Changes in the ichthyoplankton in the northern California Current during the 2015-16 warm ‘blob’ and El Niño phenomena

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Basin Environment

Bars = PDO (Pacific Decadal Oscillation Index)
Line = ONI (Oceanic Niño Index)
Temperature Anomalies
Winter (January-March)
Objectives

• Examine changes to the ichthyoplankton in the northern California Current associated with the warming events of late 2014-2016.

• Focus on phenological changes to *Engraulis mordax* (northern anchovy), *Sardinops sagax* (Pacific sardine), and *Merluccius productus* (Pacific hake).
Methods

• 60-cm bongos with 333-µm meshed nets.
• Oblique tows 30 m (near-shore [1-25 nm from shore]) or 100 m (offshore) in depth.
• Preserved in a 10% buffered-formalin sea-water solution.
• Fish larvae enumerated, measured (0.1mm), and identified to the lowest taxonomic level possible in the lab.

• 3 sampling regimes along Newport Hydrographic (NH) line off central Oregon coast:
  1. Winter
  2. Near-shore
  3. Cross-shelf
Winter Sampling

- Years: 1998-2016
- Months: January-March
- Frequency: biweekly-monthly
- Stations: NH 1-25
Near-shore Sampling

- Years: 2015-2016
- Months: January-November
- Frequency: biweekly-monthly
- Stations: NH 1-15
Cross-shelf Sampling

- Years: 2015-2016
- Months: February-November
- Frequency: Quarterly (~3 mo)
- Stations: NH 1-85

(NH 1-200 in April 2015 and February 2016)
Normal Phenology

• *Engraulis mordax* (northern anchovy):
  – Northern California Current
  – June-July
  – Offshore (Columbia River plume)

• *Sardinops sagax* (Pacific sardine):
  – Southern California Current
  – April-May (June-July when north)
  – Offshore

• *Merluccius productus* (Pacific hake):
  – Southern California Bight
  – January-March (April-May when north)
  – Offshore
Near-shore (NH 1-15) Density

* No samples collected

- Engraulis mordax
- Sardinops sagax

* Log$_{10}$ mean concentration (no. 1000 m$^{-3}$)

Month/Year
Cross-shelf Density
27-29 April 2015

Log$_{10}$ mean concentration (no. $1000\text{ m}^{-3}$)

Station (NH: nautical miles from shore)

- **Engraulis mordax**
- **Sardinops sagax**
Cross-shelf Density
3-4 November 2015

• No *Engraulis mordax* or *Sardinops sagax* larvae found.
Cross-shelf Density
14-17 February 2016

- Engraulis mordax
- Sardinops sagax
- Merluccius productus

Log$_{10}$ mean concentration (no. 1000 m$^{-3}$)

Station (NH: nautical miles from shore)
Cross-shelf Density
24-25 May 2016

Log_{10} mean concentration (no. 1000 m$^{-3}$)

Station (NH: nautical miles from shore)

- **Engraulis mordax**
- **Sardinops sagax**
Total Weighted Mean Length
(Winter [NH 1-25], Near-shore [NH 1-15], Cross-shelf [NH 1-200])

- **Engraulis mordax**
- **Sardinops sagax**

*M. productus*: mean = 4.8 mm, range = 2.8-7.2

* No samples collected

14 February, 13 October, 8 January

Month/Year

* No samples collected
Anchovy Lengths 2015

4 February
Mean = 3.44 mm
SE = 0.09 mm
N = 26

5 March
Mean = 3.35 mm
SE = 0.14 mm
N = 150

26 March
Mean = 7.30 mm
SE = 0.17 mm
N = 124

7 April
Mean = 3.41 mm
SE = 0.11 mm
N = 120

28 April
Mean = 5.11 mm
SE = 0.17 mm
N = 306

19 May
Mean = 2.45 mm
SE = 0.17 mm
N = 63

Anchovy Lengths 2016

16 February
Mean = 3.32 mm
SE = 0.05 mm
N = 93

11 March
Mean = 5.50 mm
SE = 1.04 mm
N = 4

26 March
Mean = 3.34 mm
SE = 0.02 mm
N = 370

18 April
Mean = 5.52 mm
SE = 0.22 mm
N = 90

12 May
Mean = 6.03 mm
SE = 0.58 mm
N = 34

25 May
Mean = 4.21 mm
SE = 0.15 mm
N = 229
Winter MRPP Analysis

Percentage of years (N = 19) when significantly different winter ichthyoplankton
Winter Cluster Analysis
# Winter ISA Analysis

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Year</th>
<th>IV</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Engraulis mordax</em></td>
<td>Northern anchovy</td>
<td>2016</td>
<td>25.6</td>
<td>0.0018*</td>
</tr>
<tr>
<td><em>Sebastolobus</em> spp.</td>
<td>Thornyheads</td>
<td>2016</td>
<td>24.9</td>
<td>0.0018*</td>
</tr>
<tr>
<td><em>Sardinops sagax</em></td>
<td>Pacific sardine</td>
<td>2015</td>
<td>25.7</td>
<td>0.0022*</td>
</tr>
<tr>
<td><em>Citharichthys</em> spp.</td>
<td>Pacific or speckled sanddab</td>
<td>2015</td>
<td>16.6</td>
<td>0.0046*</td>
</tr>
<tr>
<td><em>Microgadus proximus</em></td>
<td>Pacific tomcod</td>
<td>2002</td>
<td>14.0</td>
<td>0.0138*</td>
</tr>
<tr>
<td><em>Isopsetta isolepis</em></td>
<td>Butter sole</td>
<td>2010</td>
<td>12.4</td>
<td>0.0208*</td>
</tr>
<tr>
<td><em>Ammodytes personatus</em></td>
<td>Pacific sand lance</td>
<td>2000</td>
<td>12.6</td>
<td>0.0212*</td>
</tr>
<tr>
<td><em>Lyopsetta exilis</em></td>
<td>Slender sole</td>
<td>2002</td>
<td>12.9</td>
<td>0.0334*</td>
</tr>
<tr>
<td><em>Liparis fucensis</em></td>
<td>Slipskin snailfish</td>
<td>1999</td>
<td>11.1</td>
<td>0.0448*</td>
</tr>
</tbody>
</table>

* Only significant indicator taxa shown
Summary/Conclusions

- 2015-16 stand out as highly anomalous years for the ichthyoplankton in the northern California Current (NCC).
- *Engraulis mordax* and *Sardinops sagax* spawned throughout most of the year in 2015-16 (normally just summer for *E. mordax*, and *S. sagax* far south [or summer when north]).
- Earliest occurrence of *E. mordax*, *S. sagax*, and *Merluccius productus* larvae ever recorded in NCC.
- Highest concentrations of *E. mordax*, *S. sagax*, and *Merluccius productus* larvae in the winter and spring ever recorded in NCC.
- Could have major implications on food chain in the NCC.
- Maybe loss of *E. mordax* and *S. sagax* in southern California Current is just a move north?
- Need for continuous and cross-shelf sampling in future.
Acknowledgements

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