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Supplemental Materials for

Long-Term Changes in Summer Zooplankton Communities of the Western Chukchi Sea, 1945–2012

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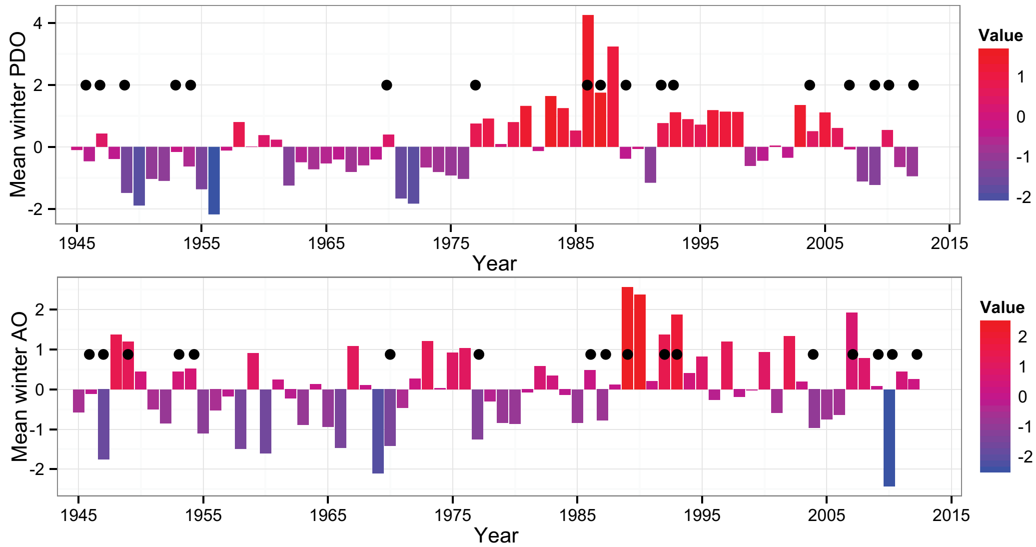

FIGURE S1. Mean six-month winter index values for the Pacific Decadal Oscillation (PDO) and the Arctic Oscillation (AO). Black dots indicate zooplankton biomass anomaly.

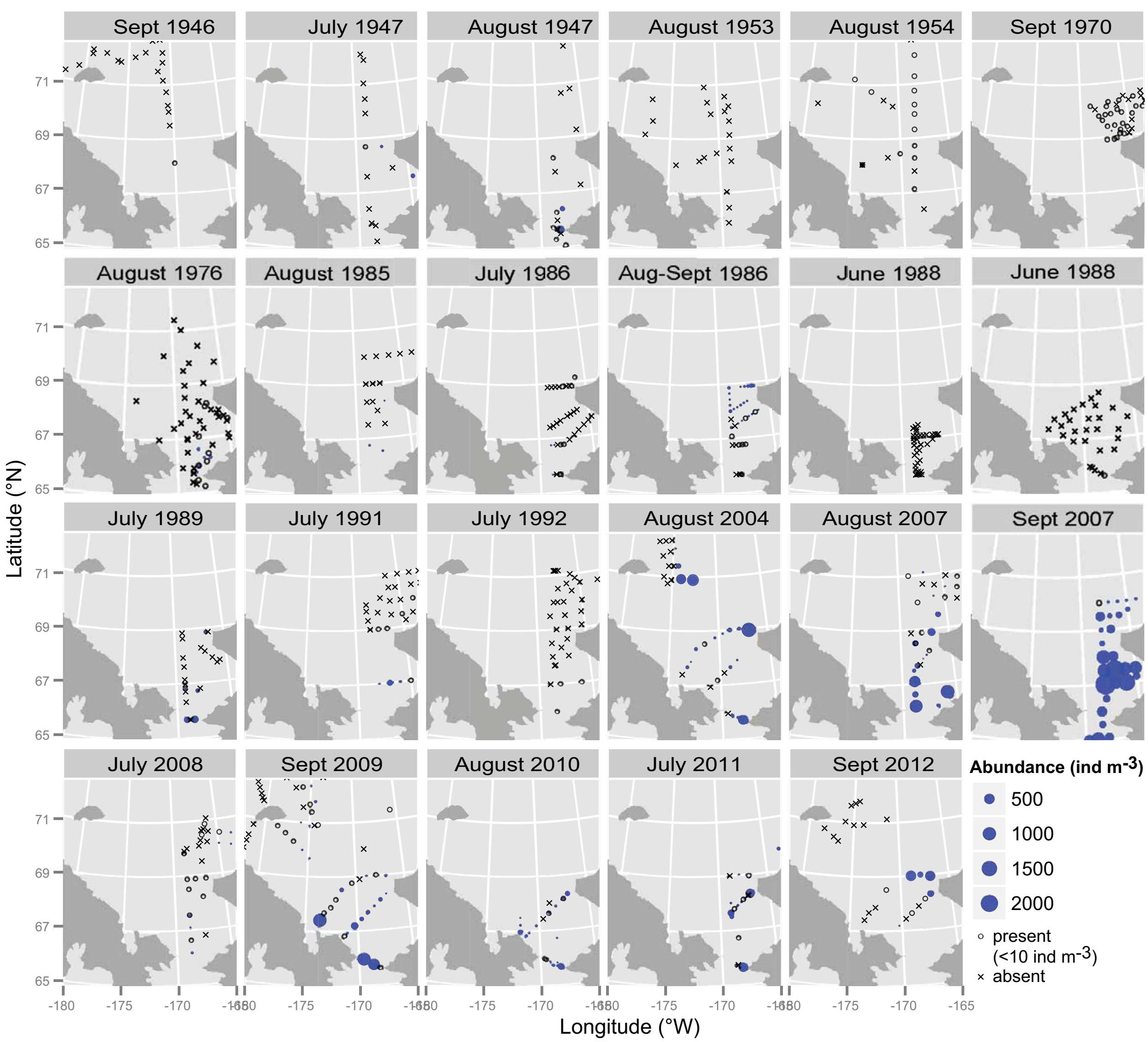

FIGURE S2. Distribution of Alaska Coastal Water (ACW) indicator species (listed in Table 2) in the Chukchi Sea during 1946–2012. o = stations where taxon was present (<10 ind m^{-3}). x = stations where taxon was not found.

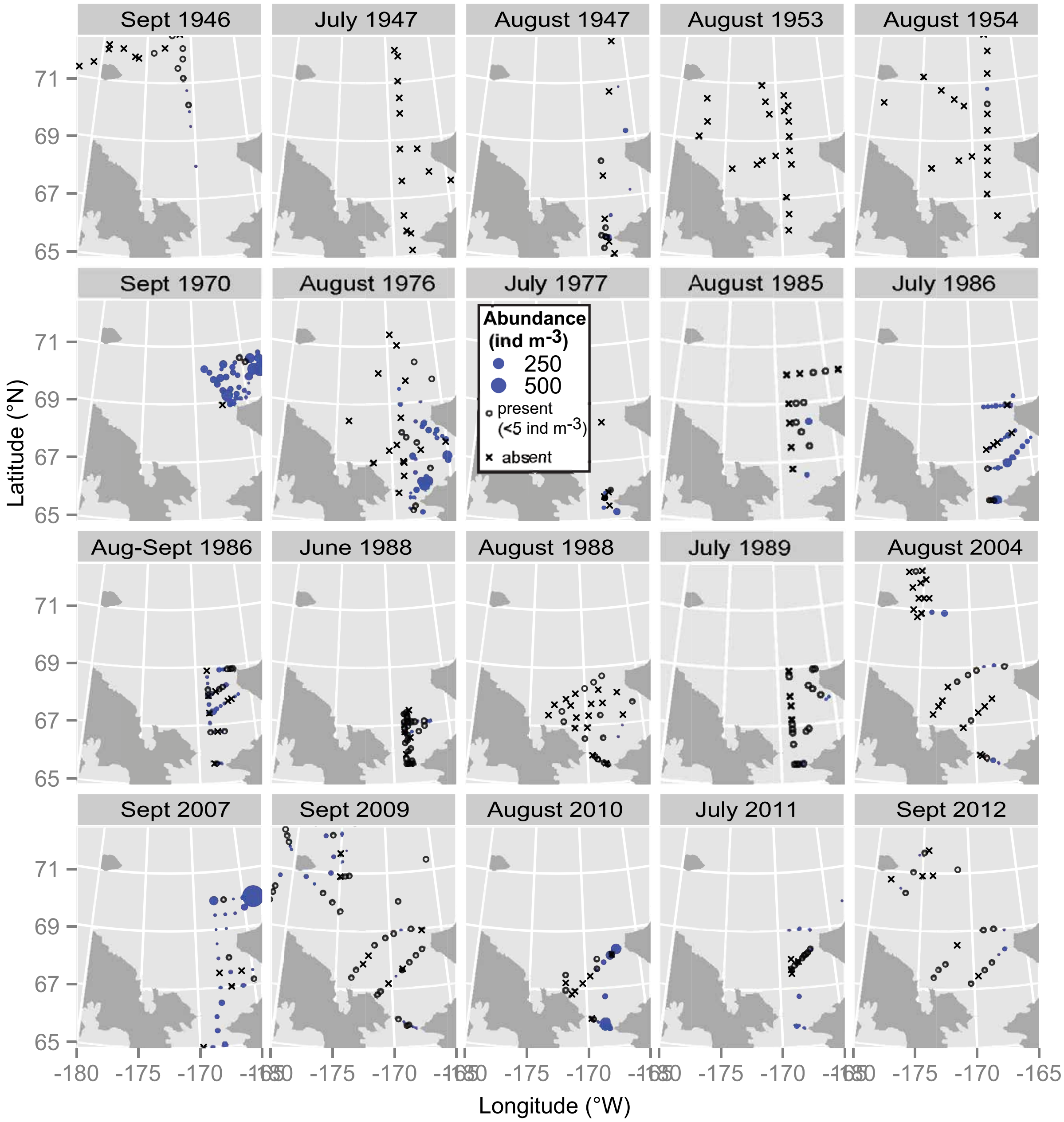

FIGURE S3. Distribution of *Aglantha digitale* in the Chukchi Sea during 1946–2012. o = stations where taxon was present (<1 ind m^{-3}). x = stations where taxon was not found.

TABLE S1. Summary of data sets. Taxonomic resolution: Low: <30 species. Medium: 30–50 species. High >50 species. Methods of calculating biomass: (1) biomass from abundance data using mean weights from literature; (2) length-weight regressions; (3) wet weight converted to dry weight; and (4) preserved wet weight with correction for weight loss. SST = sea surface temperature. DW = dry weight.

EXPEDITION/Ship	Year	Month	No. of Stations	Mesh size	CTD Data	Mean SST	Taxonomic Resolution	Biomass Method	Mean Biomass (mg DW m^{-3})	Mean Abund. (ind m^{-3})	Source
Severnyj Polyus	1946	Sep	36	167 µm Juday	NO	2.16	High	1	23.7	1,621	Unpublished and Markhaseva et al. (2005)
Nereus	1947	July	14	500 µm	YES	2.14	Medium	1	13.5	2,500	Johnson (1953)
Cedarwood	1949	August	21	~150 µm	YES	2.20	High	2	28.7	1,068	Unpublished
Lomonosov	1953	August	19	333 µm	YES	3.27	Low	3	10.35	254	Unpublished
Lomonosov	1954	August	21	333 µm	YES	3.41	Medium	3	84.75	2,986	Unpublished
WEBSEC/CGC *Glacier*	1970	Sep-Oct	39	570 µm	YES	3.24	Medium	1	17.7	114	Ingham et al. (1972)
Mayak	1976	August	25	167 µm Juday	NO	4.93	Low	3	46.3	4,104	Pavshtiks (1984)
OSCEAP/*Discoverer*	1976	August	25	333 µm	NO	4.93	Medium	1	41.6	537	Unpublished
OSCEAP/*Surveyor*	1977	July	7	333 µm	NO	3.64	Medium	1	49.1	1,212	Unpublished
ISHTAR HX74/*Alpha Helix*	1985	Aug-Sep	16	505 µm	YES	4.72	Low	4	141.9	415	Springer et al. (1989)
ISHTAR HX85/*Alpha Helix*	1986	July	38	505 µm	YES	4.24	Medium	4	84.4	252	Springer et al. (1989)
ISHTAR HX88/*Alpha Helix*	1986	Aug-Sep	38	505 µm	YES	5.39	High	4	57.1	247	Springer et al. (1989)
ISHTAR TT221/*Thomas Thompson*	1988	June	24	505 µm	YES	1.5	Low	4	13.4	225.5	Unpublished
BERPAC/*Akademik Korolev*	1988	August	32	505 µm	YES	3.92	Medium	4	33.1	147	Kulikov (1992)
ISHTAR HX128/*Alpha Helix*	1989	July	42	505 µm	YES	3.62	Medium	4	106.7	337	Unpublished
Oshoro-Maru	1991	July	27	333 µm	YES	5.0	Medium	3	117.5	1,616	Matsuno et al. (2011)
Oshoro-Maru	1992	July	34	333 µm	YES	4.7	Medium	3	76.4	1,110	Matsuno et al. (2011)
RUSALCA/*Khromov*	2004	August	34	Bongo 150 µm	YES	6.3	High	2	49.7	5,762	Hopcroft et al. (2010)
Oshoro-Maru	2007	August	31	333 µm	YES	8.9	Medium	3	91.7	1,728	Matsuno et al. (2011)
Oscar Dyson	2007	Sep	25	505 µm/150 µm	YES	9.6	High	1	175/57	64/1,348	Eisner et al. (2012)
Oshoro-Maru	2008	July	28	333 µm	YES	3.4	Medium	3	119.2	2,771	Matsuno et al. (2011)
Laurier	2009	July	5	Bongo 150 µm	NO	4.9	High	2	76.4	4,061	Unpublished
RUSALCA/*Khromov*	2009	Sept	60	Bongo 150 µm	YES	3.2	High	2	72.1	8,967	Ershova et al. (2015)
Laurier	2010	July	16	Bongo 150 µm	NO	5.4	High	2	170	16,313	Unpublished
RUSALCA/*Khromov*	2010	August	17	Bongo 150 µm	YES	5.6	High	2	70.7	14,070	Ershova et al. (2015)
Laurier	2011	July	23	Bongo 150 µm	NO	5.5	High	2	126.6	12,327	Unpublished
RUSALCA/*Khromov*	2011	July	9	Bongo 150 µm	NO	5.5	High	2	98.1	2,359	Unpublished
RUSALCA/*Khromov*	2012	Sep	25	Bongo 150 µm	YES	2.6	High	2	85.4	3,224	Ershova et al. (2015)

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TABLE S2. (a) Summary and (b) comparisons between least squares means for factors (only significant comparisons reported) for the mixed model log(Biomass) ~ Year + Month + PDO + Water mass +Gear + 1|Facet. PDO = Pacific Decadal Oscillation. ACW = Alaska Coastal Water. BSAW = Bering Sea/Anadyr Water. WW = Winter Water. SCW = Siberian Coastal Water.

(a)	Factor	Estimate	Standard Error	df	t-value	p-value
Intercept	–	–22.5428	2.5479	451	–8.8475	***
Year	–	0.0119	0.0012	451	9.3447	***
PDO index	–	–0.0949	0.0272	451	–3.4839	**
Month	June	0.7555	0.1148	536.7	6.58	***
	July	1.6596	0.0782	366	21.23	***
	August	1.4347	0.0735	362.5	19.52	***
	September	1.4416	0.0746	391	19.33	***
Water mass (bottom water mass/surface water mass)	ACW	1.1815	0.0778	193.2	15.19	***
	BSAW	1.4871	0.0484	66.3	30.72	***
	BSAW/ACW	1.4308	0.0518	83.8	27.6	***
	BSAW/SCW	1.4518	0.1556	363	9.33	***
	BSAW/WW	1.1901	0.2552	576.5	4.66	***
	SCW	0.7784	0.1708	302.4	4.56	***
	WW	1.3178	0.0766	275.6	17.2	***
	WW/BSAW	1.2919	0.0945	349.3	13.67	***
	WW/SCW	1.1051	0.151	516.4	7.32	***

(b)	Factor A	Factor B	Estimate (difference)	Error	p-value
Month	June	September	–0.7	0.1002	***
	July	June	0.9	0.1045	***
	July	September	0.2	0.0602	***
	August	July	–0.2	0.0588	***
	August	June	0.7	0.0973	***
Water mass (bottom water mass/surface water mass)	ACW	BSAW	–0.3	0.0812	***
	ACW	BSAW/ACW	–0.2	0.0749	***
	ACW	SCW	0.4	0.182	*
	BSAW	SCW	0.7	0.1745	***
	BSAW	WW	0.2	0.0856	*
	BSAW	WW/BSAW	0.2	0.1037	•
	BSAW	WW/SCW	0.4	0.155	*
	BSAW/ACW	SCW	0.7	0.1721	***
	BSAW/ACW	WW/SCW	0.3	0.1524	*
	BSAW/SCW	SCW	0.7	0.2142	**
	BSAW/SCW	WW/SCW	0.3	0.2038	•
	SCW	WW	–0.5	0.1846	**
	SCW	WW/ACW	–1.2	0.5231	*
	SCW	WW/BSAW	–0.5	0.1907	**
	WW/ACW	WW/SCW	0.9	0.5155	•

p-value codes:

*** <0.001
** <0.01
* <0.05
• <0.1

TABLE S3. Mixed model results of *Calanus glacialis* abundance in Bering Sea/Anadyr Water. Best model reported as predicted by the Akaike Information Criterion (AIC). (a) Results and (b) comparisons between least squares means for month (only significant comparisons reported) for the model log(Abundance+1) ~ Year + Month + PDO + (Gear) + 1|Facet. PDO = Pacific Decadal Oscillation.

(a)	Factor	Estimate	Std. Error	df	t-value	p-value
(Intercept)	–	–17.50	3.14	402.00	–5.57	***
Year	–	0.01	0.00	402.00	5.98	***
PDO index	–	–0.11	0.03	386.50	–3.30	**
Month	June	1.14	0.11	257.10	10.51	***
	July	1.60	0.08	130.40	19.26	***
	August	1.32	0.06	51.30	22.58	***
	September	1.16	0.07	81.00	17.24	***

(b)	Estimate	Std. Error	df	t-value	p-value
July–June	0.50	0.12	373.50	3.75	***
July–September	0.40	0.09	387.40	5.03	***
August–July	–0.30	0.08	396.50	–3.39	***
August–September	0.20	0.07	400.70	2.25	*

p-value codes:
*** <0.001
** <0.01
* <0.05

TABLE S4. Mixed model results of *Metridia pacifica* abundance in BSAW. Best model reported as predicted by AIC. (a) Results and (b) comparisons between least squares means for month (only significant comparisons reported) for the model log(Abundance+1) ~ Year + Month + Surface T + (Gear) + 1|Facet.

(a)	Factor	Estimate	Std. Error	df	t-value	p-value
(Intercept)		–26.97	6.30	372.70	–4.28	***
Year		0.01	0.00	372.70	4.40	***
Mean Bottom Temperature		0.37	0.07	371.00	5.22	***
Month	June	0.07	0.18	315.00	0.40	
	July	0.72	0.13	212.00	5.45	***
	August	1.03	0.10	117.00	10.34	***
	September	1.05	0.12	170.00	8.97	***

(b)	Estimate	Std. Error	df	t-value	p-value
June–September	–1.00	0.17	367.70	–5.90	***
July–June	0.70	0.18	356.00	3.69	***
July–September	–0.30	0.14	363.80	–2.37	*
August–June	1.00	0.17	363.80	5.50	***
August–July	0.30	0.12	362.50	2.57	*

p-value codes:
*** <0.001
** <0.01
* <0.05

TABLE S5. Mixed model results of *Eucalanus bungii* abundance in Bering Sea/Anadyr Water. Best mixed model reported as predicted by AIC. (a) Results and (b) comparisons between least squares means for month (only significant comparisons reported) for the model log(Abundance+1) ~ Year + Month + Bottom T + (Gear) + 1|Facet.

(a)	Factor	Estimate	Std. Error	df	t-value	p-value
(Intercept)	–	–24.65	4.74	323	–5.19	***
Year	–	0.01	0.00	323	5.10	***
Mean Bottom Temperature	–	0.46	0.06	323	7.82	***
Month	June	0.83	0.18	335.9	0.69	***
	July	0.28	0.12	220.5	1.46	*
	August	0.83	0.08	107.5	10.62	***
	September	0.95	0.10	175.5	10.06	***

(b)	Estimate	Std. Error	df	t-value	p-value
June–September	–0.1	0.18	372.4	–0.66	***
July–June	–0.5	0.16	368.8	–3.28	**
July–September	–0.7	0.12	361.8	–5.70	***
August–July	0.50	0.10	360.1	5.51	***

p-value codes:
*** <0.001
** <0.01
* <0.05

TABLE S6. Mixed model results of *Neocalanus* spp. abundance in Bering Sea/Anadyr Water. Best model reported as predicted by AIC. (a) Results and (b) comparisons between least squares means for month (only significant comparisons reported) for the model log(Abundance+1) ~ Year + Month + (Gear) + 1|Facet.

(a)	Factor	Estimate	Std. Error	df	t-value	p-value
(Intercept)	–	–10.24	3.62	370.8	-3.43	***
Year	–	0.01	0.00	371.4	3.53	***
Mean bottom temperature	–	0.19	0.05	368.8	3.53	***
Month	June	0.50	0.14	217.5	3.61	
	July	0.42	0.08	204.9	6.71	***
	August	0.58	0.05	122.0	10.88	***
	September	0.21	0.07	227.7	2.96	***

(b)	Estimate	Std. Error	df	t-value	p-value
June–September	0.30	0.15	312.6	2.31	*
July–September	0.30	0.13	363.1	3.56	***
August–September	0.40	0.07	364.5	5.35	***

p-value codes:
*** <0.001
** <0.01
* <0.05