What do we know about benthic invertebrates?

Review of Prior Work
Razor Clam Management
Razor Clam Life History
How near shore disposal might affect razor clams?
Key Points from previous studies

1) This benthic community is characterized by species who have adapted to a high energy environment, including waves, sediment movement, storms, freshwater, strong tides.
2) Distribution of benthic species is inherently patchy and variable.
3) The members of this community are highly motile rapid burrowers, quick tube builders or rapid colonizers.
4) Some effect to the community is expected following disposal, but this will not necessarily have a long term negative impact. The time frame of recovery is variable depending on project specific details such as thickness of material disposed, timing, etc.
5) More information is needed about similarities between dredge material to be disposed and the natural sediments in the disposal area.
Dominant Benthic Invertebrates from Inshore Stations 1974-1996

Nemertea
Nemertea sp

Polychaeta
Capitellidae sp
Chaetozoana setosa
Chaetozoana spinosa
Eteone sp
Magelona sacculata
Nephtys californiensis
Prionospio lighti
Owenia fusiformis
Spio filicornis
Spiochaetopterus costarum
Spiophanes bombyx

Mollusca
Olivella biplicata - snail
Olivella pycna - snail
Siliqua patula - razor clam
Siliqua spp.
Spiromoellaria quadrae - snail

Crustacea
Anisogammarus confervicolus - amphipod
Archeomysis grebnitzkii - amphipod
Diastylopis dawsoni – cumacean
Diastylopis spp. - cumacean
Diastylopis tenuis - cumacean
Eohaustorius sencillus - amphipod
Hippomedon denticulatus - amphipod
Hippomedon sp. - amphipod
Mandibulophoxus uncirostratus- amphipod
Mytilidae - mussels
Monocolides spinipes - amphipod
Paraphoxus milleri - amphipod
Paraphoxus obtusidens - amphipod
Paraphoxus obtusidens major - amphipod
Photis macinerneyi - amphipod
Rhepoxynius vigitegus - amphipod

Echinodermata
Dendraster excentricus – sand dollar

Razor Clam Management in Washington State
The management objectives for the razor clam fishery are:

- Manage the razor clam resource on all coastal beaches for recreational use with a minor separate commercial fishery located only on detached spits of Willapa Bay.
- Manage the resource to maintain stable and healthy populations.
- Maximize recreational opportunity.
- Independently manage the razor clam populations on Kalaloch, Mocrocks, Copalis, Twin Harbors and Long Beach while considering the pertinent interactions of seasons, effort, opportunity and tribal allocations.
- Provide for consistent commercial fishing opportunity that does not conflict with the recreational fishery.
Razor clams are part coastal history and culture.
Many people depend on the social value of the fishery...
Clam seasons are very important to the many businesses depend on the income generated by thousands of visitors.
Washington Recreational Razor Clam
Average Effort By Month
1997 through 2009
2008-2009 Fishery Review

3.2 million clams

$12.2 million to local economies.

249,000 digger trips

Average of 12.9 clams per digger trip
Reaching Our Goal
WDFW Annual Management Cycle:

• May through September – complete coast wide stock assessment / develop TAC by beach.

• August – Negotiate Fishery Management Plans for U&A beaches with tribal governments.

• September - Hold a series of 5 public meetings.

• Early October - Make season decision / announce season.

• October through April – Monitor harvest / manage to TAC / collect needed bio-toxin samples.
Annual Coast-wide Stock Assessment
Starting in May and ending in September, WDFW and tribal co-managers survey a total of 58 miles of Razor Clam habitat from the sound end of the Long Beach Peninsula (Beard’s Hollow) to the north end of Kalaloch.
Each **TRANSECT** runs from top of clam beds to the edge of the surf, approximately 600 feet (depending on the location).

**UPLAND DRIVING AREA**

Six SAMPLE PLOTS are pumped at each elevation. 
• = Plot

**ELEVATIONS** are randomly chosen to run north or south of the transect at 50 foot intervals.
Water is pumped up the beach and used to liquefy the sand within a \( \frac{1}{2} \) square meter aluminum ring.
Each ring is pumped for 3 minutes. This allows time for all the clams living in this $\frac{1}{2}$ square meter area to float to the surface.
Each clam is recorded, measured and returned to the beach.
Development of Total Allowable Catch (TAC) by beach.
## Long Beach Razor Clam Population and Harvest Data

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RECRUITS</th>
<th>PRE-RECRUITS</th>
<th>TAC (clams)</th>
<th>HARVEST</th>
<th>% of TAC harvested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Harvest rate @ 25.4% of recruits</td>
<td>TOTAL (clams)</td>
<td></td>
</tr>
<tr>
<td>1997-98</td>
<td>2,119,325</td>
<td>3,831,718</td>
<td>538,309</td>
<td>495,615</td>
<td>92.1%</td>
</tr>
<tr>
<td>1998-99</td>
<td>2,422,618</td>
<td>2,645,228</td>
<td>615,345</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>1999-00</td>
<td>4,090,683</td>
<td>5,582,944</td>
<td>1,039,033</td>
<td>1,194,779</td>
<td>115.0%</td>
</tr>
<tr>
<td>2000-01</td>
<td>4,472,665</td>
<td>961,200</td>
<td>1,136,057</td>
<td>1,098,115</td>
<td>96.7%</td>
</tr>
<tr>
<td>2001-02</td>
<td>7,959,677</td>
<td>16,525,001</td>
<td>2,021,758</td>
<td>1,865,729</td>
<td>92.3%</td>
</tr>
<tr>
<td>2002-03</td>
<td>11,729,090</td>
<td>39,094,638</td>
<td>2,979,189</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>2003-04</td>
<td>4,424,363</td>
<td>21,160,972</td>
<td>1,327,309</td>
<td>1,290,978</td>
<td>97.3%</td>
</tr>
<tr>
<td>2004-05</td>
<td>6,265,021</td>
<td>24,964,188</td>
<td>1,879,506</td>
<td>1,696,283</td>
<td>90.3%</td>
</tr>
<tr>
<td>2005-06</td>
<td>4,464,062</td>
<td>18,349,025</td>
<td>1,339,219</td>
<td>1,378,575</td>
<td>102.9%</td>
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<tr>
<td>2006-07</td>
<td>6,093,834</td>
<td>4,380,820</td>
<td>1,828,150</td>
<td>1,751,151</td>
<td>95.8%</td>
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<tr>
<td>2007-08</td>
<td>4,151,123</td>
<td>444,971</td>
<td>1,245,337</td>
<td>1,227,519</td>
<td>98.6%</td>
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<tr>
<td>2008-09</td>
<td>3,509,940</td>
<td>5,894,291</td>
<td>1,052,982</td>
<td></td>
<td>0.0%</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>5,141,867</td>
<td>11,986,250</td>
<td></td>
<td>1,333,194</td>
<td></td>
</tr>
</tbody>
</table>
## COPALIS RAZOR CLAM POPULATION AND HARVEST DATA

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RECRUITS</th>
<th>PRE-RECRUITS</th>
<th>TAC (clams) Harvest Rate @ 25.4% of recruits</th>
<th>State's Share (50% w/ adjustments)</th>
<th>State's HARVEST (clams) TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-98</td>
<td>1,180,874</td>
<td>3,768,905</td>
<td>299,942</td>
<td>149,971</td>
<td>146,886</td>
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<td>1998-99</td>
<td>3,013,553</td>
<td>1,777,219</td>
<td>765,442</td>
<td>382,721</td>
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<tr>
<td>1999-00</td>
<td>2,954,952</td>
<td>2,034,445</td>
<td>750,558</td>
<td>375,279</td>
<td>365,191</td>
</tr>
<tr>
<td>2000-01</td>
<td>3,236,440</td>
<td>9,540,718</td>
<td>822,056</td>
<td>411,028</td>
<td>381,369</td>
</tr>
<tr>
<td>2001-02</td>
<td>8,122,270</td>
<td>17,488,883</td>
<td>2,063,057</td>
<td>1,364,528</td>
<td>1,270,953</td>
</tr>
<tr>
<td>2002-03</td>
<td>7,090,319</td>
<td>3,282,696</td>
<td>1,800,941</td>
<td>900,471</td>
<td>0</td>
</tr>
<tr>
<td>2003-04</td>
<td>2,841,229</td>
<td>11,727,251</td>
<td>852,369</td>
<td>426,184</td>
<td>462,520</td>
</tr>
<tr>
<td>2004-05</td>
<td>7,105,212</td>
<td>8,852,948</td>
<td>2,131,564</td>
<td>1,245,782</td>
<td>1,239,173</td>
</tr>
<tr>
<td>2005-06</td>
<td>4,953,508</td>
<td>4,799,194</td>
<td>1,486,052</td>
<td>743,026</td>
<td>817,228</td>
</tr>
<tr>
<td>2006-07</td>
<td>2,838,707</td>
<td>3,146,425</td>
<td>851,612</td>
<td>425,806</td>
<td>466,620</td>
</tr>
<tr>
<td>2007-08</td>
<td>4,751,308</td>
<td>6,567,921</td>
<td>1,425,392</td>
<td>712,696</td>
<td>636,376</td>
</tr>
<tr>
<td>2008-09</td>
<td>6,453,563</td>
<td>9,953,166</td>
<td>1,936,069</td>
<td>968,034</td>
<td></td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>4,371,670</strong></td>
<td><strong>6,635,146</strong></td>
<td></td>
<td></td>
<td>642,924</td>
</tr>
</tbody>
</table>
How many days can we dig?

1. Stock assessment (total clams / average size)

2. TAC (total allowable catch) =
   total clams 3 inches or greater $\times$ 30.0%

3. Number of days = TAC / expected daily harvest
NEWS RELEASE

Public meetings scheduled on razor clam season

OLYMPIA – The Washington Department of Fish and Wildlife (WDFW) will seek recommendations on the fall razor clam season at a series of five public meetings in western Washington this month…

• Long Beach
• Westport
• Ocean Shores
• Forks
• Tacoma
During daylight tides (at the peak of the effort) the number of diggers are counted and...

...diggers are surveyed to determine the number of clams per digger...
To determine effort, during night tides...

...lanterns are counted and diggers are additionally surveyed to determine the number of diggers per lantern...
Razor Clam Life History

- Most razor clams spawn in the late spring, however spawning can and often does occur at other times during the year.
- Individual razor clams are either male or female, with the sex ratio about 1:1.
- Eggs and sperm are broadcast into the water column where fertilization occurs.
- The larval period (trochophore to veliger to umbo stages) lasts 6 to 8 weeks.
- As metamorphosis ends, the shell forms and a distinct foot is evident and the clams begin to settle to the bottom.
- At about 10 weeks the clams have reached about 5 mm and can begin to hold themselves moved about by currents and shifting sand.
- As razor clams grow and mature - they remain in one place.
- Young clams grow rapidly – reaching 4 inches in shell length in between 15-18 months.
- Most razor clams spawn for the first time by the time they reach 4 inches.
- The largest razor clam on record in Washington is 178 mm (7 inches).
- Maximum natural life span for Washington razor clams is between 5 to 6 years.
After metamorphosis, young clams settle to the bottom and dig into the sand. Depending on ocean currents, the clams will settle in deep water or shallow.
Long Beach Razor Clam Recruits
Distribution Averaged Across Elevations
2000-2008

$R^2 = 0.5602$
Long Beach Razor Clam Population
Recruit / Pre-recruit Distribution - 2008

south to north → Transect

clams per square meter
Profile 20

~55 m onshore bar migration

Profile 11

~175 m onshore bar migration
Beach Profile Change (1997-2005)
Razor Clam Population Density

Shoreline Change Rates
WDFW's goal is to provide maximum harvest opportunities that are safe and enjoyable experiences, while still maintaining healthy populations.