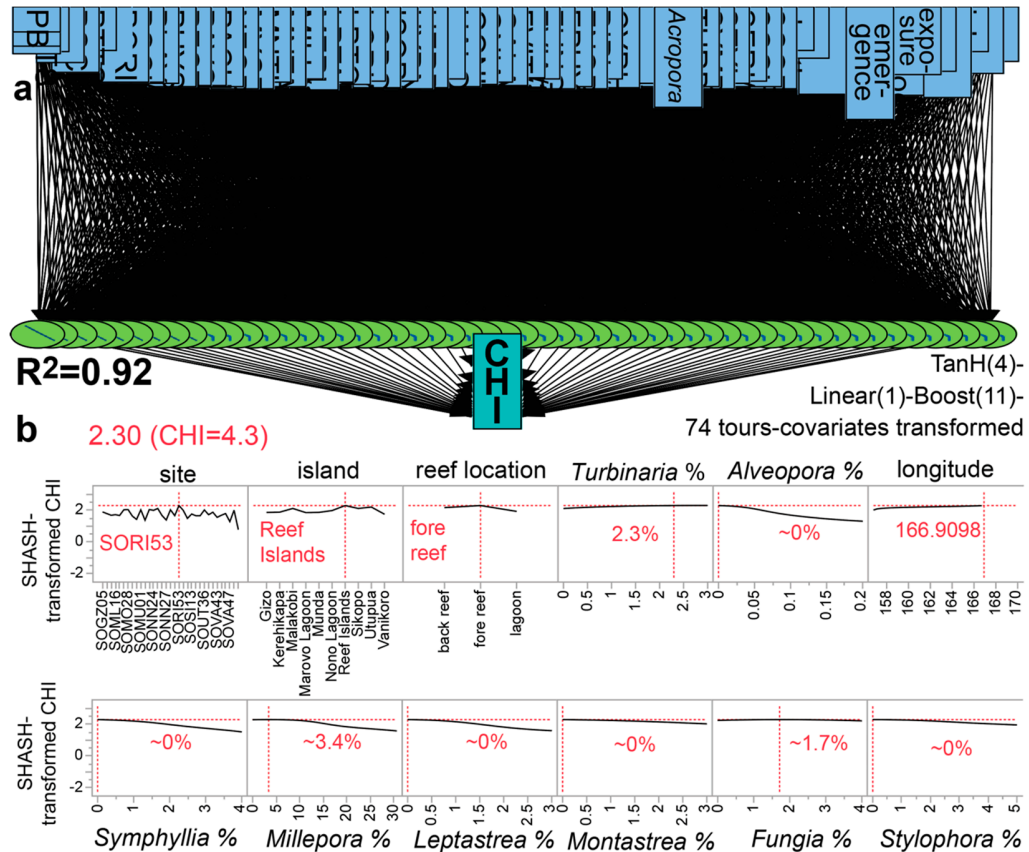


**Figure S1.** A neural network (a) for predicting the coral health index (CHI) from 14 environmental (ENV) parameters and a machine-learning-based “desirability analysis” (b) based on the associated model. The model was validated with test sample data (i.e., both holdback validation samples & test data from corals from random field sites). The conditions/levels resulting in a hypothetical maximum CHI are displayed in the center of each plot in (b). The maximum SHASH-transformed CHI obtained of 2.7 corresponds to a raw CHI of ~ 5.



**Figure S2.** A neural network (a) for predicting the coral health index (CHI) from both 14 environmental parameters and 50 benthic survey parameters, followed by a machine-learning-based “desirability analysis” (b) based on the associated model. Twenty percent of coral samples were randomly excluded from the model and then used as validation samples. Only select predictors have been shown in (a). PB=percent barren substrate. The highest plotted values in each of the sub-panels within (b) represent the condition in which the SHASH-transformed CHI was maximized; only the 12 most influential predictors have been shown (based on a dependent resampled inputs algorithm). The maximum SHASH-transformed CHI obtained of 2.3 corresponds to a raw, back-transformed CHI of ~4.3. The predictors are presented in order of influence, from most (top-left) to least important (bottom-right).

**Table S1.** All partial least squares analyses (non-iterative [NIPALS]) of multivariate coral physiology (n=120). Models that yielded no meaningful solution are denoted by “0 factors,” with those that could not be run due to computational limitations deemed “too computationally intensive” (TCI; >64 GB RAM). Coral health was assessed as either the 16 coral physiological response variables (PRV) or the 4 factors from a factor analysis of these PRV as Y’s (“4 PRV factors”). When the ecological (ECO) parameters were included as X’s, either all 50 benthic categories (“ECO(50)”) or the 15 factors from a factor analysis of these 50 bins (“ECO(15)”) were included. Superscripts represent degree of factorial combinations of the respective model X’s. ENV=environmental parameters (see Table 2.). RS=response surface. Val col=validation column. Val w/test=both validation and test data columns.

Model Y’s	Model X’s	Validation type	Conclusion
16 PRV	ENV(14) <sup>1</sup>	Kfold7	0 factors
16 PRV	ENV(14) <sup>1</sup>	Val col	0 factors
16 PRV	ENV(14) <sup>1</sup>	Val w/ test	0 factors
16 PRV	ENV(14) <sup>2</sup>	Kfold7	0 factors
16 PRV	ENV(14) <sup>2</sup>	Val col	0 factors
16 PRV	ENV(14) <sup>2</sup>	Val w/ test	0 factors
16 PRV	ENV(14) <sup>3</sup>	Kfold7	0 factors
16 PRV	ENV(14) <sup>3</sup>	Val col	0 factors
16 PRV	ENV(14) <sup>3</sup>	Val w/ test	0 factors
16 PRV	ENV(14)-RS	Kfold7	0 factors
16 PRV	ENV(14)-RS	Val col	0 factors
16 PRV	ENV(14)-RS	Val w/ test	0 factors
4 PRV factors	ENV(14) <sup>1</sup>	Kfold7	0 factors
4 PRV factors	ENV(14) <sup>1</sup>	Val col	0 factors
4 PRV factors	ENV(14) <sup>1</sup>	Val w/ test	9 factors (48%)
4 PRV factors	ENV(14) <sup>2</sup>	Kfold7	0 factors
4 PRV factors	ENV(14) <sup>2</sup>	Val col	0 factors
4 PRV factors	ENV(14) <sup>2</sup>	Val w/ test	15 factors (57%)
4 PRV factors	ENV(14) <sup>3</sup>	Kfold7	0 factors
4 PRV factors	ENV(14) <sup>3</sup>	Val col	0 factors
4 PRV factors	ENV(14) <sup>3</sup>	Val w/ test	7 factors (52%)
4 PRV factors	ENV(14)-RS	Kfold7	0 factors
4 PRV factors	ENV(14)-RS	Val col	0 factors
4 PRV factors	ENV(14)-RS	Val w/ test	8 factors (51.5%)
16 PRV	ECO(50) <sup>1</sup>	Kfold7	2 factors (16%)
16 PRV	ECO(50) <sup>1</sup>	Val col	0 factors
16 PRV	ECO(50) <sup>1</sup>	Val w/ test	1 factor (9.9%)
16 PRV	ECO(50) <sup>2</sup>	Kfold7	2 factors (16.5%)
16 PRV	ECO(50) <sup>2</sup>	Val col	0 factors
16 PRV	ECO(50) <sup>2</sup>	Val w/ test	2 factors (19%)
16 PRV	ECO(50) <sup>3</sup>	Kfold7	2 factors (17%)
16 PRV	ECO(50) <sup>3</sup>	Val col	0 factors
16 PRV	ECO(50) <sup>3</sup>	Val w/ test	2 factors (19.5%)
16 PRV	ECO(50)-RS	Kfold7	2 factors (16.5%)

<b>Model Y's</b>	<b>Model X's</b>	<b>Validation type</b>	<b>Conclusion</b>
16 PRV	ECO(50)-RS	Val col	0 factors
16 PRV	ECO(50)-RS	Val w/ test	2 factors (19%)
4 PRV factors	ECO(50) <sup>1</sup>	Kfold7	0 factors
4 PRV factors	ECO(50) <sup>1</sup>	Val col	0 factors
4 PRV factors	ECO(50) <sup>1</sup>	Val w/ test	1 factor (9.3%)
4 PRV factors	ECO(50) <sup>2</sup>	Kfold7	0 factors
4 PRV factors	ECO(50) <sup>2</sup>	Val col	0 factors
4 PRV factors	ECO(50) <sup>2</sup>	Val w/ test	3 factors (28%)
4 PRV factors	ECO(50) <sup>3</sup>	Kfold7	2 factors (18%)
4 PRV factors	ECO(50) <sup>3</sup>	Val col	0 factors
4 PRV factors	ECO(50) <sup>3</sup>	Val w/ test	4 factors (30.5%)
4 PRV factors	ECO(50)-RS	Kfold7	0 factors
4 PRV factors	ECO(50)-RS	Val col	0 factors
4 PRV factors	ECO(50)-RS	Val w/ test	3 factors (28%)
16 PRV	ECO(15) <sup>1</sup>	Kfold7	0 factors
16 PRV	ECO(15) <sup>1</sup>	Val col	0 factors
16 PRV	ECO(15) <sup>1</sup>	Val w/ test	0 factors
16 PRV	ECO(15) <sup>2</sup>	Kfold7	0 factors
16 PRV	ECO(15) <sup>2</sup>	Val col	0 factors
16 PRV	ECO(15) <sup>2</sup>	Val w/ test	0 factors
16 PRV	ECO(15) <sup>3</sup>	Kfold7	0 factors
16 PRV	ECO(15) <sup>3</sup>	Val col	0 factors
16 PRV	ECO(15) <sup>3</sup>	Val w/ test	0 factors
16 PRV	ECO(15)-RS	Kfold7	2 factors (18%)
16 PRV	ECO(15)-RS	Val col	0 factors
16 PRV	ECO(15)-RS	Val w/ test	0 factors
4 PRV factors	ECO(15) <sup>1</sup>	Kfold7	0 factors
4 PRV factors	ECO(15) <sup>1</sup>	Val col	0 factors
4 PRV factors	ECO(15) <sup>1</sup>	Val w/ test	0 factors
4 PRV factors	ECO(15) <sup>2</sup>	Kfold7	0 factors
4 PRV factors	ECO(15) <sup>2</sup>	Val col	0 factors
4 PRV factors	ECO(15) <sup>2</sup>	Val w/ test	2 factors (25%)
4 PRV factors	ECO(15) <sup>3</sup>	Kfold7	0 factors
4 PRV factors	ECO(15) <sup>3</sup>	Val col	0 factors
4 PRV factors	ECO(15) <sup>3</sup>	Val w/ test	2 factors (19%)
4 PRV factors	ECO(15)-RS	Kfold7	0 factors
4 PRV factors	ECO(15)-RS	Val col	0 factors
4 PRV factors	ECO(15)-RS	Val w/ test	1 factor (13%)
16 PRV	ENV(14)+ECO(50)	Kfold7	0 factors
16 PRV	ENV(14)+ECO(50)	Val col	0 factors
16 PRV	ENV(14)+ECO(50)	Val w/ test	1 factor (18%)
16 PRV	(ENV[14]+ECO[50]) <sup>2</sup>	Kfold7	0 factors
16 PRV	(ENV[14]+ECO[50]) <sup>2</sup>	Val col	0 factors
16 PRV	(ENV[14]+ECO[50]) <sup>2</sup>	Val w/ test	1 factor (21%)
16 PRV	(ENV(14)+ECO[50]) <sup>3</sup>	Kfold7	TCI

Model Y's	Model X's	Validation type	Conclusion
16 PRV	(ENV(14)+ECO[50]) <sup>3</sup>	Val col	0 factors
16 PRV	(ENV(14)+ECO[50]) <sup>3</sup>	Val w/ test	0 factors
16 PRV	(ENV[14]+ECO[50])-RS	Kfold7	0 factors
16 PRV	(ENV[14]+ECO[50])-RS	Val col	0 factors
16 PRV	(ENV[14]+ECO[50])-RS	Val w/ test	1 factor (21%)
4 PRV factors	ENV(14)+ECO(50)	Kfold7	1 factor (16%)
4 PRV factors	ENV(14)+ECO(50)	Val col	0 factors
4 PRV factors	ENV(14)+ECO(50)	Val w/ test	4 factors (46%)
4 PRV factors	(ENV[14]+ECO[50]) <sup>2</sup>	Kfold7	0 factors
4 PRV factors	(ENV[14]+ECO[50]) <sup>2</sup>	Val col	0 factors
4 PRV factors	(ENV[14]+ECO[50]) <sup>2</sup>	Val w/ test	13 factors (59%)
4 PRV factors	(ENV(14)+ECO[50]) <sup>3</sup>	Kfold7	TCI
4 PRV factors	(ENV(14)+ECO[50]) <sup>3</sup>	Val col	0 factors
4 PRV factors	(ENV(14)+ECO[50]) <sup>3</sup>	Val w/ test	TCI
4 PRV factors	(ENV[14]+ECO[50])-RS	Kfold7	0 factors
4 PRV factors	(ENV[14]+ECO[50])-RS	Val col	0 factors
4 PRV factors	(ENV[14]+ECO[50])-RS	Val w/ test	13 factors (59%)
16 PRV	ENV(14)+ECO(15)	Kfold7	0 factors
16 PRV	ENV(14)+ECO(15)	Val col	0 factors
16 PRV	ENV(14)+ECO(15)	Val w/ test	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>2</sup>	Kfold7	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>2</sup>	Val col	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>2</sup>	Val w/ test	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>3</sup>	Kfold7	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>3</sup>	Val col	0 factors
16 PRV	(ENV[14]+ECO[15]) <sup>3</sup>	Val w/ test	0 factors
16 PRV	(ENV[14]+ECO[15])-RS	Kfold7	0 factors
16 PRV	(ENV[14]+ECO[15])-RS	Val col	0 factors
16 PRV	(ENV[14]+ECO[15])-RS	Val w/ test	0 factors
4 PRV factors	ENV(14)+ECO(15)	Kfold7	1 factor (15%)
4 PRV factors	ENV(14)+ECO(15)	Val col	0 factors
4 PRV factors	ENV(14)+ECO(15)	Val w/ test	1 factor (14%)
4 PRV factors	(ENV[14]+ECO[15]) <sup>2</sup>	Kfold7	0 factors
4 PRV factors	(ENV[14]+ECO[15]) <sup>2</sup>	Val col	0 factors
4 PRV factors	(ENV[14]+ECO[15]) <sup>2</sup>	Val w/ test	4 factors (53%)
4 PRV factors	(ENV[14]+ECO[15]) <sup>3</sup>	Kfold7	0 factors
4 PRV factors	(ENV[14]+ECO[15]) <sup>3</sup>	Val col	0 factors
4 PRV factors	(ENV[14]+ECO[15]) <sup>3</sup>	Val w/ test	1 factor (19%)
4 PRV factors	(ENV[14]+ECO[15])-RS	Kfold7	0 factors
4 PRV factors	(ENV[14]+ECO[15])-RS	Val col	0 factors
4 PRV factors	(ENV[14]+ECO[15])-RS	Val w/ test	1 factor (19%)

**Table S2.** Predictive models of the coral health index (CHI; SHASH-transformed;  $n \sim 80,000$ ) in order from fewest (9) to most (64) model terms. In all models, CHI was the Y, and first, second, and third-order factorial combinations of environmental (ENV) and/or ecological (ECO; i.e., benthic) predictors were considered. In the neural network (NN) GUI, models (sample size in “Model details” column) were run with either one (“HL(1)”) or two (“HL(2)”) hidden layers (HL); with the former, up to 20 boosts were allowed (learning rate: 0.05-0.3). The number of activation nodes ranged from 0 to 4 (up to 6 in models followed by “-6,” which also featured up to 200 tours instead of the maximum of 100 for all other NN models & 30 boosts maximum instead of 20 for the HL1 models), the weight decay penalty was used, and up to 100 tours were considered; covariates were transformed in half of all models, and half were robustly fit (randomly assigned in both cases). For ECO, either all 50 categories were tested (first- & second-order factorials+response surface [RS]) or the factor loading scores ( $n=15$ ) were instead used. When test samples were used in addition to validation (Val) samples (Val w/test), the test  $R^2$  is shown in the “ $R^2$ ” column; all other values represent validation  $R^2$  (from Kfold, 20% holdback, or validation column [Val col]-based validation). Details of several models with  $R^2 > 0.8$  (highlighted in green) are shown in Table 3; these models were re-run at least 10 times, with the mean validation  $R^2$  presented in the table (necessary because of the large number of tours, which means successive iterations yield slightly different results; “—”=mean validation or test  $R^2 < 0.8$  upon averaging results of these additional runs). GEN=7 general benthic categories (see online supplemental data file [OSDF; Supplementary file S2]). Gen-reg=generalized regression. NA=not applicable. NIPALS=non-iterative partial least squares. TCI=too computationally intensive ( $>64$  GB RAM).

X's (#)	Validation	Model type	$R^2$	Model details
<b>ENV(9): latitude, longitude, island, depth, reef type, reef location, lagoon, emergence, &amp; exposure</b>				
ENV(9) <sup>1</sup>	Kfold5	Model screen	0.32	NN: TanH(3)-Boost(16)
ENV(9) <sup>1</sup>	Val col	Model screen	0.21	NN: TanH(3)-Boost(20)
ENV(9) <sup>1</sup>	Val w/test	Model screen	0.45	Gen-reg-pruned forward selection
ENV(9) <sup>1</sup>	20% holdback	NN GUI-HL(1)	0.56	5,000 models tested
ENV(9) <sup>1</sup>	Val col	NN GUI-HL(1)	0.43	5,000 models tested
ENV(9) <sup>1</sup>	Val w/test	NN GUI-HL(1)	0.57	5,000 models tested
ENV(9) <sup>1</sup>	20% holdback	NN GUI-HL(2)	0.76	5,000 models tested
ENV(9) <sup>1</sup>	Val col	NN GUI-HL(2)	0.57	5,000 models tested
ENV(9) <sup>1</sup>	Val w/test	NN GUI-HL(2)	0.57	5,000 models tested
ENV(9) <sup>1</sup>	20% holdback	NN GUI-HL(1)-6	0.65	5,000 models tested
ENV(9) <sup>1</sup>	Val col	NN GUI-HL(1)-6	0.70	5,000 models tested
ENV(9) <sup>1</sup>	Val w/test	NN GUI-HL(1)-6	0.59	5,000 models tested
ENV(9) <sup>1</sup>	20% holdback	NN GUI-HL(2)-6	0.68	5,000 models tested
ENV(9) <sup>1</sup>	Val col	NN GUI-HL(2)-6	0.58	5,000 models tested
ENV(9) <sup>1</sup>	Val w/test	NN GUI-HL(2)-6	0.63	5,000 models tested
ENV(9) <sup>1</sup>	Kfold7	NIPALS	0.15	1 factor
ENV(9) <sup>1</sup>	Val col	NIPALS	0.16	1 factor
ENV(9) <sup>1</sup>	Val w/test	NIPALS	failed	0 factors
ENV(9) <sup>2</sup>	Kfold7	NIPALS	0.20	1 factor
ENV(9) <sup>2</sup>	Val col	NIPALS	0.25	1 factor

<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
ENV(9) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
ENV(9) <sup>3</sup>	Kfold7	NIPALS	0.25	1 factor
ENV(9) <sup>3</sup>	Val col	NIPALS	failed	0 factors
ENV(9) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors
ENV(9)-RS	Kfold7	NIPALS	0.20	1 factor
ENV(9)-RS	Val col	NIPALS	0.25	1 factor
ENV(9)-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(11): the former nine plus temperature and salinity</b>				
ENV(11) <sup>1</sup>	Kfold5	Model screen	0.51	NN: TanH(3)-Boost(20)
ENV(11) <sup>1</sup>	Val col	Model screen	0.47	NN: TanH(3)-Boost(20)
ENV(11) <sup>1</sup>	Val w/test	Model screen	0.43	NN: TanH(3)-Boost(20)
ENV(11) <sup>1</sup>	Kfold5	NN GUI-HL(1)	0.90	1,000 models tested
ENV(11) <sup>1</sup>	10% holdback	NN GUI-HL(1)	0.81 <sup>-</sup>	1,100 models tested
ENV(11) <sup>1</sup>	20% holdback	NN GUI-HL(1)	0.83 <sup>-</sup>	2,000 models tested
ENV(11) <sup>1</sup>	Val col	NN GUI-HL(1)	0.57	1,600 models tested
ENV(11) <sup>1</sup>	Val w/test	NN GUI-HL(1)	0.67	1,000 models tested
ENV(11) <sup>1</sup>	20% holdback	NN GUI-HL(2)	0.71	1,000 models tested
ENV(11) <sup>1</sup>	Val col	NN GUI-HL(2)	0.58	1,000 models tested
ENV(11) <sup>1</sup>	Val w/test	NN GUI-HL(2)	0.54	1,000 models tested
ENV(11) <sup>1</sup>	20% holdback	NN GUI-HL(1)-6	0.90 <sup>-</sup>	1,100 models tested
ENV(11) <sup>1</sup>	Val col	NN GUI-HL(1)-6	0.82 <sup>-</sup>	1,000 models tested
ENV(11) <sup>1</sup>	Val w/test	NN GUI-HL(1)-6	0.67	1,000 models tested
ENV(11) <sup>1</sup>	20% holdback	NN GUI-HL(2)-6	0.74	1,000 models tested
ENV(11) <sup>1</sup>	Val col	NN GUI-HL(2)-6	0.68	1,000 models tested
ENV(11) <sup>1</sup>	Val w/test	NN GUI-HL(2)-6	0.56	20,000 models tested
ENV(11) <sup>1</sup>	Kfold7	NIPALS	0.34	2 factors
ENV(11) <sup>1</sup>	Val col	NIPALS	0.23	1 factor
ENV(11) <sup>1</sup>	Val w/test	NIPALS	failed	0 factors
ENV(11) <sup>2</sup>	Kfold7	NIPALS	0.34	1 factor
ENV(11) <sup>2</sup>	Val col	NIPALS	0.35	1 factor
ENV(11) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
ENV(11) <sup>3</sup>	Kfold7	NIPALS	0.37	1 factor
ENV(11) <sup>3</sup>	Val col	NIPALS	failed	0 factors
ENV(11) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors
ENV(11)-RS	Kfold7	NIPALS	0.32	1 factor
ENV(11)-RS	Val col	NIPALS	0.35	1 factor
ENV(11)-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(11)+pop: the former 11 plus population (pop) of nearest island (n=12 predictors)</b>				
ENV(11)+pop	Kfold5	Model screen	0.62	NN: TanH(3)-Boost(20)
ENV(11)+pop	Val col	Model screen	0.50	NN: TanH(3)-Boost(20)
ENV(11)+pop	Val w/test	Model screen	0.45	NN: TanH(3)-Boost(20)
ENV(11)+pop	Kfold5	NN GUI-HL(1)	0.85 <sup>-</sup>	300 models tested
ENV(11)+pop	20% holdback	NN GUI-HL(1)	0.69	1,000 models tested
ENV(11)+pop	Val col	NN GUI-HL(1)	0.56	2,000 models tested
ENV(11)+pop	Val w/test	NN GUI-HL(1)	0.58	2,000 models tested

<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
ENV(11)+pop	20% holdback	NN GUI-HL(2)	0.68	2,000 models tested
ENV(11)+pop	Val col	NN GUI-HL(2)	0.55	6,000 models tested
ENV(11)+pop	Val w/test	NN GUI-HL(2)	0.56	2,000 models tested
ENV(11)+pop	20% holdback	NN GUI-HL(1)-6	0.76	500 models tested
ENV(11)+pop	Val col	NN GUI-HL(1)-6	0.65	500 models tested
ENV(11)+pop	Val w/test	NN GUI-HL(1)-6	0.63	500 models tested
ENV(11)+pop	20% holdback	NN GUI-HL(2)-6	0.67	1,000 models tested
ENV(11)+pop	Val col	NN GUI-HL(2)-6	0.52	10,000 models tested
ENV(11)+pop	Val w/test	NN GUI-HL(2)-6	0.60	2,000 models tested
ENV(11)+pop	Kfold7	NIPALS	0.34	2 factors
ENV(11)+pop	Val col	NIPALS	0.24	1 factor
ENV(11)+pop	Val w/test	NIPALS	failed	0 factors
(ENV[11]+pop) <sup>2</sup>	Kfold7	NIPALS	0.31	1 factor
(ENV[11]+pop) <sup>2</sup>	Val col	NIPALS	0.35	1 factor
(ENV[11]+pop) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[11]+pop) <sup>3</sup>	Kfold7	NIPALS	0.37	1 factor
(ENV[11]+pop) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[11]+pop) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors
ENV(11)+pop-RS	Kfold7	NIPALS	0.32	1 factor
ENV(11)+pop-RS	Val col	NIPALS	0.35	1 factor
ENV(11)+pop-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(14): the former 11 ENV plus date, site, &amp; time of day (excluding population)</b>				
ENV(14) <sup>1</sup>	Kfold5	Model screen	0.53	NN: TanH(3)-Boost(20)
ENV(14) <sup>1</sup>	Val col	Model screen	0.46	NN: TanH(3)-Boost(20)
ENV(14) <sup>1</sup>	Val w/test	Model screen	0.52	Gen-reg-forward selection
ENV(14) <sup>1</sup>	20% holdback	NN GUI-HL(1)	0.86 <sup>a</sup>	1,500 models tested
ENV(14) <sup>1</sup>	Val col	NN GUI-HL(1)	0.76	1,500 models tested
ENV(14) <sup>1</sup>	Val w/test	NN GUI-HL(1)	0.83 <sup>a,b</sup>	2,000 models tested
ENV(14) <sup>1</sup>	20% holdback	NN GUI-HL(2)	0.80	1,700 models tested
ENV(14) <sup>1</sup>	Val col	NN GUI-HL(2)	0.64	1,500 models tested
ENV(14) <sup>1</sup>	Val w/test	NN GUI-HL(2)	0.73	1,500 models tested
ENV(14) <sup>1</sup>	Kfold7	NIPALS	0.32	1 factor
ENV(14) <sup>1</sup>	Val col	NIPALS	0.32	1 factor
ENV(14) <sup>1</sup>	Val w/test	NIPALS	0.50	7 factors
ENV(14) <sup>2</sup>	Kfold7	NIPALS	0.38	1 factor
ENV(14) <sup>2</sup>	Val col	NIPALS	failed	0 factors
ENV(14) <sup>2</sup>	Val w/test	NIPALS	0.58	6 factors
ENV(14) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
ENV(14) <sup>3</sup>	Val col	NIPALS	failed	0 factors
ENV(14) <sup>3</sup>	Val w/test	NIPALS	0.61	5 factors
ENV(14)-RS	Kfold7	NIPALS	0.38	1 factor
ENV(14)-RS	Val col	NIPALS	failed	0 factors
ENV(14)-RS	Val w/test	NIPALS	0.59	6 factors
<b>ECO(15): the 15 factors scores from a factor analysis of the 50 benthic categories</b>				
ECO(15) <sup>1</sup>	Kfold5	Model screen	0.54	NN



<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
ECO(15) <sup>1</sup>	Val col	Model screen	0.27	NN
ECO(15) <sup>1</sup>	Val w/test	Model screen	0.39	Boosted tree
ECO(15) <sup>1</sup>	20% holdback	NN GUI-HL(1)	0.55	1,500 models tested
ECO(15) <sup>1</sup>	Val col	NN GUI-HL(1)	0.37	1,500 models tested
ECO(15) <sup>1</sup>	Val w/test	NN GUI-HL(1)	0.41	1,500 models tested
ECO(15) <sup>1</sup>	20% holdback	NN GUI-HL(2)	0.61	1,500 models tested
ECO(15) <sup>1</sup>	Val col	NN GUI-HL(2)	0.36	1,500 models tested
ECO(15) <sup>1</sup>	Val w/test	NN GUI-HL(2)	0.45	1,500 models tested
ECO(15) <sup>1</sup>	Kfold7	NIPALS	failed	0 factors
ECO(15) <sup>1</sup>	Val col	NIPALS	failed	0 factors
ECO(15) <sup>1</sup>	Val w/test	NIPALS	failed	0 factors
ECO(15) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
ECO(15) <sup>2</sup>	Val col	NIPALS	failed	0 factors
ECO(15) <sup>2</sup>	Val w/test	NIPALS	0.35	1 factor
ECO(15) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
ECO(15) <sup>3</sup>	Val col	NIPALS	failed	0 factors
ECO(15) <sup>3</sup>	Val w/test	NIPALS	0.30	1 factor
ECO(15)-RS	Kfold7	NIPALS	failed	0 factors
ECO(15)-RS	Val col	NIPALS	failed	0 factors
ECO(15)-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(11)+pop+7GEN: as above with 7 general (GEN) benthic categories (see OSDF; n=19 predictors)</b>				
ENV(11)+pop+7GEN	Kfold5	Model screen	0.58	NN: TanH(3)-Boost(20)
ENV(11)+pop+7GEN	Val col	Model screen	0.58	NN: TanH(3)-Boost(20)
ENV(11)+pop+7GEN	Val w/test	Model screen	0.46	NN: TanH(3)-Boost(20)
ENV(11)+pop+7GEN	Kfold5	NN GUI-HL(1)	0.92	5,000 models tested
ENV(11)+pop+7GEN	20% holdback	NN GUI-HL(1)	0.80	5,000 models tested
ENV(11)+pop+7GEN	Val col	NN GUI-HL(1)	0.81	5,000 models tested
ENV(11)+pop+7GEN	Val w/test	NN GUI-HL(1)	0.66	5,000 models tested
ENV(11)+pop+7GEN	20% holdback	NN GUI-HL(2)	0.85	500 models tested
ENV(11)+pop+7GEN	Val col	NN GUI-HL(2)	0.70	500 models tested
ENV(11)+pop+7GEN	Val w/test	NN GUI-HL(2)	0.56	500 models tested
ENV(11)+pop+7GEN	20% holdback	NN GUI-HL(1)-6	0.81	500 models tested
ENV(11)+pop+7GEN	Val col	NN GUI-HL(1)-6	0.69	500 models tested
ENV(11)+pop+7GEN	Val w/test	NN GUI-HL(1)-6	0.62	500 models tested
ENV(11)+pop+7GEN	20% holdback	NN GUI-HL(2)-6	0.87	2,000 models tested
ENV(11)+pop+7GEN	Val col	NN GUI-HL(2)-6	0.69	2,000 models tested
ENV(11)+pop+7GEN	Val w/test	NN GUI-HL(2)-6	0.65	2,000 models tested
ENV(11)+pop+7GEN	Kfold7	NIPALS	0.30	1 factor
ENV(11)+pop+7GEN	Val col	NIPALS	0.31	1 factor
ENV(11)+pop+7GEN	Val w/test	NIPALS	failed	0 factors
(ENV[11]+pop+7GEN) <sup>2</sup>	Kfold7	NIPALS	0.59	5 factors
(ENV[11]+pop+7GEN) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[11]+pop+7GEN) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[11]+pop+7GEN) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[11]+pop+7GEN) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[11]+pop+7GEN) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors

<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
ENV(11)+pop+7GEN-RS	Kfold7	NIPALS	0.39	1 factor
ENV(11)+pop+7GEN-RS	Val col	NIPALS	failed	0 factors
ENV(11)+pop+7GEN-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(9)+ECO(15): as defined above (n=24 predictors)</b>				
ENV(9)+ECO(15)	Kfold5	Model screen	0.60	NN: TanH(3)-Boost(20)
ENV(9)+ECO(15)	Val col	Model screen	0.59	NN: TanH(3)-Boost(20)
ENV(9)+ECO(15)	Val w/test	Model screen	0.50	NN: TanH(3)-Boost(20)
ENV(9)+ECO(15)	20% holdback	NN GUI-HL(1)	0.68	100 models tested
ENV(9)+ECO(15)	Val col	NN GUI-HL(1)	0.66	100 models tested
ENV(9)+ECO(15)	Val w/test	NN GUI-HL(1)	0.77	100 models tested
ENV(9)+ECO(15)	20% holdback	NN GUI-HL(2)	0.71	100 models tested
ENV(9)+ECO(15)	Val col	NN GUI-HL(2)	0.37	100 models tested
ENV(9)+ECO(15)	Val w/test	NN GUI-HL(2)	0.64	100 models tested
ENV(9)+ECO(15)	Kfold7	NIPALS	failed	0 factors
ENV(9)+ECO(15)	Val col	NIPALS	0.28	1 factor
ENV(9)+ECO(15)	Val w/test	NIPALS	0.39	4 factors
(ENV[9]+ECO[15]) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[15]) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[9]+ECO[15]) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[9]+ECO[15]) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[15]) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[9]+ECO[15]) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[9]+ECO[15])-RS	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[15])-RS	Val col	NIPALS	failed	0 factors
(ENV[9]+ECO[15])-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(14)+ECO(15): as defined above (n=29 predictors)</b>				
ENV(14)+ECO(15)	Kfold5	Model screen	0.75	NN
ENV(14)+ECO(15)	Val col	Model screen	0.51	NN
ENV(14)+ECO(15)	Val w/test	Model screen	0.42	Gen-reg-forward selection
ENV(14)+ECO(15)	20% holdback	NN GUI-HL(1)	0.89 <sup>c</sup>	1,500 models tested
ENV(14)+ECO(15)	Val col	NN GUI-HL(1)	0.72	1,500 models tested
ENV(14)+ECO(15)	Val w/test	NN GUI-HL(1)	0.80	1,800 models tested
ENV(14)+ECO(15)	20% holdback	NN GUI-HL(2)	0.79	1,500 models tested
ENV(14)+ECO(15)	Val col	NN GUI-HL(2)	0.57	1,500 models tested
ENV(14)+ECO(15)	Val w/test	NN GUI-HL(2)	0.74	1,500 models tested
ENV(14)+ECO(15)	Kfold7	NIPALS	0.40	1 factor
ENV(14)+ECO(15)	Val col	NIPALS	0.40	1 factor
ENV(14)+ECO(15)	Val w/test	NIPALS	0.62	9 factors
(ENV[14]+ECO[15]) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[14]+ECO[15]) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[14]+ECO[15]) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[14]+ECO[15]) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[14]+ECO[15]) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[14]+ECO[15]) <sup>3</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[14]+ECO[15])-RS	Kfold7	NIPALS	failed	0 factors

<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
(ENV[14]+ECO[15])-RS	Val col	NIPALS	failed	0 factors
(ENV[14]+ECO[15])-RS	Val w/test	NIPALS	failed	0 factors
<b>ECO(50): all 50 benthic categories (n=50 predictors)</b>				
ECO(50) <sup>1</sup>	Kfold5	Model screen	0.52	NN
ECO(50) <sup>1</sup>	Val col	Model screen	0.30	NN
ECO(50) <sup>1</sup>	Val w/test	Model screen	0.20	Gen-reg-forward selection
ECO(50) <sup>1</sup>	20% holdback	NN GUI-HL(1)	0.78	1,500 models tested
ECO(50) <sup>1</sup>	Val col	NN GUI-HL(1)	0.67	1,700 models tested
ECO(50) <sup>1</sup>	Val w/test	NN GUI-HL(1)	0.63	1,500 models tested
ECO(50) <sup>1</sup>	20% holdback	NN GUI-HL(2)	0.60	1,500 models tested
ECO(50) <sup>1</sup>	Val col	NN GUI-HL(2)	0.39	1,700 models tested
ECO(50) <sup>1</sup>	Val w/test	NN GUI-HL(2)	0.57	1,500 models tested
ECO(50) <sup>1</sup>	Kfold7	NIPALS	failed	0 factors
ECO(50) <sup>1</sup>	Val col	NIPALS	failed	0 factors
ECO(50) <sup>1</sup>	Val w/test	NIPALS	failed	0 factors
ECO(50) <sup>2</sup>	Kfold5	NIPALS	failed	0 factors
ECO(50) <sup>2</sup>	Val col	NIPALS	failed	0 factors
ECO(50) <sup>2</sup>	Val w/test	NIPALS	0.40	3 factors
ECO(50) <sup>3</sup>	Kfold7	NIPALS	0.24	1 factor
ECO(50) <sup>3</sup>	Val col	NIPALS	failed	0 factors
ECO(50) <sup>3</sup>	Val w/test	NIPALS	0.43	5 factors
ECO(50)-RS	Kfold7	NIPALS	failed	0 factors
ECO(50)-RS	Val col	NIPALS	failed	0 factors
ECO(50)-RS	Val w/test	NIPALS	0.26	1 factor
<b>ENV(9)+ECO(50): as defined above (n=59 predictors)</b>				
ENV(9)+ECO(50)	Kfold5	Model screen	0.65	NN
ENV(9)+ECO(50)	Val col	Model screen	0.33	NN
ENV(9)+ECO(50)	Val w/test	Model screen	0.32	NN
ENV(9)+ECO(50)	20% holdback	NN GUI-HL(1)	0.69	1,500 models tested
ENV(9)+ECO(50)	Val col	NN GUI-HL(1)	0.51	1,500 models tested
ENV(9)+ECO(50)	Val w/test	NN GUI-HL(1)	0.61	1,500 models tested
ENV(9)+ECO(50)	20% holdback	NN GUI-HL(2)	0.72	1,500 models tested
ENV(9)+ECO(50)	Val col	NN GUI-HL(2)	0.48	1,500 models tested
ENV(9)+ECO(50)	Val w/test	NN GUI-HL(2)	0.41	3,000 models tested
ENV(9)+ECO(50)	Kfold7	NIPALS	failed	0 factors
ENV(9)+ECO(50)	Val col	NIPALS	0.32	1 factor
ENV(9)+ECO(50)	Val w/test	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>2</sup>	Val w/test	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[9]+ECO[50]) <sup>3</sup>	Val w/test	NIPALS	0.44	2 factors
(ENV[9]+ECO[50])-RS	Kfold7	NIPALS	failed	0 factors
(ENV[9]+ECO[50])-RS	Val col	NIPALS	failed	0 factors

<b>X's (#)</b>	<b>Validation</b>	<b>Model type</b>	<b>R<sup>2</sup></b>	<b>Model details</b>
(ENV[9]+ECO[50])-RS	Val w/test	NIPALS	failed	0 factors
<b>ENV(11)+ECO(50): as defined above (n=61 predictors)</b>				
ENV(11)+ECO(50)	Kfold5	Model screen	0.52	NN
ENV(11)+ECO(50)	Val col	Model screen	0.62	NN
ENV(11)+ECO(50)	Val w/test	Model screen	0.66	NN
ENV(11)+ECO(50)	10% holdback	NN GUI-HL(1)	0.83 <sup>a,d</sup>	1,000 models tested
ENV(11)+ECO(50)	20% holdback	NN GUI-HL(1)	0.77	1,900 models tested
ENV(11)+ECO(50)	Val col	NN GUI-HL(1)	0.77	4,600 models tested
ENV(11)+ECO(50)	Val w/test	NN GUI-HL(1)	0.55	2,000 models tested
ENV(11)+ECO(50)	20% holdback	NN GUI-HL(2)	0.45	500 models tested
ENV(11)+ECO(50)	Val col	NN GUI-HL(2)	0.49	500 models tested
ENV(11)+ECO(50)	Val w/test	NN GUI-HL(2)	0.66	1,000 models tested
ENV(11)+ECO(50)	Kfold7	NIPALS	failed	0 factors
ENV(11)+ECO(50)	Val col	NIPALS	failed	0 factors
ENV(11)+ECO(50)	Val w/test	NIPALS	0.64	15 factors
(ENV[11]+ECO[50]) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[11]+ECO[50]) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[11]+ECO[50]) <sup>2</sup>	Val w/test	NIPALS	0.40	1 factor
(ENV[11]+ECO[50]) <sup>3</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[11]+ECO[50]) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[11]+ECO[50]) <sup>3</sup>	Val w/test	NIPALS	0.64	8 factors
(ENV[11]+ECO[50])-RS	Kfold7	NIPALS	failed	0 factors
(ENV[11]+ECO[50])-RS	Val col	NIPALS	failed	0 factors
(ENV[11]+ECO[50])-RS	Val w/test	NIPALS	0.41	1 factor
<b>ENV(14)+ECO(50): as defined above (n=64 predictors)</b>				
ENV(14)+ECO(50)	Kfold5	Model screen	0.61	NN
ENV(14)+ECO(50)	Val col	Model screen	0.52	NN
ENV(14)+ECO(50)	Val w/test	Model screen	0.49	NN
ENV(14)+ECO(50)	20% holdback	NN GUI-HL(1)	0.92 <sup>a,e</sup>	1,500 models tested
ENV(14)+ECO(50)	Val col	NN GUI-HL(1)	0.72	1,500 models tested
ENV(14)+ECO(50)	Val w/test	NN GUI-HL(1)	0.78	1,500 models tested
ENV(14)+ECO(50)	20% holdback	NN GUI-HL(2)	0.75	5,000 models tested
ENV(14)+ECO(50)	Val col	NN GUI-HL(2)	0.59	1,500 models tested
ENV(14)+ECO(50)	Val w/test	NN GUI-HL(2)	0.74	1,500 models tested
ENV(14)+ECO(50)	Kfold7	NIPALS	0.42	1 factor
ENV(14)+ECO(50)	Val col	NIPALS	failed	0 factors
ENV(14)+ECO(50)	Val w/test	NIPALS	0.63	15 factors
(ENV[14]+ECO[50]) <sup>2</sup>	Kfold7	NIPALS	failed	0 factors
(ENV[14]+ECO[50]) <sup>2</sup>	Val col	NIPALS	failed	0 factors
(ENV[14]+ECO[50]) <sup>2</sup>	Val w/test	NIPALS	0.51	1 factor
(ENV[14]+ECO[50]) <sup>3</sup>	Kfold7	NIPALS	TCI	NA
(ENV[14]+ECO[50]) <sup>3</sup>	Val col	NIPALS	failed	0 factors
(ENV[14]+ECO[50]) <sup>3</sup>	Val w/test	NIPALS	0.64	6 factors
(ENV[14]+ECO[50])-RS	Kfold7	NIPALS	failed	0 factors
(ENV[14]+ECO[50])-RS	Val col	NIPALS	failed	0 factors

X's (#)	Validation	Model type	R <sup>2</sup>	Model details
(ENV[14]+ECO[50])-RS	Val w/test	NIPALS	0.62	9 factors

<sup>a</sup>See Table 3. <sup>b</sup>See Figure S1. <sup>c</sup>Excluded from main text tables and figures due to difficulties in interpretation. <sup>d</sup>See Figure 5. <sup>e</sup>See Figure S2.