

REPORT

COMMUNITY ECOLOGY

Predator control of marine communities increases with temperature across 115 degrees of latitude

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Early naturalists suggested that predation intensity increases toward the tropics, affecting fundamental ecological and evolutionary processes by latitude, but empirical support is still limited. Several studies have measured consumption rates across latitude at large scales, with variable results. Moreover, how predation affects prey community composition at such geographic scales remains unknown. Using standardized experiments that spanned 115° of latitude, at 36 nearshore sites along both coasts of the Americas, we found that marine predators have both higher consumption rates and consistently stronger impacts on biomass and species composition of marine invertebrate communities in warmer tropical waters, likely owing to fish predators. Our results provide robust support for a temperature-dependent gradient in interaction strength and have potential implications for how marine ecosystems will respond to ocean warming.

The strength of species interactions, such as predation and competition, is thought to peak at low tropical latitudes and decline toward the poles (1). Such geographic variation in interaction strength is invoked frequently as both a major cause and consequence of the latitudinal diversity gradient, one of the most robust patterns of life on Earth (2–5). However, studies available to date across large spatial scales and multiple habitats provide conflicting support for increased predation intensity in the tropics and have been mostly limited to measuring rates of prey loss. For example, predation intensity (consumption rate) on seeds (6) and terrestrial insect mimics (7) was greater in the tropics than at higher latitudes. By contrast, attacks on open ocean long-line fishing hooks baited with natural prey peaked at mid-latitudes instead of the tropics (8), as did consumption of squid baits in shallow coastal waters (9).

Currently, it remains largely unknown whether global gradients in predation intensity produce associated gradients in the magnitude of effects on prey communities, especially across latitudes. Such a gradient in community-level effects is likely to have profound consequences

for patterns of biodiversity (10), ecosystem function (11, 12), and resilience to global change (13). Although some studies have found evidence for stronger effects of predation on community composition at tropical versus temperate sites, primarily in shallow-water marine benthic habitats (14–17), these were restricted to spatial scales of 20° to 45° latitude and usually along single coastlines. Other regional-scale studies in similar marine habitats did not detect this latitudinal pattern in community effects of predators (18, 19). Where latitudinal trends in predation intensity and impact have been observed at regional spatial scales, a number of environmental factors that follow a latitudinal gradient have been proposed as drivers of this pattern, including time since glaciation, lack of freezing winters, day length, and temperature (20). Ambient temperature is likely important because it strongly influences metabolic rates and underpins organism functioning and the ecology of populations, communities, and ecosystems (21). Although temperature generally declines with latitude, the relationship varies among regions (Fig. 1). Thus, including in situ temperature as an independent predictor could help to explain the mixed results from previous studies. Clarifying the relation-

ship between predation intensity, impacts on prey communities, and temperature could also facilitate prediction of community response to future ocean warming.

We tested whether intensity of predation and its community-level effects decrease from tropical to subpolar latitudes in coastal marine ecosystems. Specifically, we assessed the impact of fish and other large, mobile predators on sessile marine invertebrate communities. We used standardized and replicated experiments at 36 nearshore sites across 115° of latitude, along both Pacific and Atlantic coasts of the Americas (Fig. 1 and table S1). We conducted three complementary experiments to test whether predation intensity and top-down control of prey communities vary consistently along latitudinal and temperature gradients in both hemispheres. We focused on coastal subtidal communities of sessile invertebrates on hard substrates for multiple reasons. These communities are widely distributed throughout the world and are especially conducive to experiments, responding rapidly to manipulation and allowing for robust tests of general ecological processes (3, 22). There is also evidence that top-down control is stronger in the tropics than in temperate regions for these hard-substrate communities at some regional scales (14–16, 18, 23). We expanded on this past work to test with high replication whether results are consistent on an extensive geographic scale, across the Americas in two oceans (24).

Our experiments measured three separate components of predation: (i) consumption of a standard bait as a measure of predation intensity, (ii) effects of sustained predation on the development of benthic community composition and biomass over 3 months, and (iii) the effects of short-term predation on already developed benthic communities (table S2) (24). The three complementary predation measures were collocated in space and time at each site. To compare predator consumption rates on a broadly palatable prey for the first component, we used dried squid as a standardized bait at all sites and recorded bait loss after 1 hour as a measure of predation intensity (25). For the second and third components, we allowed natural communities to develop on standardized substrates for 3 months (15) and manipulated predator access at different time points in community assembly, to evaluate the effect of predation on composition and biomass of sessile invertebrate communities (24). Cages were designed and used in both experiments to selectively exclude and evaluate effects of large (>1 cm) mobile predators, especially fishes, which are major consumers of benthic invertebrate prey in shallow subtidal habitats and can affect their community composition (14–18, 23). The second component contrasted communities developed continuously under caged versus uncaged control conditions for

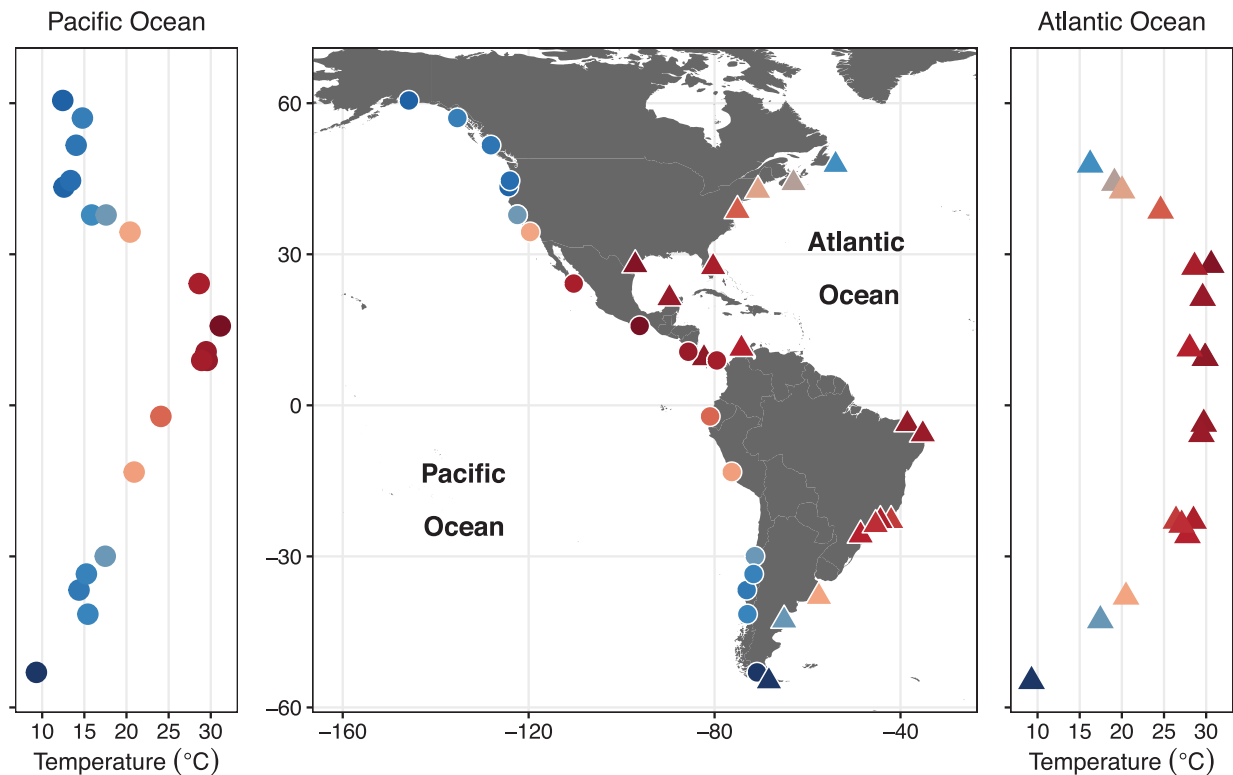


Fig. 1. Site location and mean temperatures. Location, latitude, and mean temperature recorded at experimental sites on Atlantic (triangle) and Pacific (circle) coastlines of the Americas. Color scale indicates gradient in temperature recorded across latitudes during the experiment (dark blue, $\sim 9^{\circ}\text{C}$; dark red, $\sim 31^{\circ}\text{C}$).

12 weeks. For the third component, we allowed communities to develop for 10 weeks in cages and then uncaged half of these, comparing effects of predator exposure on these established communities after 2 additional weeks. We also measured temperature at each site throughout the experiments using dataloggers (24).

We analyzed the results with mixed effects models and a model selection approach, with separate global models estimating the responses of bait consumption; sessile community biomass; and community composition to variation in seawater temperature or latitude, ocean basin, hemisphere, caging treatment, and inter-

actions among all these terms. We explicitly compared alternate models that included either latitude or temperature recorded during the experiment to evaluate which was a better predictor of predator effects (24).

Our results provide robust experimental evidence that top-down control of community

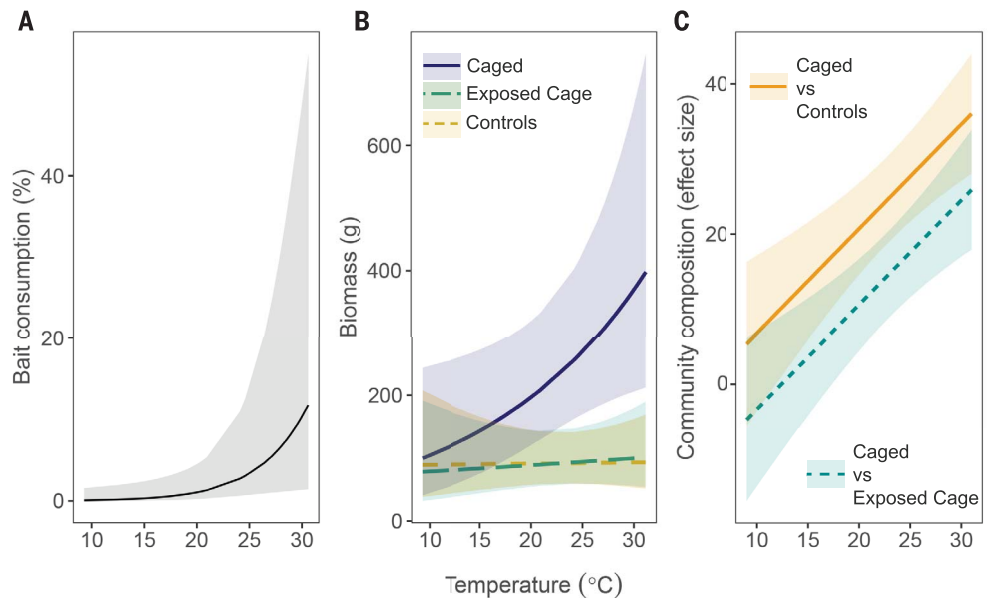
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Fig. 2. Modeled variation in predation intensity and responses of biomass and community composition to predation with increasing temperature.

(A) Predation measured as bait loss increased with in situ temperature along Atlantic and Pacific coastlines of the Americas. The line indicates predictions from a generalized linear mixed effects model [conditional coefficient of determination (R^2) = 0.79]. (B) The effect of predation on biomass accumulation increased with temperature. Dark blue indicates predators were excluded throughout the experiment; green indicates predators were excluded until the last 2 weeks of the experiment and then the experiment was exposed to predators; and yellow indicates open to predators throughout the experiment (model conditional R^2 = 0.89). Predators consumed significantly more biomass as temperature increased

between 9° and 31°C. (C) Effect of predation on community composition increased along the latitudinal temperature gradient. Exclusion of predators throughout the 3-month experiment (gold, caged versus controls) had a greater impact on community composition than 2-week exposure (blue, caged versus exposed cage) of the late-stage community to predators. Lines show effect size as predictions from linear models of square roots of the estimated component of variation for each contrast within each site. Shaded areas show 95% confidence intervals (CIs) (24).



structure consistently increases with temperature and is strongest in the tropics, supporting a major tenet in ecology and evolutionary biology. Predation intensity and its effects on marine hard-substrate communities increased from colder high-latitude to warmer tropical waters (Fig. 2). Seawater temperature and latitude were strongly correlated [correlation coefficient (r) = 0.84], and although results were qualitatively similar for seawater temperature and absolute latitude, the models with seawater temperature were more strongly supported for both predation intensity and community responses (24). Predation intensity, as measured in the first experiment with bait consumption, was greatest in the warm tropics and approached zero at sites where mean summer sea surface temperature was below ~20°C (Fig. 2A, fig. S2, and table S3). Whereas the bait loss assay provides a short-term (1 hour) measure of predation intensity, the two caging experiments integrate longer-term impacts of predators on community attributes, revealing that predators had consistently larger effects on communities at higher temperatures and during multiple stages of community development. Specifically, in the second experiment, the effect of predators increased with temperature for both biomass accumulation (wet-weight) (Fig. 2B, fig. S3, and table S4) and community composition (Fig. 2C, figs. S4 to S6, and tables S5 to S7). In the third experiment, predators reduced prey community biomass in warmer tropical waters during the 2-week exposure, compared with communities that re-

mained caged, and biomass of these exposed communities converged on uncaged control treatments across all temperatures (Fig. 2B and table S4). Community composition also responded more strongly to this later-stage predation at warmer sites (Fig. 2C and table S6). Thus, results of these three complementary experiments provide strong and consistent evidence that predation intensity by mobile predators is higher on average, and shapes community composition more strongly, in warm tropical waters.

The organisms that changed most in response to predators were solitary tunicates and encrusting bryozoans; dominance of these groups diverged among treatments with increasing temperature (fig. S4). At warm water sites, encrusting bryozoans were most prevalent on open control panels, whereas solitary tunicates occurred most frequently on caged panels that restricted predator access (Fig. 3 and table S7, C and D). This pattern may result from competitive release of less palatable bryozoans when spatially dominant tunicates are removed by predators during community assembly (19, 26). When later-stage tropical communities were exposed to predators, solitary tunicate dominance was reduced (compared with caged panels), with a coincident increase in bare space (Fig. 3). Bare space decreased toward the tropics in all treatments. It is likely that prevalence of large solitary tunicates drove the observed higher biomass in treatments protected from predators at most sites (Fig. 2B).

Although we found a strong overall increase in predation intensity and top-down control at warmer temperatures, the scale of the responses varied among ocean basins and hemispheres. For example, bait loss and community composition responses were more marked in the northern hemisphere (figs. S2, A and B, and S6B), whereas the biomass response of prey communities was more apparent in the North Atlantic and South Pacific than other regions (fig. S3B). This variation likely derives from regional differences in the species and functional characteristics of predators and prey, environmental conditions other than temperature, and/or biological factors beyond those measured here (such as productivity) (23). Fundamental differences in oceanography exist at the ocean basin scale (for example, equatorial upwelling on the Pacific coastline is largely absent from the Atlantic sites) that would be expected to have effects on the observed latitudinal patterns (27). More broadly, the variation among sites underscores the need for high replication and broad geographic coverage to thoroughly evaluate both regional and global patterns.

This study provides new insights into the macroecological pattern of biotic interactions. We show that intensity of predation indeed declines consistently with latitude, as expected, but is better predicted by mean summer temperature experienced during the experiment than by latitude, hinting at underlying mechanisms. We demonstrate that this gradient in predation intensity produces a parallel gradient in top-down control of marine community

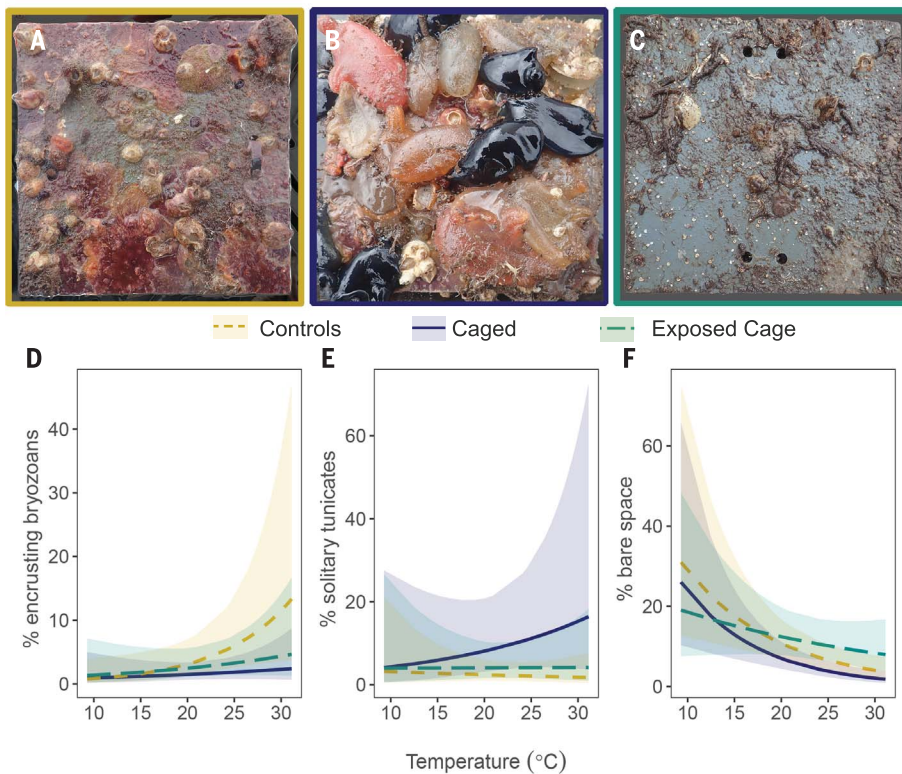


Fig. 3. Effects of predator treatments on community composition at a tropical Atlantic site and response of key functional groups from models based on all sites. (A to C) Photographs illustrate differences among experimental treatments at Bocas del Toro, Panama. At this and other warm water sites, encrusting bryozoans predominated in (A) control panels (exposed to predators), (B) solitary tunicates in caged panels (predators excluded), and (C) bare space in exposed cage panels [as in (B) but exposed to predators for the last 2 weeks through cage removal]. (D to F): Modeled percent cover across all sites of (D) encrusting bryozoans, (E) solitary tunicates, and (F) bare space, which together explained most of the variation in community composition among treatments (yellow, controls; dark blue, caged; green, exposed cage) in warm water sites. Shaded areas show 95% CIs (24).

biomass and composition that has been long suspected but not rigorously tested at this scale. As predicted, predation intensity in our shallow hard-substrate communities increased with temperature, similar to the patterns of bait loss in terrestrial and marine environments over an expansive latitudinal range (7, 9). Our results were likely driven by highly mobile fish that can exert strong effects on epibenthic invertebrates in warm tropical water (14–18, 23). We recognize that predation effects may differ for marine communities in other habitat types, including those where macroinvertebrates exert strong predation effects (3, 27). More specifically, other studies in marine systems have shown a variety of patterns (8, 9, 28), which may reflect physical differences among habitats, taxonomic composition of predator or prey groups, smaller spatial scales, or less replication.

Overall, our analyses demonstrate a strong temperature-dependent gradient of increasing predator impacts on community biomass and composition and support prior predictions of stronger interaction strengths at warmer

latitudes based on regional-scale studies [for example, (15, 17)]. This study, completed at a large spatial scale, contributes to mounting evidence that temperature is a key predictor of global gradients, not only in diversity (29) and a suite of biological processes (21) but also in the strength of interactions among species (30, 31) and the resulting effects of those interactions on communities.

Our results imply that climate change may have predictable effects on the regulation of nearshore communities along the world's shorelines. Our finding of a fundamental relationship between temperature and predation effects across large geographic scales suggests that, in addition to shifting species' distributions (32), ocean warming may cause the intensity of top-down control to expand poleward (Fig. 4). Specifically, the observed temperature-predation relationship exhibits an inflection point at ~20°C (Fig. 2) (19) that will likely move poleward with warming (Fig. 4), both promoting top-down control at high latitudes and increasing predation effects at mid- to high latitudes

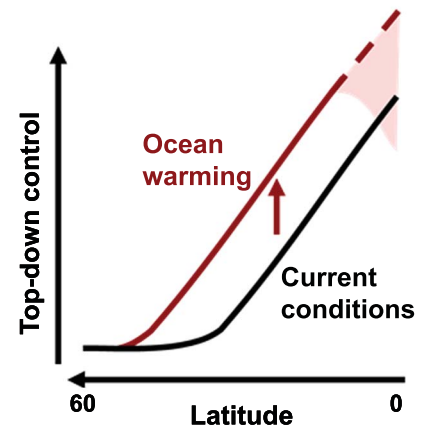


Fig. 4. Conceptual illustration of the hypothesized impact of ocean warming on future trends in top-down control of marine communities.

Predation intensity was low and had little or no effect on benthic communities at cold latitudes and increased toward the equator with temperature, above an inflection point (~20°C). The black line describes a simplified view of the current latitudinal pattern of top-down control in our study. The solid red line describes the hypothesized effect of future ocean warming, which may shift this inflection point poleward, increasing predation effects at higher latitudes. The dashed red line describes a region of uncertainty in the tropics, where increased temperatures exceed our current observations and possibly thermal tolerance of some predators, so that top-down control may increase or decline within this region (shaded to suggest a range of possible responses).

through time (33). The response to warming is less certain in the tropics, where predation may increase or decrease, because projected temperature increases are beyond our current range of observations and may exceed thermal tolerances of existing predators. Such broad-scale shifts in top-down control could have far-reaching consequences, given the key role of species interactions in maintaining ecosystem structure, diversity, biogeochemical processes, and the provision of critical ecosystem services to human communities (3, 13).

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Materials and Methods
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Predator control of marine communities increases with temperature across 115 degrees of latitude

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More predation in warmer seas

Species richness of many taxa is higher near the equator, and ecologists have long hypothesized that this pattern is linked to stronger interactions between species (e.g., competition and predation) in the tropics. However, empirical evidence showing that the strength of species interactions varies with latitude is limited. Ashton *et al.* tested whether predation on benthic marine communities is higher at lower latitudes. Using a standardized experiment at 36 sites along the Pacific and Atlantic coasts of North and South America, the authors found both greater predation intensity (consumption rate) and stronger impacts on benthic communities nearer the equator. These trends were more strongly related to water temperature than to latitude, suggesting that climate warming may influence top-down control of communities. —BEL

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Supplementary Materials for

Predator control of communities increases with temperature across 115 degrees of latitude

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This pdf includes:

Materials and methods
Figs. S1 to S6
Tables S1 to S7

Other Supplementary Materials for this manuscript include the following:

MDAR Reproducibility Checklist

35 **Materials and methods**

36 Study design

37 The study was designed to test three standardized measures of predation at a large number of
38 sites spanning the full latitudinal gradient. Standardized protocols were deployed at 36 sites
39 along the Atlantic and Pacific coasts of North, Central, and South America, covering a latitudinal
40 gradient of 115°, from 54.8° S to 60.5° N (Fig. 1; Table S1). To obtain representation across the
41 whole gradient, site selection was distributed explicitly to assure that at least 2 sites were
42 included per every 20° latitude on each coast. Sites in the northern hemisphere were deployed in
43 boreal summers between 2017 and 2019, those in the southern hemisphere were deployed during
44 austral summers during 2018 and 2019 (Table S1). Three sites deployed the experiments in two
45 years. Summers were chosen for their peak in productivity and recruitment activity. To
46 standardize environmental variables at each site (e.g., habitat, exposure, salinity), a recreational
47 marina or similar above-water structure was identified that was protected from wave energy and
48 undesirable human interaction, and with an expected salinity >25 ppt for the duration of the
49 deployment.

50 All materials and methods were shipped to each location from the Smithsonian Institution, USA,
51 ensuring standardization of the equipment across all sites. Each experimental unit consisted of a
52 PVC panel (133 × 133 × 6 mm) that was lightly sanded to facilitate settlement of sessile marine
53 invertebrates. Each panel was assigned to one of four treatments: control, cage-control (half-
54 cage), caged and exposed cage. A total of 32 experimental panels were deployed at each site,
55 along a transect with at least 1m between each panel. A randomized block design was used, with
56 each panel randomly assigned among the four treatments within eight blocks. The order of
57 treatments and blocks was the same across all sites. In this way, panels served as a standardized
58 substrate that controlled for material and age (history) across treatments and sites.

59 Panels were suspended with the experimental surface face down (Fig. S1), in order to control for
60 a variety of variables that can affect epibenthic communities, allowing us to explicitly test the
61 role of highly mobile predators on a specific standard habitat type and depth. The downward
62 facing orientation served to limit variation in light intensity and sediment accumulation among
63 sites, which can strongly affect community composition and processes, while also strongly
64 favoring epifaunal invertebrates over algal communities (16, 23). Our primary objective was to
65 evaluate the effect of large (>1cm) and highly mobile predators, especially fishes, which are
66 known to have strong effects on benthic invertebrate prey at some tropical sites (14-18, 23).
67 Thus, this approach provides a model habitat type to evaluate effects of predators across sites,
68 using a highly standardized approach to test a general question about how predation effects are
69 distributed across latitude and temperature over an exceptionally large geographic scale. While
70 our design tests the role of a subset of predators on epibenthic invertebrates, and a diverse range
71 of predator taxa can affect invertebrate communities in other bottom habitat types (e.g., 9, 14, 17,
72 35, 36), it also reduces variation due to independent environmental and habitat variables (above),
73 which affect both prey and predator communities.

74 The four treatments evaluate effects of large mobile predators by manipulating access to the
75 panels. Panels assigned to the cage-control treatment were secured in one half of a minnow-trap,
76 allowing open access through the open bottom to the experimental surface of the panel but

77 screened on all other sides. Panels assigned to the caged and exposed cage treatments were
78 enclosed in a minnow-trap that had been modified to seal all entrances. Modified minnow traps
79 were 55 cm tall with a maximum diameter of 23 cm and a mesh size of 11 × 8 mm. For weight,
80 the non-experimental surface of the panels was attached to a brick using cable ties through two 6
81 mm diameter holes on either side. The bricks were attached to a line secured at the surface such
82 that the panels were suspended at a depth of 1 m.

83 Panels were deployed for three months during the summer season (Table S1). A HOBO®
84 datalogger was deployed at each site for the duration of the experiment, recording the
85 temperature in 30 min intervals. Every two weeks the cages were replaced with ones that had
86 been cleaned of growth, and panels were photographed and redeployed in the water column.

87 After 10 weeks, the panels assigned to the exposed cage treatment had their enclosed full
88 minnow trap replaced with a half open minnow-trap, thus resembling the cage-control treatment
89 and allowing predator access to the community that had developed on the panel. At this time, for
90 all panels, a single piece of bait or ‘squidpop’ (25) was attached to each line above the brick,
91 external to the cage if present, and monitored for consumption of the bait after 1 h. If the bait
92 was still present (complete or partial) a score of 1 was assigned. Otherwise, a score of 0 was
93 assigned.

94 After 12 weeks, the panels were photographed, retrieved and returned live to the local laboratory.
95 The back sides of the panels were scraped clean and the wet weight (biomass) of remaining
96 growth attached to the front of the panels was measured. The cover of sessile organisms was
97 quantified by laying a grid with 25 points over each panel. Taxa directly under a point were
98 described to the lowest taxonomic unit possible. In some instances, the panels could not be
99 scored in this way, and the cover was quantified from the 12-week photographs using the same
100 procedure. To standardize across the different species and taxonomic resolution recorded at each
101 site, taxa were aggregated into ‘bare’ and 12 functional groups: algae, arborescent bryozoans,
102 barnacles, bivalves, calcified polychaetes, cnidarians, colonial tunicates, encrusting bryozoans,
103 non-calcified polychaetes, mud tubes (e.g., amphipod tubes), solitary tunicates and sponges.
104 Grouping data at a high taxonomic level provided standardization of the experiment across large
105 geographic scales, representing coarse functional groups, but precluded detailed analysis at finer
106 resolution, including the role of non-native species. The larger groupings contain both native
107 and non-native species. Anecdotally, we were able to record the presence of some non-native
108 species at some sites, especially for solitary tunicates, which contributed to biomass and
109 community composition, as also shown in previous studies (e.g., 16, 18, 23). Although the role
110 of non-native species is beyond the scope of this study, we recognize these non-native taxa may
111 contribute to observed effects of predators on biomass and community composition, and this
112 contribution deserves further study.

113

114 Statistical analyses and results

115 The analyses included response variables from both settlement panels (biomass and community
116 composition) and bait consumption deployments. Table S2 provides a conceptual framework of
117 the analyses used. The same explanatory variables were used in each analysis, with the
118 exception of treatment which was not relevant for the independent measure of predator intensity
119 (bait consumption). Treatment was included as two planned contrasts to assess the two different
120 questions of interest: 1) Caged vs Control (both open and partial cage controls were included in
121 this latter category); 2) Caged vs Exposed cage. Planned contrasts allow for the comparison of
122 treatment groups that are identified a priori and provide a strong test for whether caged (or
123 exposed cage) treatments differ from both the open and partial controls (15). Mean temperature
124 for the duration of the experiment was calculated for each site using data from the HOBO
125 dataloggers where available, or from field measurements taken at a depth of 1 m every 2 weeks
126 in the field. Temperature and latitude were tested independently in each model because the
127 correlation between the two was high ($R^2=0.84$) and we were interested to know which explained
128 more of the variation in the data. Models were compared using Akaike Information Criterion
129 (AIC) values and in each analysis temperature was the better predictor. The support was
130 substantially greater ($\Delta AIC > 9$) when temperature was included in all cases except in the bait
131 analysis ($\Delta AIC = 1$) and in the analysis of 2 functional groups (Cnidaria $\Delta AIC = 1$, Colonial
132 tunicate $\Delta AIC = 0$). To avoid duplication, we only present the statistical analyses relating to
133 temperature as a predictor.

134 In each analysis, we used model selection with backwards reduction from the full model,
135 beginning with the most complex interactions. In each of the three analyses, the same terms and
136 interaction terms were included in the best model.

137 Non-metric multidimensional scaling and PERMANOVA analyses were run using PRIMER 6
138 (37); all other analyses were completed in R version 3.6.1 (38). Plots were created in R using
139 packages ggeffects (39), ggplot2 (40), and sjPlot (41).

140

141 **Bait consumption**

142 We used generalized linear mixed effects models built using the package glmmTMB (42) to
143 estimate (in the full model) the response of bait consumption (presence/absence of bait) to
144 variation in temperature, latitude, ocean basin (Atlantic/Pacific), hemisphere (North/South), and
145 interactions among these terms. Consumption was a binomial response and best approximated
146 by the binomial distribution. The final model was reached by successively dropping terms from
147 the full model using the function ‘dredge’ from the package MuMIn (43) (beginning with the
148 most complex interactions) when doing so resulted in lower AIC values. Model validation
149 involved visually inspecting qq-plots and residual vs prediction plots in package DHARMA (44):

150 **Full model including Temperature (AIC=553)**

151 `BaitConsumption ~ Temperature * Ocean * Hemisphere + (1|Site) + (1|Site:Block)`

152

153 **Full model including Latitude (AIC=552)**

154 `BaitConsumption ~ Absolute(Latitude) * Ocean * Hemisphere + (1|Site) + (1|Site:Block)`

155
156 **Best model after model selection (AIC=536)**
157 BaitConsumption ~ Temperature + Ocean + Hemisphere + (1|Site) + (1|Site:Block) + Temperature:Ocean +
158 Temperature:Hemisphere +Ocean:Hemisphere + Temperature:Ocean:Hemisphere

159 Temperature ($\chi^2=5.09$, $df=1$, $p<0.01$), hemisphere ($\chi^2=5.18$, $df=1$, $p=0.01$) and ocean
160 basin*hemisphere*temperature ($\chi^2=4.6156$, $df=1$, $p<0.01$) were significant terms in the final
161 model, which had a marginal R^2 of 0.50 and a constrained R^2 of 0.79.

162
163 **Biomass**

164 We used generalized linear mixed effects models (GLMM) built using the package glmmTMB
165 (42) to estimate (in the full model) the response of biomass to the treatment as well as variation
166 in temperature or latitude, ocean basin (Atlantic/Pacific), hemisphere (North/South), and
167 interactions among these terms. Because we were interested in the effects of treatment within
168 sites, and to account for the nested block design; site, treatment (nested within site) and block
169 (nested within site) were included as random effects. Wet weights were positive, continuous,
170 negatively-skewed and best approximated by the gamma distribution with a log-link (confirmed
171 using the descdist function from the fitdistrplus package (45)). Treatments were included as two
172 contrasts: 1) Caged vs Control; 2) Caged vs Exposed cage. The final model was reached by
173 successively dropping terms from the full model using the function ‘dredge’ from the package
174 MuMIn (43) (beginning with the most complex interactions) when doing so resulted in lower
175 AIC values. Model validation involved visually inspecting qq-plots and residual vs prediction
176 plots created using package DHARMA (44) as well as individual plots for each random effect
177 created using the ‘plot_model’ function from package sjPlot (41):

178 **Full model including Temperature (AIC=11941)**
179 Wet Weight ~ Temperature * Treatment * Ocean * Hemisphere + (1|Site) + (1|Site:Block) + (1 | Site:Treatment)

181 **Full model including Latitude (AIC=11950)**
182 Wet Weight ~ Absolute(Latitude) * Treatment * Ocean * Hemisphere + (1|Site) + (1|Site:Block) + (1 |
183 Site:Treatment)

184
185 **Best model (AIC=11928)**
186 Wet Weight ~ Ocean + Temperature + Hemisphere + Treatment + (1 | Site) + (1 | Site:Block) + (1 | Site:Treatment)
187 + Ocean:Hemisphere + Ocean:Treatment + Temperature:Treatment + Hemisphere:Treatment +
188 Ocean:Hemisphere:Treatment,

189 Treatment ($\chi^2=73.02$, $df=2$, $p<0.001$), temperature*treatment ($\chi^2=15.43$, $df=2$, $p=0.001$) and
190 ocean basin*hemisphere*treatment ($\chi^2=19.66$, $df=2$, $p<0.001$) were significant terms in the final
191 model, which had a marginal R^2 of 0.15 and a constrained R^2 of 0.89.

192
193

194 **Community composition**

195 We used multivariate generalized linear mixed effects models (MGLMM, built using package
196 *mvabund* (46)) to estimate the response of abundance (spatial cover) of 13 functional groups to
197 treatment as well as variation in temperature, latitude, ocean basin (Atlantic/Pacific), hemisphere
198 (North/South), and interactions among these terms. The final model was reached by
199 successively dropping terms from the full model (beginning with the most complex interactions
200 and using the ‘drop1’ function from base R (38)) when doing so resulted in lower AIC values.
201 Because the functional groups were common across sites, we found the best model based on the
202 full data set, before resampling the data with site as a blocking factor in order to make inferences
203 across sites and treatments. The Control treatments were recoded as the same category to match
204 contrasts 1 and 2 above, with the Caged treatment being treated as the baseline. The final model
205 was validated using plots of residuals, residuals vs fitted and qq-plots created using package
206 *mvabund* (46). Resampling was done using the *shuffleSet* function in package *permute* (47) to
207 create a permutation matrix. Univariate p-values were adjusted for multiple testing using a step-
208 down resampling procedure (implemented using the *anova.manyglm* function (46)).

209 **Full model including Temperature**

```
210 SppData ~ Temperature * Treatment * Ocean * Hemisphere
```

211 **Full model including Latitude**

```
212 SppData ~ Absolute(Latitude) * Treatment * Ocean * Hemisphere
```

213 **Best model**

```
214 SppData ~ Treatment + Ocean + Hemisphere + Temperature + Treatment:Ocean + Treatment:Hemisphere +  
215 Ocean:Hemisphere + Treatment:Temperature + Ocean:Temperature + Hemisphere:Temperature +  
216 Treatment:Ocean:Hemisphere
```

217 We were interested in the community response to treatment, and how that changed with
218 temperature (and latitude). Treatment and temperature were significant independently ($P=0.005$,
219 0.030) and interactively ($P=0.005$). Pairwise comparisons were used to analyze the response of
220 individual taxa. Of interest were the taxa that experienced a change in treatment effect over the
221 temperature gradient (highlighted in the table below). Bryozoans responded significantly to the
222 treatment \times temperature interaction in both treatment contrasts, and solitary tunicates responded
223 significantly to the interaction in contrast 1 (Caged vs Control; all $P<0.05$).

224 Multivariate generalized linear models do not produce a value of effect size of the whole
225 community response. To visualize the total effect size, we used both non-metric
226 multidimensional scaling of the taxa abundances within each site (48; Fig. S5) as well as running
227 a PERMANOVA within each site to calculate an estimated component of variation for each
228 contrast within each site (ECV; 49, 50). The resemblance matrix was created using Bray Curtis
229 similarities based on the full dataset of raw abundances, before running the PERMANOVA on
230 data from each site with two contrasts of treatment (Caged vs Control; Caged vs Exposed cage)
231 as fixed effects. Components of variation for a fixed factor are the sums of squared fixed effects
232 (divided by appropriate degrees of freedom). The sizes of effects in a PERMANOVA can be
233 compared by examining the square root of the ECVs, akin to a standard deviation in a traditional
234 univariate analysis (50). The two ECVs per site were then analyzed as response variables using
235 a linear model (LM, built using function *lm* in base R (38)) with terms dropped using the step

236 function, also from base R) with the same terms included as those above (Ocean, Hemisphere,
237 Temperature, Contrast) to generate predicted ECVs that were plotted in Fig. 2C (Table S6).

238 **Full model including Temperature (AIC=678)**

239 $\sqrt{\text{ECV}} \sim \text{Temperature} * \text{Ocean} * \text{Hemisphere} * \text{Contrast}$

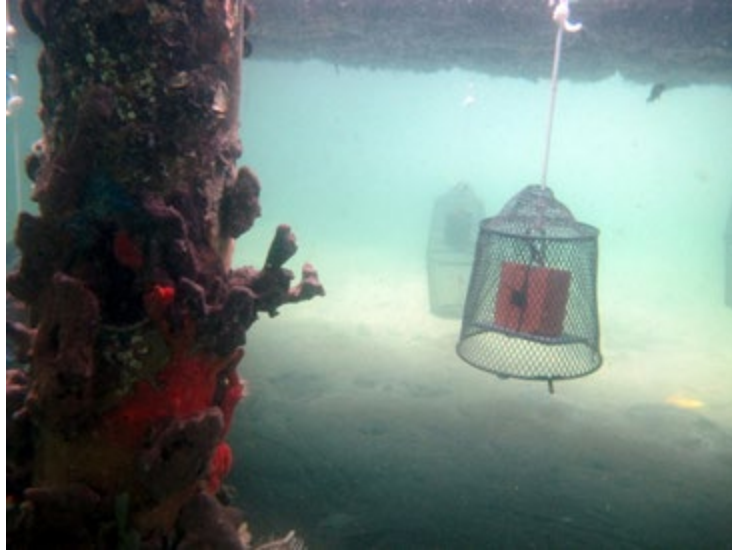
240 **Full model including Latitude (AIC=682)**

241 $\sqrt{\text{ECV}} \sim \text{Absolute(Latitude)} * \text{Ocean} * \text{Hemisphere} * \text{Contrast}$

242 **Best model (AIC=660)**

243 $\sqrt{\text{ECV}} \sim \text{Temperature} + \text{Hemisphere} + \text{Temperature:Hemisphere} + \text{Contrast}$

244

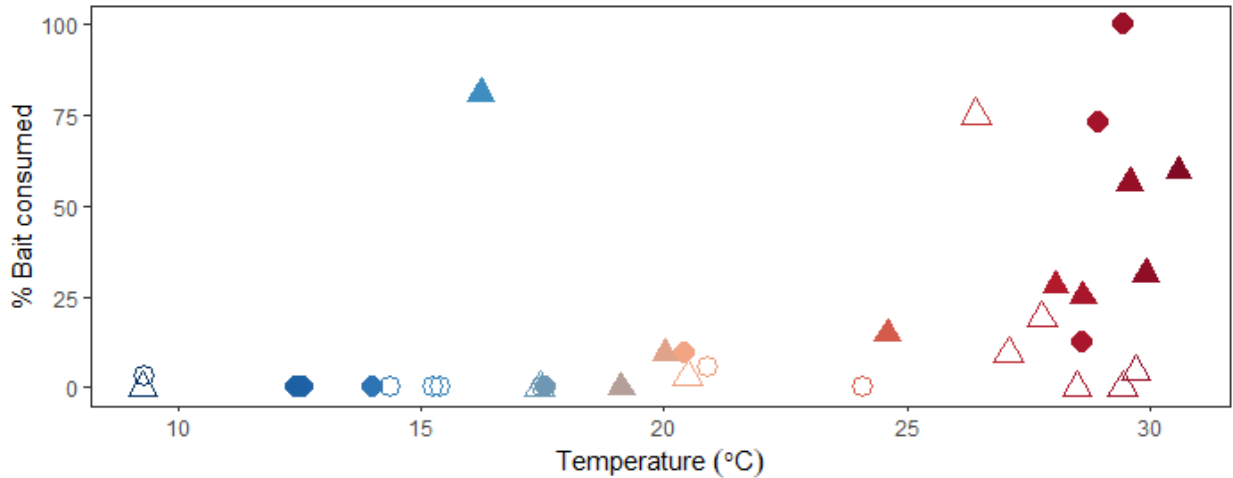


245

246 **Fig. S1.**

247 Panels treated by cage-control (foreground on the right) and cage (background) suspended from
248 a floating dock at Bocas del Toro, Panama. The experimental surface of the panel is facing
249 down, with the other surface attached to a brick that was used for weight. The background
250 community can be seen fouling the piling on the left.

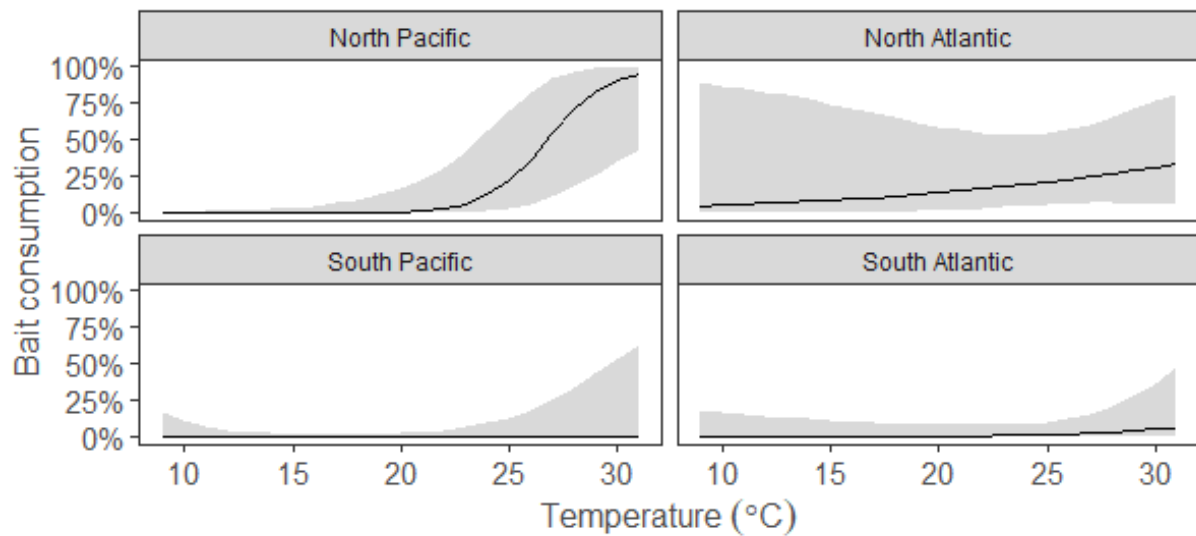
251



252

253 **Fig. S2a.**

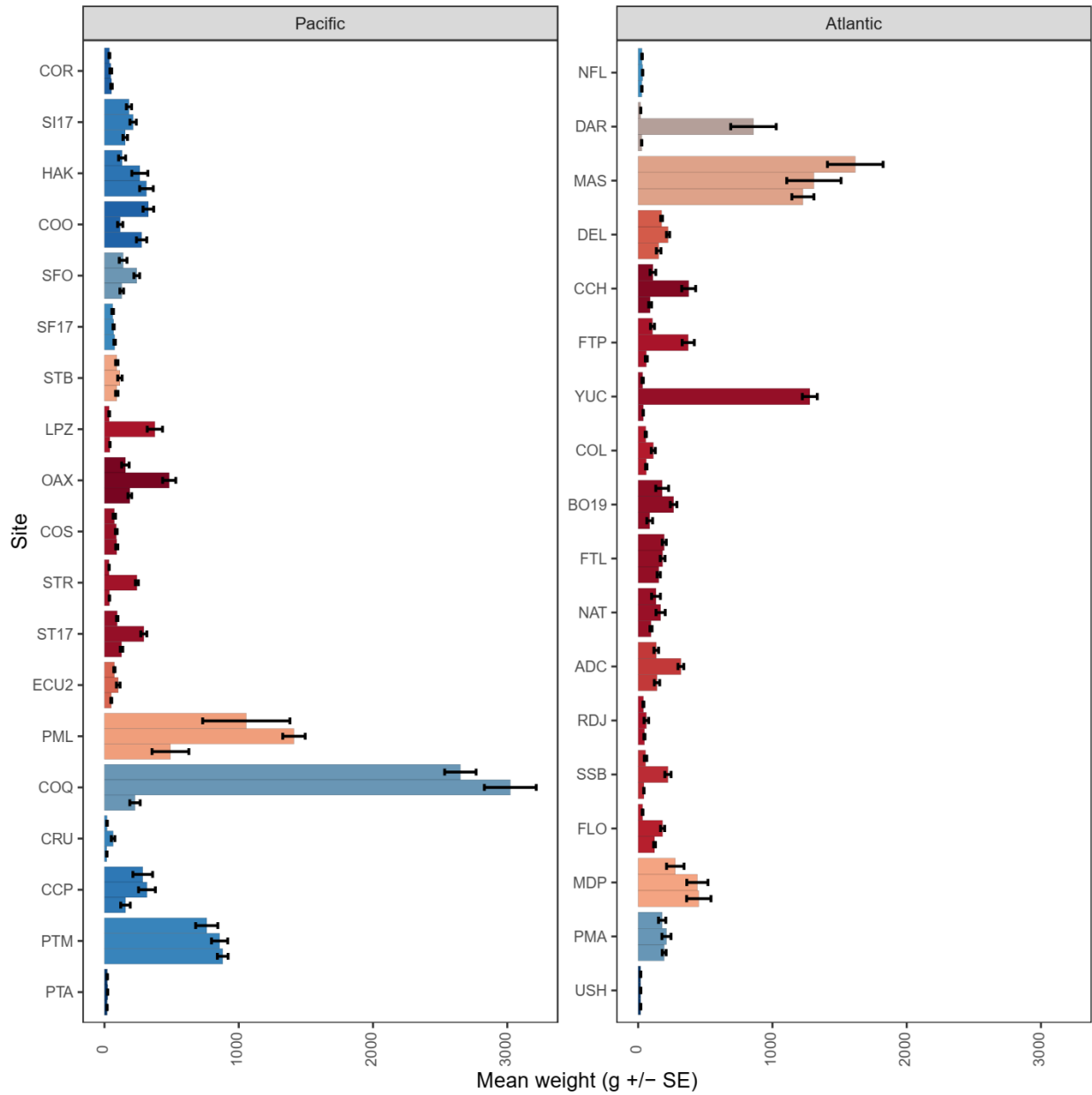
254 Bait consumption was higher, on average, at sites with warmer sea temperatures. Shape indicates
 255 ocean basin (North Pacific- filled circle, North Atlantic- filled triangle, South Pacific- open
 256 circle, South Atlantic- open triangle). Color scale indicates temperature (dark blue: ~9°C, dark
 257 red: ~31°C) as in Fig. 1. The bait consumption observed at Newfoundland (~16 °C) was an
 258 outlier relative to other sites with a similar mean temperature. The reason for the high bait
 259 consumption, unmatched by the response of the community to predator exclusion, is unknown.



260

261 **Fig. S2b.**

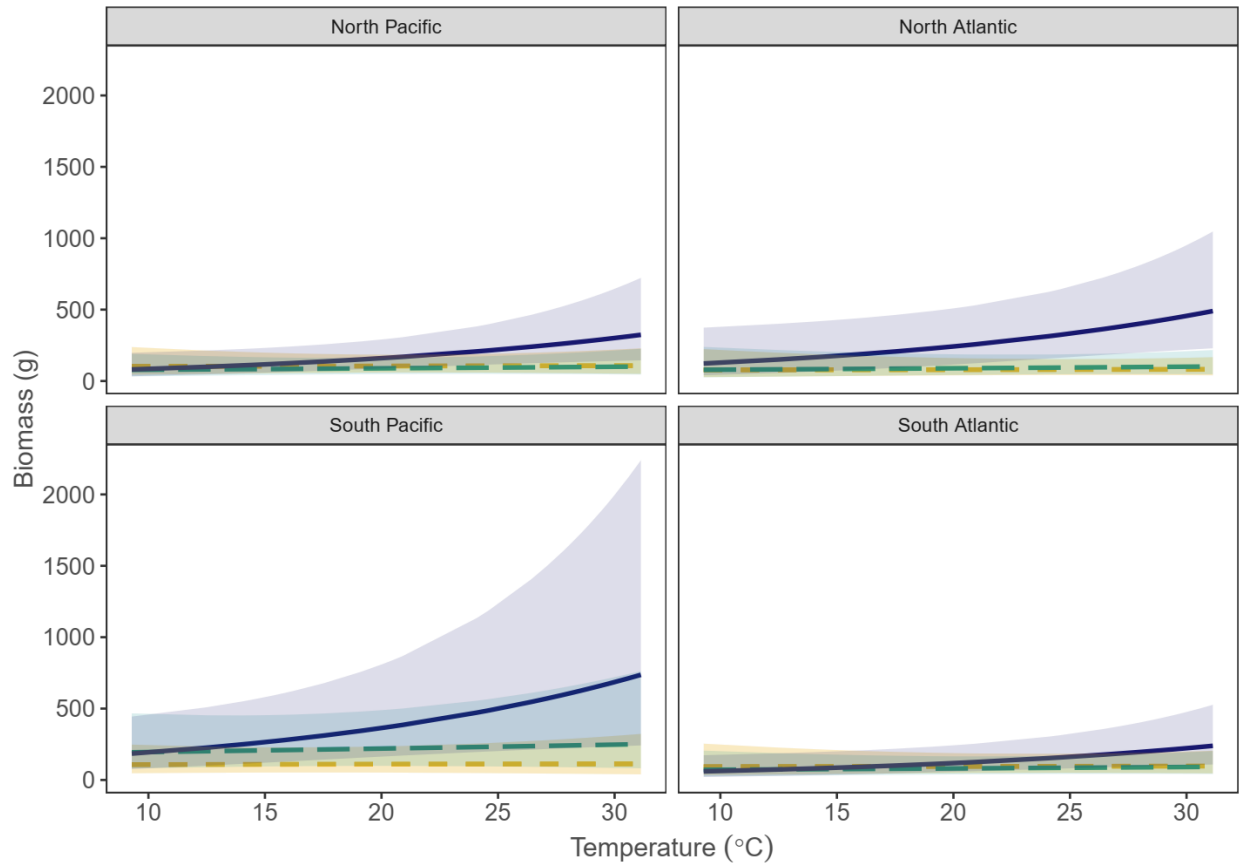
262 Modeled bait consumption in the four regions considered in this study. The large confidence
 263 interval at low temperatures in the North Atlantic is driven by the high bait consumption
 264 observed in Newfoundland (Fig S2a).



265

266 **Fig. S3a.**

267 Mean (+/-SE) wet weights of prey communities measured at the end of the experiment. Data are
 268 means for treatment within each site (top to bottom within each site: exposed cage, caged,
 269 control), fill indicates temperature (dark blue: ~9°C, dark red: 31°C) and sites are divided by
 270 ocean basin and ordered by latitude (top to bottom: 60°N-60°S).

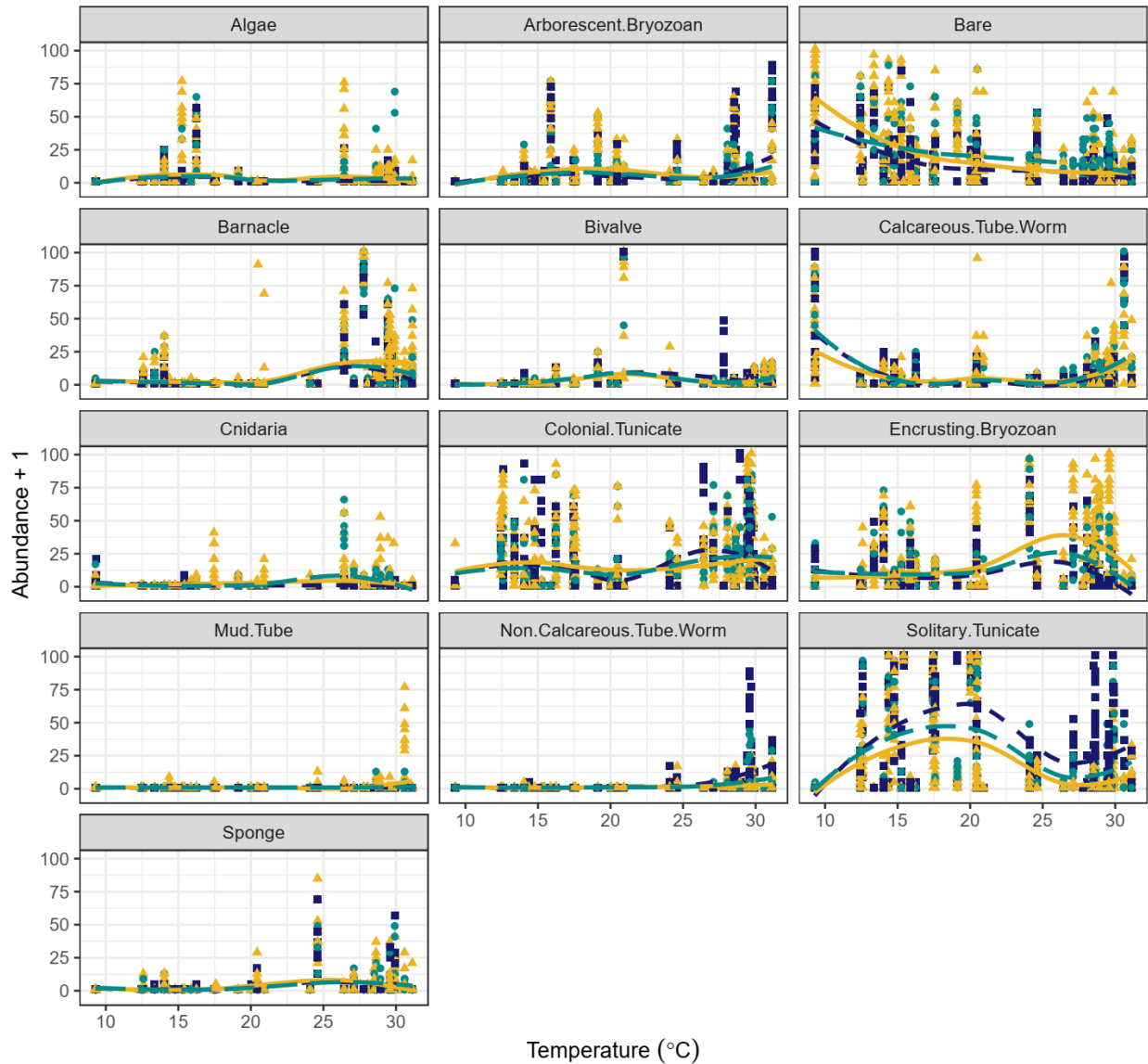


271
272 **Fig. S3b.**

273 Modeled community biomass in the four regions considered in this study (dark blue: predators
274 excluded throughout the experiment, yellow: predators excluded until the last two weeks of the
275 experiment and then exposed to predators, green: open to predators throughout the experiment).

276

277

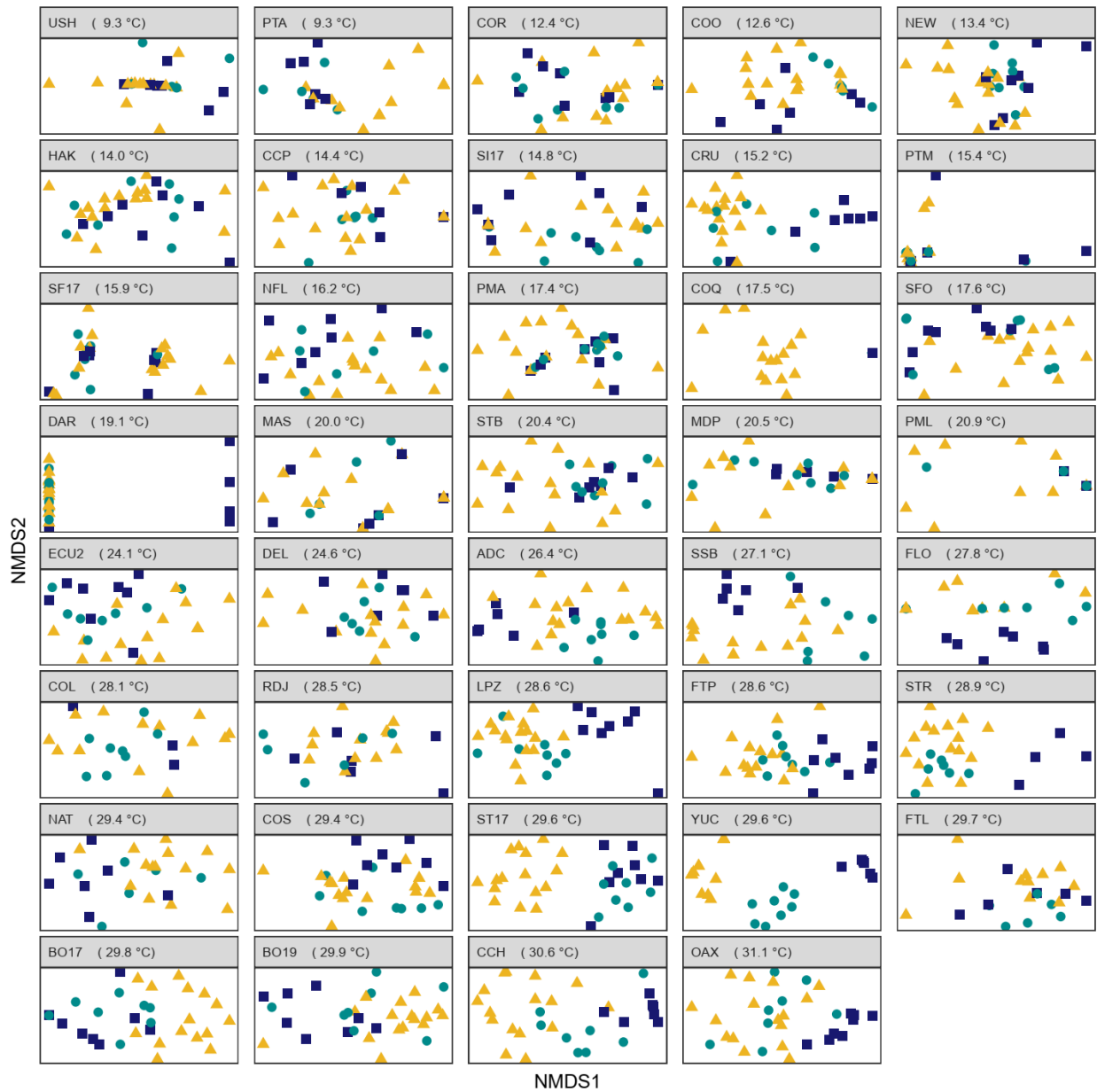


278

279 **Fig. S4.**

280 Abundance of functional groups (spatial cover out of 25 possible points) in the experimental prey
 281 communities as site temperature increases. Lines are loess lines of best fit based on the raw data
 282 (blue square: caged, green circle: exposed cage, yellow triangle: controls). Bare space is reduced
 283 in all treatments at warmer temperatures. Solitary tunicates and encrusting bryozoans diverge
 284 most among treatments at warm temperatures (Table S7, Fig. 3).

285

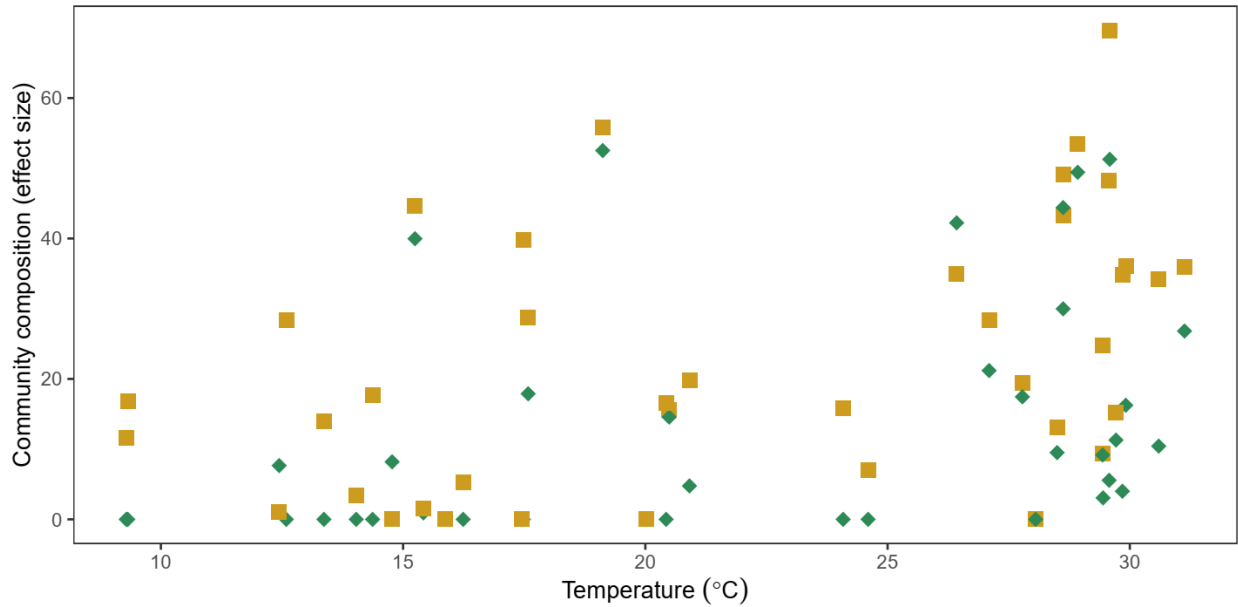


287

288 **Fig. S5.**

289 NMDS plots showing dissimilarity of prey community composition between treatments. Axes
 290 are scaled to maximize NMDS distances, calculated within each site. Fill and shape indicate
 291 treatment (dark blue square=caged, green circle=exposed cage, yellow triangle=controls), sites
 292 are ordered by mean temperature (low-top left, high-bottom right; site details can be found in
 293 Table S1).

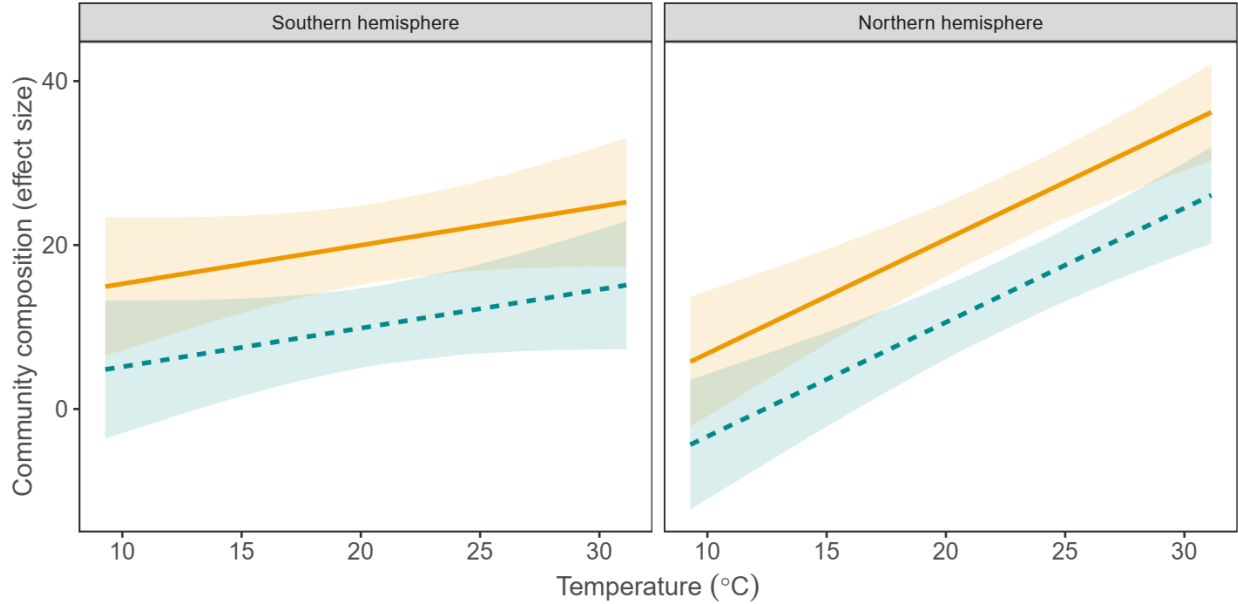
294



295

296 **Fig. S6a.**

297 Treatment effects on prey communities by site. Symbols indicate contrast 1 (gold square, caged
 298 vs control), or contrast 2 (green diamond, caged vs exposed cage). Data are square roots of
 299 estimated components of variation from PERMANOVA analyses.



300

301 **Fig. S6b.**

302 Modeled effect size of predators on prey community composition in northern and southern
 303 hemisphere sites (ocean basin was not included in the model after selection using AIC). Gold:
 304 caged vs controls; dark red: caged vs exposed cage.

305 **Table S1.**

306 **Site details including code, location name and country, ocean basin (A: Atlantic, P: Pacific),**
 307 **hemisphere (NS; N: North, S: South) and mean temperature recorded at each site for the**
 308 **duration of the experiment (Temp \pm SD). Sites are ordered alphabetically by code.**

Code	Site	Country	Start Date	Lat °	Long °	Ocean	NS	Temp °C
ADC	Arraial do Cabo	Brazil	2/7/2019	22.9708 S	42.0180 W	A	S	26.4 \pm 1.2
BO17	Bocas del Toro 2017	Panama	6/30/2017	9.3599 N	82.2740 W	A	N	29.9 \pm 0.9
BO19	Bocas del Toro 2019	Panama	8/15/2019	9.3599 N	82.2740 W	A	N	29.9 \pm 0.8
CCH	Port Aransas	USA	6/18/2018	27.8388 N	97.0673 W	A	N	30.6 \pm 0.9
CCP	Concepcion	Chile	2/19/2019	36.6863 S	73.1017 W	P	S	14.4 \pm 1.1
COL	Santa Marta	Colombia	6/13/2018	11.2415 N	74.2192 W	A	N	28.1 \pm 0.7
COO	Coos Bay	USA	6/21/2018	43.3456 N	124.3226 W	P	N	12.6 \pm 1.4
COQ	Coquimbo	Chile	2/8/2019	29.9666 S	71.3519 W	P	S	17.5 \pm 1.4
COR	Cordova	USA	7/16/2018	60.5472 N	145.7650 W	P	N	12.4 \pm 0.7
COS	Culebra	Costa Rica	6/13/2018	10.6401 N	85.6540 W	P	N	29.5 \pm 0.5
CRU	Las Cruces	Chile	2/13/2019	33.5010 S	71.6252 W	P	S	15.3 \pm 1.5
DAR	Dartmouth	Canada	7/7/2018	44.68158 N	63.61042 W	A	N	19.1 \pm 3.2
DEL	Delaware	USA	6/21/2018	38.6121 N	75.0724 W	A	N	24.6 \pm 1.3
ECU2	Salinas	Ecuador	9/25/2019	2.2007 S	80.9735 W	P	S	24.1 \pm 0.6
FLO	Guaratuba	Brazil	1/14/2019	25.8431 S	48.5806 W	A	S	27.8 \pm 1.9
FTL	Fortaleza	Brazil	2/14/2019	3.7166 S	38.5274 W	A	S	29.7 \pm 0.5
FTP	Fort Pierce	USA	6/18/2018	27.4572 N	80.3122 W	A	N	28.6 \pm 1.4
HAK	Hakai	Canada	6/28/2018	51.6544 N	128.1292 W	P	N	14.1 \pm 1.4
LPZ	La Paz	Mexico	6/15/2018	24.1827 N	110.3057 W	P	N	28.6 \pm 1.8
MAS	Massachusetts	USA	6/22/2018	42.6110 N	70.6582 W	A	N	20.0 \pm 1.8
MDP	Mar del Plata	Argentina	2/1/2019	38.0413 S	57.5373 W	A	S	20.5 \pm 1.7
NAT	Natal	Brazil	2/1/2019	5.7569 S	35.2011 W	A	S	29.4 \pm 0.4
NEW	Newport	USA	7/6/2018	44.6256 N	124.0448 W	P	N	13.4 \pm 1.0
NFL	Newfoundland	Canada	7/5/2018	47.7584 N	53.9593 W	A	N	16.2 \pm 3.0
OAX	Oaxaca	Mexico	6/13/2018	15.7639 N	96.1217 W	P	N	31.1 \pm 0.5
PMA	Puerto Madryn	Argentina	1/24/2019	42.7366 S	65.0300 W	A	S	17.5 \pm 1.1
PML	Pampa Melchorita	Peru	1/25/2019	13.2521 S	76.3062 W	P	S	20.9 \pm 1.6

Code	Site	Country	Start Date	Lat °	Long °	Ocean	NS	Temp °C
PTA	Punta Arenas	Chile	1/25/2019	53.0368 S	70.8730 W	P	S	9.3 ±0.4
PTM	Puerto Montt	Chile	1/23/2019	41.4772 S	72.9460 W	P	S	15.4 ±1.6
RDJ	Angra dos Reis	Brazil	1/15/2019	22.9810 S	44.3257 W	A	S	28.5 ±0.6
SF17	San Francisco 2017	USA	5/23/2017	37.8079 N	122.4344 W	P	N	15.9 ±1.2
SFO	San Francisco 2018	USA	6/21/2018	37.8079 N	122.4344 W	P	N	17.6 ±1.0
SI17	Sitka	USA	6/21/2017	57.0538 N	135.3500 W	P	N	14.8 ±1.0
SSB	Sao Sebastiao	Brazil	1/14/2019	23.7732 S	45.3559 W	A	S	27.1 ±1.9
STB	Santa Barbara	USA	6/20/2018	34.4049 N	119.6907 W	P	N	20.4 ±1.5
ST17	Panama City 2017	Panama	7/3/2017	8.9154 N	79.5294 W	P	N	29.6 ±0.6
STR	Panama City 2018	Panama	6/1/2018	8.9154 N	79.5294 W	P	N	28.9 ±0.4
USH	Ushuaia	Argentina	1/14/2019	54.8105 S	68.3108 W	A	S	9.3 ±0.4
YUC	Yucatan	Mexico	6/15/2018	21.2805 N	89.7007 W	A	N	29.6 ±0.9

309

310 **Table S2.**

311 **Conceptual framework of statistical analyses**

Question	Experiment	Response variable	Continuous fixed effects	Discrete fixed effects	Random effects	
1 Independent measure of local predator intensity	Bait consumption	% consumption (negative binomial) GLMM	Latitude / Temperature	Ocean basin Hemisphere	Site Block (within Site)	
2 Effect of continuous exposure to predators on community development	Panels with No predation (Caged) vs Continuous predation (Control*)	Biomass (Gamma with log-link) GLMM		Latitude / Temperature	Treatment Ocean basin Hemisphere	Site Treatment (within Site) Block (within Site)
3 Effect of exposure to predators following initial recruitment on community development	Panels with No predation (Caged) vs Late-state predation (Exposed Cage)	Community composition (negative binomial) MGLMM (visualized using Permanova & nMDS)				

312 * including both open and partial cage treatments
 313 GLMM- Generalized linear mixed effects models
 314 MGLMM- Multivariate generalized linear mixed effects models
 315 nMDS- Non-metric multidimensional scaling
 316
 317

318 **Table S3.**

319 **GLMM statistics of bait consumption response to treatment, temperature, latitude, ocean**
320 **basin, hemisphere and interactions among terms.**

Variable	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-18.8948	5.8193	-3.247	0.00117 **
Ocean	15.0417	6.8916	2.183	0.02906 *
Temperature	0.7061	0.225	3.138	0.00170 **
Hemisphere	13.5326	7.1852	1.883	0.05965 .
Ocean:Temperature	-0.6038	0.2664	-2.266	0.02343 *
Ocean:Hemisphere	-18.9251	9.3126	-2.032	0.04213 *
Temperature:Hemisphere	-0.771	0.3427	-2.25	0.02446 *
Ocean:Temperature:Hemisphere	0.8824	0.4107	2.148	0.03168 *

321 Significance codes: *** p<0.001, ** p<0.01, * p<0.05, . p<0.1, ‘ ‘ p<1

322

323 **Table S4.**
 324 **GLMM statistics of biomass response to treatment, temperature, latitude, ocean basin,**
 325 **hemisphere and interactions among terms.** Treatments were included as two contrasts: 1)
 326 Caged vs Control; 2) Caged vs Exposed cage.

Variable	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	4.32123	0.61428	7.035	2.00e-12 ***
Ocean	-0.03285	0.43537	-0.075	0.939861
Temperature	0.01975	0.02575	0.767	0.442992
Hemisphere	0.45819	0.47209	0.971	0.331765
Contrast1	-0.80512	0.37986	-2.119	0.034050 *
Contrast2	-0.44178	0.43839	-1.008	0.313589
Ocean:Hemisphere	-0.5727	0.64935	-0.882	0.377798
Ocean:Contrast1	0.69023	0.26847	2.571	0.010141 *
Ocean:Contrast2	0.41026	0.30973	1.325	0.185315
Temperature:Contrast1	0.06135	0.01588	3.864	0.000112 ***
Temperature:Contrast2	0.05155	0.01833	2.812	0.004930 **
Hemisphere:Contrast1	0.7718	0.29213	2.642	0.008241 **
Hemisphere:Contrast2	-0.08526	0.33746	-0.253	0.800527
Ocean:Hemisphere:Contrast1	-1.66769	0.40114	-4.157	3.22e-05 ***
Ocean:Hemisphere:Contrast2	-0.53266	0.46312	-1.15	0.250085

327 Significance codes: *** p<0.001, ** p<0.01, * p<0.05, . p<0.1, ‘ p<1
 328

329 **Table S5.**

330 **AIC statistics comparing full models of functional group abundance data with temperature**
331 **or latitude included, and the best full community model following model selection**

332 **AIC table**

Functional group	AIC Temperature	AIC Latitude	AIC Best Model
Algae	2176	2193	2181
Arborescent bryozoan	4022	4060	4021
Bare	7928	7957	7939
Barnacle	4123	4183	4129
Bivalve	1852	1867	1871
Calcareous tubeworm	4895	4953	4889
Cnidaria	1737	1736	1764
Colonial tunicate	7698	7698	7695
Encrusting bryozoan	6782	6839	6789
Mud tube	456	469	442
Non calcareous tube worm	1920	1997	1960
Solitary tunicate	7825	7801	7824
Sponge	2250	2264	2238

333

334

335 **Table S6.**

336 **Linear model statistics of square root of ECV response to treatment (contrast),**
337 **temperature, hemisphere and interactions among terms.**

Variable	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-7.19421	8.89386	-0.80889	0.42144
Temperature	1.41662	0.36932	3.83576	0.00028 **
Hemisphere	17.16138	12.64119	1.35758	0.17915
Contrast	-8.92117	3.78333	-2.35802	0.02130*
Temperature:Hemisphere	-0.94550	0.55889	-1.69174	0.09534

338 Significance codes: *** p<0.001, ** p<0.01, * p<0.05, . p<0.1, ‘ ‘ p<1

339

340 **Table S7.**

341 **Pairwise comparisons of functional group responses to terms in the MGLMM model.**

342 Significant responses to terms of interest (treatment × temperature interaction) are highlighted.

343 S7a: individual non-treatment terms, S7b: interactions among non-treatment terms, S7c: caged vs

344 control treatment and interactions with non-treatment terms, S7d: caged vs exposed cage terms

345 and interactions with non-treatment terms.

Table S7a. Individual terms	(Intercept)		Ocean		Hemisphere		Temperature	
	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)
Algae	1.106	0.08	3.225	0.005	5.494	0.005	1.358	0.035
Arborescent Bryozoan	2.078	0.025	4.012	0.005	10.535	0.005	1.172	0.035
Bare	12.957	0.005	2.914	0.005	0.779	0.17	7.488	0.005
Barnacle	1.676	0.065	6.933	0.005	0.118	0.17	3.769	0.005
Bivalve	3.552	0.005	4.969	0.005	4.2	0.01	3.098	0.005
Calcareous Tube Worm	0.209	0.685	0.542	0.65	4.422	0.005	1.879	0.005
Cnidaria	5.068	0.005	3.998	0.005	4.758	0.005	4.783	0.005
Colonial Tunicate	6.316	0.005	0.266	0.89	6.146	0.005	0.17	0.7
Mud Tube	8.022	0.005	6.286	0.005	5.607	0.005	4.757	0.005
Encrusting Bryozoan	0.088	0.685	0.027	0.97	0.044	0.36	0.013	0.7
Non.Calcareous Tube Worm	5.604	0.005	0.141	0.97	2.237	0.17	6.193	0.005
Solitary Tunicate	7.423	0.005	1.176	0.21	3.12	0.06	1.411	0.02
Sponge	2.291	0.015	0.326	0.89	0.181	0.17	2.434	0.005

Table S7b. Interaction terms	Ocean:Hemisphere		Ocean:Temperature		Hemisphere: Temperature	
	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)
Algae	2.083	0.02	3.244	0.01	6.44	0.005
Arborescent Bryozoan	2.747	0.01	2.944	0.01	0.889	0.215
Barnacle	0.129	0.73	5.313	0.005	1.122	0.215
Bivalve	3.966	0.005	5.219	0.005	6.603	0.005
	0.309	0.73	6.617	0.005	10.786	0.005
Calcareous Tube Worm	3.835	0.005	1.513	0.12	8.731	0.005
Cnidaria	2.891	0.01	5.855	0.005	1.484	0.075
Colonial Tunicate	0.731	0.51	1.536	0.1	6.973	0.005
Mud Tube	3.55	0.005	6.951	0.005	7.498	0.005
Encrusting Bryozoan	0.014	0.73	0.833	0.59	2.429	0.025
Non Calcareous Tube Worm	7.952	0.005	0.752	0.59	4.42	0.005
Solitary Tunicate	1.458	0.115	0.072	0.59	2.982	0.005
Sponge	0.065	0.73	1.315	0.225	2.522	0.02

346

347 **Table S7. Contd.**

Table S7c. Caged vs Controls	Treatment		Treat:Temperature		Treat:Ocean		Treat:Hemisphere		Treat:Ocean: Hemisphere	
	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)
Algae	1.334	0.425	1.817	0.255	0.126	0.975	3.152	0.03	1.588	0.15
Arborescent Bryozoan	0.432	0.94	0.911	0.815	1.306	0.415	1.846	0.19	1.927	0.115
Bare	0.215	0.95	0.988	0.78	0.792	0.885	1.504	0.19	2.317	0.075
Barnacle	0.643	0.94	0.005	1	1.405	0.38	0.099	0.89	0.104	0.875
Bivalve	0.247	0.95	0.048	1	1.503	0.315	0.02	0.97	2.191	0.1
Calcareous Tube Worm	1.328	0.425	1.9	0.245	1.808	0.1	1.812	0.19	0.513	0.775
Cnidaria	1.672	0.415	0.783	0.865	0.374	0.95	3.135	0.03	2.531	0.075
Colonial Tunicate	0.535	0.94	1.118	0.72	2.486	0.01	0.7	0.66	0.673	0.775
Encrusting Bryozoan	2.804	0.19	5.168	0.005	0.618	0.93	2.046	0.08	0.019	0.985
Mud Tube	0.018	0.95	0.039	1	0.015	0.975	0.029	0.97	0.03	0.985
Non Calc Tube Worm	2.074	0.415	2.568	0.205	0.615	0.93	5.779	0.005	4.805	0.005
Solitary Tunicate	1.542	0.415	3.247	0.035	0.453	0.935	0.537	0.66	0.975	0.475
Sponge	1.516	0.415	1.364	0.595	0.072	0.975	0.003	0.97	0.019	0.985

Table S7d. Caged vs Exposed cage	Treatment		Treat:Temperature		Treat:Ocean		Treat:Hemisphere		Treat:Ocean: Hemisphere	
	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)	Wald	Pr(>Wald)
Algae	1.269	0.695	1.789	0.335	0.232	0.97	1.867	0.23	1.767	0.22
Arborescent Bryozoan	0.221	0.985	0.132	1	1.496	0.305	0.303	0.94	1.143	0.515
Bare	0.81	0.91	2.026	0.195	0.85	0.92	0.564	0.925	1.725	0.22
Barnacle	0.958	0.91	0.866	0.895	0.831	0.92	0.002	0.995	0.002	0.625
Bivalve	0.441	0.985	0.438	0.98	0.604	0.945	0.022	0.995	1.973	0.22
Calcareous Tube Worm	1.273	0.695	1.36	0.66	0.236	0.97	1.07	0.675	0.63	0.625
Cnidaria	1.63	0.49	1.103	0.82	0.41	0.965	3.231	0.005	3.271	0.005
Colonial Tunicate	0.365	0.985	0.164	1	1.275	0.51	1.862	0.23	0.843	0.625
Encrusting Bryozoan	1.195	0.735	2.624	0.025	0.482	0.96	0.553	0.925	1.335	0.4
Mud Tube	0.054	0.985	0.054	1	0.07	0.97	0.017	0.995	0.049	0.625
Non Calc Tube Worm	0.237	0.985	0.024	1	0.135	0.97	0.247	0.94	0.255	0.625
Solitary Tunicate	0.953	0.91	2.066	0.16	0.664	0.945	0.646	0.885	0.281	0.625
Sponge	0.598	0.935	0.296	1	0.63	0.945	0.004	0.995	0.023	0.625

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349

350

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