**Methods and Challenges in Ocean Acidification Monitoring in Puget Sound**

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**WHAT ARE SOME CHALLENGES?**

1. Prior to characterizing long-term trends in pH such as due to processes like ocean acidification, it is important to understand the uncertainty of pH measurements and the variability on short time scales, such due to interplay of photosynthesis and respiration.

   Accurately measuring pH is limited by (Breeman, et al., 2014:)
   - Initial calibration approach and quality of validation samples
   - Sensor performance, conditioning and drift
   - Quality of auxiliary measurements (e.g. temperature and salinity)

2. In order to better understand OA dynamics and ecosystem impacts, it is important to measure other carbonate parameters besides pH alone (Newton, et al., 2015). The biological process of shell formation of organisms is related to the aragonite saturation state ($	ext{OAc}^{+}$). Values less than one imply this mineral has a higher potential to dissolve, with some variability on species and habitat distribution.

   E.g., the concentation of human-caused CO2 has been linked to the dissolved ion one species zooplankton (MARTZ, Takeshita, et al. (2014)). In order to derive $\text{OAc}^{+}$, all at least two properties of the carbonate system must be characterized.

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**RESULTS**

**OBJECTIVE 3: CAN THIS LEAD TO IMPROVEMENTS IN pH TIME SERIES AND UNDERSTANDING CARBONATE DYNAMICS?**

Data collected at 15-minute intervals at moorings is helpful for understanding temporal dynamics in the carbonate system, where daily and seasonal swings in pH can far exceed changes in long-term trends. One goal is to use existing data to empirically calculate $\text{OAc}^{+}$ an ecologically-relevant OA indicator.**

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**SUMMARY**

- If possible, best to directly measure at least two properties of the carbonate system to understand ocean acidification.
- In lieu of a 2nd carbonate property, it is possible to empirically derive other OA-indicators, as long as measurement errors are minimal and data are carefully quality controlled and validated with water samples.
- The alternative filtration method may be used, as long as samples are preserved with HgCl$_2$ in a mesoaromic timeframe. Replica samples are recommended for better accuracy.
- Further work is needed prior to using a different preservative such as ZnCl$_2$
- Empirically-derived total alkalinity results support the Fassbender study (2016) but further stress the need for a different calculation at low salinity (~26 PSU)
- More work is needed in order to successfully predict aragonite saturation state in Central Puget Sound, with the goal of using as a gauge of ocean acidification impacts to local species and ecosystems.

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**REFERENCES**

- Martz, Takeshita, Johnson, et al. (2014). Estuarine, Coastal and Shelf Science 140, 45-54.

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