Spatial Overlap and Trophic Interactions Between Fish and Large Jellyfish in the Northern California Current

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Why Do We Care about Jellyfish in the Northern California Current?

• Jellyfish can undergo dramatic changes in biomass between years
Why Do We Care about Jellyfish in the Northern California Current?

- Jellyfish can undergo dramatic changes in biomass between years

- Jellyfish substantially increase in biomass during the course of the production season

![Jellyfish Abundance by Month, 2000-2005](chart.png)
Biomass of Pelagic Fish vs. Jellyfish

Washington/Columbia River

Spring

Fish:Jellyfish = 1.86

Northern Oregon

Spring

10.52

Summer

0.14

Summer

0.07
Why Do We Care about Jellyfish in the Northern California Current?

GLOBEC NEP CC cruises
Large pelagic trawls to sample fish

<table>
<thead>
<tr>
<th>Species</th>
<th>Ave F.O. (%)</th>
<th>Ave #</th>
<th>max biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aequorea spp.</em></td>
<td>63</td>
<td>5397</td>
<td>26 mg C m(^{-3})</td>
</tr>
<tr>
<td><em>A. labiata</em></td>
<td>44</td>
<td>1532</td>
<td></td>
</tr>
<tr>
<td><em>C. fuscescens</em></td>
<td>52</td>
<td>10,297</td>
<td>65 mg C m(^{-3})</td>
</tr>
<tr>
<td><em>P. camtschatica</em></td>
<td>24</td>
<td>379</td>
<td></td>
</tr>
</tbody>
</table>
Copepods at Station NH-5

Data courtesy of Bill Peterson (NWFSC)
## Interaction with Fish?

<table>
<thead>
<tr>
<th>Total number caught in August 2002</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Medusae:</td>
<td>17,937</td>
</tr>
<tr>
<td>Pacific herring, sardine, anchovies:</td>
<td>9,997</td>
</tr>
<tr>
<td>Other bony fish (34 species):</td>
<td>1,923</td>
</tr>
</tbody>
</table>
Impact of Jellyfish Blooms on Pelagic Fishes

1. Do pelagic fish and jellies have similar diets?
2. Do they overlap in distribution?
3. What are the implications of this overlap for the ecosystem?
Feeding Ecology

8 stations, July-Sept. 2003
What do they eat?

Net: copepods
Diet: euphausiid eggs, gelatinous taxa

<table>
<thead>
<tr>
<th>Proportion in Environment</th>
<th>Proportion in Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

- euphausiid eggs
- euphausiid naups-calypt
- calanoid copepods
- cyclopoid copepods
- molluscs
- gelatinous zoooplankton
- polychaetes
- cladocerans
- other

$N_{medusae}=30$

$N_{prey}=30,830$
Prey selection by *Chrysaora fuscescens*

**Prey Behavior?**
Copepods have fast escape responses

**Pearre’s Index**

- **+1** = strongest selection for
- **-1** = strongest selection against
- **0** = not significant (p>0.05)

(Suchman et al. In revision, MEPS)
Aurelia labiata Feeding Patterns

Available Zooplankton

Ingested Prey

- cyclopid copepods
- calanoid copepods
- euphausiid eggs
- euphausiid nauplii, calyptopes
- larvaceans
- other

1085 ± 151 m$^{-3}$

8724 ± 6267 day$^{-1}$
Chrysaora fuscescens August 2002

Northern Inshore Region

Density (per $10^6$ m$^3$)
- 0.1 to 100
- 100 to 250
- 250 to 500
- 500 to 1000
- 1000 to 2500
- 2500 to 5000
- 5000 to 10000
- 10000 to 25000

(Suchman and Brodeur, 2005, DSR)
Aurelia labiata Collections, Aug 2002

Southern Across shelf break

Density (per 1000 m3)
- 1E-005 to 0.001
- 0.001 to 0.01
- 0.01 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- 1 to 5
- 5 to 10
- 10 to 100

(Suchman and Brodeur, 2005, DSR)
Estimation of Spatial Overlap
Spatial Overlap with Sardines

**percent catch:**

*Chrysaora fuscescens*
- 0.01 to < 10
- 10 to < 30
- 30 to < 100

*Sardinops sagax*
- 0.01 to < 10
- 10 to < 30
- 30 to < 100

sardines vs *Chrysaora*: 27 < 1
sardines vs *Aurelia*: < 1 < 1
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

73.8%

Aurelia labiata, Moon Jelly
11 medusae
8055 prey

75.4%

72.8%

calanoid copepods
euphausiid eggs
euphausiid nauplii-calyptopes
larvaceans
pteropods
other
Overlap with Pacific Herring

Diet Overlap with *C. fuscescens*:

- **Clupea pallasi**
  - 0.01 to < 10
  - 10 to < 30
  - 30 to < 100

- **Aurelia labiata**
  - 0.01 to < 10
  - 10 to < 30
  - 30 to < 100

**Percent catch:**

- **Clupea pallasi**
  - 59.6%
- **Aurelia labiata**
  - 62.4%

Spatial Overlap with *C. fuscescens*:

- **Clupea pallasi**
  - 5.4%
- **Aurelia labiata**
  - 1.7%

Spatial Overlap with *A. labiata*:

- **Clupea pallasi**
  - 42.1%
- **Aurelia labiata**
  - 38.0%
**Other Fish Diets: August 2002**

*Hypomesus pretiosus*, Surf smelt
- 59 fish, mean length = 168 mm

- **Calanoid copepods**: 14.9-21.1%
- **Euphausiid eggs**: 13.8-18.4%
- **Euphausiid nauplii-calyptopes**: 65.2-70.1%
- **Larvaceans**: Other

*Allosmerus elongatus*, Whitebait smelt
- 41 fish; mean length = 117 mm

*Engraulis mordax*, Anchovy
- 63 fish; mean length = 150 mm
Overlap with Chinook Salmon

Spatial overlap with *C. fuscescens*: 23

*Chinook*: 31.0%

*Chrysaora fuscescens*: 15

*A. labiata*: 8.6%

Chinook diets:
euphausiids, fish, hyperiid amphipods, decapod larvae

Diet Overlap = 0.2-2.3%
Overlap with Coho Salmon

Spatial overlap with *C. fuscescens*: 17 10.1%
*A. labiata*: 6 8.5%

Coho diets: euphausiids, fish, hyperiid amphipods, decapod larvae

Diet Overlap = 0.2-0.3%
## Diet Overlap of Nekton with Jellyfish

<table>
<thead>
<tr>
<th>NEKTON</th>
<th>Chrysaora</th>
<th>Aurelia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subyearling Chinook salmon</td>
<td>2.2%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Yearling Chinook salmon</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Sub-adult Chinook salmon</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Yearling Coho salmon</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Jack mackerel</td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Whitebait smelt</td>
<td>21.1%</td>
<td>14.9%</td>
</tr>
<tr>
<td>Surf smelt</td>
<td>13.8%</td>
<td>18.4%</td>
</tr>
<tr>
<td>Pacific herring</td>
<td>59.6%</td>
<td>62.4%</td>
</tr>
<tr>
<td>Pacific saury</td>
<td>67.0%</td>
<td>61.6%</td>
</tr>
<tr>
<td>Northern anchovy</td>
<td>70.1%</td>
<td>65.2%</td>
</tr>
<tr>
<td>Pacific sardine</td>
<td>73.8%</td>
<td>72.8%</td>
</tr>
</tbody>
</table>

Overlaps > 60% = Significant
## Spatial Overlap of Nekton with Jellyfish

<table>
<thead>
<tr>
<th>NEKTON</th>
<th><em>Chrysaora fuscescens</em></th>
<th><em>Aurelia labiata</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Chinook salmon</td>
<td>31.0%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Juvenile Chinook salmon</td>
<td>23.1%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Adult Coho salmon</td>
<td>6.0%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Juvenile Coho salmon</td>
<td>10.1%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Jack mackerel</td>
<td>0.7%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Whitebait smelt</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Surf smelt</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pacific herring</td>
<td>42.1%</td>
<td>38.0%</td>
</tr>
<tr>
<td>Pacific saury</td>
<td>28.6%</td>
<td>14.3%</td>
</tr>
<tr>
<td>Northern anchovy</td>
<td>5.3%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Pacific sardine</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
August 2002 – Nekton and Jellyfishes

![Graph showing the isotopic composition of different species.](image-url)
ECOPATH Ecosystem Model (see Ruzicka et al. poster)
SPRING

SUMMER

Predators
- large jellyfish
- forage fish
- carnivorous zooplankton
- E. pacifica
- T. spinifera
- pandalid shrimp
- cephalopods
- juvenile fishes
- adult salmon
- pelagic piscivores
- mesopelagic fishes
- demersal fishes
- flatfishes
- rockfishes
- marine mammals

Prey Taxa
- copepods
- carnivorous zooplankton
- Euphausia pacifica
- Thysanoessa spinifera
- herbivorous jellies
- carnivorous jellies
- amphipods
- forage fish
- carnivorous zooplankton
- predator taxa
Conclusions

• jellyfish positively select for early stages of euphausiids, gelatinous taxa (against copepods)

• jellyfish show high dietary overlap with herring, saury, anchovies and sardines and low overlap with other species

• jellyfish show high spatial overlap with herring, saury and salmon
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