Marine Extension Bulletin

August 2020

Woods Hole Sea Grant Program
Cape Cod Cooperative Extension
Southeastern Massachusetts Aquaculture Center

Growing Methods for Petite Atlantic Surf Clams (*Spisula solidissima*)

SURF CLAM BIOLOGY

Atlantic surf clams, *Spisula solidissima*, are marine bivalve mollusks common to the Atlantic coast of North America from the Gulf of St. Lawrence to Cape Hatteras, NC. A subspecies exists, the Southern surf clam, *Spisula solidissima similis* that ranges from the Gulf of Mexico to Massachusetts. Surf clams can be found from the surf zone extending offshore throughout the continental shelf to depths of over 100 meters, though they prefer medium to coarse sandy habitats with more shallow to moderate depths, such as Georges Bank and the shoals south of Cape Cod.

Surf clams, like other common bivalve species, are filter feeders utilizing siphons to access water for respiration, excretion, and planktonic food. Atlantic surf clams reproduce sexually through broadcast spawning. Upon fertilization, the resulting larvae begin the free-swimming larval portion of their life cycle which lasts several weeks, depending on temperature. Spawning occurs typically in summer for the Atlantic *S. s. solidissima*, while the Southern surf clam, *S. s. similis*, appears to spawn in late spring. Once surf clams settle in suitable habitat, they are not thought to actively migrate, though they are capable of movement.

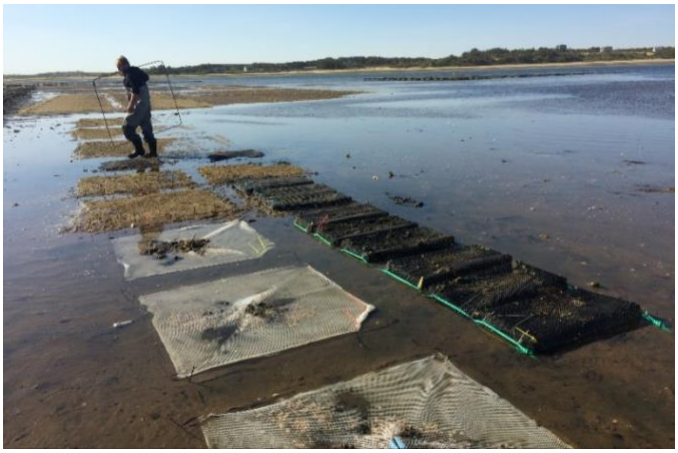
Being a mostly offshore species where the habitat has less dramatic changes than inshore environments, surf clams are generally less tolerant of extremes in temperature. Growth is reportedly greatest at around 15^{o}C (60^{o}F) for the Atlantic *S.s. solidissima*, and around 20^{o}C (68^{o}F) for the Southern *S. s. similis*, with mortality for both reported when temperatures are at ≥30^{o}C (86^{o}F) for weeks. The maximum reported size for Atlantic surf clam, *S. s. solidissima*, is nine inches while the southern *S.s. similis* stays smaller at around four inches in maximum length. Maximum reported age is approximately 20 years. While they can survive drops in salinity to around 12 ppt, they are much more common at oceanic salinities.

WHY GROW SURF CLAMS?

Small surf clams in the range of two inches in length have been shown to have attributes similar to both softshell clams and littleneck hard clams. Recent experiments in growing techniques took place in 2016-2019, and taste tests of the clams produced comments like, "delicious raw or cooked, briny, slightly sweet and very rich." Market price estimations have varied depending on potential end use (raw bar being highest, steaming clam being lower), but most estimations of a new surf clam product coming online suggest a price point similar to that of littleneck clams (*Mercenaria mercenaria*).

An active wild fishery exists in MA waters for Atlantic surf clams. The 2018 numbers reported by the state were nearly 90 million pounds harvested for both a live and a processed meat market. However, enough interest has been shown in culturing surf clams that MA Division of Marine Fisheries now allows aquaculture growers of surf clams an exemption (322 CMR 6.08,c,3) from the five-inch minimum legal size required in the wild fishery of MA waters. For aquaculture production, the minimum size is set at 1.5 inches in length.

As a new candidate species for aquaculture in the region, the other attractive aspect of surf clams is growth rate. Results of studies from the 1980s, 1990s, and more recently in 2016-2019 have all suggested potential growth to a marketable size in 12 to 18 months is possible (Table 1). Growth rate is variable and not fully understood but appears to be greatest in spring and fall as temperatures are more ideal for the species, slowing in the heat of summer and during winter lows.



ANNUAL GROWTH RATES OF SURF CLAMS IN NEW ENGLAND WATERS

Location	Initial Length (mm)	Final Length (mm)	Length Increase (mm/yr)	Data Source
Milford, CT	18	55	37	Goldberg, 1980
Cape Cod, MA	10	40	30	Rask, 1996
Wellfleet, MA	17	51	34	2016 trial
Cape Cod Bay, MA	6	34	28	2017-2018 study
Cotuit Bay, MA	6	47	41	2017-2018 study
Nantucket Sound, MA	6	35	29	2017-2018 study
Wellfleet, MA	6	36	30	2017-2018 study

Table 1. *Annual increases in average length reported for surf clams grown under aquaculture conditions in the New England region. The 2017-2018 study had clams start at 6 mm in length in July of 2017, grown in field nursery systems before being field planted in November of 2017 at 12 mm in length. The final average length reported was from July of 2018, one full year after initial planting.*

IS SEED AVAILABLE?

Methods to spawn and rear early larval stages of the Atlantic surf clam have been demonstrated since at least the 1960s when Loosanoff and Davis (1963) described techniques. Surf clams mature at a relatively young age and small size, with clams as small as one-inch-and-a-half being used as brood stock in the hatchery, usually held in sand while conditioning. Hatchery methods have been reported to be fairly straight forward, and prices have tended to be lower than of similar sized quahog seed.

At least three commercial hatcheries have produced surf clam seed in recent years (two in MA, and one in ME). These hatcheries are trying to fit surf clams into an already full schedule so getting seed orders in early to make it a priority for them is a key recommendation to interested growers. As with most shellfish seed, it's cheaper and more readily available at smaller sizes.

NURSERY METHODS

Growers have successfully used covered sand trays in the field as well as upwellers and raceways much the same as with quahog nursery culture. Use of small mesh oyster bags in cages was attempted as well with limited success as they more easily succumb to fouling and to temperature exposure if held in the intertidal zone. Sand for burial was not found to be required until they reached ¾-1 inch in length, at which point growth may be stunted if the clams are not allowed to bury themselves in the sediment.

Recent nursery growth trials in NJ suggest growth and survival are optimized at around 20$_{o}$C (68$_{o}$F), with both survival and growth declining, especially above 24$_{o}$C (75$_{o}$F). Growers have also reported stoppage in growth or stunting, especially during warmer summer water temperatures. Seed will usually rebound as temperatures come back down although overall growth is often highly variable. There is also evidence that genetics of the seed may play a factor in growth and temperature tolerance, an area that requires further research to develop appropriate lines for aquaculture.

GROW OUT

A number of methods have been tested for the full grow out of Atlantic surf clams to two inches in length. The ideal method allows the surf clams access to sediment for burial but also provides protection from predators and containment from emigration. But this is often easier said than done, as intertidal and subtidal locations offer different challenges.

Early attempts involved semi-buried cages that were deployed by divers and provided good growth but were questionable in terms of economic feasibility. Recent trials done in 2017-2019 compared three grow out methods: planted in plots under protective netting like quahog grow-out, soft nylon mesh bags (often called Florida bags, based on FL grow out methods), and box style rigid polyethylene mesh grow bags pinned to the sediment surface.

The general observations by each type:

Planted under net – Atlantic surf clams (*S.s. solidissima*) showed the most consistent growth among all the sites when planted under net. Nets are difficult to manage subtidally so are better suited to intertidal sites. Survival did suffer due to sand mounding and predation issues because the nets were not trenched on the sides to better prevent predator entry. Clams also tended to accumulate on the downwind side or corner of the nets, likely because the clams come to the surface and get washed downwind at lower tides.

Soft mesh (FL) bags – while pinned to the sediment and even after partial filling, these bags did not consistently collect and fill with sand. When they did fill with sand, surf clams seemed to grow well. More often than not, however, sand mounded underneath the bags rather than inside, leaving the clams out of the sediment and growth lagged. Crabs and moon snails attacked the clams through the soft mesh, impacting survival.

Rigid grow bags – these bags also did not accumulate sand consistently and varied by site and bag type. Box-style bags and smaller mesh sizes seemed to accumulate sand more naturally. The bags slow down sediment-laden water that flows along the bottom, which causes sediment to drop out and accumulate. When bags did accumulate sand, the surf clams grew well. Survival tended to be higher in these bags as the rigid mesh offered protection from predators in all directions. This method, if further developed, might have the most potential subtidally where it could be possible to deploy and tend in strings or trawls from a vessel.

The Haskin Shellfish Research Laboratory at Rutgers University (NJ) also conducted trials on spawning, nursery, and grow-out techniques. Their results are summarized in New Jersey Grower's Guide to Surf Clam Culture.

CHALLENGES

Combined stresses of spawning and heat in the second summer of growth can cause mortality, mostly in the intertidal where extremes can be seen. Surf clams can recover from temperatures toward the lethal limit of 86^{o}F if exposure duration is short. In the 2017-2019 trials, winter mortality did occur when exposed to extreme lows in the intertidal; clams that were in subtidal or were able to bury themselves in the lower intertidal performed better. Burial can provide some protection if exposure to subfreezing temperatures is short.

Surf clams are very susceptible to predators, especially crabs, whelk, and moon snails. Some parasites have been noted in the literature, but information is scant. No major disease issues have been noted to date.

The mobility of surf clams can be another challenge as they are more mobile than other cultured species. Boarded or sidewalled netted raceways have been suggested to help contain movement but those methods bring their own challenges. Growers using trenched netted raceways have done well until nets are breached or removed. Our best survival was seen in bags pinned to the bottom to allow sedimentation and prevent migration and predation.

Stunting was common in our trials and in the reports from growers who worked with surf clams. If left out of the sediment past a size of about ¾ to 1 inch in length, not unlike quahogs, growth tended to cease until they were given an opportunity to dig in. Likewise, summer and winter extremes in temperature caused cessations in growth.

Harvest of surf clams at the 1.5-2" length with jerk rake techniques currently employed in local quahog culture caused significant amounts of shell breakage. Hand scratching in the intertidal or use of a hydraulic harvester in subtidal conditions both reduced breakage. Allowing harvested clams to rest in off-bottom holding on the farm for 24 to 48 hours was required to ensure clearing of grit.

With any new product unfamiliar to the market, establishing markets with an adequate price point can be a challenge. Growers and wholesalers are suggested to begin marketing surf

clams as a raw bar item, and to establish relationships with local chefs that will promote the product to "early adopter" consumers of seafood. See detailed surf clam marketing and outreach recommendations for growers in Marketing and Promotion Plan, Zapalak Advisors (2019).

Being a unique and new product, shelf life and storage are new challenges to be faced. Based on our limited experience, they seem to do well in refrigerated storage from 5-10 days. They tend to gape when stored so, over time, excess drying can expedite deterioration. Methods of storage should consider this gaping tendency along the lines of other shellfish species, like razor clams, mussels and softshell clams. They do remain mobile to a degree in refrigerated storage, which is another point to consider.

SUMMARY

Opportunity exists for surf clams grown in an aquaculture setting to establish a niche high-end clam product. This opportunity is not without challenges such as building new markets and streamlining grow out and harvest. Currently, field trials comparing the growth of the Atlantic (*S.s. solidissima*) and Southern surf clams (*S.s. similis*) are being conducted at various sites around Cape Cod to, but much work still needs to be done to bring this new product into a reality for industry diversification. Hatcheries have invested in producing the seed and making it commercially available. The next hurdle is getting commercial production started to introduce this new product to the market.

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This publication was prepared by J. Reitsma, A. Archer, and D. Murphy under NOAA Fisheries Service Grant #NA16NMF4270241 in cooperation with the Saltonstall-Kennedy Program, Woods Hole Sea Grant through NOAA's National Sea Grant College Program, U.S. Dept. of Commerce; and was supported by Barnstable County's Cape Cod Cooperative Extension and the Massachusetts Department of Agricultural Resources, A.R.C. Hatchery and the Cape Cod Commercial Fishermen's Alliance. It should be cited as follows: Growing Methods for Petite Atlantic Surf clams (*Spisula solidissima)* by J. Reitsma, A. Archer, and D. Murphy. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the aforementioned organizations. NOAA's mission: To understand and predict changes in climate, weather, oceans and coasts; to share that knowledge and information with others; and to conserve and manage coastal and marine ecosystems and resources.