Dec 4 2017 *SOARCE* webinar Q & A

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Q: Can you use other macroalgae to do the same thing? Why kelp?
A: The Washington state experimental kelp team chose sugar kelp (*Saccharina latissima)* for a number of reasons: it's a native species; it's farmed commercially in many parts of the world (including Maine, see the Island Institute's kelp aquaculture education resources); propagation techniques were well established at the NOAA facility we were using; it was compatible with the farm site and infrastructure; and last but not least, it grows fast! If cultivating sugar kelp proves effective as an OA mitigation strategy, I expect other kelp and seaweed species could have a similar effect.

Q: I'm interested in whether there are good examples of kelp restoration citizen science programs to combat OA?
A: I don't know of any citizen-led kelp restoration efforts specifically aimed at combatting OA, but groups such as Washington state's Marine Resources Committees and the Puget Sound Restoration Fund that *are* engaged in kelp monitoring and restoration are aware of the potential benefits of such activities to seawater chemistry. They also recognize that restoration of kelp beds (and other components of near shore habitat) may increase resilience to OA simply by reducing the overall stress on the marine ecosystem.

Q: Experimental kelp aquaculture funded by what organization?
A: Funding for the 2-year project is from the Paul G. Allen Family Foundation; awarded through their 2013 Ocean Challenge.

Q: As someone involved in the experimental deployment of the WA kelp farm, I'd like to know how one starts a kelp farm including regulatory requirements and permitting.
A: I really haven't been involved in this aspect of the project, so I can't give you any specific guidance. I just know that there are a lot of hoops to jump through (even though we had a mariculture permit for the Hood Canal site when we submitted the proposal, it still took years to get the project approved). Farmers growing kelp for human consumption must work with the local Health Department to develop a HACCP Plan. We're working on that right now; the Puget Sound Restoration Fund hopes to have their plan approved by the Washington Dept. of Health for the 2018 spring harvest.

Q: Are there other species of kelp that may be more optimal for phytoremediation farming purposes?
A: Se haven't finished analyzing our Year 1 data yet, so it's too early to say whether the approach even works with sugar kelp, let alone whether other species might be more effective. My hunch is that most fast-growing species have the capacity to remove CO_2 from seawater. Which species is 'optimal' for a given location would depend on other factors, such as life history (e.g. annual vs. perennial), site characteristics (e.g. current strength), and project objectives (e.g. protecting shellfish growing on the bottom vs. suspended from rafts).

Q: I'm wondering how much gaseous C is lost during that decomposition. Also about localized increases in aqueous CO2 during night, the plume of which should have lower pH than the bulk seawater.

A: If the kelp were allowed to fully decompose, virtually all of the carbon stored in the plant tissue would be 'remineralized' back to CO_2. This would definitely be its fate if we didn't harvest it, or simply deposited it at SkyRoot Farm. The trick (and this is why I'm so glad Beth Wheat, with her expertise in regenerative agriculture, is part of our team), is to apply the kelp to the soil using techniques that minimize oxidation and encourages plants to transfer a portion of the carbon to the soil through their roots. It's important to note that carbon sequestration in topsoil is not a long-term sink (in the geologic sense); it's more like temporary storage, on the order of decades to centuries (by which time I hope we will have solved the real problem: our reliance on fossil fuels). Learn more about the 'fast' and 'slow' carbon cycles on these NASA and the U.S. Department of Energy pages.

To address your second point, you're correct that the same kelp captures carbon by day through photosynthesis releases some of it through respiration (i.e. oxidizing organic carbon to generate energy, just like we do) at night. We expect to see this respiration signal in our Year 1 data once it's fully analyzed.

Q: Are there dangers associated with Kelp monocropping/concentrated farming? Would it be more beneficial to have dispersed patches?

A: I think there are negatives to *anything* humans do on an industrial scale. But it's certainly possible to employ more sustainable approaches to food and energy production. I'm sure there would be pros and cons to both concentrated and dispersed kelp aquaculture. I don't think Puget Sound (or any other near shore environment in the lower 48) will ever be wall-to-wall kelp farms—there are just too many existing users (human and otherwise) competing for this space. Moving the farms offshore (>3 miles) would avoid some of these conflicts, but the open ocean is not an easy environment to work in! Whatever the future of kelp aquaculture, I hope it is done in the most environmentally sensitive way possible.

Q: My class would like to know if there has been any associated effect of the Kelp Farm to local sea otter population (they don't know how rare they are in Hood Canal--we haven't covered that!)

A: I'm glad they're thinking about how kelp aquaculture could impact other marine species! Luckily, there aren't any sea otters in Puget Sound, so we didn't have to worry about that for our project. There *are* sea otters on Washington's outer coast however, as well as in Alaska and California, where commercial kelp aquaculture is generating a lot of interest.

Q: How can a recently-graduated seaweed ecologist (Masters degree) get involved with seaweed aquaculture in the "real world"? Really wondering about non-academic avenues to practicing applied marine science!

A: The national Sea Grant Aquaculture program is a great place to start! You could also research who's received state/federal aquaculture funding; quite a few grants have been awarded lately. Here are some links to get you started:

- 2017 Sea Grant awards (also check out their 2018 funding opportunity)

- U.S. Department of Energy ARPA-E recently awarded $22 million for macroalgae aquaculture research (here's a brief overview)
- The DOE also funded algae mariculture workforce development in 2015
- Article about state support for Alaska aquaculture

Q: Is there direction to incorporate Kelp into our Farm Bill?
A: I don't know about the Farm Bill, but the USDA did just announce this new funding opportunity that could be used to help aquaculture producers develop new 'value-added' products.

Q: Where do you get those shirts???
A: The Vancouver B.C. Aquarium gift shop—I couldn't resist!

Q: Have you been able to see any results in your oceanography from the kelp farm in Hood Canal?
A: The oceanographers are still interpreting the Year 1 data—it's very complicated because there's a lot of noise from the natural phytoplankton bloom that was occurring at the same time. So it's too early to say—stay tuned!

Q: What's next after year 2?
A: Good question. This project was conceived as an 'experiment', and doesn't have any long-term funding. But it's my hope that if the results are promising, it may catalyze similar ventures.

Q: As you are showing in one picture about two NOAA buoy. How much difference you got in the water quality between the two buys?
A: I wish I could tell you! The data is still being analyzed, and it's not a straightforward process. For one thing, the direction of the current through the kelp bed changes throughout the daily tidal cycle, but our monitoring buoys were fixed to the seafloor. This means that they weren't always well positioned to record the chemistry of a 'parcel' of seawater as it entered and exited the kelp bed. Also, the monitoring equipment was only able to sample the water chemistry every 30-60 minutes, and we didn't learn until the end of the growing season that the transit time of water through the farm was often faster than that (~15 minutes), which also made it hard to compare 'before' and 'after' measurements. That's part of the reason why the analysis has been so complicated; we have to review a lot of data to find periods when the water is flowing in the right direction at the right speed to provide meaningful information. This experiment was planned as carefully as possible, given what we knew about current patterns at the site when we started, but as with most experiments, a lot of what you learn the first time around is how to do things differently next time! We hope our revised Year 2 monitoring strategy will address some of these issues.

Q: Has anyone tried this with nori?
A: Not to my knowledge (for those who aren't familiar with *nori*, that's the Japanese name for a red algae most familiar to Americans as the edible seaweed wrap used in sushi.

Q: Just a point of information - we are looking at sugar kelp on Long Island for nitrogen bioextraction to deal with our eutrophication problems. Good to know that it may help with OA too!
A: I love that project! Your results look promising. To paraphrase Homer Simpson, *"Kelp… is there anything it can't do?!"*

Q: Have you observed decreased shell decy inside the farmed kelp?
A: By 'decy', you mean 'dissolution' or corrosion of calcium carbonate shells caused by acidification? Part of the Year 1 experimental plan was to compare the shells of Puget Sound pteropods place in fine mesh net pen suspended *in* the kelp bed with others reared outside the kelp bed. We had some problems with the net pens last year, but hope to get some good data this spring! We may include juvenile oysters in the experiment this time around.