Spatio-Temporal Persistence in Mesoscale/Regional Zooplankton Communities in the Eastern North Pacific

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Photo credit: World Meteorological Association
Northeast Pacific (NEP): A complicated place

Chelle Gentemann and JPL PO.DAAC: Charles Thompson and Jeffery Hall.

Gulf of Alaska SST Anomaly Time Series

github.com/python4oceanography/PICES-tools
HYPOTHESIS: Zooplankton communities in Northeast Pacific (NEP) are spatially persistent across years of varying condition.

APPROACH: Analysis of 17 years’ (2000 - 2016) of zooplankton assemblage data in the NEP (May 16 – August 15), provided by Continuous Plankton Recorder Survey (CPR).
Continuous Plankton Recorder

• South-North & East-West transects
• Summer: May 15 – Aug. 16
CPR transects: 2000 - 2016

Zooplankton data summarized within 40 two * two degree grid cells

- 41 Spatial Bins
- ~900 data points
- 119 taxa in 60 functional groups
### Processing Data

18 dominant zooplankton taxa retained from 100+ identified taxa

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Functional group</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. plumchrus flemingeri</td>
<td>Large, cold-water grazing copepods</td>
</tr>
<tr>
<td>E. bungii</td>
<td>Small neritic copepods</td>
</tr>
<tr>
<td>N. cristatus</td>
<td>Medium widespread copepods</td>
</tr>
<tr>
<td>M. pacifica</td>
<td>Small widespread copepods</td>
</tr>
<tr>
<td>C. marshallae</td>
<td>Pteropods</td>
</tr>
<tr>
<td>A. longiremis</td>
<td>Gelatinous filter-feeders</td>
</tr>
<tr>
<td>C. abdominalis</td>
<td>Large diel migrators</td>
</tr>
<tr>
<td>C. pacificus</td>
<td>Amphipods</td>
</tr>
<tr>
<td>Pseudocalanus spp.</td>
<td>Arrow worms, predators of small copepods</td>
</tr>
<tr>
<td>Oithona spp.</td>
<td></td>
</tr>
<tr>
<td>Clione spp.</td>
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<tr>
<td>L. helicina</td>
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<tr>
<td>Salpidae</td>
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<tr>
<td>Appendicularia</td>
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<tr>
<td>Siphonophores</td>
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<tr>
<td>Euphausiacea</td>
<td></td>
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<tr>
<td>Hyperidae</td>
<td></td>
</tr>
<tr>
<td>Chaetognaths</td>
<td></td>
</tr>
</tbody>
</table>
Methods to Determine Community Spatial Patterns

1) Binning the data in spatial grid
2) Initial detrending using Principle Component Analysis
3) Hierarchical cluster analysis applied to first 2 PC loadings (HCPC)
Coastal sites

Central gyre

Aleutians & Pacific current

Unimak

Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6
Cluster 7

Cluster 1,2
Cluster 3,4
Cluster 5
Cluster 6
Cluster 7
Cluster 1,2
Cluster 5
Cluster 6
Cluster 7

60°N
55°N
50°N
180° 170°W 160°W 150°W 140°W 130°W
Coastal sites

Central gyre

Aleutians & Pacific current

Unimak

Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6
Cluster 7
Coastal sites

Central gyre

Aleutians & Pacific current

Unimak

1, 2

Clusters: 1, 2, 3, 4, 5, 6, 7
UNIMAK
E. bungii
L. helicina

COAST
A. longiremis;
C. abdominalis

SHELF
Pseudocalanus
Euphausiids
salps

DEEP
BASIN

GOA
Other explanations: Current Positioning?
Are Community Patterns Persistent? Defining Temperature Anomalies

> 0.5°C
WARM
- 2003
- 2005
- 2014
- 2015
- 2016

< 0.5°C
COLD
- 2007
- 2008
- 2009
- 2012
**COLD**
- 3 clusters, little variation.
- Unique clusters are in Unimak and coastal sites.

**WARM**
- Aleutian signal spreads
- More pronounced coastal effect
- Additional cluster in the Bering Sea and the south GOA
Summary

HYPOTHESIS: Zooplankton communities in Northeast Pacific (NEP) are spatially persistent across years of varying condition

RESULTS:
1) Spatial shifts in coastal communities associated with thermal anomalies
2) Spatial persistence in central gyre
3) No study wide thermal effect on community assemblage, but significant structuring effects of Region (Bering vs. GOA; $p = 0.012$) and Temp. * Region ($p = 0.04$)
Acknowledgements
## Cluster Traits

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Trait Description</th>
<th>Major Species and Other Entities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIMAK</strong></td>
<td>medium SST, strong current, high variance</td>
<td><em>E. bungii; L. helicina</em></td>
</tr>
<tr>
<td><strong>COASTAL</strong></td>
<td>high SST, medium current, low variance</td>
<td><em>A. longiremis; C. abdominalis; C. marshallae</em></td>
</tr>
<tr>
<td><strong>COASTAL</strong></td>
<td>wide SST, high-current, mid-high variance</td>
<td><em>Pseudocalanus spp; euphausiids; salps</em></td>
</tr>
<tr>
<td><strong>DEEP BASIN</strong></td>
<td>wide SST, wide current, wide variance</td>
<td><em>Clione spp; Oithona; chaetognaths; C. pacificus</em></td>
</tr>
<tr>
<td><strong>GOA</strong></td>
<td>wide SST, wide current, wide variance</td>
<td>Decreased abundance of most common taxa, only <em>Clione</em> spp. show sig. increase.</td>
</tr>
</tbody>
</table>