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Supplementary Information for

Climate drives the geography of marine consumption by changing predator communities

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Other supplementary materials for this manuscript include the following:

Movies S1

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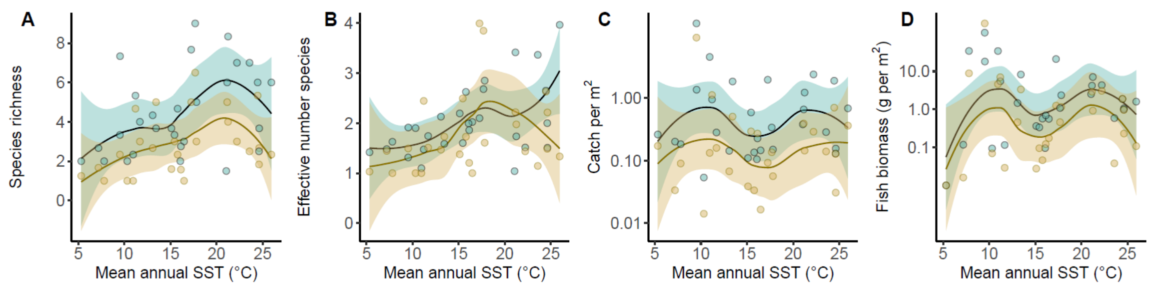

Fig. S1. Patterns of consumer (A) species richness, (B) diversity expressed as the number of equally abundant species needed to produce observed values of Hurlburt's probability of interspecific encounter **(1)**, (C) density, and (E) biomass across mean annual sea surface temperature. Lines are LOESS curves (with shaded 95% confidence intervals) independently fitted within each habitat (green=seagrass, gold=unvegetated sediments). Note that density and biomass (C,D) are shown on a log scale.

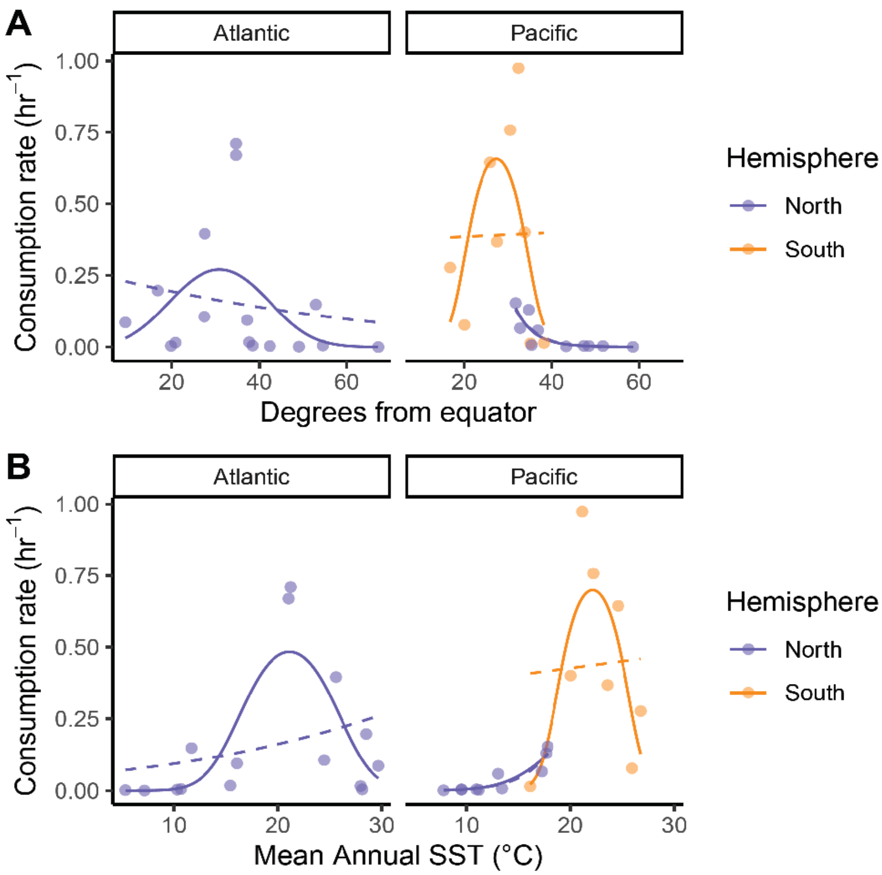

Fig. S2. Relationships between consumption rate and (A) latitude and (B) mean annual sea surface temperature (SST) along the coastlines for which we have sufficient data to test for the presence and shape of latitudinal gradients. Solid lines show logistic regressions with quadratic terms for Latitude or SST, and dashed lines show logistic regressions with linear predictor terms only. Note that while the Eastern North Pacific follows trends in the Southern Hemisphere well, we do not discuss this case specifically in the text because we lack sufficient sampling towards warmer, low latitude environments.

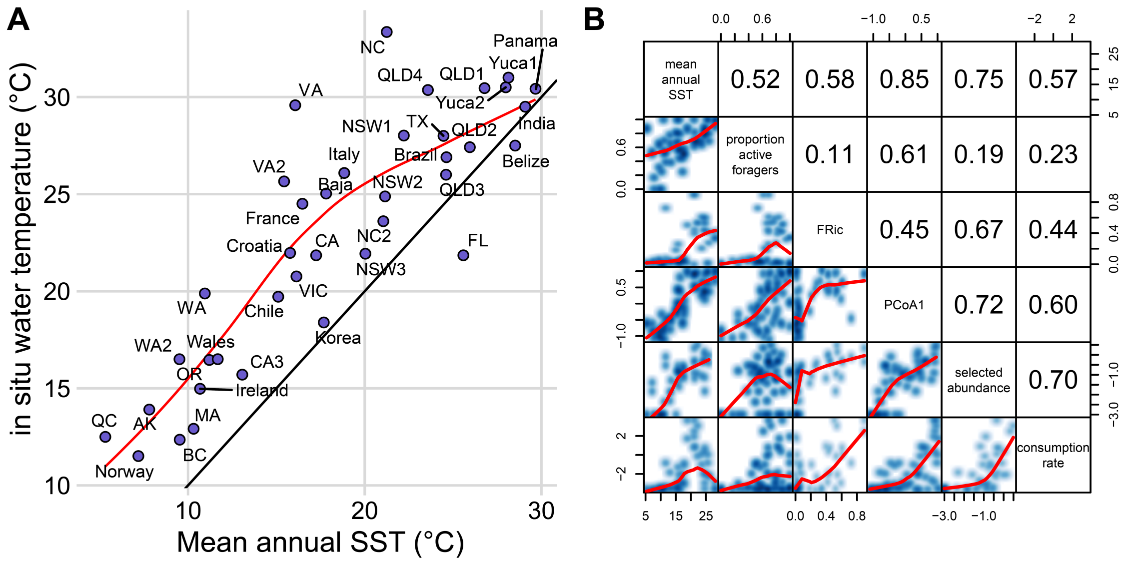

Fig. S3. Bivariate relationships among consumption rate and explanatory variables. (A) Water temperature measured at the time of feedings assays tended to exceed long-term average sea surface temperature, as most studies took place during the summer. Differences between mean annual and measured water temperature decreased toward the warmest sites, but variance was highest between 15 and 25℃. The red line shows predictions from local regression (LOESS) and the black line is the 1:1 line. (B) Correlations between mean annual SST, the proportion of active foraging consumer taxa, consumer functional richness measured from all scored traits, an index of multivariate consumer composition (PCoA axis 1 from Fig. 2), the abundance of consumers (log-transformed) identified using ordination constrained to consumption rates, and consumption rates (logit-transformed). Red lines within the scatterplots below the diagonal show predictions from LOESS, panels along the diagonal show the frequency and density of each variable, and numbers above the diagonal show Spearman rank correlation coefficients.

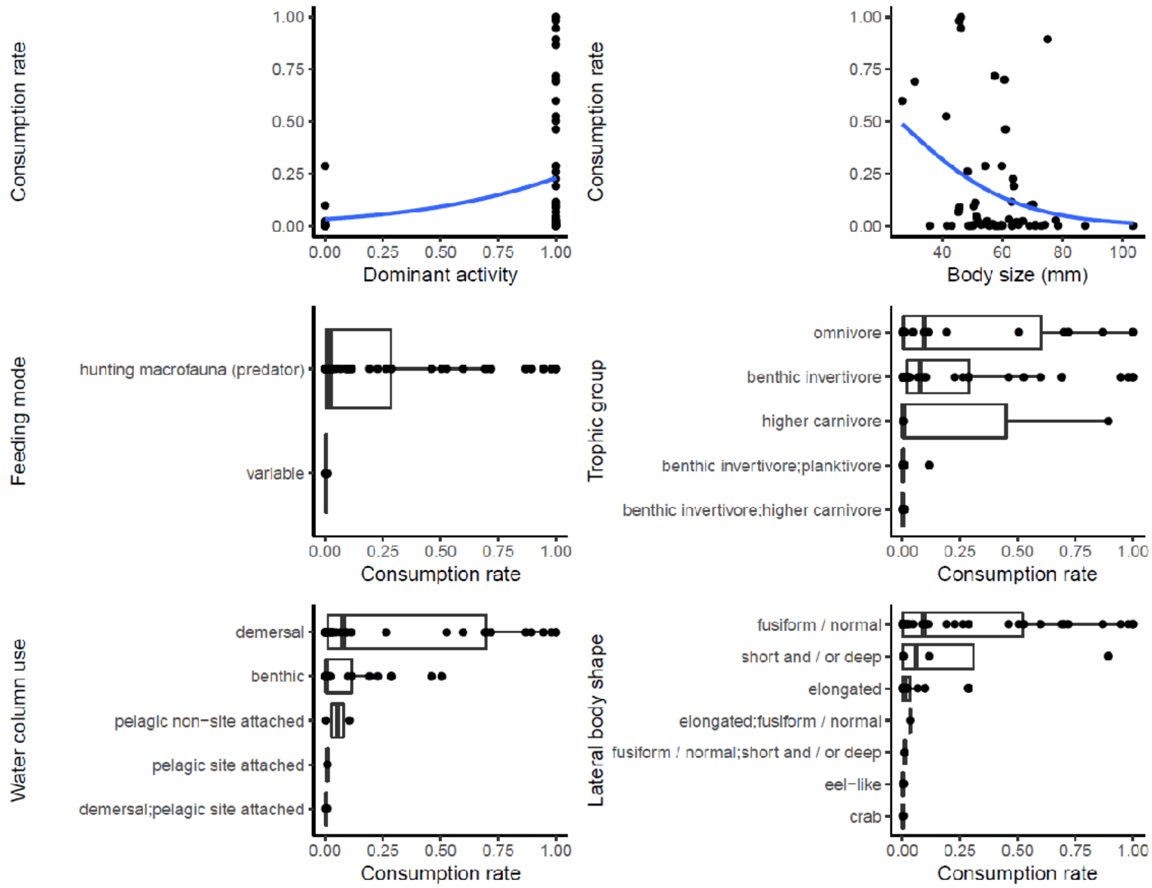

Fig. S4. Relationships between consumption rate and community-level weighted trait means for six traits relevant to feeding and locomotion. Traits means are based on presence-absence data of consumers from seines and videos for all traits except length, which we weighted by abundance and restricted to seining data. Points represent mean consumption rate for communities in each site and habitat combination. The x-axis in the upper-left panel reflects whether the dominant consumer is an active swimming forager (1) or not (0). Body size in total length for fish and carapace width for crabs.

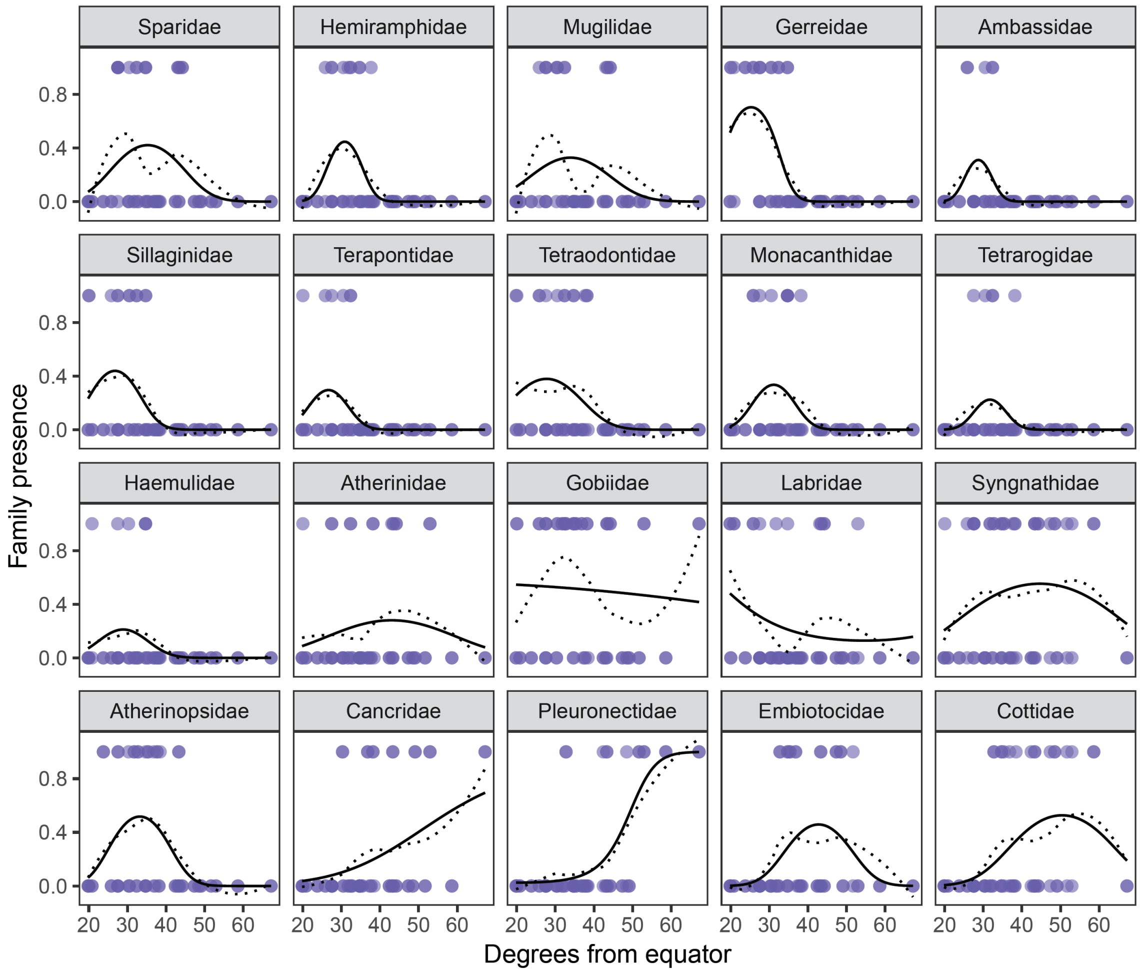

Fig. S5. Distribution of presences (1) and absences (0) for selected taxonomic families across latitude. Solid black lines are predicted values from a quadratic logistic model and the dotted lines are local regression (LOESS) curves. Shown are the 13 families with the strongest positive correlation with consumption, the 6 families with strongest negative correlation with consumption rate, and wrasses (Labridae).

Fig. S6. Consumption rate estimates within each habitat at every site. Filled symbols show rate estimates from individual assays in seagrass (green) and unvegetated (gold) habitats and are semi-transparent to show overlapping estimates. Open black symbols show the mean consumption rate in each habitat. Note the different scale of the y-axis in each panel, which span the range of observed consumption rates at each site.

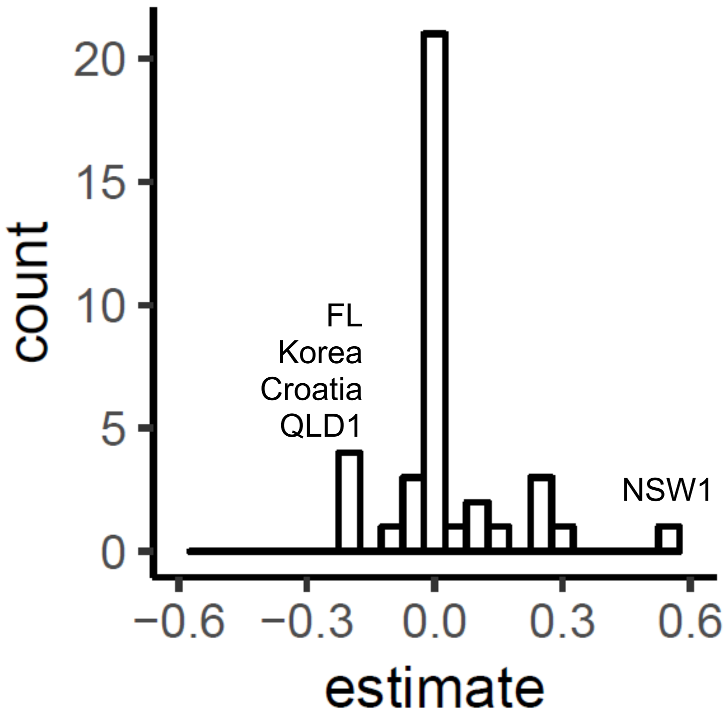

Fig. S7. Histogram of parameter estimates from linear models of consumption rate as a function of habitat (seagrass vs. unvegetated sediments), independently-fitted for each site. Estimates above zero mean that consumption rate was higher in seagrass than unvegetated sediments. Sites in the extreme bins of the histogram are labelled. At NSW1, for example, all squid bait were consumed after one hour in seagrass, while just over 40% were consumed in one hour in unvegetated sediments, representing a change in consumption rate of nearly 0.6 hr-1. Estimates for 20 of 38 within-site comparisons fell within the range -0.02 to 0.02.

Table S1. Correlations between the presence of predator families and consumption rate based on canonical correspondence analysis of predator taxonomic composition. Correlation is derived from the first axis of the constrained ordination of family composition as a function of consumption rate. Also displayed are the number of morphospecies in each family, the number of sites in our dataset where each family was observed, and patterns of presence and absence in seagrass and unvegetated habitats. Families marked with an asterisk were observed to attack or remove the squid bait from at least one of the 10 sites with video data (Table S3).

Family	Morphospecies	Sites	Seagrass	Unvegetated	Correlation
Sparidae*	14	10	1	1	0.41
Hemiramphidae*	9	7	1	1	0.29
Mugilidae	8	9	1	1	0.25
Gerreidae	6	10	1	1	0.25
Ambassidae	3	3	1	1	0.24
Sillaginidae	3	6	1	1	0.23
Terapontidae	3	5	1	1	0.23
Tetraodontidae*	10	9	1	1	0.19
Monacanthidae	6	7	1	1	0.19
Tetrarogidae	2	4	1	1	0.19
Haemulidae*	6	5	1	1	0.12
Atherinidae	6	8	1	1	0.12
Gobiidae	26	18	1	1	0.10
Monodactylidae	1	2	1	0	0.09
Penaeidae	5	5	1	1	0.09
Mullidae	4	5	1	1	0.09
Lethrinidae*	6	3	1	1	0.08
Siganidae	4	3	1	1	0.08
Batrachoididae	1	1	1	1	0.08
Carcharhinidae*	1	1	1	1	0.07
Nemipteridae*	3	1	1	1	0.07
Sphyraenidae	3	5	1	1	0.06
Soleidae	2	2	0	1	0.06
Aulostomidae	1	1	1	0	0.06
Pseudomugilidae	1	1	1	0	0.06
Eleotridae	1	1	1	0	0.06
Muraenidae*	1	1	1	0	0.05
Palaemonidae	7	7	1	1	0.04
Serranidae*	7	6	1	1	0.04
Synodontidae	3	3	1	1	0.04
Caesionidae*	1	1	1	0	0.04
Pomacentridae*	2	2	1	1	0.04
Fundulidae	6	4	1	1	0.03
Kyphosidae	2	2	1	1	0.03
Labridae*	25	10	1	1	0.03
Diodontidae	2	3	1	0	0.03
Ariidae*	1	1	1	1	0.03

Arripidae	1	1	0	1	0.03
Chaetodontidae	1	1	0	1	0.03
Echeneidae	1	1	0	1	0.03
Fistulariidae	1	1	1	0	0.02
Trichechidae	1	1	0	1	0.02
Acanthuridae	3	2	1	1	0.02
Callionymidae	3	3	1	1	0.02
Loliginidae	2	2	1	1	0.02
Sepiidae	2	2	1	1	0.01
Sciaenidae	7	6	1	1	0.01
Platycephalidae	3	4	1	1	0.01
Blenniidae*	9	9	1	1	0.01
Scyliorhinidae*	1	1	1	0	0.01
Lutjanidae*	10	5	1	1	0.01
Portunidae	7	9	1	1	0.00
Elopidae	1	1	0	1	-0.01
Panopeidae	1	1	0	1	-0.01
Lysmatidae	1	1	1	0	-0.01
Rhinobatidae	1	1	1	0	-0.01
Acropomatidae	1	1	1	1	-0.01
Lateolabracidae	1	1	1	1	-0.01
Triglidae	2	2	1	1	-0.01
Urotrygonidae*	1	1	1	0	-0.01
Gobiesocidae	1	1	1	0	-0.01
Carangidae*	8	4	1	1	-0.01
Hippolytidae	1	1	1	1	-0.01
Trachinidae	1	1	0	1	-0.01
Rhombosoleidae	1	1	0	1	-0.01
Ovalipidae	1	1	0	1	-0.01
Osmeridae	1	1	0	1	-0.01
Cheilodactylidae	1	1	1	0	-0.01
Liparidae	1	1	1	0	-0.01
Stichaeidae	1	1	1	0	-0.01
Processidae	1	1	1	1	-0.01
Hexagrammidae	4	2	1	1	-0.02
Balistidae	2	1	1	1	-0.03
Albulidae	1	1	1	1	-0.03
Varunidae	1	3	1	1	-0.03
Cyprinodontidae	2	2	1	1	-0.03
Moronidae	1	2	1	1	-0.03
Paguridae	1	1	1	1	-0.03
Phycidae	1	1	1	1	-0.03
Salmonidae	2	2	0	1	-0.03
Cyclopteridae	1	2	1	0	-0.03
Salangidae	1	1	1	1	-0.03

Paralichthyidae	9	9	1	1	-0.04
Belonidae	2	3	1	1	-0.04
Engraulidae	3	3	1	1	-0.04
Epialtidae	2	3	1	0	-0.04
Aulorhynchidae	1	3	1	0	-0.04
Agonidae	2	2	1	1	-0.04
Ammodytidae	3	3	1	1	-0.05
Sebastidae	4	3	1	1	-0.05
Clinidae	2	3	1	1	-0.06
Gadidae	7	4	1	1	-0.06
Ostraciidae*	2	3	1	1	-0.06
Crangonidae	3	4	1	1	-0.07
Gasterosteidae	8	5	1	1	-0.07
Pholidae	6	6	1	1	-0.09
Clupeidae	9	7	1	1	-0.11
Syngnathidae	14	18	1	1	-0.12
Atherinopsidae	6	11	1	1	-0.15
Cancridae*	7	7	1	1	-0.16
Pleuronectidae	9	8	1	1	-0.16
Embiotocidae	13	8	1	1	-0.17
Cottidae	16	12	1	1	-0.18

Table S2. Predator taxa observed to strike and remove bait from squidpops in video footage taken during assays. Taxa that were identified in the video footage but not observed to attack squidpops are not included. The order of fish taxa reflects the clades of bony fishes proposed by Hughes et al. 2018 **(2)**. We have included a short clip of one video from Italy in Movie S1.

	Phylum	Class	Series	Order	Family	Taxon	Site	Attack	Remove
1	Arthropoda	Malacostraca		Decapoda	Cancridae	*Carcinus maenas*	Wales	1	1
2						*Romaleon setosum*	Chile	1	1
3					Palaemonidae	*Palaemon serratus*	Wales	1	1
4	Chordata	Chondrichthyes		Carcharhiniformes	Carcharhinidae	*Carcharinus melanopterus*	QLD2	1	0
5					Scyliorhinidae	*Scyliorhinus canicula*	Wales	1	1
6				Myliobatiformes	Urotrygonidae	*Urobatis jamaicensis*	Yuca1	1	1
7	Chordata	Actinopterygii	Elopomorpha	Anguilliformes	Muraenidae	*Muraena helena*	Italy	1	1
8			Otophysa	Siluriformes	Ariidae	*Ariopsis felis*	USA (FL)	1	1
9			Carangaria	Carangiformes	Carangidae	*Carangoides fulvoguttatus*	QLD2	1	0
10			Ovalentaria		Pomacentridae	*Abudefduf saxatilis*	Yuca1	1	1
11			Ovalentaria	Blenniiformes	Blenniidae	*Petroscirtes lupus*	QLD3	1	1
12						*Scartichthys gigas*	Chile	1	1
13			Ovalentaria	Beloniformes	Hemiramphidae	*Arrhamphus sclerolepis*	QLD3	1	1
14						*Hyporhamphus regularis ardelio*	QLD3	1	1
15			Eupercaria	Perciformes	Serranidae	*Serranus scriba*	Italy	1	1
16			Eupercaria	Labriformes	Labridae	*Coris caudimacula*	QLD2	1	0
17						*Coris julis*	Italy	1	1
18						*Coris* sp.	QLD2	1	0
19						*Halichoeres bivittatus*	Yuca1	1	1
20						*Thalassoma bifasciatum*	Yuca1	1	1
21						*Thalassoma sp.*	QLD2	1	0
22			Eupercaria		Lutjanidae	*Ocyurus chrysurus*	Yuca1	1	1
23					Caesionidae	*Caesio* sp.	QLD2	1	0
24			Eupercaria		Haemulidae	*Diagramma pictum*	QLD3	1	1
25						*Haemulon plumieri*	Yuca1	1	1

26				*Isacia conceptionis*	Chile	1	1
27	Eupercaria	Spariformes	Nemipteridae	*Scolopsis lineata*	QLD2	1	0
28				*Scolopsis* sp.	QLD2	1	0
29	Eupercaria	Spariformes	Sparidae	*Acanthopagurus australis*	QLD3	1	1
30				*Diplodus annularis*	Italy	1	1
31				*Lagodon rhomboides*	USA (NC2)	1	1
32				*Oblada melanura*	Italy	1	1
33				*Sparus aurata*	France	1	1
34				*Spondyliosoma cantharus*	Italy	1	1
35	Eupercaria	Spariformes	Lethrinidae	*Lethrinus atkinsoni*	QLD2	1	0
36				*Lethrinus genivittatus*	QLD2	1	0
37				*Lethrinus* sp.	QLD2	1	0
38	Eupercaria	Tetraodontiformes	Tetraodontidae	*Sphoerioides nephelus*	USA (FL)	1	1
39	Eupercaria	Tetraodontiformes	Ostraciidae	*Lactrophis trigonius*	Yuca2	1	1

Table S3. List of all sites and habitat types used in consumption assays. We report the date of the first assay in each habitat, the geolocations of sites, and the range of squidpop numbers used in each assay.

Country	Site	First Assay Date	Habitat	Latitude	Longitude	N
Australia	NSW1	20170222	Seagrass	-30.51	153.02	24-25
Australia	NSW1	20170222	Unvegetated	-30.50	153.02	25
Australia	NSW2	20161208	Seagrass	-32.38	152.51	25
Australia	NSW2	20161208	Unvegetated	-32.38	152.51	25
Australia	NSW3	20161207	Unvegetated	-33.84	151.25	25
Australia	NSW4	20160711	Unvegetated	-35.10	150.58	25
Australia	QLD1	20170313	Seagrass	-16.76	145.97	24-25
Australia	QLD1	20170313	Unvegetated	-16.76	145.97	25
Australia	QLD2	20161202	Seagrass	-20.02	148.25	25
Australia	QLD2	20161202	Unvegetated	-20.02	148.25	25
Australia	QLD3	20170130	Unvegetated	-26.39	153.06	23-25
Australia	QLD3	20170131	Seagrass	-26.39	153.06	24-25
Australia	QLD4	20160208	Seagrass	-27.49	153.40	24-25
Australia	QLD4	20170208	Unvegetated	-27.49	153.40	23-25
Australia	VIC	20170222	Seagrass	-38.19	144.71	14-25
Australia	VIC	20170222	Unvegetated	-38.19	144.71	20-25
Belize	Belize	20161104	Seagrass	16.80	-88.08	25
Brazil	Brazil	20170307	Seagrass	-23.79	-45.36	29-30
Brazil	Brazil	20170307	Unvegetated	-23.76	-45.35	29-30
Canada	BC	20160705	Seagrass	51.68	-128.12	23-25
Canada	BC	20160705	Unvegetated	51.68	-128.11	21-25
Canada	QC	20160705	Seagrass	49.09	-68.32	25
Canada	QC	20160705	Unvegetated	49.09	-68.32	24-25
Chile	Chile	20170307	Seagrass	-30.29	-71.61	24-25
Chile	Chile	20170307	Unvegetated	-30.30	-71.61	25
Croatia	Croatia	20160625	Seagrass	44.21	15.47	25
Croatia	Croatia	20160625	Unvegetated	44.21	15.47	25
France	France	20160705	Seagrass	43.45	3.67	25
France	France	20160705	Unvegetated	43.45	3.67	25
India	India	20170116	Seagrass	10.07	73.63	25
India	India	20170116	Unvegetated	10.07	73.63	25
Ireland	Ireland	20160827	Seagrass	54.53	-5.57	24-25
Ireland	Ireland	20160827	Unvegetated	54.53	-5.58	23-25
Italy	Italy	20160727	Seagrass	43.07	9.83	21-25
Italy	Italy	20160727	Unvegetated	43.07	9.83	23-25
Korea	Korea	20160620	Seagrass	34.73	128.60	24-25
Korea	Korea	20160620	Unvegetated	34.73	128.60	24-25
Mexico	Baja	20160625	Seagrass	31.75	-116.63	25
Mexico	Baja	20160625	Unvegetated	31.75	-116.63	25

Mexico	Yuca1	20160712	Seagrass	19.83	-87.45	25
Mexico	Yuca1	20160712	Unvegetated	19.83	-87.45	25
Mexico	Yuca2	20160716	Unvegetated	20.83	-86.88	25
Mexico	Yuca2	20160718	Seagrass	20.83	-86.88	25
Norway	Norway	20160721	Seagrass	67.21	15.01	25
Norway	Norway	20160721	Unvegetated	67.21	15.01	25
Panama	Panama	20160929	Seagrass	9.35	-82.26	25
Panama	Panama	20160929	Unvegetated	9.35	-82.26	24-25
USA	AK	20160821	Seagrass	58.61	-134.93	25
USA	AK	20160821	Unvegetated	58.61	-134.93	25
USA	CA	20160623	Seagrass	32.77	-117.25	24-25
USA	CA	20160623	Unvegetated	32.77	-117.25	25
USA	CA2	20160723	Seagrass	35.35	-120.84	23-25
USA	CA2	20160723	Unvegetated	35.35	-120.84	25
USA	CA3	20160622	Seagrass	36.81	-121.78	24-25
USA	CA3	20160622	Unvegetated	36.81	-121.78	24-25
USA	CA4	20160720	Seagrass	38.32	-123.05	25
USA	CA4	20160720	Unvegetated	38.32	-123.05	22-25
USA	DE	20160620	Unvegetated	38.47	-75.95	21-25
USA	FL	20161115	Seagrass	27.54	-80.35	25
USA	FL	20161115	Unvegetated	27.54	-80.35	25
USA	MA	20160607	Seagrass	42.42	-70.92	25
USA	MA	20160607	Unvegetated	42.42	-70.92	25
USA	NC	20160815	Seagrass	34.69	-76.62	25
USA	NC	20160815	Unvegetated	34.69	-76.62	25
USA	NC2	20161028	Seagrass	34.70	-76.83	25
USA	NC2	20161028	Unvegetated	34.70	-76.83	24-25
USA	OR	20160718	Seagrass	43.32	-124.32	25
USA	OR	20160718	Unvegetated	43.32	-124.32	25
USA	TX	20160707	Seagrass	27.42	-97.19	25-28
USA	TX	20160707	Unvegetated	27.42	-97.19	21-25
USA	VA	20160811	Seagrass	37.22	-76.39	25
USA	VA	20160811	Unvegetated	37.22	-76.39	25
USA	VA2	20160621	Seagrass	37.69	-75.87	22-25
USA	VA2	20160621	Unvegetated	37.69	-75.87	25
USA	WA	20160706	Seagrass	47.35	-122.32	22-25
USA	WA	20160706	Seagrass	47.35	-122.32	24-25
USA	WA2	20160719	Seagrass	48.49	-123.08	21-25
USA	WA2	20160719	Unvegetated	48.49	-123.08	24-29
Wales	Wales	20160902	Seagrass	52.94	-4.57	24-25
Wales	Wales	20160902	Unvegetated	52.94	-4.56	23-25

Movie S1 (separate file). Example of fish feeding behavior in a seagrass meadow (*Posidonia oceanica*) from Italy showing attacks on a squidpop. Later in the video a moray eel appears and strikes at one of the smaller fish. This movie illustrates the complex ecological interactions that can take place in seagrass meadows.

SI References

Sample References:

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2. L. C. Hughes, *et al.*, Comprehensive phylogeny of ray-finned fishes (Actinopterygii) based on transcriptomic and genomic data. *Proc. Natl. Acad. Sci.* **115**, 6249–6254 (2018).