Drill, baby, drill: Invasive oyster drills are the main driver of native oyster mortality at a restoration site

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Invasive oyster drills are the main driver of native oyster mortality at a restoration site

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&

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National Marine Fisheries Service
NOAA
A New Landscape for Oyster Recovery

Photos: PSRF & Shelly Solomon

H. sapiens  S. alterniflora  C. gigas  O. inornata
Japanese Oyster Drills - *Mollusca Non Grata*

- No planktonic dispersal
- Associated with historic oyster culture sites
- Taylor Shellfish: $500k per year on control
- Consume up to 1/3 of outplanted Olys (Buhle et al. 2009)
A predator of my predator is my friend

Native Cancrids

?

Ocenebra inornata

Ostrea lurida
A predator of my predator is my friend...?

...or just another predator.

Ocenebra inornata

Ostrea lurida

Native Cancrids

Grason et al. 2012
Restoration at Liberty Bay

Photo: Brian Allen
Field Manipulation of Predators

Drills Enclosed

Drills Excluded

Ostrea lurida
Field Manipulation of Predators

Drills Enclosed

Drills Excluded

Crabs Excluded

Crabs Allowed

n = 5
April – Aug 2011
Field Manipulation of Predators

- Drills Enclosed
  - Crabs Excluded
  - Drills Excluded

- Crabs Allowed

- No Cage Control
  - n = 5
  - April – Aug 2011
Field Manipulation of Predators
Field Manipulation of Predators
GLMMs of Predator Effects

- Crabs Allowed
- Number of Drills
- Month
- Cage (Random)

Generalized Linear Mixed-effects Model

Model Averaging & Variable Weighting

Information Theory (AICc)
Which parameters appear in the best models?

Variable Weight: 0 - 1

- Oyster Survival
- Drilling Rate: How many oysters were killed by drills per day?
Oyster survival varies by season

Variable Weight
Month: 1.0
Drills Reduce Oyster Survival

Variable Weight

Month: 1.0
Drills: 1.0

Month X Drills: 0.05
Crabs Increase Oyster Survival

Variable Weight

Month: 1.0
Drills: 1.0
Crabs: 0.89

Crab X Month: 0.11
Month X Drills: 0.05
Predators interact additively

Variable Weight

Month: 1.0
Drills: 1.0
Crabs: 0.89
Crab X Drills: 0.19
Crab X Month: 0.11
Month X Drills: 0.05
Ambient predator effects vary
Drilling rates vary seasonally

Variable Weight

Month: 1.0
Drill Num.: 1.0
Crabs: 0.33
Crab X Drills: 0.09
Crab X Month: 0.04
Month X Drills: 0.09
Crabs only reduced drills in August

*only treatments where drills were included in cages
Drill feeding rates mirror mortality

# drills = Average of Initial and final number

Per capita drilling rate (no. oysters drill⁻¹d⁻¹)

<table>
<thead>
<tr>
<th>Month</th>
<th>Crabs Allowed</th>
<th>Crabs Excluded</th>
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<tbody>
<tr>
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<td>August</td>
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# drills = Average of Initial and final number
Drills are major drivers of oyster success
Crabs are not bad news for oysters
Recommendations

- **Avoid** drills at restoration sites
- Research density/size refuge for oysters
Many, many thanks are due to...

Puget Sound Restoration Fund

Brian Allen & Besty Peabody

<3 Shore Access and Hospitality <3
Gitch and Yungkeit Families

Oyster Master
Joth Davis

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- Jennifer Ruesink
- Greg and Molly Jackson
- Avanthi Jayasuria
- Nima Yazdani
- Marie Clifford
- Matt Flora-Tostado

Thirsty for more?
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