Appendices: Covariate tests

Table A1. Covariate tests for the July-September catch (S_t). M is the base model with only prior season October-March catch (N_{t-1}) as the covariate. To the base model, the environmental covariates are added. nearshore is 0-80km and regional is 0-160km. The SST data are the AVHRR data. The models are nested sets, e.g. 1, 2a, 3a and 1, 2b, 3b.

Model	Resid. df	Adj. R^2	RMSE	AICc	LOOCV RMSE	LOOCV MdAE
catch only models 1983-2015 data						
null model: $ln(S_t) = ln(S_{t-1}) + \epsilon_t$	33		1.596	126.6	1.596	0.559
base model (M): $ln(S_t) = \alpha + s(ln(N_{t-1})) + \epsilon_t$	30	21.7	1.204	115.2	1.313	0.692
Precipitation						
V_t = Jun-Jul Precipitation - ocean						
$ln(S_t)$ = M + βV_t	29.1	19.7	1.199	117.7	1.34	0.731
$ln(S_t)$ = M + $s(V_t)$	27.9	21.4	1.163	119.1	1.322	0.656‡
V_t = Jun-Jul Precipitation - land						
$ln(S_t)$ = M + βV_t	29.1	25.4	1.156	115.3	1.308	0.564‡‡
$ln(S_t)$ = M + $s(V_t)$	28	29.9	1.1	115.3	1.327	0.62‡‡
V_t = Apr-May Precipitation - ocean						
$ln(S_t)$ = M + βV_t	29.1	24.1	1.166	115.8	1.312	0.666
$ln(S_t)$ = M + $s(V_t)$	27.7	22.2	1.152	119.3	1.335	0.638‡
V_t = Apr-May Precipitation - land						
$ln(S_t)$ = M + βV_t	29.1	26.9	1.144	114.6	1.329	0.78
$ln(S_t)$ = M + $s(V_t)$	27.2	25.1	1.12	119	1.37	0.642‡
Sea surface temperature						
V_t = Mar-May SST - regional						
$ln(S_t)$ = M + βV_t	29	21.8	1.183	116.8	1.329	0.719
$ln(S_t)$ = M + $s(V_t)$	27.1	23.5	1.131	119.8	1.331	0.741
$ln(S_t)$ = M + βV_{t-1}	29	22.6	1.178	116.5	1.312	0.79
$ln(S_t)$ = M + $s(V_{t-1})$	27	26.3	1.107	118.8	1.305	0.835
V_t = Jun-Sep SST - nearshore						
$ln(S_t)$ = M + βV_t	29	28	1.136	114.1	1.278	0.733
$ln(S_t)$ = M + $s(V_t)$	27.4	32.5	1.067	115.2	1.306	0.621‡‡
$ln(S_t)$ = M + βV_{t-1}	29.1	23.1	1.174	116.3	1.357	0.695
$ln(S_t)$ = M + $s(V_{t-1})$	27.2	20.6	1.154	120.9	1.454	0.764
V_t = Oct-Dec SST - nearshore						
$ln(S_t)$ = M + βV_{t-1}	29.1	19.7	1.199	117.7	1.35	0.706
$ln(S_t)$ = M + $s(V_{t-1})$	28	20.5	1.17	119.4	1.361	0.775

Model	Resid. df	Adj. R^2	RMSE	AICc	LOOCV RMSE	LOOCV MdAE
Upwelling						
V_t = Jun-Sep nearshore-offshore SST differential						
$ln(S_t)$ = M + βV_t	29.1	25.9	1.152	115	1.308	0.66
$ln(S_t)$ = M + $s(V_t)$	27.7	29.6	1.097	115.8	1.314	0.56‡‡
$ln(S_t)$ = M + βV_{t-1}	29.1	20.8	1.191	117.2	1.361	0.803
$ln(S_t)$ = M + $s(V_{t-1})$	27.7	20.1	1.169	120	1.371	0.788
V_t = Jun-Sep SST - nearshore						
$ln(S_t)$ = M + βV_t	29	28	1.136	114.1	1.278	0.733
$ln(S_t)$ = M + $s(V_t)$	27.4	32.5	1.067	115.2	1.306	0.621‡‡
$ln(S_t)$ = M + βV_{t-1}	29.1	23.1	1.174	116.3	1.357	0.695
$ln(S_t)$ = M + $s(V_{t-1})$	27.2	20.6	1.154	120.9	1.454	0.764
V_t = Jun-Sep Ekman Mass Transport - nearshore						
$ln(S_t)$ = M + βV_t	29.1	19.2	1.203	117.9	1.359	0.81
$ln(S_t)$ = M + $s(V_t)$	27.3	16.4	1.185	122.5	1.394	0.845
$ln(S_t)$ = M + βV_{t-1}	29.1	20.3	1.195	117.5	1.344	0.701
$ln(S_t)$ = M + $s(V_{t-1})$	27.7	17.7	1.185	121.2	1.368	0.787
V_t = Apr-May Ekman Mass Transport - nearshore						
$ln(S_t)$ = M + βV_t	29.1	20.8	1.191	117.3	1.326	0.8
$ln(S_t)$ = M + $s(V_t)$	28	26.1	1.129	116.9	1.281	0.739
V_t = Jun-Sep Ekman Pumping - nearshore						
$ln(S_t)$ = M + βV_t	29.1	29.6	1.123	113.4	1.294	0.892
$ln(S_t)$ = M + $s(V_t)$	27.6	29.5	1.096	116.1	1.328	0.769
$ln(S_t)$ = M + βV_{t-1}	29.1	19.3	1.203	117.8	1.327	0.723
$ln(S_t)$ = M + $s(V_{t-1})$	27.8	19.5	1.175	120.1	1.357	0.617‡‡
V_t = Jun-Sep Ekman Pumping - tip of India						
$ln(S_t)$ = M + βV_t	29.1	22.1	1.181	116.7	1.369	0.765
$ln(S_t)$ = M + $s(V_t)$	27.7	21	1.161	119.7	1.387	0.868
$ln(S_t)$ = M + βV_{t-1}	29.1	19.3	1.204	117.7	1.334	0.768
$ln(S_t)$ = M + $s(V_{t-1})$	27.8	20.9	1.165	119.5	1.336	0.588‡‡
V_t = Jan-Feb Ekman Pumping - tip of India						
$ln(S_t)$ = M + βV_t	29	27.3	1.141	114.5	1.295	0.77
$ln(S_t)$ = M + $s(V_t)$	28.1	26.2	1.131	116.6	1.321	0.73
$ln(S_t)$ = M + βV_{t-1}	29	19	1.204	118	1.362	0.692
$ln(S_t)$ = M + $s(V_{t-1})$	28.1	17.6	1.195	120.3	1.371	0.771
Ocean climate						
V_t = 2.5-year average SST - AVHRR regional						
$ln(S_t)$ = M + βV_t	29.1	40.3	1.034	107.9††	1.29	0.691
$ln(S_t)$ = M + $s(V_t)$	28.1	47	0.958	105.7††	1.375	0.558‡‡

Model	Resid. df	Adj. R^2	RMSE	AICc	LOOCV RMSE	LOOCV MdAE
V_t = ONI Jul-Jun average						
$ln(S_t)$ = M + βV_t	29	20.5	1.193	117.4	1.335	0.716
$ln(S_t)$ = M + $s(V_t)$	28	21.5	1.165	118.9	1.349	0.697
V_t = PDO Jul-Jun average						
$ln(S_t)$ = M + βV_t	29.1	27.1	1.144	114.4	1.354	0.674
$ln(S_t)$ = M + $s(V_t)$	27.6	28.5	1.104	116.6	1.362	0.59‡‡
V_t = AMO Jul-Jun average						
$ln(S_t)$ = M + βV_t	29.1	38.9	1.047	108.6††	1.232‡	0.512‡‡‡
$ln(S_t)$ = M + $s(V_t)$	27.5	47.5	0.945	106.6††	1.215‡	0.557‡‡
V_t = Sep-Nov DMI						
$ln(S_t)$ = M + βV_{t-1}	29.1	19.2	1.203	117.9	1.328	0.733
$ln(S_t)$ = M + $s(V_{t-1})$	27	15.8	1.184	123.2	1.373	0.811
catch only models 1998-2015 data						
null model: $ln(S_t) = ln(S_{t-1}) + \epsilon_t$	18		0.616	35.9	0.616	0.425
base model (M): $ln(S_t) = \alpha + p(ln(N_{t-1})) + \epsilon_t$	15	16.2	0.364	25.8	0.478	0.228
Chlorophyll						
V_t = Jul-Sep CHL - nearshore						
$ln(S_t)$ = M + βV_t	14	12	0.361	29.4	0.535	0.24
$ln(S_t)$ = M + $p(V_t)$	13	16.4	0.339	31.8	0.733	0.272
$ln(S_t)$ = M + βV_{t-1}	14	10.3	0.364	29.7	0.49	0.248
$ln(S_t)$ = M + $p(V_{t-1})$	13	3.5	0.364	34.3	0.664	0.295
V_t = Oct-Dec CHL - nearshore						
$ln(S_t)$ = M + βV_{t-1}	14	10.9	0.363	29.6	0.515	0.259
$ln(S_t)$ = M + $p(V_{t-1})$	13	24.4	0.322	29.9	0.53	0.247

Notes: LOOCV = Leave one out cross-validation. RMSE = root mean square error. MdAE = median absolute error. AICc = Akaike Information Criterion corrected for small sample size. † and †† = AICc greater than 2 and greater than 5 below model M (base catch model). ‡, ‡‡, and ‡‡‡ = LOOCV RMSE 5%, 10% and 20% below model M, respectively. t indicates current year and $t-1$ is the prior year. N_t spans two calendar years (Oct-Mar); t is the year in Oct. Thus if $t = 2014$, S_t is Jul 2014 to Sep 2014 and N_{t-1} is Oct 2013 to Mar 2014. For covariates that are multiyear, such as the multiyear average SST, t is the calendar year at the end of the multiyear span; thus the 2.5 year average SST for 2014 is Jan 2012 to Jun 2014.