

Supplementary information to 'Exploring temporal patterns in fish feeding ecology: Are ontogenetic dietary shifts stable over time?'

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Appendix S1. Sample sizes in Arctic charr and brown trout over the study period (2001-2020).

Table S1A. Sample sizes for each sampled habitat: littoral (ca. 1-10 m depth), sublittoral (ca. 10-20 m depth), pelagic (0-6 m depth, >200m from the shoreline), profundal (>25 m depth). Data are shown for Arctic charr and brown trout according to sex identification.

	Arctic charr				Brown trout			
	Female	Male	Immature	Total	Female	Male	Immature	Total
Littoral	542	728	42	1312	503	611	6	1120
Sublittoral	41	45	1	87	13	13	0	26
Profundal	228	266	19	513	2	3	0	5
Pelagic	92	86	0	178	29	21	0	50
Total	903	1125	62	2090	547	648	6	1201

Table S1B. Empty stomachs (*n*). Data are only shown for littoral Arctic charr and brown trout.

	Arctic charr									Brown trout								
	Size group (cm)								Total	Size group (cm)								Total
	5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40		5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40	
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	2	0	1	0	0	3	1	0	0	0	0	0	0	0	1
2016	0	1	0	0	0	0	1	0	2	0	0	1	0	0	0	0	0	1
2017	0	0		0	2	1	0	0	3	0	2	0	1	0	0	0	0	3
2018	0	3	1	1	0	0	0	0	5	0	2	1	0	0	0	0	0	3
2019	0	2	6	0	1	2	1	0	12	0	1	1	1	0	0	0	3	6
2020	0	3	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	1
2001-2020	0	9	7	3	3	4	2	0	28	1	6	3	2	0	0	0	3	15

Table S1C. Sample sizes used for diet analyses in each size group. Data are shown for Arctic charr and brown trout according to sex identification (immature individuals are not shown). These sample sizes only include littoral individuals (see Methods for further information).

	Arctic charr												Brown trout											
	Size group (cm)								Total	Female	Male	Size group (cm)								Total	Female	Male		
	5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40				5-10	10-15	15-20	20-25	25-30	30-35	35-40	>40					
2001	2	20	13	11	6	6	5	0	63	30	33	0	3	15	11	4	3	0	0	36	17	19		
2002	1	13	15	11	1	1	0	0	42	17	25	0	1	3	12	6	0	1	1	24	14	10		
2003	8	34	32	21	0	2	0	2	99	41	54	0	0	0	1	1	0	0	1	3	1	2		
2004	3	29	17	18	1	0	0	0	68	25	32	1	14	31	25	5	6	1	1	84	43	41		
2005	6	32	16	11	7	10	3	1	86	39	43	6	3	21	21	7	4	0	1	63	30	32		
2006	1	12	17	4	5	0	2	0	41	19	20	1	21	10	18	3	1	0	6	60	25	35		
2007	1	22	5	5	3	0	0	0	36	23	11	3	8	16	9	3	0	1	1	41	20	19		
2008	1	45	20	15	2	3	2	2	90	33	53	0	7	10	9	7	3	2	0	38	17	21		
2009	0	36	27	10	1	1	1	0	76	28	45	8	20	33	7	5	1	1	0	75	33	41		
2010	1	2	10	33	9	5	2	4	66	26	40	1	21	20	29	14	3	2	2	92	44	48		
2011	0	18	4	3	13	1	0	0	39	18	15	0	10	37	17	6	1	1	2	74	36	38		
2012	2	9	15	6	7	7	6	2	54	28	26	0	5	16	19	2	3	0	1	46	19	26		
2013	2	31	18	1	11	5	4	1	73	23	50	0	19	7	6	2	3	0	0	37	12	25		
2014	2	36	13	1	7	4	4	1	68	24	43	0	33	30	8	5	0	0	2	78	31	47		
2015	0	21	22	7	0	16	11	2	79	29	47	2	8	29	23	11	3	1	1	78	29	49		
2016	1	37	32	2	1	3	4	1	81	42	39	0	7	7	11	12	4	0	0	41	21	20		
2017	0	8	26	4	4	19	9	2	72	36	36	4	15	25	18	10	5	0	0	77	35	41		
2018	2	15	17	5	3	3	5	0	50	18	31	0	15	29	10	2	0	1	1	58	31	27		
2019	2	26	22	7	3	9	8	1	78	28	50	0	9	27	17	8	2	4	3	70	31	39		
2020	2	22	9	1	0	10	6	1	51	15	35	1	9	8	17	6	0	0	4	45	14	31		
2001-2020	37	468	350	176	83	105	73	20	1312	542	728	27	228	374	288	119	42	15	27	1120	503	611		

Appendix S2. Differences (Kruskal-Wallis tests) in diet composition among size groups for Arctic charr and brown trout over the study period (decades, five-years periods, and two-year periods). *Kruskal-Wallis test was not calculated because some size groups did not consume the prey category over the time period.

	Arctic charr				Brown trout			
	Zooplankton (%)	Pleuston (%)	Benthos (%)	Fish (%)	Zooplankton (%)	Pleuston (%)	Benthos (%)	Fish (%)
Pooled								
2001-2020	H = 377.63; p < 0.001	H = 99.67; p < 0.001	H = 203.67; p < 0.001	H = 53.48; p < 0.001	H = 14.77; p = 0.039	H = 111.53; p < 0.001	H = 14.63; p = 0.041	H = 139.5; p < 0.001
Decade								
2001-2010	H = 174.57; p < 0.001	H = 47.959; p < 0.001	H = 72.96; p < 0.001	H = 29.97; p < 0.001	H = 6.01; p = 0.538	H = 62.32; p < 0.001	H = 13.93; p = 0.052	H = 74.04; p < 0.001
2011-2020	H = 212.48; p < 0.001	H = 49.198; p < 0.001	H = 133.23; p < 0.001	H = 39.51; p < 0.001	H = 16.59; p = 0.021	H = 70.59; p < 0.001	H = 8.55; p = 0.286	H = 92.16; p < 0.001
Five-year								
2001-2005	H = 125.13; p < 0.001	H = 51.614; p < 0.001	H = 57.30; p < 0.001	H = 27.74; p < 0.001	*	H = 17.82; p = 0.013	H = 10.23; p = 0.176	H = 32.78; p < 0.001
2006-2010	H = 70.439; p < 0.001	H = 22.547; p = 0.002	H = 29.35; p < 0.001	H = 16.25; p = 0.023	H = 4.99; p = 0.661	H = 40.69; p < 0.001	H = 10.70; p = 0.152	H = 44.31; p < 0.001
2011-2015	H = 107.4; p < 0.001	H = 41.659; p < 0.001	H = 54.45; p < 0.001	H = 50.91; p < 0.001	H = 5.81; p = 0.562	H = 35.88; p < 0.001	H = 4.29; p = 0.746	H = 56.38; p < 0.001
2016-2020	H = 104.6; p < 0.001	H = 13.363; p = 0.064	H = 86.72; p < 0.001	H = 12.91; p = 0.074	H = 15.82; p = 0.027	H = 30.19; p = 0.001	H = 12.49; p = 0.085	H = 46.37; p < 0.001
Two-year								
2001-2002	H = 45.73; p < 0.001	H = 36.20; p < 0.001	H = 15.29; p = 0.018	H = 3.77; p = 0.707	*	H = 13.91; p = 0.031	H = 4.01; p = 0.675	H = 5.68; p = 0.460
2003-2004	H = 38.12; p < 0.001	H = 20.99; p = 0.002	H = 8.95; p = 0.177	H = 30.91; p < 0.001	*	H = 14.44; p = 0.044	H = 11.99; p = 0.101	H = 21.13; p = 0.001
2005-2006	H = 48.53; p < 0.001	H = 35.34; p < 0.001	H = 39.96; p < 0.001	H = 38.46; p < 0.001	*	H = 20.08; p = 0.003	H = 6.18; p = 0.403	H = 29.94; p < 0.001
2007-2008	H = 25.42; p < 0.001	H = 5.59; p = 0.710	H = 8.91; p = 0.259	H = 24.2; p = 0.001	H = 7.64; p = 0.365	H = 14.62; p = 0.041	H = 8.98; p = 0.254	H = 15.43; p = 0.031
2009-2010	H = 77.96; p < 0.001	H = 24.44; p < 0.001	H = 23.60; p = 0.001	H = 6.80; p = 0.45	H = 7.42; p = 0.386	H = 19.95; p = 0.006	H = 12.05; p = 0.099	H = 13.40; p = 0.063
2011-2012	H = 52.96; p < 0.001	H = 30.45; p < 0.001	H = 38.32; p < 0.001	*	H = 2.55; p = 0.863	H = 14.92; p = 0.021	H = 5.491; p = 0.483	H = 21.35; p = 0.002
2013-2014	H = 29.33; p < 0.001	H = 23.90; p = 0.001	H = 22.99; p = 0.002	H = 89.37; p < 0.001	H = 2.02; p = 0.846	H = 24.19; p < 0.001	H = 3.06; p = 0.691	H = 32.81; p < 0.001
2015-2016	H = 68.61; p < 0.001	H = 4.86; p = 0.676	H = 42.18; p < 0.001	H = 19.45; p = 0.007	H = 2.47; p = 0.929	H = 11.43; p = 0.121	H = 20.74; p = 0.004	H = 25.29; p < 0.001
2017-2018	H = 49.71; p < 0.001	H = 13.30; p = 0.065	H = 20.63; p = 0.004	H = 12.36; p = 0.089	H = 8.15; p = 0.319	H = 12.87; p = 0.075	H = 5.19; p = 0.637	H = 14.01; p = 0.051
2019-2020	H = 29.63; p < 0.001	H = 7.49; p = 0.379	H = 47.11; p < 0.001	H = 1.69; p = 0.975	H = 18.14; p = 0.011	H = 24.61; p < 0.001	H = 9.318; p = 0.231	H = 21.95; p = 0.002

Appendix S3. Logistic regression models.

Table S3. Summary of logistic regression model explaining the probability of the switch feeding over the ontogeny of brown trout and Arctic charr over the study period (2001-2020). Statistically significant differences are marked in bold. SE, standard error. *Fitted curve of the logistic regression model did not enable estimate size-related timing.

	Variable	Brown trout			Arctic charr			Size-related timing (cm)		
		Model parameters			Model parameters			Size-related timing (cm)		
		Coefficient	SE	p value	Coefficient	SE	p value	25%	50%	75%
Zooplankton	Intercept	-2.038	0.407	<0.001	3.615	0.197	<0.001			
	Fish length	-0.036	0.021	0.081	-0.143	0.009	<0.001	*	*	*
Pleuston	Intercept	3.483	0.254	<0.001	0.870	0.144	<0.001			
	Fish length	-0.101	0.011	<0.001	-0.026	0.007	<0.001	45.3	34.6	23.7
Benthic prey	Intercept	-0.120	0.189	0.525	-1.745	0.154	<0.001			
	Fish length	-0.023	0.009	0.012	0.070	0.007	<0.001	41.5	*	*
Fish	Intercept	-4.363	0.295	<0.001	-7.229	0.726	<0.001			
	Fish length	0.126	0.012	<0.001	0.131	0.023	<0.001	25.7	34.5	43.3

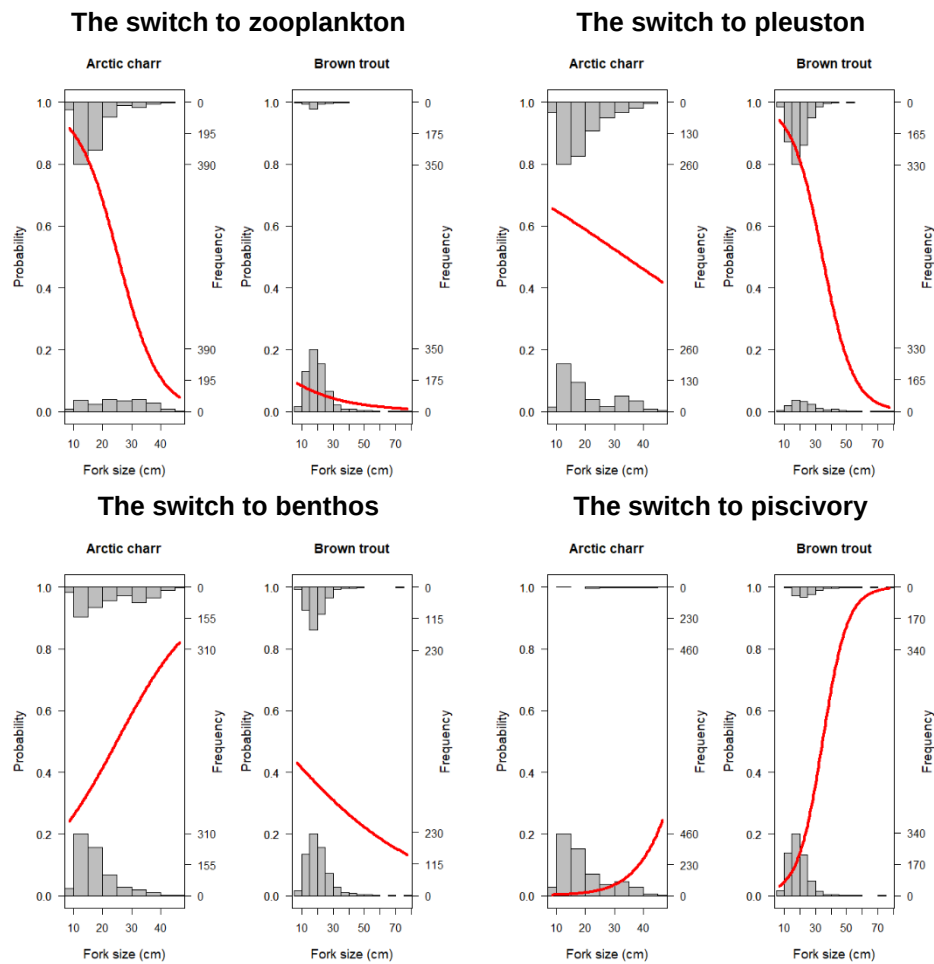
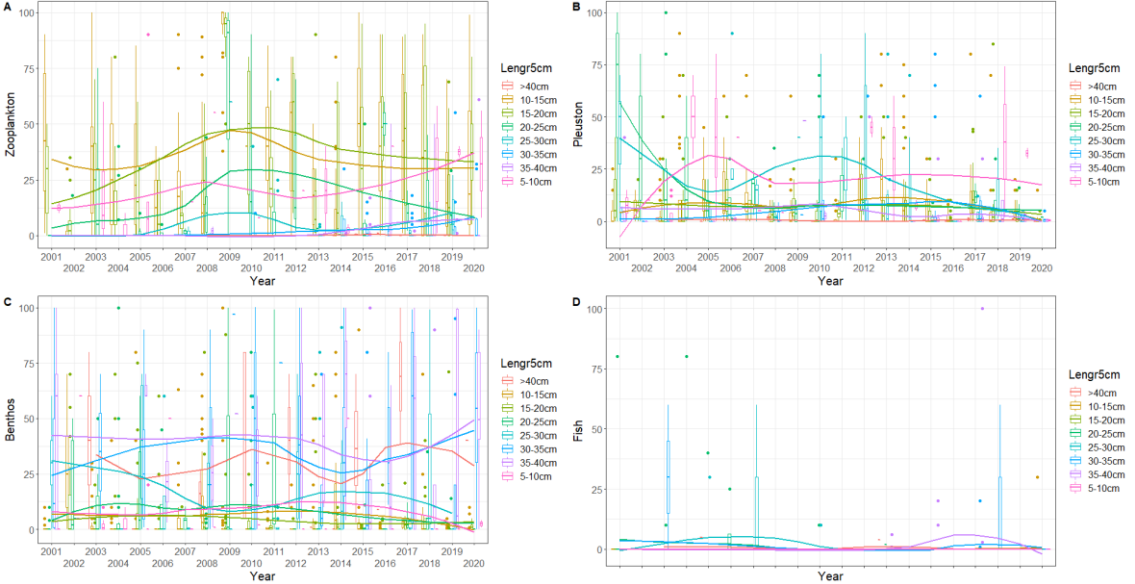


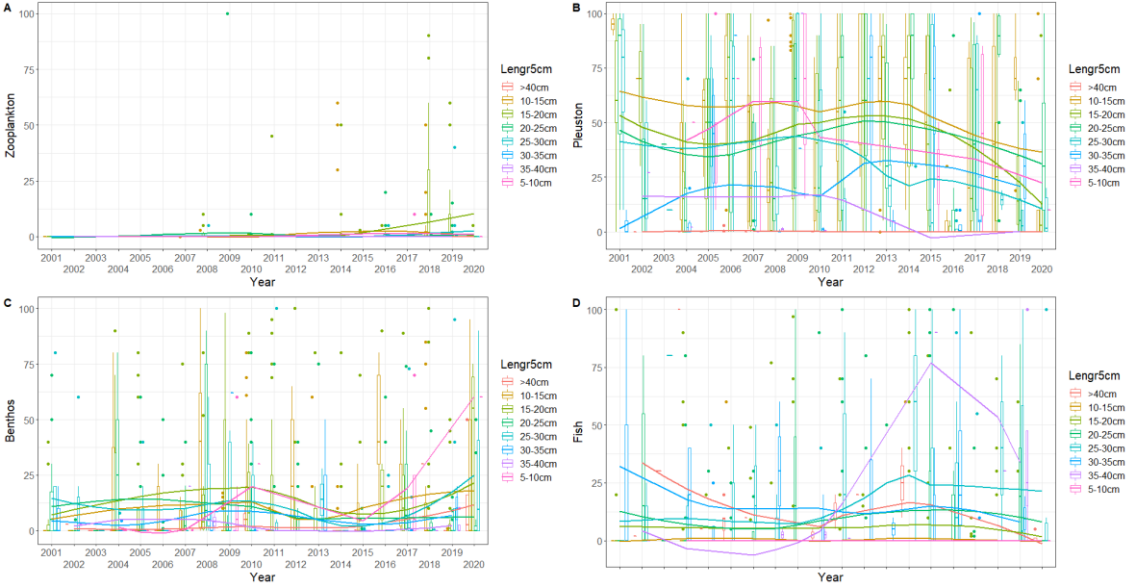
Figure S3. Probability of the ontogenetic dietary shift (zooplankton, pleuston, benthic prey, and fish) as a function of fork length of Arctic charr and brown trout over the study period (2001-2020). Bars represent histograms of occurrence frequencies across fish size spectrum grouped in five cm size classes for illustrative purposes of the size structure and based on presence-absence data (1 = prey consumed, 0 = no prey consumed). The red line represents the fitted curve of the logistic regression model.

Appendix S4. Inter-annual variation in ontogenetic dietary shifts of brown trout and Arctic charr. The boxplot indicates the median and the interquartile range with a 95% confidence interval for the median. Local polynomial regression (LOESS) curves are fitted to the data for illustrative purposes to show ontogenetic trends.

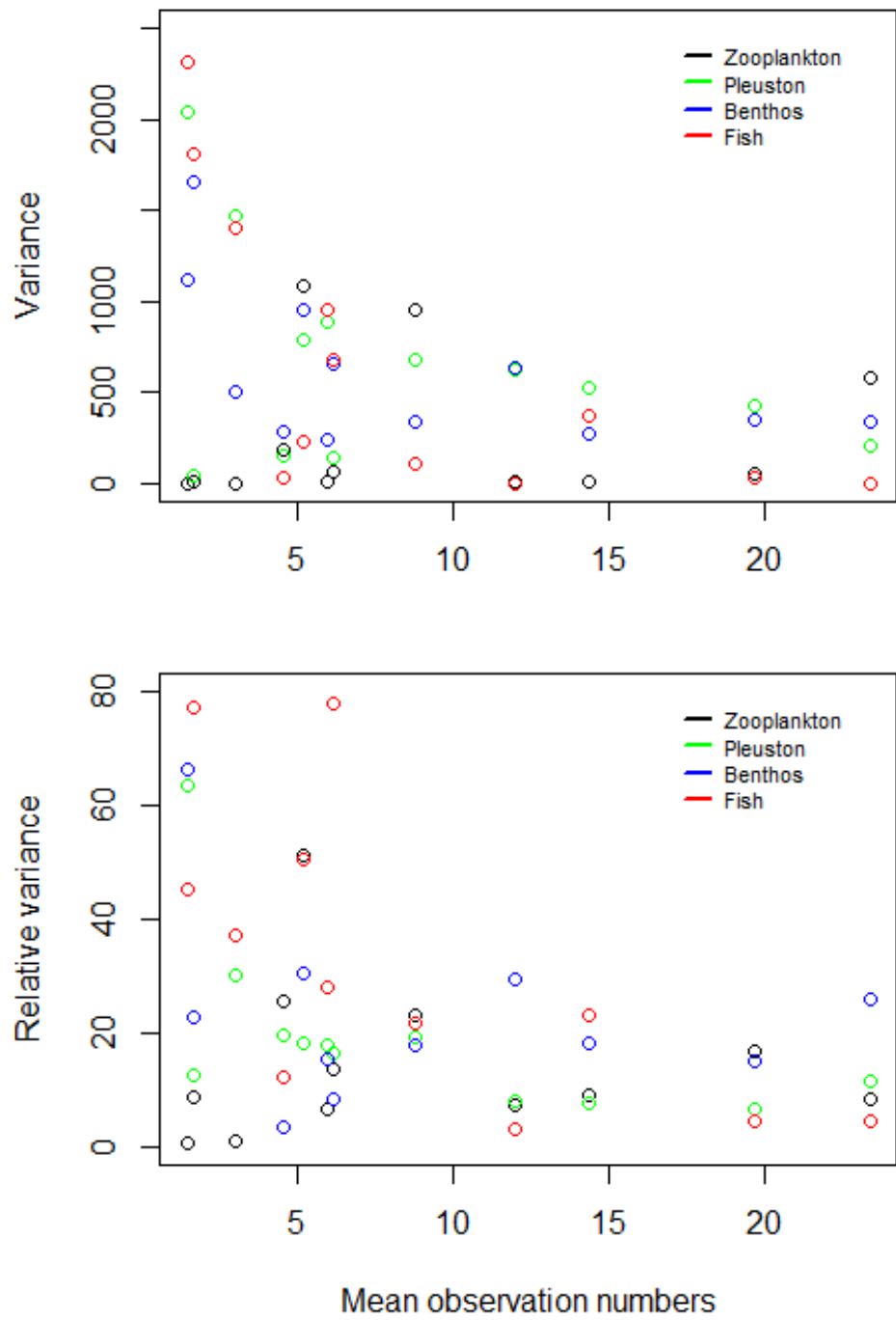
Arctic charr



Brown trout

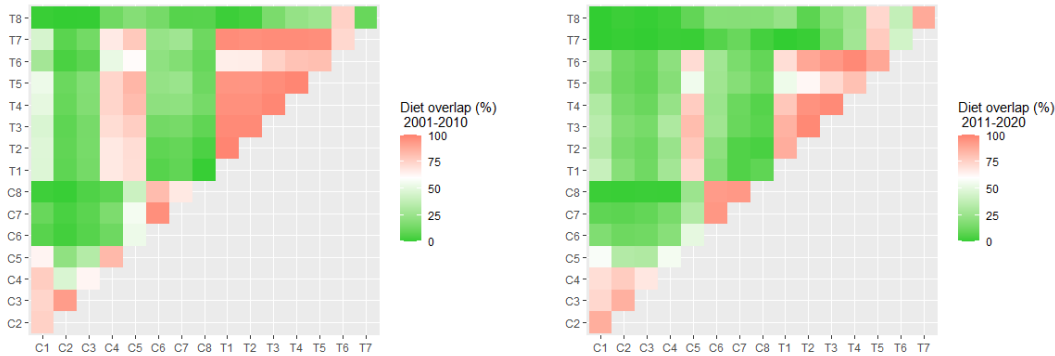


Appendix S5. Relationship between two statistical variance estimators (variance and relative variance) of the mean prey abundance over the 20-yr study period versus the average annual sample sizes for the various ontogenetic stages over the same period.

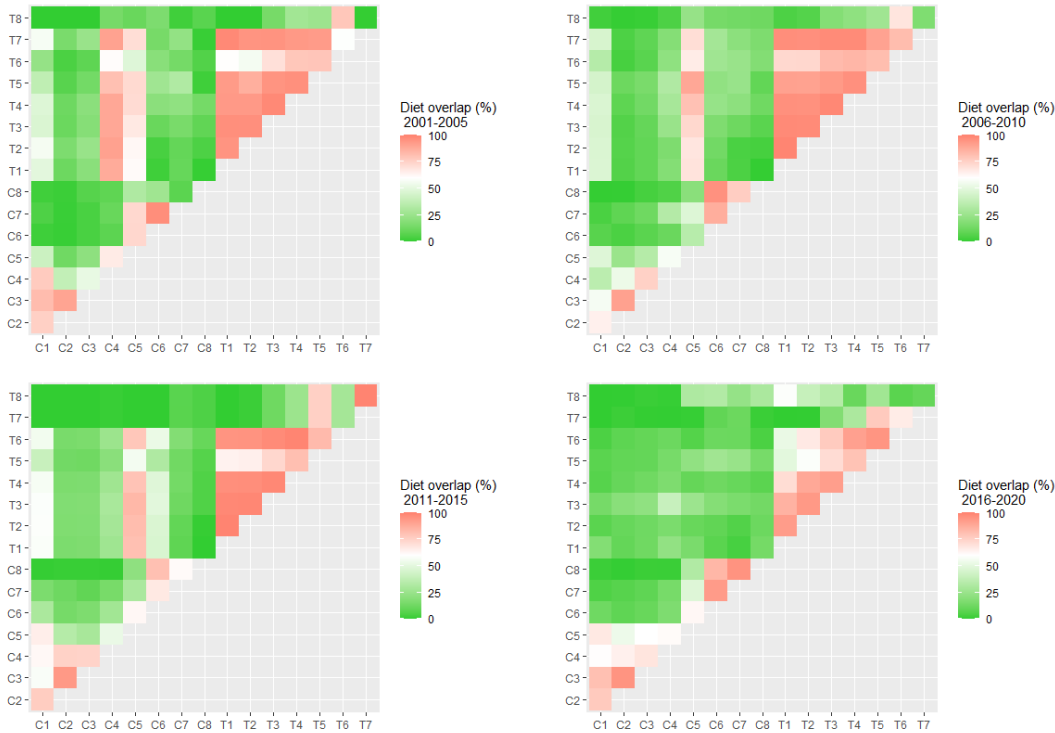


Appendix S6. Between-species overlaps (Pianka’s percent overlap index) in diet use of Arctic charr (C) and brown trout (T) for the eight size groups (numbers from 1 to 8).

A) Over decades



B) Over five-year period



C) Over two-year period

