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**Caloric Content of Oceanic Zooplankton and Fishes for Studies of  
Salmonid Food Habits and Their Ecologically Related Species**

by

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## Abstract

The caloric content of zooplankton, squid, and fish were tabulated from values given in the literature. Cnidaria (4091 cal/g ash-free dry weight) and Ctenophora (3240 cal/g ash-free dry weight) had the lowest caloric value of the organisms surveyed. Pelagic polychaetes (*Tomopterus helgolandica* 7518 cal/g ash-free dry weight), copepods (*Chiridius armatus* 7698 cal/g ash-free dry weight), mysids (*Boreomysis arctica* 8525 cal/g ash-free dry weight), arrow worms (*Sagitta elegans* 7546 cal/ ash-free dry weight), and euphausiids (*Meganyctiphanes norvegica* 8574 cal/g ash-free dry weight) had a high caloric value. Caloric content varied with season of the year (*T. helgolandica* Dec. and April, *Illex illecebrosus* winter and summer, *Metridia longa* Dec. and April), and whether the sample included females with eggs (*Euchaeta norvegica*, *Diaptomus siciloides*, *Boreomysis arctica*, *Oncorhynchus nerka*). Among the fishes, herring (*Clupea harengus harengus*) and lake char (*Salvelinus namaycush*) had a high caloric content, 5994 cal/g dry weight, and 7103 cal/g dry weight. The caloric content of the Pacific salmon (*Oncorhynchus* spp.) ranged from 3345 cal/g dry weight to 6227 cal/ g dry weight.

## Introduction

Species of zooplankton, squid, and fish have been shown to comprise the prey organisms of oceanic Pacific salmonids (*Oncorhynchus* spp.; Brodeur 1990; Davis 1990; Ito 1964; Ishida et al. 1991, 1992; and Nagasawa et al. 1993; NMFS 1993). Information on the caloric content of prey organisms can be used to evaluate the quality of salmonid diets, and to determine the role of species ecologically related to Pacific salmonids. The purpose of this report was to compile literature values for the caloric content of oceanic species that are fed upon by salmonids, or are representative of taxonomic groups known to be fed upon by salmonids.

## Methods

I summarized literature values for caloric content of organisms that are prey of Pacific salmonids during the oceanic phase of their life-history. However, not all salmonid prey organisms have had their caloric content measured. In cases where the caloric value of particular prey organisms has not been determined, I included data from taxonomically related groups. Caloric content was summarized as calories per gram of fresh weight (FW), dry weight (DW), and ash-free dry weight (AFDW). Most authors determined caloric content from bomb calorimetry. In cases where the caloric content was reported in joules, I changed the value to calories using the following conversion factor: 1 joule=0.2388 calories. When the data were available, I included information on the season or month of the year when the organism was collected, the age, sex, or body part used to make the caloric determination, and the sample area where the organism was collected. Supplementary information on the percentage of water, protein, lipid, and carbohydrate was included because caloric content can be estimated knowing the composition, and these relationships: protein is approximately 4.80 kcal/g, lipid is approximately 9.45 kcal/g, and carbohydrate is approximately 4.10 kcal/g (Brett and Groves 1979).

## Results and Discussion

Cnidaria (4091 cal/g AFDW) and Ctenophora (3240 cal/g AFDW) had the lowest caloric value of the organisms surveyed (Table 1). Pelagic polychaetes (*Tomopterus helgolandica* 7518 cal/g AFDW), copepods (*Chiridius armatus* 7698 cal/g AFDW), mysids (*Boreomysis arctica*

8525 cal/g AFDW), arrow worms (*Sagitta elegans* 7546 cal/ AFDW), and euphausiids (*Meganyctiphanes norvegica* 8574 cal/AFDW) all exhibited high caloric content (Table 1.) Caloric content varied with season of the year (*T. helgolandica* Dec. and April; *Illex illecebrosus* winter and summer; *Metridia longa* Dec. and Apr), and whether the sample includes females with eggs (*Euchaeta norvegica*, *Diaptomus siciloides*, *Boreomysis arctica*, *O. nerka*,). Samples that include females with eggs are among the highest estimates of caloric content (Table 1). Among the fishes, herring (*Clupea harengus harengus*) and lake char, (*Salvelinus namaycush*) had a high caloric content, 5994 cal/g DW, and 7103 cal/g DW (Table 1). The caloric content of the Pacific salmon ranged from 3345 cal/g DW to 6227 cal/ g DW.

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Table 1. Caloric content of zooplankton, squid, and fish. These zooplankton include species that are prey of Pacific salmonids (*Oncorhynchus* spp.) or representative of taxonomic groups that are salmonid prey organisms. General distribution is the distribution of the organisms, if known. A: Atlantic Ocean, NA: North Atlantic Ocean, P: Pacific Ocean, NP: North Pacific Ocean, Ind: Indian Ocean, Ac: Arctic Ocean, subAc: Subarctic, WW: world-wide, temp: temperate, F: freshwater. Caloric content is summarized as calorie per g (cal/g) wet weight (WW), dry weight (DW) and ash-free dry weight (AFDW). Season is the time of year when the organism was collected. Sample area is where the organisms were collected. Comments such as the percentages of protein (prot), lipid, carbohydrate (carbo), organic material (org), and total organic material (torg) as a portion of wet or dry weight are also listed when available.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<b>COELENTERATES</b>											
Cnidaria											
Medusae		60		4513				whole	NW Atlantic	Steimle et al. 1985	
Medusae				4081						Steimle et al. 1985*	
<i>Hybobocodon prolifera</i>	A-P-Ac		3400	6210	45.4	94.9	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=27.0, % lipid=17.6, % carbo=0.8, % org=54.7 (of DW)
<i>Aglantha digitale</i>	A-P-Ac		1990	4890	58.5	95.6	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=21.9, % lipid=6.5, % carbo=0.7, % org=41.5 (of DW)
<i>Aglantha digitale</i>	A-P-Ac				39.2	94.2	Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=56.5, % lipid=3.0, % carbo=0.8, % chitin=0.5 (of DW)
<i>Aurelia aurita</i>	A-P-Ac									Larson et al. 1989*	lipid=0.4 % of DW
<i>Aurelia aurita</i>	A-P-Ac					96				Larson et al. 1989*	lipid=0.3% of DW
<i>Cyanea capillata</i>	A-P-Ac					96				Larson et al. 1989*	lipid=0.6 % of DW
<i>Rhizostoma</i> sp.										Larson et al. 1989*	lipid=1% of DW
<i>Spreocodon salatrix</i>						96				Larson et al. 1989*	lipid=0.3% of DW
<i>Stomatolophus</i> sp.	A-P					96				Larson et al. 1989*	lipid=0.5% of DW
<b>Ctenophora</b>											
<i>Beroe cucumis</i>	A-P-Ac		1350	4590			Dec		NE Atlantic	Norrbin et al. 1984	% org=29.4 of DW
<i>Beroe cucumis</i>	A-P-Ac		1360	3855	66.4	96.7	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=8.8, % lipid=5.2, % carbo=0.7, % org=33.8 (of DW)
<i>Beroe cucumis</i>	A-P-Ac						Aug	whole	Arctic	Clarke et al. 1987	% lipid=0.06 of FW
<i>Beroe cucumis</i>	A-P-Ac						May-Oct		NE Pacific	Lee 1974	lipid=13% of DW
<i>Pleurobrachia pileus</i>	A		680	3240			Dec		NE Atlantic	Norrbin et al. 1984	% org=20.9 of DW
<i>Pleurobrachia pileus</i>	A						May-Oct		NE Pacific	Lee 1974	lipid=9% of DW
<i>Pleurobrachia pileus</i>	A									Larson et al. 1989*	lipid=1.7% of DW
<i>Bolinopsis infundibulum</i>	A-P		780	3510			May		NE Atlantic	Norrbin et al. 1984	org=22.2% of DW
<i>Bolinopsis infundibulum</i>	A-P						Aug	whole	Arctic	Clarke et al. 1987	lipid=0.47% of FW
<i>Bolinopsis infundibulum</i>	A-P									Larson et al. 1989*	lipid=0.5% of DW
<i>Mertensia ovum</i>	A-P-Ac		1920	4430	56.2	95.5	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=21.9, % lipid=9.9, % carbo=0.6, % org=43.9 (of DW)
Ctenophores		49	1324	4003	68.3	97.2	Dec-Mar	whole	NW Atlantic	Thayer et al. 1973	average value for mixed species, Class Tentaculate
Ctenophores				3756						Steimle et al. 1985*	
Ctenophores						95.8				Reeve et al. 1978*	AFDW=28.5% of DW; org=3% of DW
Coelenterates		494	2886	5882				whole		Cummins et al. 1971	grand mean
Coelenterates			3481	4109						Griffiths 1977	

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Table 1. Continued.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<b>POLYCHAETES</b>											
<i>Tomopteris heigoldandica</i>			5278	7518			Dec		NE Atlantic	Norrbm et al. 1984	org=70.2% of DW
<i>Tomopteris heigoldandica</i>			4407	6278			Apr		NE Atlantic	Norrbm et al. 1984	org=70.2% of DW
<i>Tomopteris septentrionalis</i>					15.1	89.9	May-Oct		NE Pacific	Lee 1974	Lipid=22% of DW
<i>Tomopteris septentrionalis</i>							Jun-Aug	whole	Bering Sea	Ikedo 1972	% prot=73.8, % lipid=8.1, % carbo=1.7, % chitin=1.3 (of DW)
Polychaetes			3641							Griffiths 1977	
Polychaetes		1094	3792	5218	28	70		whole	NW Atlantic	Steimle et al. 1985	mostly epibenthic species
Polychaetes		640		4695						Steimle et al. 1985*	
Polychaetes		673	3388			80			NW Atlantic	Steimle et al. 1985*	mean value
Polychaetes		849	4798	6070	21.1	79.3		whole	NW Atlantic	Thayer et al. 1973	average values for 3 species
Polychaetes				5502						Steimle et al. 1985*	
<b>PTEROPODS</b>											
<i>Cilone limacina limacina</i>	A-P-Ac			5878	9	89.1	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	mean values; prot=33.4%, lipid=13.3% (of DW)
<i>Cilone limacina limacina</i>	A-P-Ac				28.2	88.6	Jun-Aug	whole	Bering Sea	Ikedo 1972	% prot=52.7, % lipid=17.5, % carbo=0.5, % chitin=1.1 (of DW)
<i>Cilone limacina</i>	A-P-Ac		3680	6030	38.2	83.2	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=39.7, % lipid=20.7, % carbo=0.8, % org=60.9 (of DW)
<i>Cilone limacina</i>	A-P-Ac						May-Oct		NE Pacific	Lee 1974	Lipid=31 % of DW
<i>Limacina helicina helicina</i>	A-P-Ac	958	4585	5006	8.4	79.1	Jun-Jul	whole	Bering Sea	Nishiyama 1977	% prot=52.4, % lipid=25.4 (of DW)
<i>Limacina helicina helicina</i>	A-P-Ac				26.5	75	Jul	whole	N Pacific	Omori 1969	north of 30° N
<i>Limacina retroversa</i>	A-Ac			5026		29.5				Phillipson 1964	
<i>Cavolinia longirostris</i>	A-P				39.3		Aug	whole	N Pacific	Omori 1969	north of 30° N
Pteropods				5442	8.7	84.1	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=42.9, % lipid=19.4 (of DW)
<b>SQUIDS</b>											
<i>Illex illecebrosus</i>	A	1695	5264	5636	7	69		whole	NW Atlantic	Steimle et al. 1985	Illex spawns in winter
<i>Illex illecebrosus</i>	A			5875			winter	whole	NW Atlantic	Steimle et al. 1985	Illex spawns in winter
<i>Illex illecebrosus</i>	A			5397			summer	whole	NW Atlantic	Steimle et al. 1985	Illex spawns in winter
<i>Loligo pealei</i>	A	1337	4872	5110	8	72		whole	NW Atlantic	Steimle et al. 1985	Loligo spawns late spring
<i>Loligo pealei</i>	A			4991			winter	whole	NW Atlantic	Steimle et al. 1985	Loligo spawns late spring
<i>Loligo pealei</i>	A			5540			spring	whole	NW Atlantic	Steimle et al. 1985	Loligo spawns late spring
<i>Loligo pealei</i>	A			5134			summer	whole	NW Atlantic	Steimle et al. 1985	Loligo spawns late spring
<i>Loligo pealei</i>	A			5230			fall	whole	NW Atlantic	Steimle et al. 1985	Loligo spawns late spring
<i>Loligo brevis</i>	A	1051	5743	6342	9.4	81.7	Dec		NE Atlantic	Thayer et al. 1973	
<i>Onastrephas bartramii</i>	WW-temp			5318	5.4					Phillipson 1964	originally called Stenoteuthis sp. in this article
Squids				5578	9.2	85.2	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	mean values; % prot=63.3, % lipid=15.8 (of DW)
<b>COPEPODS</b>											
Copepods				5512	8.8	80.8	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	mean values; % prot=56.6, % lipid=20.1 (of DW)
<i>Neocalanus cristatus</i>	NP			5428	10.5	84.6	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=56.5, % lipid=16.9 (of DW)
<i>Neocalanus cristatus</i>	NP				1.7	80.8	Mar	stage IV & V	Sea of Japan	Nakai 1955	% prot=53.4, % lipid=36.1 (of DW)
<i>Neocalanus cristatus</i>	NP				2.1	83.3	Jul	stage V	N Pacific	Omori 1969	north of 30° N
<i>Neocalanus cristatus</i>	NP				3.4	84.5	Dec	stage V	N Pacific	Omori 1969	north of 30° N
<i>Neocalanus cristatus</i>	NP				2.9	66.1	May	stage V	N Pacific	Omori 1969	north of 30° N
<i>Neocalanus cristatus</i>	NP				14	84.2	Jun-Aug	stage V	Bering Sea	Ikedo 1972	% prot=60.2; % lipid=31.7, % carbo=0.6, % chitin=3.5 (of DW)
<i>Neocalanus plumchrus</i>	NP			5680	8.8	80.8	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=56.5, % lipid=20.1 (of DW)
<i>Neocalanus plumchrus</i>	NP				1.7	82.7	Mar-May	stages II, III, IV, V	Sea of Japan	Nakai 1955	% prot=44.1; % lipid=44.2 (of DW)
<i>Neocalanus plumchrus</i>	NP						May-Oct		NE Pacific	Lee 1974	lipid=47 % of DW
<i>Neocalanus plumchrus</i>	NP				1.9	72.3	Jul	female	N Pacific	Omori 1969	north of 30° N
<i>Neocalanus plumchrus</i>	NP				5.4	82.8	Jun-Aug	stage V	Bering Sea	Ikedo 1972	% prot=53.5; % lipid=38.0, % carbo=0.9, % chitin=2.2 (of DW)
<i>Calanus finmarchicus</i>	NA		6437	7020			Dec	whole	NE Atlantic	Norrbm et al. 1984	% org=91.7 of DW
<i>Calanus finmarchicus</i>	NA			5914			Jan-Dec	adult female		Cummins et al. 1971*	
<i>Calanus finmarchicus</i>	NA			7380				adult female		Cummins et al. 1971*	
<i>Calanus finmarchicus</i>	NA			6369	10.8					Phillipson 1964	
<i>Calanus finmarchicus</i>	NA				3.3		Nov	stage V		Mayzaud et al. 1975	% prot=44.5, % lipid=44.4 (of DW)
<i>Calanus heigoldandicus</i>	NA			5400				whole		Cummins et al. 1971*	
<i>Calanus heigoldandicus</i>	NA				2.8	83.8	Jan & May	mixed; mostly females	Sea of Japan	Nakai 1955	% prot=75.2, % lipid=8.1 (of DW)
<i>Calanus hyperboreus</i>				7432				adult female		Cummins et al. 1971*	
<i>Paracalanus parvus</i>	WW not Ac				2.9	84.1				Cummins et al. 1971*	% prot=70.1, % lipid=19.1 (of DW)
<i>Calanus pacificus</i>	NP				4.4	80.3	Apr	stage V	N Pacific	Omori 1969	north of 30° N
<i>Calanus pacificus</i>	NP				2.9	78.8	Nov	stage V	N Pacific	Omori 1969	north of 30° N

Table 1. Continued.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<i>Galanus gracilis</i>	Ac				7.4	78.8	Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=48.6; % lipid=40.9, % carbo=1.0, % chitin=2.1 (of DW)
<i>Pseudocalanus elongatus</i>	temp				2.3	87.7	Mar	mixed, mostly females	Sea of Japan	Nakai 1955	% prot=71.5, % lipid=17.3 (of DW)
<i>Eucalanus bungii</i>	NP						May-Oct		NE Pacific	Lee 1974	lipid=40 % of DW
<i>Eucalanus bungii bungii</i>	NP				3.9	88	Jul	female	N Pacific	Omori 1969	north of 30° N
<i>Eucalanus bungii bungii</i>	NP				18.3	86.7	Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=52.5, % lipid=25.4, % carbo=1.1, % chitin=2.7 (of DW)
<i>Rhincalanus nasutus</i>	A-P-Ind				3.4	86.5	Apr	whole	N Pacific	Omori 1969	north of 30° N
<i>Acartia clausi</i>					3.3	87.9	Apr	mixed, mostly females	Sea of Japan	Nakai 1955	% prot=82.6, % lipid=5.8 (of DW)
<i>Metridia longe</i>		6489	7030				Dec	whole	NE Atlantic	Norrbin et al. 1984	% org=92.3 of DW
<i>Metridia longa</i>		7151	7559				Apr	whole	NE Atlantic	Norrbin et al. 1984	% org=94.6 of DW
<i>Metridia okhotsensis</i>					2.7	81.2	Jul	female	N Pacific	Omori 1969	north of 30° N
<i>Euchaeta japonica</i>	NP				2.1	79.6	Jul	mixed juveniles & adults	Sea of Japan	Nakai 1955	% prot=51.8, % lipid=33.7 (of DW)
<i>Euchaeta norvegica</i>		6464	6950				Dec	whole	NE Atlantic	Norrbin et al. 1984	% org=93.0 of DW
<i>Euchaeta norvegica</i>		6289	6651				Dec	males	NE Atlantic	Norrbin et al. 1984	% org=94.7 of DW
<i>Euchaeta norvegica</i>		6898	7494				Dec	females	NE Atlantic	Norrbin et al. 1984	% org=92.0 of DW
<i>Euchaeta norvegica</i>		6927					Apr	egg sack	NE Atlantic	Norrbin et al. 1984	
<i>Euchaeta norvegica</i>		6566	7060				Apr	stage V	NE Atlantic	Norrbin et al. 1984	% org=93.0 of DW
<i>Euchaeta norvegica</i>		7020	7565				Apr	females with eggs	NE Atlantic	Norrbin et al. 1984	% org=92.6 of DW
<i>Euchaeta norvegica</i>		6595	7107				Apr	females	NE Atlantic	Norrbin et al. 1984	% org=92.8 of DW
<i>Paraeuchaeta birostrata</i>					2.1	81.5	Apr	female	N Pacific	Omori 1969	north of 30° N
<i>Paraeuchaeta sarsi</i>					2.1		Nov	egg	N Pacific	Omori 1960	north of 30° N
<i>Chiridius armatus</i>		7175	7698				Dec	females	NE Atlantic	Norrbin et al. 1984	% org=93.2 of DW
<i>Chiridius armatus</i>		5980	6550				Apr	females	NE Atlantic	Norrbin et al. 1984	% org=91.3 of DW
<i>Chiridius armatus</i>		6127	6674				Apr	females	NE Atlantic	Norrbin et al. 1984	% org=91.8 of DW
<i>Diaptomus arcticus</i>			5468				Jun	adult reproductive males		Cummins et al. 1971*	500 animals, 2.34 mm length
<i>Diaptomus arcticus</i>			5526				Jun	adult nonreproductive females		Cummins et al. 1971*	550 animals, 2.80 mm length
<i>Diaptomus sicioides</i>			5334				Jul	adult reproductive males		Cummins et al. 1971*	8500 animals, 0.75 mm length
<i>Diaptomus sicioides</i>			5643				Jul	adult nonreproductive females		Cummins et al. 1971*	12,500 animals, 0.95 mm length
<i>Diaptomus sicioides</i>		5605	5849	4.3			Aug-Nov	adult nonreproductive females		Cummins et al. 1971*	
<i>Diaptomus sicioides</i>		5877	6149	4.6			Aug-Nov	adult females with eggs		Cummins et al. 1971*	
<i>Diaptomus leptopus</i>			5396				Jun	adult reproductive females		Cummins et al. 1971*	3000 animals, 1.45 mm length
<i>Diaptomus leptopus</i>			5436				Jun	adult nonreproductive females		Cummins et al. 1971*	2100 animals, 1.70 mm length
<i>Diaptomus sp.</i>		550								Cummins et al. 1971*	
Diaptomidae		550	5741	5883				whole		Cummins et al. 1971	grand mean
Diaptomidae				5868				females with eggs		Cummins et al. 1971	grand mean
<i>Gaetanus columbiae</i>							May-Oct		NE Pacific	Lee 1974	lipid=28% of DW
<i>Heterorhabdus tanneri</i>	NP						May-Oct		NE Pacific	Lee 1974	lipid=43 % of DW
<i>Candacia columbiae</i>	NP				3.3	86.8	Aug		N Pacific	Omori 1969	north of 30° N
<b>EUPHAUSIDS</b>											
<i>Thysanoessa spp.</i>			5414	9	75.7		Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=58.8, % lipid=14.7 (of DW)
<i>Thysanoessa raschii</i>	A-P		5861				Jun-Jul	whole	Bristol Bay	Nishiyama 1977	
<i>Thysanoessa raschii</i>	A-P						Sep		NE Atlantic	Falk-Petersen 1981*	lipid=23.0 % of DW
<i>Thysanoessa raschii</i>	A-P			20.1			Sep-Apr	0-group	NE Atlantic	Falk-Petersen 1981	% prot=48.4, % lipid=27.6 (of DW)
<i>Thysanoessa raschii</i>	A-P			14.2			Jun-Apr	I-group	NE Atlantic	Falk-Petersen 1981	% prot=41.4, % lipid=37.5 (of DW)
<i>Thysanoessa raschii</i>	A-P			10.9	82.2		Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=78.6, % lipid=7.2, % carbo=0.5, % chitin=2.8 (of DW)
<i>Thysanoessa inermis</i>	A-P-Ac	6005	6430	6.7	73.9		Aug-Sept	whole	Arctic	Percy et al. 1981	% prot=43.9, % lipid=52.4, % carbo=0.3, % organic=93.4 (of DW)
<i>Thysanoessa inermis</i>	A-P-Ac			11.8			Feb-May			Falk-Petersen 1981*	% prot=52.3, % lipid=22.3 (of DW)
<i>Thysanoessa inermis</i>	A-P-Ac			19			Jul-Apr	0-group	NE Atlantic	Falk-Petersen 1981	% prot=46.9, % lipid=31.7 (of DW)
<i>Thysanoessa inermis</i>	A-P-Ac			11.9			Jul-Apr	I-group	NE Atlantic	Falk-Petersen 1981	% prot=33.8, % lipid=47.6 (of DW)
<i>Euphausia pacifica</i>	P	1138	4904	5582	12.3	76.6	Jun-Jul		Bristol Bay	Nishiyama 1977	% prot=59.3, % lipid=16.0 (of DW)
<i>Euphausia pacifica</i>	P				7.1	84.9	Feb	mixed females and males	Sea of Japan	Nakai 1955	% prot=79.3, % lipid=2.7 (of DW)
<i>Euphausia pacifica</i>	P						May-Oct		NE Pacific	Lee 1974	% lipid=19 of DW
<i>Euphausia pacifica</i>	P						May-Oct	juveniles	NE Pacific	Lee 1974	% lipid=26 of DW
<i>Euphausia pacifica</i>	P			8	79.8		Jul		N Pacific	Omori 1969	north of 30° N
<i>Euphausia pacifica</i>	P			8.5	79.3		Jul	juveniles	N Pacific	Omori 1969	north of 30° N
<i>Euphausia krohnii</i>	A		5251	8.4						Phillipson 1964	



Table 1. Continued.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<i>Meganyctiphanes norvegica</i>	A-P	940	4945			81	Feb-Dec	whole	NW Atlantic	Tyler 1973	
<i>Meganyctiphanes norvegica</i>	A-P	958	5040			81	Jan-Dec	whole	NW Atlantic	Tyler 1973	
<i>Meganyctiphanes norvegica</i>	A-P			5230	16					Phillipson 1964	
<i>Meganyctiphanes norvegica</i>	A-P	812	4633	5946	22	82		whole	NW Atlantic	Steimle et al. 1985	
<i>Meganyctiphanes norvegica</i>	A-P		7562	8574			Dec		NE Atlantic	Norrbín et al. 1984	% org=88.2 of DW
<i>Meganyctiphanes norvegica</i>	A-P		6181	6861			Dec		NE Atlantic	Norrbín et al. 1984	% org=90.1 of DW
<i>Meganyctiphanes norvegica</i>	A-P		5813	6563			Dec		NE Atlantic	Norrbín et al. 1984	% org=90.1 of DW
<i>Meganyctiphanes norvegica</i>	A-P				16.1		Jan-Nov		NE Atlantic	Falk-Petersen 1981*	% prot=56.6, % lipid=17.2 (of DW)
<i>Meganyctiphanes norvegica</i>	A-P				13.6		Nov-May		NE Atlantic	Falk-Petersen 1981*	% prot=56.5, % lipid=18.4 (of DW)
<i>Meganyctiphanes norvegica</i>	A-P				11.5		Jul-Jul 77		NE Atlantic	Falk-Petersen 1981*	% prot=61.1, % lipid=17.5 (of DW)
<i>Meganyctiphanes norvegica</i>	A-P				17		Nov-Jul	0 & I-group	NE Atlantic	Falk-Petersen 1981	% prot=40.2, % lipid=37.0 (of DW)
<i>Meganyctiphanes norvegica</i>	A-P				14.5		Jan-Jul	I & II-group	NE Atlantic	Falk-Petersen 1981	% prot=35.3, % lipid=37.3 (of DW)
<i>Tessarabrachion oculatus</i>	P				8.1	78.7	Jul		N Pacific	Omori 1969	north of 30° N
<i>Eulhamisio</i> sp.				5515	8.9					Phillipson 1964	
Euphausiids				5554	10.9	76.3	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=59.4, % lipid=15.5 (of DW)
<b>AMPHIPODS</b>											
<i>Parathemisto pacifica</i>				4556	20.8	82.8	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=54.8, % lipid=8.9 (of DW)
<i>Parathemisto libellula</i>				4458	23.4	80.9	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=50.4, % lipid=10.4 (of DW)
<i>Parathemisto libellula</i>		4920		5915	18	77.6	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=47.5, % lipid=26.2, % carbon=1.3, % organic=82.3 (of DW)
<i>Eulhamisio libellula</i>					21.1	80.6	Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=49.4, % lipid=21.6, % carbon=3.1, % chitin=4.8 (of DW)
<i>Parathemisto japonica</i>					13.4	81.6	Jul	juvenile	N Pacific	Omori 1969	north of 30° N
<i>Parathemisto abyssorum</i>		4733		5815			Apr		NE Atlantic	Norrbín et al. 1984	% org=81.4 of DW
<i>Parathemisto gaudichaudi</i>				5138			Jul	adults	NE Atlantic	Williams et al. 1979	
<i>Parathemisto</i> sp.					9.3	83.6	Mar-Jun	females	Sea of Japan	Nakai 1955	% prot=48.7, % lipid=39.6 (of DW)
<i>Hyperoche medusarum</i>			5420	6345	14.8	79.9	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=35.9, % lipid=27.2, % carbon=2.9, % organic=85.3 (of DW)
<i>Hyperia galba</i>		860	4442	5698	26	80		whole	NW Atlantic	Steimle et al. 1985	
<i>Hyperia galba</i>							May-Oct		NE Pacific	Lee 1974	% lipid=19 of DW
<i>Euprimno abyssalis</i>							May-Oct		NE Pacific	Lee 1974	% lipid=26 of DW
<i>Cyphocaris challengeri</i>					10	78	Jul		N Pacific	Omori 1969	north of 30° N
Gammaridea		810	4050	5362				whole, mixed size & sex		Cummins et al. 1971	grand mean
Gammaridea		1409	2627	4895	52	49		whole	NW Atlantic	Steimle et al. 1985	
Amphipods		1058	3761			72	Jun-Oct	whole, mixed size & sex	NW Atlantic	Brawn et al. 1968	
Amphipods		934	4002	4878						Cummins et al. 1971	grand mean
Amphipods				4517	17.8	82.2	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=53.0, % lipid=9.5 (of DW)
<b>ISOPODS</b>											
Isopoda				4439						Cummins et al. 1971	grand mean
<b>MYSIDS</b>											
<i>Boreomysis arctica</i>	A		6201	7618			Dec		NE Atlantic	Norrbín et al. 1984	% org=81.4 of DW
<i>Boreomysis arctica</i>	A		7391	8525			Apr	females with eggs	NE Atlantic	Norrbín et al. 1984	% org=86.7 of DW
<i>Boreomysis arctica</i>	A		5822	6830			Apr		NE Atlantic	Norrbín et al. 1984	% org=86.7 of DW
<i>Mysis stenolepis</i>	A	990		4714		79	Fall-Winter	whole	NW Atlantic	Tyler 1973	
<i>Neomysis americana</i>	A			3845				whole	NW Atlantic	Steimle et al. 1985	
<b>SHRIMPS</b>											
<i>Argis dentata</i>		1158	4878			76	Jun-Oct	female with eggs	NW Atlantic	Brawn et al. 1968	
<i>Argis dentata</i>		1081	4549			76	Jun-Oct	adults, mixed sexes	NW Atlantic	Brawn et al. 1968	
<i>Crangon septemspinosa</i>	NA	1111	4272			74	Jan-Apr	whole	NW Atlantic	Tyler 1973	
<i>Crangon septemspinosa</i>	NA	981	4088			76	Nov	whole	NW Atlantic	Tyler 1973	
<i>Pasiphaea multidentata</i>	NA		5007	5822			Dec		NE Atlantic	Norrbín et al. 1984	
<i>Pasiphaea pacifica</i>	P-ind						May-Oct		NE Pacific	Lee 1974	% lipid=21 of DW
Caridean shrimp		1098	4083	5230	21	75		whole	NW Atlantic	Steimle et al. 1985	
<i>Pandalus montagui</i>	NA	1291	4610			72	Aug-Dec	whole	NW Atlantic	Tyler 1973	
<i>Pandalus montagui</i>	NA	1320	4740			72	Jun-Oct	mixed sizes and sexes	NW Atlantic	Brawn et al. 1968	
<i>Pandalus montagui</i>	NA		4747	5924	24	72	Summer	adult nonreproductive female		Cummins et al. 1971	
<i>Pandalus montagui</i>	NA		4442	5634	26	71	Summer	adult reproductive male		Cummins et al. 1971	
Panidean shrimp		1648	3892	4895	21	59		whole	NW Atlantic	Steimle et al. 1985	
<b>CRAB ZOEAE</b>				5032	26.3	80.8	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=36.0, % lipid=11.0 (of DW)

Table 1. Continued.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<b>OSTRACODS</b>											
<i>Conchoecia elegans</i>							May-Oct		NE Atlantic	Lee 1974	% lipid=17 of DW
<i>Conchoecia elegans</i>			6180					females with eggs	NE Atlantic	Norbin et al. 1984	
<b>CHAETOGNATHS</b>											
<i>Sagitta elegans</i>	Ac-subAc		5860	6814			Dec		NE Atlantic	Norbin et al. 1984	% org=86 of DW
<i>Sagitta elegans</i>	Ac-subAc		6716	7546			Apr		NE Atlantic	Norbin et al. 1984	% org=89 of DW
<i>Sagitta elegans</i>	Ac-subAc		4272	4800			Apr		NE Atlantic	Norbin et al. 1984	% org=89 of DW
<i>Sagitta elegans</i>	Ac-subAc		5035	6210	18.2	90.3	Aug-Sep	whole	Arctic	Percy et al. 1981	% prot=63.3, % lipid=20.8, % carbo=0.07, % organic=81.9 (of DW)
<i>Sagitta elegans</i>	Ac-subAc				6.7		Nov	whole, mature	NW Atlantic	Mayzaud et al. 1975	% prot=54.2, % lipid=7.8 (of DW)
<i>Sagitta elegans</i>	Ac-subAc						May-Oct		NE Pacific	Lee 1974	% lipid=14 of DW
<i>Sagitta elegans</i>	Ac-subAc				4.8	85.9	Jul		N Pacific	Omori 1969	north of 30°N
<i>Sagitta elegans</i>	Ac-subAc				8	91.5	Jun-Aug	whole	Bering Sea	Ikeda 1972	% prot=84.0, % lipid=6.7, % carbo=0.7, % chitin=0.6 (of DW)
<i>Sagitta nagae</i>					4.2	88.4	Nov		N Pacific	Omori 1969	north of 30°N
<i>Eukrohnia hamata</i>	WW		5789	7218			Apr		NE Atlantic	Norbin et al. 1984	% org= 80.2 of DW
Chaetognaths				5032	8.6	90.1	Jun-Jul	whole	Bristol Bay	Nishiyama 1977	% prot=49.9, % lipid=6.5 (of DW)
Chaetognaths				5808						Steimle et al. 1985*	
<b>APPENDICULARIA</b>											
<i>Oikopleura vanhoeffeni</i>							Feb	stage 2-4	NW Atlantic	Diebel et al. 1992	% lipid=5.1 (of DW); before spring diatom bloom
<i>Oikopleura vanhoeffeni</i>							May	stage 1-4	NW Atlantic	Diebel et al. 1992	% lipid=7.8 (of DW); after spring diatom bloom
<b>SALPS</b>											
<i>Pegaeo confederata</i>					70			aggregate, whole	N Atlantic	Madin et al. 1981	% prot=81.3, % lipid=10.2 (of torq)
<i>Salpa cylindrica</i>					78.1			solitary, whole	N Atlantic	Madin et al. 1981	% prot=82.5, % lipid=5.9 (of torq)
<i>Salpa maxima</i>					69.2			aggregate, whole	N Atlantic	Madin et al. 1981	% prot=76.9, % lipid=9.4 (of torq)
Thaliacea					73.4			adult	N Atlantic	Madin et al. 1981	% prot=81.8, % lipid=7.6 (of torq)
Salpidae		96	2125	4346	51	95		whole	NW Atlantic	Steimle et al. 1985	
<b>FISH LARVAE</b>											
<i>Pleurogrammus monopecteniglus</i>	NP			5049	10.8	67.9	Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=12.9 of DW
<i>Tarletonbeania crenularis taylori</i>	NP			5204	16.7	75.2	Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=21.2 of DW
<i>Hippoglossoides sp.</i>				5329	10.9	77.1	Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=18.8 of DW
<i>Liparis sp.</i>				5395	12.9		Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=20.9 of DW
<i>Ammodytes hexapterus</i>	NP			5598	12.2		Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=21.0 of DW
Stichaeidae				5332	13.2		Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=13.0 of DW
Larvae				4960	14.5		Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	% lipid=13.3 of DW
Larvae				5207	12.3	73.8	Jun-Jul	larvae	Bristol Bay	Nishiyama 1977	mean value; % lipid=15.7 of DW
<b>FISHES</b>											
<i>Ammodytes americanus</i>	A	1624	5182	5922	12	69		adult	NW Atlantic	Steimle et al. 1985	
<i>Tautoglabrus asaperus</i>	A	1058	4880				Jun-Oct	whole	NW Atlantic	Brawn et al. 1968	22 cm length
<i>Clupea harengus harengus</i>	A	1927	6360				Jun-Oct	whole	NW Atlantic	Brawn et al. 1968	% lipid= 6.6 of DW; 14 cm length
<i>Clupea harengus harengus</i>	A	2531	5994	6496	8	57		whole	NW Atlantic	Steimle et al. 1985	
<i>Sardinella aurita</i>	A	1433	4752	5516	14	70		whole	NW Atlantic	Steimle et al. 1985	
<i>Anchoa hepsetus</i>	A	1385	4752	5637	16	71		whole	NW Atlantic	Steimle et al. 1985	
<i>Scorpaenopsis saurus</i>	A	2030	5325	5874	9	62		whole	NW Atlantic	Steimle et al. 1985	
<i>Scorpaenopsis japonicus</i>	NA-NP	1481	5158	5827	12	71		whole	NW Atlantic	Steimle et al. 1985	
<i>Cyclothone alba</i>	A-P-Ind				8.9	81.4	Aug		N Pacific	Omori 1969	north of 30° N
<i>Engraulis japonicus</i>	P-Ind				6.8	78.9	Aug	juvenile	N Pacific	Omori 1969	north of 30° N
<i>Thunnus albacares</i>	A-P		5588					muscle	NW Atlantic	Steimle et al. 1985	
<i>Salvelinus namaycush</i>	F	2674	7103				Apr-Nov	males	Lake Michigan	Rottiers et al. 1982	% lipid=50.5 of DW; mean length=584 mm
<i>Salvelinus namaycush</i>	F	2575	5909				Apr-Nov	females	Lake Michigan	Rottiers et al. 1982	% lipid=46.9 of DW; mean length=619 mm
<i>Salvelinus namaycush</i>	F	2059	5486				Apr-Nov	immatures	Lake Michigan	Rottiers et al. 1982	% lipid=32.1 of DW; mean length=507 mm
<i>Salvelinus namaycush</i>	F	2458	6885				Apr-Nov	all samples	Lake Michigan	Rottiers et al. 1982	% lipid=46.3 of DW; mean length=570 mm
<i>Salvelinus namaycush</i>	F	1247	5421				Apr-Nov	age 1	Lake Michigan	Rottiers et al. 1982	% lipid=18.2 of DW
<i>Salvelinus namaycush</i>	F	1637	6101				Apr-Nov	age 2	Lake Michigan	Rottiers et al. 1982	% lipid=25.1 of DW; mean length=304 mm
<i>Salvelinus namaycush</i>	F	2235	6721				Apr-Nov	age 3	Lake Michigan	Rottiers et al. 1982	% lipid=44.2 of DW; mean length=510 mm
<i>Salvelinus namaycush</i>	F	2652	7050				Apr-Nov	age 4	Lake Michigan	Rottiers et al. 1982	% lipid=49.7 of DW; mean length=566 mm
<i>Salvelinus namaycush</i>	F	2569	7014				Apr-Nov	age 5	Lake Michigan	Rottiers et al. 1982	% lipid=48.2 of DW; mean length=607 mm
<i>Salvelinus namaycush</i>	F	2739	7140				Apr-Nov	age 6	Lake Michigan	Rottiers et al. 1982	% lipid=51.5 of DW; mean length=644 mm

Table 1. Continued.

Organism or Group	General Distribution	cal/G WW	cal/G DW	cal/G AFDW	% Ash (of DW)	% Water (of WW)	Season	Maturity, Stage, or Sex	Sample Area	Reference	Comments
<i>Oncorhynchus mykiss</i>	F	1180				71.5		adult muscle		Exler 1987	rainbow trout
<i>Oncorhynchus mykiss</i>	F					71.5		adult muscle		Sabry 1990	rainbow trout; % prot=20.5, % lipid=3.4 (of WW)
<i>Oncorhynchus nerka</i>	F	1292	3345	3479	3.81	61.4	Oct	breeding females	Kamchatka	Cummins et al. 1971*	kokanee
<i>Oncorhynchus nerka</i>	NP-F	1368	3446	3580	3.73	60.3	Aug-Sep	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus nerka</i>	NP-F	1943					Jun-Jul	muscle; maturing female	Bristol Bay	Nishiyama 1977	% muscle=67.5, % gonad=7.5% (of BW); length=30 cm
<i>Oncorhynchus nerka</i>	NP-F	1881					Jun-Jul	muscle; maturing male	Bristol Bay	Nishiyama 1977	% muscle=67.5, % gonad=7.5% (of BW); length=30 cm
<i>Oncorhynchus nerka</i>	NP-F	2910					Jun-Jul	gonad; maturing female	Bristol Bay	Nishiyama 1977	% muscle=67.5, % gonad=7.5% (of BW); length=30 cm
<i>Oncorhynchus nerka</i>	NP-F	1150					Jun-Jul	gonad; maturing male	Bristol Bay	Nishiyama 1977	% muscle=67.5, % gonad=7.5% (of BW); length=30 cm
<i>Oncorhynchus nerka</i>	NP-F	1680			1.18	70.2		adult muscle		Exler 1987	
<i>Oncorhynchus keta</i>	NP-F	1597	3606	3745	3.72	55.7	Aug-Sep	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus keta</i>	NP-F	1200			1.18	75.4		adult muscle		Exler 1987	
<i>Oncorhynchus keta</i>	NP-F					73.3		adult muscle	British Columbia	Sabry 1990	% prot=23.1, % lipid=3.7 (of WW)
<i>Oncorhynchus gorbuscha</i>	NP-F	1687	4043	4187	3.44	58.3	Aug-Sep	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus gorbuscha</i>	NP-F	1565	3599	3732	3.56	56.5	Sep	breeding females	Murmansk	Cummins et al. 1971*	
<i>Oncorhynchus gorbuscha</i>	NP-F	1160				76.4		adult muscle		Exler 1987	
<i>Oncorhynchus gorbuscha</i>	NP-F					71.5		adult muscle	British Columbia	Sabry 1990	% prot=20.4, % lipid=6.7 (of WW)
<i>Oncorhynchus kisutch</i>	NP-F	1931	6227				Apr-Nov	male	Lake Michigan	Rottiers et al. 1982	% lipid=28.6 (of DW); mean length=602 mm
<i>Oncorhynchus kisutch</i>	NP-F	1866	6157				Apr-Nov	female	Lake Michigan	Rottiers et al. 1982	% lipid=26.4 (of DW); mean length=576 mm
<i>Oncorhynchus kisutch</i>	NP-F	1664	6003				Apr-Nov	immature	Lake Michigan	Rottiers et al. 1982	% lipid=20.23 (of DW); mean length=503 mm
<i>Oncorhynchus kisutch</i>	NP-F	1818	6123		6.51	70.8	Apr-Nov		Lake Michigan	Rottiers et al. 1982	mean; % lipid=25.0 (of DW); mean length=560 mm
<i>Oncorhynchus kisutch</i>	NP-F	1381	3446	3592	4.07	59.9	Oct	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus kisutch</i>	NP-F	1460				72.6		adult muscle		Exler 1987	
<i>Oncorhynchus kisutch</i>	NP-F					72.6		adult muscle	British Columbia	Sabry 1990	% prot=20.0, % lipid=4.6% (of WW)
<i>Oncorhynchus tshawytscha</i>	NP-F	1363	3648	3740	2.45	62.6	Aug	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus tshawytscha</i>	NP-F	1800				73.12		adult muscle		Exler 1987	
<i>Oncorhynchus masou</i>	NP-F	1719	3767	3905	3.55	54.4	Aug-Sep	breeding females	Kamchatka	Cummins et al. 1971*	
<i>Oncorhynchus masou</i>	NP-F	1566	3464	3588	3.48	54.6	Aug-Sep	breeding females	Kamchatka	Cummins et al. 1971*	
salmon		1375						adult muscle		Sabry 1990	mean
Poeciliidae				5823						Cummins et al. 1971	grand mean
Cottidae			4620	5102				whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Centrarchidae			4677	5130				whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Gobiidae			3880					whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Cyprinidae			5761					whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Labridae		1058	4880					whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Clupeidae		1927	6360					whole, mixed sizes & sexes		Cummins et al. 1971	grand mean
Salmonidae		1492	3598	3736				breeding females		Cummins et al. 1971	grand mean
Osteichthyes		1493	5086	5296				whole, mixed sizes and sexes		Cummins et al. 1971	grand mean
Fish, Pelagic		1504		5784					NW Atlantic	Steimle et al. 1985	
Fish, Pelagic		1208	4924	5826	16.4	75.3	all		NW Atlantic	Theyer et al. 1973	average values
Fish, Pelagic		1459		5826						Steimle et al. 1985*	
Fish, Pelagic		1825								Steimle et al. 1985*	
<b>Grand Means</b>											
Fish			4928	5774						Griffiths 1977	average values 4000-6600 cal/g AFDW
Bristol Bay sockeye prey		1100					Jun-Jul	whole	Bristol Bay	Nishiyama 1977	average value
Zooplankton				6591						Steimle et al. 1985*	
Zooplankton		392		5512						Steimle et al. 1985*	

\*data are summarized in this reference, but this is not the original author.