Science, Service, Stewardship

Seasonal predation patterns of Pacific cod and walleye pollock on crustaceans in Marmot Bay, Alaska.

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NOAA FISHERIES SERVICE

RESOURCE PARTITIONING

Pacific cod, *Gadus macrocephalus*

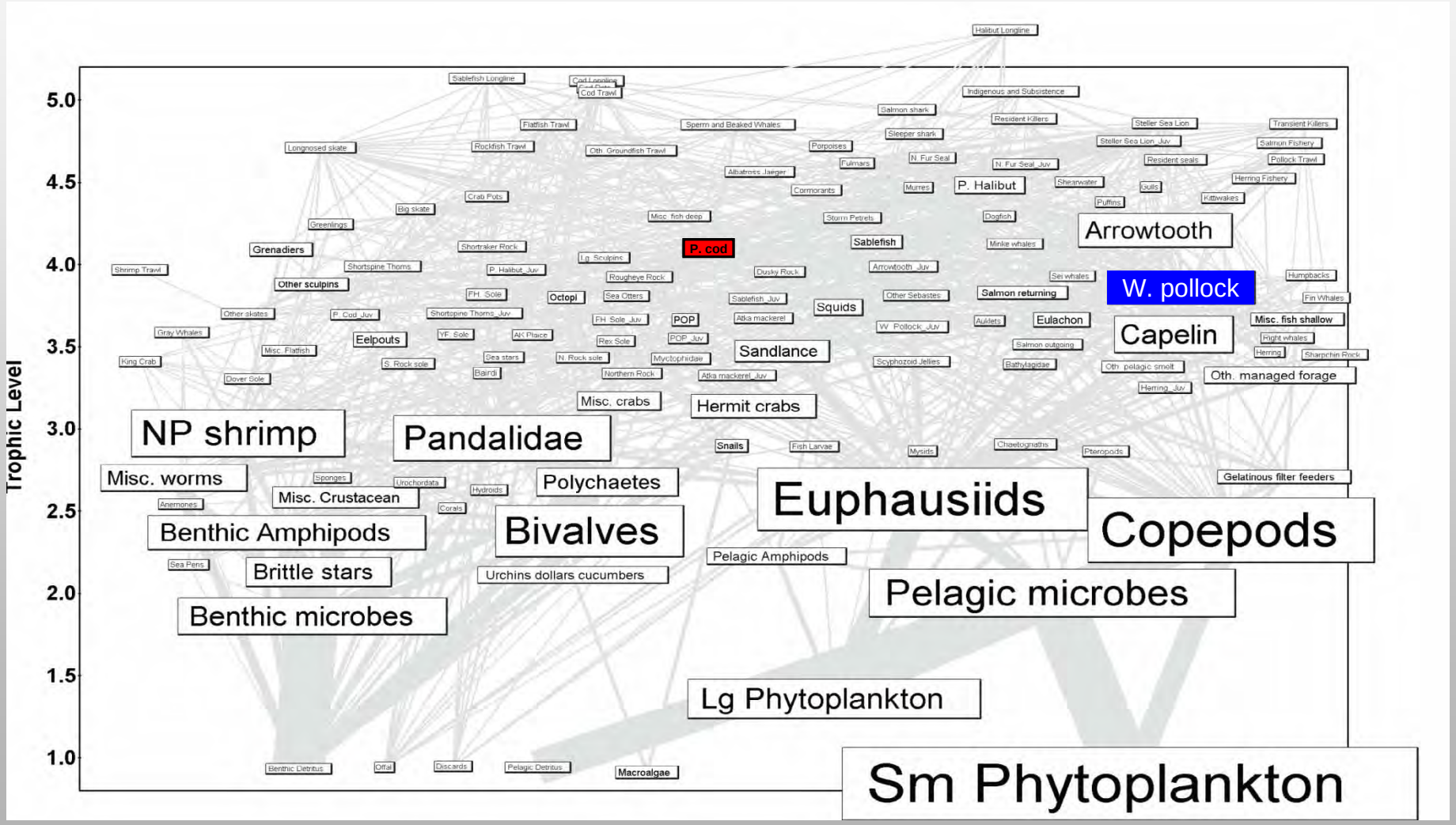
Max. length: 119 cm
Max. weight: 22.7 kg
Max. age: 18 years

www.fishbase.org/

walleye pollock, *Theragra chalcogramma*

Max. length: 91 cm
Max. weight: 3.8 kg
Max. age: 15 years

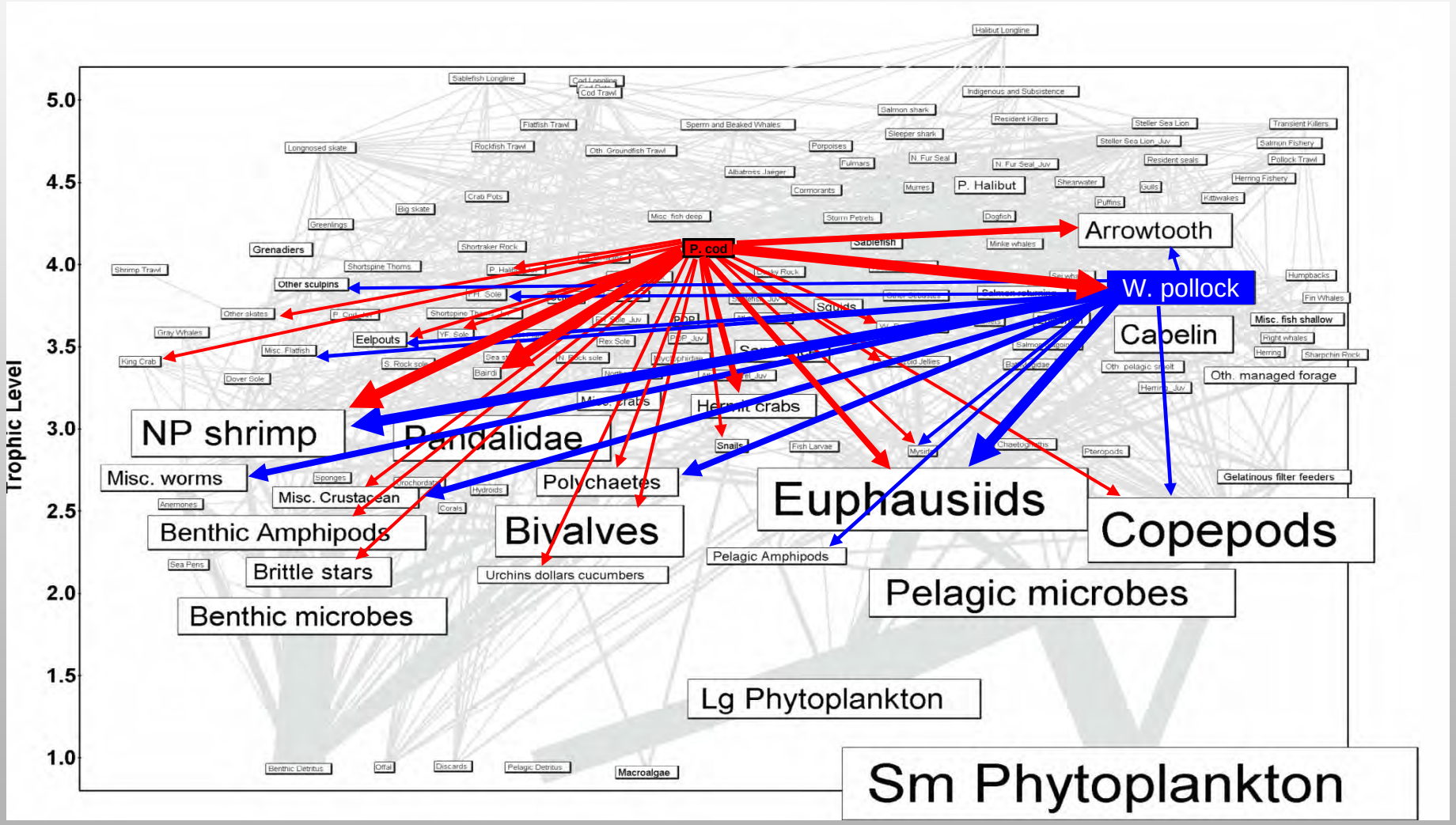
GULF OF ALASKA FOOD WEB



Aydin et al. 2007

GULF OF ALASKA FOOD WEB

Species richness: P. cod = 82, pollock = 41



Aydin et al. 2007

RESOURCE PARTITIONING OF CRUSTACEANS

How do cod and pollock partition the crustacean resource?

- **Do these species share the same diet?**
- **Does diet overlap vary spatially and seasonally?**
- **Is there a shared foraging strategy, ie. specialist or generalist?**

RESOURCE PARTITIONING

How do cod and pollock partition the crustacean resource?

- **Do these species share the same diet?**
- **Does diet overlap vary spatially and seasonally?**
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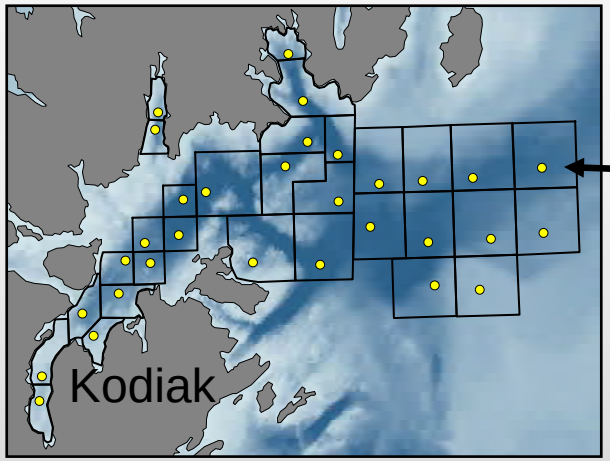
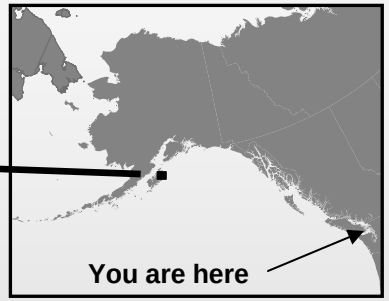
METHODS



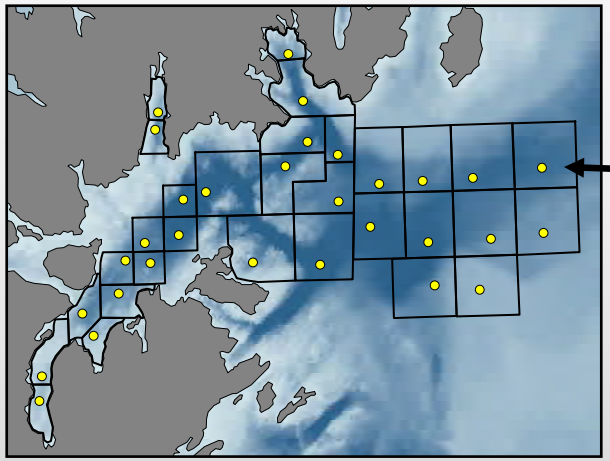


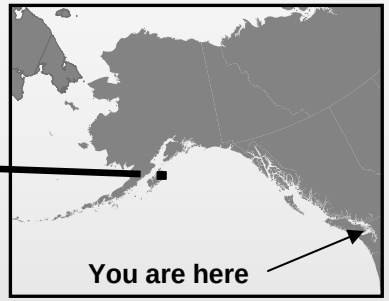
- 400 Eastern trawl net, hard on bottom
- Daylight hours only
- Goal of 200 stomachs/species/sampling period
- At least five stomachs per station
- Stomach analyzed by NMFS food habits lab, Seattle

Five Sampling periods

1. August 24-29, 1998
2. October 26-31, 1998
3. January 7-17, 1999
4. March 30 – April 5, 1999
5. June 19-23, 1999

METHODS





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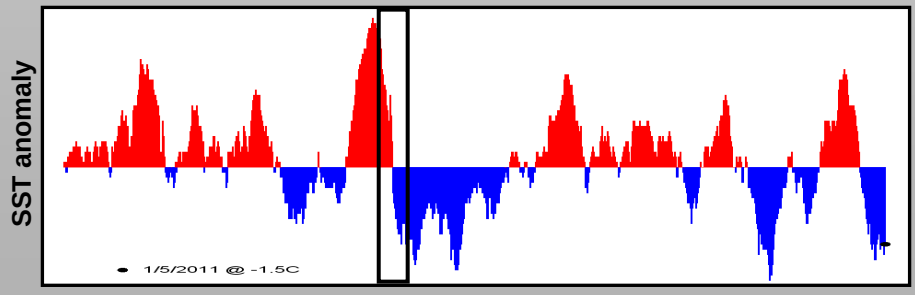
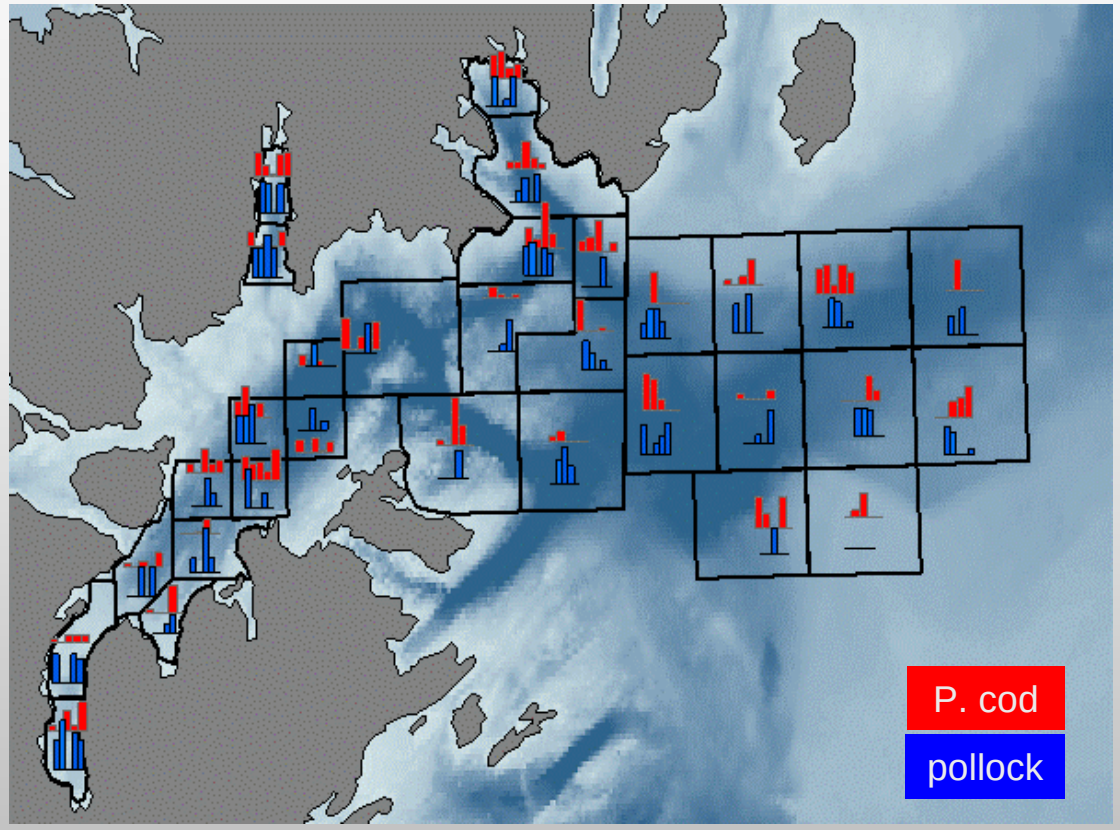


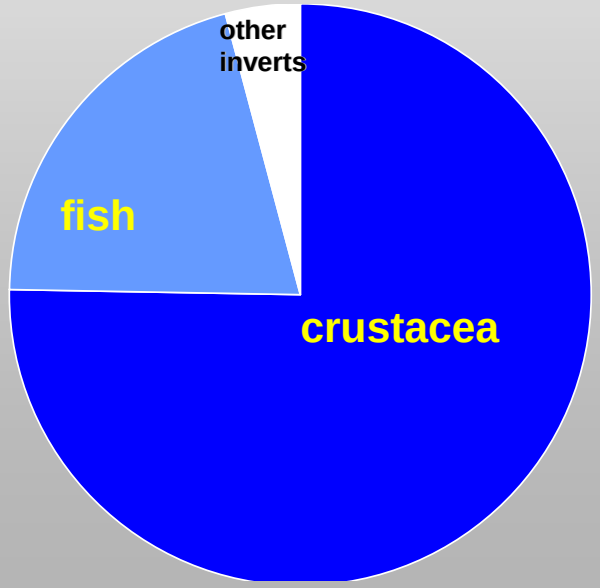
STOMACH COLLECTIONS



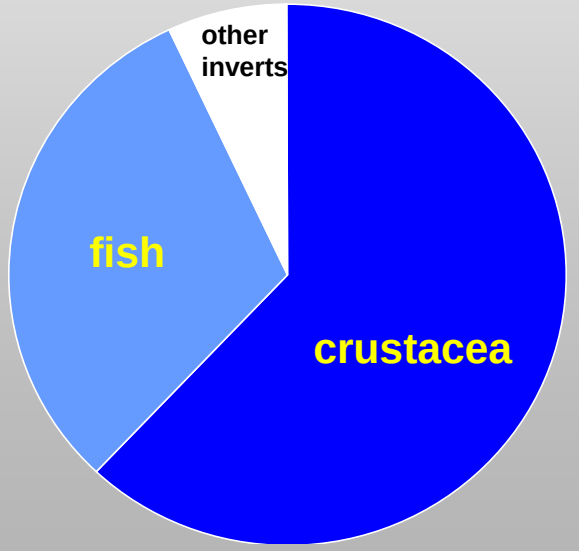
- 748 Cod stomachs
- 959 Pollock stomachs
- Collection locations do not always overlap
- Fish sizes evenly distributed, mostly mature
- Cod in 87% of tow, pollock in 94% of tows

RESULTS

cod

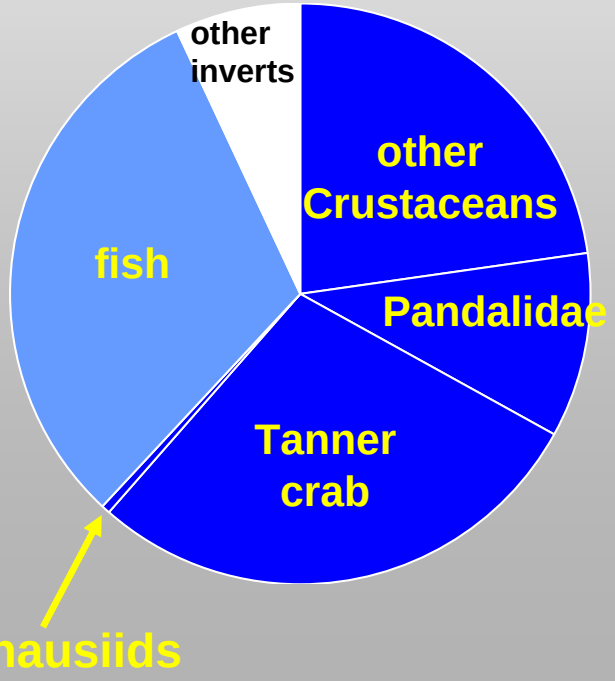


pollock

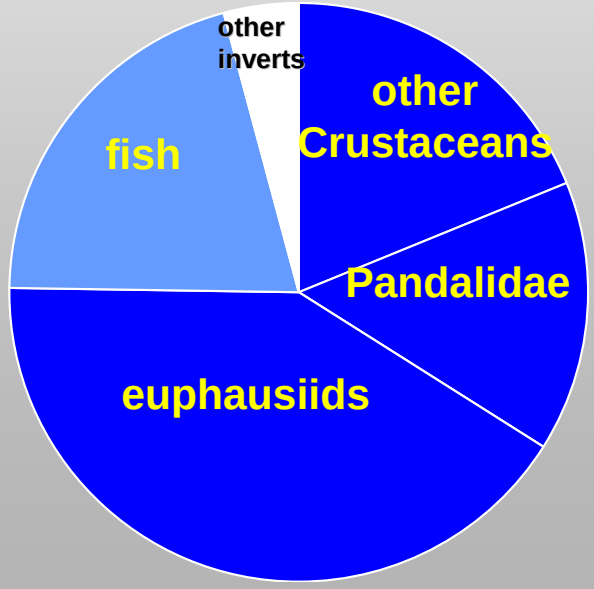


RESULTS

cod



pollock



TOP 2% OF DIETS

Prey counts

	cod	pollock
Caridea (shrimp)	3.5%	2.3%
Chionoecetes bairdi (crab)	8.5%	0.0%
Crangon communis (shrimp)	3.9%	0.4%
Eualus avinus (shrimp)	3.4%	0.5%
Eualus sp. (shrimp)	5.6%	3.4%
Euphausiid	14.5%	33.7%
Hippolytidae (shrimp)	4.3%	6.3%
Mysida	6.3%	0.9%
Pandalus eous (shrimp)	13.5%	2.3%
Pinnixa sp. (pea crab)	2.7%	0.9%
Reptantia (crab)	5.1%	1.3%
Thysanoessa sp. (euphausiid)	0.0%	15.9%
T. spinifera (euphausiid)	0.0%	8.5%

Prey weight

	cod	pollock
Ammodytes hexapterus	0.0%	4.2%
Aphroditidae (sea mouse)	0.2%	0.0%
Atheresthes stomias (flounder)	2.0%	1.1%
Caridea (shrimp)	2.7%	2.5%
Chionoecetes bairdi (crab)	21.8%	0.0%
Eualus sp. (shrimp)	0.5%	2.5%
Euphausiid	0.7%	20.1%
Hippolytidae (shrimp)	0.9%	3.2%
Osteichthyes Teleostei (fish)	3.1%	5.1%
Paguridae (hermit crab)	5.0%	0.1%
Pandalus eous (shrimp)	8.7%	13.2%
walleye pollock	13.2%	7.0%
Thysanoessa sp. (euphausiid)	0.0%	16.0%
T. spinifera (euphausiid)	0.0%	4.4%

DIET OVERLAP

Prey counts

P. cod \ W. pollock	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	0.22	0.12	0.28	0.21	0.27
Nov. 98	0.78	0.36	0.35	0.27	0.38
Jan. 99	0.29	0.39	0.32	0.60	0.25
Apr. 99	0.23	0.13	0.18	0.63	0.22
Jun. 99	0.10	0.04	0.02	0.56	0.07

Prey weight

P. cod \ W. pollock	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	0.28	0.20	0.24	0.20	0.20
Nov. 98	0.61	0.26	0.22	0.30	0.48
Jan. 99	0.34	0.16	0.19	0.18	0.18
Apr. 99	0.08	0.10	0.07	0.09	0.09
Jun. 99	0.12	0.09	0.09	0.11	0.11

Renkonen measure of overlap

$$P_{jk} = \left[\sum_{i=1}^{n} (\text{minimum } p_{ij}, p_{ik}) \right]$$

DIET OVERLAP

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Nov. 98	0.78	0.36	0.35	0.27	0.38
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Apr. 99	0.23	0.13	0.18	0.63	0.22
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Crangon communis, pink shrimp

Euphausiids

Prey weight

P. cod \ W. pollock	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
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pink shrimp, pollock

DIET OVERLAP

Prey counts

W. pollock	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.23	0.34	0.51	0.34
Nov. 98		1.00	0.32	0.30	0.14
Jan. 99			1.00	0.57	0.51
Apr. 99				1.00	0.65
Jun. 99					1.00

Prey weight

W. pollock	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.42	0.44	0.38	0.38
Nov. 98		1.00	0.60	0.21	0.35
Jan. 99			1.00	0.21	0.40
Apr. 99				1.00	0.30
Jun. 99					1.00

DIET OVERLAP

Prey counts

W. pollock

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.23	0.34	0.51	0.34
Nov. 98		1.00	0.32	0.30	0.14
Jan. 99			1.00	0.57	0.51
Apr. 99				1.00	0.65
Jun. 99					1.00

Euphausiids

Prey weight

W. pollock

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.42	0.44	0.38	0.38
Nov. 98		1.00	0.60	0.21	0.35
Jan. 99			1.00	0.21	0.40
Apr. 99				1.00	0.30
Jun. 99					1.00

Euphausiids, pink shrimp

DIET OVERLAP

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	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
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Euphausiids

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Jan. 99			1.00	0.21	0.40
Apr. 99				1.00	0.30
Jun. 99					1.00

Euphausiids, pink shrimp

P. cod

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.59	0.55	0.59	0.66
Nov. 98		1.00	0.78	0.80	0.65
Jan. 99			1.00	0.81	0.64
Apr. 99				1.00	0.74
Jun. 99					1.00

DIET OVERLAP

Prey counts

W. pollock

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.23	0.34	0.51	0.34
Nov. 98		1.00	0.32	0.30	0.14
Jan. 99			1.00	0.57	0.51
Apr. 99				1.00	0.65
Jun. 99					1.00

Euphausiids

P. cod

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.23	0.34	0.51	0.34
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Apr. 99				1.00	0.65
Jun. 99					1.00

Tanner crab, shrimp

Prey weight

W. pollock

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.42	0.44	0.38	0.38
Nov. 98		1.00	0.60	0.21	0.35
Jan. 99			1.00	0.21	0.40
Apr. 99				1.00	0.30
Jun. 99					1.00

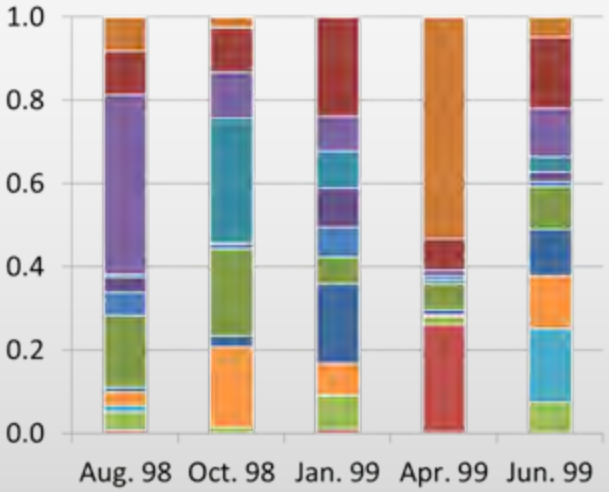
Euphausiids, pink shrimp

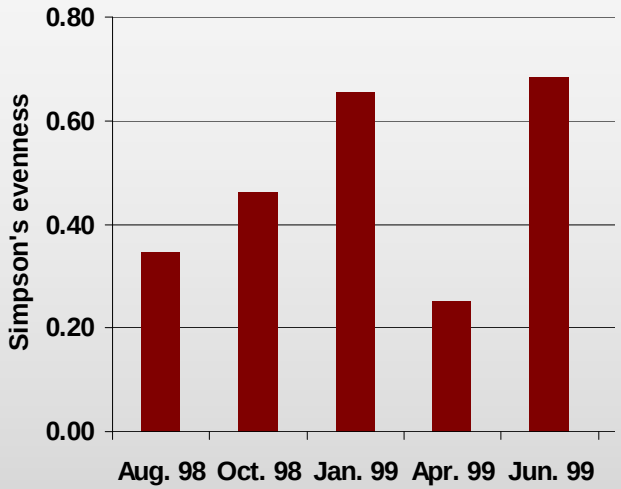
P. cod

	Aug. 98	Nov. 98	Jan. 99	Apr. 99	Jun. 99
Aug. 98	1.00	0.59	0.55	0.59	0.66
Nov. 98		1.00	0.78	0.80	0.65
Jan. 99			1.00	0.81	0.64
Apr. 99				1.00	0.74
Jun. 99					1.00

Tanner crab, pollock

EVENNESS: SPECIALIST OR GENERALIST?





Simpson's evenness measure

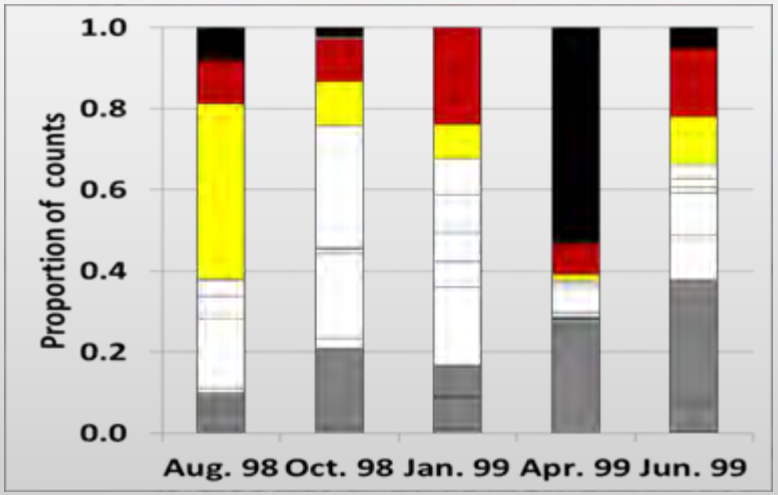
$$E_{1/\hat{D}} = \frac{1/\hat{D}}{S}$$

where

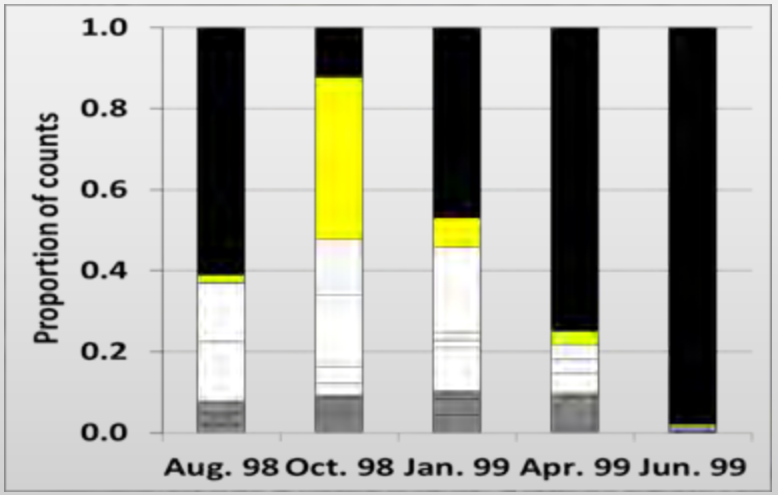
$$\hat{D} = \sum p_i^2$$

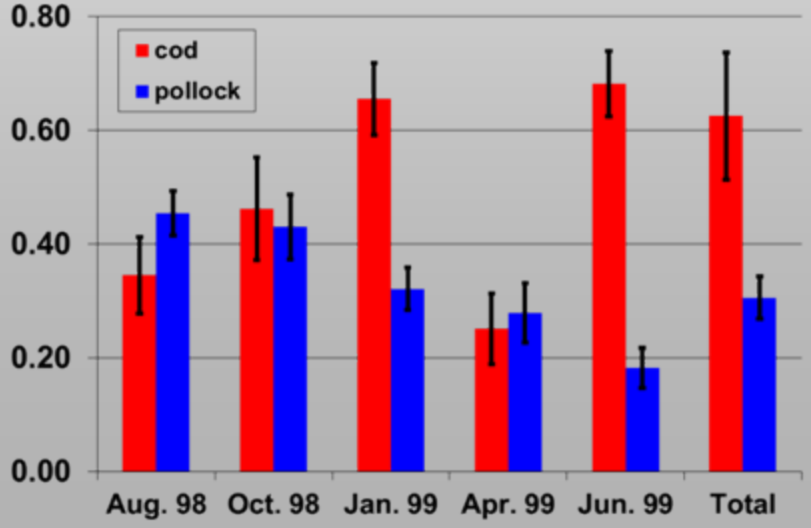
PREY COUNTS BY SAMPLING PERIOD

P. cod



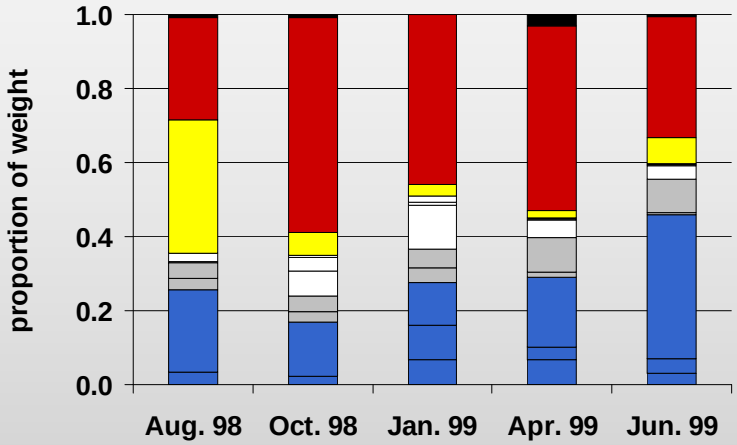
pollock



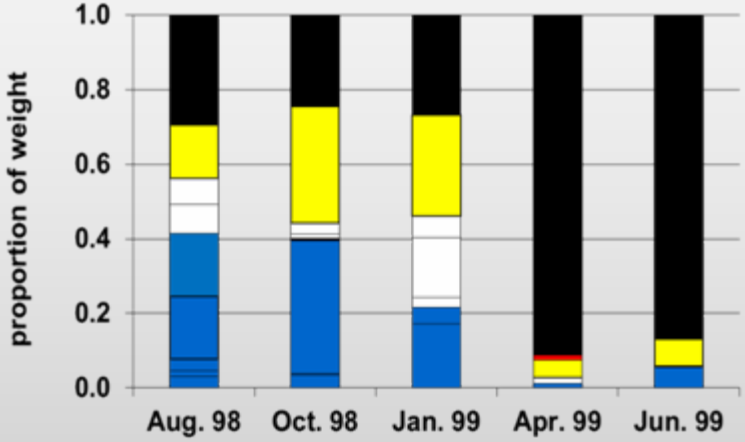


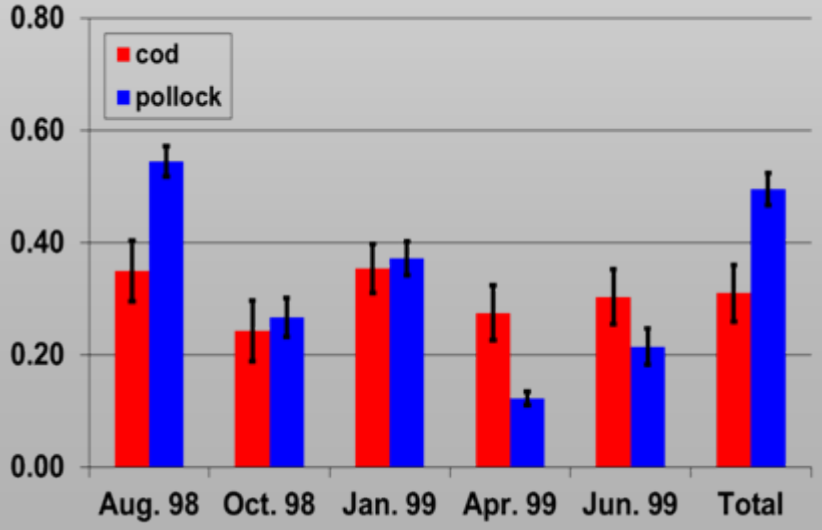
PREY WEIGHTS BY SAMPLING PERIOD

P. cod



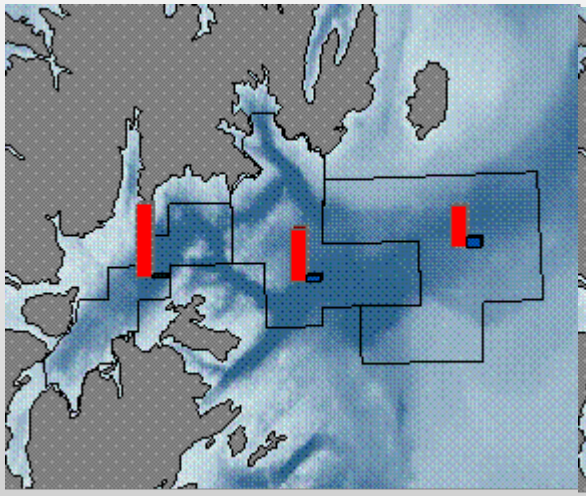
pollock



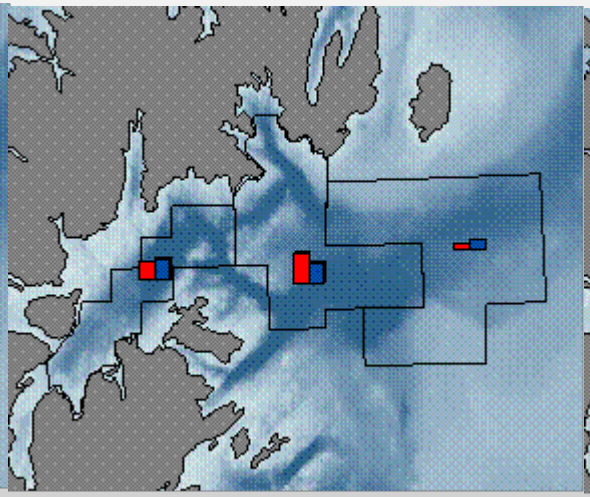


Grams of pink shrimp per stomach

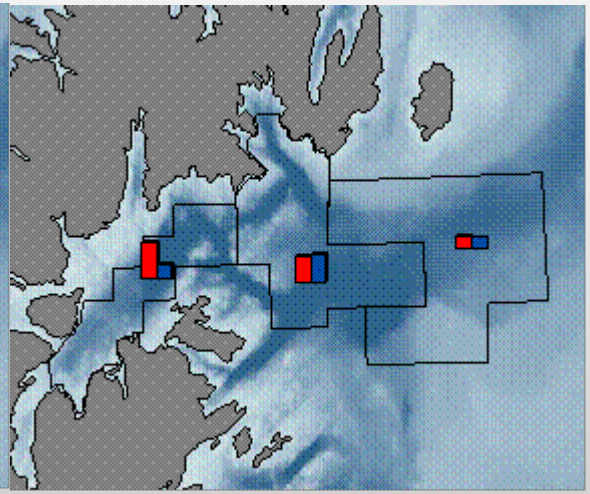
Aug. 98



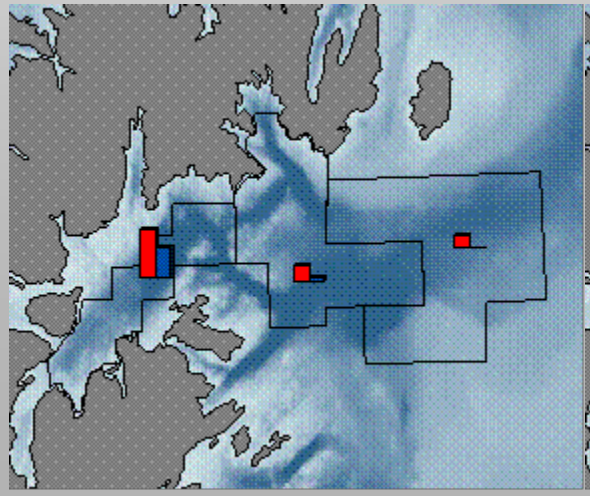
Oct. 98



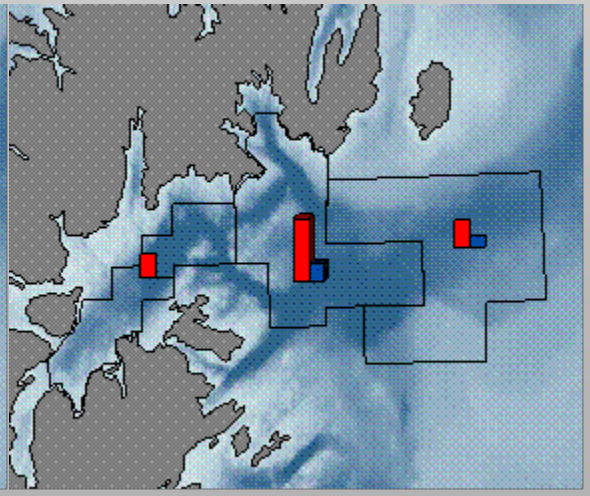
Jan. 99

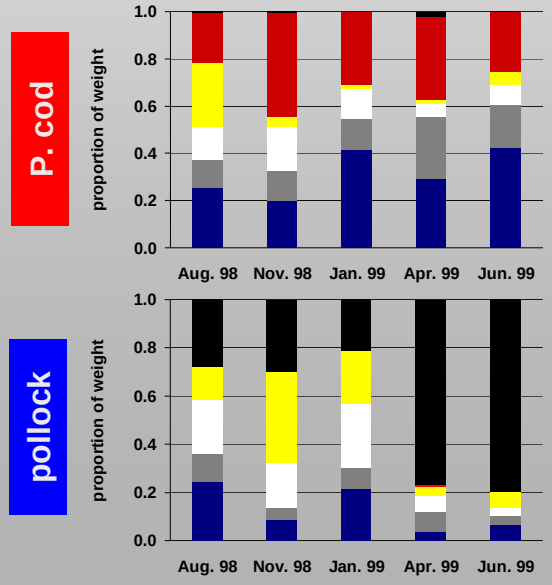


Apr. 99



Jun. 99





Cod foraging

Shumagin Islands
150 m of water
Cod at ~ 75 m

RESOURCE PARTITIONING OF CRUSTACEANS

How do cod and pollock partition the crustacean resource?

- **Do these species share the same diet?**
- **Does diet overlap vary spatially and seasonally?**
- **Is there a shared foraging strategy, ie. specialist or generalist?**

Acknowledgments

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