# Uranium in oysters: an inexpensive and accessible method of measuring ocean corrosivity?

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## Introduction

Shellfish represent a **$270 million industry** in the Pacific Northwest[1]. In addition to their economic significance, oysters provide a variety of ecosystem services including:

- Providing substrate and habitat for other organisms
- Increasing biodiversity
- Improving water quality

Rising atmospheric carbon dioxide ($CO_2$) levels have resulted in acidification of the Earth's oceans. As $CO_2$ levels rise, great concern exists over the impact ocean acidification (OA) will have on marine ecosystems.

Measuring OA in situ often involves the need for expensive instrumentation. Thus, measurements of OA are limited to areas that are easily accessible and where communities or organizations have the capital to support the placement of these instruments. **This work seeks to provide a new method of measuring OA that is cost effective and accessible to a multitude of communities through the use of oysters (*Crassostrea gigas*) as bio-monitors.**


## Summary & Applications

Once proxy has been calibrated, oysters can be used as a biomoniter. Oyster samples can be sent to OSU for analysis, U/Ca can be measured, and using calibration equation developed, we can determine the corrosivity of the water the oysters have experienced

References

[1] USDA 2013 Census of Aquaculture
[2] Levin, L. et al (2015). *Oceanography*

## Acknowledgements

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## Background

### Ocean Acidification

$CO_2$

$CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$

$\downarrow$

$H^+ + CO_3^{2-} \rightarrow HCO_3^-$

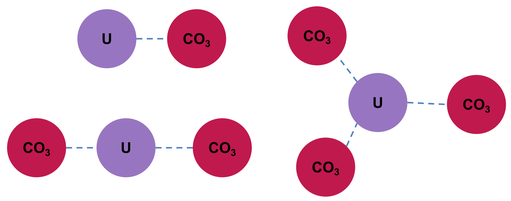
$CO_3^{2-}$ $CO_3^{2-}$

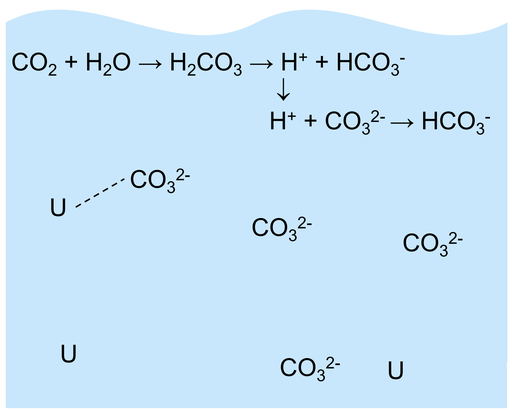
Atmospheric $CO_2$ ↑
leads to ↑ $CO_2$ in seawater
drives concentration $CO_3$ ↓

### Uranium in Seawater[2]

Natural levels in water column: ~3.3 ppb (µg/kg seawater)

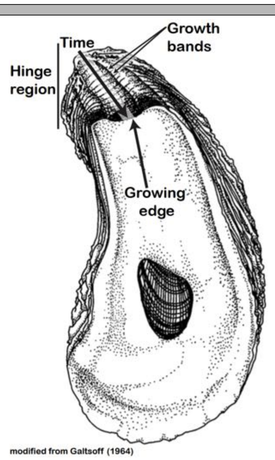
Most common forms of U in seawater bonded to carbonate ions. When concentration $CO_3$ ↓, U speciation shifts to binding to fewer $CO_3$ ions




### Shell Growth

- Oyster shells are composed of $CaCO_3$
- Because oysters filter the water around them, they continuously sample their environment.
- When U is bonded to $CO_3$, it may be incorporated into oyster shells during shell formation.
- The concentration of U incorporated into the shells depends upon the concentration of $CO_3$ in the water column.
- We measure U/Ca ratio to relate the U to calcification of the shell




Spat on shell, Age: 2 weeks

Adult Oyster, Age: 2 yr

Adult Oyster, Age: 2 yr

## Method Development & Results

### Project Goals

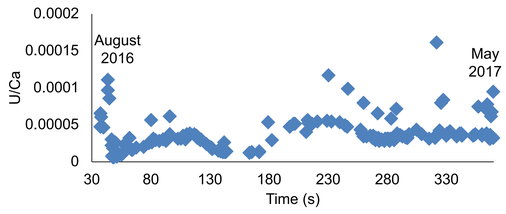
1. Develop method of marking time in oysters
2. Determine the U/Ca ratio in oysters using LA-ICP-MS
3. Calibrate proxy using in situ measurements of $CO_3$

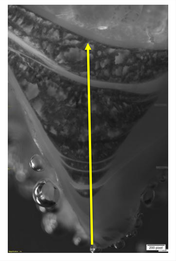
### Marking Time

Staining with fluorescent calcein marker

| Stain Date | Days between staining | Growth (µm) | Growth rate (µm/day) |
|---|---|---|---|
| Aug 19, 2016 | --- | --- | --- |
| Oct 17, 2016 | 59 | 461 | 7.7 |
| Nov 14, 2016 | 28 | 586 | 21 |
| Dec 14, 2016 | 30 | 293 | 9.8 |
| Mar 31, 2017 | 107 | 154 | 1.4 |
| May 11, 2017 | 41 | 1314 | 32 |
| May 27, 2017 | 16 | 754 | 47 |


### Measuring U & Ca Content via LA-ICP-MS



### In situ $CO_3$ Measurements

Whiskey Creek Shellfish Hatchery equipped with sensor capable of calculating seawater carbonate chemistry conditions in 2-minute increments

### Proxy Calibration

Using growth data, analyze U/Ca vs. time compare with sensor data, plot U/Ca vs. CO3