Micronekton in the North Pacific ... what do we know?

Michael P. Seki
NOAA Fisheries
Pacific Islands Fisheries Science Center
“micronekton” defined ...

- Small but actively swimming organisms ranging from ca. 2 to 10 cm; mainly mesopelagic (200-1000 m depths)
- Taxa too vagile to be caught with conventional plankton nets yet too small to be retained by most large trawls.
  - Fishes – mainly mesopelagics and juveniles of epipelagic nekton
  - Crustaceans – includes adult euphausiids, pelagic decapods, mysids, hyperiid amphipods
  - Cephalopods – small adults and subadults of large oceanics
- Many undertake extensive diel vertical migrations
Why do we care?

- Represents a substantial biomass in the world’s oceans
- A critical but poorly understood intermediate (missing?) trophic link between the mesozooplankton & higher trophic levels (i.e., fish, marine mammals, etc.)
- Significant contributors to the “biological pump” (i.e., rapid transport of $C_{surface}$, as well as pollutants, to deep sea).
Relatively scant attention paid to micronekton as a whole

In 1997, PICES establishes a WG to assimilate knowledge of micronekton & their sampling in the North Pacific

Broadly, much of what is known results from research of the 1960s & 70s

... most focused on the marginal seas around the basin rim (i.e., we know least about the open ocean)

... and little effort expended in comparing relative sampling efficiencies and selectivity of the gears
Some history and milestones of micronekton research around Hawaii and the Central North Pacific:

- King & Iversen (1962): oceanic Central Pacific & Hawaii – 6’ & 10’ IKMT; $z_{\text{max}} \sim 350$ m
- Clarke, Young, and others (1972-78): off Hawaii; 6’ & 10’ IKMT, Cobb trawl; $z_{\text{max}}$ to 1200 m
- Wilson, Boehlert and others (1985-88): Hancock Smts – “engybenthic” micronektonic fauna; qualitative acoustics
- Reid et al. (1991): off Hawaii; Mesopelagic Boundary Community (MBC); IOS-RT 40 m$^2$, HU-200 m$^2$ trawl; $z_{\text{max}} \sim 500-600$ m
- PICES (2004): off Hawaii; 6’ IKMT, Cobb trawl, HU-RT gear comparison; quantitative acoustics
SE Hancock Acoustic transects, July 1984
(38 kHz Simrad echo sounder)
"Minimum no. species caught"

<table>
<thead>
<tr>
<th></th>
<th>Summer '84</th>
<th></th>
<th>Winter '85</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'on'</td>
<td>'off'</td>
<td>'on'</td>
<td>'off'</td>
</tr>
<tr>
<td>No. tows</td>
<td>12</td>
<td>6</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Crustaceans</td>
<td>23</td>
<td>26</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>Fishes &amp; cephalopods</td>
<td>21</td>
<td>24</td>
<td>47</td>
<td>61</td>
</tr>
</tbody>
</table>
### Fishes & Squid

![Maurolicus muelleri](image)

#### Mean densities (individuals/1000 m$^3$ water filtered) of selected micronekton species in the vicinity of SE Hancock

*(number in parentheses indicate rank among top five species)*

<table>
<thead>
<tr>
<th>Species</th>
<th>Summer (Jul-Aug '84)</th>
<th>Winter (Jan-Feb '85)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;on&quot;</td>
<td>&quot;off&quot;</td>
</tr>
<tr>
<td><strong>Maurolicus muelleri</strong></td>
<td>4.19 (2)</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Lampanyctus alatus</strong></td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Ceratoscopelus townsendi</strong></td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td><strong>Vinciguerria nimbaria</strong></td>
<td>0.80</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Vinciguerria attenuata</strong></td>
<td>0.17</td>
<td>0.93</td>
</tr>
<tr>
<td><strong>Iridoteuthis iris</strong></td>
<td>0.35</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Onychoteuthis n. sp. D</strong></td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Megalocranchia cf. fisheri</strong></td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

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**Vinciguerria nimbaria**

![Vinciguerria nimbaria](image)

**Iridoteuthis iris**

![Iridoteuthis iris](image)
## Crustaceans

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of selected micronekton species in the vicinity of SE Hancock
(number in parentheses indicate rank among top five species)

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<tbody>
<tr>
<td></td>
<td>&quot;on&quot;</td>
<td>&quot;off&quot;</td>
</tr>
<tr>
<td><strong>Gnathophausia longispina</strong></td>
<td>11.60 (1)</td>
<td>2.59 (4)</td>
</tr>
<tr>
<td><strong>Euphausia gilboidea</strong></td>
<td>1.23 (4)</td>
<td>5.50 (1)</td>
</tr>
<tr>
<td><strong>Euphausia hemigibba</strong></td>
<td>0.82 (5)</td>
<td>1.93</td>
</tr>
<tr>
<td><strong>Euphausia mutica</strong></td>
<td>1.38 (3)</td>
<td>2.24 (5)</td>
</tr>
<tr>
<td><strong>Thysanopoda monacantha</strong></td>
<td>0.07</td>
<td>2.81 (3)</td>
</tr>
<tr>
<td><strong>Thysanopoda orientalis</strong></td>
<td>0.15</td>
<td>3.75 (2)</td>
</tr>
<tr>
<td><strong>Thysanopoda tricuspida</strong></td>
<td>--</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Stylocheiron abbreviatum</strong></td>
<td>0.19</td>
<td>0.91</td>
</tr>
<tr>
<td><strong>Thysanoessa gregaria</strong></td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Gennadas incertus</strong></td>
<td>--</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Oplophorus spinosus</strong></td>
<td>0.01</td>
<td>0.29</td>
</tr>
</tbody>
</table>
Cobb trawls at large-scale frontal systems, SAFZ August 1991

Subarctic Domain

- Subarctic Frontal Zone
- "Subarctic Boundary"

Subtropic-Transition Zone

- Pyroteuthis addolux
- Onychoteuthis sp. D*
- Enoploteuthis chunii*
- Ocythoe tuberculata*
- Megalocranchia abyssicola*
- Cthenopteryx sp. A

"Cold-water" boreal-subarctic

- Gonatus pyros
- Octopoteuteuthis deletron
- Taonius borealis
- Japatella diaphana
- Abraliopsis felis
- Onychoteuthis borealijaponica
- Galiteuthis phyllura
- Gonatopsis borealis
- Mastigoteuthis pyrodes
- Discoteuthis discus
- Chiroteuthis calyx

Salinity (PSU)

Temperature (°C)

Latitude

$T_f = 23.0$
$T_f = 24.0$
$T_f = 25.0$
$T_f = 26.0$
$T_f = 27.0$

179°30'W
Cobb trawls at large-scale frontal systems, STFZ February 1992

Transition Zone

"Warm-water" subtropical-tropical

Subtropical Frontal Zone

Subtropical Domain

Medusa, rajiform

Enoploteuthis higginsi

Enoploteuthis jonesi

Enoploteuthis reticulata

Onychoteuthis sp. C

Cthenopteryx sp. A

Enoploteuthis chunii*

"Warm-water" subtropical-tropical

Abraliopsis felis

Walvisteuthis cf. rancureli

Onychoteuthis sp. D*

Pyroteuthis addolux

Pterygioteuthis giardi

Pterygioteuthis microlampas

Abraliopsis pacificus

Abraliopsis sp. A

Onychoteuthis compacta

Cranchia scabra
**Onychoteuthis sp. D & O. borealijaponica**

- South spawning – north feeding migrations
- Spatially complementary distributions
- Past reports of extensive distribution likely a composite of 2 species
Cruise objectives:

- to conduct the sampling for a gear comparison and to gain a subtropical perspective of the micronekton community
- use the benign weather and sea conditions to evaluate and refine the protocols, logistics, and design of the experiment
Micronekton Intercalibration Experiment – 1
Cruise participants

Michael P. Seki
Daniel Curran
Donald R. Hawn
Reka Domokos
   National Marine Fisheries Service, NOAA
   Pacific Islands Fisheries Science Center

Richard Brodeur
   National Marine Fisheries Service, NOAA
   NW Fisheries Science Center, Newport OR

Doug Yelland
   Institute of Ocean Sciences
   Department of Fisheries & Oceans, Canada

Evgeny Pakhomov
   Larissa Pakhomova
   University of British Columbia
   Dept. Earth & Ocean Sciences

Hiroki Yasuma
   Masayuki Abe
   Hokkaido University
   Graduate School of Fisheries Sciences
   & Faculty of Fisheries

Andrei Suntsov
   Harbor Branch Oceanographic Institution
Sampling gears

140 m² “Stauffer modified” pelagic Cobb trawl

1.8 m IKMT

2 m Hokkaido University Rectangular Frame Trawl
MIE-1, operations tracks
EK-60 38 kHz echogram, 9 October 2004:

Day tows ≈ 550 m

Night tows ≈ 120 m

One series night tows ≈ 550 m

| Simrad EK-60 38 kHz, avg Nautical Area Scattering Coefficients (m²•nmi⁻²) |
|----------------|----------------|----------------|
| **Cobb Trawl** | **HU-RT**      | **6' IKMT**    |
| Day            | Night          | Day            | Night          | Day            | Night          |
| 472.704        | 288.191        | 428.696        | 318.828        | 390.104        | 321.254        |
Sampling Distribution:

- 17 Cobb trawls
- 19 IKMTs
- 20 HU-RFTs
Gear-types for intercomparison (what is micronekton?):

MIE-1 – “what one defines as micronekton ≠ another”; enabled all size range evaluation of multiple acoustic λs

MIE-2 – ‘appropriate’ gear of similar mesh sizes; standard gear (RMT 1+8, IKMT?);
towed acoustics (high frequencies)
Opisthoproctus soleatus

Oplophorus gracilirostris

Abralia trigonura
What now?

- Advances in technology
- Signal strength (acoustics)
- Time series – observation systems
- Refined trophic links
- Ecosystem roles