

Title Predator-prey mass ratios of mid-trophic level fishes in a coastal marine ecosystem vary with taxonomy and body size

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Supplementary Information

Online Resource 1 Type III analysis of variance of population density ($\ln[\text{ind. m}^{-3}]$) across classes of body weight ($\ln[\text{g}]$) with class midpoints at 0.25 intervals as in Ursin (1973) (*lm* function, *stats* package, R version 3.6.1, R Core Team [2019]) ($n = 78$, $r^2 = 0.75$). Body weight for each zooplankton group was total prey weight / total prey count by year and diel sampling period. Body weight for each predator group was averaged across predators by year and diel period. Population density for each of the ten zooplankton and four predator groups was the back-transformed mean 4th-root transformed number m^{-3} by year and diel period following Wilson (2009). Population density was summed across groups within size classes. The 95% confidence interval around the slope coefficient (-1.261 - -0.944) encompassed -1, which is consistent with Ursin's (1973) assumption of constant biomass across body size classes

Term	Sum Sq	Df	F	P	Coefficient (95% CI)
(Intercept)	1982.69	1	214.480	<0.001	-6.356 (-7.223, -5.490)
$\ln(\text{body size class})$	1788.86	1	193.513	<0.001	-1.102 (-1.261, -0.944)
Year	1.31	2	0.071	0.932	
Diel	6.76	1	0.731	0.396	
$\ln(\text{body size class})$:Year	0.26	2	0.014	0.986	
$\ln(\text{body size class})$:Diel	0.61	1	0.066	0.798	
Year:Diel	2.49	2	0.135	0.874	
$\ln(\text{body size class})$:Year:Diel	5.53	2	0.299	0.743	
Residuals	610.12	66			

Online Resource 2 Analysis of variance of the relationship between \ln count of prey predator⁻¹ and \ln predator body weight class, $\ln(m)$, by predator-prey combination, including the number of predator size classes and years with day and night sampling. Regression coefficients and 95% confidence interval (95% CI) account for year and diel effects. Predator-prey combinations not fitted by the model are not shown

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Capelin	Amphipod	24	2001	intercept	1.277	1	3.432	0.080	-0.790	0.893
				2003	$\ln(m)$	0.250	1	0.673	0.422	-0.248
				year	0.009	1	0.024	0.880		
				diel	2.949	1	7.923	0.011		
				year:diel	2.824	1	7.588	0.013		
				Residuals	7.070	19				
Capelin	Appendicularia	34	2000	intercept	0.005	1	0.004	0.952	0.043	1.471
				2001	$\ln(m)$	0	1	0	0.993	-0.005
			2003	year	8.609	2	2.866	0.074		
				diel	2.066	1	1.375	0.251		
				year:diel	2.877	2	0.958	0.396		
				Residuals	40.550	27				
Capelin	Chaetognath	23	2000	intercept	6.924	1	12.847	0.002	-1.863	1.102
				2001	$\ln(m)$	0.639	1	1.185	0.293	0.434
			2003	year	0.195	2	0.181	0.837		
				diel	0.021	1	0.039	0.845		
				year:diel	2.232	2	2.071	0.159		
				Residuals	8.623	16				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Capelin	Copepod	81	2000 2001 2003	intercept	135.533	1	92.723	<0.001	3.592	0.743
				ln(m)	17.639	1	12.067	0.001	-0.977	0.560
				year	13.005	2	4.449	0.015		
				diel	1.318	1	0.901	0.345		
				year:diel	13.658	2	4.672	0.012		
				Residuals	108.165	74				
Capelin	Euphausiid	77	2000 2001 2003	intercept	1.955	1	2.141	0.148	-0.488	0.666
				ln(m)	25.676	1	28.126	<0.001	1.097	0.413
				year	1.832	2	1.004	0.372		
				diel	8.365	1	9.163	0.003		
				year:diel	7.337	2	4.019	0.022		
				Residuals	63.903	70				
Capelin	Pteropod	53	2000 2001 2003	intercept	8.117	1	6.743	0.013	1.144	0.887
				ln(m)	5.999	1	4.984	0.030	-0.750	0.677
				year	10.803	2	4.488	0.017		
				diel	0.877	1	0.728	0.398		
				year:diel	0.108	2	0.045	0.956		
				Residuals	55.37	46				
Eulachon	Amphipod	37	2000 2001 2003	intercept	1.067	1	2.509	0.124	-0.745	0.960
				ln(m)	0.001	1	0.001	0.971	0.005	0.284
				year	0.010	2	0.012	0.988		
				diel	1.532	1	3.600	0.067		
				year:diel	0.594	2	0.698	0.506		
				Residuals	12.765	30				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Eulachon	Copepod	28	2000	intercept	0.159	1	0.283	0.600	0.234	0.914
			2001	ln(m)	1.144	1	2.040	0.168	-0.271	0.395
			2003	year	2.847	2	2.538	0.103		
				diel	1.318	1	2.349	0.140		
				year:diel	0.277	2	0.247	0.783		
			Residuals	11.782	21					
Eulachon	Euphausiid	153	2000	intercept	0.097	1	0.235	0.629	0.075	0.308
			2001	ln(m)	10.440	1	25.310	<0.001	0.267	0.105
			2003	year	2.318	2	2.810	0.063		
				diel	0.026	1	0.063	0.802		
				year:diel	9.527	2	11.548	<0.001		
			Residuals	60.224	146					
Eulachon	Fish	6	2001	intercept	0.541	1	0.571	0.588	-1.149	19.316
			2003	ln(m)	0.014	1	0.015	0.923	-0.067	6.993
				year	0.021	1	0.022	0.906		
				diel	0.388	1	0.410	0.638		
			year:diel	0.155	1	0.164	0.755			
			Residuals	0.947	1					
Pollock, age-0	Amphipod	130	2000	intercept	125.879	1	221.246	<0.001	-2.043	0.272
			2001	ln(m)	32.106	1	56.430	<0.001	0.742	0.196
			2003	year	13.068	2	11.484	<0.001		
				diel	0.195	1	0.342	0.560		
				year:diel	2.730	2	2.399	0.095		
			Residuals	69.981	123					

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Pollock, age-0	Appendicularia	126	2000	intercept	153.652	1	87.518	<0.001	2.041	0.432
			2001	ln(m)	9.135	1	5.203	0.024	-0.418	0.363
			2003	year	63.602	2	18.113	<0.001		
				diel	9.703	1	5.527	0.020		
				year:diel	2.451	2	0.698	0.500		
				Residuals	208.923	119				
Pollock, age-0	Chaetognath	97	2000	intercept	46.415	1	62.161	<0.001	-1.445	0.364
			2001	ln(m)	0.355	1	0.475	0.492	0.105	0.302
			2003	year	4.075	2	2.729	0.071		
				diel	1.737	1	2.326	0.131		
				year:diel	1.736	2	1.162	0.317		
				Residuals	67.202	90				
Pollock, age-0	Copepod	151	2000	intercept	752.447	1	835.007	<0.001	3.784	0.259
			2001	ln(m)	52.307	1	58.046	<0.001	-0.769	0.199
			2003	year	15.610	2	8.662	<0.001		
				diel	3.808	1	4.226	0.042		
				year:diel	2.477	2	1.374	0.256		
				Residuals	129.762	144				
Pollock, age-0	Crab	98	2000	intercept	152.709	1	305.231	<0.001	-3.278	0.373
			2001	ln(m)	62.332	1	124.588	<0.001	1.380	0.246
			2003	year	33.801	2	33.780	<0.001		
				diel	0.635	1	1.268	0.263		
				year:diel	5.806	2	5.803	0.004		
				Residuals	45.528	91				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Pollock, age-0	Euphausiid	140	2000 2001 2003	intercept	5.140	1	11.025	0.001	-0.384	0.229
				ln(m)	46.948	1	100.702	<0.001	0.837	0.165
				year	9.600	2	10.296	<0.001		
				diel	3.369	1	7.227	0.008		
				year:diel	2.745	2	2.944	0.056		
				Residuals	62.006	133				
Pollock, age-0	Fish	50	2000 2001 2003	intercept	71.421	1	251.970	<0.001	-3.912	0.497
				ln(m)	9.434	1	33.282	<0.001	0.955	0.334
				year	0.577	2	1.018	0.370		
				diel	0.039	1	0.138	0.712		
				year:diel	1.595	2	2.814	0.071		
				Residuals	12.188	43				
Pollock, age-0	Pteropod	124	2000 2001 2003	intercept	193.142	1	145.107	<0.001	2.262	0.372
				ln(m)	118.461	1	88.999	<0.001	-1.550	0.325
				year	6.109	2	2.295	0.105		
				diel	1.788	1	1.344	0.249		
				year:diel	3.593	2	1.350	0.263		
				Residuals	155.731	117				
Pollock, age-0	Shrimp	17	2000 2001 2003	intercept	9.371	1	41.527	<0.001	-3.287	1.136
				ln(m)	0.343	1	1.522	0.246	0.485	0.875
				year	1.270	2	2.814	0.107		
				diel	0.441	1	1.954	0.192		
				year:diel	0.492	2	1.089	0.373		
				Residuals	2.257	10				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Pollock, age-1	Amhipod	50	2000 2001	intercept	1.216	1	2.492	0.121	-1.486	1.896
				ln(m)	1.122	1	2.300	0.136	0.348	0.462
				year	0.112	1	0.229	0.635		
				diel	0.058	1	0.118	0.733		
				year:diel	0.033	1	0.068	0.795		
				Residuals	21.957	45				
Pollock, age-1	Appendicularia	33	2000 2001	intercept	12.369	1	10.259	0.003	5.824	3.724
				ln(m)	14.892	1	12.352	0.002	-1.652	0.963
				year	4.600	1	3.815	0.061		
				diel	0.211	1	0.175	0.679		
				year:diel	4.276	1	3.546	0.070		
				Residuals	33.757	28				
Pollock, age-1	Chaetognath	35	2000 2001	intercept	2.164	1	3.215	0.083	2.517	2.867
				ln(m)	4.349	1	6.463	0.016	-0.893	0.717
				year	0.155	1	0.231	0.635		
				diel	5.665	1	8.417	0.007		
				year:diel	0.310	1	0.46	0.503		
				Residuals	20.191	30				
Pollock, age-1	Copepod	56	2000 2001	intercept	2.076	1	1.534	0.221	-1.592	2.581
				ln(m)	6.074	1	4.487	0.039	0.679	0.644
				year	4.280	1	3.162	0.081		
				diel	3.920	1	2.896	0.095		
				year:diel	5.244	1	3.875	0.054		
				Residuals	69.028	51				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Pollock, age-1	Crab	45	2000 2001	intercept	0.341	1	0.299	0.588	-0.856	3.164
				ln(m)	0.201	1	0.176	0.677	0.164	0.789
				year	4.452	1	3.897	0.055		
				diel	0.152	1	0.133	0.717		
				year:diel	1.759	1	1.540	0.222		
				Residuals	45.688	40				
Pollock, age-1	Euphausiid	62	2000 2001	intercept	0.443	1	0.875	0.354	-0.679	1.454
				ln(m)	8.792	1	17.347	<0.001	0.752	0.361
				year	0.308	1	0.608	0.439		
				diel	0.623	1	1.230	0.272		
				year:diel	6.603	1	13.028	0.001		
				Residuals	28.89	57				
Pollock, age-1	Fish	32	2000 2001	intercept	3.168	1	8.601	0.007	-3.610	2.526
				ln(m)	1.081	1	2.935	0.098	0.509	0.610
				year	0.156	1	0.425	0.520		
				diel	0.072	1	0.195	0.662		
				year:diel	0.037	1	0.102	0.752		
				Residuals	9.946	27				
Pollock, age-1	Mysid	8	2000 2001	intercept	0.104	1	0.152	0.722	-1.537	12.53
				ln(m)	0.005	1	0.008	0.936	-0.083	3.059
				year	0.037	1	0.054	0.831		
				diel	0.194	1	0.284	0.631		
				year:diel	0.061	1	0.090	0.784		
				Residuals	2.041	3				

Predator	Prey	Predator size classes	Years	Analysis of variance					Regression	
				Terms	Sum Sq	DF	F	P	Coefficient	95% CI
Pollock, age-1	Pteropod	27	2000 2001	intercept	1.995	1	1.732	0.202	2.738	4.314
				ln(m)	3.942	1	3.422	0.078	-0.974	1.092
				year	10.955	1	9.509	0.005		
				diel	0.430	1	0.373	0.547		
				year:diel	1.279	1	1.110	0.303		
				Residuals	25.345	22				
Pollock, age-1	Shrimp	24	2000 2001	intercept	0.234	1	0.549	0.468	-1.154	3.262
				ln(m)	0.051	1	0.119	0.734	-0.133	0.805
				year	0.420	1	0.985	0.333		
				diel	0.055	1	0.129	0.723		
				year:diel	4.412	1	10.349	0.005		
				Residuals	8.100	19				

Online Resource 3 Analysis of variance of the relationship between \ln prey body weight and \ln predator body weight, $\ln[m_i]$, by predator-prey combination for data from the western Gulf of Alaska during September 2000, 2001, and 2003. Regression coefficients (slope, intercept) and Wald's 95% confidence interval (95% CI) account for year and random effects. Predator-prey combinations not shown were not fitted by the model

Predator	Prey	Number		Fixed effect	Sum	Deg of Freedom		F	P	Random effect variance			Regression	
		Sample	Fish			Num	Den			Haul:Site	Site	Residual	Coefficient	95% CI
Capelin	Appendicularia	25	50	$\ln(m_i)$	1.908	1	41.710	3.426	0.071	0.840	0.05	0.557	0.822	0.870
				year	1.024	2	21.781	0.919	0.414				-11.807	1.177
	Copepod	61	225	$\ln(m_i)$	8.129	1	213.104	10.492	0.001	0.510	0.11	0.775	0.640	0.387
				year	4.831	2	38.339	3.118	0.056				-9.113	0.568
	Euphausiid	71	254	$\ln(m_i)$	13.67	1	229.565	14.982	<0.001	0.633	0.02	0.913	0.669	0.339
				year	2.357	2	56.570	1.291	0.283				-5.486	0.574
Pteropod	35	97	$\ln(m_i)$	9.364	1	84.062	7.049	0.009	0.404	0.18	1.328	0.982	0.725	
			year	3.154	2	22.255	1.187	0.324				-11.234	1.001	
Eulachon	Amphipod	24	42	$\ln(m_i)$	0.316	1	28.611	1.616	0.214	0.158	0.03	0.195	-0.161	0.248
				year	0.327	2	15.500	0.837	0.452				-5.365	0.839
	Euphausiid	67	333	$\ln(m_i)$	16.63	1	146.944	28.673	<0.001	0.154	0.00	0.580	0.307	0.112
				year	3.298	2	40.345	2.842	0.070				-4.461	0.354
Pollock, age 0	Appendicularia	125	863	$\ln(m_i)$	0.588	1	669.938	0.920	0.338	0.098	0.06	0.639	0.072	0.147
				year	15.91	2	68.746	12.460	<0.001				-10.028	0.193
	Chaetogna	91	282	$\ln(m_i)$	22.53	1	160.370	12.069	0.001	0.293	0.08	1.867	0.698	0.394
				year	27.76	2	51.462	7.436	0.001				-6.714	0.489
	Copepod	151	1795	$\ln(m_i)$	37.86	1	1077.90	56.173	<0.001	0.233	0.01	0.674	0.380	0.099
				year	11.46	2	124.700	8.500	<0.001				-8.677	0.146
Crab	99	346	$\ln(m_i)$	20.28	1	292.925	29.745	<0.001	0.067	0.11	0.682	0.652	0.234	

Predator	Prey	Number		Fixed effect	Sum	Deg of Freedom		F	P	Random effect variance			Regression	
		Sample	Fish			Num	Den			Haul:Site	Site	Residual	Coefficient	95% CI
Pollock, age 0	Euphausiid	140	1411	year	8.825	2	58.571	6.470	0.003	0.470	0.19	1.182	-6.573	0.361
				ln(m _i)	83.64	1	1311.42	70.738	<0.001				0.684	0.159
	Pteropod	103	609	year	6.957	2	100.749	2.942	0.057	0.456	0.39	0.826	-5.355	0.277
				ln(m _i)	7.606	1	593.720	9.210	0.003				0.318	0.205
Pollock, Age 1	Amphipod	41	176	year	8.394	2	84.853	5.082	0.008	0.141	0.05	0.773	-9.842	0.339
				ln(m _i)	1.230	1	165.006	1.592	0.209				0.268	0.416
	Appendi- cularia	25	54	year	0.623	2	18.105	0.403	0.674	0.586	0.21	0.596	-6.989	1.750
				ln(m _i)	0.028	1	45.074	0.046	0.831				0.073	0.666
	Copepod	44	229	year	0.481	2	8.918	0.403	0.680	0.022	0.61	0.561	-9.093	2.697
				ln(m _i)	2.517	1	216.041	4.484	0.035				0.328	0.304
	Euphausiid	49	366	year	1.927	2	38.288	1.717	0.193	0.020	0.09	0.686	-8.802	1.344
				ln(m _i)	2.167	1	294.137	3.158	0.077				0.232	0.256
	Pteropod	19	45	year	4.964	2	39.379	3.617	0.036	0.060	0.16	0.214	-4.434	1.078
				ln(m _i)	0.124	1	36.672	0.581	0.451				0.176	0.453
				year	0.044	2	10.192	0.104	0.903				-7.972	1.891

Online Resource 4 Scatterplot of Tsai et al.'s Proxy against Ursin's PPMR by predator group

