

Testing Different Sporing Methods, Water Flow, and Nutrient Conditions on the Growth of *Saccharina latissima* in the Hatchery Phase



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Introduction

- Sugar kelp (*Saccharina latissima*) is a widely cultivated macroalgae species with strong potential for sustainable aquaculture in Atlantic Canada [1]. Climate-driven warming has altered the timing of natural sporulation, reduced wild kelp biomass, and narrowed seeding windows for farmers, increasing reliance on wild kelp populations for spore collection [2;3;4].
- Recent innovations, including artificially induced sporophyte maturation and gametophyte-based seeding, offer promising solutions by enabling year-round spore production and reducing pressure on natural kelp beds [2;3;5].
- Hatchery conditions such as nutrient delivery and water flow are known to strongly influence early kelp growth and productivity [6].
- This study aimed to compare hatchery-stage growth among three sugar kelp seeding methods and evaluate the influence of different nutrient delivery systems on early sporophyte development in terms of length and density.

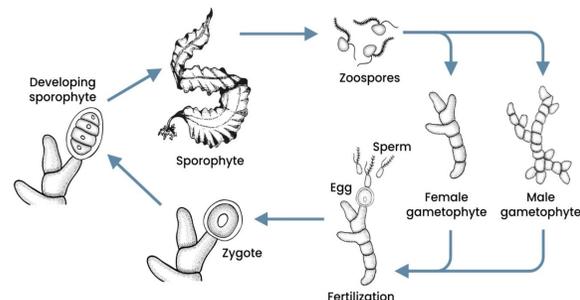


Figure 1. Sugar kelp life cycle [7].

Methods

Forced Maturation Experiment

- Short-day photoperiod conditions trigger sorus development for spore release [4].
- Maturation was induced by exposing 17 immature kelp blades in a tank of 10°C seawater to 8 hours of light and 16 hours of dark
- Photos of 11 select blades were taken twice a week for 40 days to track sorus development (Figure 2).
- Growth of sorus tissue over time was analyzed using ImageJ software.



Figure 2. Example of sorus cover analysis

Hatchery Design

- Nine tanks and 54 spools were used in total. Hatchery tanks were maintained at 10–15 °C under a 12:12 light:dark cycle.
- Growth was assessed 40 days after inoculation by measuring sporophyte density and average sporophyte length on twine samples using microscope imaging and ImageJ analysis.



Figure 3. Spools set up in flowthrough (left) and recirculated water (right) before seeding

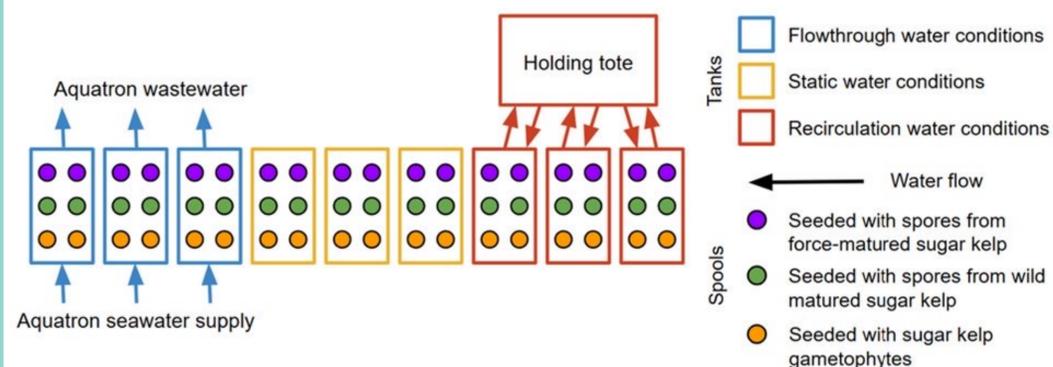


Figure 4. Experimental design for hatchery stage, testing three setups and three seeding methods.

Results

Forced Maturation Experiment

- 17 blades in total produced ~150 grams of sorus tissue in 40 days
- Only used 59 grams to seed 18 spools
- Calculated that we would've had enough at 30 days



Figure 5. Photos showing change in sorus cover with time for 2 different blades.

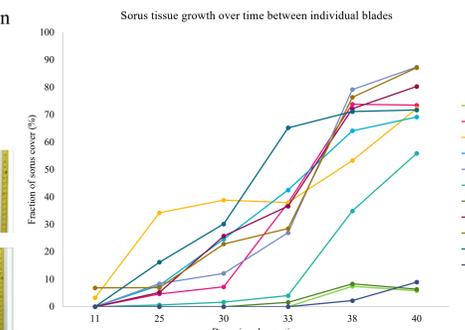


Figure 6. Change in sorus cover over time for different individual blades.

Blade Density Data

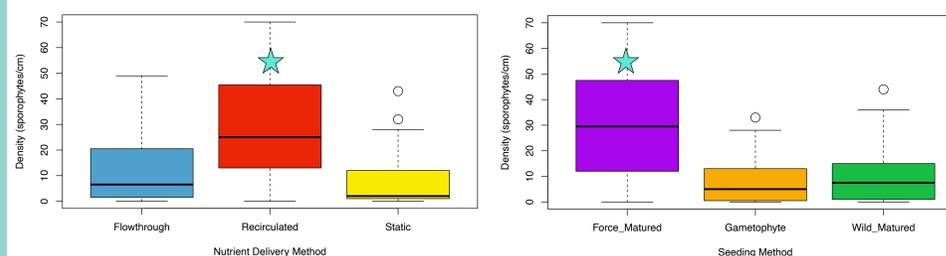


Figure 7. Blade density results between hatchery setups for nutrient delivery (left) and spool seeding method (right). Groups significantly different from the others are marked with a star.

- The ANOVA and pairwise comparison results showed that sporophyte density was significantly higher in the force-matured treatment.
- No significant difference was observed between the gametophyte and wild-matured groups.
- Sporophyte density in recirculated tanks differed significantly.
- Densities in the flow-through and static treatments were not significantly different.

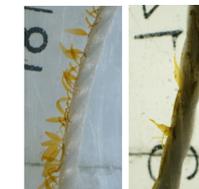


Figure 8. Microscope images of twine samples taken from a high-density sample (left) and a low-density sample (right)

Blade Length Data

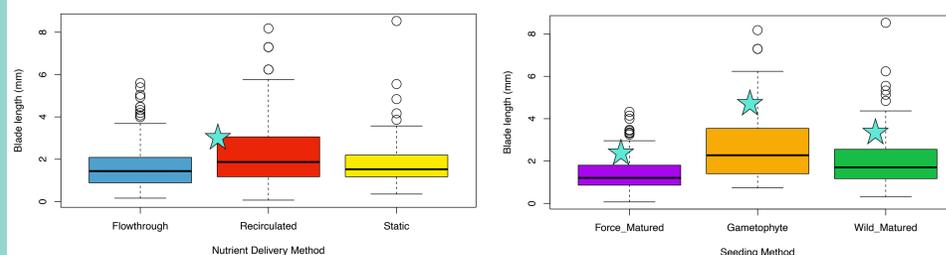


Figure 9. Blade length results between hatchery setups for nutrient delivery (left) and spool seeding method (right). Groups significantly different from the others are marked with a star.

- The ANOVA and pairwise comparisons showed significant differences in average blade length among all three seeding methods
- Difference between gametophyte and wild-matured samples was smaller than that between force-matured samples.
- Difference between samples from flowthrough and recirculated tanks was significant
- Differences between flowthrough and static, and recirculated and static, were not significant.



Figure 10. Microscope images of twine samples taken from a longer-blade sample (left) and a shorter-blade sample (right)

Discussion

- Artificial maturation successfully induced sorus development, although the rate and extent of sorus formation varied among blades.
- We estimate for this experiment, there was enough sorus material after 30 days of short-day photoperiod conditions
- Significant differences in sporophyte length and density were observed among seeding methods.
- Hatchery conditions also affected growth outcomes - with longest and densest blades typically coming from recirculated tanks.
- Observed differences in sporophyte conditions could be attributed to increased contamination on the spools seeded with gametophytes and wild-matured spores, as well as varying levels of contamination between tanks (Figure 11).
- Overall, the results demonstrate that artificially matured spores and gametophytes can support equally strong hatchery performance



Figure 11. Images of 4 spools showing varying levels of growth of sporophytes as well as green and brown contamination.

Acknowledgements

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References

- Grebe GS, Byron CJ, Gelais AST, Kotowicz DM, Olson TK. 2019. An ecosystem approach to kelp aquaculture in the Americas and Europe. *Aquaculture Reports*. 15:100215. doi:10.1016/j.aqrep.2019.100215.
- Wade R, Augyte S, Harden M, Nuzhdin S, Yarish C, Filipe A. 2020. Macroalgal germplasm banking for conservation, food security, and industry. *PLoS Biology*. 18(2):e3000641.
- Forbord S, Skjermo J, Arff J, Handá A, Reitan KI, Bjerregaard R, Lüning K. 2012. Development of *Saccharina latissima* (Phaeophyceae) kelp hatcheries with year-round production of zoospores and juvenile sporophytes on culture ropes for kelp aquaculture. *Journal of Applied Phycology*. 24(3):393–399. doi:10.1371/journal.pbio.3000641.
- Krumhansl KA, Lauzon-Guay J-S, Scheibling RE. 2014. Modeling effects of climate change and phase shifts on detrital production of a kelp bed. *Ecology*. 95(3):763–774.
- Boderskov T, Rasmussen MB, Bruhn A. 2021. Obtaining spores for the production of *Saccharina latissima*: seasonal limitations in nature, and induction of sporogenesis in darkness. *J Appl Phycol*. 33(2):1035–1046. doi:10.1007/s10811-020-02357-0.
- Harrison PJ, Hurd CL. 2001. Nutrient physiology of seaweeds: Application of concepts to aquaculture. *Cah Biol Mar*. 42(1–2):71–82.
- Greenwave. 2022 Jul 19. Kelp Farming 101: Life Cycle | Getting Started: Assess Courses | Ocean Farming Hub. Ocean Farming Hub. [accessed 2025 Dec 6]. <https://hub.greenwave.org/lms/lesson-section/life-cycle/>.