_{(16,237)} = 1.10$, $P = 0.358$). ■ = Control, ⊡ = -0.3 pH, ■ = -0.5 pH. Mid. = middle of the respective month; end = end of respective month.



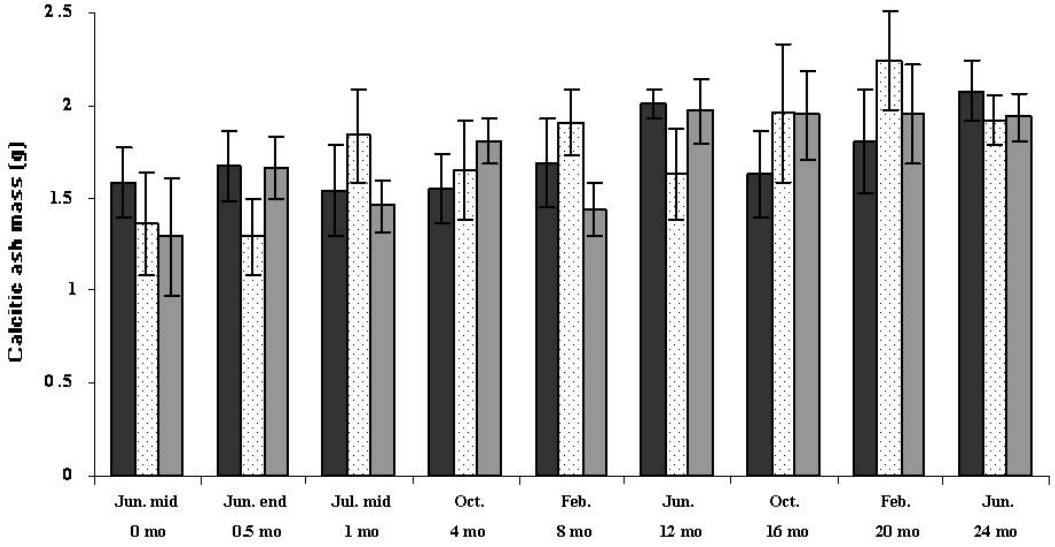
Supplementary Figure S4: Mean whole animal wet mass (g; ± SE) of adult *S. neumayeri* exposed to control and reduced pH conditions. There were no significant differences for each treatment across time nor were there differences between treatments at any given time point for the duration of the experimental period, but an interaction effect was possible (Treatment: $F_{(2,216)} = 0.32$, P = 0.730; Time: $F_{(8,216)} = 2.25$, P = 0.025; Tank: $F_{(3,216)} = 0.65$, P = 0.583; Interaction (treatment*time): $F_{(16,216)} = 2.74$, P = 0.014). Post-Hoc tests revealed that when treatments were inspected individually this interaction effect was not present and therefore there was no interaction of time with individual treatments (Control: $F_{(8,99)} = 1.20$, P = 0.453; -0.3 pH: $F_{(8,99)} = 1.54$, P = 0.299; -0.5 pH: $F_{(8,99)} = 0.55$, P = 0.853). ■ = Control, ⊡ = -0.3 pH, ▩ = -0.5 pH. Mid. = middle of the respective month; end = end of respective month.



Supplementary Figure S5: Mean whole animal dry mass (g; ± SE) of adult *S. neumayeri* exposed to control and reduced pH conditions. There were no significant differences for each treatment across time nor were there differences between treatments at any given time point for the duration of the experimental period (Treatment: $F_{(2,237)} = 0.06$, 0.939; Time: $F_{(8,237)} = 0.85$, $P = 0.559$; Interaction: $F_{(16,237)} = 0.74$, $P = 0.756$). ■ = Control, ⊡ = -0.3 pH, ■ = -0.5 pH. Mid. = middle of the respective month; end = end of respective month.



Supplementary Figure S6: Mean whole animal ash free dry mass (g; ± SE) of adult *S. neumayeri* exposed to control and reduced pH conditions. This was not significantly different across treatments at any given time point for the duration of the experimental period nor across time for any treatments (Treatment: $F_{(2,236)}$ =0.19, P = 0.824; Time: $F_{(8,236)}$ = 0.69, P = 0.700; Interaction: $F_{(16,236)}$ = 0.89, P = 0.586). ■ = Control, ⊡ = -0.3 pH, ▩ = -0.5 pH. Mid. = middle of the respective month; end = end of respective month.



Supplementary Figure S7: Skeleton mass (measured as ash remaining after ignition) (g; ± SE) of adult *S. neumayeri* exposed to control and reduced pH conditions. ■ = Control , ⊡ = -0.3 pH, ▭ = -0.5 pH. Skeleton mass did not significantly differ between treatments at any given time point for the duration of the experimental period up to 24 months exposure time, but initial analyses indicated that skeleton mass significantly differed across time for treatments (Treatment: $F_{(2,237)} = 0.06$, P = 0.938; Time: $F_{(8,237)} = 2.91$, P = 0.004; Interaction: $F_{(16,237)} = 0.76$, P = 0.727; Figure 6.7). However post-hoc tests confirmed that there were no significant differences across time for each treatment (C: $F_{(8,79)} = 1.18$, P = 0.421; M: $F_{(8,79)} = 1.53$, P = 0.260; E: $F_{(8,79)} = 1.77$, P = 0.202). Mid. = middle of the respective month; end = end of respective month.