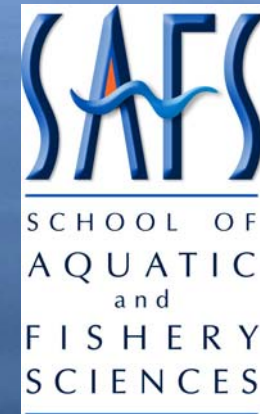


Review of BASIS Food Habits Studies and Considerations on Continuing and New Research Directions

N.D. Davis, A.V. Volkov, A. Ya. Efimkin, N.A. Kuznetsova, J.L. Armstrong, and O. Sakai



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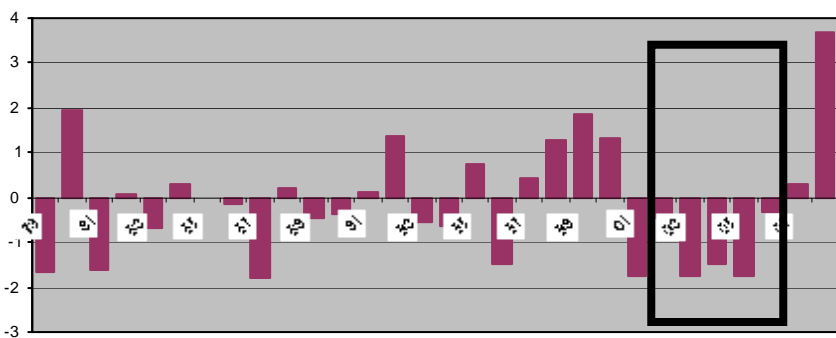


Outline

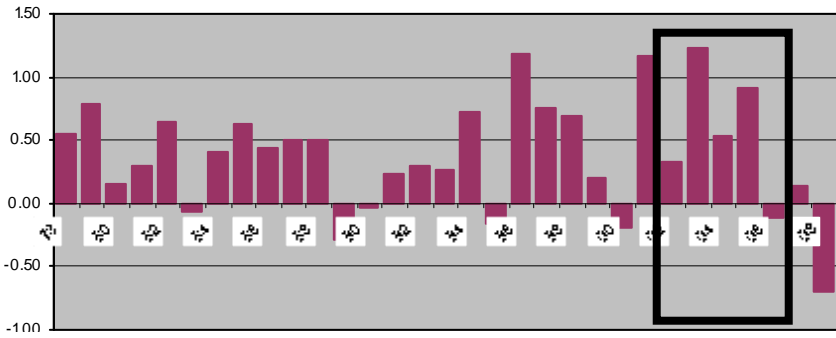
Brief overview of the BASIS salmon food habits studies 2002-2006

Who are the primary prey components

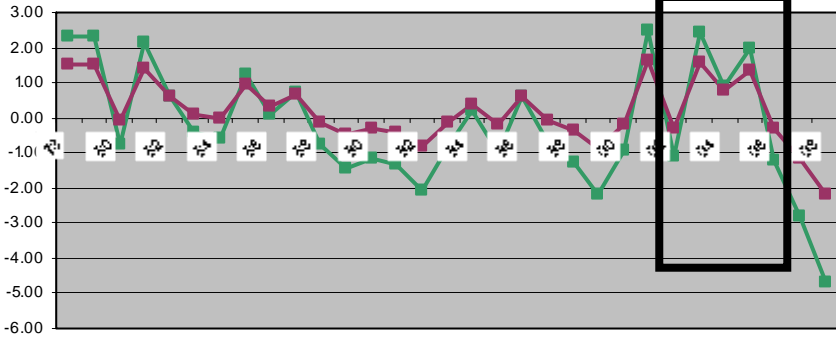
**Brief examination of Chum and Chinook salmon food habits
in the Bering Sea Central Basin 2002-2006**



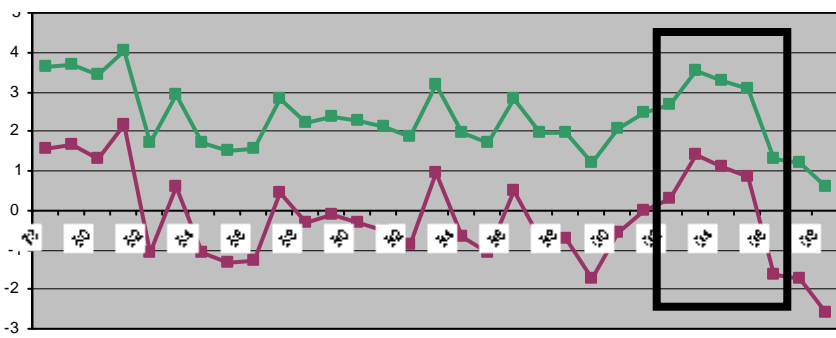
Ice Cover Index, average ice conc. Jan 1-May 31 (56-58N, 163-165W) normalized anomalies relative to '81-'00



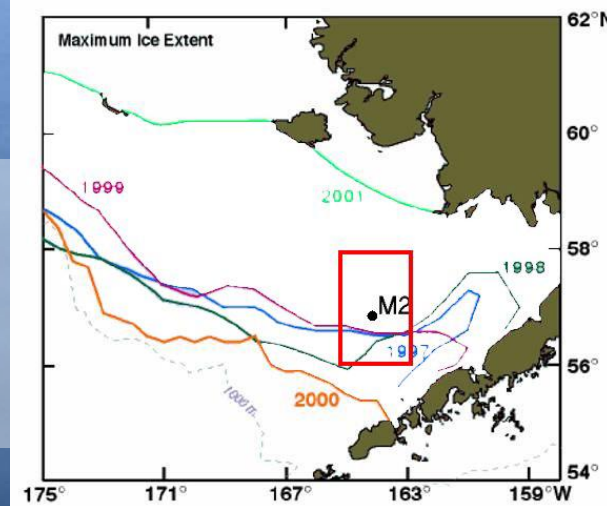
Winter SST Pribilofs Jan-Mar anomaly normalized to '50-'00, 5x5 grid centered at 55N 170W, edge of EBS shelf, 100 mi S of Pribilofs



Jan-Apr SST at Mooring 2 (normalized anomalies relative to '63-'00)

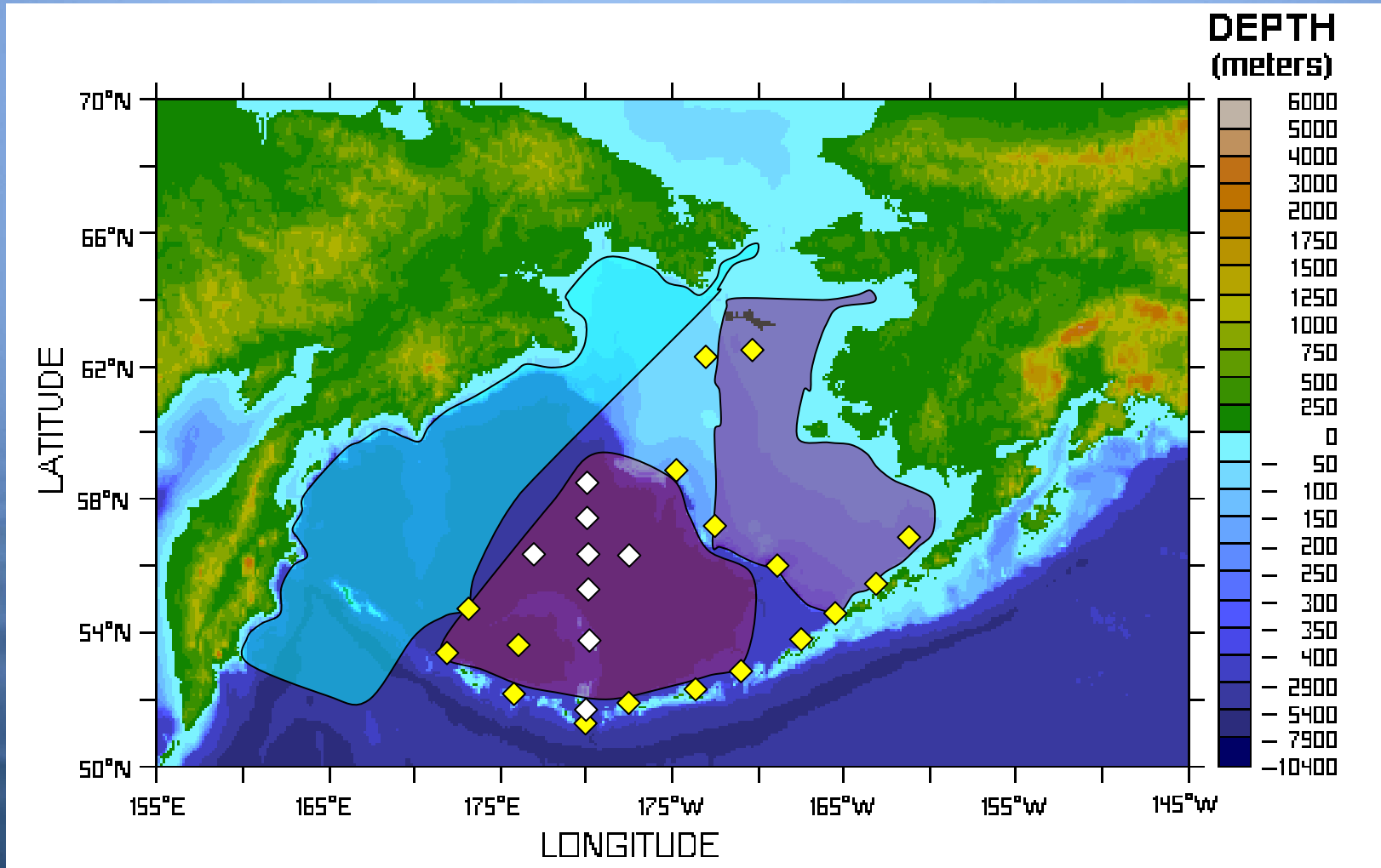


May SST EBS mean SST (54-60N 161-172W) normalized anomalies relative to '61-'00



SST °C
 Anomalies

Generalized Sampling Areas for Salmon Food Habits



Tinro

Wakatake maru

Sea Storm

Kaiyo maru

NW Explorer

Salmon Food Habits Sampling Strata

Before BASIS

	Decade	Spring	Summer	Fall	Winter
Western	1950-59	Green	Blue	Brown	White
	1960-69	Green	Blue	Brown	White
	1970-79	Green	Blue	Brown	White
	1980-89	Green	Blue	Brown	Yellow
	1990-99	Green	Blue	Brown	Yellow
	2000-01	Green	Blue	White	White
Central	1950-59	White	White	White	White
	1960-69	White	Blue	Brown	White
	1970-79	White	White	White	White
	1980-89	White	Blue	White	White
	1990-99	White	Blue	White	White
	2000-01	White	Blue	White	White
Eastern	1950-59	White	White	White	White
	1960-69	Green	Blue	Brown	White
	1970-79	White	Blue	Brown	White
	1980-89	White	White	White	White
	1990-99	White	White	White	White
	2000-01	White	White	White	White
Aleutians	1950-59	White	White	White	White
	1960-69	White	White	White	White
	1970-79	White	White	White	White
	1980-89	White	White	White	White
	1990-99	Green	White	White	White
	2000-01	White	White	White	White

BASIS 2002-2006

	Year	Spring	Summer	Fall	Winter
Western	2002	White	Blue	Brown	White
	2003	White	Blue	Brown	White
	2004	White	White	Brown	White
	2005	White	Blue	White	White
	2006	White	Blue	Brown	White
	Central	2002	White	Blue	Brown
2003		White	Blue	Brown	White
2004		White	Blue	White	White
2005		White	Blue	White	White
2006		Green	Blue	White	White
Eastern		2002	White	White	Brown
	2003	White	White	Brown	White
	2004	White	White	Brown	White
	2005	White	White	Brown	White
	2006	White	White	Brown	White
	Aleutians	2002	White	Blue	Brown
2003		White	Blue	White	White
2004		White	Blue	White	White
2005		White	Blue	White	White
2006		White	Blue	White	White

BASIS Salmon Food Habits Data 2002-2006

Region	Vessel	Year	Season	Sockeye		Chum		Pink		Chinook		Contact Person	
				Groups	Stomachs	Groups	Stomachs	Groups	Stomachs	Groups	Stomachs		
				(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)		
Western	TINRO	2002	Summer-Fall	99	571	124	834	23	240	24	61	Volkov	
		2003	Summer-Fall	151	807	178	1102	43	514	56	186	Volkov	
		2004	Fall	179	986	187	1208	65	673	82	267	Volkov	
		2005	Summer	143	433	225	888	146	873	65	153	Volkov	
		2006	Summer-Fall	95	145	151	1580	48	748	48	154	Volkov	
Central	Kaiyo maru	2002	Summer	--	*	395	--	--	--	--	--	Sakai	
		2002	Fall	--	*	575	--	--	--	--	--	Sakai	
		2002	Fall	*	47	*	238	*	1	*	63	Davis	
		2003	Summer	--	*	255	--	--	--	--	--	Sakai	
		2003	Fall	--	*	189	--	--	--	--	--	Sakai	
		2003	Fall	23	463	45	803	--	--	--	--	Volkov	
		2004	Summer	3	37	38	544	--	--	5	30	Volkov	
	2006	Spring	27	357	59	849	22	375	4	57	Volkov		
		NW Explorer	2002	Fall	*	46	*	166	--	--	*	34	Davis
		Wakatake maru	2002	Summer	*	139	*	242	*	40	*	89	Davis
	2003		Summer	*	155	*	183	*	168	*	77	Davis	
	2004		Summer	*	143	*	180	*	142	*	114	Davis	
	2005		Summer	*	112	*	152	*	124	*	27	Davis	
	2006		Summer	*	72	*	91	*	35	*	32	Davis	
	Eestern	NW Explorer	2002	Fall	*	5	*	71	--	--	*	23	Davis
2003			Fall	54	394	50	247	18	175	6	17	Volkov	
		Sea Storm	2004	Fall	100	677	161	879	96	517	102	329	Volkov
2005			Fall	103	600	157	581	89	437	84	272	Volkov	
2006			Fall	41	127	309	1228	26	144	60	119	Volkov	
Aleutians	NW Explorer	2002	Fall	*	39	*	65	--	--	4	16	Davis	
		2003	Summer	*	2	*	7	--	--	--	--	Davis	
		Wakatake maru	2003	Summer	--	--	*	4	*	10	--	Davis	
	2004		Summer	--	--	*	1	*	2	--	Davis		
	2005		Summer	*	1	--	--	*	1	--	Davis		
	2006		Summer	--	--	*	5	--	--	--	Davis		

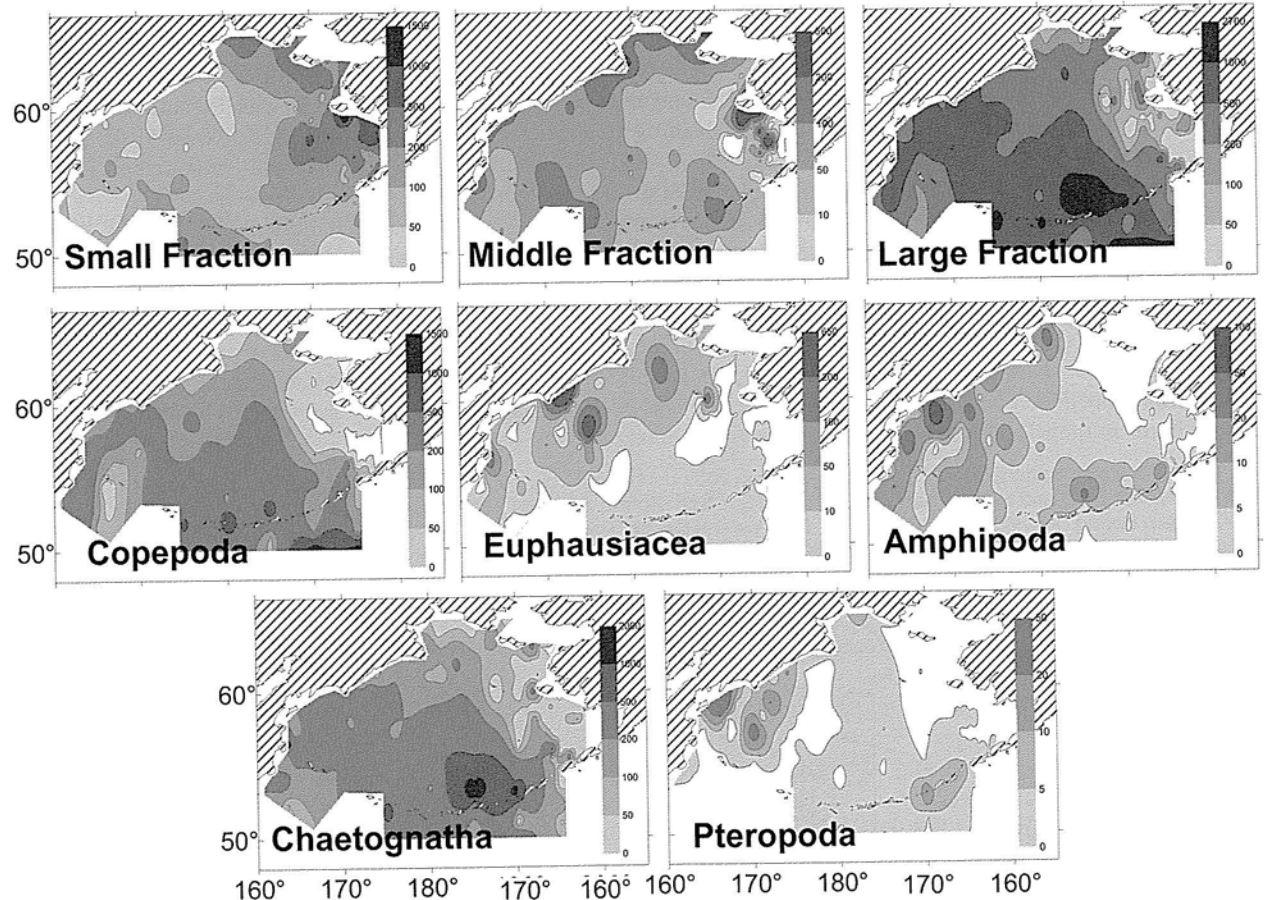
Biomass (mg/m^3) fraction of zooplankton and large fraction major components at 0-200 (bottom), daytime

Fractions

Small <1.2 mm)

Middle 1.2-3.3 mm)

Large >3.3 mm)



Conclusions BASIS 2002-2006 Food Habits

Farley et al. 2007. Spring SSTs on EBS shelf impact marine survival rates of juvenile western Alaska salmon through bottom-up control in the ecosystem.

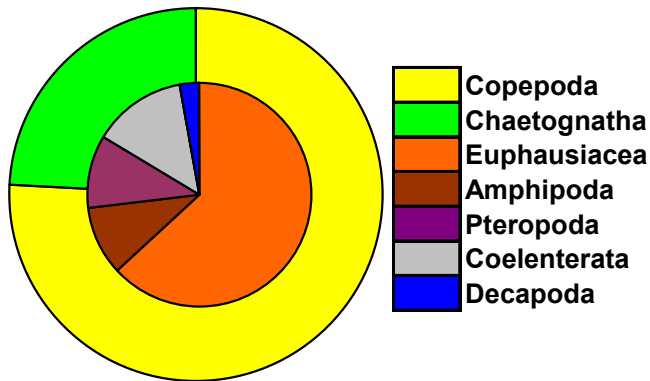
Volkov et al. 2007. Salmon diets varied by season, ocean region, body size group, and maturity stage. Salmon spatial distribution may be an adaptive strategy aimed at reducing density-dependent interactions and maximizing use of available feeding grounds.

Zavolokin et al. 2007. Low potential of feeding competition among salmon and juvenile Atka mackerel.

Davis et al. 2005, Karpenko et al. 2007. Very high diet overlap in diets of pink and sockeye in odd and even years. In odd years, diet overlap between chum and sockeye and chum and pink were reduced.

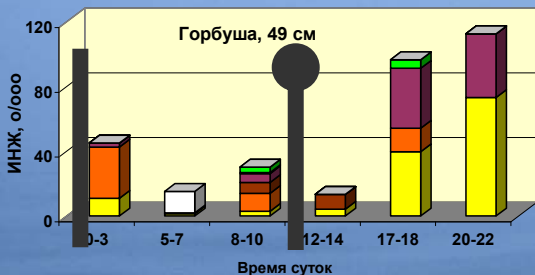
Karpenko et al. 2007: Pacific salmon are the best plankton and nekton gear. Chum the best indicator because it is the most flexible consumer.

Diurnal Study of Salmon Food Habits

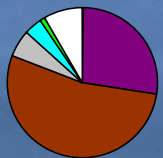
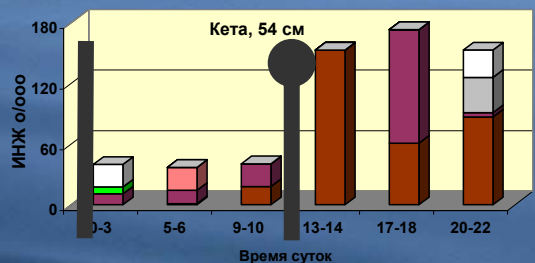


Composition of large fraction zooplankton in 3-daily station in a layer of 0-50 m. Big circle - dominating groups (a biomass of 1307 mg/m³), a small circle - minor groups (a biomass of 34 mg/m³)

Index (prey wt/body wt * 10,000)



Pink 49cm



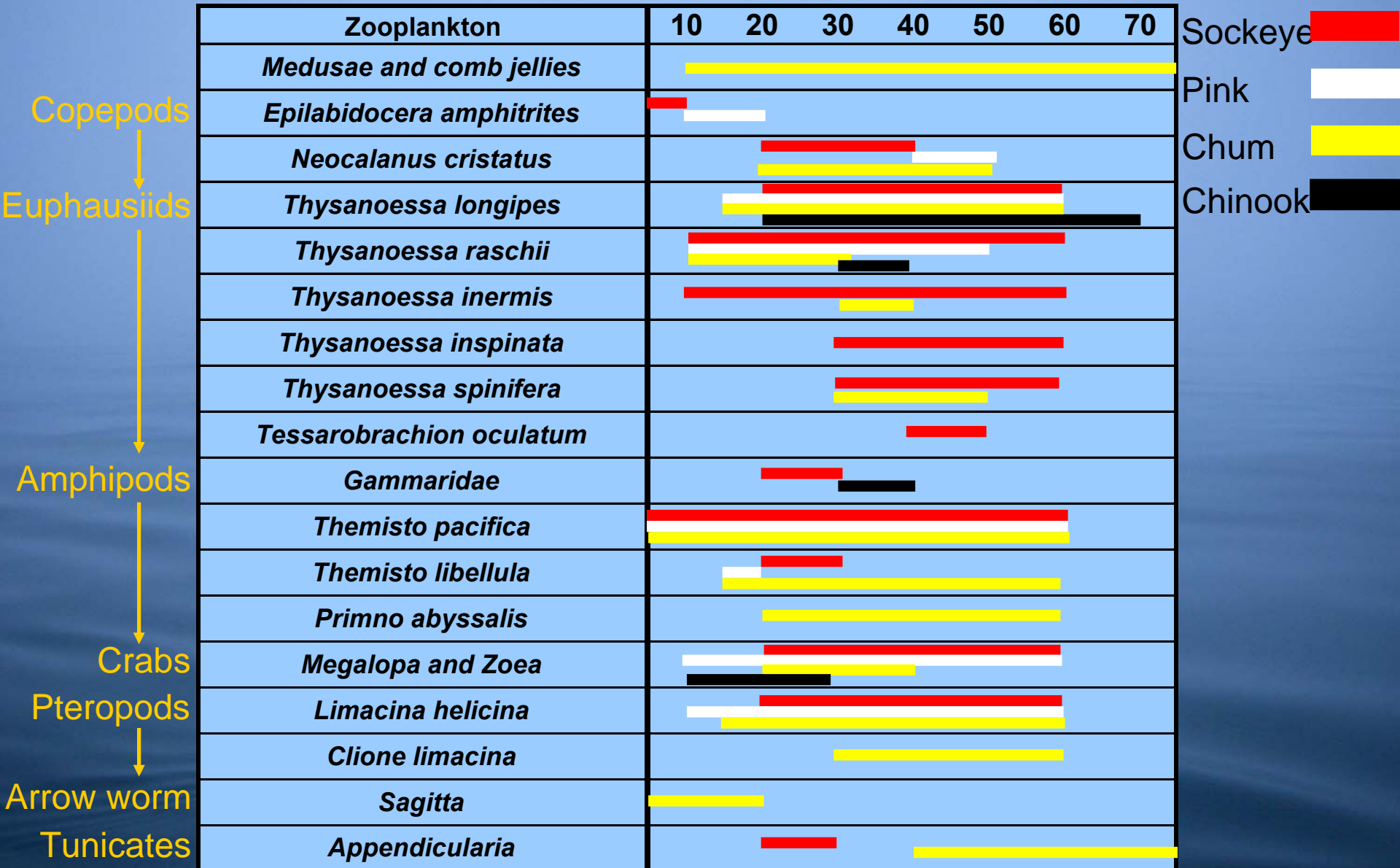
Chum 54cm



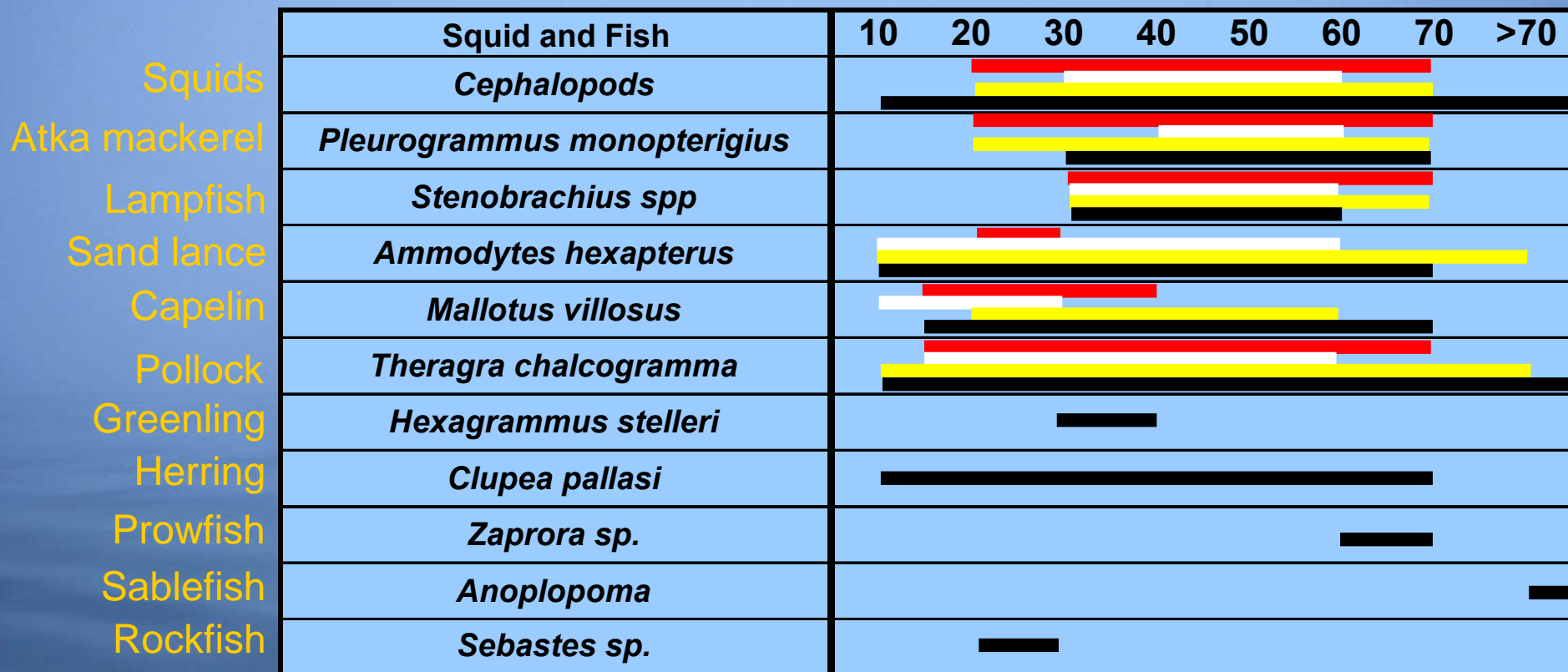
Coho 53cm

Daily feeding periodicity of pink, chum and coho salmon on 3-daily station in a NW part of Pacific ocean (July 21-24, 2006, 48°28N, 159°01E.). Average length: pink salmon 49 cm, chum 54 cm, coho 53 cm. Circles: average daily prey composition.

Major Zooplankton Prey Consumed by Salmon by Body Size (FL)



Major Nekton Prey Consumed by Salmon by Body Size (FL)



Sockeye



Pink



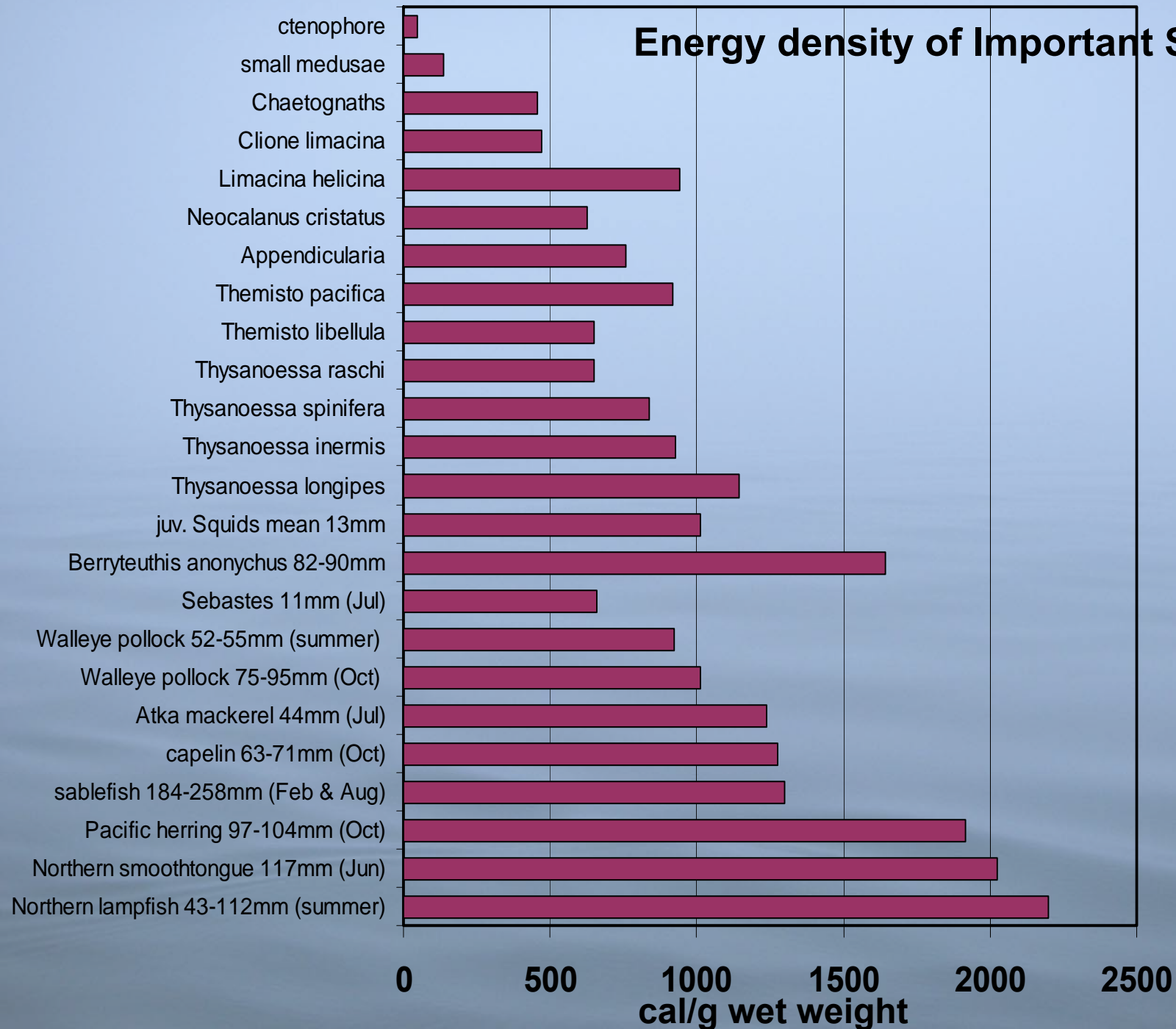
Chum



Chinook



Energy density of Important Salmon Prey



Basin 2002-2006: Chum and Chinook Salmon Food Habits

Method:

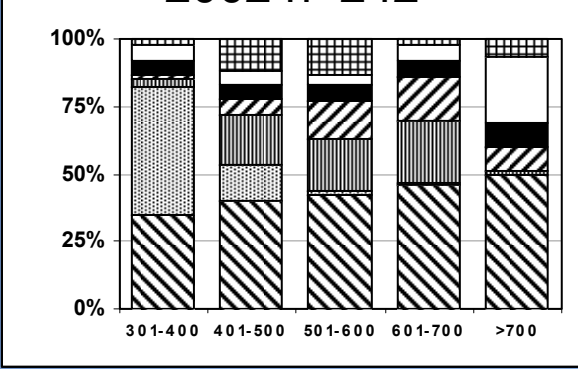
Total weight in each prey category for each 10 cm body sizes group was converted to a percentage and the resulting prey composition plotted as histograms.

To examine changes in prey quality, the proportions in each prey category was multiplied by a caloric value and the annual total caloric value was plotted.

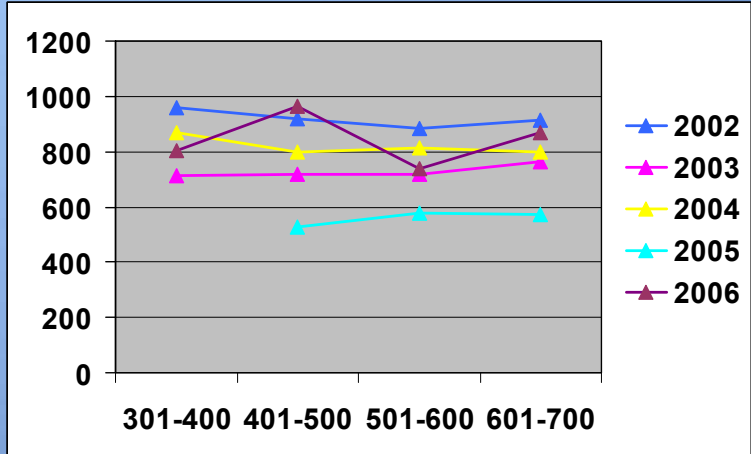
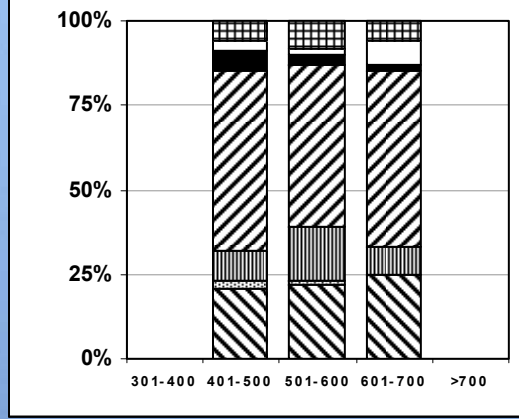
Chum Salmon				Chinook Salmon			
Prey Category	Body size	Prey	cal/g/WW	Prey Category	Body size	Prey	cal/g/WW
Euphausiacea	all	<i>Thysanoessa longipes</i>	1142	Euphausiacea	all	<i>Thysanoessa longipes</i>	1142
Amphipods	all	<i>Themisto pacifica</i>	917	Cephalopods	<40cm	juv squids	947
Pteropod	all	<i>Limacina helicina</i>	940	Cephalopods	>40cm	<i>Berryteuthis anonychus</i>	1636
Cephalopods	all	small squids	947	Pisces	<50cm	juv Atka mackerel (44mm)	1240
Gelatinous	all	small medusae	136	Pisces	>50cm	Northern lampfish (112mm)	2365
Other	all	<i>Neocalanus cristatus</i>	627				
Pisces	<50cm	juv flounder (20mm)	624				
Pisces	>50cm	juv Atka mackerel (44mm)	1240				

Chum Salmon 2002-2006 Basin Summer

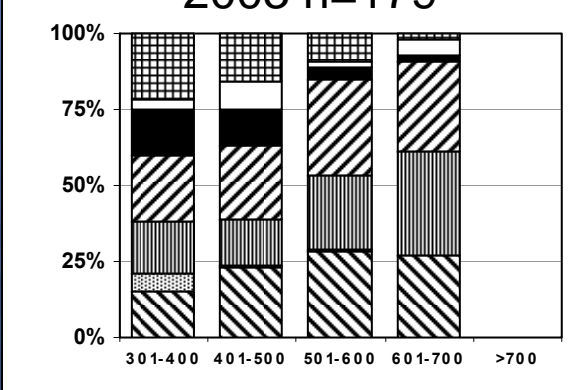
2002 n=242



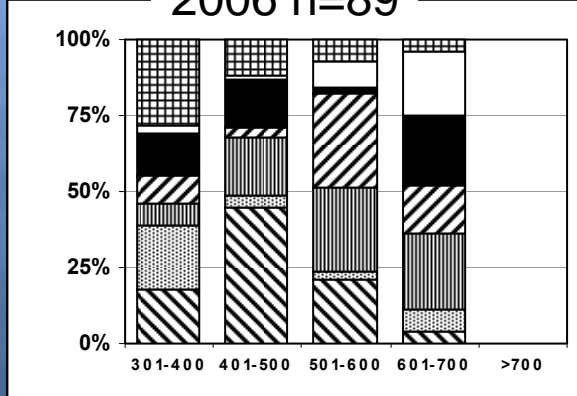
2005 n=142



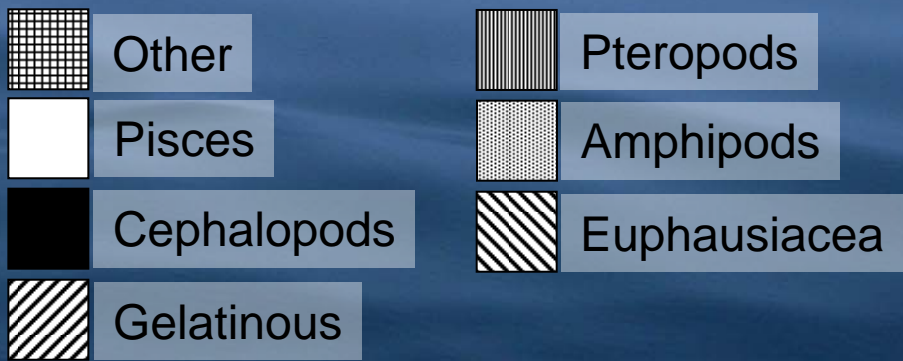
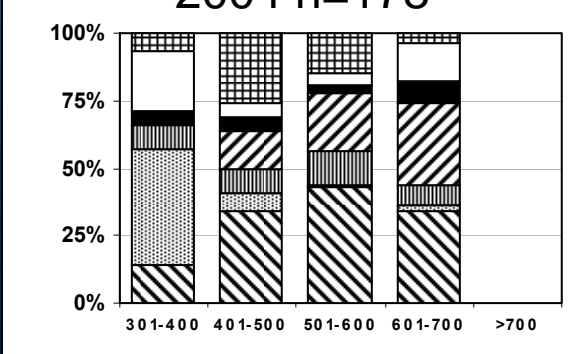
2003 n=179



2006 n=89

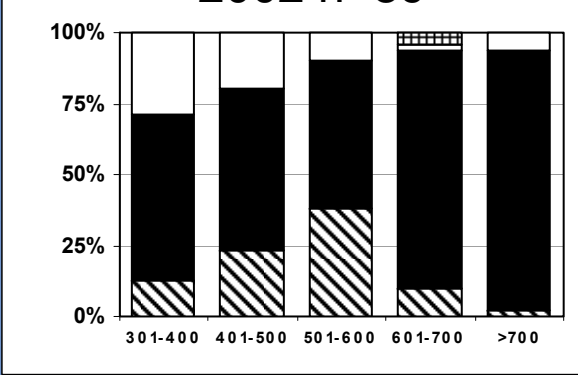


2004 n=178

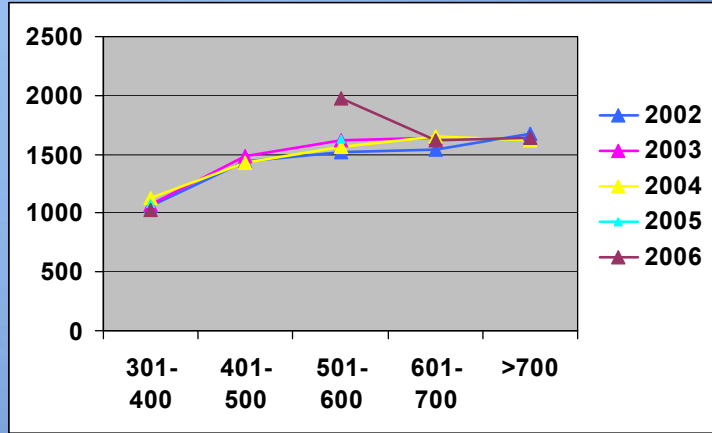
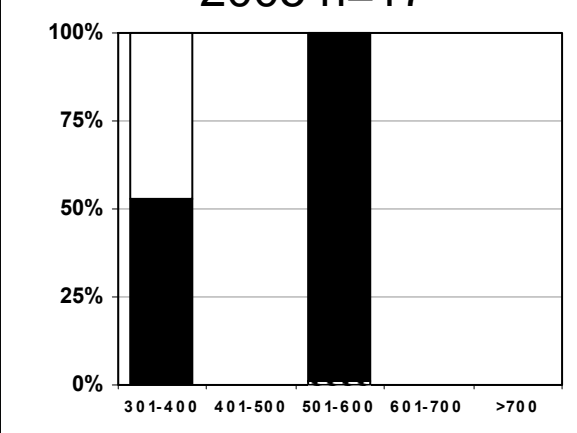


Chinook Salmon 2002-2006 Basin Summer

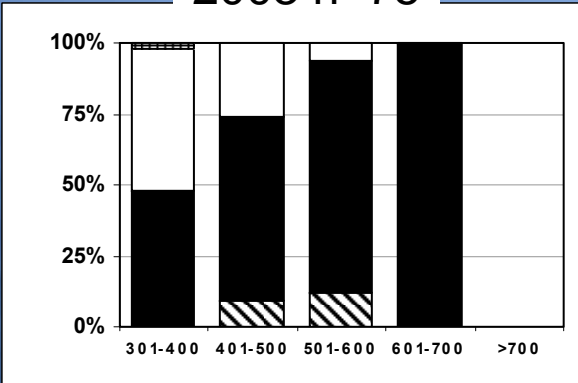
2002 n=89



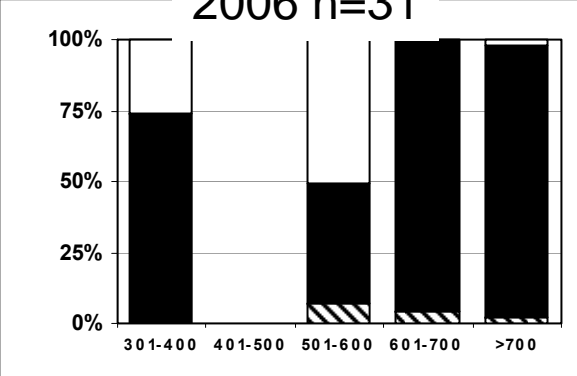
2005 n=17



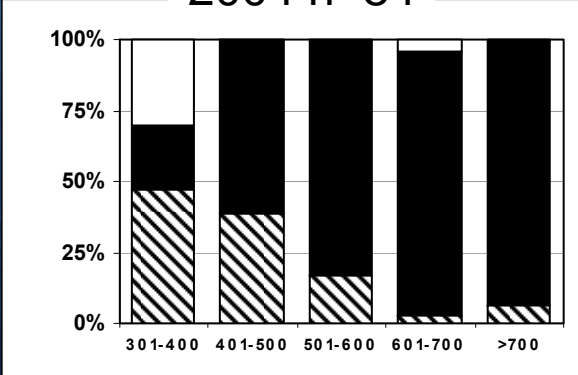
2003 n=75



2006 n=31





2004 n=84



 Other

 Cephalopods

 Pisces

 Euphausiacea

BASIS Food Habits Summary

Expanded sampling coverage into the fall season and increased temporal coverage of the EBS

Salmon diets have been shown to vary by season, region, and body size group

Salmon diet overlap has been examined and diet overlap is greatest between sockeye and pink salmon

Diurnal feeding studies have shown periodicity in pink, chum, coho salmon feeding

Monitoring the abundance and distribution of the most common prey organisms increases understanding of the salmon's feeding conditions.

Prey caloric values may be one way to evaluate the differences in quality in prey composition