

DEVELOPING AN INTEGRATED SEAWEED AND GREEN SEA URCHIN AQUACULTURE MODEL IN MAINE

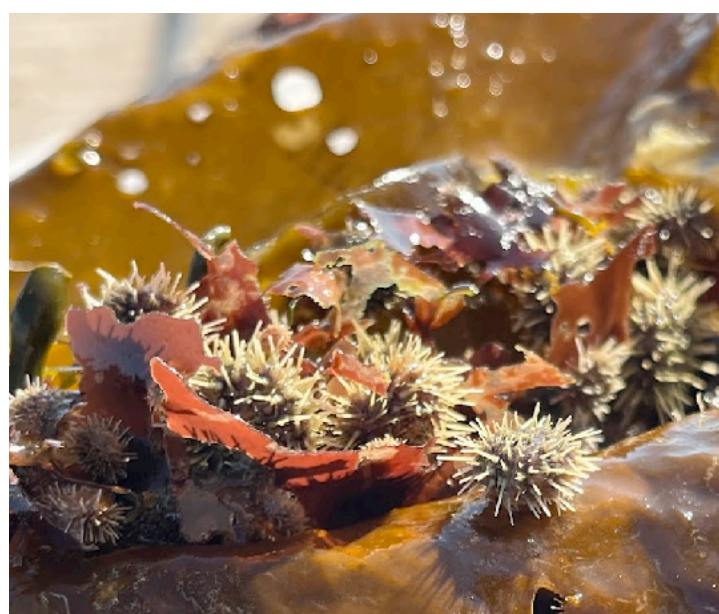
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Green Sea Urchins (*Strongylocentrotus droebachiensis*) are prized for their edible uni, present inside the shell of the urchin as five yellow to orangish lobes. Ideal uni has a rich, slightly sweet, mildly briny flavor that is created by the urchin's natural diet of macroalgae. Springtide Seaweed, LLC, a vertically integrated seaweed aquaculture company in Maine, is developing new mariculture farm models to integrate green sea urchins and seaweed to share infrastructure, provide feed, and develop new high-value aquaculture crops. Springtide is integrating macroalgae into every stage of urchin production, including seed production, juvenile development, on-farm growth, uni development, and harvest. The development of their commercial urchin hatchery, new culture gear, farm models, and markets will allow for a diverse range of sea farmers to incorporate sea urchins into their farms, increasing resilience, value, and diversification of the Maine aquaculture industry.

SEED PRODUCTION

Urchin Stage	Algal Feeds	Urchin Stage	Algal Feeds	Urchin Stage	Algal Feeds	Urchin Seed Production
March 1 hour Fertilization, Development of Halos 2 Days Morula Stage 3 Days Gastrula Stage	No Feed Required Prepare microalgae for larval stage feeding and macroalgal substrates No Feed Required Prepare microalgae for larval stage feeding and macroalgal substrates Prepare for Feeding Daily feeding of microalgae required once larvae develop into the late gastrula stage/early prism stage	 12 Days 6-arm Pluteus 20 Days 8-arm Pluteus with Rudiment 28 Days Newly settled urchin post-metamorphosis	Microalgal Feeding: Until Metamorphosis <i>Dunaliella</i> , <i>Chaetoceros calcitrans</i> , <i>Rhodomonas</i> sp., <i>Phaeodactylum tricornutum</i> Microalgal Feeding Macroalgal Feeding Urchin larvae settle onto substrates prepared with juvenile kelp, dulse, and natural biofilm 	 47 Days Microscopic Urchin 126 Days Macroscopic Juvenile Urchins August 164 Days 10mm Seed Urchin	Macroalgal Feed Juvenile kelp and dulse: seeded substrates and free living plants Macroalgal Feed Mixed kelp and dulse, with additions of a variety of mixed available fresh seaweeds Macroalgal Feed Seed Size: Ready for ocean deployment Continue on a mixed diet of seaweeds	Urchin "Seed" are juvenile urchins produced in a hatchery utilizing a mixture of microalgae and macroalgae for feed. It takes about 6 months to produce juvenile urchins with a diameter of 10mm, at which time they are ready to be deployed for cultivation at sea. Seed urchins should be stocked in a fine mesh cage to avoid escapes, and fed a mixture of fresh seaweeds to optimize growth.

FARM CULTIVATION



Urchin seed is deployed at sea in suspended or bottom cages for cultivation. Cages are regularly fed with seaweed from the farm site throughout the year. Cages should be fed at least once per month, but if this is not possible, urchins will supplement their diet with naturally occurring algae, invertebrates, and other organisms that settle in their cages. A steady supply of seaweeds is important to optimize growth and to build healthy uni for harvest. Sugar kelp, horsetail kelp, and dulse are ideal feed for urchins, and can be cultivated on site. Wild-set seaweed and juvenile mussel seed can also be utilized as a supplemental source of feed.



Cages and lines are often covered with biofouling organisms in the summer months. Biofouling control strategies can include a spray or dip utilizing vinegar or fresh water, changing out cages, or dropping cages to the bottom for cleaning by crabs and other benthic organisms. Urchins should be removed or protected during this process. Cages can be dropped down further in the water column in summer months for cooler temperatures, and brought up closer to the surface in winter to encourage microalgal growth on cages for feed.



Urchin growth rates are around 10mm/yr, requiring an estimated 3-5 years to reach harvestable size (>52mm). Farm sites should be located in areas with seawater temperatures that remain around or below 16°C, with full salinity, as urchins are sensitive to high temperatures and salinity fluctuations. Urchins can chew through any kind of twine or mesh in their cages, so lantern nets are not recommended for culture. Coated wire, rigid plastic mesh, and stainless steel have been found to be effective materials for cultivation.