The following supplements accompany the article

Support for the trophic theory of island biogeography across submarine banks in a predator-depleted large marine ecosystem

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Supplement 1. Community dissimilarity analyses

We used Detrended Correspondence Analysis (DCA) to examine the degree of similarity of the species composition and relative density (species occurrence per survey tow) among banks during the interval 1970-2016. DCA is a highly regarded ordination technique in community ecology and is considered an improvement on Principle Component Analysis (PCA) and Reciprocal Averaging (RA) due to its correction of arching behaviour in ordination axes and standardization of eigenvalues within each ordination axis (Hill & Gauch, 1980; Jackson & Somers, 1991; Oksanen & Minchin, 2009; Oksanen, et al., 2017). The results of this analysis (Fig. S1) provided evidence for a distinction between the fish communities inhabiting the offshore banks (labelled by name) relative to those inhabiting all other areas on the Scotian Shelf (labelled by number; Fig. S2).

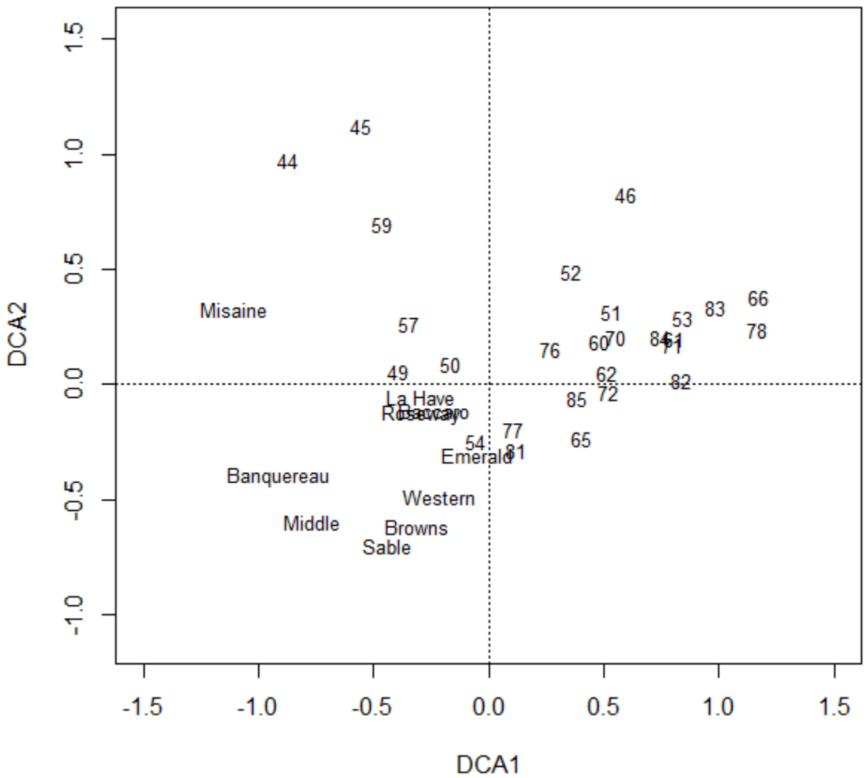

Fig. S1. Detrended Correspondence Analysis to evaluate community similarity among banks and other Scotian Shelf strata. Note that the banks (listed by name) cluster within one quadrant (with the exception of Misaine), while the remaining strata (listed by number) cluster across the remaining quadrants. See Fig. S2 for strata locations.

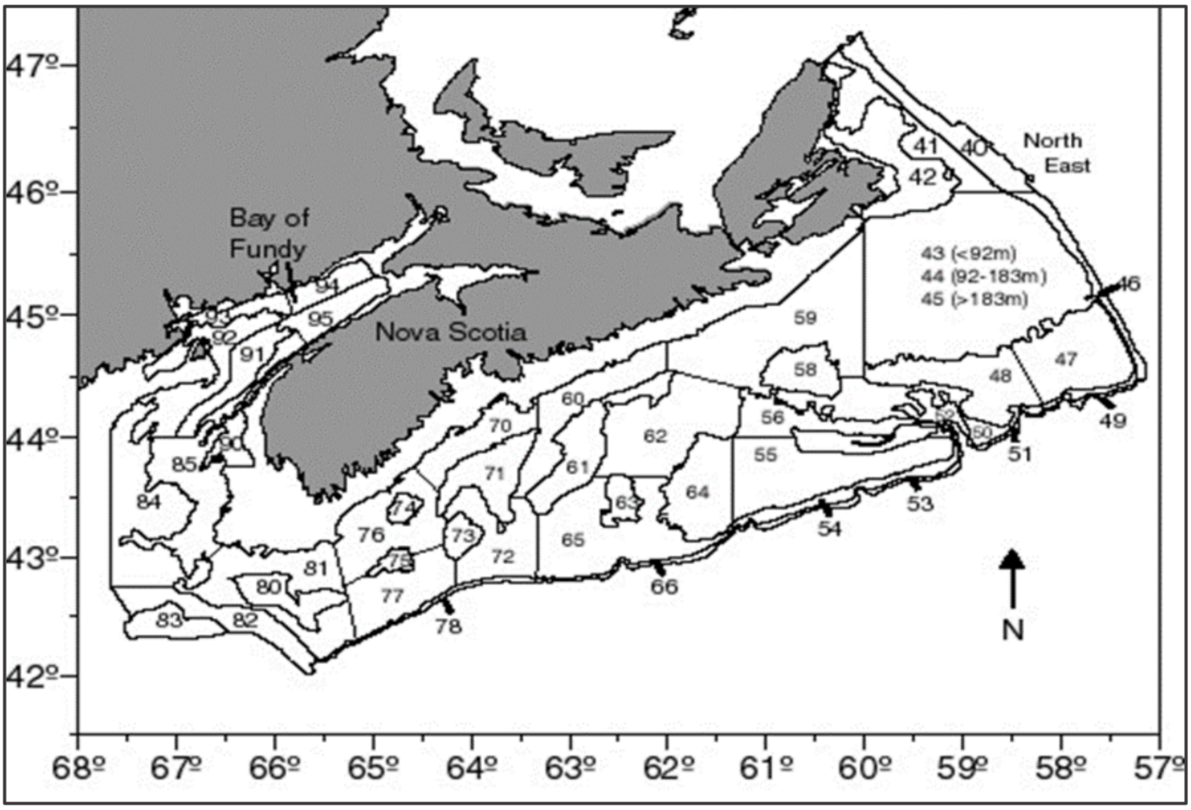

Fig. S2. Two-digit numeric designations of Research Vessel (RV) survey strata (DFO, 2016) sampled annually in July by Fisheries and Oceans Canada. The banks correspond to specific strata: Banquereau (47 & 48), Misaine (43), Middle (58), Sable (55 & 56), Western (64), Emerald (63), La Have (73), Roseway (74), Baccaro (75), and Brown's (80).

Supplement 2. Bank habitat characteristics

The area of each bank (Fig. S3a) was quantified using ArcMap 10.5 (ESRI, 2016), informed by the boundaries defined by depth in the design of DFO's July trawl survey strata (Supplement 1, Fig. S2). The topography (depth) of each bank was as defined by the Canadian Hydrographic Service (Fig. S3c). Average bottom temperature, per regime, was calculated for each bank given bottom temperature data collected annually per tow, during the DFO July trawl survey (Fig. S3b). Time-invariant indices of average scope for growth (Fig. S3d; a metric quantifying the combined effect of thermal energy, productivity, and oxygen availability; Kostylev & Hannah, 2007), and average natural disturbance (Fig. S3e; the ratio of frictional velocity exerted on the sea floor by oceanographic forces, to the resistance of the sediments to movement; Kostylev & Hannah, 2007) were obtained for each bank from the Geological Survey of Canada (V. Kostylev pers. comm.). Area was the single strongest predictor of alpha diversity for both prey and mesopredator trophic groups. No other habitat characteristics, after accounting for collinearity (Dormann et al. 2013) could explain the residual variability in the SARs, which was limited for the prey trophic group (R^2 = 0.87), and substantial for the mesopredator group (R^2 = 0.44).

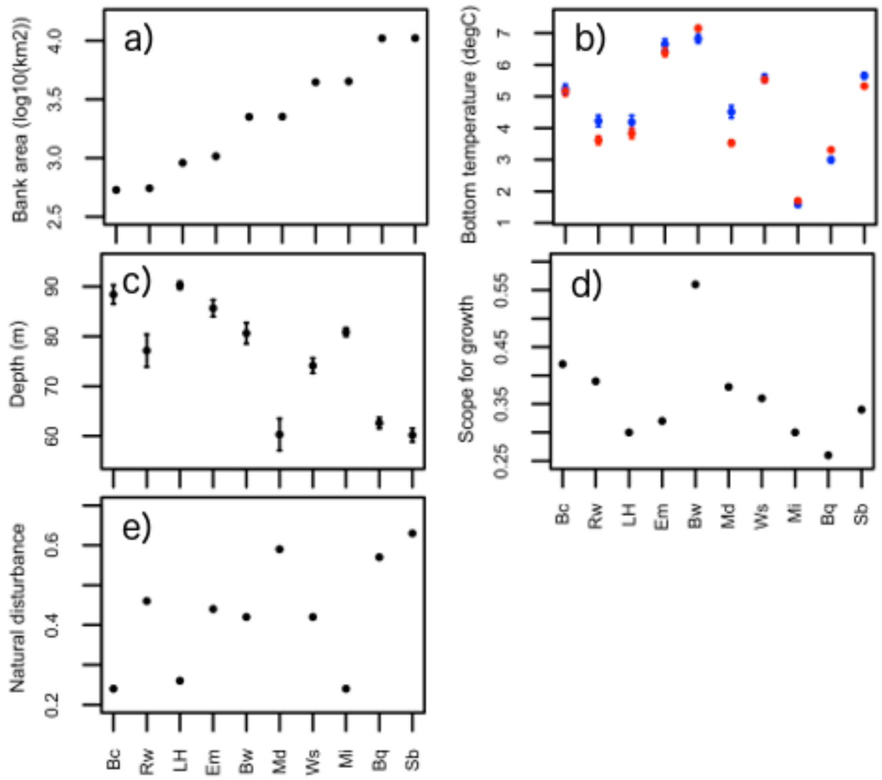

Fig. S3. Habitat characteristics of the banks (listed from smallest to largest along the x-axis). Error bars depict 95% confidence intervals derived from the standard error associated with the average values (points) per bank. *b) Average bottom temperature (and associated error) was calculated for both pre- (blue) and post-collapse (red) regimes, but there was little change between regimes on any of the banks.

Supplement 3. Fish species traits and occupancy of the banks in pre- and post-collapse regimes.

For each species observed on the Scotian Shelf offshore banks through the RV survey (DFO, 2016), we recorded the proportion (0-1) of banks on which the species was observed (PO), and the average of all recorded maximum lengths per tow (ML) across the Scotian Shelf offshore banks (Table S4.1). Species commercial status (C = commercially fished for any period within 1970-2016, N = never commercially fished), and the trophic group to which they were assigned, based on average ML within the pre-collapse regime (prey = 1-30 cm, mesopredators = 31-60 cm, top predators = > 60 cm), was also recorded (Table S1). Where there were no ML records on the banks, average ML was calculated using all ML records across the Scotian Shelf. For some rare, small-bodied species, body lengths were not recorded in the RV survey. In these cases, the global maximum body length provided by fishbase.org (Froese & Pauly 2000) was used. In some cases, average ML did not reflect the trophic level of certain species; Herring and Atlantic mackerel are known planktivores, therefore, despite their average ML's above 30 cm, these species were categorized as prey rather than mesopredators.

It is important to note that 30 species of the species sampled on the banks during the trawl surveys during the post-collapse regime, were not observed on the banks during the pre-collapse regime. Twenty-six of these species were in the prey trophic group, and four were mesopredators (Table S1). Of the 26 "new" prey species, 15 were not observed anywhere else on the Scotian Shelf before 1991 (New species status = "Colonist" in Table S1). Of the four new mesopredator species, only two were colonists (Table S1). New species that were previously (pre-collapse) observed in off-bank areas, were recorded as originating from the Scotian Shelf species pool (New species status = "SS pool" in Table S1). "Core" species were observed on the banks in the pre-collapse regime.

We also examined the frequency of observation (number of tows in which the species was observed during the summer research vessel survey) of prey (Table S2) and mesopredator (Table S3) species on each bank during each regime. This provided insight into the rarity of each species, and potential range expansions of more common species during the post-1991 era.

Table S1. Pre-collapse to post-collapse changes in the proportion of banks occupied (PO), and average maximum length per tow (cm) of all fish species observed on the banks. Commercial status (C: Commercial; N: Non-commercial; N* indicates where a species may be fished, but either not on the banks, or very infrequently and at low allowable catch) and trophic group, as defined by body size, are also provided. Where max. length was not recorded in the survey, it was estimated from fishbase.org (Froese & Pauly, 2000). (**) indicates where max. length did not reflect a species' trophic level and, consequently, the species was categorized based on diet.

Species name	Pre-collapse PO	Post-collapse PO	Max. length (cm)	Trophic group	Commercial status	New species status
American plaice	1	1	44	mesopred	C	-
Haddock	1	1	55	mesopred	C	-
Redfish	1	1	31	mesopred	C	-
Silver hake	1	1	40	mesopred	N*	-
Smooth skate	1	1	46	mesopred	N	-
Thorny skate	1	1	56	mesopred	N	-
Longhorn sculpin	1	1	30	prey	N	-
Mailed sculpin	1	1	12	prey	N	-
Atlantic cod	1	1	67	large pred	C	-
Pollock	1	1	67	large pred	C	-
Striped Atlantic wolffish	1	1	62	large pred	C	-
Oceanpout	0.9	0.8	56	mesopred	N	-
Sea raven	0.9	1	42	mesopred	N	-
Witch flounder	0.9	1	45	mesopred	N*	-
Yellowtail flounder	0.9	1	39	mesopred	N*	-
Herring	0.9	1	29	prey	C	-
Halibut	0.9	0.9	67	large pred	C	-
Spiny dogfish	0.9	0.9	84	large pred	C	-
White hake	0.9	0.9	62	large pred	C	-
Winter skate	0.9	1	71	large pred	C	-
Alligatorfish	0.8	1	13	prey	N	-
Northern sandlance	0.8	1	21	prey	N	-
Monkfish	0.8	1	62	large pred	N	-
Lumpfish	0.7	0.5	41	mesopred	N	-
Red hake	0.7	0.6	38	mesopred	N*	-
Butterfish	0.7	0.7	17	prey	N	-

Mackerel	0.7	0.9	34	prey**	C	-
Cusk	0.6	0.5	50	mesopred	C	-
Winter flounder	0.6	1	41	mesopred	N*	-
Arctic hookear sculpin	0.6	0.7	7	prey	N	-
Barndoor skate	0.5	0.3	94	large pred	N	-
Little skate	0.5	0.5	52	large pred	N	-
Atlantic argentine	0.4	0.4	24	prey	N	-
Atlantic saury	0.4	0.6	27	prey	N	-
Capelin	0.4	0.4	16	prey	N	-
Atlantic spiny lumpsucker	0.3	0.9	4	prey	N	-
Longfin hake	0.3	0.1	29	prey	N	-
Snake blenny	0.3	0.3	18	prey	N	-
Arctic eelpout	0.2	0	42	mesopred	N	-
Turbot	0.2	0.3	31	mesopred	N*	-
Atlantic seapoacher	0.2	0.5	17	prey	N	-
Blackbelly rosefish	0.2	0.2	12.5	prey	N	-
Daubed shanny	0.2	0.4	12	prey	N	-
Marlin-spike grenadier	0.2	0	21	prey	N	-
Shorttailed eelpout	0.2	0.3	28	prey	N	-
Windowpane	0.2	0.2	29	prey	N	-
Spotted Wolffish	0.2	0	80	large pred	N	-
Laval's eelpout	0.1	0.2	43	mesopred	N	-
Offshore hake	0.1	0	55	mesopred	N	-
4-line snake blenny	0.1	0.1	13	prey	N	-
Alewife	0.1	0.3	28	prey	N	-
Arctic alligatorfish	0.1	0.1	18	prey	N	-
Common searobin	0.1	0	45	mesopred	N	-
Cunner	0.1	0.2	23	prey	N	-
Fourbeard rockling	0.1	0.2	22	prey	N	-
Gulf Stream flounder	0.1	0.4	14	prey	N	-
Radiated shanny	0.1	0.4	15	prey	N	-
Rock gunnel (eel)	0.1	0.4	14	prey	N	-

Short-nose greeneye	0.1	0.1	6	prey	N	-
Twohorn sculpin	0.1	0.2	6	prey	N	-
Newfoundland eelpout	0	0.1	37	mesopred	N	Colonist
Round skate	0	0.2	42	mesopred	N	Colonist
Atlantic torpedo	0	0.1	40	mesopred	N	SS pool
Snipe eel	0	0.1	45	mesopred	N	SS pool
American barrelfish	0	0.2	12	prey	N	Colonist
Tonguefish	0	0.2	9	prey	N	Colonist
Spotted hake	0	0.1	22	prey	N	Colonist
Spotfin dragonet	0	0.4	17	prey	N	Colonist
Spatulate sculpin	0	0.5	11	prey	N	Colonist
Slender eelblenny	0	0.1	15	prey	N	Colonist
Sea tadpole	0	0.3	8	prey	N	Colonist
Ribbed sculpin	0	0.3	11	prey	N	Colonist
Polar eelpout	0	0.1	12	prey	N	Colonist
Nybelin sculpin	0	0.1	14	prey	N	Colonist
Grubby sculpin	0	0.3	7	prey	N	Colonist
Atlantic soft pout	0	0.3	11	prey	N	Colonist
Atlantic moonfish	0	0.1	5	prey	N	Colonist
Atlantic hookear sculpin	0	1	7	prey	N	Colonist
Arctic staghorn sculpin	0	0.2	17	prey	N	Colonist
American John Dory	0	0.2	20	prey	N	SS pool
White barracudina	0	0.2	29	prey	N	SS pool
Summer flounder	0	0.1	24	prey	N	SS pool
Shorthorn sculpin	0	0.4	27	prey	N	SS pool
Northern puffer	0	0.3	3	prey	N	SS pool
Muller's pearlsides	0	0.1	5	prey	N	SS pool
Fish doctor	0	0.1	15	prey	N	SS pool
Common wolf eel	0	0.1	20	prey	N	SS pool
Boa dragonfish	0	0.1	28	prey	N	SS pool
Atlantic batfish	0	0.3	11	prey	N	SS pool
American shad	0	0.2	29	prey	N	SS pool

Table S2. Pre-1992 and post-1991 frequency of occurrence of each prey species on each of the ten banks. Frequency of occurrence (white = 0, yellow = lowest, red = highest) represents the number of tows in which the species was observed on the bank, during the specified regime.

		Baccaro		Banquereau		Browns		Emerald		La Have		Middle		Misaine		Roseway		Sable		Western	
Colonist ID	Species	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991
Colonist	American barrelfish	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Colonist	Arctic staghorn sculpin	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Colonist	Atlantic moonfish	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colonist	Atlantic soft pout	0	0	0	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Colonist	Grubby or little sculpin	0	0	0	1	0	0	0	0	0	0	0	3	0	5	0	0	0	0	0	0
Colonist	Hookear sculpin,atl.	0	7	0	11	0	4	0	2	0	7	0	6	0	24	0	3	0	6	0	3
Colonist	Nybelin s sculpin	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Colonist	Polar eelpout	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Colonist	Ribbed sculpin	0	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Colonist	Sea tadpole	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0
Colonist	Slender eelblenny	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Colonist	Spatulate sculpin	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	1	0	1	0	2
Colonist	Spotfin dragonet	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
Colonist	Spotted hake	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colonist	Tonguefish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1
SS pool	American John Dory	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
SS pool	Atlantic batfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
SS pool	Boa dragonfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SS pool	Common wolf eel	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
SS pool	Fish doctor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SS pool	Mueller's pearlsides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
SS pool	Northern puffer	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
SS pool	American shad	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
SS pool	Shorthorn sculpin	0	0	0	13	0	0	0	0	0	0	0	8	0	2	0	0	0	2	0	0
SS pool	Summer flounder	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
SS pool	White barracudina	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0
Core	4-line snake blenny	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Core	Alewife	0	0	0	0	1	7	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Core	Alligatorfish	2	12	1	69	4	36	0	2	2	5	0	47	8	47	1	3	3	60	3	17
Core	Arctic alligatorfish	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Core	Argentine (atlantic)	0	0	1	1	3	2	4	1	0	0	0	0	0	0	0	0	1	0	0	2
Core	Atlantic saury,needlefish	0	1	1	2	0	1	0	0	0	0	0	1	0	0	1	0	1	3	1	1
Core	Atlantic sea poacher	0	0	1	7	1	0	0	0	0	0	0	2	0	12	0	1	0	2	0	0
Core	Atlantic spiny lumpsucker	0	3	1	47	0	2	0	0	0	7	0	27	2	24	0	5	1	10	0	5
Core	Windowpane	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	22	15	0	0
Core	Butterfish	1	0	0	0	3	18	2	5	0	4	2	3	1	0	0	1	4	20	3	9
Core	Capelin	0	0	3	51	0	0	0	0	0	0	2	22	4	20	0	0	3	23	0	0
Core	Cunner	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	4	7	0	0
Core	Daubed shanny	0	0	2	3	0	0	0	0	0	0	0	3	3	27	0	0	0	2	0	0
Core	Fourbeard rockling	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Core	Gulf Stream flounder	0	2	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	1	0	13
Core	Herring (atlantic)	1	33	1	23	3	117	9	36	0	31	6	30	1	11	2	17	45	135	16	86
Core	Longfin hake	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	0	1	0
Core	Longhorn sculpin	23	21	126	216	48	134	17	20	8	16	48	100	9	17	5	19	239	300	75	97
Core	Lumpfish	1	1	1	1	0	0	0	0	1	0	0	1	6	1	4	2	1	0	1	0
Core	Mackerel (atlantic)	0	6	10	1	1	19	2	6	0	2	6	1	2	0	0	1	40	49	15	14
Core	Mailed sculpin	14	15	27	129	10	33	6	4	7	17	9	69	32	64	10	7	23	78	17	19
Core	Marlin-spike grenadier	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Core	Northern sand lance	0	2	38	276	3	19	4	5	0	2	12	120	7	85	1	3	25	143	3	20
Core	Radiated shanny	1	0	0	0	0	3	0	0	0	2	0	0	0	3	0	0	0	0	0	1
Core	Rock gunnel(eel)	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	1
Core	Rosefish(black belly)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Core	Short-nose greeneye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Core	Shorttailed eelpout(vahl)	0	0	1	6	0	0	0	0	0	0	0	0	5	19	0	0	0	2	0	0
Core	Snake blenny	0	0	2	2	0	0	0	0	0	0	0	0	0	14	0	0	1	3	1	0
Core	Snowflake hookear sculpin	0	0	5	7	1	1	0	0	1	1	0	4	6	12	0	0	1	10	2	1
Core	Twohorn sculpin	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0

Table S3. Pre-1992 and post-1991 frequency of occurrence of each mesopredator species on each of the ten banks. Frequency of occurrence (white = 0, yellow = lowest, red = highest) is the number of tows in which the species was observed on the bank, during the specified regime.

	Baccaro		Banquereau		Brown's		Emerald		La Have		Middle		Misaine		Roseway		Sable		Western	
Species	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991	Pre-1992	Post-1991
American plaice	24	30	196	293	25	91	27	36	10	26	73	144	85	100	22	28	228	260	92	136
Arctic eelpout	0	0	1	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
Atlantic torpedo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cusk	7	4	0	0	8	3	1	0	3	1	0	0	0	0	2	2	0	0	5	2
Newfoundland eelpout	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
Haddock	44	51	74	58	90	194	46	58	44	50	54	127	12	3	40	52	205	317	103	169
Laval's eelpout	0	0	1	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Little skate	0	2	2	1	14	84	0	0	0	0	2	0	0	0	0	0	29	44	4	16
Longhorn sculpin	23	21	126	216	48	134	17	20	8	16	48	100	9	17	5	19	239	300	75	97
Lumpfish	1	1	1	1	0	0	0	0	1	0	0	1	6	1	4	2	1	0	1	0
Monkfish,goosefish,angler	5	9	8	4	15	59	18	13	0	3	11	2	0	1	4	2	86	33	43	74
Common sea robin	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Ocean pout	3	2	2	2	10	29	1	4	0	0	5	1	11	1	1	0	78	33	16	27
Off-shore hake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Redfish spp.	13	30	13	19	3	26	8	16	13	22	5	5	16	24	8	28	15	31	5	39
Round skate	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sea raven	16	21	43	140	28	96	8	5	5	14	32	88	0	5	4	15	156	170	48	75
Silver hake	5	12	54	27	15	84	8	36	1	5	24	82	3	2	1	8	194	302	59	141
Smooth skate	11	4	41	19	5	3	6	3	2	1	15	1	9	2	5	8	79	16	27	14
Snipe eel	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Squirrel or red hake	1	3	0	0	2	29	7	12	0	0	2	7	0	0	1	0	52	83	16	75
Thorny skate	26	4	196	233	50	26	16	4	15	1	51	27	74	49	20	5	186	25	81	26
Turbot, Greenland halibut	0	0	0	1	0	1	0	0	0	0	0	0	1	2	0	0	1	0	0	0
Winter flounder	1	4	0	1	23	162	0	3	0	1	1	13	0	1	1	7	146	228	15	106
Witch flounder	6	13	99	137	8	27	13	17	0	6	26	20	32	24	6	17	117	105	56	87
Yellowtail flounder	6	7	185	308	66	173	29	31	0	2	78	153	34	41	12	23	279	384	101	149

Supplement 4. A comparison of alpha diversity estimators

Forty-six years of annual sampling has not resulted in cumulative species richness reaching a clearly defined asymptote for most of the Scotian Shelf offshore banks (Fig. S4). Therefore, using a species richness estimator based on such an assumption would be unwise. Further, several non-parametric species richness estimators have proven more accurate than estimates based on species accumulation curves in multiple field studies and computer simulations (Palmer, 1990; Gotelli & Colwell, 2011).

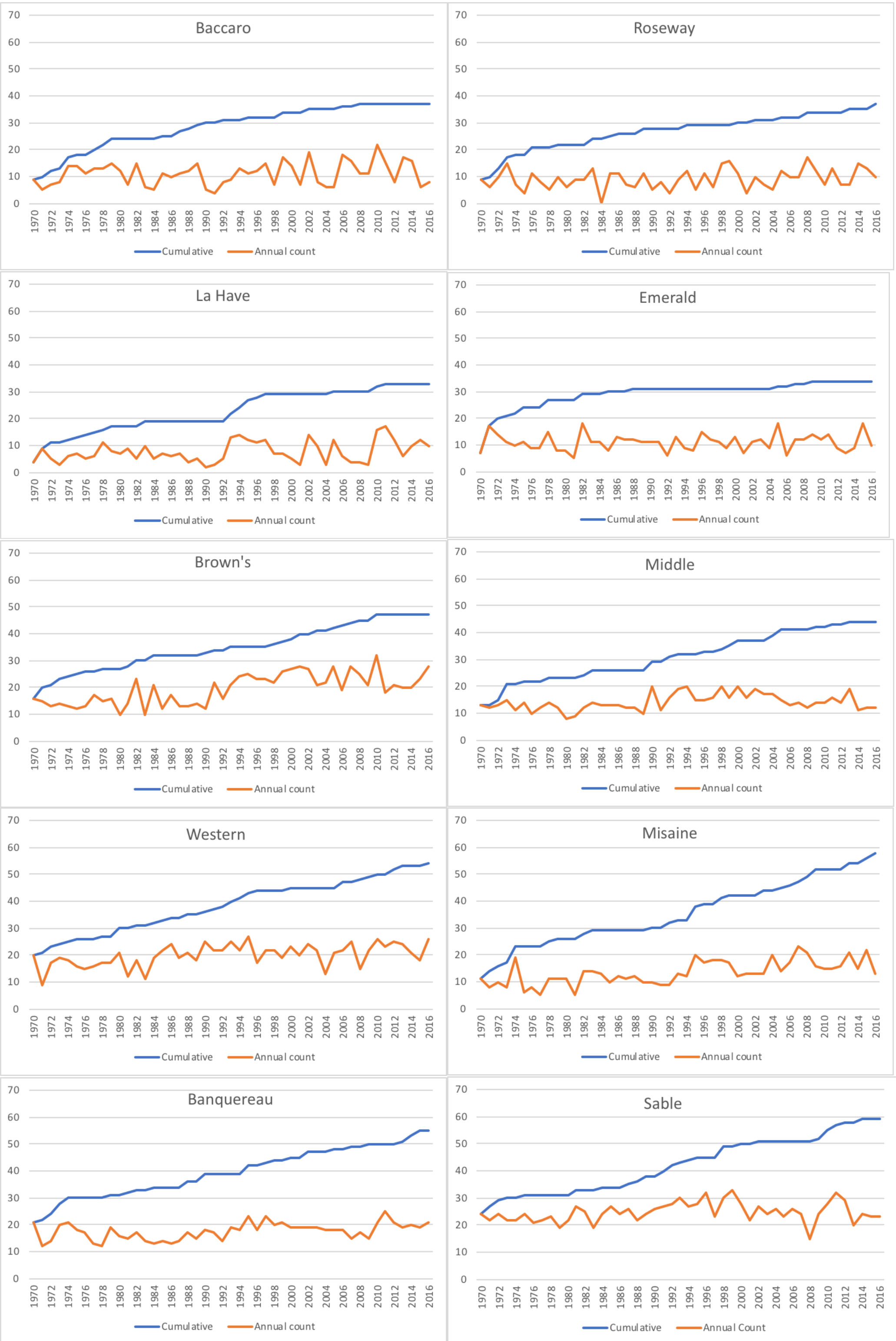

Fig. S4. Species accumulation and yearly species count (richness) per bank derived from the annual Fisheries and Oceans Canada Research Vessel survey observations.

Chao (Chao, 1987), Jackknife (Heltshe & Forrester, 1983), and Bootstrap (Smith & van Belle, 1984) approaches were used to estimate regime-specific alpha diversity on each of the ten banks for each trophic group (prey – Fig. S5; mesopredators – Fig. S6), as well as for the entire fish community (Fig. S7). These estimates were also compared to species counts (blue dots, Figs. S5 – S7). All calculations were completed using the R package "vegan" (Oksanen *et al.*, 2017). Equations for each estimate (S_e) are shown below.

Chao	$S_e = S_0 + \left(\frac{a_1^2}{2a_2} * \frac{(N-1)}{N}\right)$
Chao (bias-corrected)	$S_e = S_0 + \left(\frac{a_1(a_1-1)}{2(a_2-1)} * \frac{(N-1)}{N}\right)$
First order Jackknife	$S_e = S_0 + \left(a_1 * \frac{(N-1)}{N}\right)$
Bootstrap	$S_e = S_0 + \sum_{i=1}^{S_0}(1-p_i)^N$

S_0 is the number of species observed, a_1 is the number of species only observed in one sample (i.e., one year), N is the total number of samples (years), and p_i is the frequency of species i (i.e., the number of years in which the species was observed). For Chao estimates, the original Chao was used when doubletons were observed, but the vegan function, "specpool" switches automatically to the bias-corrected Chao estimate when doubletons were not observed (Chiu et al. 2014). Standard error associated with each estimate were based on the following sources: Chiu et al. (2014) for the Chao estimates and Smith & van Belle (1984) for the first-order Jackknife and the bootstrap.

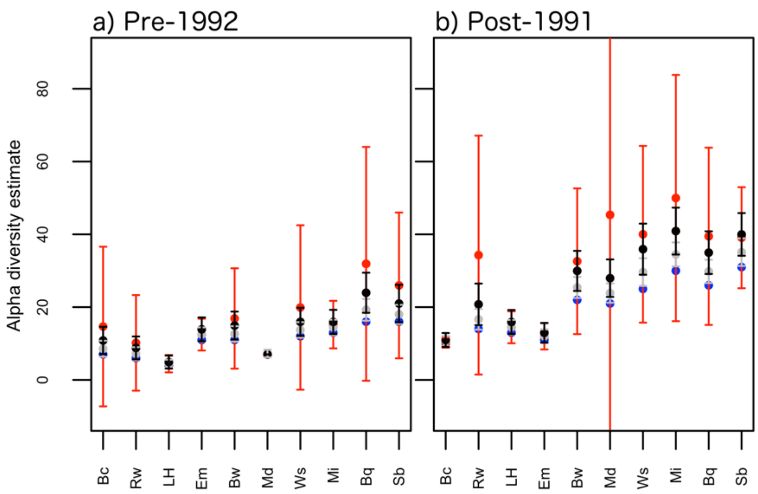

Fig. S5. Alpha diversity estimates (for the prey trophic group) on each bank listed on the x-axis from smallest (Bc) to largest (Sb) during the pre- (a) and post-collapse (b) regimes. Estimates are as follows: Raw species count (blue), Chao (red), Jackknife (black), and Bootstrap (grey).

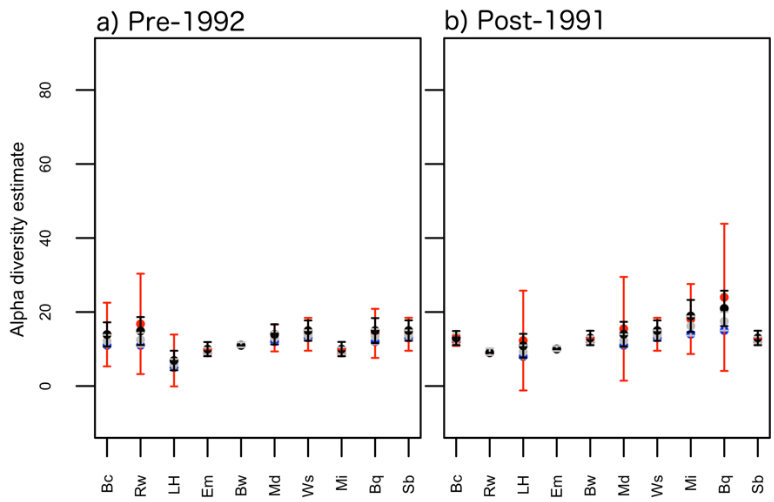

Fig. S6. Alpha diversity estimates (for the mesopredator trophic group) on each bank listed on the x-axis from smallest (Bc) to largest (Sb) during the pre- (a) and post-collapse (b) regimes. Estimates are as follows: Raw species count (blue), Chao (red), Jackknife (black), and Bootstrap (grey).

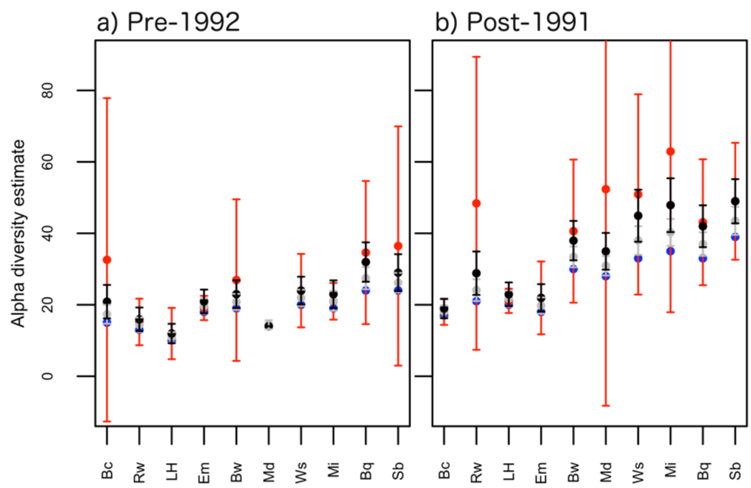

Fig. S7. Alpha diversity estimates (for all fish species) on each bank listed on the x-axis from smallest (Bc) to largest (Sb) during the pre- (a) and post-collapse (b) regimes. Estimates are as follows: Raw species count (blue), Chao (red), Jackknife (black), and Bootstrap (grey).

All estimates were nearly perfectly correlated (Fig. S8), and differed by only 5 species on average. Chao estimates were confounded by large error (Fig. S5 – S7). Jackknife and Bootstrap-based estimations of alpha diversity had smaller associated error. Jackknife proved to be more sensitive to the increased occurrence of rare prey species in the post-collapse regime than Bootstrap (Fig. S5). Bootstrap estimates were generally not statistically different from the average species count (Fig. S5 – S8), suggesting that this estimate may not effectively estimate the number of undetected species. Given these results, we used the Jackknife estimate of alpha diversity throughout our study.

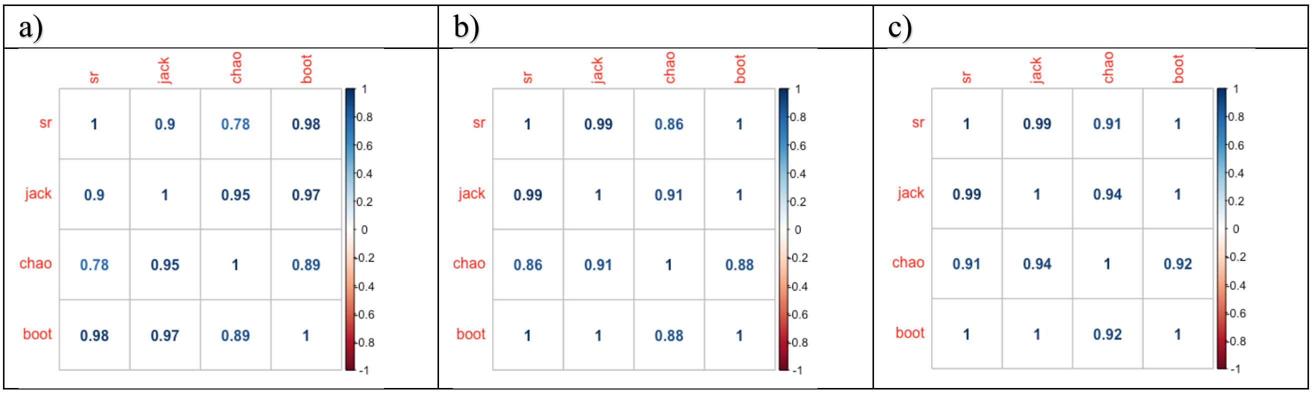

Fig. S8. Correlation of alpha diversity estimates given all regime- and bank-specific estimates for all fish species (a), as well as for prey (b) and mesopredator (c) trophic groups alone.

Supplement 5. Diagnostic plots for SARs and multivariate models

The slope of the prey species SAR increased significantly between regimes ($p < 0.05$), as did the strength of the relationship ($R^2 = 0.51$ pre-1992, and $R^2 = 0.83$ post-1991). The regime-specific semi-log (Gleason 1922) SARs for the prey trophic group generally did not deviate substantially from assumptions of normality and linearity (Figs. S9 & S10). However, in the pre-1992 regime, a major outlier (Middle bank; point 12 in Fig. S9), which had uncharacteristically low prey diversity during this period (Fig. 4a in main text), contributed to the weaker strength of the semi-log SAR.

Through their interaction, bank area and regime (factor) explained 80% (adjusted R^2) of variance in prey alpha diversity estimates. Diagnostics generally supported assumptions of normality and linearity in the semi-log multivariate (ANCOVA) model (Fig. S11).

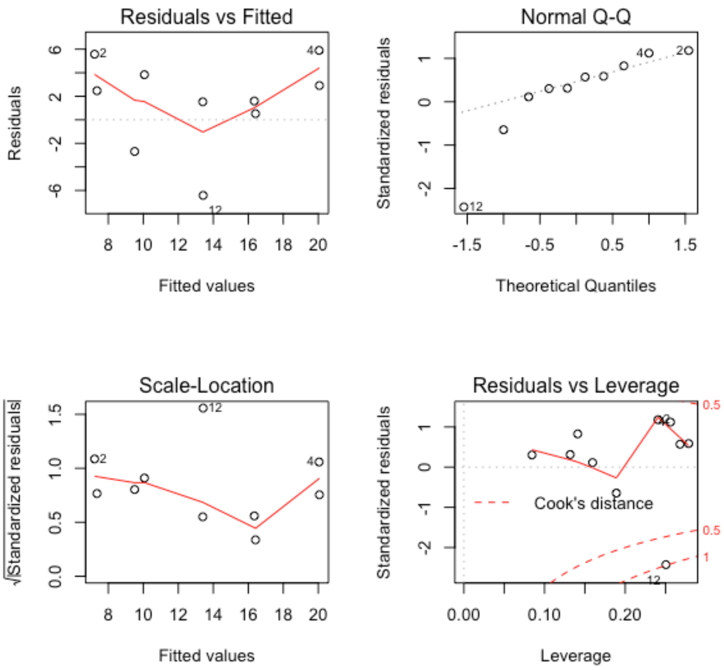

Fig. S9. Diagnostic plots for prey species pre-1992 SAR model.

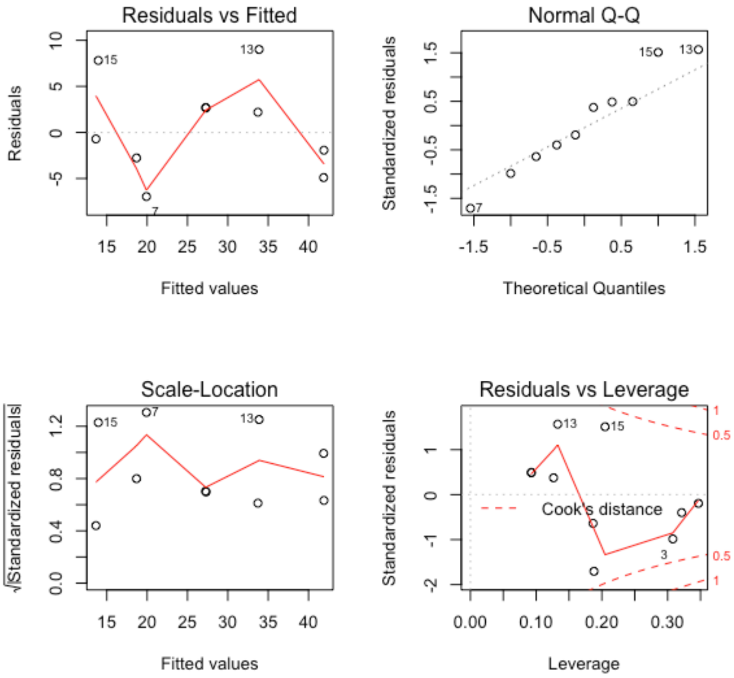

Fig. S10. Diagnostic plots for prey species post-1991 SAR model.

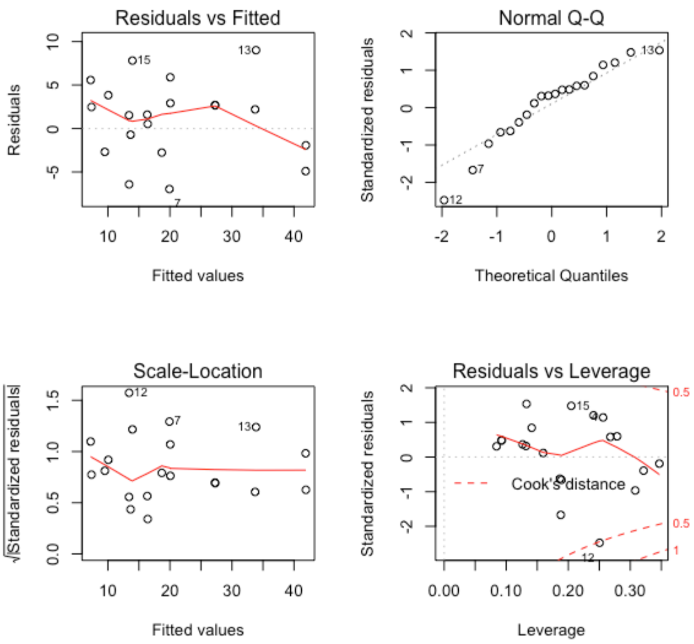

Fig. S11. Diagnostic plots for prey species multivariate (ANCOVA) model with bank area-regime interaction term.

The regime-specific semi-log (Gleason 1922) SARs for the mesopredator trophic group did not deviate from assumptions of normality and linearity (Figs. S12 & S13). Through their interaction, bank area and regime (factor) explained 28% (adjusted R^2) of variance in mesopredator alpha diversity estimates. This reflected the lack of SAR for this group in the pre-1992 era (R^2 = 0.12). Diagnostics generally supported assumptions of normality and linearity in the semi-log multivariate (ANCOVA) model (Fig. S14).

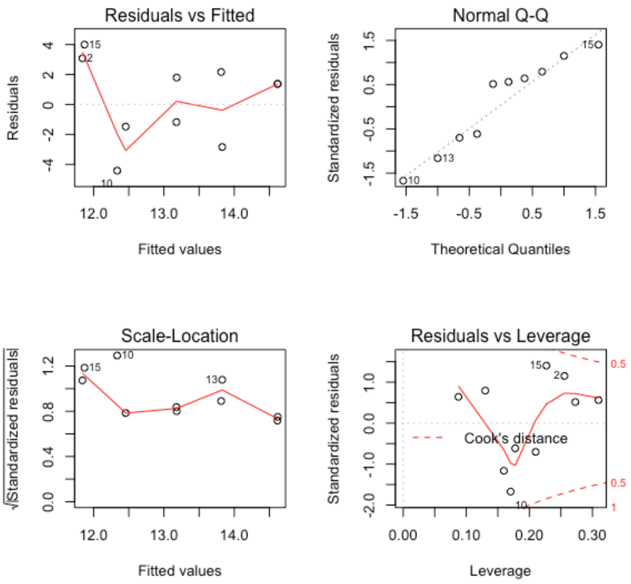

Fig. S12. Diagnostic plots for mesopredator species pre-1992 SAR model.

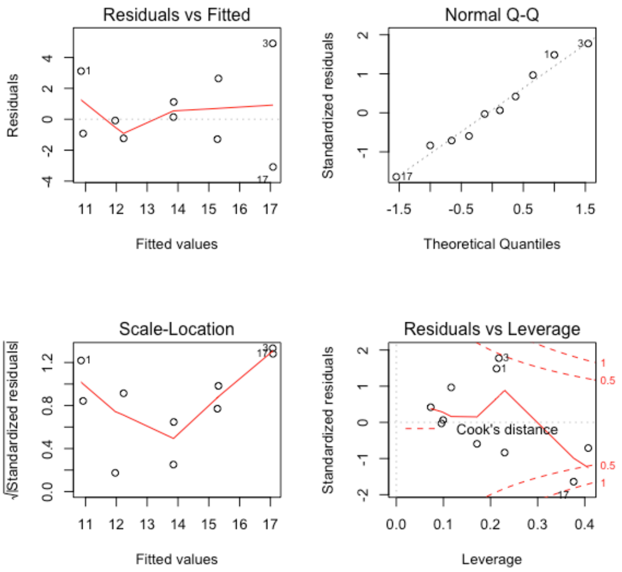

Fig. S13. Diagnostic plots for mesopredator species post-1991 SAR model.

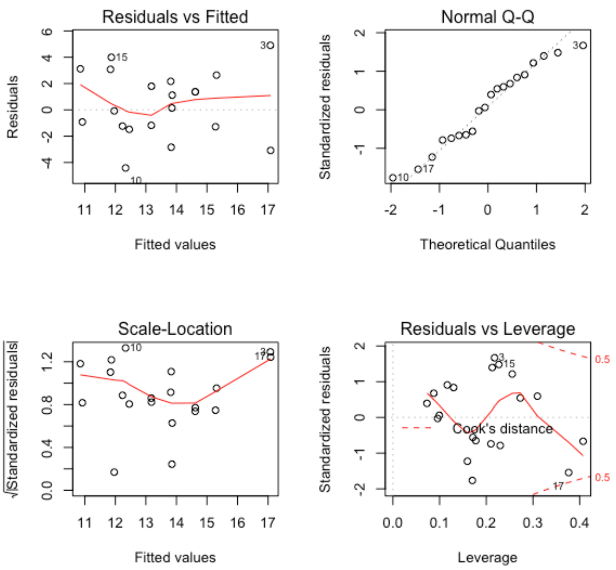

Fig. S14. Diagnostic plots for mesopredator species multivariate (ANCOVA) model with bank area-regime interaction term.

Supplement 6. Model selection for residual variability in alpha diversity

Using a step-wise AICc (Akaike information criterion, adjusted for small sample sizes; Mazerolle 2017) approach, we determined if any other bank habitat characteristics could explain residual variability in prey and mesopredator alpha diversity among banks. Table S4 gives AICc values for each step-wise model, which include the variables (columns) selected with an X. At first, we examined models with the following predictor variables: bottom temperature (btemp), range of depths (DepthRANGE), mean depth (DepthMEAN), sediment type (Sed), range of sediment types (Sed_range), log10(bank area) (larea), and regime. Given Variance Inflation Factors (vif) above 4, DepthRANGE and Sed were removed; these variables were highly correlated with bank area (Fig. S15). Given VIFs of around 2, sequential regression was used (Graham 2003) to include residual effects of DepthMEAN and Sed_range after accounting for their correlation with bank area and with one another. Consequently, the starting model of each step-wise selection process included the following predictor variables: larea, regime, btemp, residual(DepthMEAN), and residual(Sed_range).

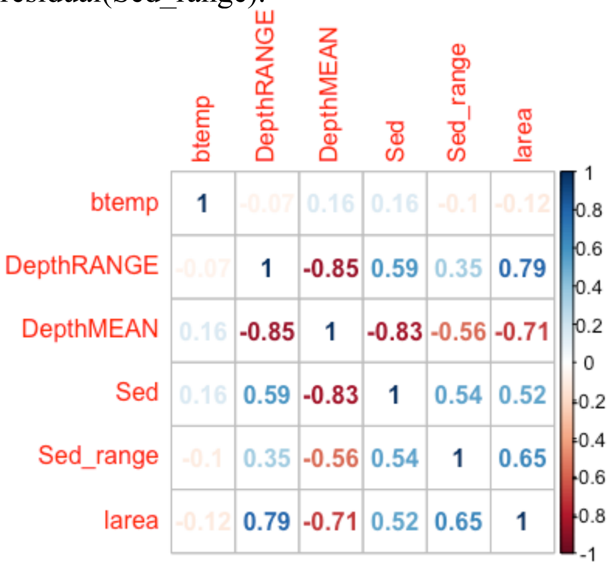

Fig. S15. Correlation matrix of bank habitat characteristics: average (1970-2016) bottom temperature (btemp), range of depths recorded (DepthRANGE), mean depth (DepthMEAN), average sediment type (Sed), range of sediment types (Sed_range), and log10(area) (larea).

For both prey and mesopredator trophic groups, bank area was the most important predictor of alpha diversity across the ten offshore banks (Table S4). For the prey trophic group, the best model consisted of bank area and regime as interacting predictor variables, reflecting the significant change in SAR slope among regimes (Fig. 4a in main text). For the mesopredator trophic group, the best model consisted of bank area as the sole predictor variable, reflecting the lack of significant change in slope among regimes (due to the weak SAR in the pre-1992 era), but also the strong SAR that developed in the post-1991 regime.

Table S4. AICc step-wise model selection for best model to predict alpha diversity within prey and mesopredator trophic groups on the offshore banks of the Scotian Shelf. Each row represents each step in the model selection process; the predictor variables included in each model are given an X. The AICc of each model is provided. The rows highlighted in grey represent the final (best -- lowest AICc) model after step-wise selection.

Group	Area	Regime	A:R	BTEMP	Depth (resid)	Sediment type range (resid)	AICc
Prey	X	X	X	X	X	X	143.24
	X	X	X		X	X	137.48
	X	X	X				129.86
Meso	X	X	X	X	X	X	117.22
	X	X	X	X		X	112.50
	X	X	X	X			109.08
	X	X	X				106.24
	X	X					104.37
	X						101.81

Supplement 7. Moving window analysis of SAR slopes

To test whether our results were robust to our definition of the regimes, we conducted an analysis of prey and mesopredator SARs across moving windows of 15 (Fig. S16a) and 20 years (Fig. S16b). The SAR slope (z) was calculated for each window given the following equation:

$$S_e = k + z\big(log_{10}(A)\big), \qquad (1)$$

where S_e is the Jackknife estimated cumulative alpha diversity per bank, k is the model-derived, constant intercept, z is the slope, and A is bank area measured in km^2.

SAR slopes and associated standard error (95% confidence intervals) are plotted in Fig. S16, in which the starting year of each window is displayed on the x-axis. We defined "true" pre-collapse windows as those for which the final year was pre-1992, and "true" post-collapse windows as those for which the starting year was post-1991. In our 20-year window analysis, all prey SAR slopes from true post-collapse windows were significantly higher (Fig. S16b) than all prey SAR slopes from the true pre-collapse windows. In our 15-year window analysis, this was also true, except for 1970-1984, 1971-1985, 1994-2008, 1995-2009, and 1997-2011 (Fig. S16a). However, both time series exhibited evident positive temporal trends in SAR slope for the prey trophic group, with windows crossing pre- and post-collapse regimes having intermediate SAR slopes. In both cases, there were no significant temporal trend in mesopredator SAR slope; true post-collapse SAR slopes were not significantly higher than true pre-collapse SAR slopes.

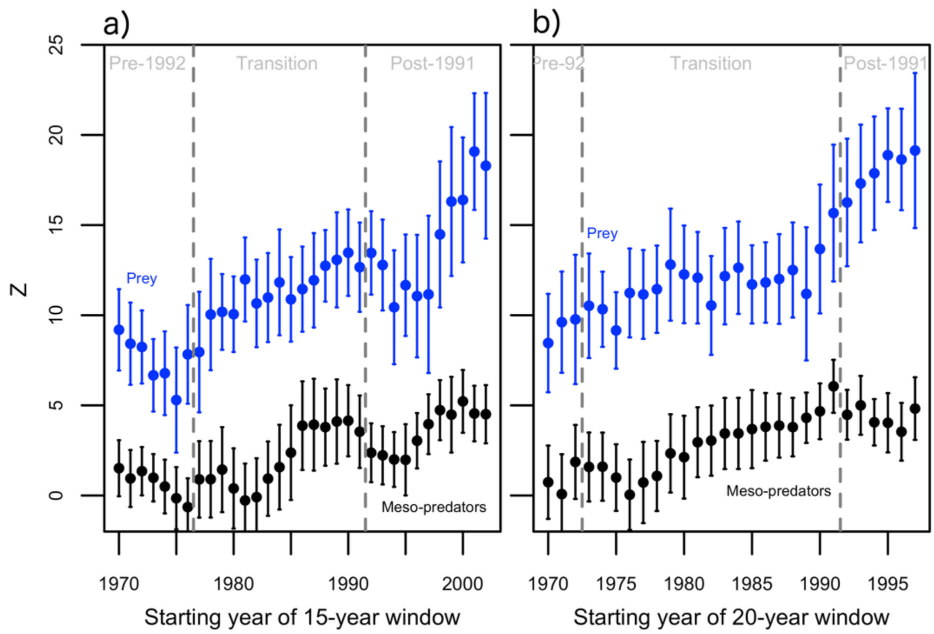

Fig. S16. SAR slopes (Z) and associated error (95% confidence intervals shown as error bars) for prey (blue) and mesopredator (black) trophic groups in each of 33 fifteen-year moving windows (a) and each of 28 twenty-year moving windows (b), within the 1970-2016 time period. Vertical, grey dotted lines delineate strict pre-1992 and strict post-1991 regimes, with a transition period in between.

Supplement 8. Annual prey and mesopredator species counts and average densities

In the main text, we assessed the correlation between regime- and bank-specific alpha diversity estimates and densities (average abundance per survey tow) within prey and mesopredator trophic groups. We found that area-dependent increases in alpha diversity were strongly and positively correlated with increases in density in the post-collapse regime, especially for the prey trophic group. Correlations were weak for the mesopredator group, indicating that increases in density on some banks were not accompanied by increases in alpha diversity within this trophic group. To assess the relationship between alpha diversity and density at a finer temporal scale, and on a bank-by-bank basis, we evaluated bank-specific correlations between time series of annual species counts (alpha diversity estimates are not appropriate on an annual time scale as some banks are sampled only twice per year, e.g., Baccaro and Roseway banks) and densities for both prey (Fig. S17) and mesopredator (Fig. S18) trophic groups. In general, we found that prey species counts and densities were strongly and positively correlated on the majority of banks (Fig. S17). The strongest correlations occurred on Brown's (Bw), Middle (Md), Misaine (Mi), Banquereau (Bq), and Western (Ws) banks, which are the largest in size (Fig. S17). Temporal trends were less dramatic in the mesopredator group, and correlations between species counts and densities were weaker on average (Fig. S18). However, strong correlations and positive trends were evident on Brown's, Western, La Have, and Roseway banks (Fig. S18).

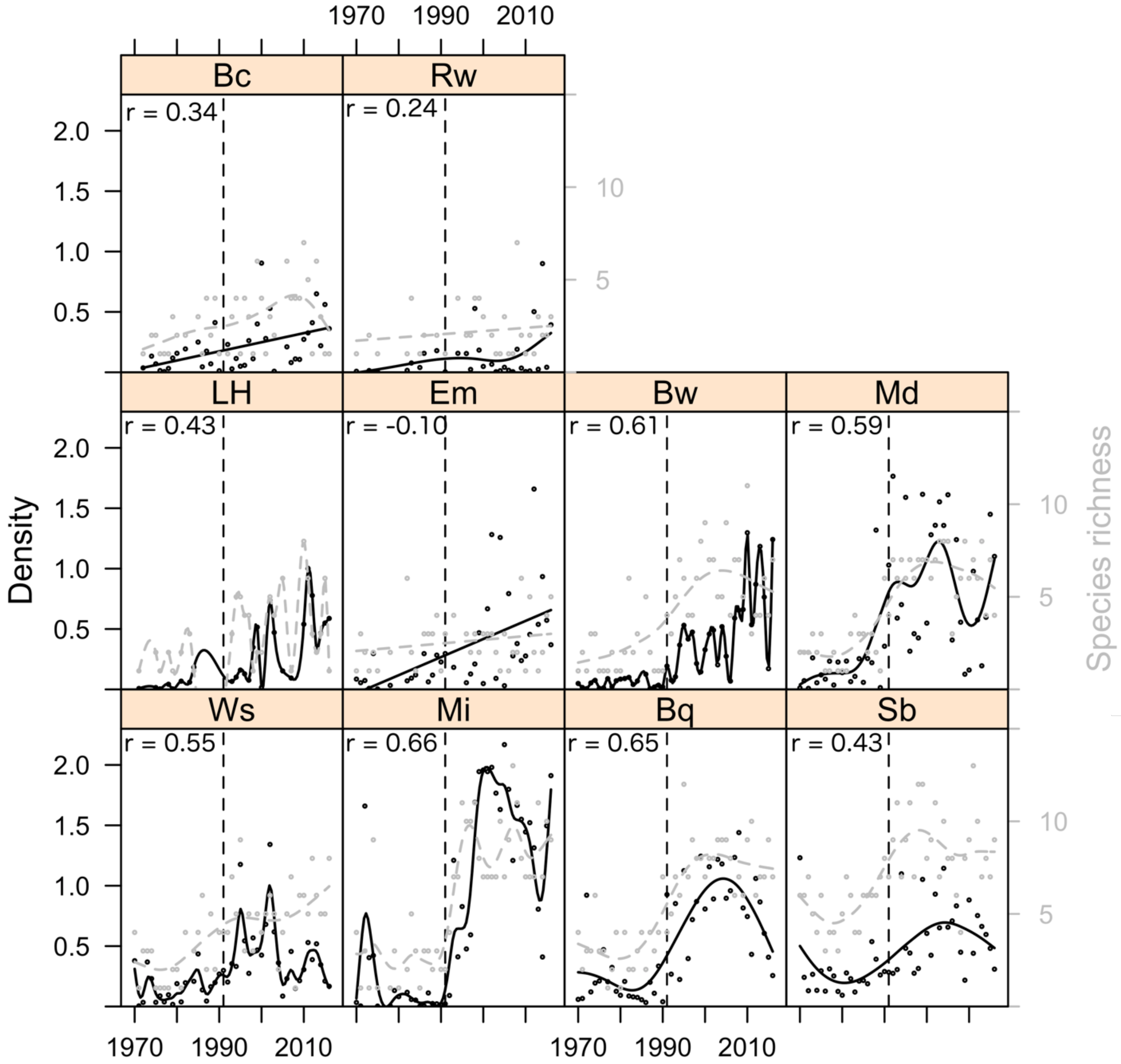

Fig. S17. Time series of species richness (annual species counts; grey) and densities ($\log_{10}$-transformed average abundance per survey tow; black) for the prey trophic group on each of the banks, listed from smallest (top left, Baccaro bank (Bc)) to largest (bottom right, Sable bank (Sb)). Splines depict average temporal trends, while points depict annual values. Pearson correlation coefficients (r) in the top left corner of each plot represent the correlation between species richness and density over time.

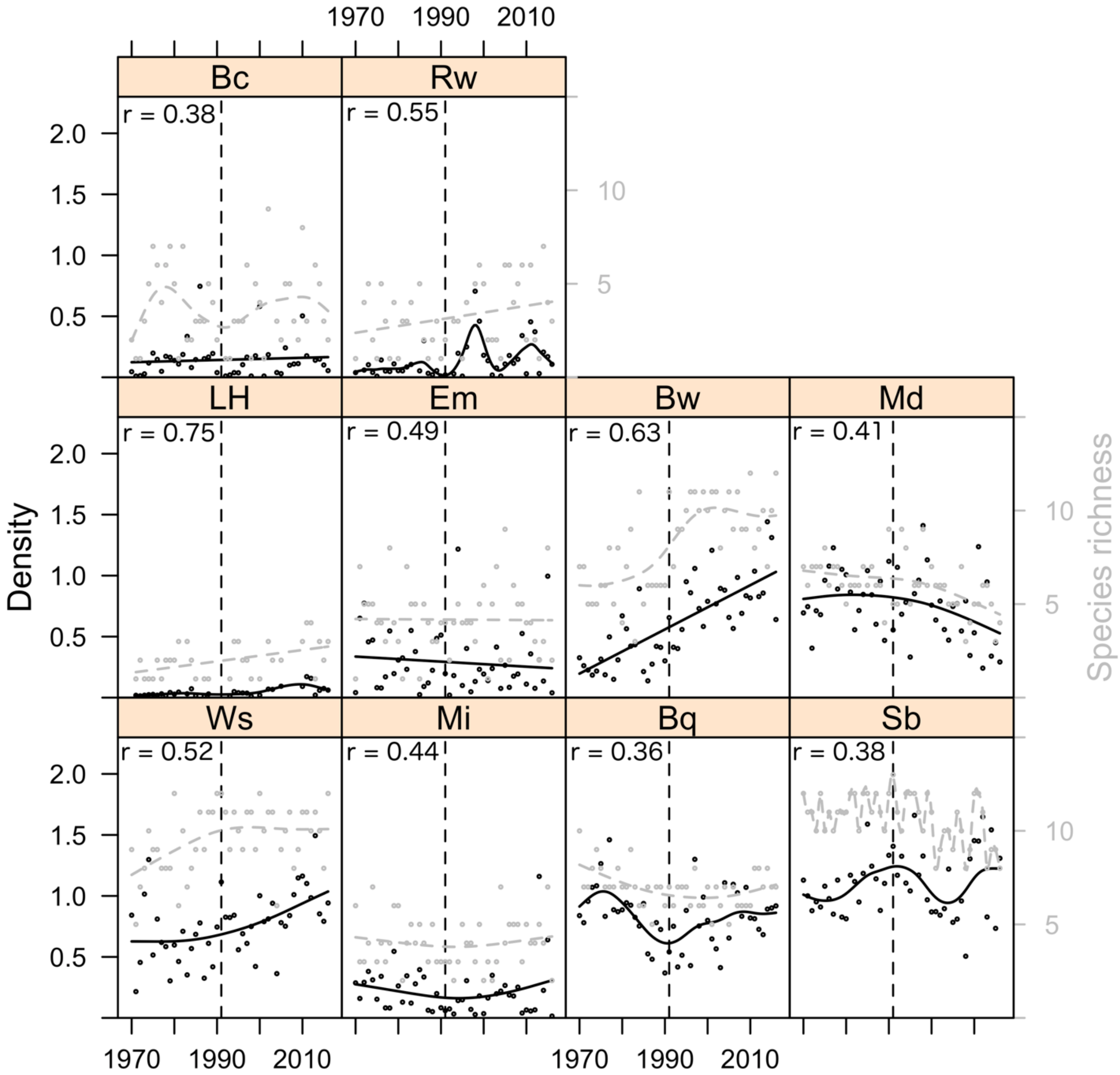

Fig. S18. Time series of species richness (annual species counts; grey) and densities (log_{10}-transformed average abundance per survey tow; black) for the mesopredator trophic group on each of the banks, listed as in Fig. S17. Splines and points as in Fig. S17. Pearson correlation coefficients (r) in the top left corner of each plot represent the correlation between species richness and density over time.

Supplement 9. Annual bank-specific core, SS pool, and colonist prey and mesopredator species densities

We assessed the contribution of new prey species (SS pool and colonists) to the overall positive temporal trend in prey species densities across the banks (Fig. S19). We found that core species (those observed in both pre- and post-collapse regimes) dominated the trend. Minor positive trends in the density of new prey species were observed in the post-collapse regime on some of the banks (Baccaro (Bc), Roseway (Rw), and Misaine (Mi)). Consequently, there is little evidence that new prey species were detected in the post-collapse regime due to increased detectability. There is evidence, however, to support the prediction that extinction risk was lessened for core prey species in the post-collapse regime due to increased abundances.

We conducted a similar analysis for the mesopredator trophic group. Only two mesopredator species colonized the banks from other regions, and two immigrated from within the Scotian Shelf. These new species did not contribute substantially to the increased density of mesopredator fishes on Brown's and Western banks (Fig. S20). Increased densities occurred within the core group of mesopredators.

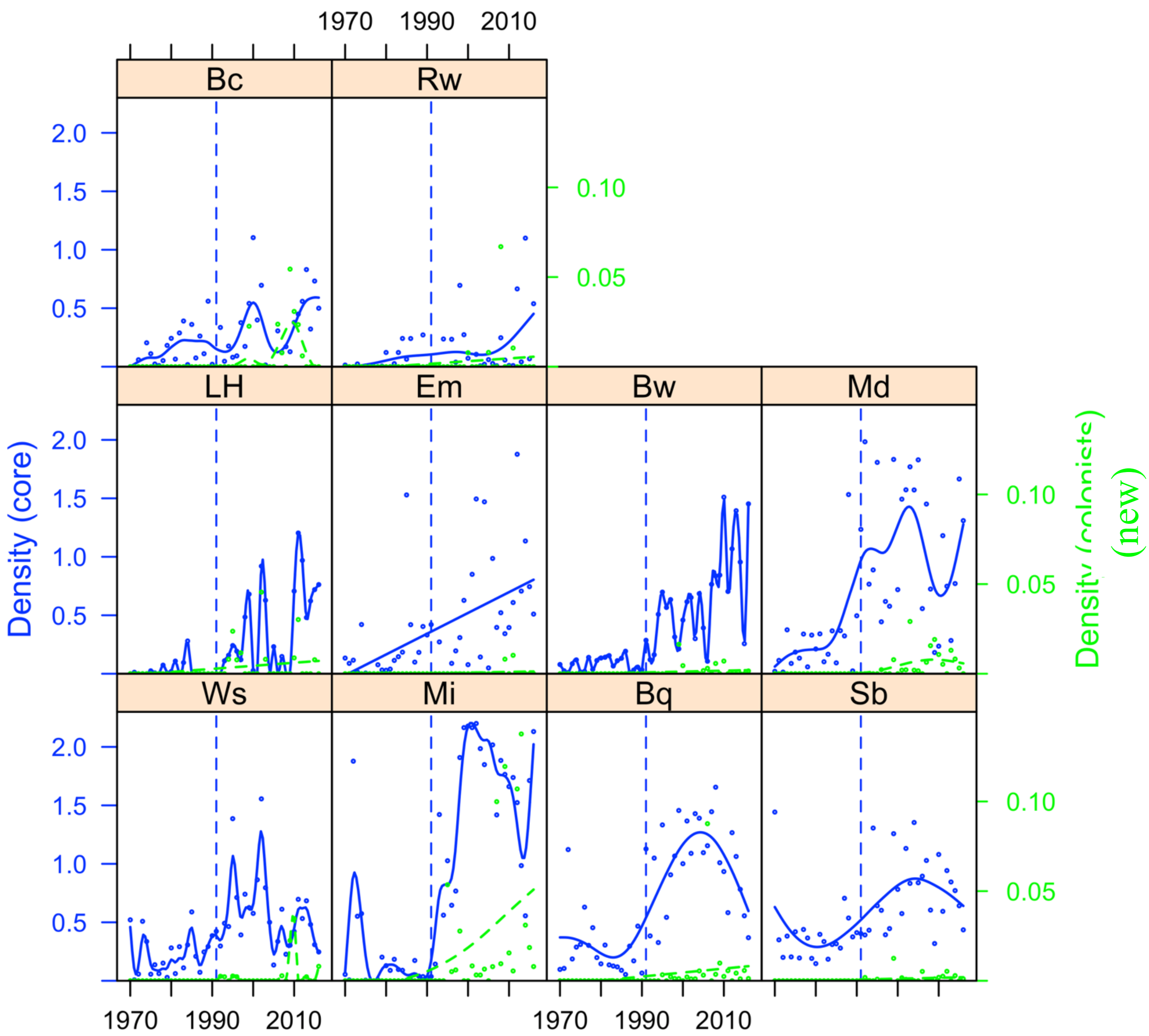

Fig. S19. Annual average densities (log_{10}-transformed average abundance per survey tow) of core (species observed in both pre- and post-collapse regimes; blue) and new (SS pool and colonist species, observed only in the post-collapse regime; green) prey species on each of the banks listed from smallest (top left, Baccaro bank (Bc)) to largest (bottom right, Sable bank (Sb)).

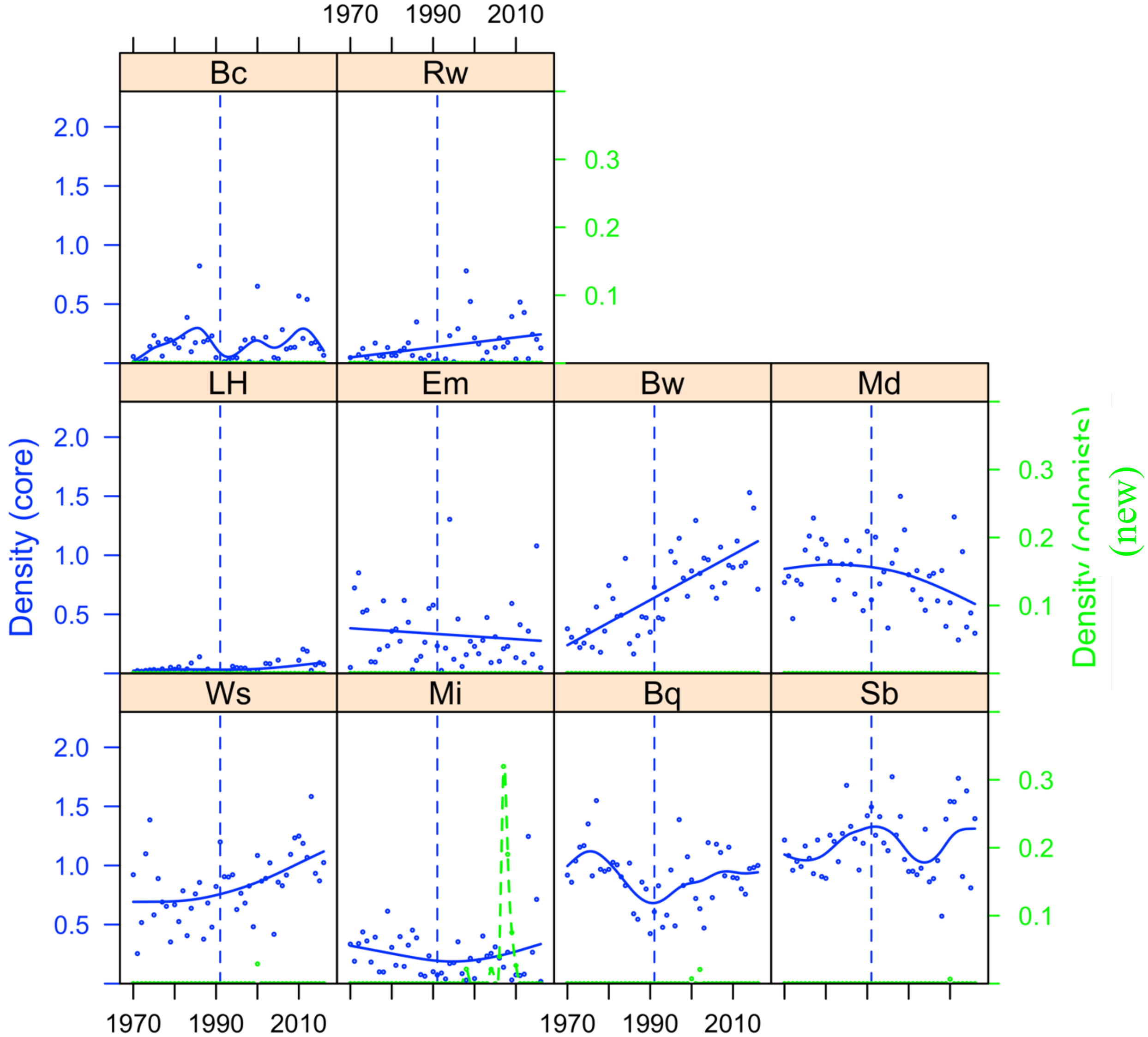

Fig. S20. Annual average densities ($\log_{10}$-transformed average abundance per survey tow) of core (species observed in both pre- and post-collapse regimes; blue) and new (SS pool and colonist species, observed only in the post-collapse regime; green) mesopredator species on each of the banks listed from smallest (top left, Baccaro bank (Bc)) to largest (bottom right, Sable bank (Sb)).

Supplement 10. Large-bodied predators SAR

Large-bodied predator alpha diversity was not significantly correlated with bank area in either regime (Fig. S21). This is largely due their size-dependent mobility and large home ranges (Jenkins *et al.,* 2007; Luiz *et al.,* 2013). A SAR with an area by regime interaction term explained little to no variation in among-bank large predator alpha diversity (adjusted $R^2 = -0.03$, $p = 0.49$).

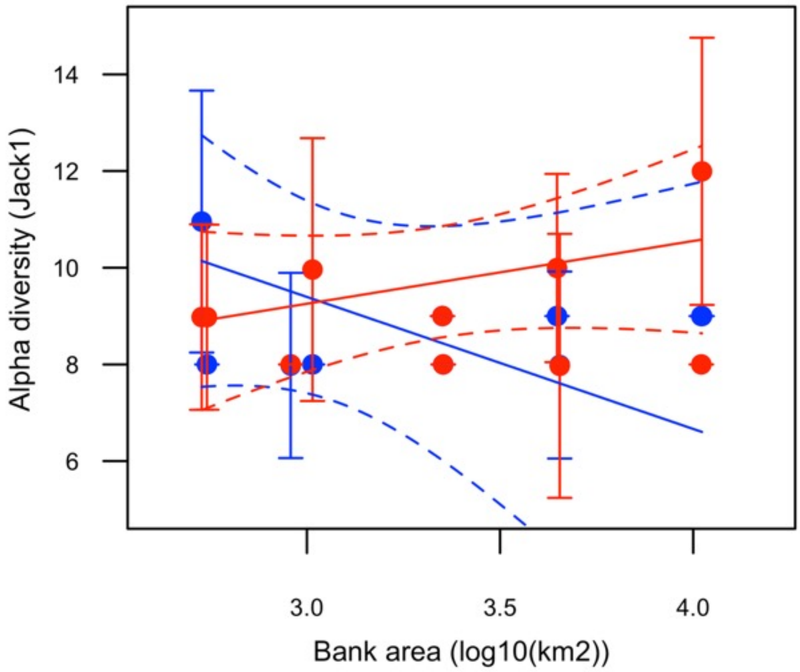

Fig. S21. The relationship between bank-specific large-bodied predator alpha diversity and bank area in pre- (blue) and post-collapse (red) regimes.

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