# SEA URCHINS

## Integrating New Crops into Seafarms in Maine

### Maine Seaweed Exchange

Maine Seaweed Exchange (MSE) is a 501(c)(3) non-profit corporation with a mission to support the development of an organic, sustainable, and restorative seaweed aquaculture industry. We work to support the seaweed aquaculture industry through seaweed farming education and training, innovative research and outreach, and building stronger networks for the industry. For more information, contact the Maine Seaweed Exchange at www.maineseaweedexchange.com.

### USDA SARE

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### A Resource for the Aquaculture Industry

Seaweed and shellfish aquaculture is a fast growing industry in Maine, but most farms rely on only one crop and lack diversification options. Green sea urchins (*Strongylocentrotus droebachiensis*) represent an opportunity for multi-cropping on aquaculture farms, especially if seaweed can be cultivated on the farm for feed. The MSE facilitated a research project that tested kelp and sea urchin integration strategies on two farms in Maine over 2 growing seasons—an oyster farm in mid-coast Maine and on a seaweed farm in Downeast Maine. Juvenile urchins overwintered well on the oyster farm, and grew well in suspended lantern nets through the spring and summer, but experienced 100% mortality in early fall, with high temperatures and a major rainfall event. The kelp line grown on the mid-coast oyster farm produced large, clean, healthy plants until May, when it quickly fouled began to disintegrate. On the downeast seaweed farm, juvenile urchins grew in size over several seasons, with 100% survival. Kelp lines produced large, healthy, clean plants until July, when plants began to foul. Sea urchins fed on seaweeds added to the cages, as well as wild set algae and juvenile mussels throughout the year. Sea urchins are sensitive to high

## Environmental Conditions - Green Sea Urchins

The green sea urchin is a cold water echinoderm species distributed globally in Northern seas, and the only sea urchin species found in the Gulf of Maine. As the dominant herbivore in the Northwest Atlantic, sea urchins are an important component of nearshore coastal ecosystems, both as consumers and as food for other species.

Sea urchins are benthic omnivore grazers, grazing on a wide range of foods including diatoms, algae, small invertebrates, and detritus, but are commonly associated with the Laminarian kelps.

Urchins can be found from the intertidal zone down to 1200m, in a temperature range of -1°C to 18°C for larvae and 20°C for benthic urchins. Juvenile urchins grow best at 9-13°C. Maximum lethal temperatures are 19°C for larvae and 22°C for benthic stages.

While green sea urchins can tolerate changes in salinity, variability and low salinity environments can be stressful. temperatures and salinity fluctuations, so will probably not be a viable crop on typical oyster farms that are sited in warmer, shallow areas near estuarine environments. Sea urchin cultivation is easily integrated into a cold water seaweed or shellfish farm, and requires minimal time investment. Further work is required to develop high value markets for Maine farmed sea urchins to create a business plan for further commercialization.

### *Nursery Seed*

Seed urchin "seed" are juvenile sea urchins produced in a hatchery. Typically wild sea urchins are spawned and hatched when they are reproductive in the late winter/early spring, cultivated through their free-floating larval stages, and settled as microscopic benthic urchins. It takes about 6-8 months for a seed urchin to reach 5-10mm in the hatchery, when they can be placed in a small mesh (4mm) lantern net on a sea farm.

### *Farm Cultivation*

Juvenile seed urchins can be cultivated in lantern nets suspended from long lines systems, in cages on the seafloor, or by ocean ranching. Contained culture, using net or cages, protects the urchins from predators, and reduces the risk of loss. Open culture, or ranching, places juvenile urchins on ocean bottom that is supportive of urchin growth, allowing urchins to grow in their natural habitat. Open culture eliminates the use of gear, but has an increased risk of loss from predators, harvesters, or urchins moving off site.

Suspended lantern nets or cages allow existing sea farms to integrate sea urchins into their farms as supplementary crop.

## Economic Potential

Once the fastest growing marine fishery in the US, the Maine green sea urchin fishery is another "boom and bust" cautionary tale. While Maine has had a small urchin fishery since the 1930's, the fishery rapidly expanded in the late 1980's, peaked in 1993 at 41 million pounds, then declined to 2 million pounds in 2018. Efforts at reseeding wild populations were unsuccessful due to high predation, and wild stocks have not recovered. The increasing demand for high quality uni (sea urchin gonads), global market of $400 million, and limited wild resource presents an opportunity for aquaculture, but urchin aquaculture represents less than 0.01% of worldwide production.

High quality uni is worth up to 90% more than low quality uni, with an optimal gonadal yield of 12-25% . Further work is required to develop high-value cultivated uni distribution markets to support the development of a viable and valuable sea urchin aquaculture industry in the US.

Lantern nets can be suspended from existing seaweed or shellfish longlines. In the winter, nets can be closer to the surface, but should be at least 6-10 feet below the water's surface. This will protect urchins from rough surface water or drifting ice. In the warmer summer months, lines and nets can be lowered in the water column down to 10-50 ft to take advantage of colder, deeper waters. On shellfish farms, urchins can be overwintered in bottom cages, and cultivated in either suspended nets or bottom cages. Bottom cages should be in areas free of mud or silt to avoid suffocation, avoiding areas of strong current that could stress the urchins or damage the gear.

Juvenile urchins are placed out in smaller mesh gear the first year (4mm), and moved to larger mesh gear (9mm) as they grow. Stocking densities can be higher with smaller animals, up to 20-30 per level, and should be reduced as the urchins grow, to 10 per level. Smaller mesh gear has a greater surface area to foul, which can reduce water flow through the system. Biofouling organisms on nets or cages are highly seasonal and site dependent, and can include diatoms, skeleton shrimp, tunicate, sponge, mussel seed, and starfish, and need to be changed at least once or twice a year. Heavy diatom fouling can easily be rinsed off with a saltwater wash to improve water flow and reduce weight on the cage.

Urchins can be fed by adding cultivated or wild algae into cages or nets as needed, stocking at levels that will not impact water flow through the cages. This is accomplished by winching gear out of the water and adding feed. During periods of very high or very low temperature extremes, cages should not be removed from the water to avoid stressing the animals. Urchins are opportunistic feeders, and will feed on the other organisms that settle on the cages or nets.

When reaching a marketable size (2"), in about 2-3 years, uni can be enhanced by feeding urchins an ideal diet of mixed red and brown seaweeds. Ideal green sea urchin uni has a rich, slightly sweet, briny flavor with a lingering aftertaste, a flavor profile thought to be lent by the diet of kelp.