The following supplement accompanies the article

Shining a light on the composition and distribution patterns of mesophotic and subphotic fish communities in Hawai'i

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Supplement 1. Functional groups represented in the main Hawaiian Islands (MHI) Atlantis ecosystem model and species composition of the 13 functional groups considered in this study.

Atlantis ecosystem models (https://research.csiro.au/atlantis/) are whole-of-ecosystem, spatially-explicit models that integrate oceanographic (temperature, salinity, fluxes, oxygen, pH) and ecological (population dynamics, predator-prey relationships) processes with human uses (e.g., fisheries). All marine organisms from bacteria and primary producers to whales, as well as fisheries-target species and bycatch, can be explicitly represented in Atlantis, and key processes for these different organisms can be simulated. Recently, the National Oceanographic and Atmospheric Administration (NOAA) Pacific Islands Fisheries Science Center (PIFSC) has started developing an Atlantis ecosystem model for the insular (0-400 m depth range) ecosystems surrounding the main Hawaiian Islands (MHI; Fig. S1), which is referred to as "MHI Atlantis". The main objective of MHI Atlantis is understanding how changes in fisheries management and climate may affect ecosystem structure and functioning in the MHI region and the social, cultural, and economic ecosystem services upon which the human community relies. Trophic interactions in Atlantis strongly depend on the way species groups' biomasses are allocated spatially, because species groups' biomass distributions condition patterns of spatial overlap among predators, prey, and competitors. At present there is little knowledge on these important aspects, hence, results of this study will help with the parameterization of the MHI Atlantis model.

Fish species were assigned to functional groups based on their diet, forage behavior, preferred habitat (including depth range and common depth from the cluster analysis in this study), life history characteristics, and interest to fisheries (Table S1.1). The functional group UKU is left out of Table S1.1 as it consists of only one species (often associated with the Deep-7 bottomfishes but also frequently observed in shallow reefs). Table S1.2 has the complete list of species that comprise functional groups.

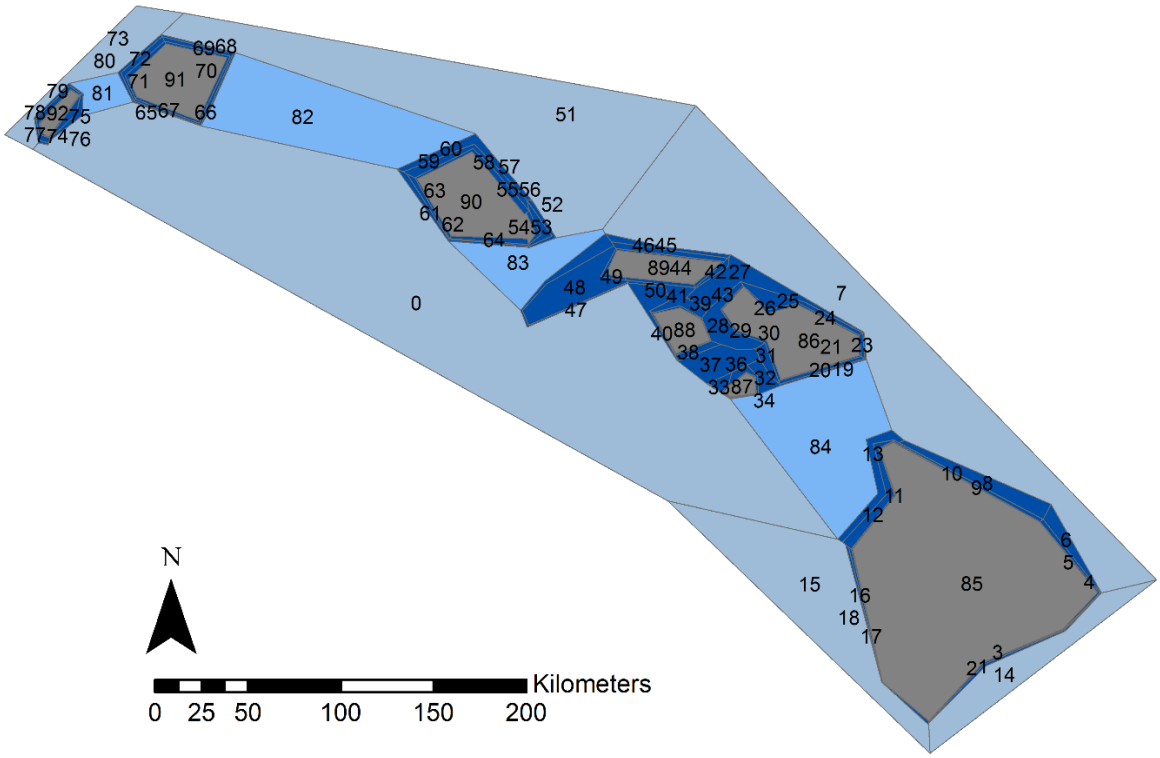


Figure S1. Spatial domain of the main Hawaiian Islands Atlantis model where the numbers represent the spatial areas, i.e. each island has three adjacent spatial areas that encompass the 30 m, 150 m and 400 m depth range. For example, area 1 is along the south coast of island 85 (Hawaii Island) and extends from 150 – 400 m; adjacent to that area is area 2 which extends from 30-150 m and hugging the coast is spatial area #1 which extends from 0-30 m.

Table S1.1. Criteria to group meso- and subphotic species into functional groups. Criteria are ranked in order of importance from left (diet) to right (trophic level), i.e., if no diet data was available, we used feeding mode; if feeding mode was not available, we used information on position in the water column in combination with trophic level data. An additional criteria to group the species in a separate group was interest to fisheries. NA = not applicable.

Functional Group	**Diet**	**Feeding mode**	**Position in water column**	**Trophic Level**	**Fisheries Interest**
Meso/Subphotic Benthic Carnivores (MBC/SBC)	Dominated by benthic invertebrates but also includes (small) fishes	Epibenthic predator, epifaunal cropper, benthic searcher, benthic hoverer (species maximum length <25 cm), small species hunter, benthivorous infaunal predator	Benthopelagic, bathybenthic or benthic (species maximum length <25 cm)	3.6-3.9	No
Meso/Subphotic Planktivore (MPL/SPL)	Dominated by zooplankton	Micro- and macroplanktivores, hoover and wait, midwater hoverer	Pelagic or benthopelagic (species max length <60 cm)	3.2-3.6	No

Functional Group	Diet	Feeding mode	Position in water column	Trophic Level	Fisheries Interest
Mesopelagic Scatter Layer (MSL)	Dominated by zooplankton	Micro- and macroplanktivores, vertically migrate at night time from depth >400 m	Pelagic (species max length <15 cm)	3.2	No
Forage fish (SHP)	Dominated by zooplankton	Micro- and macroplanktivores, schooling	Pelagic (species maximum length <40 cm), often aggregate in bays	3.2-3.6	Yes
Meso- and subphotic benthic piscivores (MBP)	Dominated by fish	Ambush predator, hunter, benthic hoverer (species maximum length >25 cm), schooling hunter	Benthopelagic (species maximum length >25 cm)	>4.0	No
Piscivores (PIS)	Dominated by pelagic fish	Roving piscivores	Pelagic (species maximum length >60 cm)	>4.0	Yes
Bottomfish-bottom (BFB)	Dominated by benthic fish and macroinvertebrates	Benthic piscivores	Benthopelagic (species maximum length >40 cm)	>4.0	Yes
Bottomfish-water column (BFW)	Dominated by pelagic fishes	Pelagic piscivores, macroplanktivores	Pelagic (species maximum length >60 cm)	> 4.0	Yes
Sharks (SHR) and carnivorous rays (IRY)	NA (based on species being a shark or carnivorous ray)	NA	NA	NA	No
Planktivorous rays (RAY)	NA (based on species being a planktivor-ous ray)	NA	NA	NA	No

Table S1.2. Species composition of the 13 functional groups considered in this study. The short names of functional groups are provided here, and their full names are given in Table S1.1.

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Etelis carbunculus	Lutjanidae	BFB	940	100	400
Hyporthodus quernus	Serranidae	BFB	179	89	272
Pristipomoides zonatus	Lutjanidae	BFB	196	165	290
Aphareus rutilans	Lutjanidae	BFW	117	61	310
Etelis coruscans	Lutjanidae	BFW	523	162	393.5
Etelis spp.	Lutjanidae	BFW	1	305	305
Pristipomoides filamentosus	Lutjanidae	BFW	509	52	343
Pristipomoides sieboldii	Lutjanidae	BFW	350	86	302
Pristipomoides spp.	Lutjanidae	BFW	21	88.1	223.2
Acanthuridae	Acanthuridae	MBC	108	30.8	152
Acanthurus spp.	Acanthuridae	MBC	57	40	117
Aluterus monoceros	Monacanthidae	MBC	5	92	129.8
Aluterus scriptus	Monacanthidae	MBC	14	55	176
Anampses chrysocephalus	Labridae	MBC	18	43	139
Apogon spp.	Apogonidae	MBC	8	61	143
Apolemichthys arcuatus	Pomacanthidae	MBC	211	43	208
Arothron hispidus	Tetraodontidae	MBC	27	30.8	122
Arothron meleagris	Tetraodontidae	MBC	6	61	144
Arothron spp.	Tetraodontidae	MBC	3	75	100
Astronesthes lucifer	Stomiidae	MBC	14	119	185
Balistes polylepis	Balistidae	MBC	5	38.7	49
Balistidae	Balistidae	MBC	39	37	228.8
Bodianus albotaeniatus	Labridae	MBC	192	30.5	193.8
Bothidae	Bothidae	MBC	100	43.6	400
Bothus pantherinus	Bothidae	MBC	9	66	220
Bothus thompsoni	Bothidae	MBC	14	70	113
Cantherhines verecundus	Monacanthidae	MBC	1	42.4	42.4
Canthigaster epilampra	Tetraodontidae	MBC	20	30.8	124
Canthigaster rivulata	Tetraodontidae	MBC	31	67	275
Canthigaster sp.	Tetraodontidae	MBC	1	111	111
Canthigaster spp.	Tetraodontidae	MBC	5	56	107
Centropyge fisheri	Pomacanthidae	MBC	10	39	67
Centropyge potteri	Pomacanthidae	MBC	50	43	136
Chaetodon auriga	Chaetodontidae	MBC	22	30.8	78
Chaetodon fremblii	Chaetodontidae	MBC	20	43	138
Chaetodon kleinii	Chaetodontidae	MBC	51	30.8	92
Chaetodon lineolatus	Chaetodontidae	MBC	2	57	73
Chaetodon lunula	Chaetodontidae	MBC	21	36.5	86
Chaetodon lunulatus	Chaetodontidae	MBC	2	44	44
Chaetodon multicinctus	Chaetodontidae	MBC	16	33	89
Chaetodon ornatissimus	Chaetodontidae	MBC	6	43	50
Chaetodon reticulatus	Chaetodontidae	MBC	1	50	50

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Cheilio inermis	Labridae	MBC	5	30.8	71
Chilomycterus affinis	Diodontidae	MBC	1	123	123
Chilomycterus reticulatus	Diodontidae	MBC	10	30.8	141
Coris ballieui	Labridae	MBC	38	30.2	152.3
Coris flavovittata	Labridae	MBC	13	30.5	130.6
Coris gaimard	Labridae	MBC	9	30.2	61
Coris venusta	Labridae	MBC	1	34.1	34.1
Cymolutes lecluse	Labridae	MBC	7	30.8	119
Diodon holocanthus	Diodontidae	MBC	1	72	72
Diodon hystrix	Diodontidae	MBC	4	31.7	62.5
Diodontidae	Diodontidae	MBC	6	31	114
Echeneis naucrates	Echeneidae	MBC	1	114	114
Evistias acutirostris	Pentacerotidae	MBC	14	40	188
Forcipiger flavissimus	Chaetodontidae	MBC	79	34	139
Forcipiger spp.	Chaetodontidae	MBC	74	33	145
Gnathophis nystromi	Congridae	MBC	2	218	303
Gomphosus varius	Labridae	MBC	1	48.2	48.2
Gunnellichthys curiosus	Microdesmidae	MBC	4	30.5	51.2
Histiopterus acutirostris	Pentacerotidae	MBC	2	110	181
Holocentrus xantherythrus	Holocentridae	MBC	3	66	101
Iniistius baldwini	Labridae	MBC	6	42.4	71.9
Iniistius pavo	Labridae	MBC	4	39	138
Iniistius spp.	Labridae	MBC	1	66.5	66.5
Iniistius umbrilatus	Labridae	MBC	3	58.8	81.7
Labridae	Labridae	MBC	113	30.2	150
Labroides phthirophagus	Labridae	MBC	18	45.7	132.2
Lactoria fornasini	Ostraciidae	MBC	21	35.7	124
Lutjanidae	Lutjanidae	MBC	25	70.5	150
Lutjanus fulvus	Lutjanidae	MBC	17	46	128
Lutjanus kasmira	Lutjanidae	MBC	315	33	200
Lutjanus spp.	Lutjanidae	MBC	1	71	71
Malacanthus brevirostris	Malacanthidae	MBC	24	30.2	110
Malthopsis spp.	Ogcocephalidae	MBC	4	141	268.5
Microcanthus strigatus	Kyphosidae	MBC	8	75	139
Monacanthidae	Monacanthidae	MBC	2	82	101.5
Monotaxis grandoculis	Lethrinidae	MBC	12	49	99
Mullidae	Mullidae	MBC	3	45.7	156.8
Mulloidichthys pfluegeri	Mullidae	MBC	33	30.5	196.7
Myripristis chryseres	Holocentridae	MBC	126	70	194
Neoniphon aurolineatus	Holocentridae	MBC	50	49	273.5
Neoniphon sammara	Holocentridae	MBC	1	137	137
Oplegnathus punctatus	Oplegnathidae	MBC	9	62	146
Ostorhinchus maculiferus	Apogonidae	MBC	61	75	153
Ostraciidae	Ostraciidae	MBC	1	78	78
Oxycheilinus bimaculatus	Labridae	MBC	40	30.2	77.7

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Oxycheilinus unifasciatus	Labridae	MBC	17	30.5	121.7
Oxycirrhites typus	Cirrhitidae	MBC	23	70	172
Parupeneus chrysonemus	Mullidae	MBC	65	31.7	128
Parupeneus cyclostomus	Mullidae	MBC	26	34.1	113
Parupeneus multifasciatus	Mullidae	MBC	245	30.5	155.9
Parupeneus pleurostigma	Mullidae	MBC	67	30.2	139
Parupeneus porphyreus	Mullidae	MBC	20	37	120
Parupeneus spp.	Mullidae	MBC	4	53	92
Parupeneus forsskali	Mullidae	MBC	8	75	104
Pegasus papilio	Pegasidae	MBC	8	66	219
Pervagor aspricaudus	Monacanthidae	MBC	1	35.7	35.7
Plagiotremus ewaensis	Blenniidae	MBC	3	30.5	48.2
Plagiotremus goslinei	Blenniidae	MBC	3	32.9	48.2
Pleuronectiformes	Pleuronectidae	MBC	4	93	93
Polydactylus sexfilis	Polynemidae	MBC	1	99	99
Pristiapogon kallopterus	Apogonidae	MBC	9	61	150
Pseudocheilinus evanidus	Labridae	MBC	38	34.1	98
Pseudojuloides cerasinus	Labridae	MBC	64	30.2	119
Pterois sphex	Scorpaenidae	MBC	7	83	124
Samariscus corallinus	Samaridae	MBC	6	119	128
Sargocentron ensifer	Holocentridae	MBC	1	98	98
Sargocentron microstoma	Holocentridae	MBC	1	166	166
Sargocentron spp.	Holocentridae	MBC	6	60	178.5
Sargocentron xantherythrum	Holocentridae	MBC	15	61	217
Sphoeroides cutaneus	Tetraodontidae	MBC	88	70	292
Stethojulis balteata	Labridae	MBC	5	30.8	90
Sufflamen bursa	Balistidae	MBC	37	30.2	114.5
Sufflamen fraenatum	Balistidae	MBC	249	30.2	162
Sufflamen spp.	Balistidae	MBC	4	61	136.5
Synagrops spp.	Acropomatidae	MBC	36	100	371
Taenianotus triacanthus	Scorpaenidae	MBC	1	109	109
Thalassoma ballieui	Labridae	MBC	2	59	61
Thalassoma duperrey	Labridae	MBC	17	30.8	110
Thalassoma spp.	Labridae	MBC	1	77	77
Torquigener florealis	Tetraodontidae	MBC	67	45	242.5
Torquigener randalli	Tetraodontidae	MBC	16	53.9	179.7
Trimma spp.	Gobiidae	MBC	6	92	97
Xyrichtys spp.	Labridae	MBC	2	61	109.5
Zanclus cornutus	Zanclidae	MBC	236	31	139
Anguilliformes	Anguilliformes	MBP	126	72	400
Antennariidae	Antennariidae	MBP	1	128	128
Antennarius striatus	Antennariidae	MBP	4	90	191
Antimora microlepis	Moridae	MBP	2	396	399.5
Apterichtus flavicaudus	Ophichthidae	MBP	3	90	229

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Araiophos gracilis	Sternoptychidae	MBP	5	310	340
Argyripnus ephippiatus	Sternoptychidae	MBP	5	326	388
Ariomma brevimanum	Ariommatidae	MBP	3	154	251
Ariosoma marginatum	Congridae	MBP	104	43	385
Aulostomidae	Aulostomidae	MBP	1	146	146
Aulostomus chinensis	Aulostomidae	MBP	36	49	150
Bathyuroconger vicinus	Congridae	MBP	14	260	350
Benthodesmus tenuis	Trichiuridae	MBP	1	335	335
Chlorophthalmus proridens	Chlorophthalmidae	MBP	167	182	400
Chlorophthalmus spp.	Chlorophthalmidae	MBP	9	305	395
Chrionema spp.	Percophidae	MBP	72	194	400
Conger oligoporus	Congridae	MBP	96	81	400
Congridae	Congridae	MBP	38	108	379
Congrina aequoreus	Congridae	MBP	8	238	388
Dendrochirus barberi	Scorpaenidae	MBP	9	66	124
Epinnula magistralis	Gempylidae	MBP	3	175	300
Gonorhynchus spp.	Gonorynchidae	MBP	13	181	191
Gymnothorax berndti	Muraenidae	MBP	121	89	272
Gymnothorax elegans	Muraenidae	MBP	1	200	200
Gymnothorax flavimarginatus	Muraenidae	MBP	8	30.5	59
Gymnothorax javanicus	Muraenidae	MBP	1	45.4	45.4
Gymnothorax meleagris	Muraenidae	MBP	1	57	57
Gymnothorax nudivomer	Muraenidae	MBP	21	87	183
Gymnothorax nuttingi	Muraenidae	MBP	79	104	315
Gymnothorax spp.	Muraenidae	MBP	102	43	358
Gymnothorax steindachneri	Muraenidae	MBP	7	61	196
Gymnothorax undulatus	Muraenidae	MBP	7	30.2	51.8
Gymnothorax ypsilon	Muraenidae	MBP	5	194	253
Hoplichthys citrinus	Hoplichthyidae	MBP	94	100	396
Hoplostethus crassispinus	Trachichthyidae	MBP	10	299	393.5
Iracundus signifer	Scorpaenidae	MBP	4	66	110
Kaupichthys spp.	Muraenidae	MBP	1	346	346
Lophiidae	Lophiidae	MBP	1	360	360
Muraenidae	Muraenidae	MBP	3	44.2	213
Myrichthys magnificus	Holocentridae	MBP	1	68.3	68.3
Neomerinthe rufescens	Scorpaenidae	MBP	17	104	128
Paracirrhites forsteri	Cirrhitidae	MBP	1	30.8	30.8
Physiculus grinnelli	Moridae	MBP	8	145	356
Polymixia berndti	Polymixiidae	MBP	117	99	400
Pontinus macrocephalus	Scorpaenidae	MBP	315	31	400
Rhinopias xenops	Scorpaenidae	MBP	4	89	336
Scorpaena colorata	Scorpaenidae	MBP	30	99	264
Scorpaenas altirostris	Scorpaenidae	MBP	13	183	238
Scorpaenidae	Scorpaenidae	MBP	355	73	400

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Scorpaenopsis altirostris	Scorpaenidae	MBP	5	143	312
Synaphobranchidae	Synaphobranchidae	MBP	3	400	400
Synodontidae	Synodontidae	MBP	14	58.5	367
Synodus falcatus	Synodontidae	MBP	11	42.5	225
Synodus kaianus	Synodontidae	MBP	95	100	396
Synodus spp.	Synodontidae	MBP	8	115	333
Tetronarce tokionis	Torpedinidae	MBP	3	305	367
Trachichthyidae	Trachichthyidae	MBP	2	392.5	395
Trachinocephalus myops	Synodontidae	MBP	90	58.8	234
Zeidae	Zeidae	MBP	1	399	399
Chaetodon spp.	Chaetodontidae	MBC	3	76.5	112.5
Ammodytoides pylei	Ammodytidae	MPL	1	220	220
Aulotrachichthys heptalepis	Trachichthyidae	MPL	22	100	261.5
Chaetodon miliaris	Chaetodontidae	MPL	352	33	176
Chaetodontidae	Chaetodontidae	MPL	4	81.7	177.2
Chromis leucura	Pomacentridae	MPL	161	30.5	146
Chromis ovalis	Pomacentridae	MPL	29	46	166
Chromis spp.	Pomacentridae	MPL	51	33	183
Chromis verater	Pomacentridae	MPL	379	37	199
Cirrhilabrus jordani	Labridae	MPL	11	30.5	72.5
Dascyllus albisella	Pomacentridae	MPL	84	34	111
Etrumeus teres	Clupeidae	MPL	1	220	220
Gorgasia hawaiiensis	Congridae	MPL	3	55.5	67
Hemitaurichthys polylepis	Chaetodontidae	MPL	13	31	70
Heniochus acuminatus	Chaetodontidae	MPL	17	90	124
Heniochus diphreutes	Chaetodontidae	MPL	237	34	228
Hippocampus kuda	Syngnathidae	MPL	1	110	110
Lachneratus phasmaticus	Apogonidae	MPL	7	146	172
Lactoria diaphana	Ostraciidae	MPL	25	68	126
Luzonichthys earlei	Serranidae	MPL	57	72.5	200
Melichthys niger	Balistidae	MPL	36	46.5	62.5
Myripristis berndti	Holocentridae	MPL	27	37	177
Myripristis kuntee	Holocentridae	MPL	4	70	80
Myripristis spp.	Holocentridae	MPL	4	49	76.5
Naso annulatus	Acanthuridae	MPL	2	66	73.2
Naso hexacanthus	Acanthuridae	MPL	131	34.1	229
Naso lopezi	Acanthuridae	MPL	1	101	101
Naso maculatus	Acanthuridae	MPL	48	65	170.3
Naso spp.	Acanthuridae	MPL	80	46	190.44
Pentaceraster cumingi	Cyprinidae	MPL	1	88.5	88.5
Priacanthus spp.	Priacanthidae	MPL	11	114	226
Pseudanthias bicolor	Serranidae	MPL	14	63	99
Pseudanthias hawaiiensis	Serranidae	MPL	107	46	199
Pseudocaranx dentex	Carangidae	MPL	1	113	113
Serranidae	Serranidae	MPL	16	51	186

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Xanthichthys sp.	Balistidae	MPL	4	61	61.5
Benthosema fibulatum	Myctophidae	MSL	58	75	396
Bregmaceros spp.	Bregmacerotidae	MSL	1	123	123
Diaphus adenomus	Myctophidae	MSL	30	119	396
Diaphus spp.	Myctophidae	MSL	26	75	190
Diaphus termophilus	Myctophidae	MSL	5	124	183
Idiolychnus urolampus	Myctophidae	MSL	23	124	190
Lampadena urophaos	Myctophidae	MSL	1	183	183
Myctophidae	Myctophidae	MSL	82	107	400
Alectis ciliaris	Carangidae	PIS	3	50	80
Aphareus furca	Lutjanidae	PIS	31	45.7	180
Berycidae	Berycidae	PIS	3	387	394
Beryx decadactylus	Berycidae	PIS	52	235	400
Beryx spp.	Berycidae	PIS	2	299	342
Carangidae	Carangidae	PIS	50	54.9	400
Carangoides ferdau	Carangidae	PIS	4	30.5	86
Carangoides orthogrammus	Carangidae	PIS	50	30.5	208
Carangoides spp.	Carangidae	PIS	3	53	75
Caranx ignobilis	Carangidae	PIS	67	30.8	190
Caranx lugubris	Carangidae	PIS	2	78	129
Caranx melampygus	Carangidae	PIS	44	30.5	147.7
Caranx sexfasciatus	Carangidae	PIS	1	54	54
Caranx spp.	Carangidae	PIS	55	46.5	226
Elagatis bipinnulata	Carangidae	PIS	6	88.46	180.5
Fistularia petimba	Fistulariidae	PIS	2	100	124
Fistularia commersonii	Fistulariidae	PIS	28	30.5	122
Fistularia petimba	Fistulariidae	PIS	49	68	200
Fistularia spp.	Fistulariidae	PIS	2	159.8	200.5
Gempylidae	Gempylidae	PIS	9	180	399.5
Gnathanodon speciosus	Congridae	PIS	3	42.4	176
Promethichthys prometheus	Gempylidae	PIS	1	190	190
Pseudocaranx cheilio	Carangidae	PIS	4	113.2	170.5
Rexea nakamurai	Gempylidae	PIS	21	110	400
Ruvettus pretiosus	Gempylidae	PIS	3	324	375
Scomberoides lysan	Fistulariidae	PIS	1	30.5	30.5
Seriola dumerili	Carangidae	PIS	974	42.7	400
Seriola rivoliana	Carangidae	PIS	432	74	367
Seriola spp.	Carangidae	PIS	88	69.5	368
Sphyraena barracuda	Sphyraenidae	PIS	4	30.2	122.7
Sphyraena helleri	Sphyraenidae	PIS	6	67	210
Thyrsitoides marleyi	Gempylidae	PIS	1	361	361
Trichiuridae	Trichiuridae	PIS	12	77	360
Manta birostris	Mobulidae	RAY	3	114	200.5
Manta spp.	Mobulidae	RAY	1	79	79
Mobula tarapacana	Myliobatidae	RAY	1	241.7	241.7

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Abudefduf abdominalis	Pomacentridae	reef fish	1	43	43
Acanthurus blochii	Acanthuridae	reef fish	43	36.5	108
Acanthurus dussumieri	Acanthuridae	reef fish	46	31	108
Acanthurus nigrofuscus	Acanthuridae	reef fish	4	34.1	77
Acanthurus nigroris	Acanthuridae	reef fish	1	48.2	48.2
Acanthurus olivaceus	Acanthuridae	reef fish	78	30.2	134
Acanthurus thompsoni	Acanthuridae	reef fish	4	65.5	119
Acanthurus xanthopterus	Acanthuridae	reef fish	59	43	148
Calotomus carolinus	Scaridae	reef fish	2	39.9	66
Chlorurus sordidus	Scaridae	reef fish	1	34.1	34.1
Ctenochaetus hawaiiensis	Acanthuridae	reef fish	6	49.5	62.5
Ctenochaetus strigosus	Acanthuridae	reef fish	14	36.5	113
Iniistius aneitensis	Labridae	reef fish	1	30.5	30.5
Melichthys vidua	Balistidae	reef fish	62	30.5	89
Naso brevirostris	Acanthuridae	reef fish	62	30.2	120.1
Naso lituratus	Acanthuridae	reef fish	41	35.4	86
Naso unicornis	Acanthuridae	reef fish	9	30.5	120.1
Paracirrhites arcatus	Cirrhitidae	reef fish	7	30.2	55
Plectroglyphidodon johnstonianus	Pomacentridae	reef fish	1	49.5	49.5
Scaridae	Scaridae	reef fish	29	34	99
Scarus psittacus	Scaridae	reef fish	2	34.1	48.2
Scarus rubroviolaceus	Scaridae	reef fish	10	48.2	95.5
Scarus spp.	Scaridae	reef fish	1	45.7	45.7
Zebrasoma flavescens	Acanthuridae	reef fish	27	34	86.5
Zebrasoma veliferum	Acanthuridae	reef fish	1	48.2	48.2
Acromycter alcocki	Congridae	SBC	1	388	388
Aldrovandia phalacra	Halosauridae	SBC	1	100	100
Apogon deetsie	Apogonidae	SBC	3	121	167
Arnoglossus debilis	Bothidae	SBC	74	100	294
Aulotrachichthys prosthemius	Trachichthyidae	SBC	14	155	224.5
Aulotrachichthys spp.	Trachichthyidae	SBC	2	138	200
Bembradium roseum	Bembridae	SBC	41	210	377
Bembrops filiferus	Percophidae	SBC	43	100	400
Bembrops spp.	Percophidae	SBC	24	147	352
Bodianus bathycapros	Labridae	SBC	34	178	220.9
Bodianus cylindriatus	Labridae	SBC	5	284	302
Bodianus sanguineus	Labridae	SBC	7	99.5	168
Bothus myriaster	Bothidae	SBC	4	142	206
Brotula multibarbata	Ophidiidae	SBC	5	95	224.5
Brotulid spp.	Ophidiidae	SBC	1	234	234
Callionymidae	Callionymidae	SBC	2	200	300
Callionymus caeruleonotatus	Callionymidae	SBC	36	96	396

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Callionymus decoratus	Callionymidae	SBC	11	99	124
Cantherhines dumerilii	Monacanthidae	SBC	1	45.7	45.7
Canthigaster coronata	Tetraodontidae	SBC	96	30.2	122
Canthigaster inframacula	Tetraodontidae	SBC	12	66.5	260
Canthigaster jactator	Tetraodontidae	SBC	18	30.2	89
Carapidae	Carapidae	SBC	8	266	322
Centrodraco rubellus	Centrophoridae	SBC	3	262	364
Chaetodon tinkeri	Chaetodontidae	SBC	98	48.5	153
Champsodon fimbriatus	Champsodontidae	SBC	8	201	220
Chascanopsetta crumenalis	Bothidae	SBC	3	335	364
Chascanopsetta prorigera	Bothidae	SBC	57	225	396
Chascanopsetta spp.	Bothidae	SBC	8	300	350
Chaunax spp.	Chaunacidae	SBC	8	366	399
Chaunax umbrinus	Chaunacidae	SBC	128	183	400
Chrionema chryseres	Percophidae	SBC	149	163	400
Chrionema squamiceps	Percophidae	SBC	85	147	400
Coelorinchus aratrum	Macrouridae	SBC	1	384	384
Coelorinchus gladius	Macrouridae	SBC	7	329	396
Coelorinchus spilonotus	Macrouridae	SBC	15	319	400
Coelorinchus spp.	Macrouridae	SBC	5	365	395.5
Coelorinchus tokiensis	Macrouridae	SBC	1	400	400
Cyttomimus stelgis	Zeniontidae	SBC	12	336	400
Dactyloptena orientalis	Dactylopteridae	SBC	70	62	185
Engyprosopon xenandrus	Bothidae	SBC	56	62	205
Forcipiger longirostris	Chaetodontidae	SBC	54	43	208
Gadella molokaiensis	Moridae	SBC	10	158	226.5
Gadella spp.	Moridae	SBC	3	309	335
Genicanthus personatus	Pomacanthidae	SBC	24	43	191
Gnathophis spp.	Congridae	SBC	95	104	393
Gobiidae	Gobiidae	SBC	4	90	191
Halieutaea retifera	Ogcocephalidae	SBC	106	90	280
Haplomacrourus nudirostris	Macrouridae	SBC	1	398	398
Haplomacrourus spp.	Macrouridae	SBC	2	331	332
Heteropriacanthus cruentatus	Priacanthidae	SBC	1	300	300
Hime japonica	Aulopodidae	SBC	59	100	248
Ijimaia plicatellus	Ateleopodidae	SBC	43	236	400
Ijimaia spp.	Ateleopodidae	SBC	1	361	361
Kentrocapros aculeatus	Aracanidae	SBC	32	181	229
Laemonema rhodochir	Moridae	SBC	90	281	400
Liopropoma aurora	Serranidae	SBC	10	128	268
Lophiodes miacanthus	Lophiidae	SBC	75	249	444
Lutjanidae deep	Lutjanidae	SBC	46	152	400
Macroramphosinae	Centriscidae	SBC	4	245	367

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Macroramphosus scolopax	Centriscidae	SBC	1	329	329
Macrorhamphosus hawaiiensis	Centriscidae	SBC	4	185	238
Macrouridae	Macrouridae	SBC	24	319	400
Malacocephalus hawaiiensis	Macrouridae	SBC	5	335	388
Malacocephalus spp.	Macrouridae	SBC	10	306	397
Malthopsis jordani	Ogcocephalidae	SBC	23	201	348
Meadia abyssalis	Synaphobranchidae	SBC	157	275	400
Metavelifer multiradiatus	Veliferidae	SBC	6	100	143
Moridae	Moridae	SBC	70	104.5	400
Moringuidae	Moringuidae	SBC	1	398	398
Mulloidichthys flavolineatus	Mullidae	SBC	8	46	76
Mulloidichthys vanicolensis	Mullidae	SBC	19	38	132.2
Myrophinae	Ophichthidae	SBC	55	335.5	392.5
Nettastoma parviceps	Nettastomatidae	SBC	3	237	386
Nettastoma solitarium	Nettastomatidae	SBC	1	230	230
Nettastomatidae	Nettastomatidae	SBC	3	200	343
Nettenchelys gephyra	Nettastomatidae	SBC	11	169	399
Ogcocephalidae	Ogcocephalidae	SBC	1	350	350
Ophichthidae	Ophichthidae	SBC	311	217	400
Ophichthus spp.	Ophichthidae	SBC	10	335	398
Ophidiidae	Ophidiidae	SBC	50	102	384
Ophidion spp.	Ophidiidae	SBC	14	86	304
Osopsaron spp.	Percophidae	SBC	9	183	248
Ostichthys archiepiscopus	Holocentridae	SBC	3	213.5	238
Ostichthys japonicus	Holocentridae	SBC	1	119	119
Owstonia hawaiiensis	Cepolidae	SBC	63	201	397.5
Oxyurichthys spp.	Gobiidae	SBC	8	108	124
Parabothus chlorospilus	Bothidae	SBC	126	100	340
Parabothus coarctatus	Bothidae	SBC	65	100	336
Parapercis roseoviridis	Pinguipedidae	SBC	100	165	396
Parapercis spp.	Pinguipedidae	SBC	18	50	273
Parascombrops argyreus	Acropomatidae	SBC	83	75	388
Parupeneus insularis	Mullidae	SBC	1	113	113
Percophidae	Percophidae	SBC	50	71	400
Pervagor spilosoma	Monacanthidae	SBC	221	31	162
Physiculus nigripinnis	Moridae	SBC	17	285.5	383
Physiculus rhodopinnis	Moridae	SBC	25	140	385
Physiculus spp.	Moridae	SBC	64	102	343
Physiculus sterops	Moridae	SBC	14	151	352
Plectranthias helenae	Serranidae	SBC	8	122	228.8
Plectrogenium nanum	Scorpaenidae	SBC	11	274	396
Poecilopsetta hawaiiensis	Bothidae	SBC	143	100	396
Polylepion russelli	Labridae	SBC	9	250	288.5

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Polymixia japonica	Polymixiidae	SBC	45	234	400
Polymixia spp.	Polymixiidae	SBC	28	335	400
Pristilepis oligolepis	Holocentridae	SBC	45	91	281
Pristipomoides auricilla	Lutjanidae	SBC	28	123.7	295
Prognathodes basabei	Chaetodontidae	SBC	41	88.5	350
Pycnocraspedum armatum	Ophidiidae	SBC	14	201	396
Pycnocraspedum spp.	Ophidiidae	SBC	1	396	396
Randallichthys filamentosus	Lutjanidae	SBC	69	131.2	400
Satyrichthys spp.	Peristediidae	SBC	3	331	391
Saurenchelys spp.	Nettastomatidae	SBC	27	179	396
Saurenchelys stylura	Nettastomatidae	SBC	46	137	354
Scalicus engyceros	Peristediidae	SBC	114	183	400
Scolecenchelys puhioilo	Ophichthidae	SBC	1	328	328
Scorpaena pele	Scorpaenidae	SBC	5	110	166
Scorpaenodes corallinus	Scorpaenidae	SBC	4	156	300
Setarches guentheri	Scorpaenidae	SBC	133	223	400
Solocisquama stellulata	Ogcocephalidae	SBC	1	396	396
Sphagemacrurus gibber	Macrouridae	SBC	1	384	384
Sphoeroides pachygaster	Tetraodontidae	SBC	10	122	364
Stethopristes eos	Parazenidae	SBC	28	235	400
Suezichthys notatus	Labridae	SBC	24	159	262
Symphurus undatus	Cynoglossidae	SBC	4	274	298
Synagrops argyreus	Acropomatidae	SBC	39	154	400
Synagrops japonicus	Acropomatidae	SBC	9	148	253
Synodus dermatogenys	Synodontidae	SBC	37	62	201
Taeniopsetta radula	Bothidae	SBC	117	100	340
Taractichthys steindachneri	Bramidae	SBC	21	240	400
Tetraodontidae	Tetraodontidae	SBC	9	64	360.5
Uroconger lepturus	Congridae	SBC	7	228	396
Ventrifossa ctenomelas	Macrouridae	SBC	5	376	393
Zalanthias kelloggi	Serranidae	SBC	156	218	367
Decapterus macarellus	Carangidae	SHP	30	30.2	136
Decapterus muroadsi	Carangidae	SHP	6	127.8	220.2
Decapterus pinnulatus	Carangidae	SHP	14	101	229
Decapterus spp.	Carangidae	SHP	18	54	198.7
Decapterus tabl	Carangidae	SHP	5	175	367
Selar crumenophthalmus	Carangidae	SHP	6	64	230
Aetobatus narinari	Myliobatidae	IRY	6	33	97
Bathytoshia lata	Dasyatidae	IRY	104	34.1	266.5
Bathytoshia spp.	Dasyatidae	IRY	14	75.1	233.4
Batoidea	Batoidea	IRY	2	145	350
Dasyatidae	Dasyatidae	IRY	37	71.6	222
Plesiobatis daviesi	Plesiobatidae	IRY	88	84	444
Rajiform	Dasyatidae	IRY	1	98.6	98.6
Alopias pelagicus	Alopiidae	SHR	2	318	338

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Carcharhinidae	Carcharhinidae	SHR	6	57	306
Carcharhinus altimus	Carcharhinidae	SHR	1	185	185
Carcharhinus amblyrhynchos	Carcharhinidae	SHR	5	53	151.8
Carcharhinus galapagensis	Carcharhinidae	SHR	22	98	371
Carcharhinus milberti	Carcharhinidae	SHR	1	128	128
Carcharhinus plumbeus	Carcharhinidae	SHR	75	54.9	236.5
Carcharhinus spp.	Carcharhinidae	SHR	26	61	347.5
Carcharodon carcharias	Lamnidae	SHR	1	350	350
Centrophoridae	Centrophoridae	SHR	1	308	308
Centrophorus granulosus	Centrophoridae	SHR	1	361	361
Centrophorus tessellatus	Centrophoridae	SHR	8	354	400
Dalatias licha	Dalatiidae	SHR	3	300	396
Echinorhinus cookei	Echinorhinidae	SHR	4	297	382
Etmopterus lucifer	Etmopteridae	SHR	1	181	181
Etmopterus spp.	Etmopteridae	SHR	4	228	300
Galeocerdo cuvier	Carcharhinidae	SHR	8	45.4	188.1
Hexanchus griseus	Hexanchidae	SHR	1	347	347
Pseudotriakis microdon	Pseudotriakidae	SHR	1	327	327
Selachii	Cetorhinidae	SHR	14	50	400
Squalidae	Squalidae	SHR	5	284	397.5
Squalus blainvillei	Squalidae	SHR	9	100	396
Squalus mitsukurii	Squalidae	SHR	440	214	400
Tetranatce spp.	Torpedinidae	SHR	2	265	274
Anthiinae	Serranidae	SPL	9	59	211
Antigonia capros	Caproidae	SPL	5	109	287
Antigonia eos	Caproidae	SPL	218	97	351
Antigonia rubescens	Caproidae	SPL	2	89	102
Antigonia spp.	Caproidae	SPL	438	180	368
Antigonia steindachneri	Caproidae	SPL	98	179	396
Apogonidae	Apogonidae	SPL	29	65	111
Argyripnus spp.	Sternoptychidae	SPL	20	179	335
Ariomma luridum	Ariommatidae	SPL	18	100	398
Beryx splendens	Berycidae	SPL	1	305	305
Callanthiidae	Callanthiidae	SPL	19	90	334.5
Caprodon longimanus	Serranidae	SPL	12	159	251.5
Chromis hanui	Pomacentridae	SPL	2	113	146
Chromis struhsakeri	Pomacentridae	SPL	138	43	264.5
Cirrhitops fasciatus	Cirrhitidae	SPL	1	153	153
Cookeolus japonicus	Priacanthidae	SPL	99	91	291
Draconetta xenica	Draconettidae	SPL	19	100	369
Emmelichthys karnellai	Emmelichthyidae	SPL	8	146	267
Emmelichthys struhsakeri	Emmelichthyidae	SPL	11	151.7	383
Epigonus atherinoides	Epigonidae	SPL	4	324	381.5
Epigonus devaneyi	Epigonidae	SPL	8	301	399

Taxa	Family	Functional group code	No. of obser-vations	Min. depth (m)	Max. depth (m)
Epigonus fragilis	Epigonidae	SPL	7	305	399
Epigonus glossodontus	Epigonidae	SPL	52	257	400
Epigonus spp.	Epigonidae	SPL	124	251.5	400
Erythrocles schlegelii	Emmelichthyidae	SPL	15	128	236
Erythrocles scintillans	Emmelichthyidae	SPL	90	153	394.5
Glossanodon struhsakeri	Argentinidae	SPL	53	100	396
Grammatonotus laysanus	Callanthiidae	SPL	113	194	364
Grammatonotus spp.	Callanthiidae	SPL	252	171	346
Grammicolepis brachiusculus	Grammicolepididae	SPL	21	343.5	400
Hemitaurichthys thompsoni	Chaetodontidae	SPL	2	46	92
Hollardia goslinei	Triacanthodidae	SPL	257	317.5	400
Holocentridae	Holocentridae	SPL	37	43	251.5
Lestidium nudum	Paralepididae	SPL	2	183	183
Maurolicus muelleri	Sternoptychidae	SPL	3	234	326
Mola mola	Molidae	SPL	2	164.5	216
Odontanthias elizabethae	Serranidae	SPL	302	89	300
Odontanthias fuscipinnis	Serranidae	SPL	250	83.5	214
Parapercis schauinslandii	Pinguipedidae	SPL	108	30.5	258
Pinguipedidae	Pinguipedidae	SPL	3	91	272
Polyipnus nuttingi	Sternoptychidae	SPL	2	128	384
Pomacentridae	Pomacentridae	SPL	10	32.9	150
Priacanthidae	Priacanthidae	SPL	18	61	285
Priacanthus alalaua	Priacanthidae	SPL	162	55	238
Priacanthus meeki	Priacanthidae	SPL	60	61	238
Pseudanthias fucinus	Serranidae	SPL	54	114	234
Pseudanthias kelloggi	Serranidae	SPL	5	221	238
Pseudanthias spp.	Serranidae	SPL	18	60.5	203.5
Pseudanthias thompsoni	Serranidae	SPL	63	37	228
Pseudopentaceros wheeleri	Pentacerotidae	SPL	1	367	367
Pyramodon ventralis	Carapidae	SPL	5	238	370
Roa excelsa	Chaetodontidae	SPL	284	99	300
Snyderidia canina	Carapidae	SPL	7	281	339
Symphysanodon maunaloae	Symphysanodontidae	SPL	715	89	392
Symphysanodon typus	Symphysanodontidae	SPL	269	80	260
Xanthichthys auromarginatus	Balistidae	SPL	71	31	162
Xanthichthys caeruleolineatus	Balistidae	SPL	34	59	146.4
Xanthichthys mento	Balistidae	SPL	27	61	158
Xanthichthys spp.	Balistidae	SPL	46	73.5	120.5
Zenopsis nebulosa	Zeidae	SPL	12	216	367
Aprion virescens	Lutjanidae	UKU	115	30.5	193.7

Supplement 2. Depth distribution of 112 families between 30 and 410 m and abundance estimates from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program.

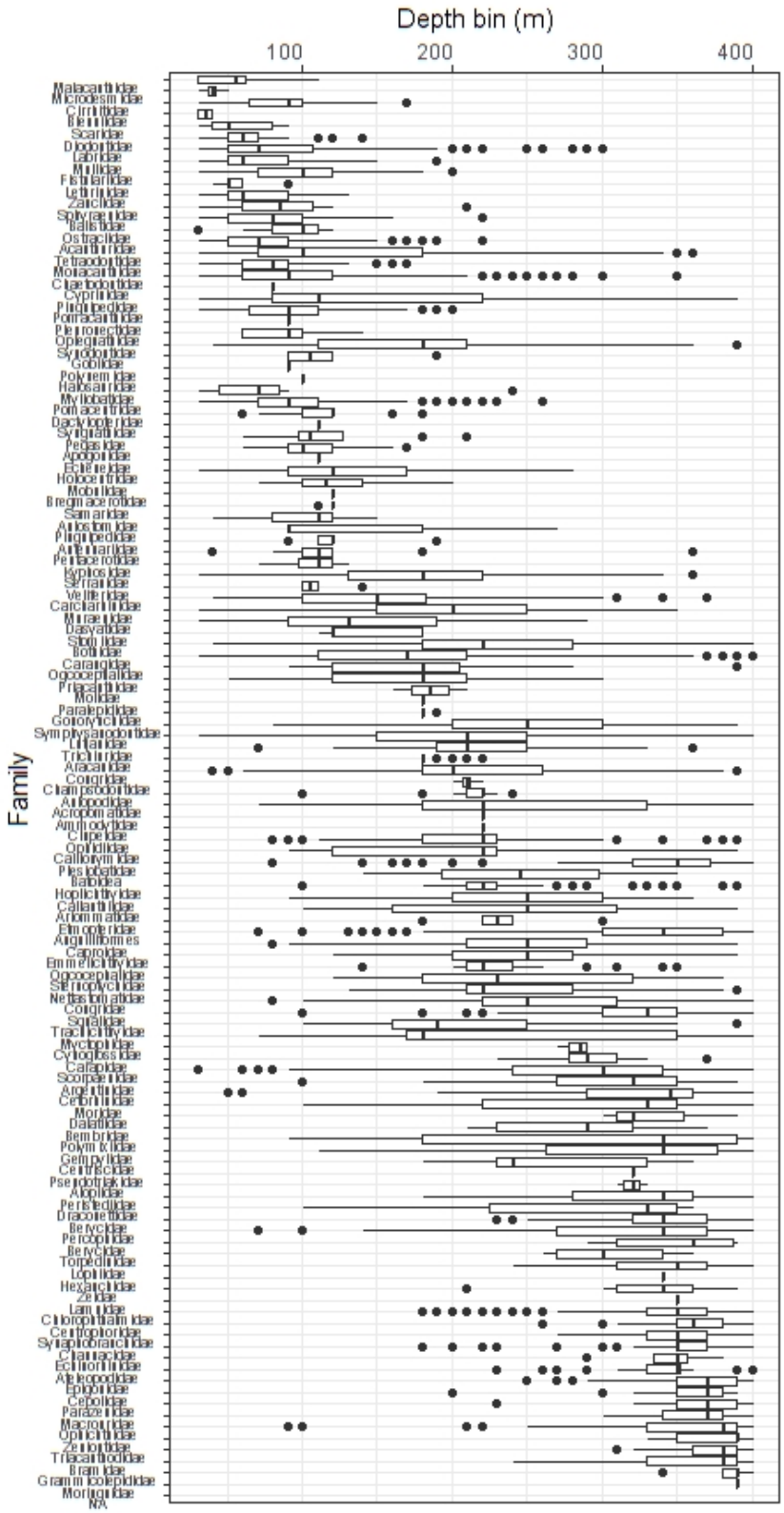


Figure S2.1. Depth distribution of 112 fish families derived from 24,785 observations between 30 and 410 m. Boxes indicate the 25th and 75th quartile, whiskers are for 1.5 the interquartile, and circles are outliers.

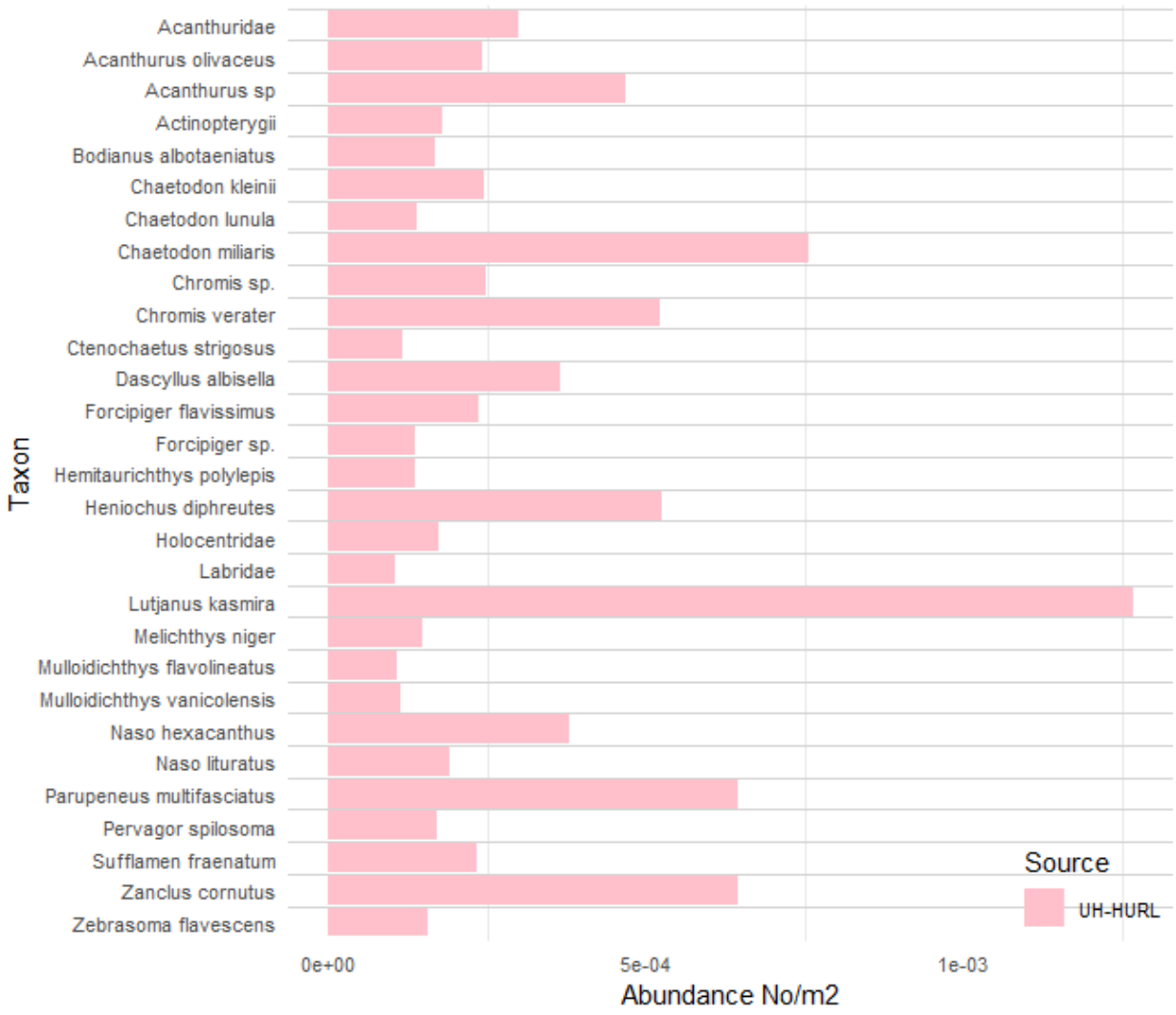


Figure S2.2. Abundance estimates of taxa in the upper mesophotic (30-59 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 $g.m^{-2}$ are not shown.

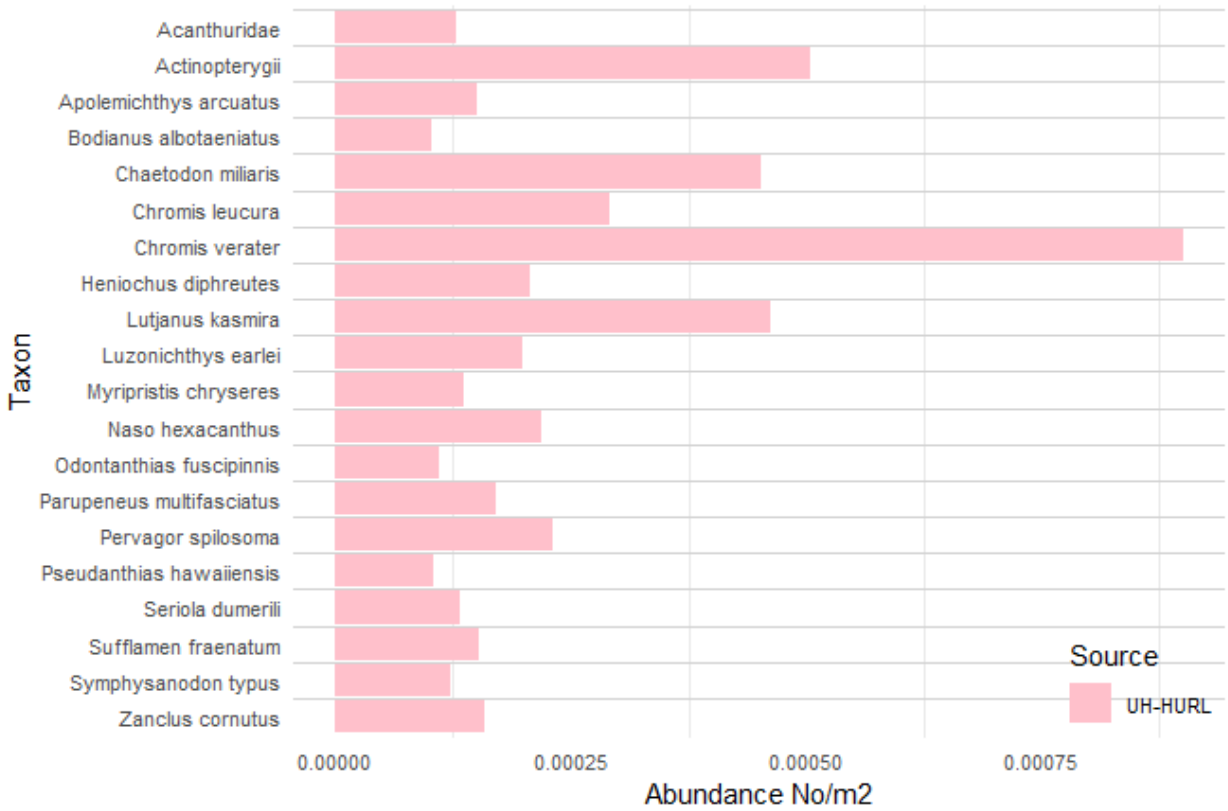


Figure S2.3. Abundance estimates of taxa in the lower mesophotic (60-129 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 $g.m^{-2}$ are not shown.

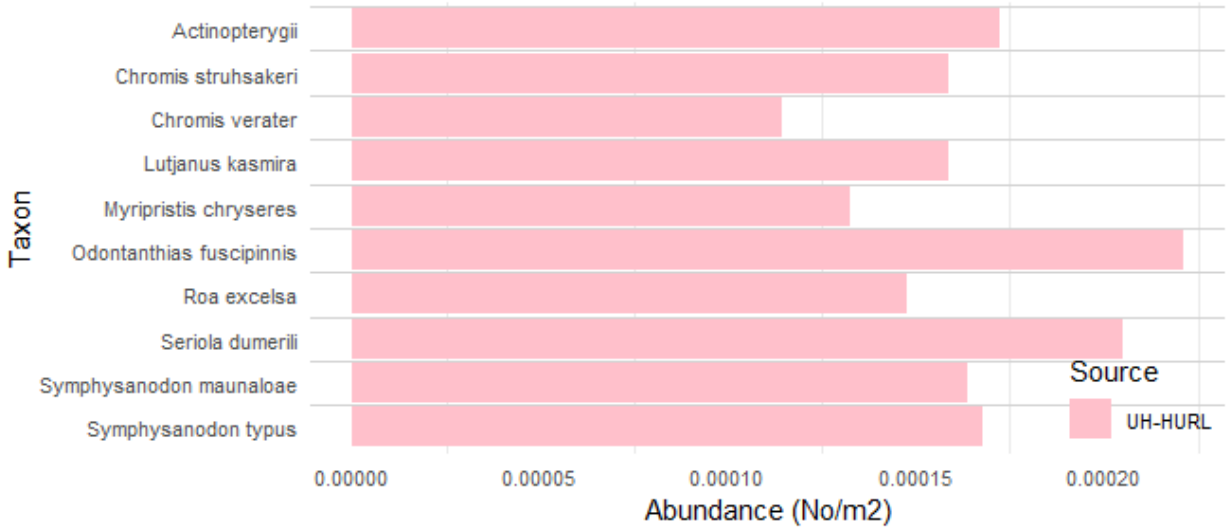


Figure S2.4. Abundance estimates of taxa in the upper rariphotic (130-169 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 $g.m^{-2}$ are not shown.

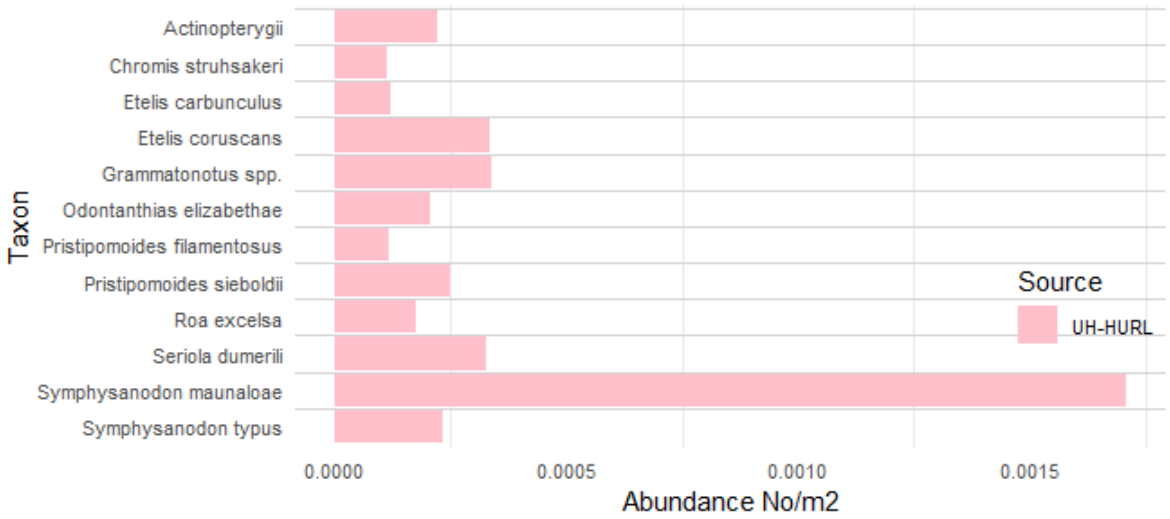


Figure S2.5. Abundance estimates of taxa in the mid rariphotic (170-239 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 g.m^{-2} are not shown.

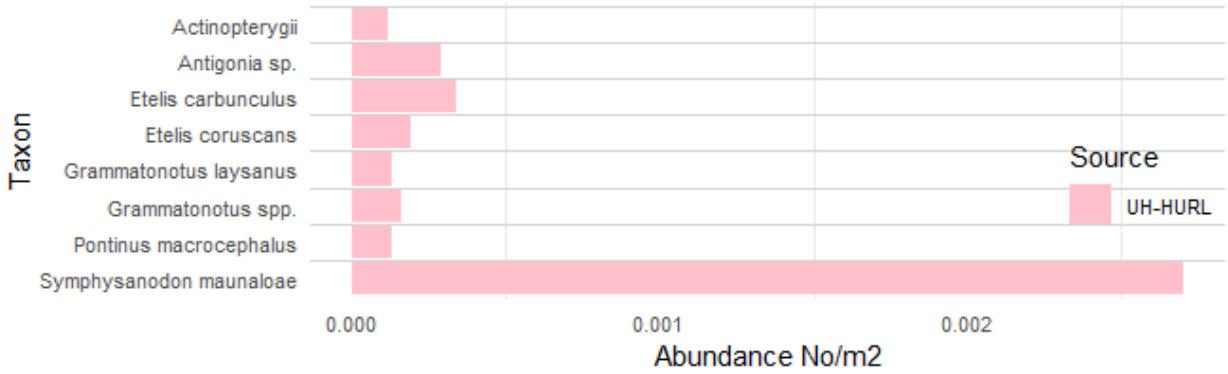


Figure S2.6. Abundance estimates of taxa in the lower rariphotic (240 – 319 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 g.m^{-2} are not shown.

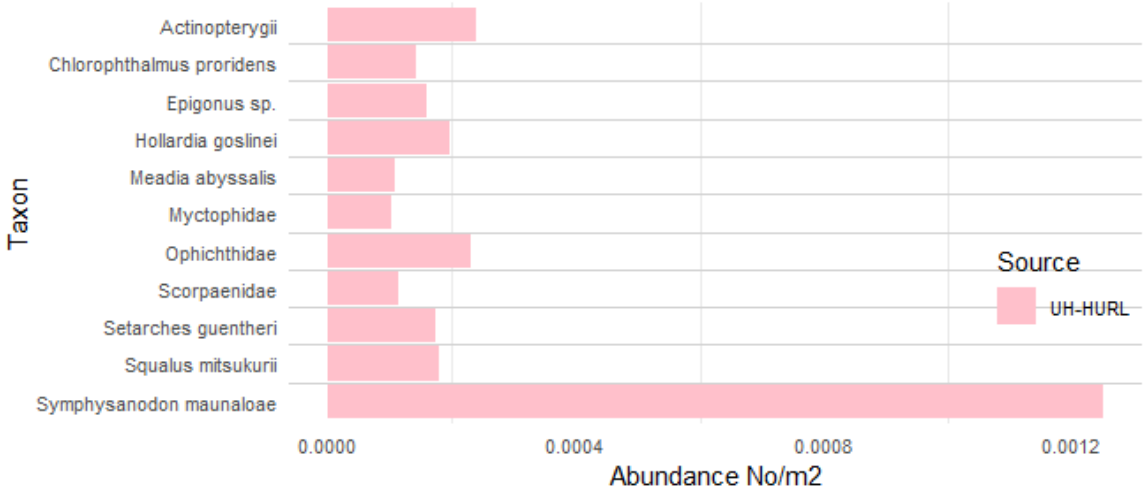


Figure S2.7. Abundance estimates of taxa in the upper bathyal (320-409 m) zone from the University of Hawaii Hawai'i Underwater Research Lab (UH-HURL) monitoring program. Taxa whose abundance was less than 0.0001 g.m^{-2} are not shown.

Supplement 3. Results of generalized additive modeling efforts for each of the functional groups considered in this study**.**

S3.1: Mesophotic benthic carnivores (MBC group)

Formula of the final binomial generalized additive model (GAM) of the MBC group (deviance explained: 31.2%):

$$logit(p) = s(depth_{25m}) + s(slope_{25m}) + factor(program) + factor(year) \quad \text{(S3.1.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (meters) at the 25 m resolution, and $slope_{25m}$ is slope (degrees) at the 25 m resolution.

Formula of the final gamma GAM of the MBC group (deviance explained: 45.0%):

$$log(d) = s(eastness_{25m}) + s(depth_{25m}) + s(slope_{25m}) + s(chla) + factor(program) + factor(year) \quad \text{(S3.1.2)}$$

where d is the relative biomass; $eastness_{25m}$ is eastness (unitless) at the 25 m resolution; $depth_{25m}$ is depth (meters) at the 25 m resolution; $slope_{25m}$is slope (degrees) at the 25 m resolution; and $chla$ is the chlorophyll-*a* concentration (mg.m^{-3}).

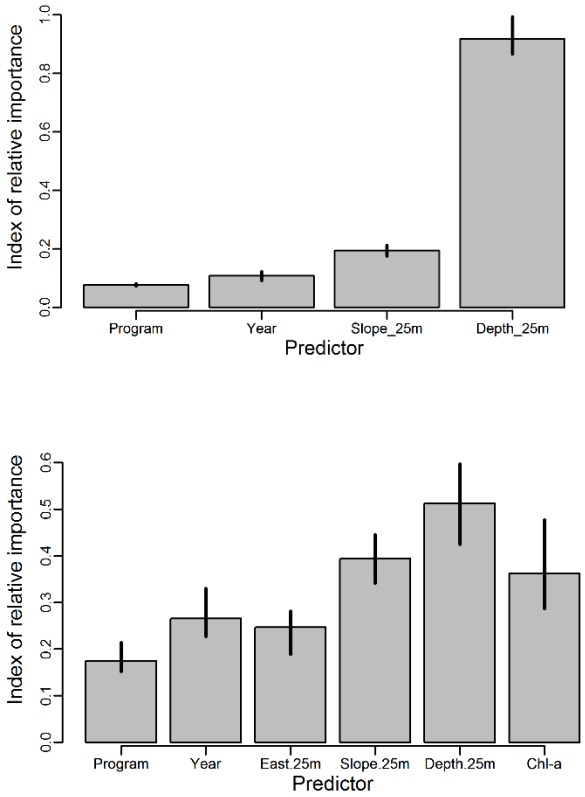


Figure S3.1.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the mesophotic benthic carnivore (MBC) group. Vertical black lines indicate confidence intervals.

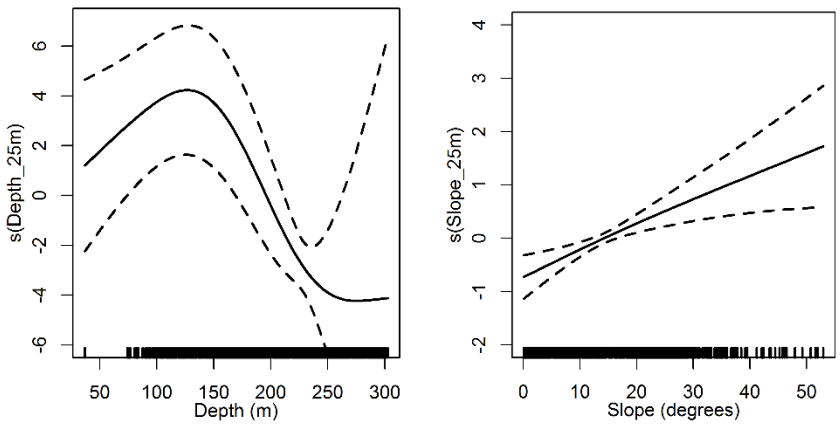


Figure S3.1.2. Smoothed curves of the additive effect to the estimated probability of encounter of the mesophotic benthic carnivore (MBC) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation. Note that the scale of the y-axis differs from one panel to the next for display purposes.

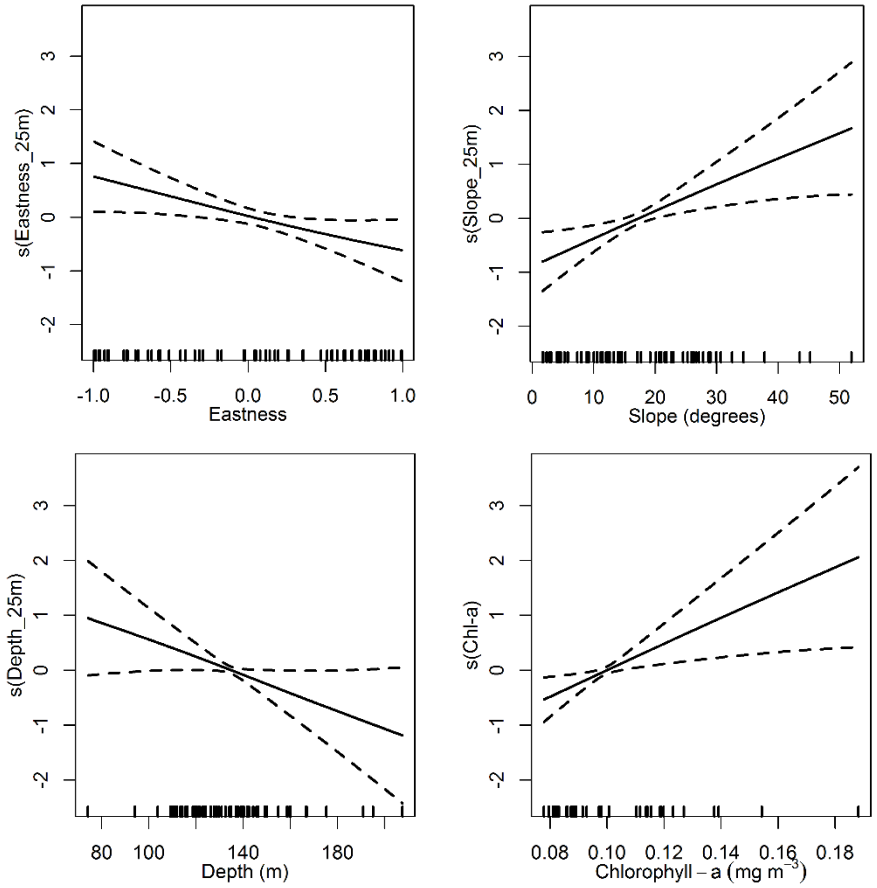


Figure S3.1.3. Smoothed curves of the additive effect to the estimated relative biomass of the mesophotic benthic carnivore (MBC) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

S3.2 Mesophotic planktivores (MPL group)

Formula of the final binomial generalized additive model (GAM) of the MPL group (deviance explained: 38.0%):

$$logit(p) = s(depth_{25m}) + s(slope_{25m}) + s(chla) + factor(program) + factor(year) \quad \text{(S3.2.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (m) at the 25 m resolution; $slope_{25m}$ is slope (degrees) at the 25 m resolution; and $chla$ is the chlorophyll-*a* concentration (mg.m^{-3}).

Formula of the final gamma GAM of the MPL group (deviance explained: 47.3%):

$$log(d) = s(RDMV_{125m}) + factor(HS_{4cl}) + factor(program) + factor(year) \quad \text{(S3.2.2)}$$

where d is relative biomass; $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution; and HS_{4cl} is the 4-level hard-soft (substrate type) factor.

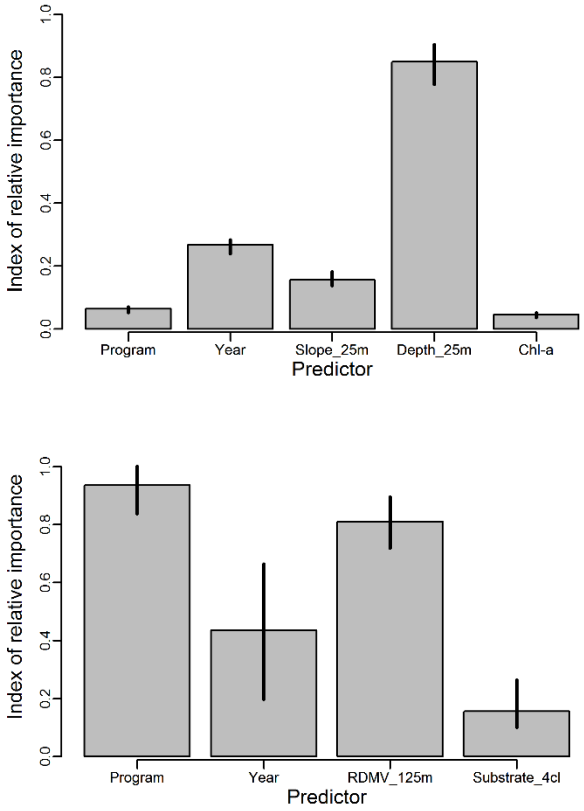


Figure S3.2.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the mesophotic planktivore (MPL) group. Vertical black lines indicate confidence intervals. Chl-a = Chlorophyll-*a* concentration.

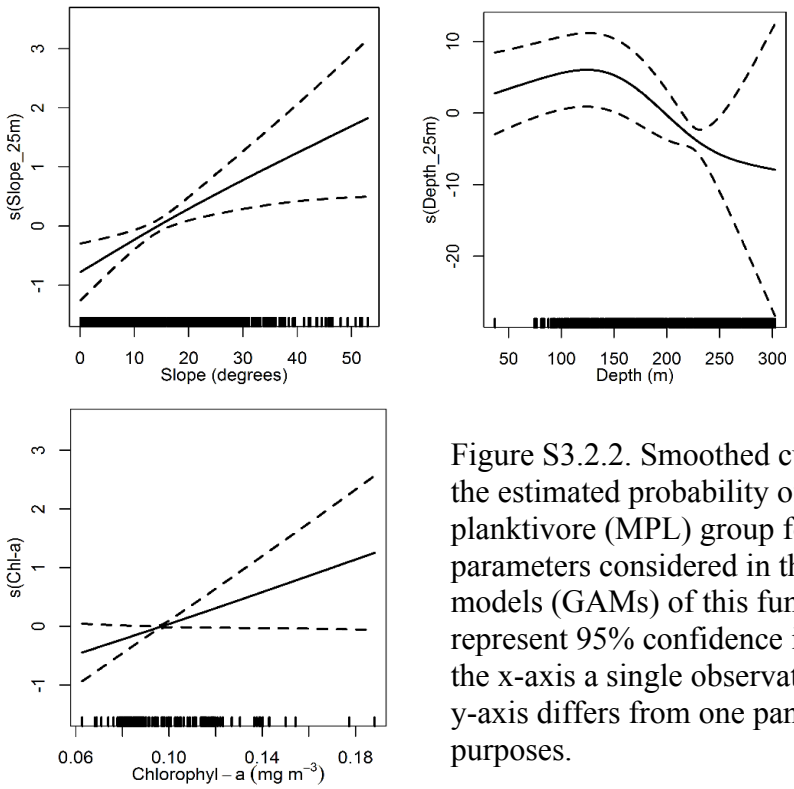


Figure S3.2.2. Smoothed curves of the additive effect to the estimated probability of encounter of the mesophotic planktivore (MPL) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation. Note that the scale of the y-axis differs from one panel to the next for display purposes.

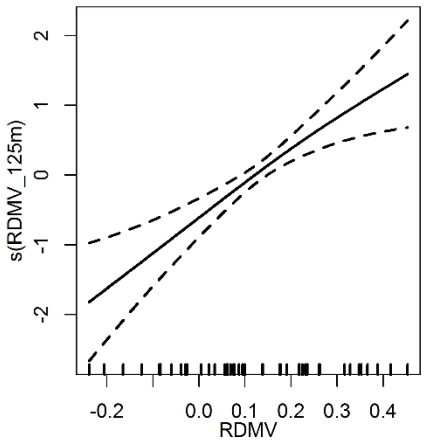


Figure S3.2.3. Smoothed curve of the additive effect to the estimated relative biomass of the mesophotic planktivore (MPL) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

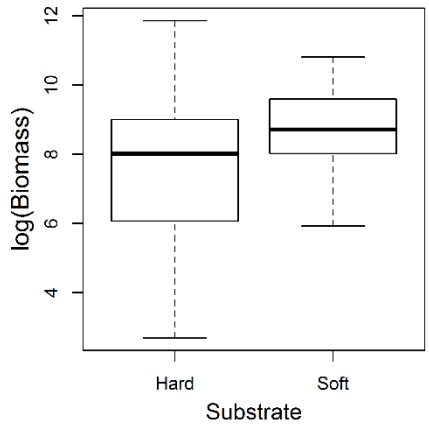


Figure S3.2.4. Distribution of the relative biomass of the mesophotic planktivore (MPL) group for each substrate type predicted by the gamma generalized additive model. Relative biomass is expressed here in ln(relative biomass + 1).

S3.3 Subphotic benthic carnivores (SBC group)

Formula of the final binomial generalized additive model (GAM) of the SBC group (deviance explained: 16.9%):

$$logit(p) = s(slope_{125m}) + s(RDMV_{125m}) + s(backscatter_{125m}) + factor(HS_{7cl}) + factor(program) + factor(year) \quad \text{(S3.3.1)}$$

where p is probability of encounter; $slope_{125m}$ is slope (degrees) at the 125 m resolution; $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution; $bckscatter_{125m}$ is backscatter (decibels) at 125 m resolution; and HS_{7cl} is the 7-level hard-soft (substrate type) factor.

Formula of the final gamma GAM of the SBC group (deviance explained: 39.6%):

$$log(d) = s(RDMV_{25m}) + factor(HS_{4cl}) + factor(program) + factor(year) \quad \text{(S3.3.2)}$$

where d is the relative biomass; $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution; and HS_{4cl} is the 4-level hard-soft (substrate type) factor.

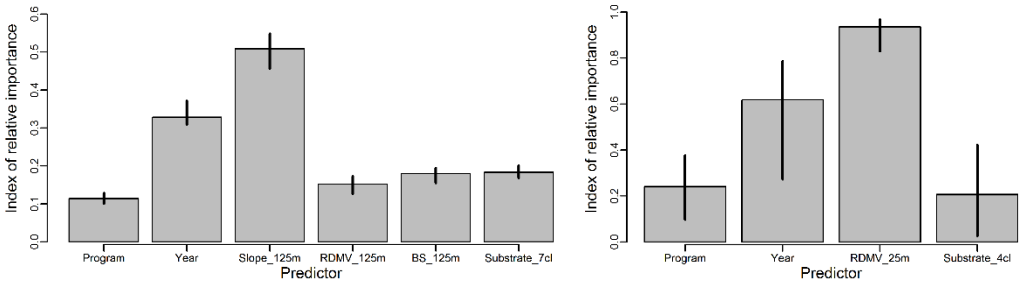


Figure S3.3.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the subphotic benthic carnivore (SBC) group. Vertical black lines indicate confidence intervals. BS is backscatter.

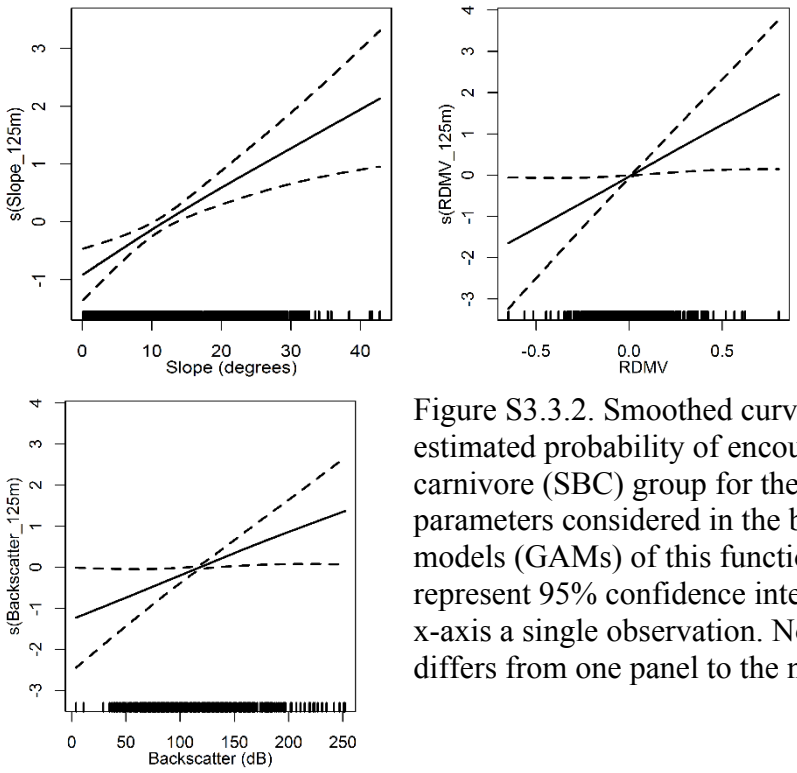


Figure S3.3.2. Smoothed curves of the additive effect to the estimated probability of encounter of the subphotic benthic carnivore (SBC) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation. Note that the scale of the y-axis differs from one panel to the next for display purposes.

Table S3.3.1 Contingency table of the binomial distribution substrate type (2-level) for the subphotic benthic carnivore (SBC) group showing the number of encounters (1) and non-encounters (0) of the functional group for each substrate type.

	0	1
HARD	407	32
SOFT	490	7

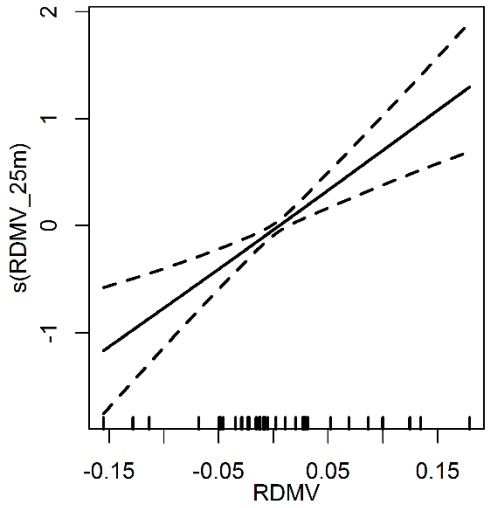


Figure S3.3.3. Smoothed curve of the additive effect to the estimated relative biomass of the subphotic benthic carnivore (SBC) group for some of the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

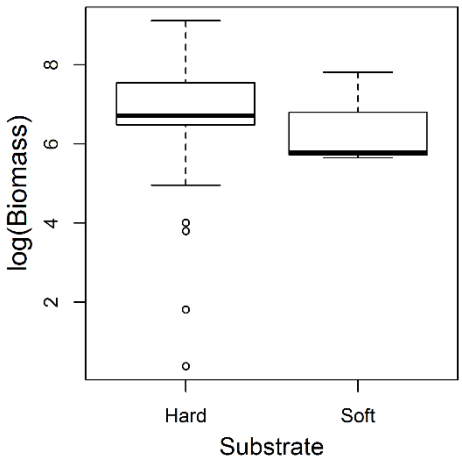


Figure S3.3.4. Distribution of the relative biomass of the subphotic benthic carnivore (SBC) group for each substrate type predicted by the gamma generalized additive model. Relative biomass is expressed here in ln(relative biomass + 1).

S3.4 Subphotic planktivores (SPL group)

Formula of the final binomial generalized additive model (GAM) of the SPL group (deviance explained: 21.1%):

$$logit(p) = s(depth_{25m}) + s(slope_{25m}) + s(backscatter_{25m}) + factor(program) + factor(year) \quad \text{(S3.4.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (meters) at the 25 m resolution; $slope_{25m}$ is slope (degrees) at the 25 m resolution; and $backscatter_{25m}$ is backscatter (decibels) at the 25 m resolution.

Formula of the final gamma GAM of the SPL group (deviance explained: 15.9%):

$$log(d) = s(northness_{25m}) + s(HS_{7cl}) + factor(program) + factor(year) \quad \text{(S3.4.2)}$$

where d is the relative biomass; $northness_{25m}$ is northness (unitless) at the 25 m resolution; and HS_{7cl} is the 7-level hard-soft (substrate type) factor.

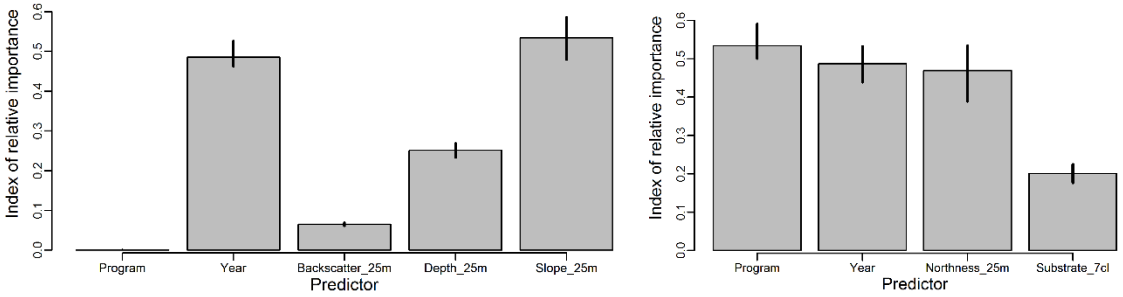


Figure S3.4.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the subphotic planktivore (SPL) group. Vertical black lines indicate confidence intervals.

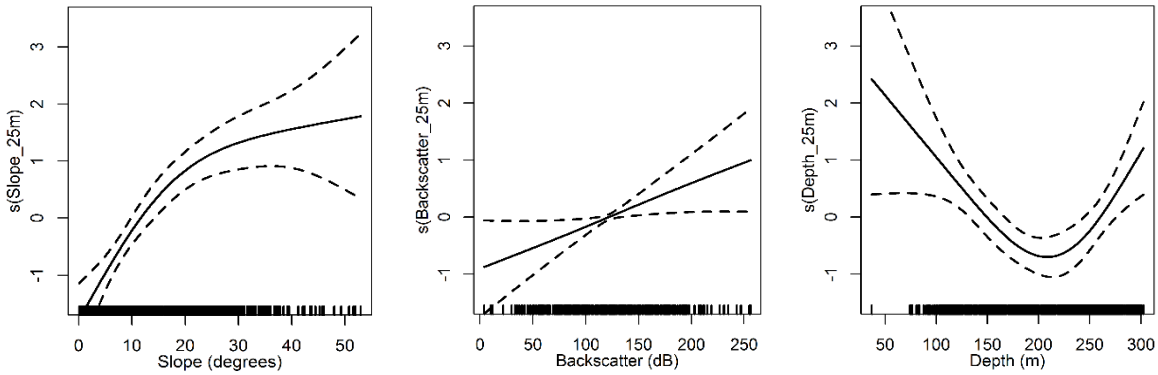


Figure S3.4.2. Smoothed curves of the additive effect to the estimated probability of encounter of the subphotic planktivore (SPL) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

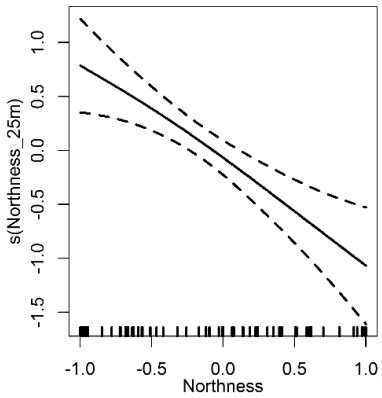


Figure S3.4.3. Smoothed curves of the additive effect to the estimated relative biomass of the subphotic planktivore (SPL) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

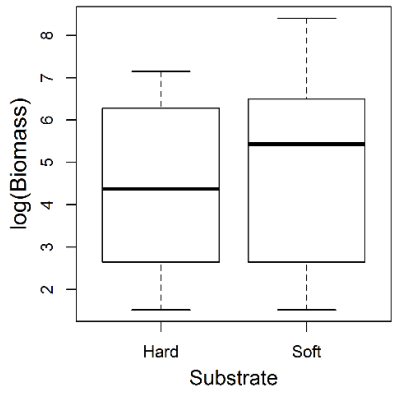


Figure S3.4.4. Distribution of the relative biomass of the subphotic planktivore (SPL) group for each substrate type predicted by the gamma generalized additive model. Relative biomass is expressed here in ln(relative biomass + 1).

S3.5 Meso- and subphotic benthic piscivores (MBP group)

Formula of the final binomial generalized additive model (GAM) of the MBP group (deviance explained: 16.7%):

$$logit(p) = s(northness_{625m}) + s(eastness_{625m}) + factor(HS_{2cl}) + factor(program) + factor(year) \quad \text{(S3.5.1)}$$

where p is probability of encounter; $northness_{625m}$ is northness (unitless) at the 625 m resolution; $eastness_{625m}$ is eastness (unitless) at the 625 m resolution; and HS_{2cl} is the 2-level hard-soft (bottom type) factor.

Formula of the final gamma GAM of the MBP group (deviance explained: 85.4%):

$$log(d) = s(slope_{125m}) + s(HS_{2cl}) + factor(program) + factor(year) \quad \text{(S3.5.2)}$$

where d is the relative biomass; $slope_{125m}$ is slope (degrees) at the 125 m resolution; and HS_{2cl} is the 2-level hard-soft (bottom type) factor.

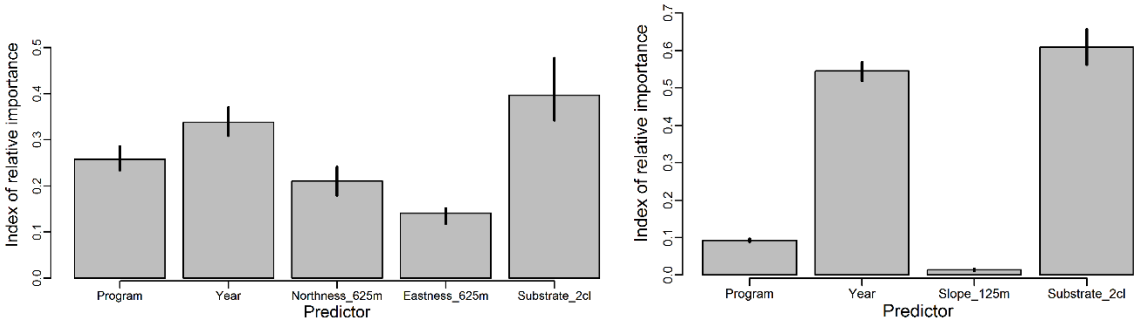


Figure S3.5.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the meso- and subphotic benthic piscivore (MBP) group. Vertical black lines indicate confidence intervals.

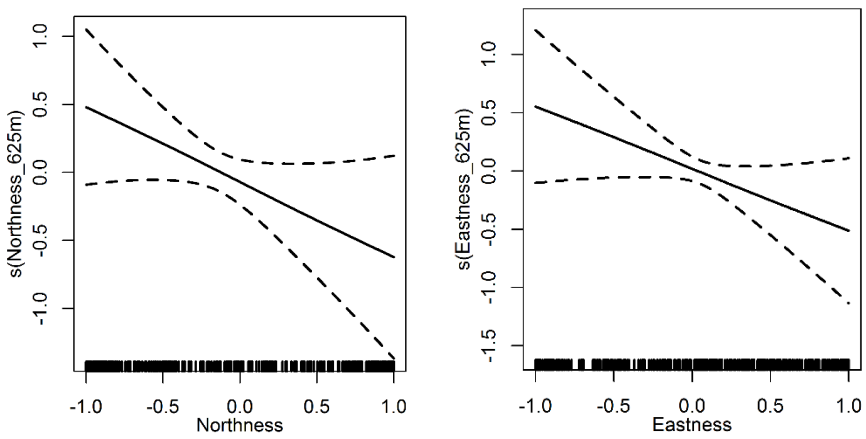


Figure S3.5.2. Smoothed curves of the additive effect to the estimated probability of encounter of the meso- and subphotic benthic piscivore (MBP) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

Table S3.5.1 Contingency table of the binomial distribution substrate type (2-level) for the meso- and subphotic benthic piscivore (MBP) group showing the number of encounters (1) and non-encounters (0) of the functional group for each substrate type.

	0	1
HARD	416	21
SOFT	255	2

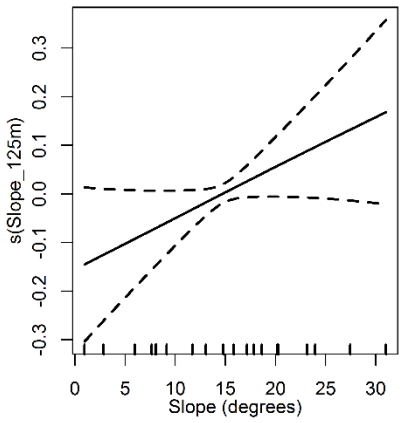


Figure S3.5.3. Smoothed curves of the additive effect to the estimated relative biomass of the meso- and subphotic benthic piscivore (MBP) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

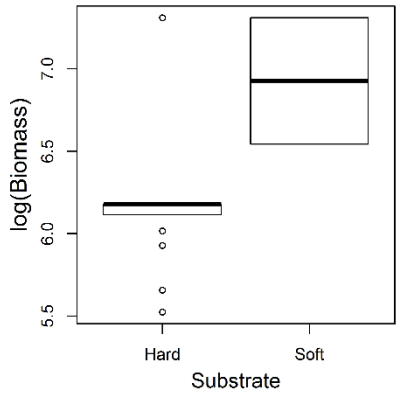


Figure S3.5.4. Distribution of the relative biomass of the meso- and subphotic benthic piscivore (MBP) group for each substrate type predicted by the gamma generalized additive model. Relative biomass is expressed here in ln(relative biomass + 1).

S3.6 Bottomfish-WC (BFW group)

Formula of the final binomial generalized additive model (GAM) of the BFW group (deviance explained: 21.6%):

$$logit(p) = s(RDMV_{125m}) + s(slope_{125m}) + s(backscatter_{125m}) + s(chla) + factor(HS_{7cl}) + factor(program) + factor(year) \quad \text{(S3.6.1)}$$

where p is probability of encounter; $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution; $slope_{125m}$ is slope (degrees) at the 125 m resolution; $backscatter_{125m}$ is backscatter (decibels) at the 125 m resolution; $chla$ is the chlorophyll-*a* concentration (mg.m^{-3}); and HS_{7cl} is the 7-level hard-soft (substrate type) factor.

Formula of the final gamma GAM of the BFW group (deviance explained: 12.7%):

$$log(d) = s(northness_{125m}) + s(chla) + + factor(program) + factor(year) \quad \text{(S3.6.2)}$$

where d is the relative biomass; $norhtness_{125m}$ is northness (unitless) at the 125 m resolution; $chla$ is the chlorophyll-*a* concentration (mg.m^{-3}).

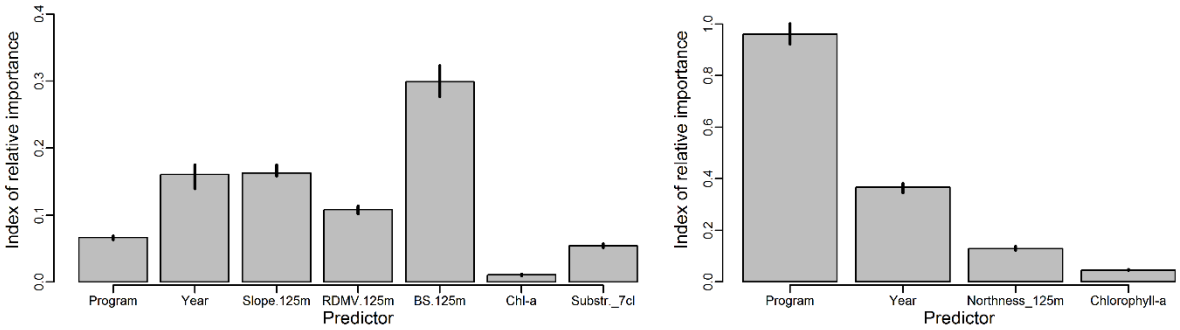


Figure S3.6.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the bottomfish-water column (BFW) group. Vertical black lines indicate confidence intervals. RDMV = relative deviance from mean value.

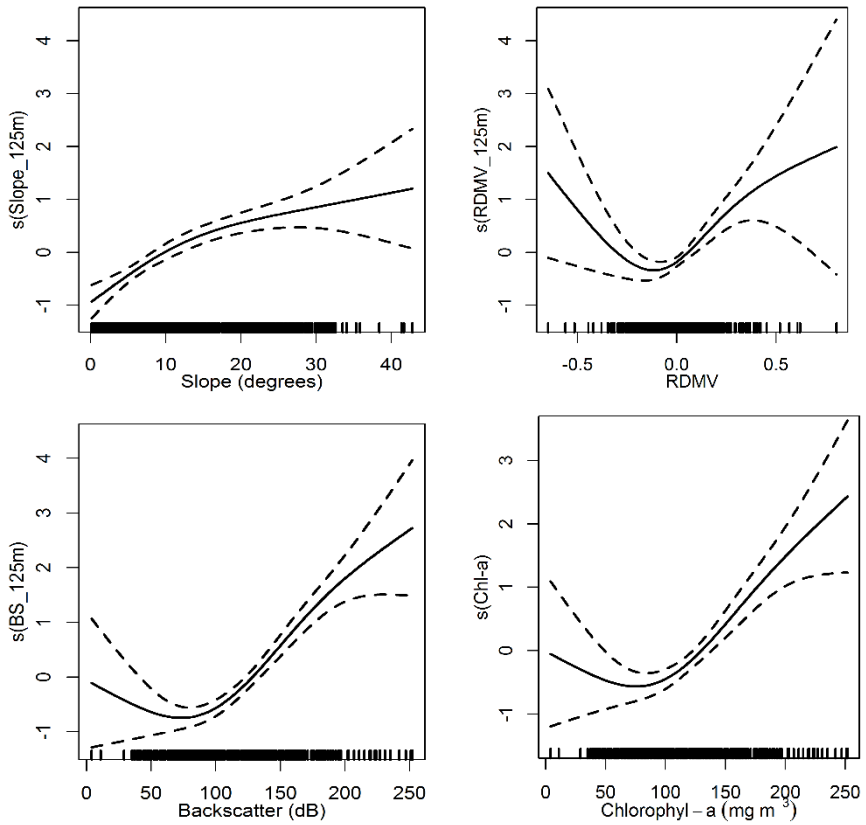


Figure S3.6.2. Smoothed curves of the additive effect to the estimated probability of encounter of the bottomfish-water column (BFW) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

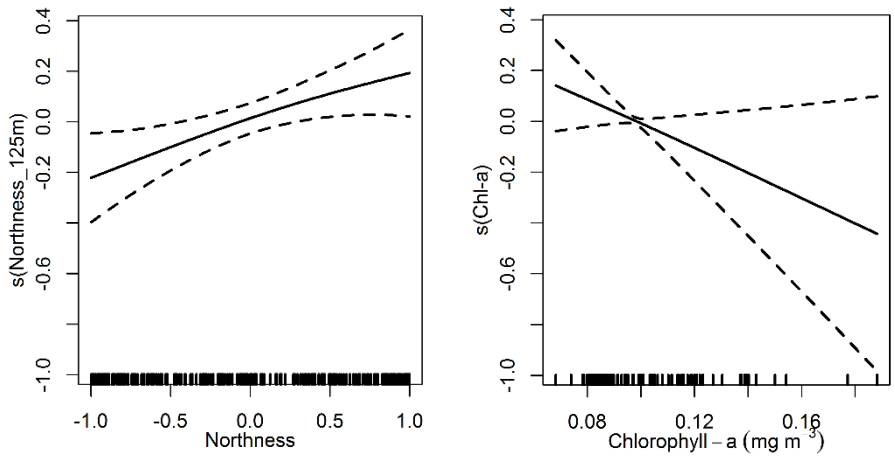


Figure S3.6.3. Smoothed curves of the additive effect to the estimated relative biomass of the bottomfish-water column (BFW) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

S3.7 Bottomfish-bottom (BFB group)

Formula of the final binomial generalized additive model (GAM) of the BFB group (deviance explained: 30.3%):

$$logit(p) = s(depth_{25m}) + s(backscatter_{25m}) + factor(HS_{4cl}) + factor(program) + factor(year) \quad \text{(S3.7.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (m) at the 25 m resolution; $backscatter_{25m}$is backscatter (decibels) at the 25 m resolution; and HS_{4cl} is the 4-level hard-soft (substrate type) factor.

Formula of the final gamma GAM of the BFB group (deviance explained: 21.9%):

$$log(d) = s(northness_{125m}) + s(depth_{125m}) + s(backscatter_{125m}) + factor(program) + factor(year) \quad \text{(S3.7.2)}$$

where d is the relative biomass; $northness_{25m}$ is northness (radians) at the 125 m resolution; $depth_{125m}$ is depth (meters) at the 125 m resolution; and $backscatter_{125m}$ is backscatter (decibels) at the 125 m resolution.

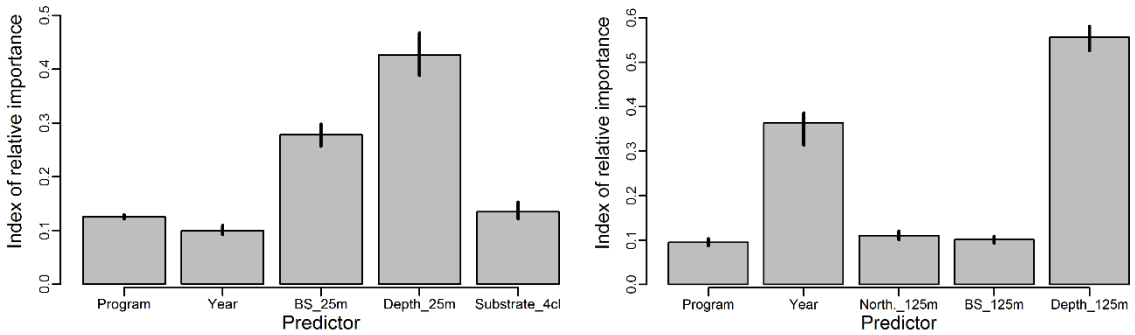


Figure S3.7.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the bottomfish-bottom (BFB) group. Vertical black lines indicate confidence intervals. North is Northness; BS is backscatter.

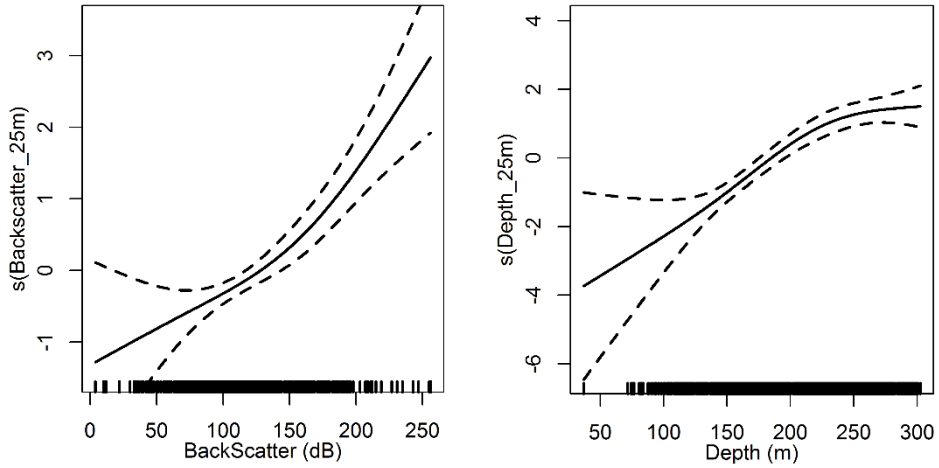


Figure S3.7.2. Smoothed curves of the additive effect to the estimated probability of encounter of the bottomfish-bottom (BFB) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation. Note that the scale of the y-axis differs from one panel to the next for display purposes.

Table S3.7.1 Contingency table of the binomial distribution substrate type (4-level) for the the bottomfish-bottom (BFB) group showing the number of encounters (1) and non-encounters (0) of the functional group in each substrate type.

	0	1
HARD	462	151
SOFT	310	13

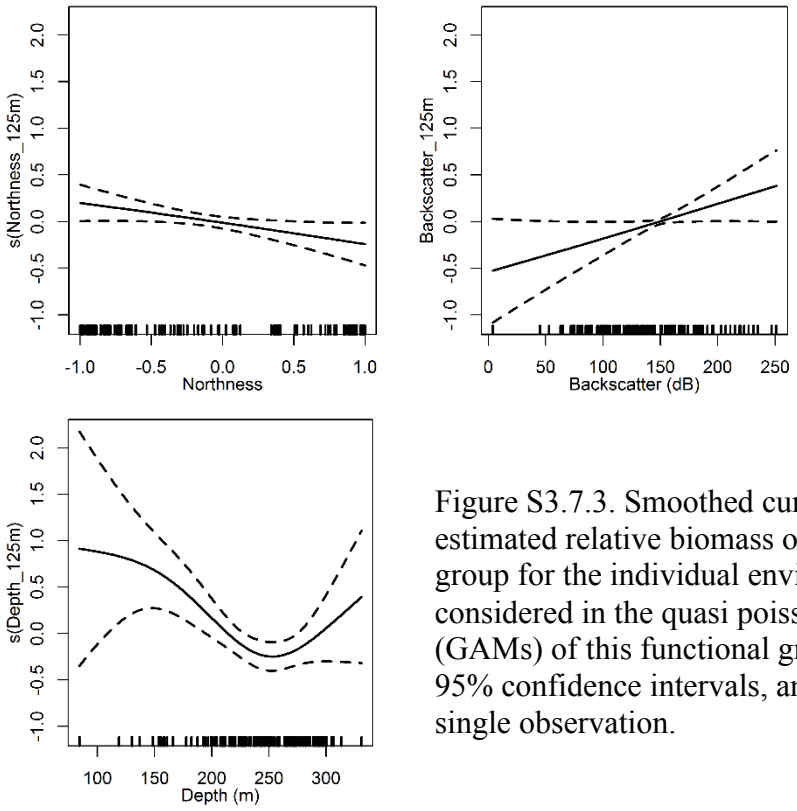


Figure S3.7.3. Smoothed curves of the additive effect to the estimated relative biomass of the bottomfish-bottom (BFB) group for the individual environmental parameters considered in the quasi poisson generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

S3.8 Uku (Green jobfish) (UKU group)

Formula of the final binomial generalized additive model (GAM) of the UKU group (deviance explained: 36.7%):

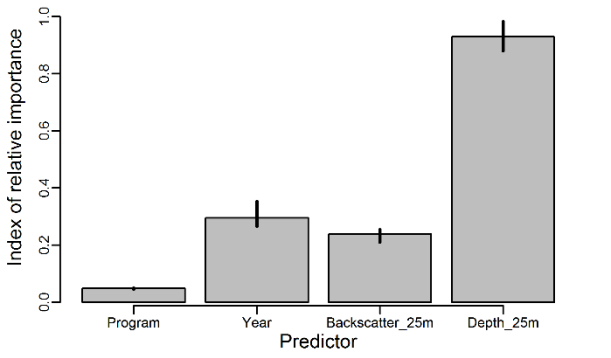
$$logit(p) = s(depth_{25m}) + s(backscatter_{25m}) + factor(program) + factor(year) \quad \text{(S3.8.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (meters) at the 25 m resolution; and $backscatter_{25m}$ is backscatter (decibels) at the 25 m resolution.

Formula of the final gamma GAM of the UKU group (deviance explained: 55.2%):

$$log(d) = s(northness_{125m}) + s(slope_{125m}) + s(RDMV_{125m}) + factor(program) + factor(year) \quad \text{(S3.8.2)}$$

where d is the relative biomass; $northness_{125m}$ is northness (unitless) at the 125 m resolution; $slope_{125m}$ is slope (degrees) at the 125 m resolution; and $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution.



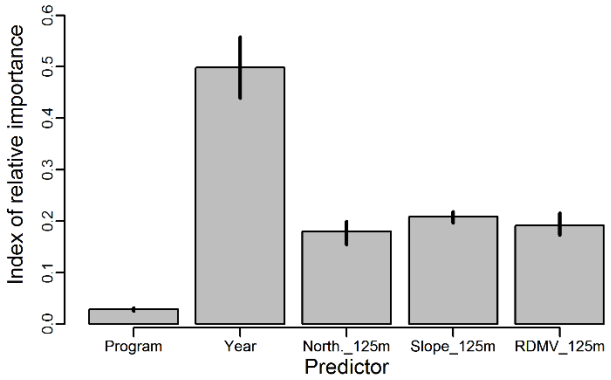


Figure S3.8.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the uku (UKU) group. Vertical black lines indicate confidence intervals.

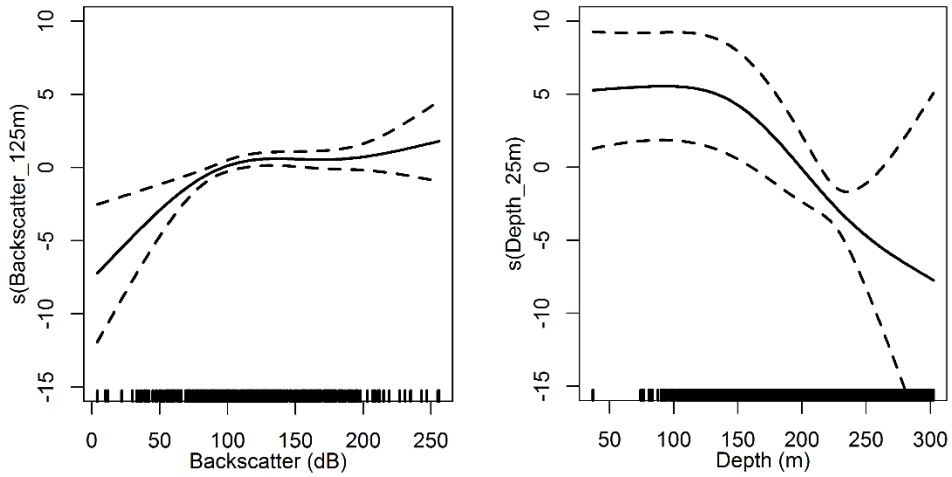


Figure S3.8.2. Smoothed curves of the additive effect to the estimated probability of encounter of the uku (UKU) group for the individual environmental parameters considered in the binomial gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

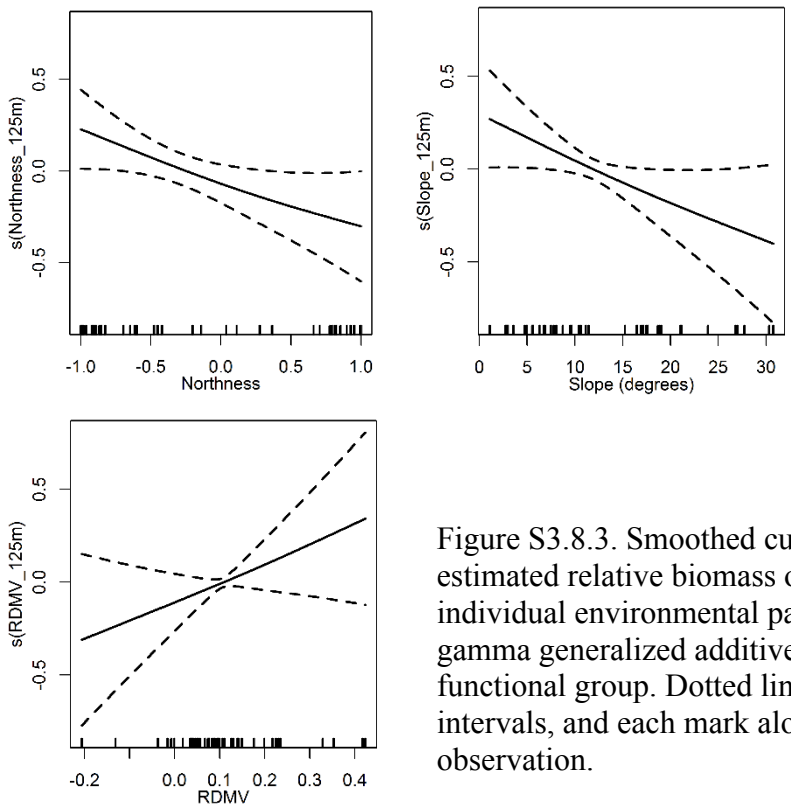


Figure S3.8.3. Smoothed curves of the additive effect to the estimated relative biomass of the uku (UKU) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

S3.9 Roving piscivores (PIS group)

Formula of the final binomial generalized additive model (GAM) of the PIS group (deviance explained: 22.1%):

$$logit(p) = s(depth_{25m}) + s(slope_{25m}) + s(northness_{25m}) + factor(HS_{7cl}) + factor(program) + factor(year) \quad \text{(S3.9.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (m) at the 25 m resolution; $slope_{25m}$ is slope (degrees) at the 25 m resolution; $northness_{25m}$ is northness (unitless) at the 25m resolution; and HS_{7cl} is the 7-level hard-soft (substrate type) factor.

Formula of the final gamma GAM of the PIS group (deviance explained: 16.2%):

$$log(d) = s(depth_{125m}) + s(northness_{125m}) + s(RDMV_{125m}) + factor(program) + factor(year) \quad \text{(S3.9.2)}$$

where d is the relative biomass; $depth_{125m}$ is depth (m) at the 125 m resolution; $northness_{125m}$ is northness (unitless) at the 125 m resolution; and $RDMV_{125m}$ is relative deviance from mean value (unitless) at the 125 m resolution

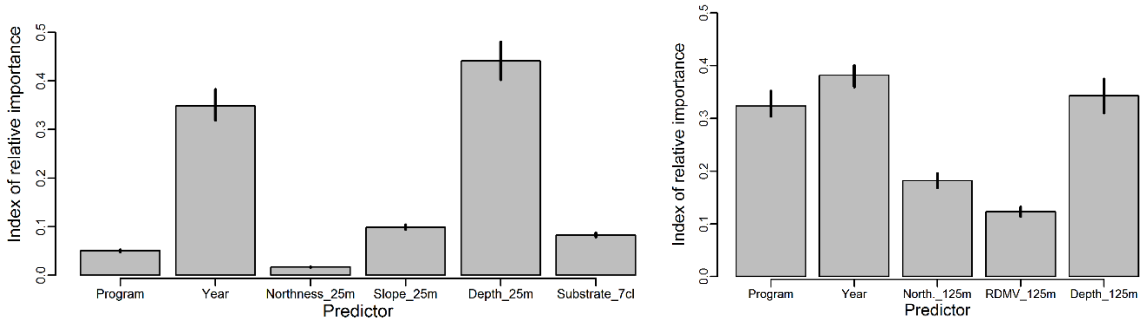


Figure S3.9.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the roving piscivore (PIS) group. Vertical black lines indicate confidence intervals.

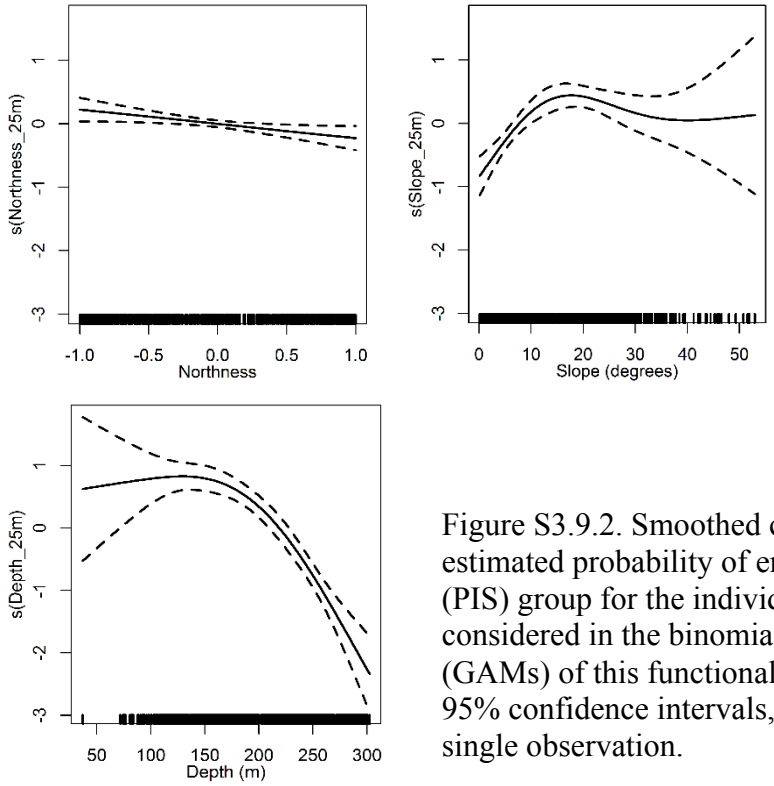


Figure S3.9.2. Smoothed curves of the additive effect to the estimated probability of encounter of the roving piscivore (PIS) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

Table S3.9.1 Contingency table of the binomial distribution substrate type (7-level) for the roving piscivore (PIS) group showing the number of encounters (1) and non-encounters (0) of the functional group in each substrate type.

	0	1
HARD	213	248
SOFT	331	214

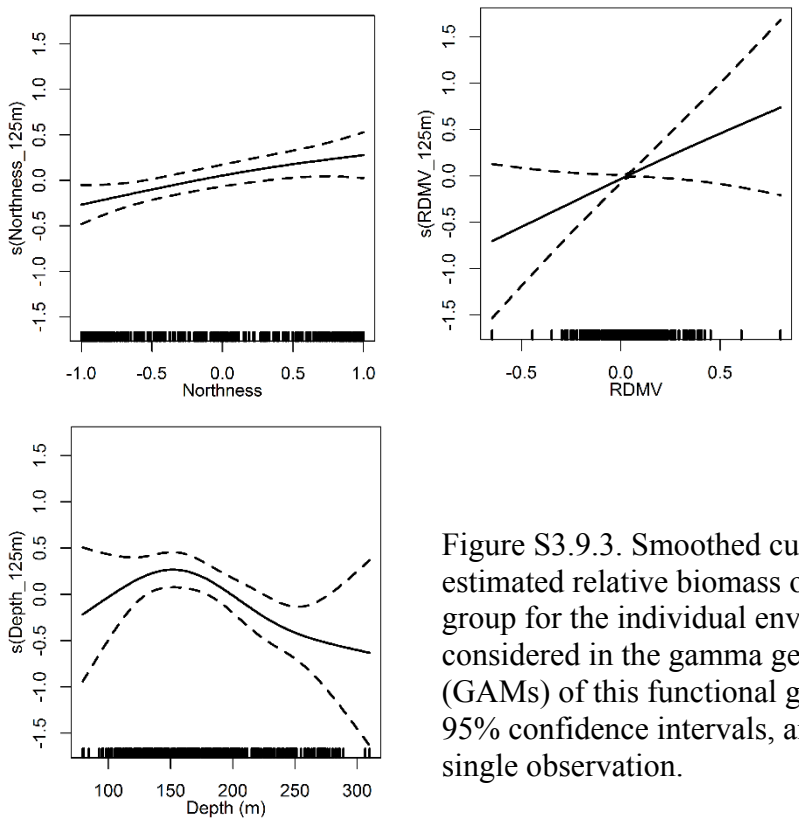


Figure S3.9.3. Smoothed curves of the additive effect to the estimated relative biomass of the roving piscivore (PIS) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

S3.10 Prey fish (SHP group)

Formula of the final binomial generalized additive model (GAM) of the SHP group (deviance explained: 19.4%):

$$logit(p) = s(depth_{25m}) + s(eastness_{25}) + s(slope_{25}) + factor(program) + factor(year) \quad \text{(S3.10.1)}$$

where p is probability of encounter; $depth_{25m}$ is depth (meters) at the 25 m resolution; $eastness_{25}$ is eastness (unitless) at the 25 m resolution; and $slope_{25}$ is slope (degrees) at the 25 m resolution.

Formula of the final gamma GAM of the SHP group (deviance explained: 95.1%):

$$log(d) = s(RDMV_{25m}) + factor(HS_{7cl}) + factor(program) + factor(year) \quad \text{(S3.01.2)}$$

where d is the relative non-zero biomass; $RDMV_{25m}$ is relative deviance from mean value (unitless) at the 25 m resolution; and HS_{7cl} is the 7-level hard-soft (substrate type) factor.

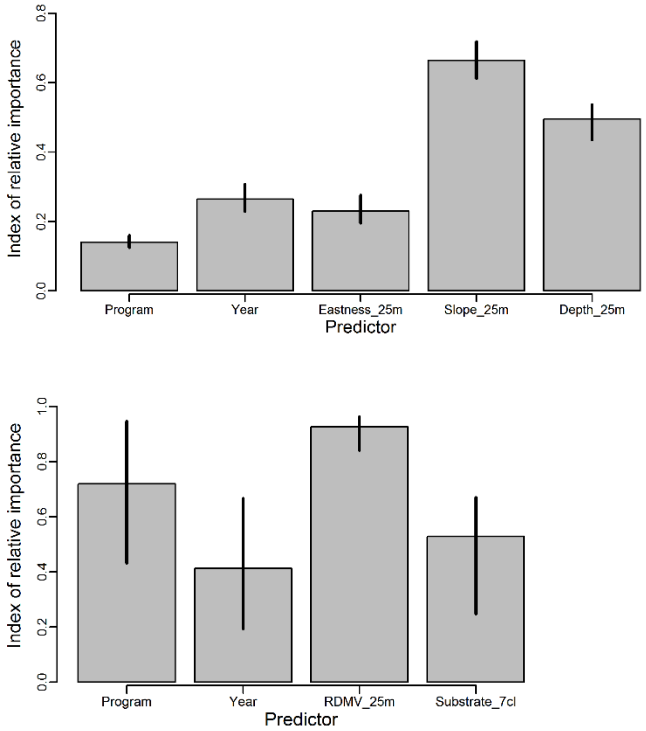


Figure S3.10.1. Relative importance of environmental predictors and the fixed effects of monitoring program and year in the spatial patterns of (*left*) probability of encounter and (*right*) relative biomass of the prey fish (SHP) group. Vertical black lines indicate confidence intervals.

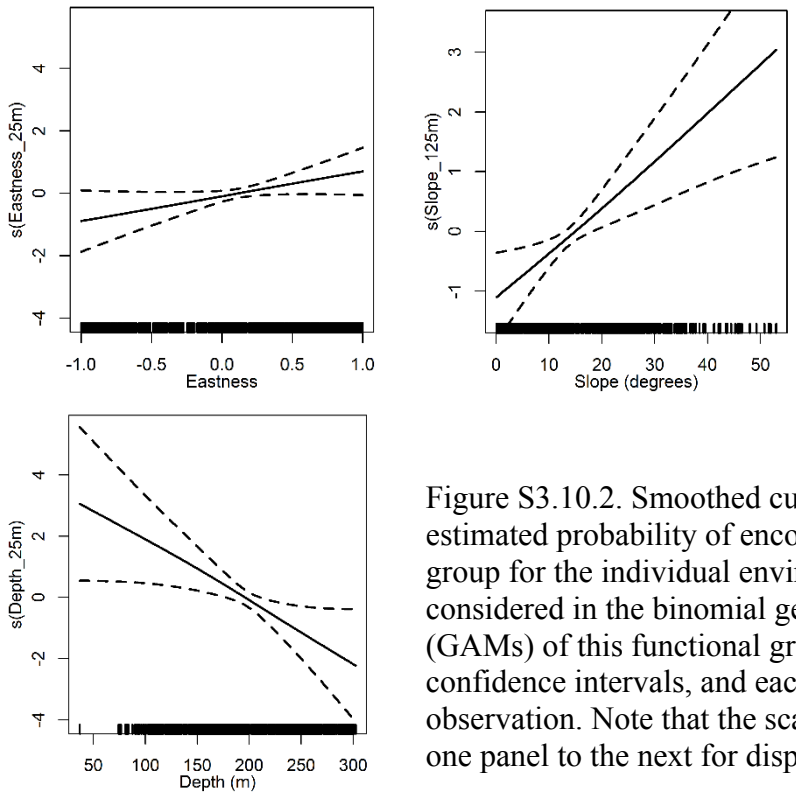


Figure S3.10.2. Smoothed curves of the additive effect to the estimated probability of encounter of the prey fish (SHP) group for the individual environmental parameters considered in the binomial generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation. Note that the scale of the y-axis differs from one panel to the next for display purposes.

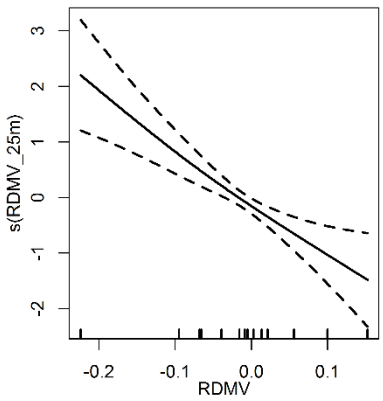


Figure S3.10.3. Smoothed curve of the additive effect to the estimated relative biomass of the prey fish (SHP) group for the individual environmental parameters considered in the gamma generalized additive models (GAMs) of this functional group. Dotted lines represent 95% confidence intervals, and each mark along the x-axis a single observation.

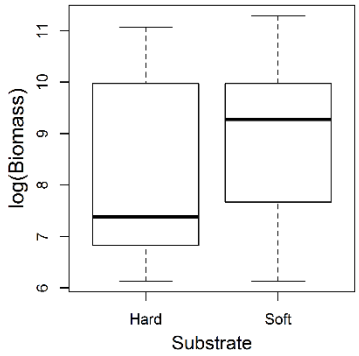
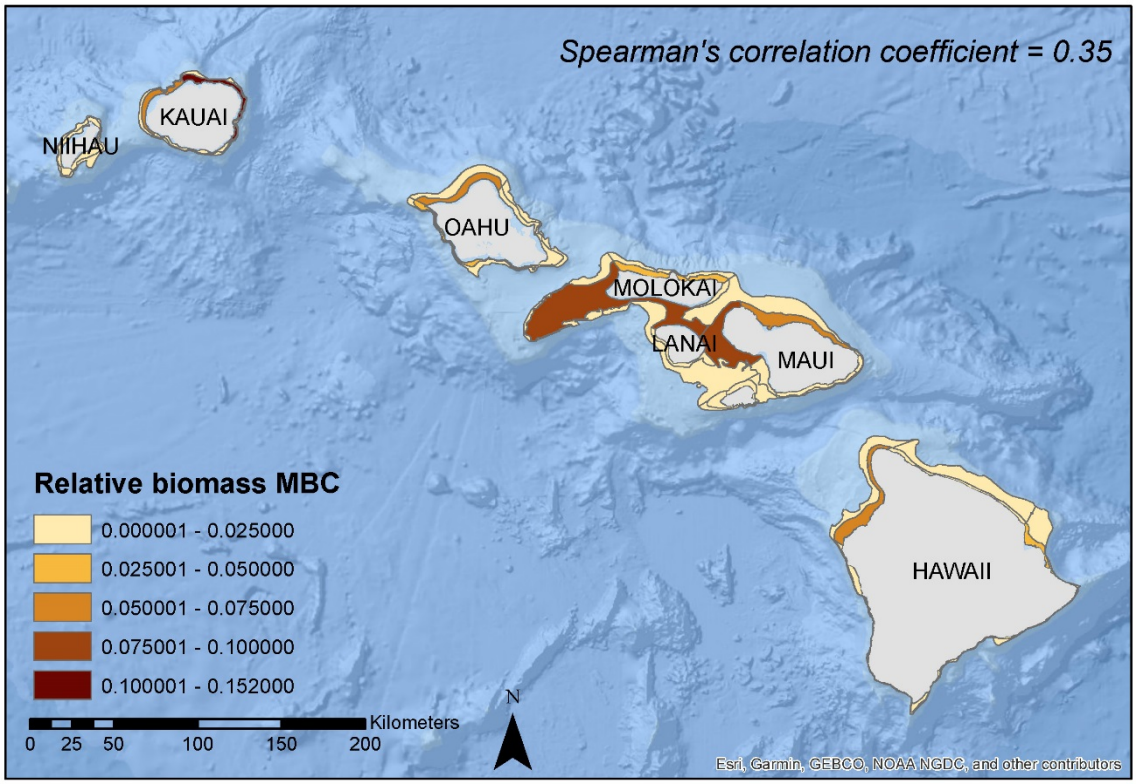
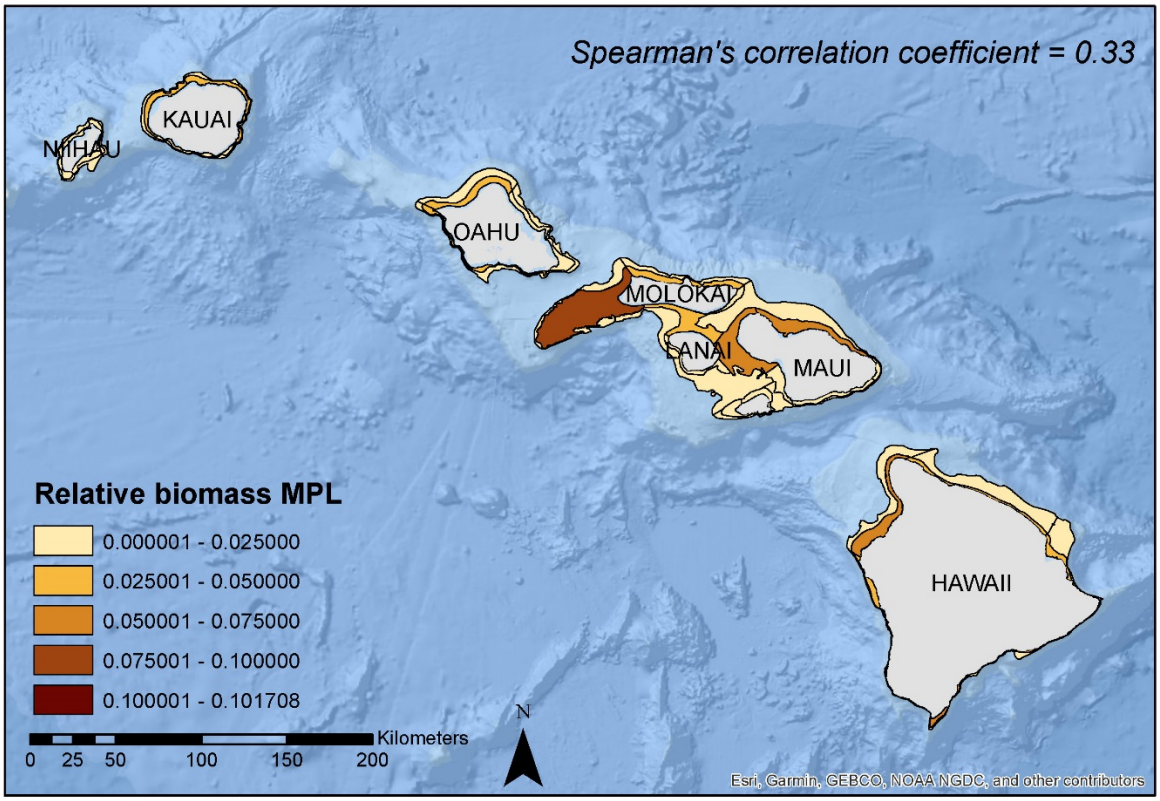


Figure S3.10.4. Distribution of the relative biomass of the prey fish (SHP) group for each substrate type predicted by the quasi poisson generalized additive model. Relative biomass is expressed here in ln(relative biomass + 1).

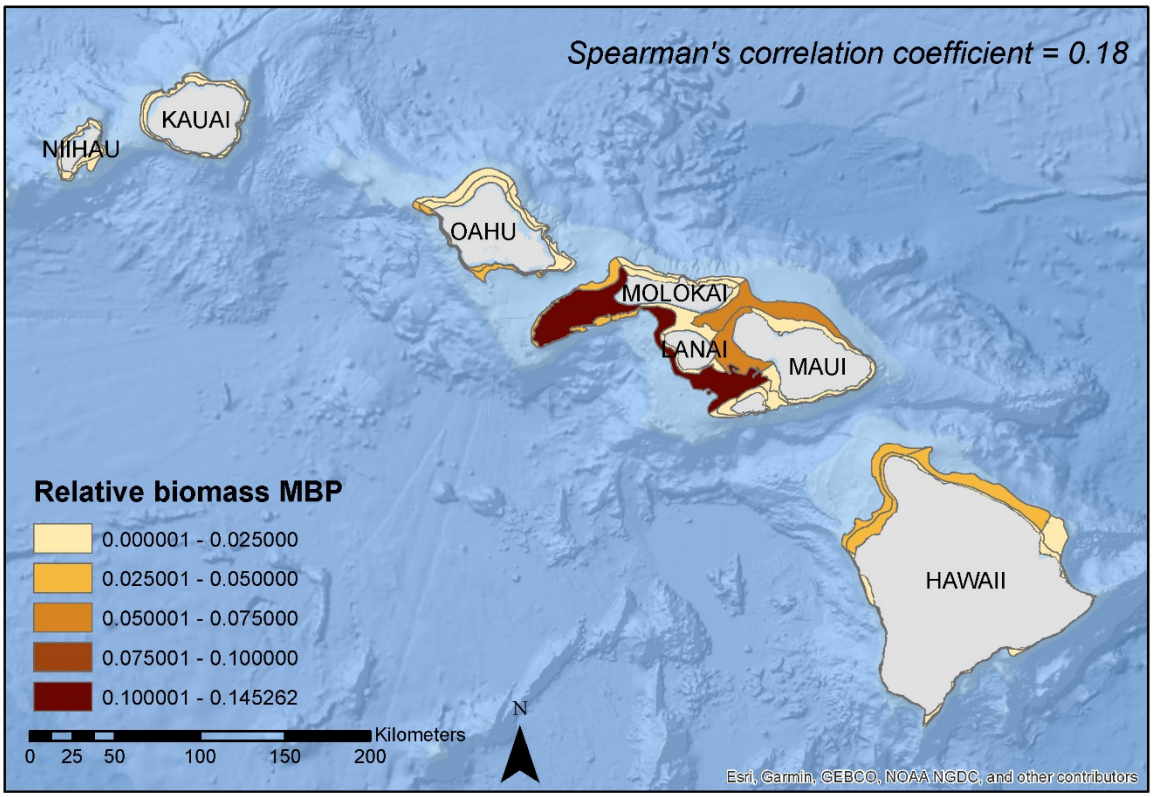
Supplement 4. Relative biomass maps of the fish functional groups represented in the main Hawaiian Islands (MHI) Atlantis model that were considered in this study.



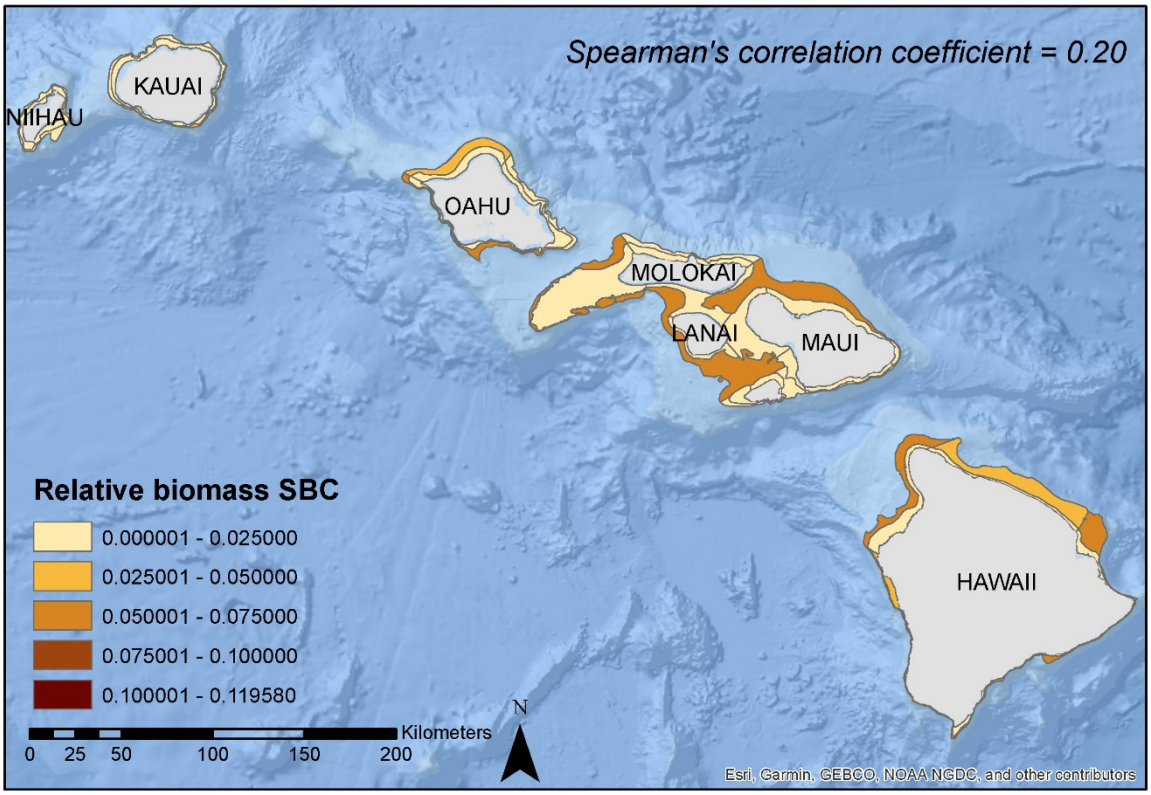
Mesophotic benthic carnivores - MBC



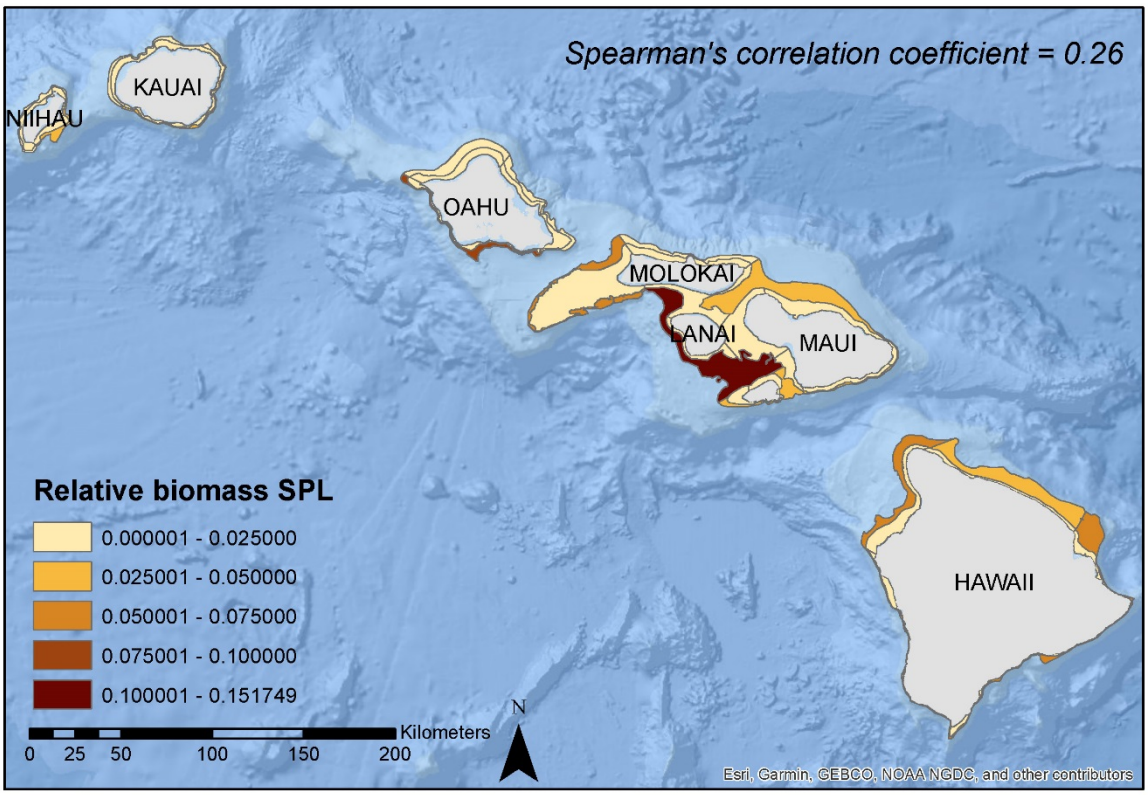
Mesophotic planktivores – MPL



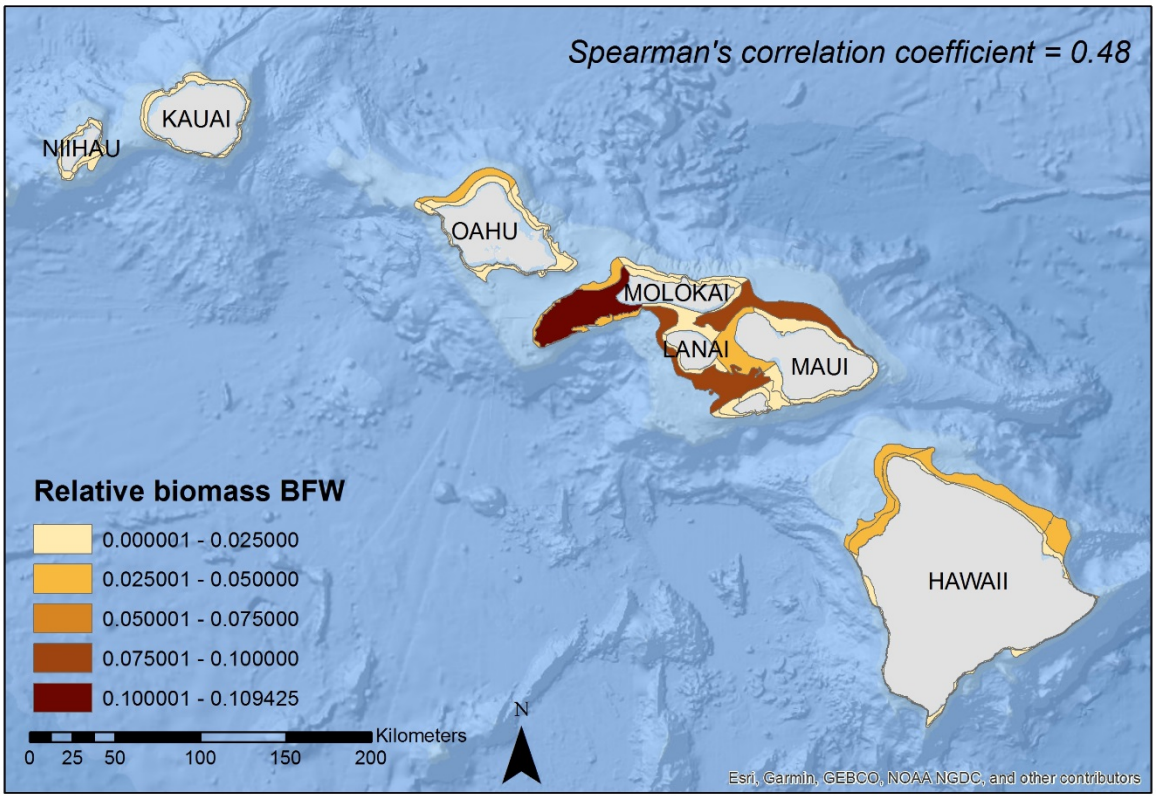
Meso- and subphotic benthic piscivores



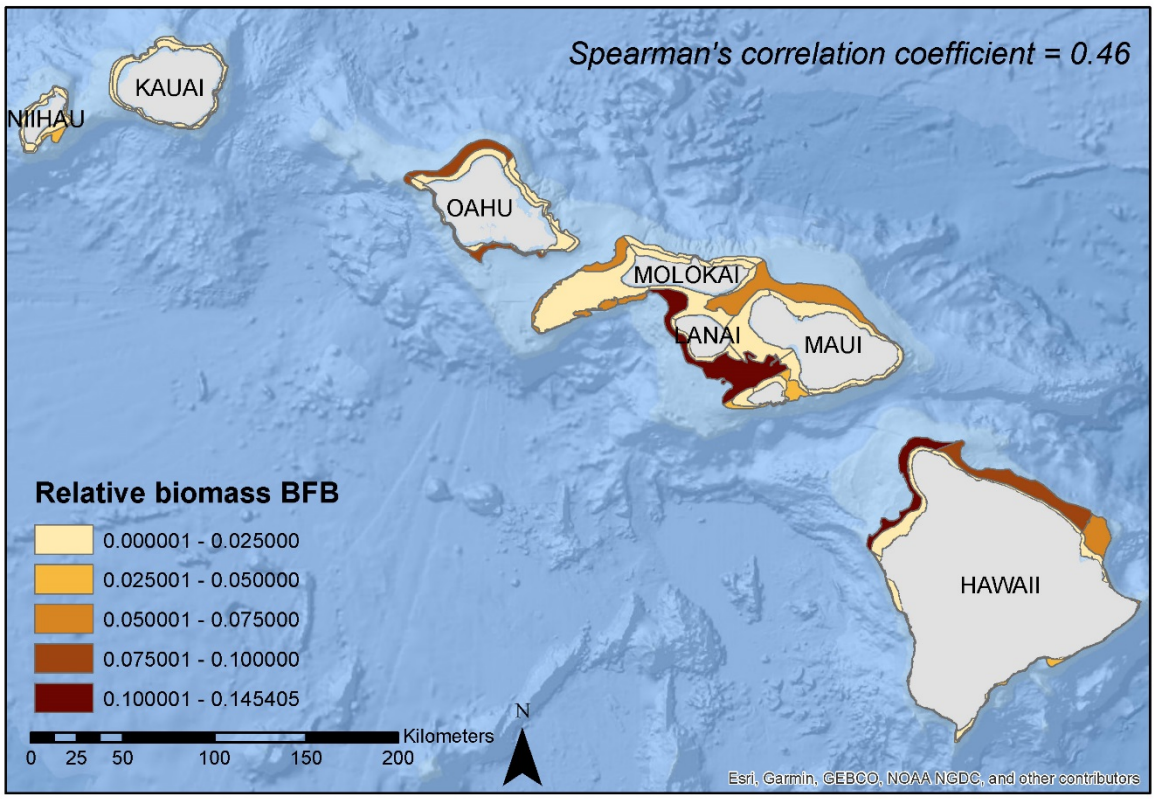
Subphotic benthic carnivores - SBC



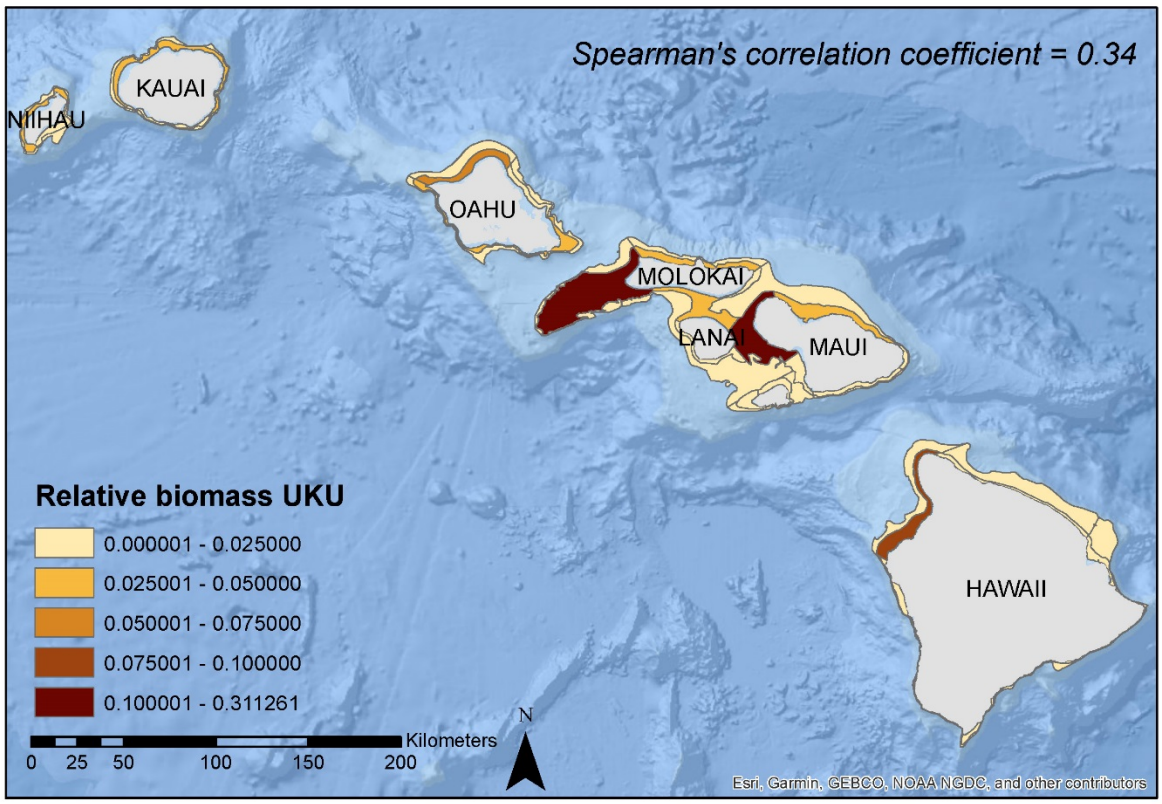
Subphotic planktivores - SPL



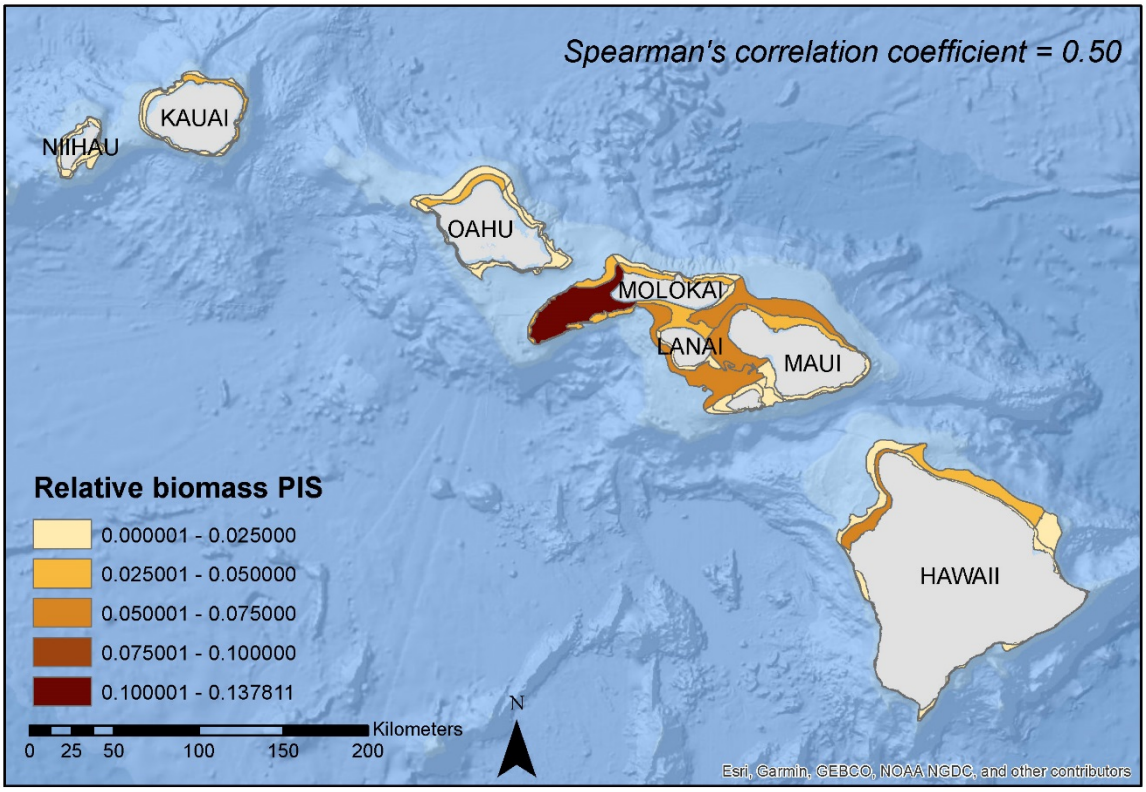
Bottomfish – water column (BFW)



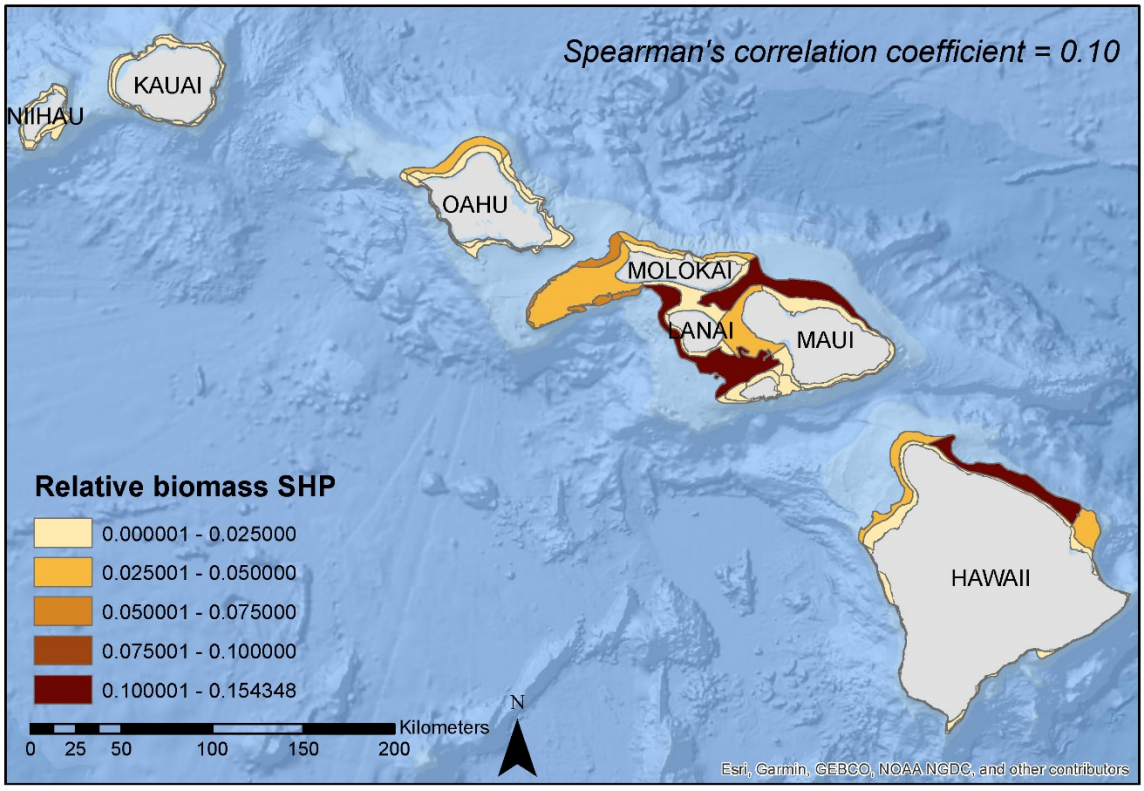
Bottomfish – bottom (BFB)



Uku – UKU



Roving piscivores (PIS)



Prey fish – SHP

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