Supplementary Material

Additional methods description

Here we provide a more complete description of our SCUBA surveys. The text is somewhat redundant with the main text but includes additional detail. At each site, we conducted visual surveys on scuba on 30 x 2 m transects to quantify: 1) fish abundance, 2) macroinvertebrate abundance, 3) kelp abundance, 4) other biotic habitat, and 5) substratum type (abiotic habitat, e.g., cobble, pavement, etc) (modified from Malone et al. 2022). Kelp and invertebrates were surveyed along a 2-m wide swath (60 m^2), while fishes were counted within a 2-m x 2-m box along the transect (120 m^3). At each site, we sample two locations, separated by 100+ m and marked by separate down lines, and at two depths at each location (5 m and 10 m). One pair of divers sampled fishes and quantified biotic habitat. The second pair of divers sampled macroinvertebrates and kelp and quantified substratum type. The lead diver laid down the transect tape and counted fish or macroinvertebrates and kelp. The second diver followed recording biotic habitat or substratum characteristics respectively. Both biotic habitat and substratum type were quantified using uniform point contact (UPC) methods by recording the organism or substratum directly under every meter mark along the transect for 30 data points per transect. Each pair of divers began transects from the same drop point marked by the down-line and followed the same overall heading. However, pairs did not necessarily cover the exact same ground, so one cannot directly match fish counts to substratum characteristics at the transect level, for example. Therefore, we summarize data by year x site x location x depth for some analyses.

We counted canopy-forming kelp species within a 2-m swath along the 30-m transect (Table S2). For *Macrocystis pyrifera,* we counted stipes greater than 1.0 m in height from the base of the holdfast. For *Nereocystis luetkeana* and *Pterygophora californica* plants with stipes > 30 cm in height were included, along with other brown algae species > 30 cm in overall length. We used the segment subsampling for abundant species described in Malone et al. (2022) for invertebrate species (and see below Urchin and Kelp Segment Expansion).

Large mobile invertebrates were enumerated on the same transects as kelp (Table S3). We counted individuals greater than 2.5 cm in greatest dimension, with the exception of sea stars where we measured longest ray length. We counted individuals under prostrate algae and within bottom topography and on algae up to a height of 1.0 m above the substrate. This category included species of sea urchins, sea star, sea cucumbers, crabs, bivalves, nudibranchs, etc. We included only species that were easily identifiable to avoid concerns about the detection of cryptic species. For abundant species the transect was broken into 10-m segments, and the distance at which 30 individuals were counted per 10-m segment was recorded, to be used in expansion calculations (see below Urchin and Kelp Segment Expansion). We also recorded sea urchin test diameter, the length of the longest ray for sea stars, and crab carapace width.

We counted and estimated the size (total length) of all fishes we observed within a 2-m wide swatch along the transect and within 2 m of the bottom (Table S4). We counted fishes > 5 cm total length, except young-of-the-year rockfishes (*Sebastes* spp.), which we estimated sizes for all individuals, since we were interested in monitoring rockfish recruitment. Individuals ≤ 10 cm were considered juveniles (Table S5). Divers estimated visibility on each transect by determining the distance at which the lead diver could see the fingers of their buddy. Transects with visibility less than 2.0 m were excluded from the analyses including fishes.

For percent cover of sessile and sedentary invertebrates and algae, we recorded the organism directly under the transect every meter mark (uniform point contact, UPC). Percent cover was rarely species-specific but instead included the following functional groups: brown algae, red algae, green algae, encrusting species (e.g., tunicates, sponges), diatom layer, eelgrass/surfgrass, or non-living substratum (rock/sand). However, these percent cover data are not used in the present study but are discussed here to clarify diver sampling responsibilities.

We classified abiotic habitat (substratum) based on a simplified version of a system used extensively on the U.S. West Coast (Pearcy et al. 1989, Stein et al. 1992, Malone et al. 2022): sand, cobble, boulder, or bedrock; these features were recorded every meter (UPC). Additionally, we included an estimate of the slope every 1 m by estimating the relative change in elevation across the 1-m width of the transect and bounded by 0.25 m forward and backward of the meter mark as: 0-10 cm, 10-100 cm, 1-2 m, or >2 m.

Supplement Tables

Table S1. Sampling effort. Number of transects completed by year and site. Kelp and invertebrates were counted on the same transects, while fish were counted on separate transects. For fish, transects with visibility lower than 2.0 m were removed resulting in no (NA) transects at some sites and years.

Year	Site	Fish	Kelp/Invertebrates
2015	Cape Johnson	2	2
2015	Cape Alava	2	2
2015	Tatoosh Island	2	2
2015	Neah Bay	2	2
2015	Destruction Island	NA	2
2016	Destruction Island	3	7
2016	Cape Johnson	10	13
2016	Cape Alava	12	10
2016	Tatoosh Island	8	9
2016	Neah Bay	10	10
2017	Destruction Island	4	12
2017	Cape Johnson	9	13
2017	Cape Alava	18	14
2017	Tatoosh Island	13	11
2017	Neah Bay	16	12
2018	Cape Johnson	7	12
2018	Cape Alava	16	12
2018	Tatoosh Island	15	12
2018	Neah Bay	15	14
2018	Destruction Island	NA	14
2019	Destruction Island	16	11
2019	Cape Johnson	15	14
2019	Cape Alava	16	14
2019	Tatoosh Island	14	9
2019	Neah Bay	15	14
2021	Destruction Island	10	11
2021	Cape Johnson	16	14
2021	Cape Alava	14	12
2021	Tatoosh Island	14	13
2021	Neah Bay	16	13

Table S2. Macroalgae species observed on transects from 2015-2021 across all sites. Mean density is stipes per m^2 averaged across all sites and years.

Species	Density	SD	Multivariate designation
Pterygophora californica	1.11	1.38	*Ptery*
Nereocystis luetkeana	0.87	1.70	*Nereo*
Macrocystis pyrifera	0.55	1.37	*Macro*
Laminaria setchellii	0.13	0.40	Other
Saccharina dentigera	0.09	0.29	Other
Pleurophycus gardneri	0.09	0.31	Other
Desmarestia spp.	0.07	0.21	Other
Costaria costata	0.06	0.17	Other
Saccharina latissima	0.04	0.22	Other
Alaria marginata	0.01	0.06	Other
Cymathere triplicata	0.00	0.02	Other
Agarum fimbriatum	0.00	0.04	Other

Table S3. Invertebrate species showing group designation in the multivariate analyses. Density is the number per m^2 across all sites and years. SD = 1.0 standard deviation. Values of 0.0 indicate density less than 0.01 per m^2. The following groups were used in the multivariate analyses: anemone, blood star, brood star, chiton, crabs, cucumber, green urchin, hermit crabs, kelp crab, large star, leather star, medium star, nudibranch, *Pisaster*, purple urchin, *Pycnopodia*, red urchin, shelled gastropod, sponge, and tunicate.

Species	Multivariate Group	Density	SD
Balanus nubilus	barnacle	0.83	3.67
Strongylocentrotus purpuratus	purple urchin	0.71	2.40
Nucella lamellosa	shelled gastropod	0.29	1.36
Mesocentrotus franciscanus	red urchin	0.16	0.60
Cucumaria miniata	cucumber	0.11	0.16
Henricia spp.	blood star	0.10	0.09
Styela montereyensis	tunicate	0.09	0.14
Strongylocentrotus droebachiensis	green urchin	0.06	0.31
Dermasterias imbricata	leather star	0.06	0.10
Ceratostoma foliatum	shelled gastropod	0.05	0.09
Crassadoma gigantea	bivalve	0.03	0.08
Diodora aspera	shelled gastropod	0.02	0.05
Leptasterias spp.	brood star	0.02	0.09
Urticina spp.	anemone	0.02	0.04
Pisaster ochraceus	*Pisaster*	0.02	0.06
Eupentacta quinquesemita	cucumber	0.01	0.03
Anthopleura xanthogrammica	anemone	0.01	0.03
Peltodoris nobilis	nudibranch	0.01	0.02
small chitons	chiton	0.01	0.02
Patiria miniata	medium star	0.01	0.04
Evasterias troschelii	large star	0.01	0.02
Doris odhneri	nudibranch	0.01	0.02
Scyra spp.	crabs	0.01	0.02
Orthasterias koehleri	large star	0.01	0.02
Cryptochiton stelleri	chiton	0.01	0.01
Dirona albolineata	nudibranch	0.01	0.02

Acmaea mitra	shelled gastropod	0.00	0.01
Lirabuccinum dirum	shelled gastropod	0.00	0.02
sea star recruits	sea_star_YOY	0.00	0.03
Epiactis prolifera	anemone	0.00	0.03
Pagurus spp.	hermit_crabs	0.00	0.02
Triopha catalinae	nudibranch	0.00	0.01
Cancer spp.	crabs	0.00	0.01
Craniella arb	sponge	0.00	0.01
Janolus fuscus	nudibranch	0.00	0.01
Acanthodoris hudsoni	nudibranch	0.00	0.01
Cancer oregonensis	crabs	0.00	0.01
Parastichopus californicus	cucumber	0.00	0.01
Pugettia producta	kelp crab	0.00	0.01
Mytilus californianus	shelled mussel	0.00	0.01
Pugettia gracilis	kelp crab	0.00	0.01
Urticina crassicornis	anemone	0.00	0.01
Pododesmus spp.	bivalve	0.00	0.01
Solaster stimpsoni	large star	0.00	0.01
Cryptolithodes sitchensis	crabs	0.00	0.00
Urticina lofotensis	anemone	0.00	0.01
Mediaster aequalis	medium star	0.00	0.00
Urticina piscivora	anemone	0.00	0.00
Pycnopodia helianthoides	Pycnopodia	0.00	0.00
Fusitriton oregonensis	shelled gastropod	0.00	0.00
Pisaster brevispinus	Pisaster	0.00	0.00
Mimulus foliatus	crabs	0.00	0.00
misc clams	bivalve	0.00	0.00
Metridium giganteum	anemone	0.00	0.00
Lopholithodes mandtii	crabs	0.00	0.00
Anthopleura elegantissima	anemone	0.00	0.00

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Table S4. Fish species observed during SCUBA surveys from 2015-2021. Observations with visibility below 2.0 m have been excluded. Greenling species were combined into one group for the multivariate analyses. Species in bold were used in the multivariate analyses.

Species	Common name	Total
Sebastes melanops	**black rockfish**	**1387**
Hexagrammos decagrammus	**kelp greenling**	**522**
Embiotoca lateralis	striped surfperch	470
Aulorhynchus flavidus	tubesnout	240
Forage fish	bait-sardines-anchovy	200
Clupeidae	herring	148
Ophiodon elongatus	**lingcod**	**45**
Rhinogobiops nicholsii	blackeye goby	28
Scorpaenichthys marmoratus	**cabezon**	**23**
Sebastes caurinus	**copper rockfish**	**20**
Sebastes maliger	**quillback rockfish**	**19**
Sebastes nebulosus	**china rockfish**	**17**
Artedius harringtoni	scalyhead sculpin	15
Rhacochilus vacca	pile perch	11
Cottidae	sculpins	7
Hemilepidotus hemilepidotus	red Irish lord	7
Oxylebius pictus	**painted greenling**	**7**
Embiotocidae	surfperches	5
Hexagrammos lagocephalus	**rock greenling**	**5**
Synchirus gilli	manacled sculpin	5
Hexagrammos stelleri	**whitespotted greenling**	**4**
Jordania zonope	longfin sculpin	4
Chirolophis nugator	mosshead warbonnet	3
Rimicola muscarum	kelp clingfish	3
Pholidae	gunnels	1
Sebastes flavidus	yellowtail rockfish	1
fish	unidentified fish	1

Table S5. Rockfish juveniles observed during SCUBA surveys from 2015-2021. Observations with visibility below 2.0 m were excluded.

Species	**Common name**	**Total**
Sebastes melanops/flavidus	Yellowtail and black rockfish juveniles (YTB)	3544
Sebastes spp. juveniles	rockfish juveniles	199
Sebastes caurinus/maliger/auriculatus	Copper, quillback, and brown rockfishes (CQB)	141
Sebastes pinniger	canary rockfish	103
Sebastes mystinus	blue rockfish	36

Table S6. Marine heatwave statistics for four locations from 1992-2021. Days above 90% indicate the total number of days above the 90th percentile regardless of whether those days were within a 5+ day MHW; MHW events is the number of MHWs in a year, MHW days (5+) is the number of days within a MHW; Min and Max days are the length of individual MHWs. Mean intensity and other statistics are the intensity of the anomaly in °C.

Site	Year	Days > 15°C	Days above 90%	MHW events	MHW days (5+)	Min days	Max days	Mean intensity	Var intensity	Max intensity
Tatoosh Is. & Neah B.	1992	4	44	4	33	5	11	2.03	0.5	3.34
Tatoosh Is. & Neah B.	1993	6	42	2	36	6	30	2.27	0.42	4.3
Tatoosh Is. & Neah B.	1994	14	47	1	30	30	30	2.64	0.71	4.14
Tatoosh Is. & Neah B.	1995	4	59	6	46	5	14	2.14	0.47	5.18
Tatoosh Is. & Neah B.	1996	0	18	1	9	9	9	1.78	0.16	1.98
Tatoosh Is. & Neah B.	1997	30	128	4	114	11	50	2.21	0.48	4.25
Tatoosh Is. & Neah B.	1998	14	144	5	135	7	40	1.98	0.39	3.81
Tatoosh Is. & Neah B.	1999	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2000	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2001	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2002	0	12	1	13	13	13	1.55	0.24	1.92
Tatoosh Is. & Neah B.	2003	0	31	3	23	5	10	1.67	0.27	2.51
Tatoosh Is. & Neah B.	2004	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2005	0	39	1	15	15	15	1.96	0.32	2.58
Tatoosh Is. & Neah B.	2006	0	22	1	6	6	6	1.9	0.29	2.38
Tatoosh Is. & Neah B.	2007	5	8	1	8	8	8	2.58	0.67	3.33
Tatoosh Is. & Neah B.	2008	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2009	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2010	0	29	2	15	7	8	1.51	0.09	1.75
Tatoosh Is. & Neah B.	2011	0	7	1	7	7	7	1.9	0.13	2.05
Tatoosh Is. & Neah B.	2012	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2013	5	26	3	19	5	8	2.49	0.64	4.43
Tatoosh Is. & Neah B.	2014	2	83	4	77	6	29	2.59	0.5	3.73
Tatoosh Is. & Neah B.	2015	0	98	6	77	5	22	1.73	0.26	2.41
Tatoosh Is. & Neah B.	2016	0	116	5	108	5	38	1.72	0.27	3.37
Tatoosh Is. & Neah B.	2017	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2018	0	0	0	0	-	-	-	-	-
Tatoosh Is. & Neah B.	2019	9	43	3	26	5	13	1.93	0.32	3.83
Tatoosh Is. & Neah B.	2020	0	27	1	21	21	21	1.89	0.64	2.9
Tatoosh Is. & Neah B.	2021	0	28	2	20	5	15	1.67	0.18	2.23
Cape Alava	1992	4	49	5	48	5	17	1.68	0.31	2.72
Cape Alava	1993	7	32	1	29	29	29	2.57	0.6	3.65
Cape Alava	1994	27	38	1	27	27	27	2.66	0.58	3.93
Cape Alava	1995	9	43	3	26	5	14	1.98	0.53	4.84
Cape Alava	1996	0	15	1	9	9	9	1.58	0.11	1.75
Cape Alava	1997	37	128	6	110	5	50	1.97	0.34	4.15
Cape Alava	1998	29	123	6	108	5	44	1.98	0.26	3.42
Cape Alava	1999	3	0	0	0	-	-	-	-	-
Cape Alava	2000	0	0	0	0	-	-	-	-	-
Cape Alava	2001	0	0	0	0	-	-	-	-	-
Cape Alava	2002	0	14	1	19	19	19	1.54	0.23	1.93
Cape Alava	2003	0	29	1	10	10	10	1.5	0.13	1.69

Cape Alava	2004	0	15	1	6	6	6	1.49	0.08	1.61
Cape Alava	2005	0	28	1	7	7	7	1.85	0.11	2.01
Cape Alava	2006	0	16	1	5	5	5	1.57	0.15	1.83
Cape Alava	2007	7	9	1	8	8	8	2.45	0.28	2.84
Cape Alava	2008	0	0	0	0	-	-	-	-	-
Cape Alava	2009	0	0	0	0	-	-	-	-	-
Cape Alava	2010	0	20	2	11	5	6	1.57	0.13	1.77
Cape Alava	2011	0	0	0	0	-	-	-	-	-
Cape Alava	2012	2	0	0	0	-	-	-	-	-
Cape Alava	2013	25	35	2	30	8	22	2.44	0.5	3.45
Cape Alava	2014	4	97	3	95	23	47	2.41	0.56	3.89
Cape Alava	2015	0	137	10	114	5	36	1.68	0.22	3.09
Cape Alava	2016	2	121	5	107	5	38	1.76	0.28	3.52
Cape Alava	2017	0	0	0	0	-	-	-	-	-
Cape Alava	2018	0	0	0	0	-	-	-	-	-
Cape Alava	2019	24	64	4	39	6	17	2.17	0.41	3.27
Cape Alava	2020	0	18	1	14	14	14	2.04	0.34	2.48
Cape Alava	2021	4	18	1	7	7	7	2.18	0.19	2.43
Cape Johnson	1992	4	49	3	34	5	15	1.84	0.32	2.72
Cape Johnson	1993	15	35	1	29	29	29	2.65	0.62	3.8
Cape Johnson	1994	26	32	1	26	26	26	2.84	0.54	4.04
Cape Johnson	1995	14	38	1	9	9	9	1.46	0.13	1.61
Cape Johnson	1996	0	0	0	0	-	-	-	-	-
Cape Johnson	1997	50	136	5	113	7	50	2.16	0.41	4.12
Cape Johnson	1998	23	109	6	92	5	43	1.88	0.29	3.07
Cape Johnson	1999	4	0	0	0	-	-	-	-	-
Cape Johnson	2000	0	0	0	0	-	-	-	-	-
Cape Johnson	2001	0	0	0	0	-	-	-	-	-
Cape Johnson	2002	0	0	0	0	-	-	-	-	-
Cape Johnson	2003	1	25	2	26	8	18	1.64	0.18	2.15
Cape Johnson	2004	5	0	0	0	-	-	-	-	-
Cape Johnson	2005	3	32	2	12	5	7	1.81	0.15	2.1
Cape Johnson	2006	0	17	1	8	8	8	1.59	0.16	1.8
Cape Johnson	2007	17	18	1	11	11	11	2.31	0.46	3.02
Cape Johnson	2008	0	0	0	0	-	-	-	-	-
Cape Johnson	2009	3	0	0	0	-	-	-	-	-
Cape Johnson	2010	0	16	2	10	5	5	1.59	0.1	1.76
Cape Johnson	2011	0	0	0	0	-	-	-	-	-
Cape Johnson	2012	4	0	0	0	-	-	-	-	-
Cape Johnson	2013	35	37	2	30	9	21	2.54	0.44	3.25
Cape Johnson	2014	27	102	4	102	5	47	2.28	0.48	3.79
Cape Johnson	2015	8	136	8	103	5	34	1.84	0.27	2.69
Cape Johnson	2016	6	123	4	109	5	36	1.88	0.29	3.45
Cape Johnson	2017	0	0	0	0	-	-	-	-	-
Cape Johnson	2018	2	17	2	11	5	6	1.71	0.2	2.37
Cape Johnson	2019	54	81	3	46	7	22	2.21	0.31	3.29
Cape Johnson	2020	0	18	1	15	15	15	2.27	0.37	2.78
Cape Johnson	2021	12	19	2	15	5	10	2.25	0.38	2.8
Destruction Island	1992	12	54	4	40	5	22	1.9	0.32	2.84
Destruction Island	1993	43	46	2	39	10	29	2.5	0.47	3.96

Destruction Island	1994	36	30	1	26	26	26	3.15	0.59	4.14
Destruction Island	1995	35	43	4	32	7	9	2	0.27	2.92
Destruction Island	1996	6	0	0	0	-	-	-	-	-
Destruction Island	1997	97	146	6	128	6	71	2.32	0.39	4.11
Destruction Island	1998	18	94	5	79	5	42	1.8	0.22	3.18
Destruction Island	1999	4	0	0	0	-	-	-	-	-
Destruction Island	2000	5	0	0	0	-	-	-	-	-
Destruction Island	2001	6	0	0	0	-	-	-	-	-
Destruction Island	2002	2	0	0	0	-	-	-	-	-
Destruction Island	2003	13	21	2	19	8	11	1.8	0.24	2.48
Destruction Island	2004	20	23	2	13	5	8	2.23	0.34	3.65
Destruction Island	2005	17	22	1	5	5	5	1.96	0.12	2.13
Destruction Island	2006	0	27	1	19	19	19	2.05	0.3	2.62
Destruction Island	2007	12	0	0	0	-	-	-	-	-
Destruction Island	2008	0	0	0	0	-	-	-	-	-
Destruction Island	2009	18	0	0	0	-	-	-	-	-
Destruction Island	2010	0	0	0	0	-	-	-	-	-
Destruction Island	2011	0	0	0	0	-	-	-	-	-
Destruction Island	2012	4	7	1	6	6	6	1.47	0.17	1.66
Destruction Island	2013	42	38	2	36	9	27	2.71	0.58	3.94
Destruction Island	2014	39	102	4	103	8	41	2.38	0.51	3.52
Destruction Island	2015	35	140	6	118	7	45	1.91	0.3	3.07
Destruction Island	2016	27	130	5	120	5	37	2.01	0.3	3.6
Destruction Island	2017	4	0	0	0	-	-	-	-	-
Destruction Island	2018	15	27	2	13	6	7	1.93	0.22	2.92
Destruction Island	2019	84	82	4	67	5	25	2.34	0.36	3.81
Destruction Island	2020	0	15	1	14	14	14	2.18	0.27	2.58
Destruction Island	2021	22	17	1	11	11	11	2.51	0.44	3.13

Table S7. Results of permutation-based multivariate analysis of variance PerMANOVA for kelp assemblage structure at five sites along the Washington coast at two depths (5-m, 10-m) from 2016-2021.

	DF	SS	R^2	F	p-value
Depth	1	4.61	0.10	57.93	0.001
Site	4	12.35	0.26	38.80	0.001
Year	4	0.72	0.02	2.27	0.007
Depth x Site	4	5.61	0.12	17.64	0.001
Depth X Year	4	0.71	0.01	2.02	0.017
Site X Year	16	2.12	0.04	1.67	0.002
Residual	266	21.16	0.41		

Table S8. Results of permutation-based multivariate analysis of variance PerMANOVA for invertebrate assemblage structure at five sites along the Washington coast at two depths (5-m, 10-m) from 2016-2021.

	DF	MS	R^2	F	p-value
Depth	1	0.63	0.01	6.80	0.001
Site	4	23.26	0.41	62.64	0.001
Year	4	1.91	0.03	5.14	0.001
Depth x Site	4	2.18	0.04	5.87	0.001
Depth X Year	4	0.68	0.01	1.83	0.022
Site X Year	16	4.07	0.07	2.74	0.001
Residual	260	24.13	0.42		

Table S9. Results of permutation-based multivariate analysis of variance PerMANOVA for fish assemblage structure at five sites along the Washington coast at two depths (5-m, 10-m) from 2016-2021.

	DF	MS	R2	F	p-value
Depth	1	0.92	0.03	11.68	0.001
Site	4	3.74	0.12	11.94	0.001
Year	4	1.23	0.04	3.91	0.001
Depth x Site	4	1.49	0.05	4.76	0.001
Depth X Year	4	0.74	0.02	2.38	0.018
Site X Year	15	2.02	0.06	1.72	0.01
Residual	269	21.08	0.68		

Table S10. Results of permutation-based multivariate analysis of variance PerMANOVA for rockfish Sebastes spp young of year assemblage structure at five sites along the Washington coast at two depths (5-m, 10-m) from 2016-2021.

	DF	MS	R2	F	p-value
Depth	1	0.22	0.01	2.62	0.064
Site	4	1.37	0.03	4.13	0.001
Year	4	11.33	0.29	34.18	0.001
Depth x Site	4	0.82	0.02	2.48	0.011
Depth X Year	4	0.40	0.01	1.21	0.254
Site X Year	15	2.89	0.07	2.33	0.001
Residual	269	22.30	0.57		

Table S11. Results of the REWB model for *Nereocystis* at Tatoosh Island. B = between effect, W = within effect, d = depth, a = area, t = transect, y = year. Random effects are random intercept an slopes for the relevant terms.

Random effects Group	Parameter	Variance	s.d.
Transect	$W_{d,a,t,y}$	0	0
Depth x Area	$W_{d,a,y}$	0	0
Residual		0.240	0.490
Fixed effects Parameter	**Estimate**	**s.e.**	**t-value**
Intercept	194.320	79.262	2.452
Depth – 10 m	-0.455	0.305	-1.491
Area – South	-1.356	0.865	-1.568
Year	-0.096	0.039	-2.437
B_{da}	0.136	0.150	0.907
W_{day}	-0.022	0.026	-0.850
W_{daty}	-0.004	0.024	-0.164

Table S12. Results of the REWB model for *Pterygophora* at Tatoosh Island. B = between effect, W = within effect, d = depth, a = area, t = transect, y = year. Random effects are random intercept an slopes for the relevant terms.

Random effects Group	Parameter	Variance	s.d.
Transect	$W_{d,a,t,y}$	0	0
Depth x Area	$W_{d,a,y}$	0.014	0.117
Residual		0.304	0.551
Fixed effects Term	**Estimate**	**s.e.**	**t-value**
Intercept	-68.646	101.884	-0.674
Depth – 10 m	-0.074	0.343	-0.217
Area – South	0.062	0.972	0.063
Year	0.034	0.050	0.682
B_{da}	-0.004	0.168	-0.025
W_{day}	-0.003	0.084	-0.031
W_{daty}	0.001	0.027	0.038

Table S13. Results of model selection for binomial models predicting the probability of occurrence of juvenile rockfishes. Table shows the coefficient for terms present in the model. All models include Site and Year as random, fixed effects. Data were summarized by Site x Depth x Area x Year bins prior to analysis. Total kelp is the sum of all stipitate kelps, surface canopy is the sum of *Macro* and *Nereo*, *Macro = Macrocystis, Nereo = Nereocystis, Ptery = Pterygophora.* Canopy kelps is the sum of *Macrocystis* and *Nereocystis.* Other is the sum of remaining stipiate kelps. Kelps were included as continuous variables, Year and Site and random factors and included in all models.

Intercept	Total kelp	Surface canopy	*Macro*	*Nereo*	*Ptery*	Other	df	AICc	ΔAICc
-0.274		2.553					4	71.00	0.00
-1.154	1.409						4	72.39	1.39
-0.586		2.494			0.446		5	72.74	1.74
-0.380		2.552				0.360	5	73.14	2.14
-0.272			2.517	2.570			5	73.27	2.27
-0.978		2.487			0.652	0.797	6	74.58	3.58
-0.655			1.839	2.785	0.582		6	74.88	3.88
-0.379			2.535	2.560		0.359	6	75.48	4.47
-0.488				2.807	1.017		5	76.02	5.02
-1.235				2.965	1.335	1.413	6	76.60	5.59
-1.123			1.646	2.877	0.851	0.911	7	76.66	5.66
0.461				2.494			4	76.94	5.94
0.254				2.496		0.649	5	78.74	7.73
0.568			1.983			1.022	5	84.13	13.13
0.874			1.838				4	84.49	13.48
0.005			1.538		0.735	1.313	6	84.58	13.57
0.047					1.061	1.565	5	84.66	13.65
0.523			1.551		0.577		5	84.93	13.93
0.737					0.840		4	85.92	14.91
1.037						1.125	4	86.78	15.78
1.393							3	88.01	17.01

Table S14. Model coefficients for a) the best-fit binomial model: summed canopy kelp, b) the binomial model including *Macrocystis* and *Nereocystis* as predictors, and c) the best-fit positive abundance model.

(a) Canopy kelp - occurrence

Random effect	Variance	SD		
Year	5.33	2.31		
Site	3.25	1.80		
Fixed effect	**Estimate**	**SE**	**z-value**	**P**
Intercept	-0.274	1.447	-0.189	0.850
Canopy kelp summed	2.553	1.009	2.531	0.011

(b) *Macrocystis* and *Nereocystis* - occurrence

Random effect	Variance	SD		
Year	5.31	2.30		
Site	3.28	1.81		
Fixed effect	**Estimate**	**SE**	**z-value**	**P**
Intercept	-0.272	1.449	-0.188	0.851
Macrocystis	2.517	1.608	1.565	0.117
Nereocystis	2.570	1.174	2.189	0.027

(c) *Macrocystis* and *Nereocystis* - occurrence

Random effect	Variance	SD
Year	1.965	1.402
Residual	1.770	1.330

Table S15. Results of model selection for positive abundance models predicting the density of juvenile rockfishes. Table shows the coefficient for terms present in the model. All models include Site and Year as random, fixed effects. Data were summarized by Site x Depth x Area x Year bins prior to analysis. Total kelp is the sum of all stipitate kelps, surface canopy is the sum of *Macro* and *Nereo*, *Macro = Macrocystis, Nereo = Nereocystis, Ptery = Pterygophora.* Canopy kelps is the sum of *Macrocystis* and *Nereocystis.* Other is the sum of remaining stipiate kelps. Kelps were included as continuous variables, Year and Site and random factors and included in all models.

Intercept	Total kelp	Surface canopy	*Macro*	*Nereo*	*Ptery*	Other	df	AICc	ΔAICc
1.378							4	238.19	0.00
1.499			-0.206				5	240.42	2.23
1.335						0.071	5	241.67	3.49
1.440					-0.046		5	242.63	4.44
1.290				0.075			5	242.73	4.54
1.444		-0.038					5	243.30	5.11
1.442			-0.212			0.101	6	243.87	5.68
1.446	-0.018						5	244.38	6.20
1.547			-0.205		-0.035		6	244.99	6.81
1.447			-0.195	0.041			6	245.36	7.17
1.400					-0.069	0.111	6	245.95	7.77
1.288				0.070		0.015	6	246.24	8.05
1.399		-0.060				0.131	6	246.49	8.30
1.388				0.103	-0.097		6	246.76	8.58
1.472		-0.031			-0.028		6	247.71	9.53
1.503			-0.211		-0.062	0.134	7	248.29	10.10
1.423			-0.204	0.025		0.079	7	248.80	10.61
1.508			-0.187	0.064	-0.068		7	249.67	11.48
1.374				0.096	-0.104	0.053	7	250.25	12.06
1.437		-0.050			-0.050	0.148	7	250.88	12.69
1.486			-0.197	0.047	-0.080	0.100	8	253.09	14.90

Supplement Figures

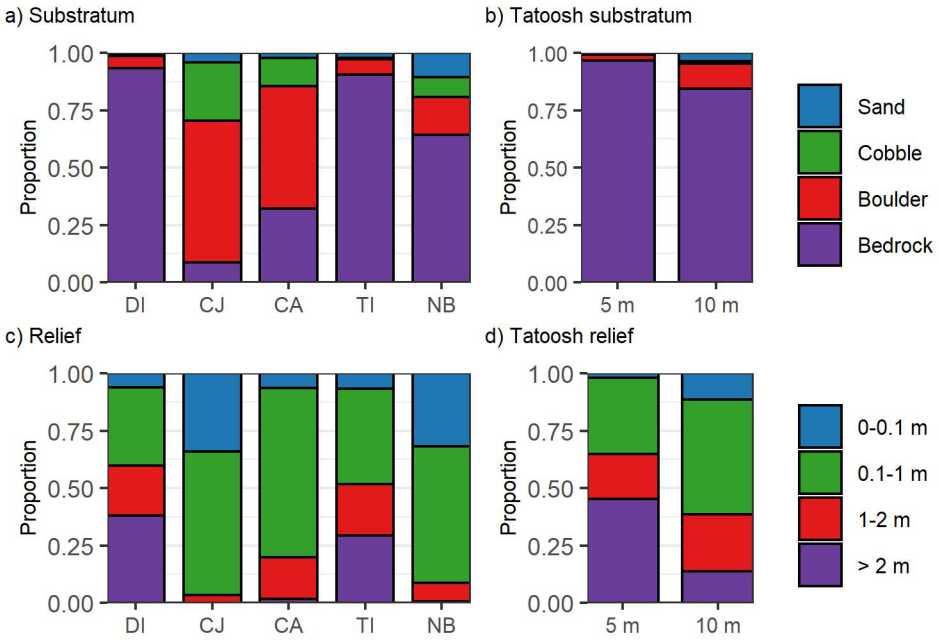


Figure S1. Substrate and relief at the five sites: DI = Destruction Island, CJ = Cape Johnson, CA = Cape Alava, TI = Tatoosh Island, NB = Neah Bay and at two depths (5 and 10 m) for Tatoosh Island. Relief categories measure the change in elevation across the width of the 2-m transect.

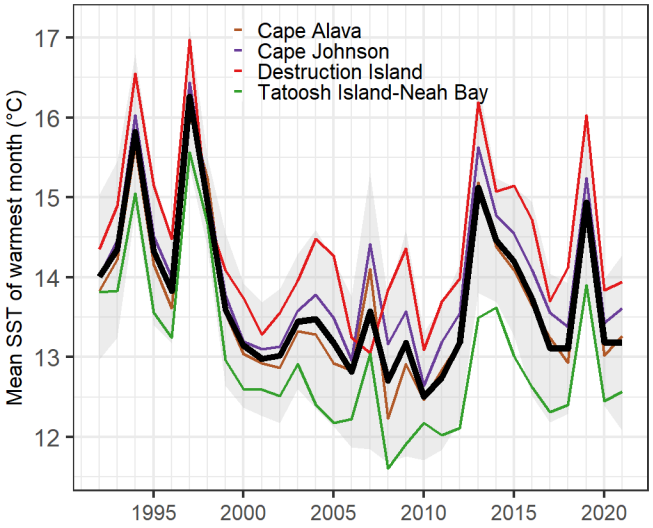


Figure S2. Mean maximum monthly SST at the five sites (5-day smooth) from 1992-2021. Note Tatoosh Island and Neah Bay are in the same interpolated grid cell and are combined. Black line is the mean across sites and the grey envelope is its 1.0 s.e.

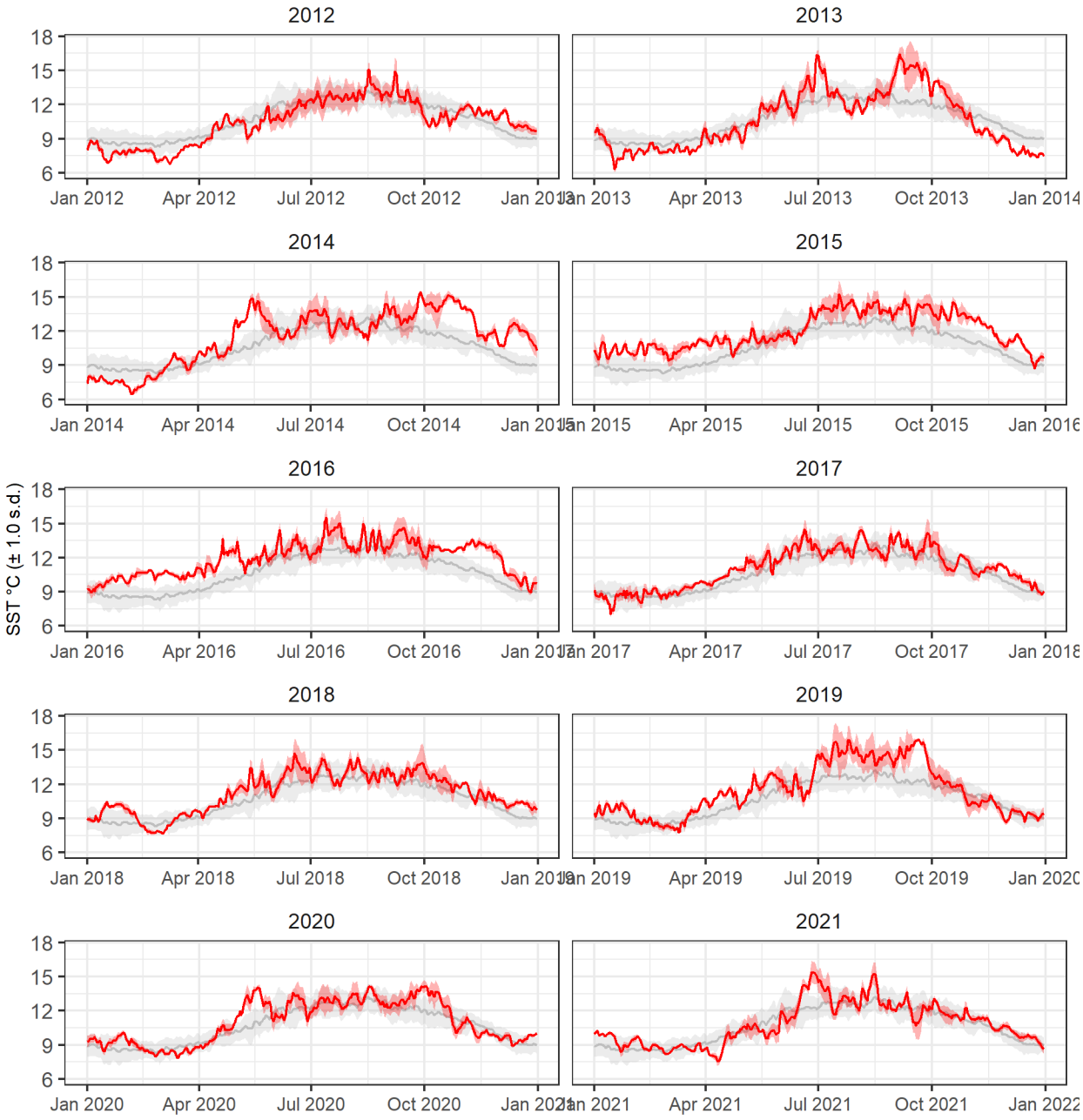


Figure S3. Yearly progression of SST for 2012-2021 compared to the average of 1992-2012. Red line is the average across the four sites for each year. Envelopes represent 1.0 s.d.

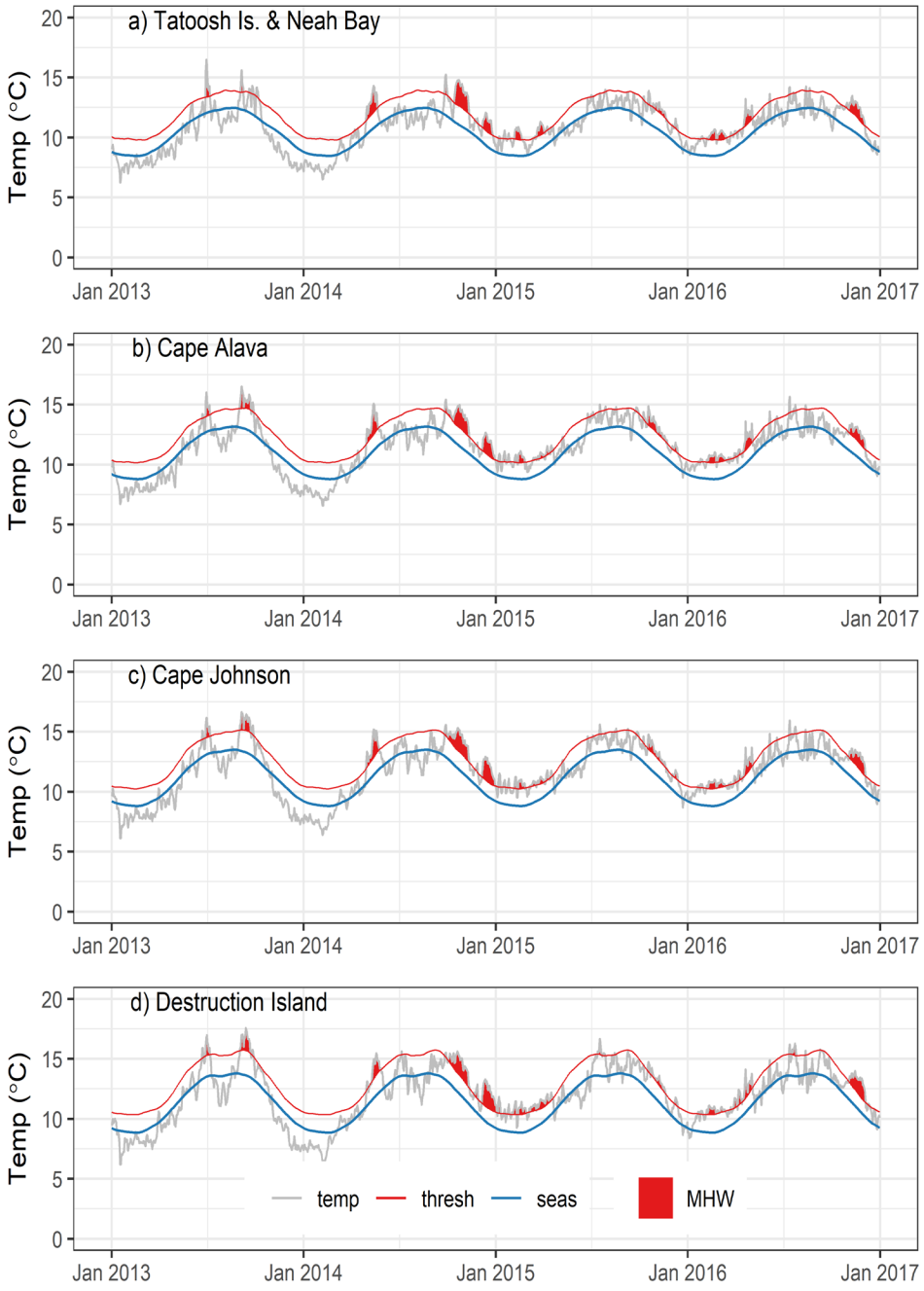
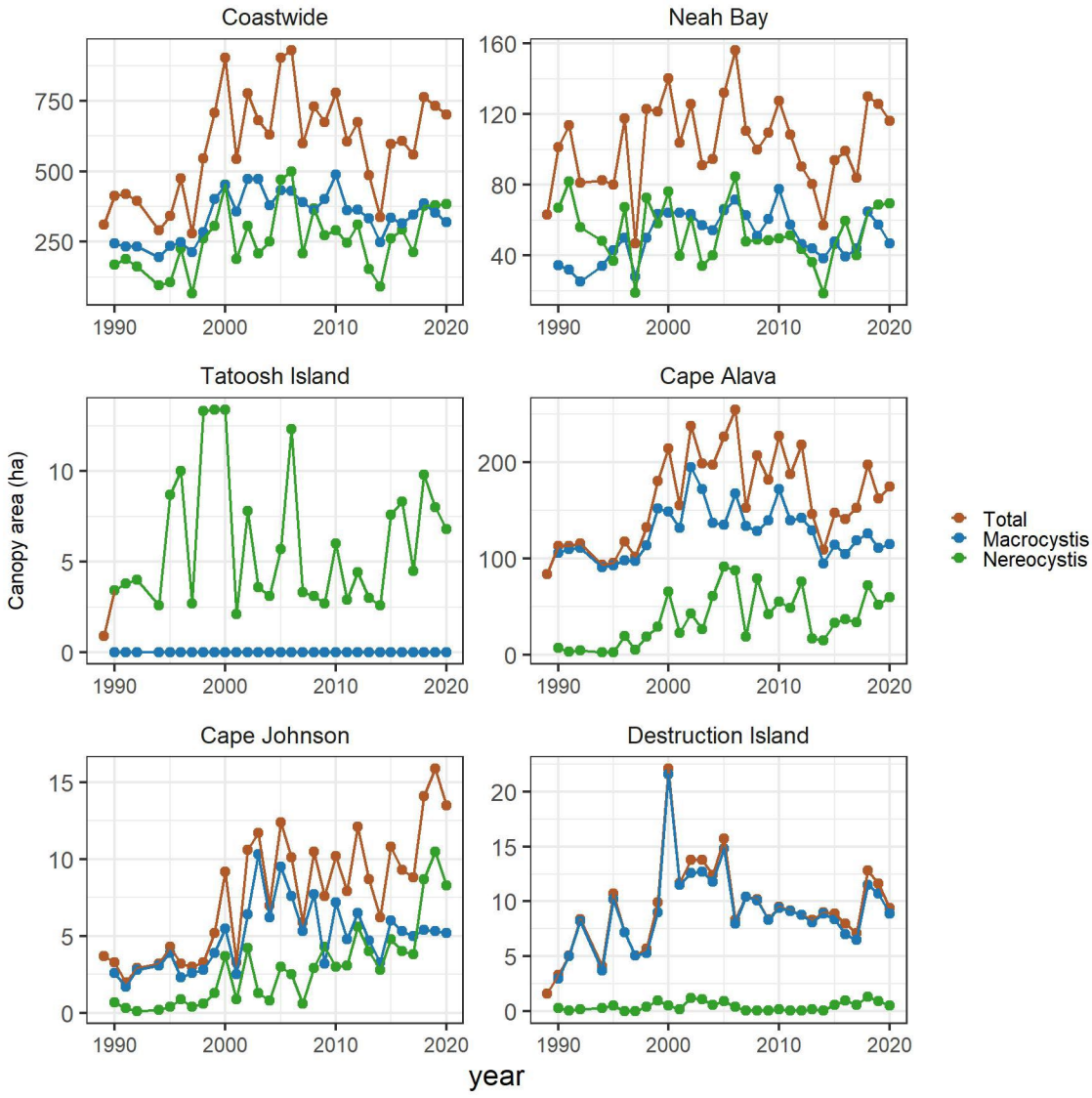


Figure S4. Occurrence of marine heatwaves for four locations along the Washington coast from 2013 through 2016. Grey line (temp) indicates observed, daily mean temperature; blue line indicates the 30-year (1992-20221) climatological mean by day of year; red line indicates the 90% threshold; filled areas represent marine heatwaves with 5+ consecutive days above the threshold (Hobday et al. 2016).



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173 Figure S5. Canopy area of *Nereocystis* and *Macrocystis* from 1989 to 2020 coastwide and at five sites
174 along the Washington coast. Canopy area is the spatial extent of kelp blades, stipes and bulbs floating on
175 the water surface (Van Wagenen 2015). Note, there was no *Macrocystis* at Tatoosh Island, so the Total
176 and *Nereocystis* values overlap.

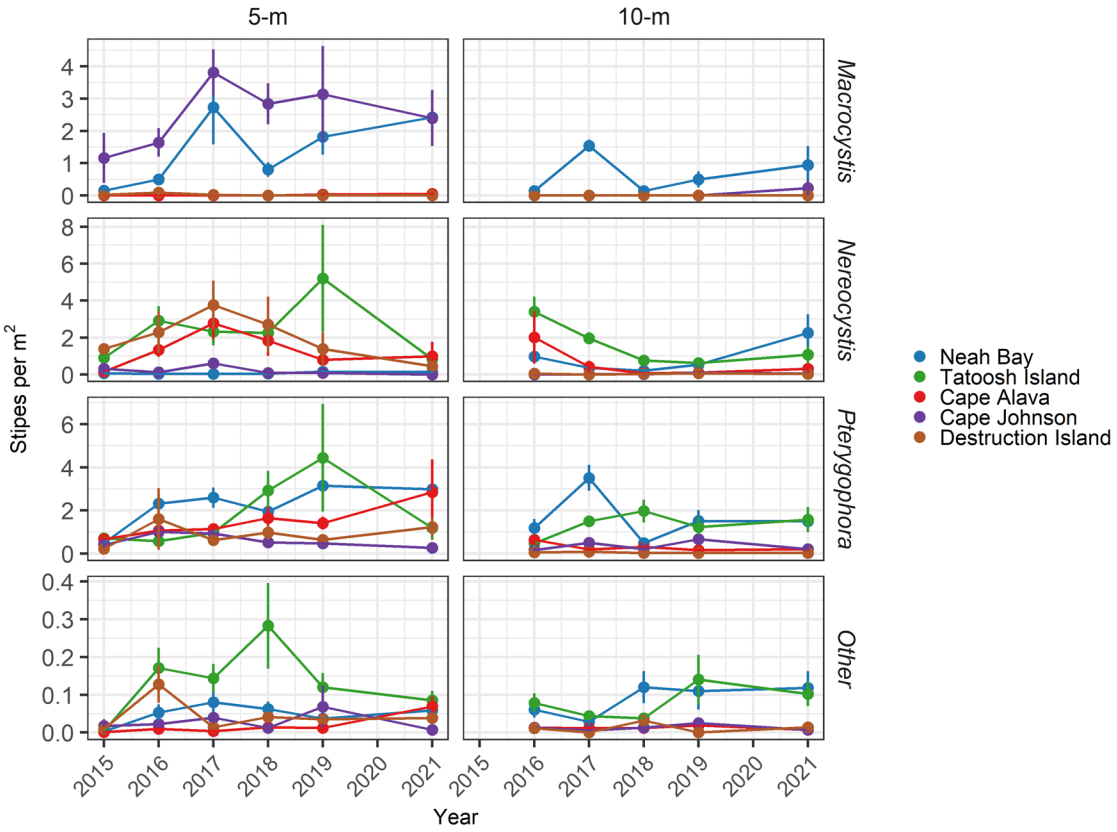


Figure S6. Stipe density for the three primary kelps and the sum of other stipitate kelps at five sites and two depths from 2015-2021.

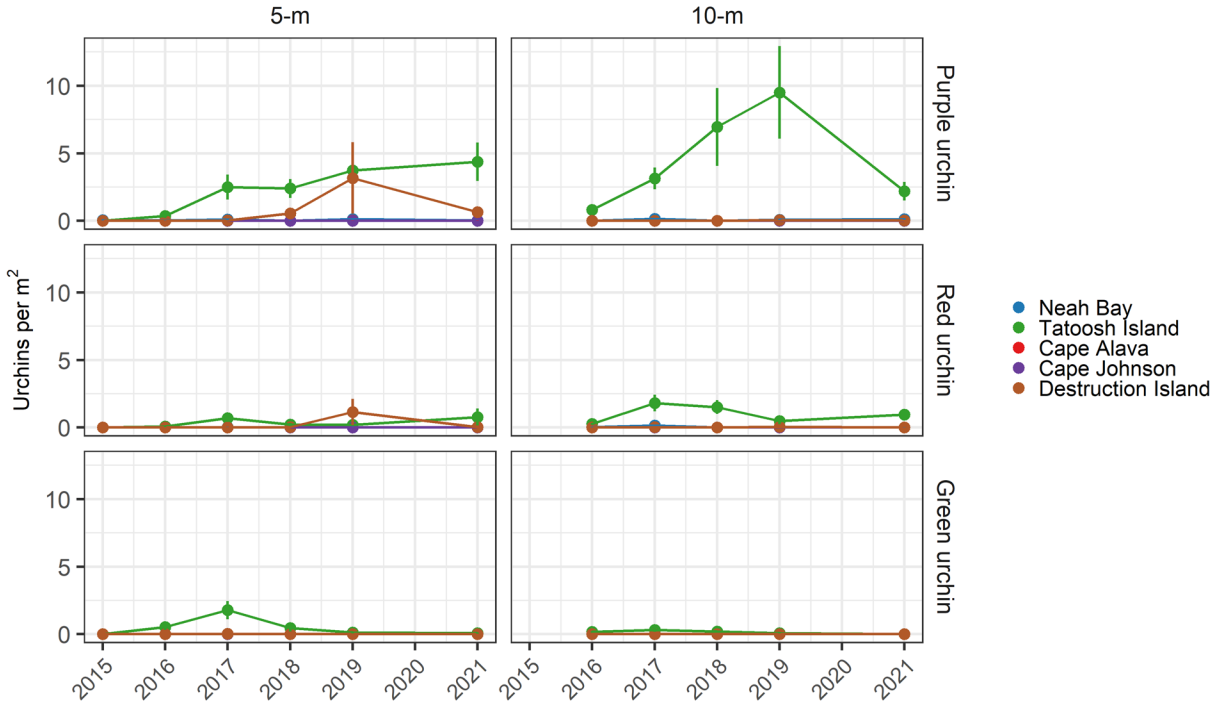
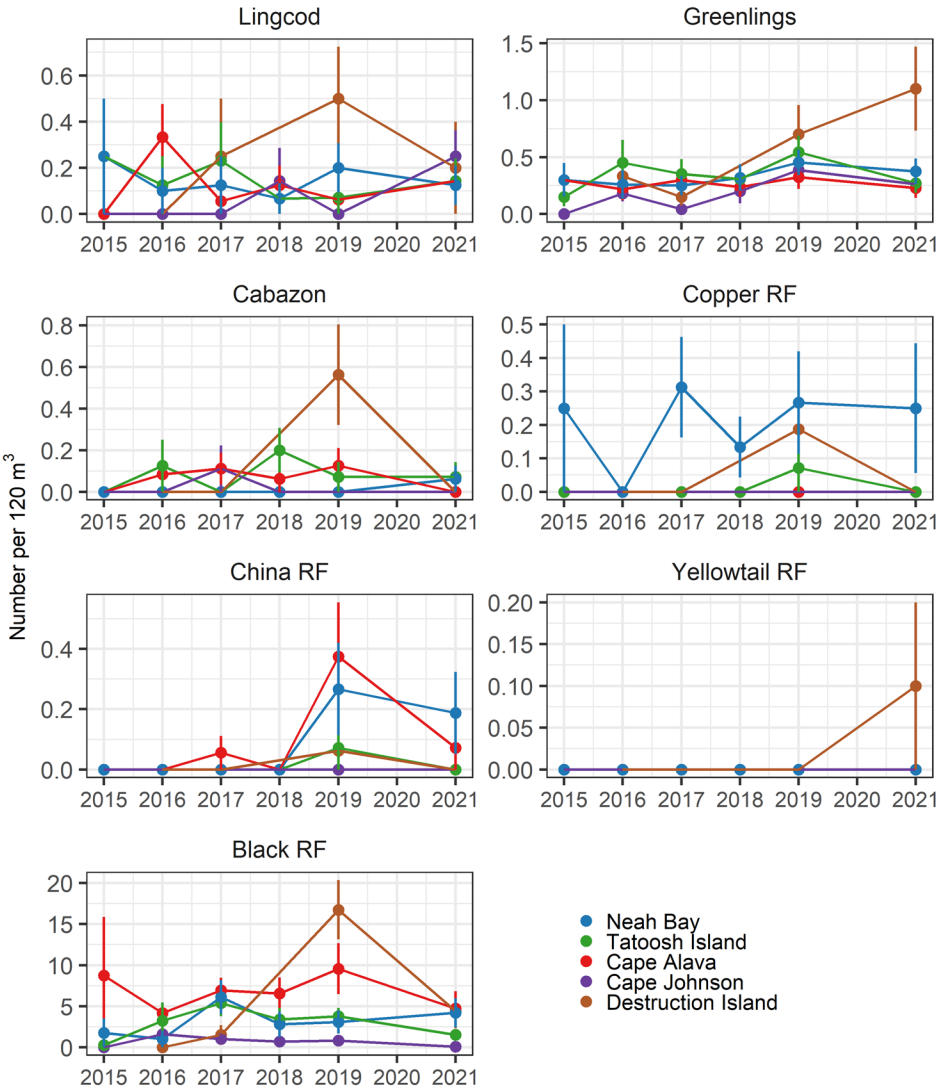


Figure S7. Abundance of urchins at five sites and two depths from 2015-2021.



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192 Figure S8. Abundance of seven fish species at five sites from 2015-2021.

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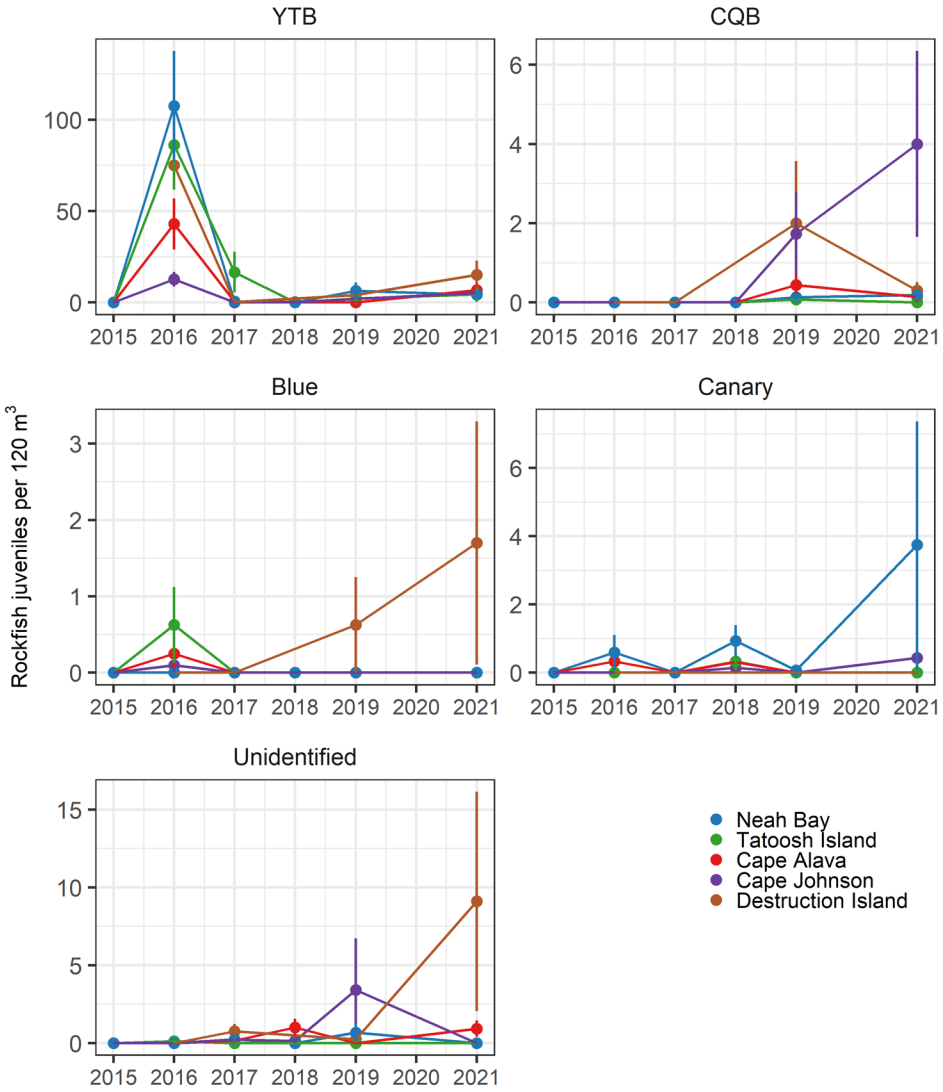

195

196 Figure S9. Abundance of rockfish young-of-year at five sites from 2015-2021. Note the scales on the y-
197 axes differ. YTB = yellowtail and black rockfishes. CQB = copper, quillback, and brown rockfishes.

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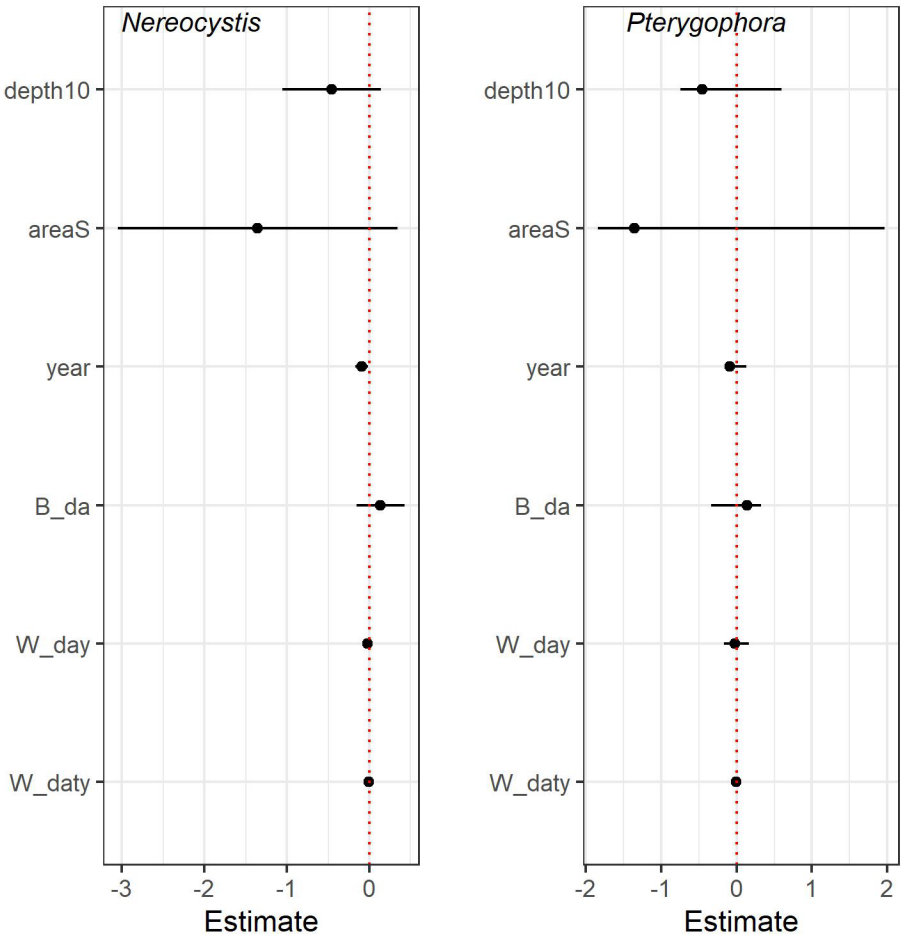

199

200 Figure S10. Results of REWB models for *Nereocystis* and *Pterygophora* at Tatoosh Island. Data are the
201 parameter estimates for the fixed effects for each model. Error bars are 95% confidence limits. The
202 intercepts are not shown. Dotted red line indicates zero.

203

204

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