Table 2 Prey species found in herring stomachs from Hecate Strait in 1987 (prey counts converted to weights using 1985 average weight/species).

Fishing date				*Total*		PREY SPECIES
July 1987		*Nov. 1987*				
Wgt (*g*)	%	Wgt (*g*)	%	Wgt (*g*)	%	
1.829	2.6	65.243	48.0	67.073	32.7	*Parathemisto spp.*
41.452	59.7	21.747	16.0	63.199	30.8	Euphausiidae
14.113	20.3	16.388	12.1	30.501	14.9	*Euphausia spp.*
1.840	2.6	23.238	17.1	25.078	12.2	Copepoda calanoida
7.778	11.2	6.364	4.7	14.142	6.9	*Thysanoessa spp.*
0.006	0.0	1.272	0.9	1.278	0.6	*Oikopleura*
0.721	1.0	0.203	0.1	0.924	0.5	*Metridia spp*
0.867	1.2	0.000	0.0	0.867	0.4	*Cancer spp*
0.147	0.2	0.499	0.4	0.646	0.3	Hyperiidae
0.215	0.3	0.088	0.1	0.303	0.1	*Cyphocaris spp.*
0.000	0.0	0.285	0.2	0.285	0.1	*Mesocalanus spp.*
0.177	0.3	0.077	0.1	0.254	0.1	*Calanus spp.*
0.116	0.2	0.007	0.0	0.123	0.1	*Neocalanus spp.*
0.114	0.2	0.006	0.0	0.120	0.1	*Euchaeta spp.*
0.000	0.0	0.118	0.1	0.118	0.1	*Corycaeus spp.*
0.009	0.0	0.081	0.1	0.090	0.0	*Pseudocalanus spp.*
0.000	0.0	0.058	0.0	0.058	0.0	*Acartia spp.*
0.009	0.0	0.046	0.0	0.055	0.0	*Primno spp.*
0.034	0.0	0.002	0.0	0.037	0.0	Paguridae
0.013	0.0	0.022	0.0	0.036	0.0	*Epilabidocera spp.*
0.013	0.0	0.022	0.0	0.036	0.0	Amphipoda
0.000	0.0	0.014	0.0	0.014	0.0	*Scolecithricella spp.*
0.002	0.0	0.011	0.0	0.014	0.0	*Limacina helicina*
101		*350*		*451*		Number of stomachs examined

Over winter energy changes in herring from Prince William Sound, Alaska

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During the fall of 1995 and spring of 1996, the whole body energy content (WBEC) of *Clupea pallasi* from Prince William Sound (PWS), was examined. Somatic energy exhibited a wide range of values relative to length (SL). In the fall age 0 recruits had an average of 5.7 $kJ \cdot g^{-1}$ wet wt for whole body samples vs 8.0 for age 1 and 0.4-10.2 $kJ \cdot g^{-1}$ for fish of ages 2 to 7. The following spring the 1995 year class, which had just survived their first winter, averaged 4.4 $kJ \cdot g^{-1}$ wet wt for somatic samples, and age 1 fish had similar values, while herring ages 2 to 7 had WBEC > 5 $kJ \cdot g^{-1}$. The fall measures of WBEC showed the young-of-year and age 1 fish stored markedly less energy for overwintering than older herring.

In PWS many sea birds prey on juvenile herring. During the spring and summer, we examined WBEC of herring ≤ 165 mm SL.

From May to October, somatic energy ($kJ \cdot g^{-1}$ wet wt) exhibited a wide range of values relative to SL. Young of the year recruits appeared in July and had WBEC of 2-3 $kJ \cdot g^{-1}$ wet wt after metamorphosis and older fish had WBEC of 4-6 $kJ \cdot g^{-1}$ wet wt. By October the WBEC of juvenile herring was typically 4-6 $kJ \cdot g^{-1}$ wet wt.

Age 0 Pacific herring were surveyed in October of 4 years. There were distinct regional and interannual variations in SL and WBEC for individual groups of herring. Likewise within each collection there was typically a large range of size and WBEC values.

Changes in WBEC of captive age 0 herring forced to fast during winter was measured and compared to cohorts collected in the field. Somatic energy content of fasting captives declined at a rate of 23 $kJ \cdot g^{-1}$ wet $wt \cdot d^{-1}$ from 1 December 1995 to 25 January 1996 at mean temperature of 6.6°C. In another observation, fish captured on 1 December 1995 and held without feeding until 1 April 1996 had an average WBEC that changed from 5.2 to 3.2 $kJ \cdot g^{-1}$ wet wt during captivity at ≈5.2°C. Fish that died during fasts had WBEC values ranging from 2.8 to 3.6 $kJ \cdot g^{-1}$ wet wt. During March 1996 the WBEC of field collected age 0 herring averaged 3.8 $kJ \cdot g^{-1}$, with ≈40% having WBEC ≤ 3.6 $kJ \cdot g^{-1}$ wet wt. Thus, by March the average recruit had used most of its stored energy.

These observations on WBEC of Pacific herring determined that in PWS, storing enough energy to survive the first winter is an important hurdle in the recruitment process. Energetically, the recruiting year class, and those entering their second winter, are the most at risk of nutritionally related overwinter mortality. When modelling the transfer of energy from herring to predators fish age, time of collection, site of collection, SL, body wt all modify WBEC. Even within age groups or schools there is a wide range in WBEC values which must be taken into account when producing consumption models.

References

Paul, A. J. and J. M. Paul. 1999. Interannual and regional variations in body length, weight and energy content of age 0 Pacific herring from Prince William Sound, Alaska, *J. Fish Biol.* 54(5): 996-1001.

Paul, A. J. and J. M. Paul. 1998. Spring and summer whole body energy content of Alaskan juvenile Pacific herring. *Alaska Fishery Res. Bulletin*. 5(2): 131-136.

Paul, A. J. and J. M. Paul. 1998. Comparisons of whole body energy content of captive fasting age zero Alaska Pacific herring (*Clupea pallasi Valenciennes*) and cohorts over-wintering in nature. *J. Exp. Mar. Biol. Ecol.* 226: 75-86.

Paul, A. J., J. M. Paul and E. D. Brown. 1998. Fall and Spring somatic energy content for Alaskan Pacific (*Clupea pallasi*) relative to age, size and sex. *J. Exp. Mar. Biol. Ecol.* 223: 133-142.

Foy, R. J. and A. J. Paul. Winter feeding and changes in somatic energy content for age 0 Pacific herring in Prince William Sound, Alaska. *Trans. Amer. Fish. Soc.*, *in press*.