European Green Crab: Species Overview:

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Young European Green Crab
*Carcinus maeans*

physiologically tolerant ecological generalist
- temperature
- salinity
- desiccation
- starvation
Overview of the Green crab

- **Biology**
  - Life cycle
  - Habitat
  - Diet
  - Natural enemies

- **Distribution/Invasion History**

- **Impacts**

- **Status in the Pacific NW**
4 zoea stages

46 mm female → 185,000 eggs

megalopa
Comparison of life history features of *C. maenas*

<table>
<thead>
<tr>
<th></th>
<th># months above 10 deg. C</th>
<th>CW by first winter (mm)</th>
<th>Age at maturity (years)</th>
<th>Estimated Life span (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>5</td>
<td>3-10</td>
<td>2-3</td>
<td>5-6</td>
</tr>
<tr>
<td>S. North Sea</td>
<td>7</td>
<td>16-30</td>
<td>1-2</td>
<td>3-4</td>
</tr>
<tr>
<td>Oregon</td>
<td>8-12</td>
<td>30-60</td>
<td>&lt;1</td>
<td>5-6</td>
</tr>
</tbody>
</table>
Molt Increments are similar

Maine

Belgium

Portugal
Logical inference of molt increment regression equation analysis

- Crabs are growing faster in Oregon than in Maine, the North Sea and Portugal.
- Increase in size per molt is constant regardless of geographic location (*not* food limited)
- Inference: green crabs in Oregon molt more frequently.
Possible reasons for more frequent molting

• Longer growing season

• Ecological Release
  – Competition is low
  – Predation is low
  – Few or no parasites
Habitat –

- **Europe and East Coast of North America** – *diverse habitats*
  - semi-protected rocky shores - estuaries - mudflats - marshes
  - shallow water – subtidal

- **West coast of North America** – *more marginal habitats*
  - low energy soft sediment mudflats and marshes
  - lower salinity and
    - higher temperature
  - refuges from larger crabs
  - shellfish growing areas
  - nurseries for fishes and Dungeness
  - foraging habitat for shore birds
Diet - opportunistic omnivore

158 genera from 19 phyla

- mollusks (clams, mussels, oysters, snails)
- arthropods (barnacles, ostracods, amphipods, crabs)
- marine worms (nematodes, flatworms, annelids)
- urchins, tunicates
- algae, marsh vegetation
- carrion
- bacteria and foraminifera in sediment
- plankton - larval stages
Natural Enemies - Predators

- **filter feeders** trap larvae
- **fishes** – perch, flounder, goby, striped bass
- **crabs** – rock crabs, blue crab, lobster,
- **birds** – gulls, scoters
- **mammals** – seal, raccoons, mink, fox
Natural Enemies – Parasites

• *Sacculina caricini* –
• *Portunion maenadis* –
• *Carinonemertes* – egg predator
• *Nicothoid* – egg predator
• *Microorganisms* – protozoans, bacteria, viruses
What limits the distribution of the European green crab?

- **Latitudinal**
  - Temperature

- **Local**
  - Salinity
  - Biotic Resistance
  - Recruitment - unfavorable currents
Carcinus maenas
Native range and global introductions
Lower Temperature Limit

- $< 10 \, ^\circ C$ crabs stop molting*
- $< 8 \, ^\circ C$ crabs stop feeding
- $-9 \, ^\circ C$ ice crystals form in blood
Upper Temperature Limit

- 18 °C minimum needed for brooding*
- 26 °C maximum for long term adult survival
Geographic Distribution

- **Mauritania (20° N latitude)**
  - 18° C in February*
  - 25° C in August

- **Iceland (64° N latitude)**
  - 5° C in February
  - just above 10° C in August*
$10^\circ$ C and $18^\circ$ C isotherms
Temperature is correlated with Range Expansion and Contraction on the East Coast

- Arrived on prior to 1817
- **Range expansions** during a series of years with mild winters: around 1930, 1950, 1970 and at present
- **Range contractions** after severe cold winters 2-3 months < 3° C.
Salinity Tolerance (*no temperature stress*)

- 4 - 54 ‰  adult short-term survival
- 15 - 34 ‰  low metabolic costs
- < 15 ‰  metabolic costs increase
- 11 ‰  adult long term survival *
- 16 ‰  larval development *
Range Expansions and Contractions

Baltic Sea - ranges and abundances follow salinity fluctuations
Biotic Resistance – mainland Australian

- Green crabs have been present in SE Australia prior to 1900 but have not become a pest.
- Many native predators, including heavily armored and aggressive crab species, skates and rays as well as parasites.
Biotic Resistance-

**East Coast NA** – blue crab, rock crab, *H. sanguineus*

**West Coast NA** – red and brown rock crabs
Site Comparison: Box Trap (#/trap/day)

Trap Sites (>5,000 trap hours)

- Port of Toledo
- Riverbend
- Roberts' Dock
- OCA
- South Beach Marina

Species Comparison:
- **Carcinus maenas**
- **Cancer productus**
Predation of *Cancer productus* on *Carcinus maenas*

Percent Predation (%)

Carapace width of *Cancer productus* (mm)

- **small Carcinus**
- **medium Carcinus**
Biotic Resistance – NW estuaries

- The red rock crab can keep the green crab out of the lower estuary.

- The green crab will thrive in the mid-estuary where temperatures are too high and salinities too low for the red rock crab.
Currents and Recruitment

South Africa – introduced prior to 1983

-range is stable 1990-2002 Hout Bay – Cape Town Harbor
Currents and Recruitment

Tasmania

1. Discovered in 1993 in Georges Bay

2. Spread by
   • favorable currents for larval transport and
   • shellfish transplants
What limits Green Crabs?

- Temperatures below 10° C
- Temperatures above 18° C
- Salinities below 16° C
  
  *no larval survival, high metabolic cost*
- Biotic Resistance *predators/competitors*
- Recruitment *off-shore currents*
Impacts

- Prevent establishment of cockles, mussels, clams and beds – thus favoring algae, polychaetes, tube building amphipods

- Blamed for decline of soft-shelled clam industry on East Coast
  
  14 million lbs in 1938 → 2.3 million lbs in 1959

- Select for predator resistance morphology and behavior in prey

- Disrupt eelgrass restoration plots
Impact - West Coast of North America

- *Nutricula sp.*
- *Venerupis philippinarum*
- *Hemigrapsus oregonensis*
- *Cancer magister*
- *Ostrea conchaphila* (native oyster) 40/day
## Commercial species west coast of North America

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<tr>
<th></th>
<th>Metric tons</th>
<th>Value Million $</th>
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<tbody>
<tr>
<td>Pacific oyster (NIS)</td>
<td>8,400</td>
<td>25</td>
</tr>
<tr>
<td>Manila clam (NIS)</td>
<td>3,500</td>
<td>15</td>
</tr>
<tr>
<td>Native Littleneck</td>
<td>164</td>
<td>0.3</td>
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<tr>
<td>Butter clam</td>
<td>1,280</td>
<td>0.1</td>
</tr>
<tr>
<td>Geoduck</td>
<td>4,000</td>
<td>35</td>
</tr>
<tr>
<td>Dungeness crab</td>
<td>25,000</td>
<td>133</td>
</tr>
<tr>
<td>English sole</td>
<td>2,100</td>
<td>1.5</td>
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