Crab Signatures: Differentiating crab species-specific repair scars on mollusc prey for reconstructing crab abundance through time

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Background

Crustacean fisheries are increasing in economic importance globally with crabs being BC's most valuable fishery in 2021.[1,2] Crabs are also a significant Food, Social, and Ceremonial (FSC) resource for many indigenous communities in BC.[3,4] Limited long-term crab population data make it difficult to assess the impacts of increased commercial fishing and climate change on the sustainability of these important species.

Scars crabs leave on their prey ("repair scars") are common tools to assess predation patterns in modern and fossil systems. Repair scars have been shown to track crab abundance across environmental gradients and provide a robust signal of crab abundance from tens to hundreds of thousands of years.[5-9] However, it is unknown if repair scars can be used to identify species-specific crab abundances that would allow for improved fishery management.

Research Question

Do individual crab species make uniquely shaped repair scars?

Study Species

Predators

Red rock crab (*Cancer productus*)

Dungeness crab (*Metacarcinus magister*)

European green crab (EGC) (*Carcinus maenas*)

Figure 1. Three of the most socioeconomically important crab species in British Columbia.

Prey

Black turban snail (*Tegula funebralis*)

Figure 2. This snail is found in the range of all three crab species and is a common crab prey item that has been well studied in terms of its repair scars and relationship with crabs.

Hypothesis

Repair scar shape will vary significantly among crab species (Dungeness, Red rock, European green crab)

Predictions

Red rock: Scars will be deeper and wider than those made by other species since have larger, stronger claws

Dungeness: Scars will be narrower and shallower than those made by red rocks as they have more gracile, longer, narrower claws

European green: scars will be smaller than those made by other species since they have smaller claws

Materials and Methods

Experimental Trials

Manipulated feeding experiments to produce repair scar damage on *T. funebralis*

- One crab in experimental tank with 6 snails matched to crab size
- Sample sizes obtained from trials:
  - Red rock: n = 16
  - Dungeness: n = 9
  - European green: n = 21

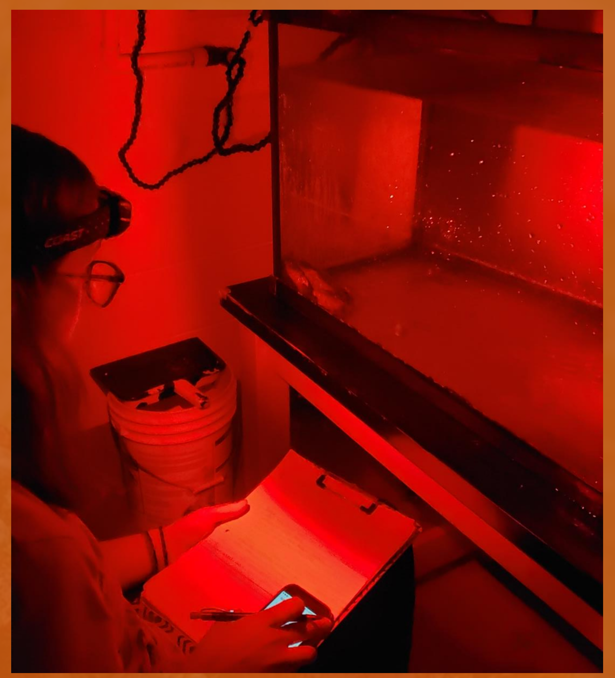

Figure 3. Blue dots represent the landmarks that were placed on images of *T. funebralis* with damage caused by the crabs during the experiments.

Morphometric analysis

1. Landmarks placed on scars on images using tpsDig software.[10]
2. Landmarks were used to compute differences in scar shape (relative warp analysis) among crab species.[11]
3. Repair scar shape was compared between species using GLM of relative warp scores of landmarks for each scar.

Results

Visual Differences

Red rock damage: triangular and deep

Dungeness damage: shallower and damage spread along edge of shell

European green damage: wider, shallower, and more rectangular

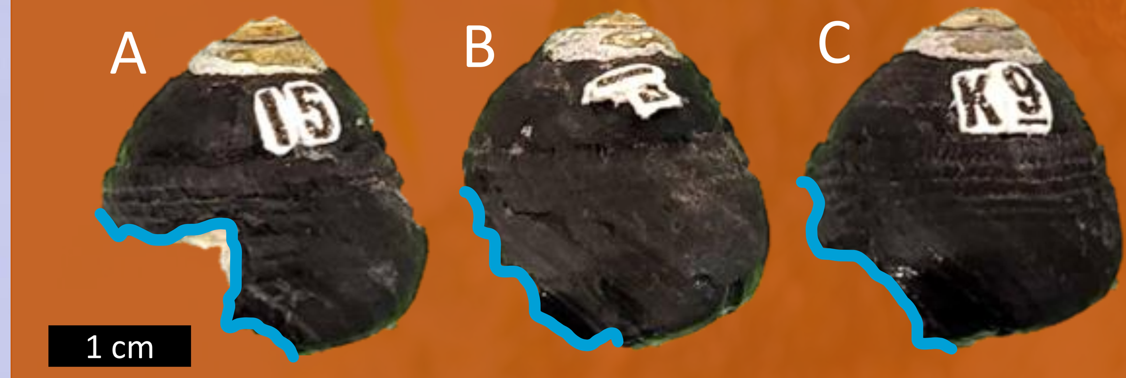

Figure 4. Typical shell damage created by the various species: A) red rock, B) Dungeness, C) European green. Claw damage is outlined in blue.

Quantitative Results

Preliminary GLM models indicate the shape of damage made by red rock crabs are statistically different from the other two crab species and create the deepest damage (p>0.001). Scar change was primarily characterized by a change in depth of the scar, which accounted for 58.34% of the overall shape change (Axis 1, relative warp scores).

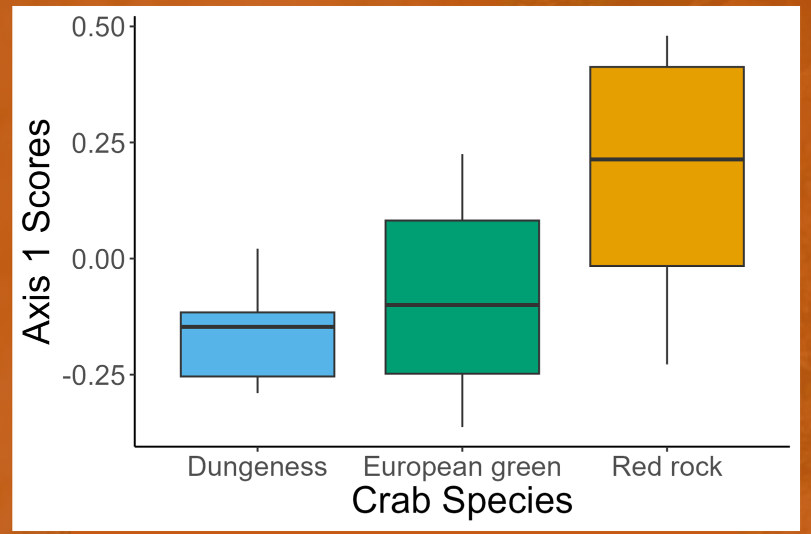

Figure 5. Boxplot of axis 1 scores from relative warp analysis. Axis 1 represents 58.34% of the overall shape change, indicated primarily by the depth of the damage.

Discussion

Repair scar shape is related to crab claw size and strength, with the strongest claws making the deepest marks (i.e., red rock crabs). These results indicate that it is possible to distinguish repair scars among species, even in the field, meaning repair scars could track crab species abundance separately through space and time.

- Repair scars could be used to track Dungeness and red rock crab abundances separately through time, which could be used for their management (e.g., are there different outcomes for commercial vs. recreational crab fisheries?).
- Since EGC damage is distinct from at least red rock crabs, surveys for EGC repair scars could provide a cost-effective method to identify areas of invasion.

Future Research

1. Apply species-level repair scar surveys to see if Dungeness and red rock crab abundances have changed/responded differently through time
2. Use surveys of repair scars as a cost-effective early detection method for European green crab invasions and monitoring efforts

References

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