Coupling crustacean zooplankton production and primary production rates to estimate energy transfer in the NE Pacific

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<table>
<thead>
<tr>
<th>Year</th>
<th>SVI Southern copepods</th>
<th>NVI Southern copepods</th>
<th>SVI Boreal copepods</th>
<th>NVI Boreal copepods</th>
<th>SVI SubArctic copepods</th>
<th>NVI SubArctic copepods</th>
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<tbody>
<tr>
<td>2015</td>
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<td>2016</td>
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Zooplankton Production

- The rate at which biomass is generated
  - Focus on crustacean zooplankton production rates
- Key to understanding energy transfer to higher trophic levels
- Zooplankton production rates and transfer efficiencies are critical measures of ecosystem function that are not well understood
Rate of production of chitobiase in water column = biomass production rate (BPR) of entire crustacean zooplankton community.
Energy Transfer

- Rate of crustacean zooplankton production divided by the rate of primary production = Ecological Efficiency (EE)
- Generally assumed to be 10% in marine ecosystems
  - Large variation observed
- Range of factors influence can influence transfer efficiencies
- A region’s productivity is not necessarily indicative of its EE (or trophic transfer efficiency (TTE))

<table>
<thead>
<tr>
<th>Location</th>
<th>TTE Range</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean</td>
<td>&lt;1 - 35</td>
<td>Cushing 1973</td>
</tr>
<tr>
<td>Japan</td>
<td>7.4 - 16.2</td>
<td>Parsons and Chen 1994</td>
</tr>
<tr>
<td>World Fisheries Catch</td>
<td>2 – 24</td>
<td>Pauly and Christensen 1995</td>
</tr>
<tr>
<td>North Sea</td>
<td>3.7 – 12.4</td>
<td>Jennings et al. 2002</td>
</tr>
<tr>
<td>Southern Plateau, NZ</td>
<td>1.5 – 25.8</td>
<td>Bradford-Grieve et al. 2003</td>
</tr>
</tbody>
</table>
Estimating Energy Transfer

Crustacean BPR

Net Community Production ($O_2$/Ar and $N_2O$)

$^{14}$C Primary Production

Ecological Efficiency
West Coast Vancouver Island (WCVI)
Line P to Ocean Station Papa
BPR for West Coast Vancouver Island
BPR along Line P to Ocean Station Papa

- Jun-05
- Aug-05
- Feb-16
- Jun-16
- Aug-16
- Feb-17

BPR mg C m^{-2} d^{-1}
**2015 and 2016 Average BPR for WCVI**

**2015:**
- **May:** $32.2 \pm 28.5 \text{ mg C m}^{-2} \text{ d}^{-1}$
- **September:** $108.8 \pm 72.8 \text{ mg C m}^{-2} \text{ d}^{-1}$

**2016:**
- **May:** $64.6 \pm 40.0 \text{ mg C m}^{-2} \text{ d}^{-1}$
- **September:** $69.5 \pm 32.1 \text{ mg C m}^{-2} \text{ d}^{-1}$
Average BPR along Line P

2016:
February- 40.7 ± 39.4 mg C m\(^{-2}\) d\(^{-1}\)
June- 53.5 ± 12.8 mg C m\(^{-2}\) d\(^{-1}\)
August- 78.1 ± 131.4 mg C m\(^{-2}\) d\(^{-1}\)

2017:
February- 10.0 ± 10.6 mg C m\(^{-2}\) d\(^{-1}\)
Ecological Efficiencies for WCVI

On Shelf Average: 9%

Off Shelf Average: 5%

Southern WCVI Average: 6%

Northern WCVI Average: 11%
Ecological Efficiencies along Line P

2016

Inshore Average:
February- 6 %
June- 14 %
August- 9 %

Offshore Average:
June- 9 %
August- 11 %
$^{14}$C and 5m BPR EE along Line P

2016

June:
Inshore - 3 %
Offshore - 2 %

August:
Inshore - 2 %
Offshore - 0.8 %
$^{14}$C and 50m int BPR EE along Line P

2016

June:  
Inshore- 32 %  
Offshore- 20 %

August:  
Inshore- 23 %  
Offshore- 9 %
Summary

• Crustacean zooplankton BPR higher in September than May for 2015 off WCVI, no difference in 2016 and in August over June along Line P in 2016
  • Very low compared to previous years
  • More “normal” years May/June is higher than August/September

• Generally higher at stations on the shelf than at off shelf stations

• EE is also higher at on shelf stations off WCVI

• EE at southern WCVI stations lower than northern WCVI

• EE at inshore stations along Line P highest in June, but highest in August at offshore stations