Habitat and Ecology of Large Medusa in the Northern California Current: An Overview of Recent Studies

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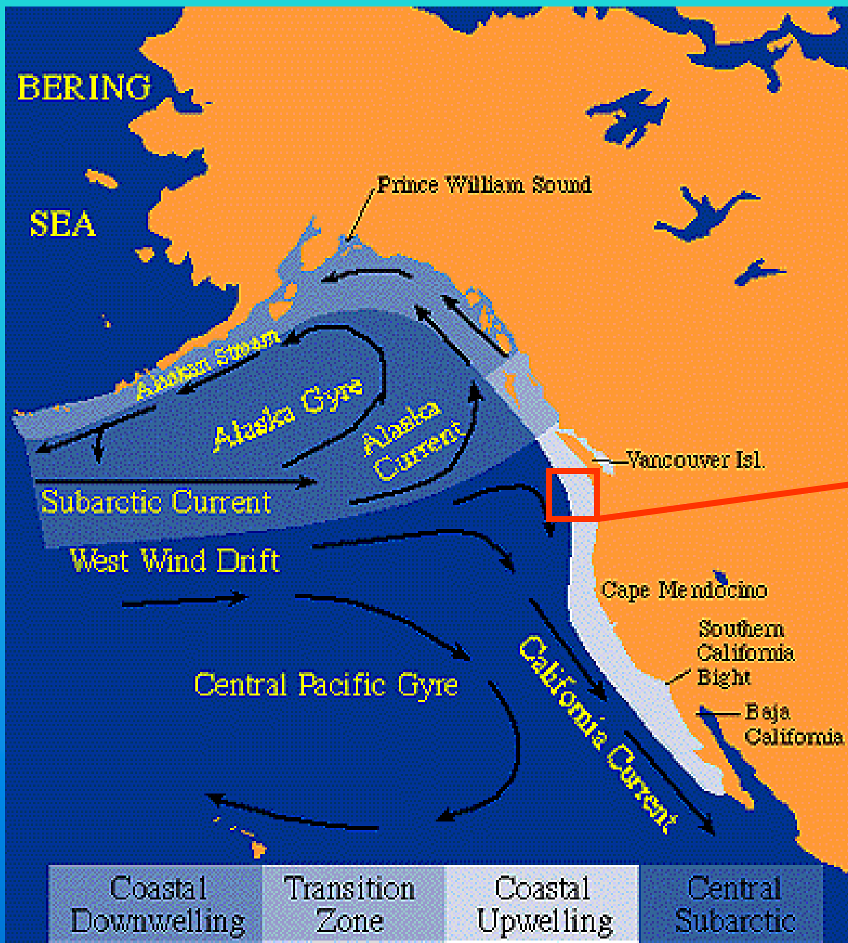
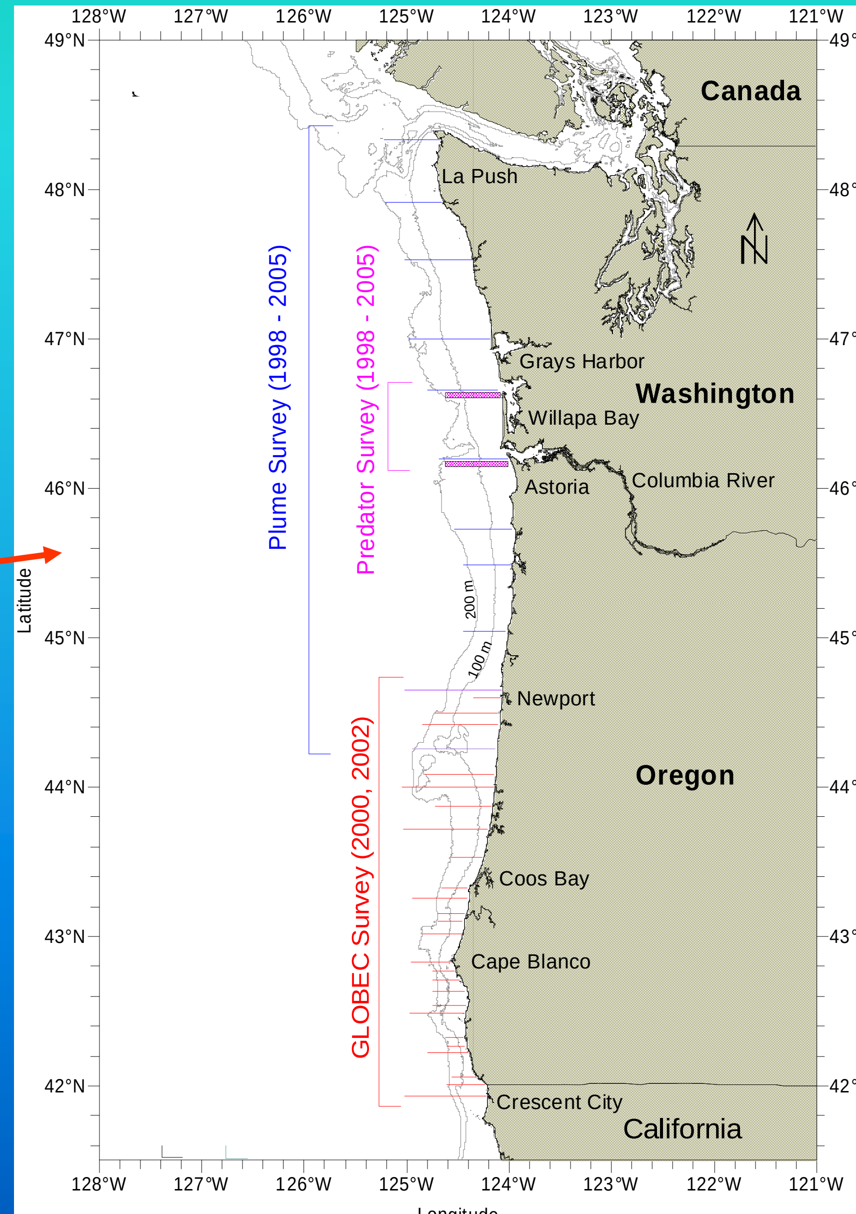
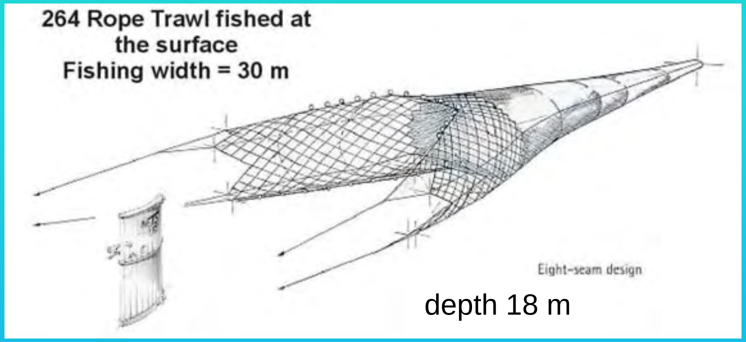
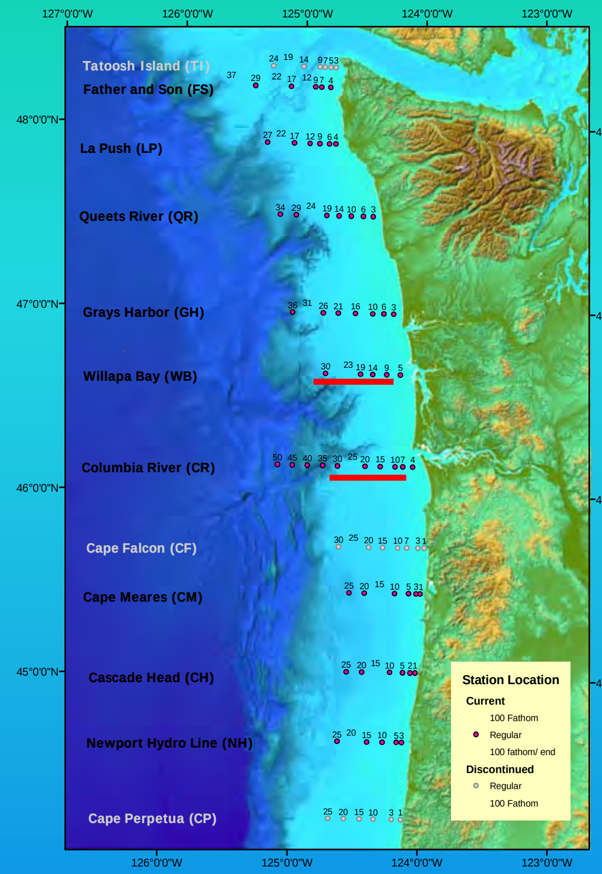
Sampling Locations





Sampling Methods



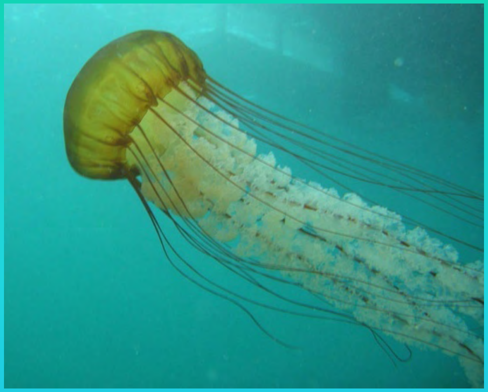


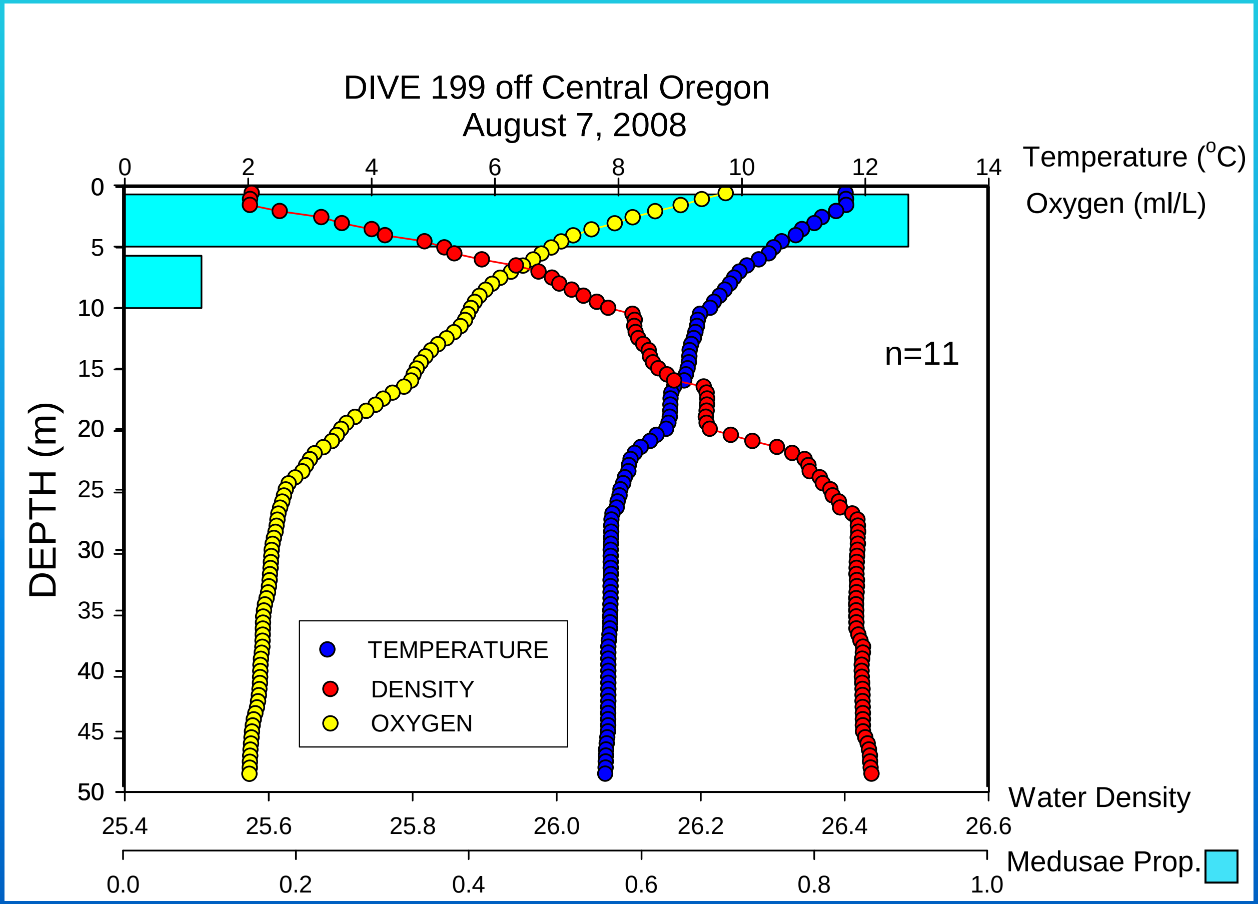
<u>Mesoscale 10-day cruises (trawls=1102):</u>
May, June, Sept. 2000-2008
8 cross-shelf transects (1-40 nm from shore)
surface trawls, CTD, zooplankton tow, chl a

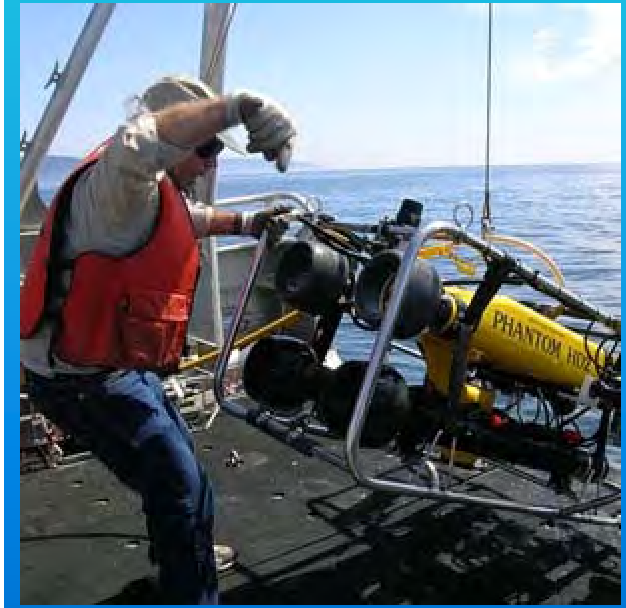
<u>Biweekly 2-night cruises (trawls=882):</u>
April-August 2000-2008
2 cross-shelf transects (Columbia River and Willapa Bay)
surface trawls and CTD

Vertical Distribution from ROV Surveys

Chrysaora fuscescens: Depth Distributions







Phantom ROV

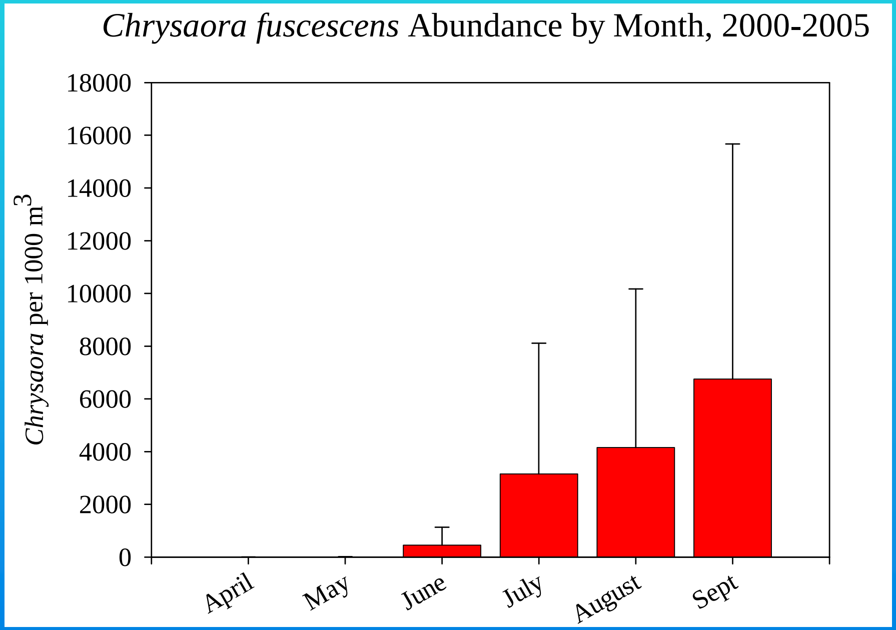

19:13:56:15
DIVE 210
174°
09.16.08
E S
-1
33
0.0
9.9

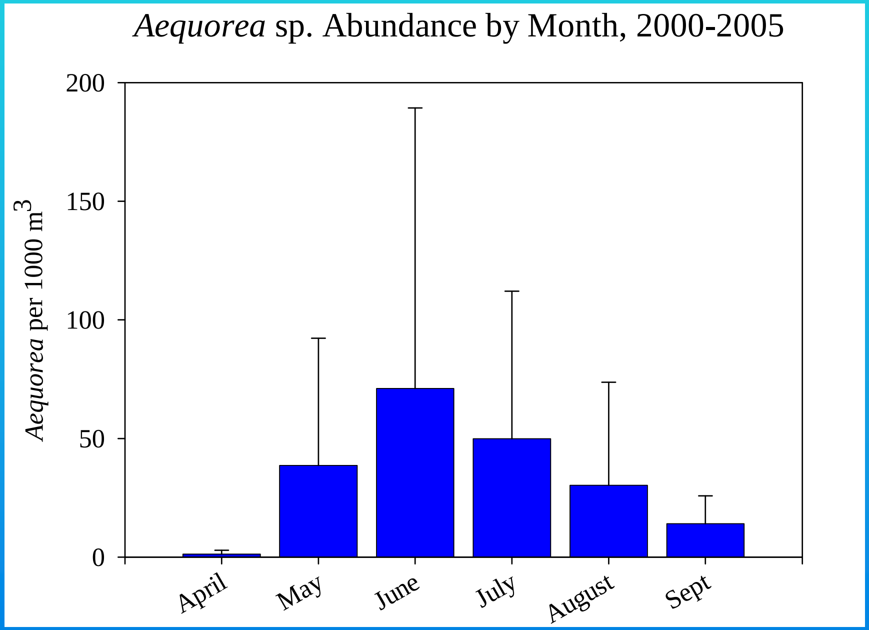
Catch Summary:
Mesoscale Cruises 2000-2007

Medusa	FO (%±sd)	# /km^{-2} (±sd)	Max (per 1000 m^3)
C. fuscescens	42 ± 15	2930 ± 1417	140 (Sept 2000)*
Aequorea sp.	40 ± 21	217 ± 177	3.5 (June 2002)
Aurelia labiata	19 ± 18	20 ± 33	2.5 (June 2004)
Phacellophora/ Cyanea	10 ± 11	2 ± 13	0.01 (June 2002)
All medusae	66 ± 19		

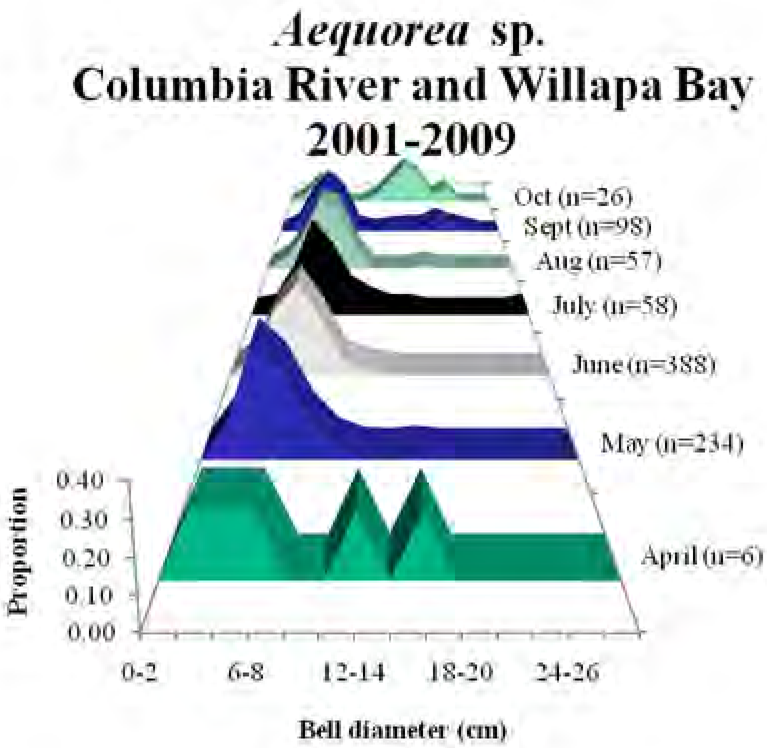
* Twice the maximum caught in previous surveys off Central OR, August 2000 (Suchman and Brodeur DSR 2005); approx **120 mg C/m^3**

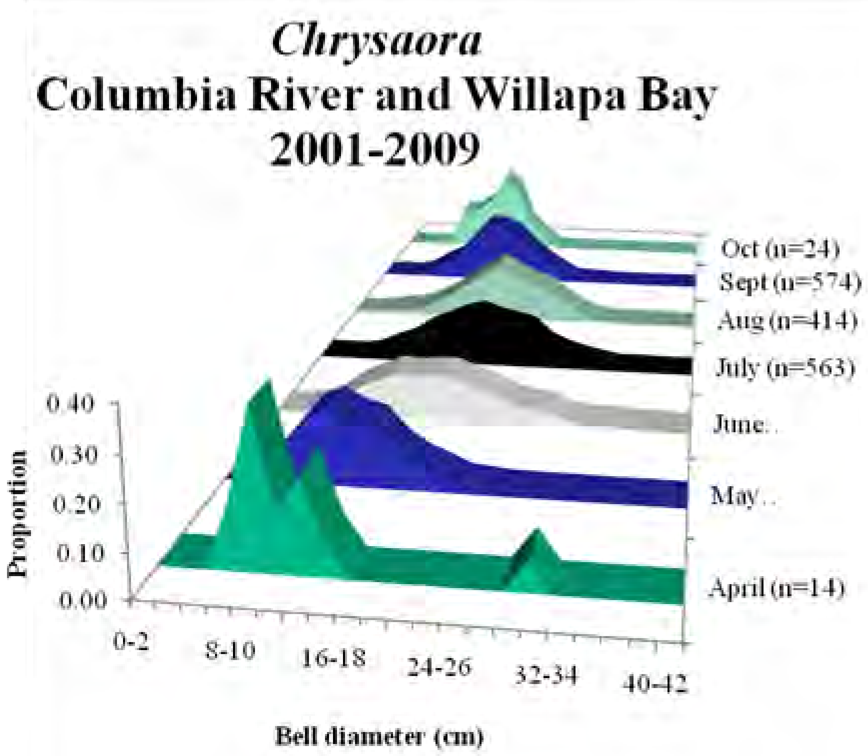
Seasonal Patterns





Length Distributions by Month

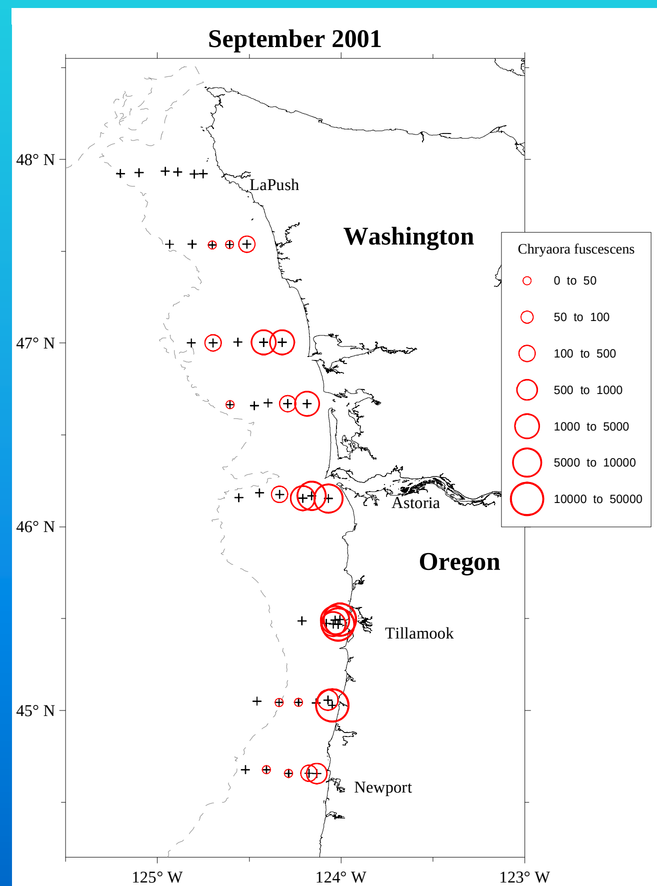


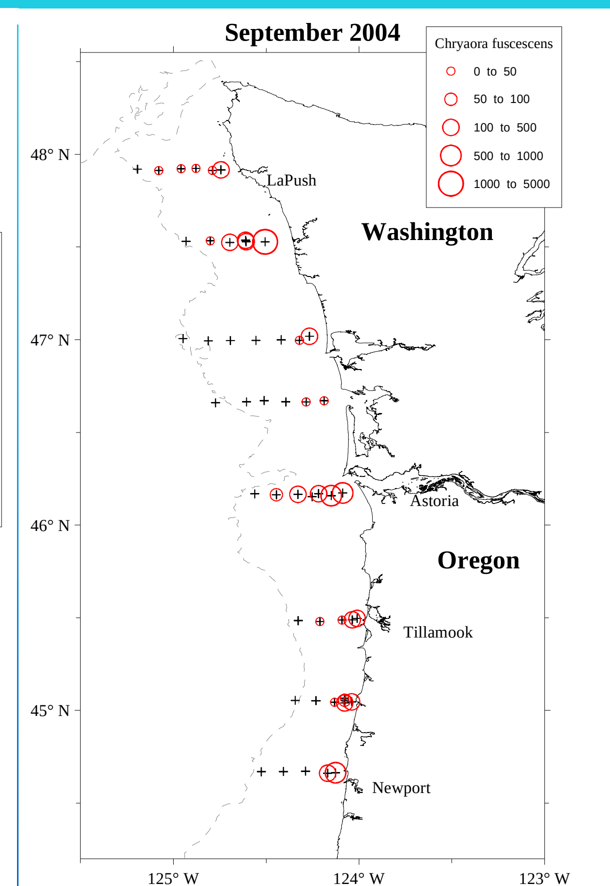


General Additive Modeling of Environmental Variables

Chrysaora fuscescens

- Deviance explained:47.7%
- Significant:
  latitude (+/-)
  temperature (-)
  distance (-)
  salinity (-)

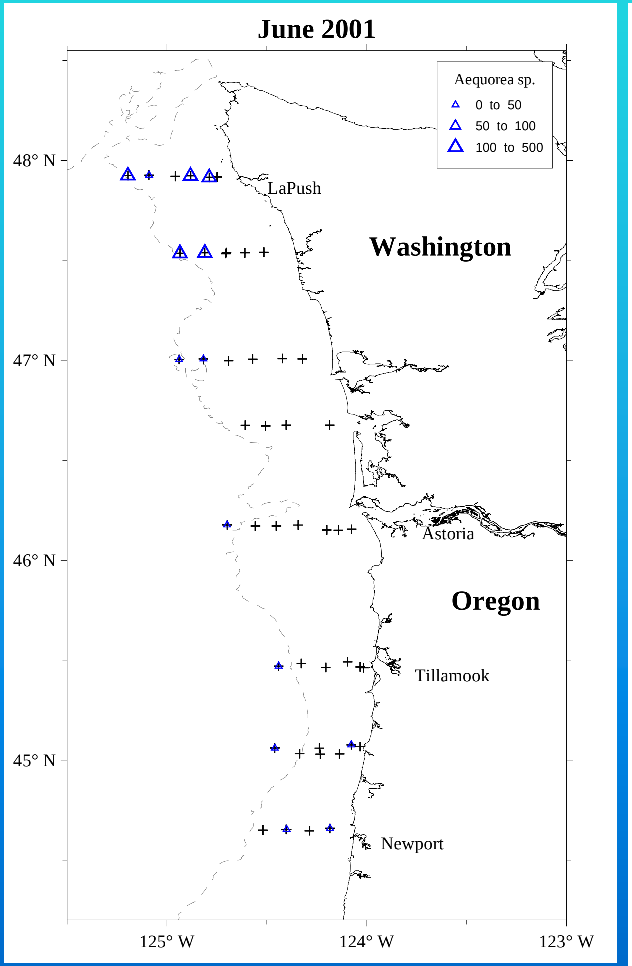


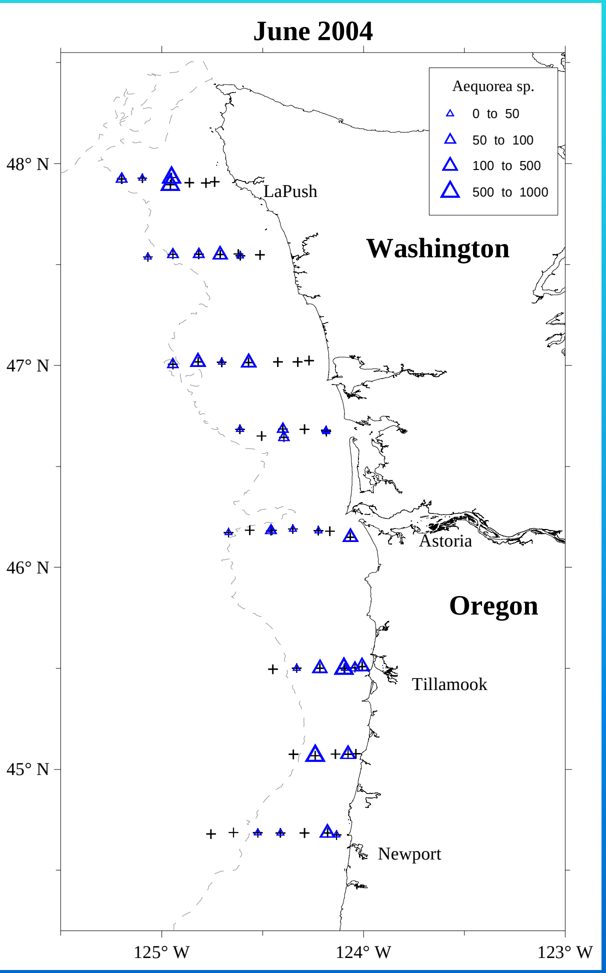


General Additive Modeling of Environmental Variables

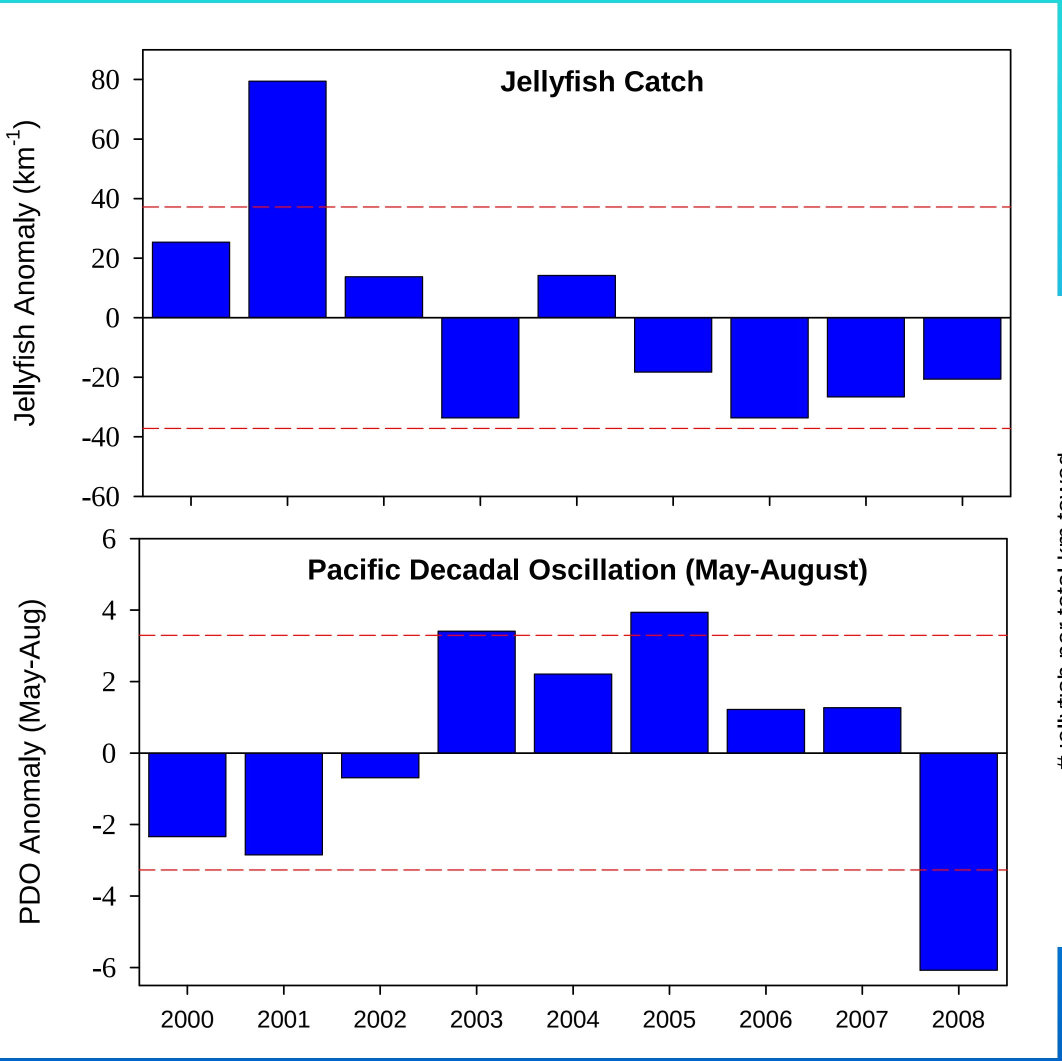
Aequorea sp.:

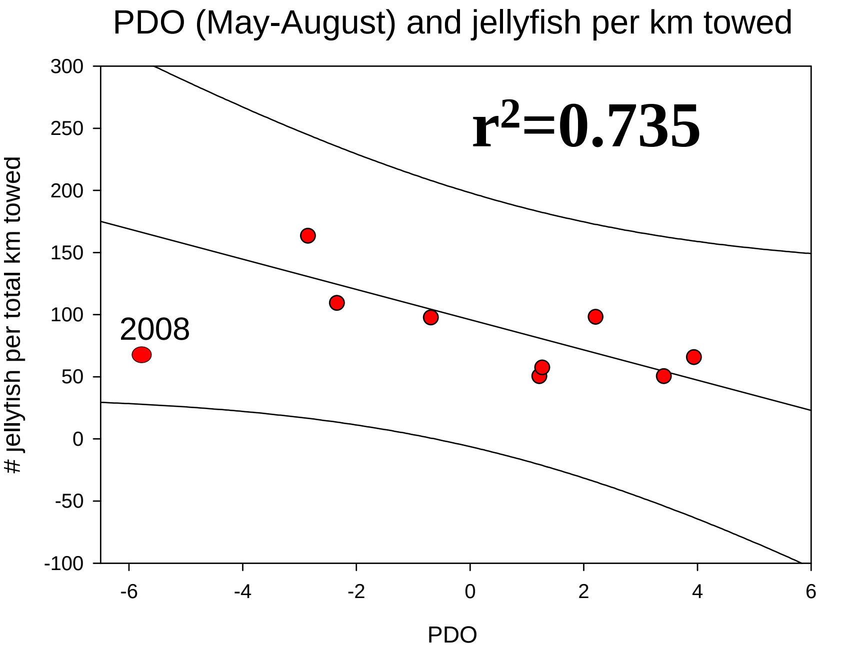
- Deviance explained: = 33.6%
- Significant: latitude (+) chlorophyll (+) salinity (+) distance (-)





Correlation with Climate: Pacific Decadal Oscillation

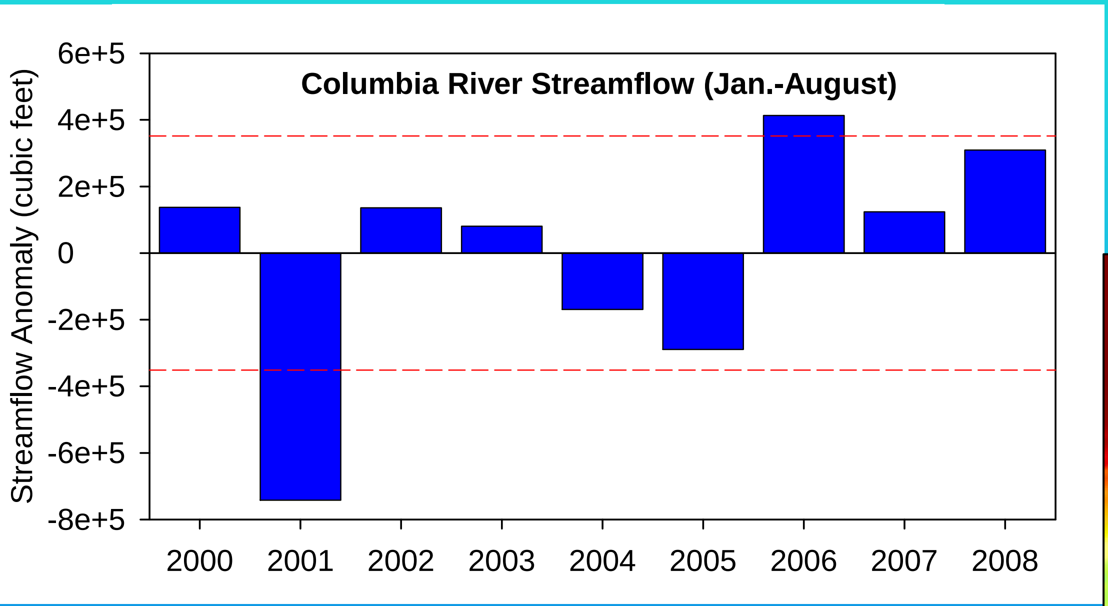




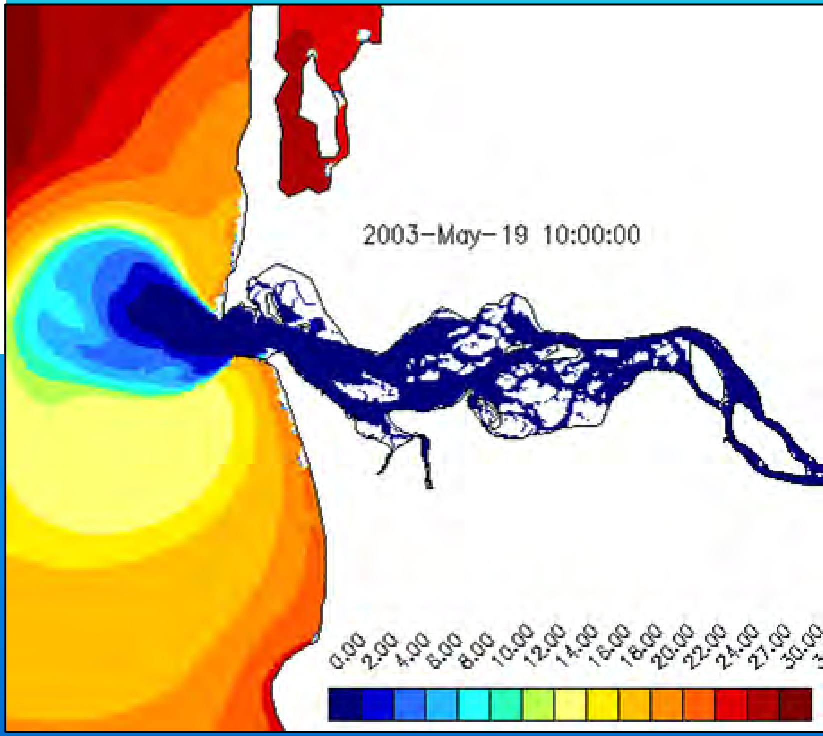
http://jisao.washington.edu/pdo/PDO.latest

(Suchman et al. In prep.)

Correlation with Columbia River Flow



USGS, Columbia River at Beaver Army Terminal



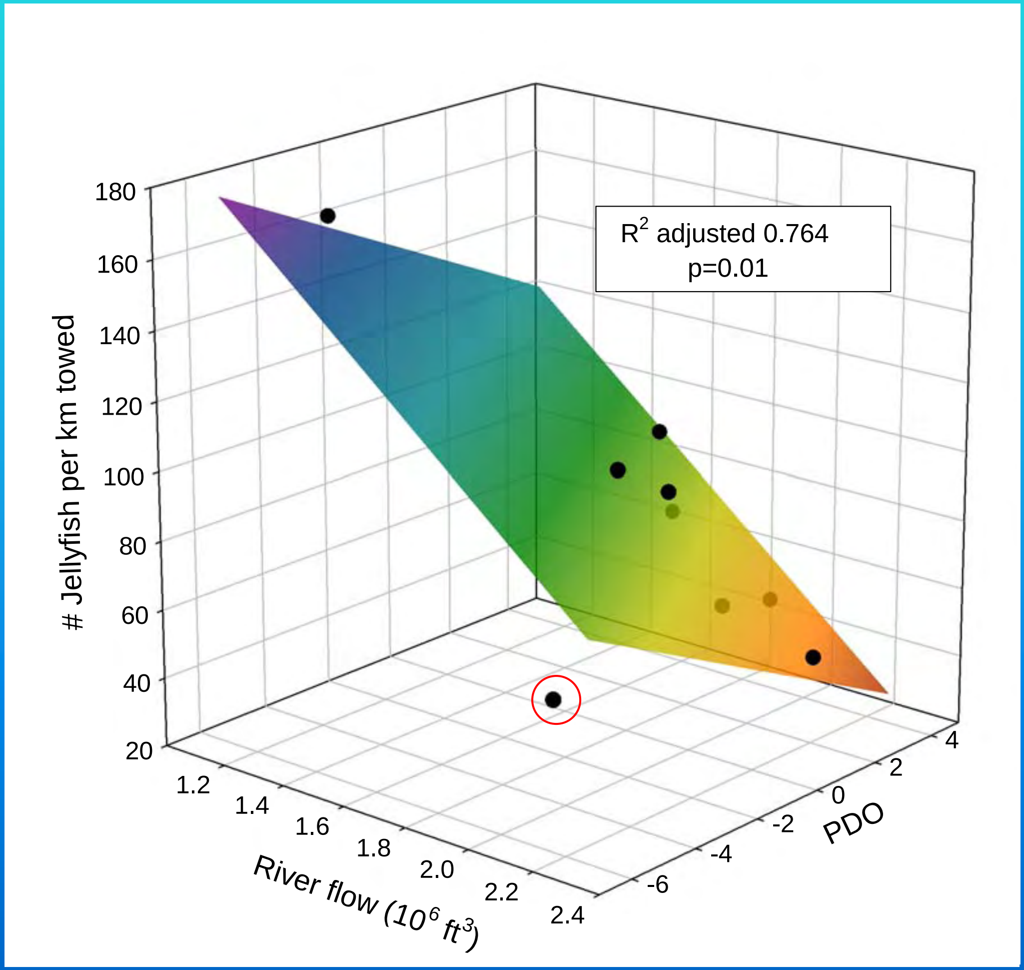
(Suchman et al. In prep.)

Multiple Linear Regression

catch/km = 7.64 - (0.0001 * annual flow ft³/s) - (9.86 * summer PDO anomaly)

r^2 adj = 0.927
$p < 0.001$

r^2 adj = 0.764
$p = 0.013$



Interactions with Fish?

Total number caught in August 2002	
Large Medusae:	**17,937**
Pacific herring, sardine, anchovies:	**9,997**
All other fishes (34 species):	**1,923**

Summary

- *Chrysaora fuscescens* dominated the biomass
- Mesoscale distribution characterized largely by latitude, depth, chlorophyll and salinity – highest abundances along inner shelf
- Annual abundance of large medusae in the region correlates (negatively) with spring-summer PDO (SST anomalies) and Columbia River flow
- Contrary to hypothesis of ‘warm’ conditions leading to jelly blooms

Acknowledgements

- Bonneville Power Administration
- National Research Council
- U.S. GLOBEC Program (NOAA/NSF)
- NOAA Fisheries

- Cheryl Morgan, Jim Ruzicka (OSU)
- Ed Casillas, Bob Emmett (NOAA NWFSC)
- Bill Miller, Dave Fox (ODFW)
- Captains and crew of FV Frosti, FV Sea Eagle, RV Miller Freeman, RV Ricker, and the many seagoing scientists participating in the fieldwork component of this project

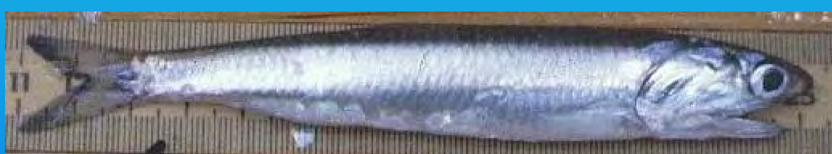
Can Jellyfish Blooms Have an Impact on Pelagic Fishes?

1. **Do pelagic fish and jellies have similar diets?**
2. **Do they overlap in distribution?**

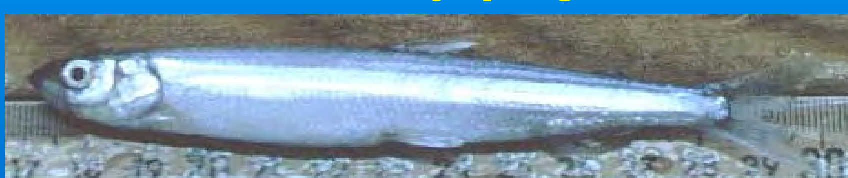
Pelagic Fishes Examined

Pacific herring (*Clupea pallasi*)

Pacific sardine (*Sardinops sagax*)



Northern anchovy (*Engraulis mordax*)



Surf smelt (*Hypomesus pretiosus*)

Whitebait smelt (*Allosmerus elongatus*)

Jack mackerel (*Trachurus symmetricus*)

Pacific saury (*Cololabis saira*)

Juvenile coho (*Oncorhynchus kisutch*)

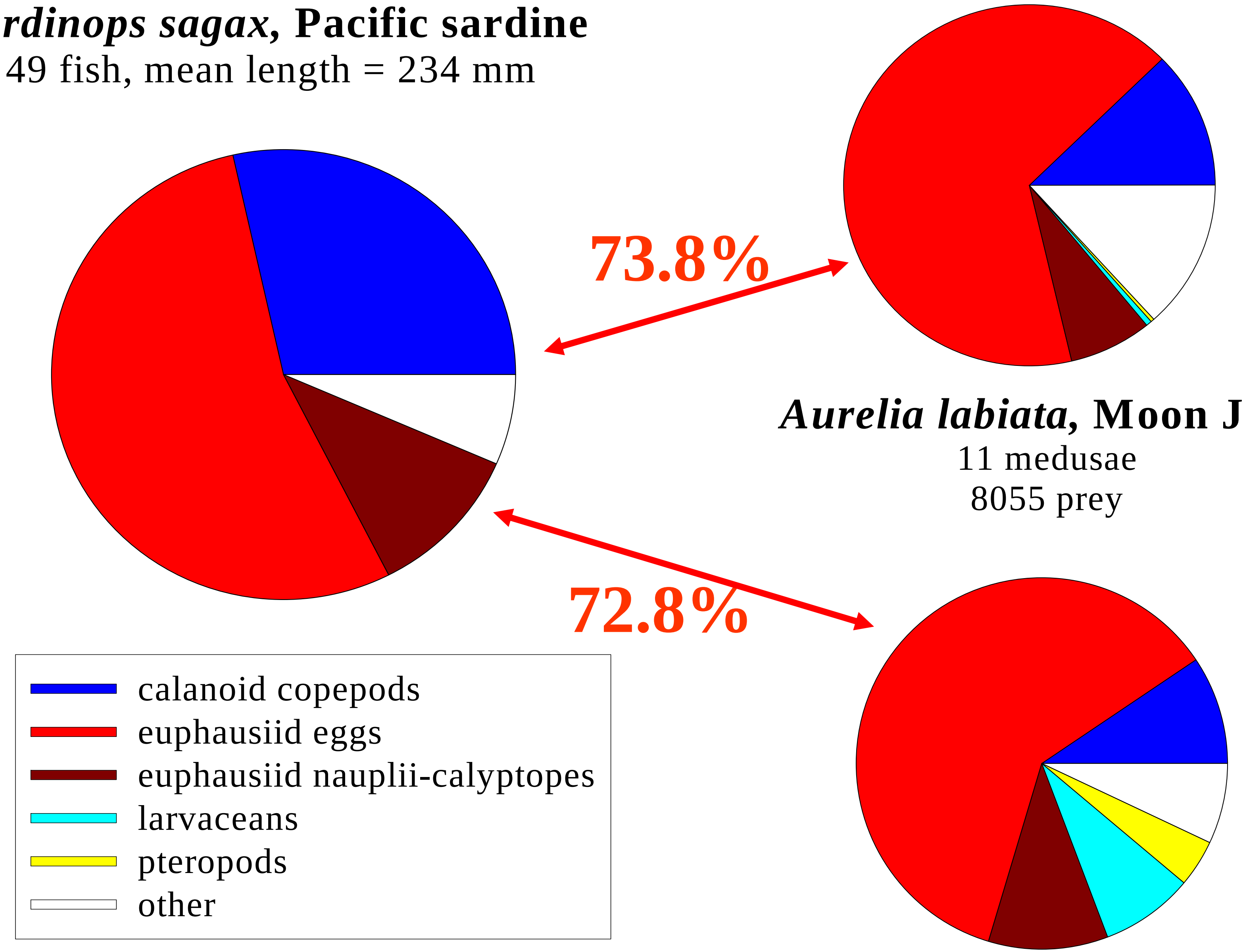
Juvenile chinook (*O. tshawytscha*)

Comparison of Fish and Jellyfish Diets: August 2002

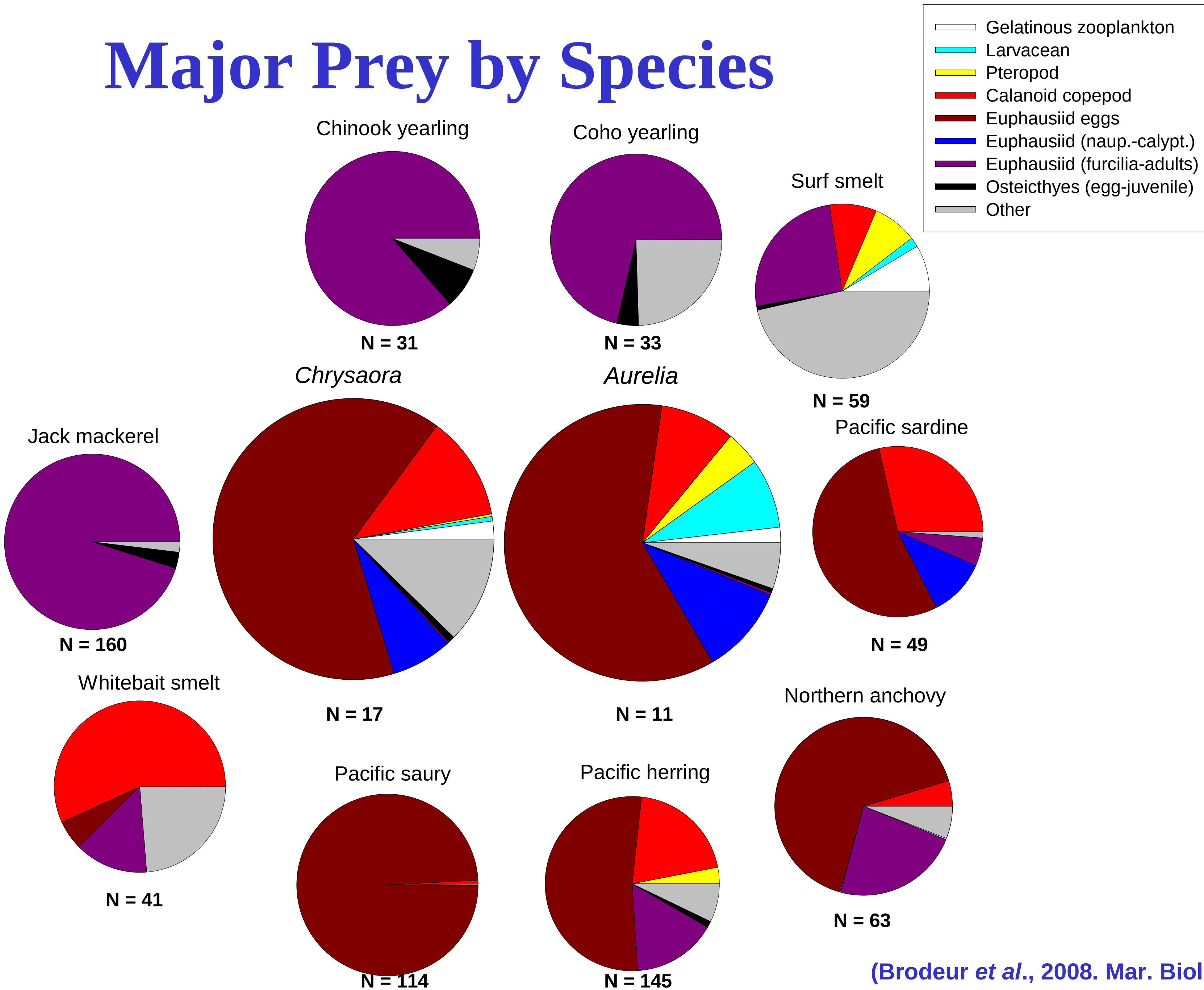
***Sardinops sagax*, Pacific sardine**
49 fish, mean length = 234 mm

***Chrysaora fuscescens*, Sea nettle**
17 medusae
26,040 prey

***Aurelia labiata*, Moon Jelly**
11 medusae
8055 prey

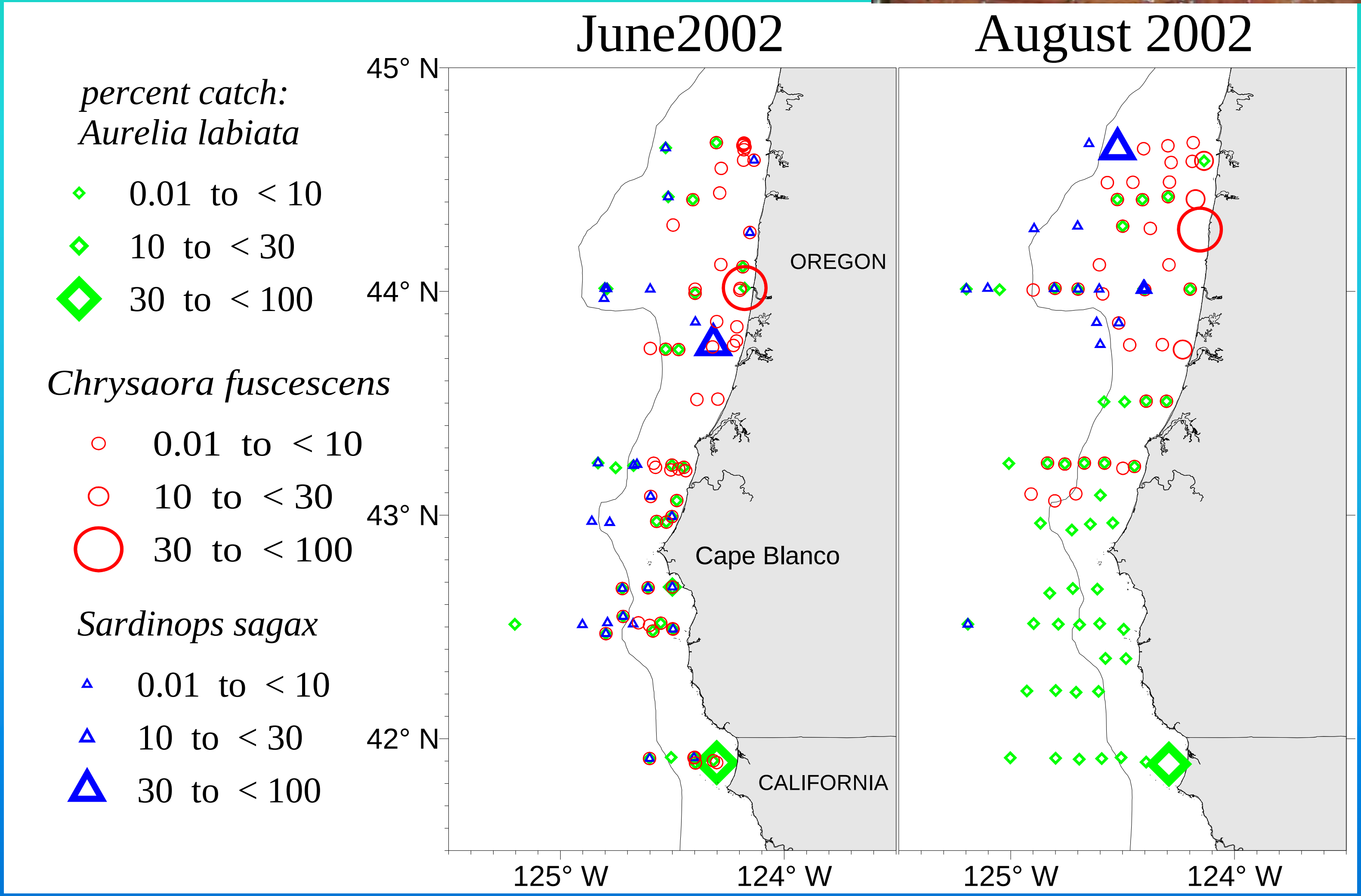


Major Prey by Species



(Brodeur *et al*., 2008. Mar. Biol.)

Spatial Overlap with Sardines



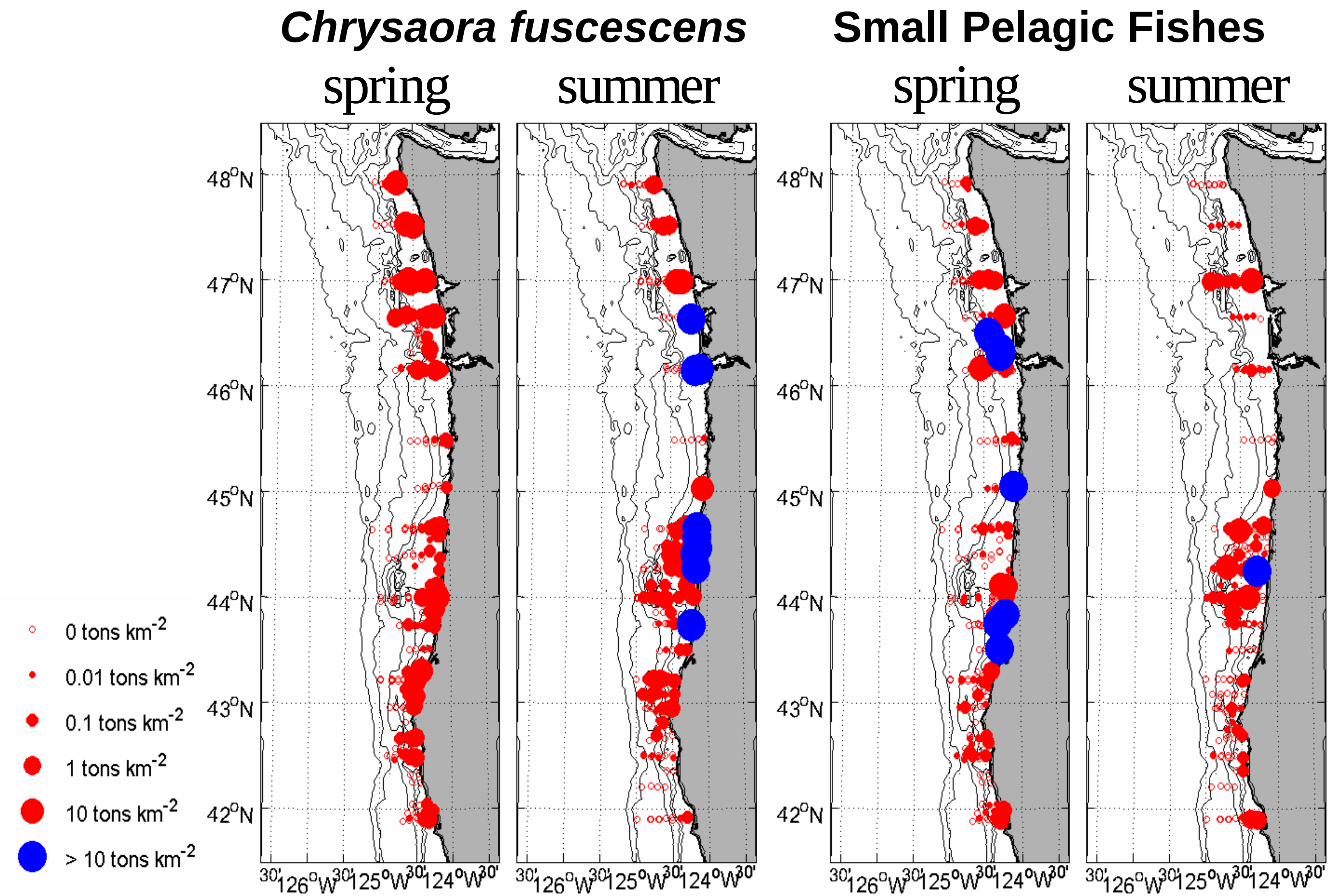
	June 2002	August 2002
sardines vs *Chrysaora*:	**21.2**	**27.3**
sardines vs. *Aurelia*:	**< 1**	**< 1**

Index of Potential Overlap of Nekton with Jellyfish

Nekton	*Chrysaora*	*Aurelia*
Juvenile Chinook salmon	0.24	0.08
Juvenile coho salmon	0.18	0.04
Jack mackerel	0.17	0.02
Whitebait smelt	0.36	0.07
Surf smelt	0.19	0.47
Pacific herring	0.41	0.50
Pacific saury	0.34	0.38
Northern anchovy	0.46	0.35
Pacific sardine	0.51	0.36

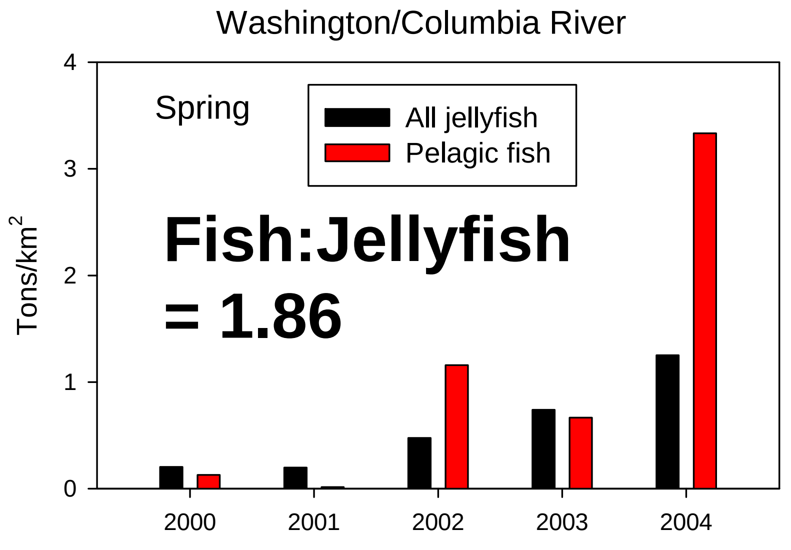
(Brodeur *et al*., 2008. Mar. Biol.)

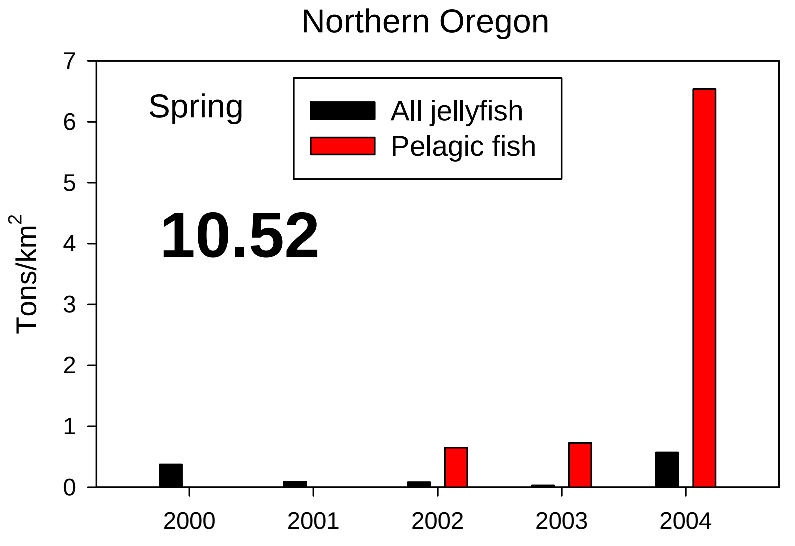
Biomass of Pelagic Fish vs. Jellyfish

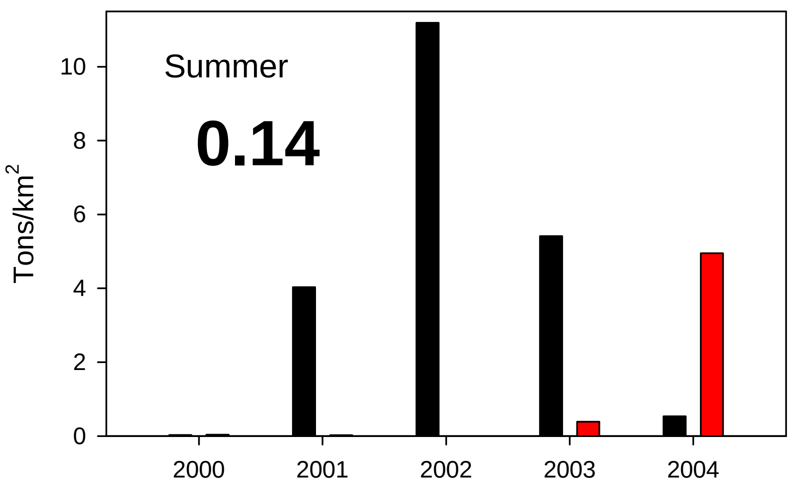


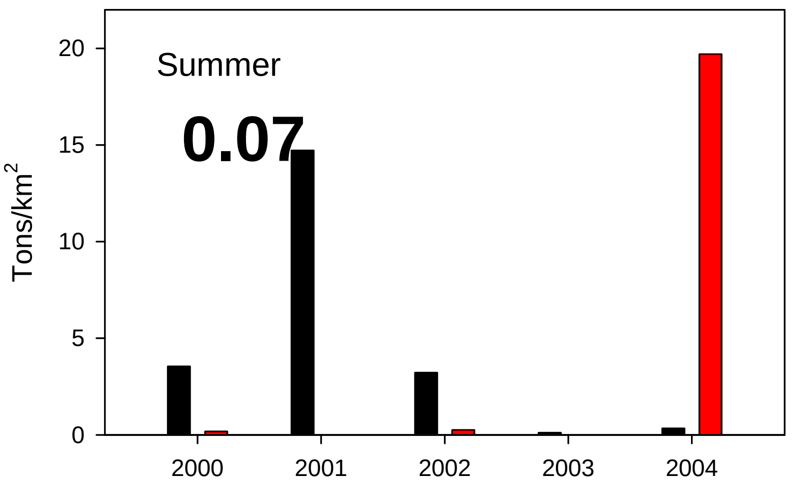
(Ruzick et al. 2007. CalCOFI Rep.)

Biomass of Pelagic Fish vs. Jellyfish

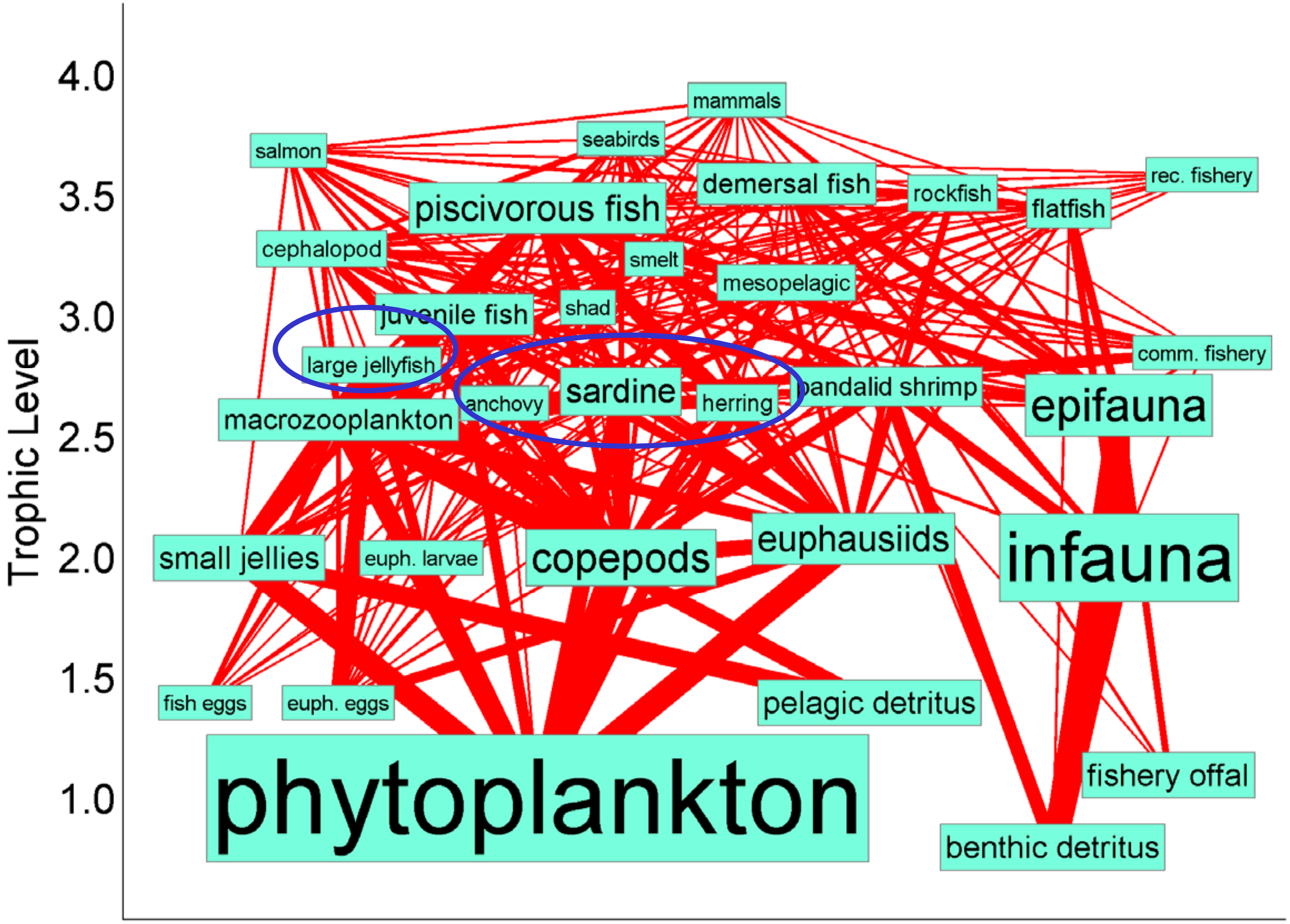






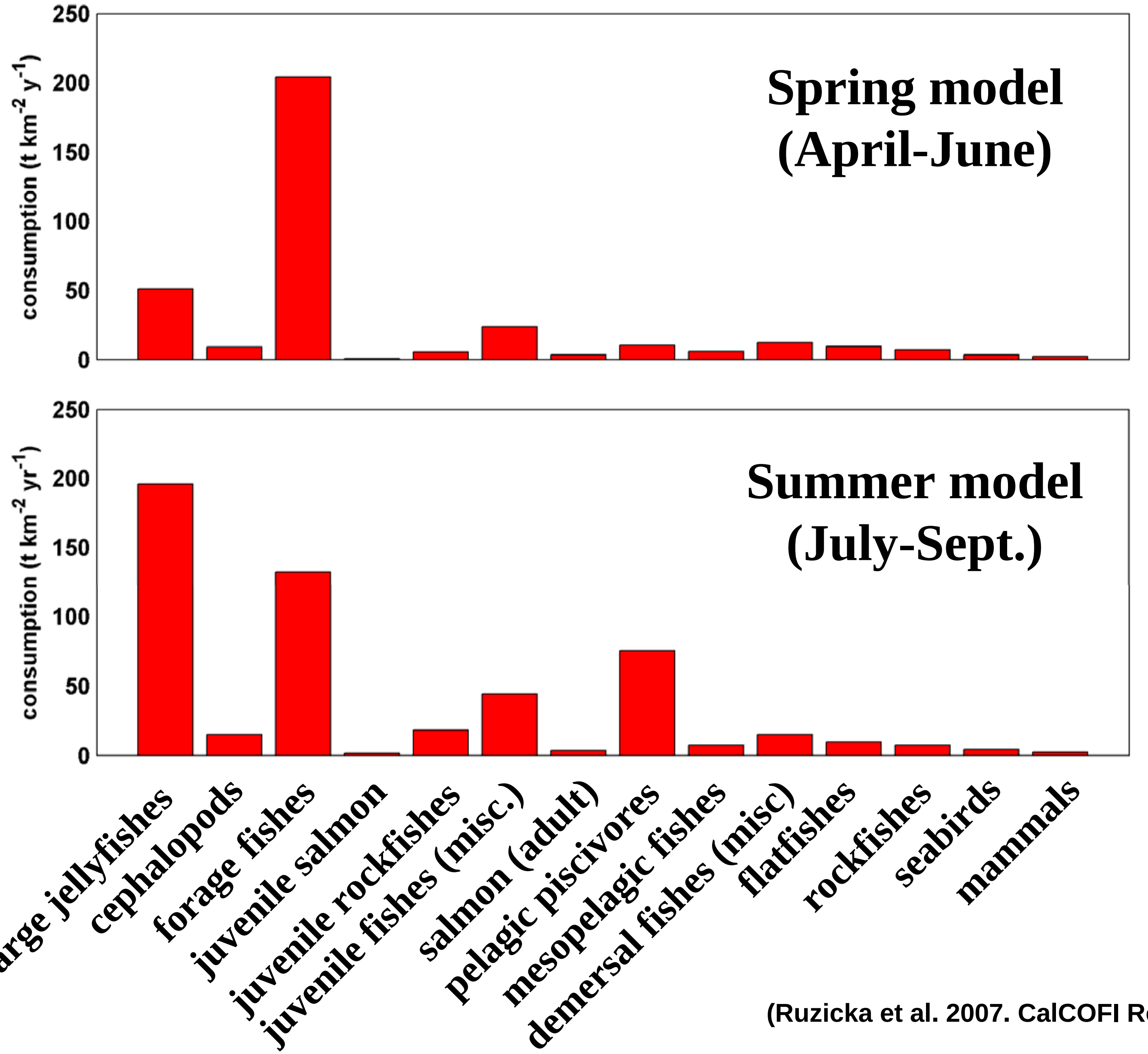


ECOPATH Ecosystem Model - Spring



(Ruzicka et al. 2007. CalCOFI Rep.)

Estimated Food Consumption during Different Seasons



(Ruzicka et al. 2007. CalCOFI Rep.)

Conclusions

In spring, jellyfish are a modest consumer of zooplankton production and small pelagic forage fishes are much more important consumers. By late summer, however, jellyfish are the major consumers of zooplankton.

Conclusions

As they are preyed upon by few species, jellyfish become an important pathway that diverts lower trophic level production away from upper trophic levels. In summer < 1% of consumption of large jellyfish is passed on to higher trophic levels while > 20% of the energy consumed by forage fish is passed upwards.