From days to decades: short- and long-term variation in environmental conditions affect offspring diet composition of a marine top predator

Richard J. Howells*, Sarah J. Burthe, Jon A. Green, Michael P. Harris, Mark A. Newell, Adam Butler, David G. Johns, Edward J. Carnell, Sarah Wanless, Francis Daunt

*Corresponding author: ricwel14@ceh.ac.uk

Fish length/mass equations

Table S1. Fish otolith length/width (mm) to fish length(mm) and otolith length (mm)/otolith width (mm)/fish length (cm)to mass equations used for calculation of biomass proportions. FL = fish length (mm for column 2 and cm for column 5), OL = otolith length (mm), OW = otolith width (mm), M = mass (g). References: (a) Harris et al. (unpublished data); (b) Härkönen (1986); (c) Harris & Hislop (1978); (d) Coull et al. (1989); (e) Carss (1993). R^2 values provided where available.

Prey	Otolith length/width (mm) to fish length (mm)	R^2	Ref	Otolith length (mm)/ otolith width (mm)/ fish length (cm) to fish mass	R^2	Ref
1+ group sandeel	Various [i]	-	a	$M=0.00209\ FL^{3.148}$		c
0 group sandeel	Various [i]	-	a	$M=0.00209\ FL^{3.148}$		c
Pholidae (Gunnels)	FL=11.273+169.26 OW	0.61	a	$M=0.0006\ FL^{3.659}$	0.86	
Gadidae (Cod fishes)	FL=-11.936+19.7 OL[ii]	0.98	b	$M=0.00854\ FL^{2.978}$ [ii]		c
Callionymidae (Dragonets)	- [iii]	-	-	$M=0.22\ FL^{2.5907}$ [iv]		d
Cottidae (Cottids)	- [v]	-	-	$M=0.0096\ FL^{3.20}$ [vi]	0.98	e
Pleuronectidae (Right-eyed Flounders)	FL=-3.81+47.63 OL[vii]	0.93	b	$M=0.0044\ FL^{3.2039}$ [viii]		d
Clupeidae (Clupeids)	FL = 14.025+65.097 OL [ix]	0.89	a	$M=0.009708\ FL^{2.855}$ [ix]		c
Labridae (Wrasses)	FL = 3.05 + 63.54 OL	0.92	b	$M =3.29\ OL^{3.30}$	0.96	b
Gobiidae (Gobies)	FL = -20.41 + 87.59 OL	0.91	b	$M=0.00209\ FL^{3.148}$ [x]		c
Zoarcidae (Eelpouts)	FL = -23.65 + 179.30 OW [xi]	0.83	b	$M = 12.58\ OW^{4.432}$	0.83	b
Blenniidae (Blennies)	- [xii]	-	-	- [xii]		-
Lotidae (Rocklings)	FL = 9.385 + 32.747 OL	-	a	$M=0.00209\ FL^{3.148}$ [x]		c
Syngnathidae (Pipefishes)	- [xii]	-	-	- [xii]	-	-

[i] Used regression equations based on an annual sample of intact fish collected by mist-netting Atlantic puffins *Fratercula arctica* at this colony over the same period shag diet was sampled.

[ii] Used whiting *Merlangius merlangus*.

[iii] No otolith fish length equation available so used otolith length/vertebrate length relationship from sample of fish in 2012 to show that these otoliths come from small fish so set length to be 50mm.

[iv] Used common dragonet *Callionymus lyra.*

[v] No otolith fish length equation available so fixed length at 100.

[vi] Used sea scorpion *Taurulus bubalis.*

[vii] Used plaice Pleuronectes platessa.

[viii] Used long rough dab *Hippoglossus platessoides.*

[ix] Used sprat *Sprattus sprattus.*

[x] Used sandeel.

[xi] OW estimated as 25% of OL.

[xii] No otoliths recovered.

Collinearity in explanatory covariates
In order to identify the existence of collinearity between explanatory covariates we created a scatterplot matrix of Pearson correlation coefficients (Table S2). It was decided that none of the explanatory covariates exhibited excessive collinearity, which we considered to be R > 0.6.

Table S2. Correlation matrix showing correlation coefficients between candidate explanatory covariates. Breeding pop. size = Breeding population size. t-1 indicates that covariates are lagged by one year.

	Day of year	Total daily rain	Mean daily wind	SST	SST t-1	*Calanus* nauplii	*Calanus* nauplii t-1	*C. finmarchicus*	*C. finmarchicus* t-1	Breeding pop. size
Day of year	1.00									
Total daily rain	-0.05	1.00								
Mean daily wind	-0.04	-0.04	1.00							
SST	-0.32	0.07	0.02	1.00						
SST t-1	-0.05	0.03	0.13	0.36	1.00					
Calanus nauplii	-0.11	-0.06	-0.03	-0.06	-0.11	1.00				
Calanus nauplii t-1	-0.03	0.03	0.17	-0.19	0.07	0.08	1.00			
C. finmarchicus	0.28	-0.02	0.14	-0.10	-0.06	-0.15	0.10	1.00		
C. finmarchicus t-1	0.07	0.02	-0.02	-0.45	-0.24	-0.05	-0.09	-0.15	1.00	
Breeding pop. size	0.37	0.01	0.01	-0.37	-0.42	-0.14	0.09	0.08	0.23	1.00

Dietary trends

To investigate trends in the dietary response variables we fitted models with both linear and quadratic trend (Table S3). Although linear trends were identified in the Sandeel, Callionymidae, and sample-level Prey Richness models, there was no evidence of non-linear trends.

Table S3. Modelled response variables and fixed effects included in trends analysis of diet proportions and sample-level Prey Richness. Estimates (±SE), t-values (t) and as backwards-stepwise deletion was used, p-values (p) are reported.

Response	Trend	Fixed effect	Estimate	SE	t	p
Sandeel relative to non-sandeel prey	Linear	Year	-14.49	3.22	-4.50	<0.001
	Linear & Quadratic	Year	-14.30	3.27	-4.37	<0.001
		$Year^2$	29.88	41.25	0.72	0.475
1+ group relative to 0 group sandeel	Linear	Year	4.65	5.42	0.86	0.398
	Linear & Quadratic	Year	3.36	5.67	0.59	0.558
		$Year^2$	-46.09	67.73	-0.68	0.502
Pholidae relative to other non-sandeel prey	Linear	Year	5.48	4.17	1.31	0.202
	Linear & Quadratic	Year	9.10	5.61	1.62	0.119
		$Year^2$	-79.72	62.71	-1.27	0.216
Callionymidae relative to other non-sandeel prey	Linear	Year	-13.91	4.84	-2.87	0.008
	Linear & Quadratic	Year	-13.54	4.95	-2.74	0.012
		$Year^2$	59.59	62.55	0.95	0.351
Gadidae relative to other non-sandeel prey	Linear	Year	-0.10	4.69	-0.02	0.984
	Linear Quadratic	Year	1.00	5.25	0.19	0.850
		$Year^2$	-58.63	66.22	-0.89	0.385
Sample-level Prey Richness	Linear	Year	12.09	2.37	5.09	<0.001
	Linear & Quadratic	Year	12.25	2.45	5.00	<0.001
		$Year^2$	-27.21	30.22	-0.90	0.376

Detrending

In order to examine the robustness of our models and to account for any trends within our data, we adopted a detrending approach (Table S4). Following backwards stepwise deletion, year was forced into the final models and non-significant terms dropped. Year was retained in the final model irrespective of whether or not it was significant. Following this procedure the effect, of *breeding* population size was dropped from the Sandeel to all non-sandeel, Callionymidae to all non-sandeel and sample-level Prey Richness models (Table S4).

Table S4. Detrended models for each dietary component. Estimates (± SE), t-values (t) and p-values (p) reported.

Response	Fixed effect	Estimates	SE	t	p
Sandeel relative to non-sandeel prey	Mean Daily Wind Speed (ms^{-1})	-0.06	0.03	-2.10	0.036
	Year	-14.46	3.24	-4.47	<0.001
1+ relative to 0 group sandeel prey	SST t-1	-1.99	0.73	-2.72	0.011
	Day of year	-0.09	0.01	-7.11	<0.001
	Year	-1.34	4.76	-0.28	0.780
Pholidae relative to other non-sandeel prey	SST t-1	1.65	0.47	3.48	0.002
	C. finmarchicus abundance	-0.25	0.09	-2.69	0.013
	Year	2.54	3.76	0.68	0.507
Callionymidae relative to other non-sandeel prey	*Calanus* nauplii abundance	0.05	0.02	2.92	0.008
	Calanus nauplii abundance t-1	0.05	0.02	3.12	0.005
	Year	-10.10	3.70	-2.73	0.012
Sample-level Prey Richness	SST t-1	0.98	0.27	3.60	0.001
	Calanus nauplii abundance	-0.03	0.01	-2.83	0.009
	Year	10.32	1.80	5.72	0.000

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