Reviewing Recent Methods and History for Farming Sea Scallops (*Placopecten magellanicus*) and Issues Important to the Development of Scallop Aquaculture in Maine

Dana L. Morse  
Maine Sea Grant,  
Univ. of Maine Cooperative Extension  
Darling Marine Center  
193 Clark's Cove Road  
Walpole, ME 04573  
USA  
207.563.3146 x205  
dana.morse@maine.edu
Goals of this talk

Review methods for scallop production, and other issues like the market, public health issues, permitting and regulation, etc

To bring people together to address the many issues that need to be solved in order to develop scallop aquaculture in Maine

Acknowlegements:
To the many farmers, fishermen and scientists who have shared freely of their information and considerable knowledge, and to the Univ. of Maine and Maine Sea Grant, for time on sabbatical to make several of these visits
Biological and Market Rationale for Scallop Aquaculture

Case studies
- Tom Pottle, Maine
- Mutsu Bay, Japan
- Bay Tender Shellfish, Nova Scotia
- Sea Perfect Cultivated Products, Cape Breton
- Magellan Aqua Farms, New Brunswick
- Culti-Mer, Magdalene Islands, Quebec
- Hillsburn Basin Scallop Group, LTD, Nova Scotia
- Darling Marine Center, and Mid-coast Lobster Pounds
- Bottom Seeding

Spat Collection
Permitting
Biotoxins
Diseases and Pests
Market Considerations
Suggestions for the Development of a Maine Scallop Aquaculture Industry
Biological and Market Rationale for Developing Scallop Aquaculture in Maine:

Seafood trade deficit ($10 Billion as of 2010)

Good quality scallops from Maine, reputation is established on the global market

Well developed infrastructure

Management becoming more active to improve and stabilize wild production

Diversification for the fishing industry

Locally produced, fresh products are popular

Strong 'foodie' culture in Maine, great creativity in restaurant sector
Rationale, cont.

Seafood consumption in the US is on the rise, emphasis on prepared foods

Scallops are an endemic, coast-wide species, occurring in upper bays to fully oceanic conditions.

Excellent outlook for seed supply, minimal impacts to wild larval supply, and scallop farms would likely add to local recruitment (high fertilization success)

Large size of scallops in collectors means that scallops could reach market size (50+mm) in 1 to 2 growing seasons; shorter than other areas and quicker to start of cash flow
BUT! On The Other Hand......

- Culture of *Placopecten magellanicus* has a lot more failures than successes. Improvements are still needed in equipment, husbandry, handling, processing, product development and marketing.

- Niche market means that production can't outgrow the market, and the market must be grown

- Risks from toxic algae are real and must be given the very highest priority to ensure public health.

- New ventures often take a while to work out

- Aquaculture is farming, and farming is risky.
Scallops: Domestic Production and Imported Product
(includes several species and product forms)

Maine Landings
2010-2011: 190,000 lbs., worth $1,490,000 ($7.80/lb)

US landings
2009: 58,000,000+ lbs, worth $382,000,000 (~ $6.58/lb)

Imports of Scallop Products to the US
- 2010: 50,318,400 lbs. imported, worth about $232 million ($4.60/lb).
Most imports are for frozen product, either meats or value-added.

Who were the major scallop importers to the US in 2010-2011?
China = 9.4 million kg.
Mexico = 1.8 million kg.
Canada = 846,000 kg.
Case Studies
JAPAN – Aomori Prefecture, Mutsu Bay

Spat collection experimentation in the 60's
Transition of fishermen from wild capture to farming
Cooperative structure
Government research and development
Scallop production in Hokkaido and Honshu ~ 400,000 mt traditionally
Diversified products: meats, mantles, whole, roe on, boiled, smoked, dried, etc..
Impact of 2011 tsunami will have a profound impact on all Japanese seafood production, including scallops.

Production cycle:
Wild spat collection, nursery culture, growout: pearl nets, lantern nets, ear hanging, bottom seeding

Principal lessons:
Spat collection procedure
We will not have same focus in Maine on single species production
Equipment and processing knowledge can be obtained
Diversification in products is good for business
Figure 2. Annual Japanese scallop landings from Aomori
Huge landings, labor-intensive culture equipment, and specialized vessels in Japan, all targeting scallop culture.
Japanese processing and product development is highly advanced, production cycle is well known, and the entire region is focused almost solely on scallop production.
Norito Matsui

Mutsu Bay Scallop Production Devastating, Prices Soar

[Asomio] Scallop production in the Mutsu Bay in Aomori Prefecture has been devastating. According to the Aomori Prefecture Federation of Fisheries Cooperatives, fiscal 2011 harvest through May amounted to 8,890 tons, down 72% over the same period in the previous year. Output of semi-grown shells, of which shipment is at its peak, totaled 6,968 tons, down 76%. Annual production plan is set to ...

Read also

- Aomori Semi-Grown Scallop Port Price Soars Amid Poor Harvest
- Aomori's Mutsu Bay Scallop 3rd Auction Hits Even Higher Prices
- Frozen Scallop Price May Hit Peak in Osaka
- Aomori's Mutsu Bay Scallop 3rd Auction Hits Even Higher Prices
- Aomori Semi-Grown Scallop Port Price Soars Amid Poor Harvest

The tsunami of 2011 is having severe effects in Aomori Prefecture, a hub of scallop production in Japan – harvest is down 72% presently…. 
Maine: Tom Pottle, 1999-2000

- Longtime fisherman and has family lumber business
- Funding from National Fish and Wildlife Foundation
- Scallop seed sourced from Canada
- Bottom cage trials for growout in Cobscook Bay (using AquaTray equipment)
- Routine water quality tests
- Bi-weekly sampling for toxins in scallop tissues
- Scallops grew from about 10mm to about 50 mm in 12 months
- Developed a Memorandum of Understanding with ME DMR for sale of whole product
- Used 4-5" scallops from an earlier experiment to do a market trial, sold into Portland and Boston for $1.35 per piece
- Tom discontinued the project to tend his fishing and lumber businesses, remains very supportive and optimistic about potential for scallop culture – willing to talk!
Steve Backman – Magellan Aqua Farms

- Located in St. Andrews, Passamaquoddy Bay, New Brunswick
- Lantern net style of production, tended by diving
- Working on a super-size lantern net, can swim into it
- 2-4 year growout
- Sells animals whole, live
- Long process for leasing, virtually the only shellfish farm on the Fundy side of New Brunswick (biotoxin risks)
Water table, used for washing, sorting, grading, etc: careful handling is needed to minimize stress
10-tier lantern nets, serviced by diving. Harvest is 4-5" scallops.
Scallops are held wet during the workday – ripe female at right..
Steve's scallops as a special appetizer – Rossmount Inn, St. Andrew's, NB
Owner/Chef Chris Aerni holds them live in a display tank, until prepared......
Some press for Magellan Aqua Farm......
Getting to the Plate

Northeast Aquaculture Conference and Expo
December 4, 2008

Steve Presented at the 2008 NACE conference in Portland; presentation is available as a PDF document...
Steve is working on larger cages, will still be serviced by diving. Cages can be set on bottom or suspended.
Bay Tender Shellfish – Mahone Bay, NS

Duncan Bates, operator

Former grad student of Dr. Mike Dadswell (Acadia University), had worked the site for Mike, then took it over as a business opportunity

Collected spat on site and purchased some as well, used pearl net and lantern nets for growout, on suspended longline

Site was well protected and well flushed – his farm helped local spat collection

Sold live scallops at about 70mm size, for about $0.35/ea., sold principally to Pec-Nord (Paul-Aime Joncas)
Mahone Bay, near Chester, NS
Typical spat collector bag (left) and re-stocking pearl nets. He used a little plastic tray for holding a corn cob to regulate volume, covers about 20% of the bottom to start
Hydraulic star wheel to pick up a longline float, and then run the longline in – can move back and forth
Lifting a line of pearl nets, bottom of the nets don't foul much, top net fouls a lot. 10 nets in a string, starting about 15' down.
Strings of pearl nets, spaced about 2.5 feet apart on the longline.
Swapping fouled nets for clean ones, fouled nets get cleaned at home.
Many lantern nets also for larger product. Below, male and female scallops in spawning condition.
Harvesting – product ready for market gets stored in a lantern net temporarily.
Unusual colors and shell patterns occur (left), and even really damaged shells can repair (right)
Scallops, sold to Pec-Nord, were destined for products like these:
Sea Perfect Cultivated Products
W. Arichat, Cape Breton, NS
Ron Boudreau (L) and Rodney Fougere

Spat collection specialists, often 10k+ scallops per bag, collectors set right in the harbor
Clearwater Seafoods LTD
Lobster pool system (L), and refrigerated, individual holding system
Processing line for sorting/grading scallop spat from bags. Hopper (L), conveyer, grader.
Scallop seed grader, rotates in and out of a water bath. Scallops pass through parallel spaces, mussels and other shellfish pass through holes. Several panels, with increasing space and aperture sizes.
Shoreside facility (red barn) for sorting bags, adults, etc..
Rotating drum grader of SDR pipe. Driven by a small electric motor on a belt – Ron thought 7 grades was too many, should be 3 or maybe 4.
Savory Tray for suspension culture. Photo: Cyr Couturier
Cult-Mer

Located in the Magdalene Islands, Quebec, Canada

Originally started as stock enhancement for scallops

Mixed results, but learned a lot about culture operations and equipment

Now focusing on scallop culture

Fresh, Frozen, Half-shell, marketing through Pec-Nord

Facebook: Cultimerilselectemadeleine

Principals:
Sylvain Vigneault
and
Melanie Bourgeois
Magdalene Islands:
4 hour ferry from Souris, PEI
Gulf of St. Lawrence
Melanie Bourgeois

Culti-Mer is fully mechanized; Netron beater in foreground to shake scallops out of spat collector material, leads into the spat grader.

Drum grader in background
Spat grader – large size...
Spat sorter/grader does an exceptional job of separating scallops from other species like mussels and rock borers....
Netron beater, Culti-Mer

My recommendation for collectors: Cut Netron lengthways, so that each piece opens into a sheet (not a tube), or use roll netting (a la Jerry Gallagher, North West Shellfish Limited, Donegal, Ireland)

http://www.scallops.ie/index.htm
Crew is gearing up to produce spat collector lines, and remove spat from other lines. Employment looked to be about 12-15 seasonally, with 4-6 regular employees.
Spat bags are hog–ringed to vertical lines, at both top and bottom of the bag, and set in pairs, one opposite the other. They put a little slack in the bags, so they don't tear.
Lines of spat bags are assembled, then put into the form on the right; a big concrete block lowered on to them, then tied in a bundle to save room on the vessel.
Bundles of assembled lines ready for deployment
Very small spat is put into a spat bag, inside a lantern net, while the crew can service the larger seed first. Temporary storage.

Otherwise, scallops go into lantern and pearl nets for growout; 2-4 years
Lantern net stretcher
VERY nice, welded-aluminum vessels are all over Atlantic Canada. This is outfitted to service longlines..
2009 Packaging
6 Females and 6 Males
Digestive Gland removed

Note the placemat/poster below, on the counter....
2011 Packaging:
Frozen half shell, and live in net bags (holds the shells shut, only 2-4 days shelf life)
Other shots from the Culti-Mer FB page, give a hint as to the products for sale, the markets being accessed, and how they want their product to be viewed. Note the smoothness of the shells, few heavy stress checks.
Also experimenting with ear hanging: shells will foul, so this technique is best for meat market, but higher volume. Machines are finicky.....
Hillsburn Basin Scallop Group, LTD, Annapolis, Nova Scotia, 1994-2000
via: Blair Cooper, former Operations Manager

- Tale of 'too many chiefs'
- Production company selling Princess scallops (<75mm) to the fresh and frozen half shell market
- Wrote live animal protocol to sell live product
- Bottom cages with ADPI-style shellfish bags in large rack (strong tides)
- Purchased spat from Sea Perfect
- Product sold for ~$0.35/ea., meats-only market viewed as not feasible
- Had knowledgeable brokers for the product, selling into a niche market
- Product was differentiated from wild
- Reason for failure was corporate structure; 17 shareholders wanted to grow too quickly and could not agree. Meetings often had no quorum, impossible for production and marketing crews to function
- Greatest success was the development and marketing of the unique (at the time) product: half-shell IQF. Buyer was pre-paying for shipments. Even had buyers wanting seed as garnish for salads.......
Scallops at Darling Center, for experimentation, demonstration.
Top two trays (AquaTrays) are left empty (need a better system) so that predators are excluded better (below). Trays are nested, rather than stacked.
Smooth shells indicate low stress, even though overcrowed - good meat size per shell size.
Scallops in pumped-system lobster pounds?

- Possible to use as interim culture method: between spat bag and field site?

- Some facilities have unused/under utilized tanks, or could capture exhaust water

- Part of an MAIC-funded project tested scallop growth in three indoor systems
  Ready Seafood, Portland
  Atlantic Edge (the Freezer), Boothbay
  Robinson's Wharf, Southport

- ADPI bag with 30 scallops deployed in November 2007, retrieved May or June 2008

- Winter growth at each site
  Ready Seafood – 2.5mm
  Atlantic Edge – 7.4mm
  Robinson's Wharf – 13.8mm

- Conclusion: scallops will put on shell during the winter and early spring, should be investigated more thoroughly
Ready Seafood (left) and Robinson's Wharf: white ring is new shell
Bottom Seeding as a Potential Culture Strategy?

- Lower cost than suspended culture, but more extensive – need more lease area

- Used with other pectinid species: *Pecten maximus* (King scallop) and *Patinopecten yessoensis* (Japanese scallop). These species seem to be less active than *Placopecten*

- Brian Beal/Jonesport Fishermen project indicated that larger scallops would stay put on a bottom site

- SeaStead project in Massachusetts deployed animals 40-100+mm, and found that scallops stayed reasonably in the area.

- Problems include:
  Why put large scallops down at a large size, when they can be sold?
  Investment needed to get scallops to a larger size (50+mm)
  Seeding small scallops results generally in high mortality and emigration off-site
http://www.mamut.net/hellandskjell/

Helland Skjell A/S
Manger, NORWAY

Rigid and flexible bottom fences
*P. maximus*
Spat Collection for Sea Scallops in Maine Waters

One outcome of the visit to Aomori Prefecture, Japan, in 1999

Good success in Maine, many sites in excess of 1000/bag, most areas still untested

Results vary strongly by location: species mix, size and growth, fouling

Best spat collection time appears to be September; watch for storms and rapid water temp changes

Soft bottom areas seem to produce high spat sets

Further offshore is much better than inshore areas

Need to determine max deployment time for spat bags: to achieve max growth without suffocation or predation of scallops

Best done by fishermen who know the local area, are known by their colleagues, and who can check gear frequently.
Scallop Life Cycle:
From fertilization to settlement is about 45 days.

Figure 2. Generalized life cycle of the sea scallop, from Stewart and Arnold (1994).

Young scallops and the end of a paper clip
Typical setup for Maine (left) and Canada (below)
Scallop Stock Enhancement Project Year 2
July 2000 to June 2001
Marsden Brewer

Marsden Brewer photos
Scallop seed just barely visible, during early winter

Sally McCloskey, with 1 bags' worth of scallop seed, W. Pen Bay
Bags set in Sept 2005, retrieved Dec. 2006. 17% alive, average size ~22mm, max. 41mm. 1000 total per bag, minimum fouling, few other shellfish, many starfish.

*How long to leave bags deployed???
BIOTOXINS and Public Health
The Impact of Toxic Algae on Scallops: Culture and Fisheries

Sandra E. Shumway
Department of Marine Science, University of California, Santa Cruz, California, U.S.A.

Allan D. Cembella
National Oceanic and Atmospheric Administration, Federal Laboratories, Seattle, Washington, U.S.A.

ABSTRACT: Toxic algal blooms have been recorded in waters of the northeastern and northwestern U.S. These blooms are associated with the growth of cyanobacteria and diatoms, which produce a variety of toxins that can contaminate shellfish. The toxins produced by these algal species can cause severe illness and even death in humans who consume contaminated shellfish. This paper reviews recent studies on the impact of toxic algal blooms on shellfish culture and fisheries. It discusses the methods used to detect and monitor toxic algal blooms and the measures taken to control their growth. The economic impact of toxic algal blooms on shellfish culture and fisheries is also examined. The paper concludes with recommendations for future research and management strategies to mitigate the effects of toxic algal blooms on shellfish culture and fisheries.

KEYWORDS: Toxic algal blooms, shellfish culture, fisheries, cyanobacteria, diatoms, toxins, detection, monitoring, control, economic impact, research, management.

1. INTRODUCTION

Shellfish have been a valuable resource in many coastal regions for centuries. However, the increasing demand for shellfish has led to concerns about the sustainability of shellfish culture and fisheries. One of the major threats to shellfish culture and fisheries is the growth of toxic algal blooms. These blooms can contaminate shellfish with a variety of toxins that can cause severe illness and even death in humans who consume contaminated shellfish. This paper reviews recent studies on the impact of toxic algal blooms on shellfish culture and fisheries. It discusses the methods used to detect and monitor toxic algal blooms and the measures taken to control their growth. The economic impact of toxic algal blooms on shellfish culture and fisheries is also examined. The paper concludes with recommendations for future research and management strategies to mitigate the effects of toxic algal blooms on shellfish culture and fisheries.
Shumway and Cembella, 1993
Some major points

1. Toxins are not evenly distributed in tissues, more in digestive gland and mantle
2. Some scallop tissues may stay toxic for months or longer
3. Toxicity varies greatly between animals in close proximity
4. No correlations seen between toxins in gonads and other tissues

Recommendations and cautions
1. Adductor-only culture can happen in areas prone to toxic blooms
2. Marketing of mantles or whole scallops is feasible under only strict regulation
3. Public health risks are real, and therefore extensive monitoring is critical

Graphic from:
Paralytic Shellfish Toxins in Bivalve Molluscs: Occurrence, Transfer Kinetics, and Biotransformation
Monica Bricelj and Sandy Shumway
Reviews in Fisheries Science
Volume 6, Number 4
Pages 315-383
1998
Clear documentation and agreement of testing and sale of product is critical!

2000 - Memorandum of Understanding (MOU) for Tom Pottle project with ME DMR included:

- Scallops to be tagged according to DMR regs
- Details of landings and sales to be maintained: site, date, toxin analysis, etc
- Samples will be determined safe prior to any sales
- Testing regime (A TEMPLATE ONLY!) 12-scallop samples sent to DMR lab
  - Nov. 1 through May 1: monthly
  - May 1 through June 1: Bi-weekly
  - June 1 through Oct. 1: weekly
  - October 1 through November 1: bi-weekly
- Any shellfish closure in the harvest area prohibited sale
- Harvests were limited to the open season of scalloping (Dec. 1 – Apr. 15 at that time)
- Lot being tested is removed from the water during testing, to avoid potential toxicity during the time test is run

A personal observation: a land-based facility might be well worth it for a scallop farm:
- Stage product for shipment
- Cool product down to low temps to increase shelf life
- Allow some depuration: ie. empty digestive tract, which runs through gonad tissue
Diseases, Pests and other Problems for Prospective Farmers

Mud blister worm

Undetermined
'Pus spots' likely caused by marine bacterium \textit{Williamsia maris}

Grey or off-color meats
Permitting and Regulation for Scallops in Maine

Two Major Areas:

1. There is now a clear regulatory pathway to collect seed and retain on lease or license:
   A - LPA or Lease (preferred by DMR)
   B - Special License (not preferred, but certainly possible)

   *However: Would it be better to develop a spat collection license specifically?*

2. We have a template for a biotoxin testing program, from the Tom Pottle project. This will need to be revisited, perhaps adjusted, and revived. *data needs to be collected and shared, for confidence in the public health issue*
Market Questions and Considerations:

- Two seasons for roe-on production: June-Aug and Jan-Mar?

- Roe-on products can be offered fresh or frozen

- "Princess" size (2.5-3.5") offer quick return, reduced risk, and possible 1 year crop post-spat bag

- Diversification in products would be wise, as in Japan: sell seed, small scallops, meats, meats attached to shell, and value-added products (Japanese produce smoked meats, dried mantles, boiled whole, etc)

- Use the local chef and food community to test products and get to know the consumer

- A current economic review would be helpful, in light of today's scallop prices and the loss of Japanese production. Boat prices for meats for 2011/2012 in the $12-14/lb range?

- A focus on roe-on/live/value added would keep competition to the wild fishery at a minimum
- Premiums being paid in the marketplace today for local and high quality product

- $0.35-$1.00 per scallop (for whole or roe-on) seems likely, at least for modest or moderate volumes; must increase the market along with increased production to maintain price stability

- Kuenster market study (NMFS, 1998) indicated that price is biggest factor in scallop meat purchases, also estimated costs of production ranging from $0.19 to $0.42/scallop. No information on price sensitivity for roe-on, whole, etc....

- Penney and Mills bioeconomic study (J. Shell. Res., 2000) recommended vertical integration; with processing and marketing done in-house, and stock going to market at the "Princess" size of 50-65mm (~2" to 2.5")
Thumbnail SWOT Analysis for the Development of a Scallop Industry

**Strengths**
- Good spat supply
- Good growth
- Available industry knowledge
- High quality product
- Access to knowledge in Canada and elsewhere
- Good regulatory process for collection and culture (not sale)

**Weaknesses**
- Few economic models
- Need site selection data
- Need PSP testing data and clear regulatory process
- Niche market
- Potential for conflict with capture fishery
- Short shelf life for live product, shore-side facility necessary?
- Need processing knowledge and training

**Opportunities**
- Ramp up spat collection
- Find max growth for spat in bags
- Site trials
- Diversification for fishermen, markets
- Feed the market year-round
- Product development
- Gear innovation
- Stock enhancement

**Threats**
- PSP and public health
- Monitoring capacity and cost
- Disease, fouling, pests, predators
- Backlash from wild harvest
- Availability of lease sites
Suggestions for a Developing Scallop Aquaculture Industry in Maine

- Review Biotoxin data for 5-10 years, produce maps to guide farm siting

- **Stimulate experimentation**, particularly with members of fishing industry (I suggest avoiding pearl net or lantern net operations, in favor of bottom cages or ear hanging)

- Base operations on selling half shell, roe-on product, fresh and frozen; avoid meats-only market (perhaps sale of meats, but only outside of the scallop season?)

- Support efforts to market Maine scallops, both wild AND cultured. Two messages: First – if it's Maine, it's Good. Second: educate the buyer and consumer about the differences between the two, and play to the strengths of both.

- Consider risks with respect to movement of seed scallops, create appropriate testing or monitoring, or restrictions
Recommendations cont'd.

- Continue to experiment with locations for spat collection, and deployment duration
- Work with restaurant/chef community to develop/refine products
- Integrate production with processing; land-based facilities helpful
- Create conditions for collecting and sharing biotoxin data between regulators, growers and scientists
- Require spat collection activities to return some percentage of the catch to the wild
Opportunities.