Short-term Effects of Extreme Upwelling on Juvenile Gopher Rockfish (Sebastes carnatus)

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SHORT-TERM EFFECTS OF EXTREME UPWELLING ON VENTILATION RATES IN JUVENILE GOPHER ROCKFISH

Lauren Kashiwabara, Jacoby Baker, Melissa Palmisciano, Neosha S Kashef, David Stafford, Dr. Susan Sogard, Dr. Scott L. Hamilton, and Dr. Cheryl Logan
Upwelling

Surface winds push surface water away from an area. Warmer surface water moves offshore.

Deeper, colder, nutrient rich water rises up from beneath the surface to replace the water that was pushed away.

Phytoplankton and zooplankton are shown in the diagram.
Upwelling

- Cold-nutrient, rich water
- Low dissolved oxygen
- Low pH
Upwelling and Climate Change

Climate change is causing:
- More intense upwelling predicted by the end of the century
- Lower dissolved oxygen
- Lower pH (more acidic)
Juvenile Gopher Rockfish

**Rockfish** over 60 species along the west coast of the US; Ecologically/economically important; Slow growing and reproducing

**Gopher** 1-2 month pelagic larval stage; recruits to kelp canopy April-May

**Juveniles** fish that are approximately four to six months old
Why ventilation?

**Effects of low DO**
- Need to get more oxygen across gills and into blood
- Less oxygen means lowered ability to bind oxygen to hemoglobin
- Essential in brain function

**Effects of low pH**
- Many body functions are pH sensitive
- Fish use gills for ion regulation and acid-base balance regulation
Hypothesis

Question: How will juvenile gopher rockfish ventilation rates respond to a short-term upwelling cycle?

$H_1$: Juvenile gopher rockfish will increase ventilation rates when exposed to an upwelling event

$H_2$: Juvenile gopher rockfish will decrease ventilation rates when returned to ambient conditions after an upwelling exposure
Sample Collection
Sample Collection
Treatments

Control Group
n=10
• 8.0 pH
• 8.0 mg O₂ / L

Upwelling Group
n=10
• 7.3 pH
• 2.0 mg O₂ / L
Experimental Design

Upwelling Level:
7.3 pH
2.0 mg O₂ / L

Control Level:
8.0 pH
8.0 mg O₂ / L

Experimental Design

Days

Upwelling Phase

Relaxation Phase
Fish Hammocks and Go Pros

SJSU IACUC protocol # 1007
Experimental Design

Control Level:
8.0 pH
8.0 mg O₂ / L

Upwelling Level:
7.3 pH
2.0 mg O₂ / L

Days

Upwelling Phase

Relaxation Phase

Upwelling

0 1 2 3 4 5 6 7 8 9 10

Days
More videos
Results: How did the numbers stack up?

Beats per Minute by Treatment

Treatment
- Control
- Upwelling

Day 05
Day 10

Upwelling
- Ambient Level: 8.0 pH, 8.0 mg O₂/L
- Upwelling Level: 7.3 pH, 2.0 mg O₂/L

Relaxation Phase

Days 5 to 10
Recovery Phase

Box plot showing beats per minute for Control and Upwelling treatments at Day 05 and Day 10.
Results: How did the numbers stack up?

Beats per Minute by Treatment

Treatment
- Control
- Upwelling

Timepoint
- Day 05
- Day 10

Days
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Ambient Level:
- 8.0 pH
- 6.0 mg O₂ / L

Upwelling Level:
- 7.3 pH
- 2.0 mg O₂ / L

Relaxation Phase

0 1 2 3 4 5 6 7 8 9 10
Discussion: Could they recover?

Ventilation rates ~50% higher

- Reduced energy available for growth and locomotion, susceptible to predation (energy budget)
- Must compensate for upwelling conditions
Discussion: Could they recover?

Ventilation rates ~50% higher
- Reduced energy available for growth and locomotion, susceptible to predation (energy budget)
- Must compensate for upwelling conditions

Ventilation rates return to normal
- Fish appear to recover after extreme upwelling when returned to ambient levels
Future (Current!) Work

• Quantify metabolic cost of increased ventilation
• Look at effects on the molecular level
• Identify protein activity
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• Everyone for listening
Questions?