SUMMARY FROM THE TECHNOLOGY WORKSHOP NORD-OSTRON

May 3-4 2010, Ekenäs, Koster

TECHNOLOGICAL CHALLENGES FOR SPAT PRODUCTION AND ONGROWTH OF OYSTERS (*Ostrea edulis*) IN SCANDINAVIA

Susanne Lindegarth opened the workshop and welcomed the participants.
She encouraged the speakers to invite the audience to ask questions and participate in discussions in order to create a true Scandinavian meeting arena for both researchers and producers.

She then introduced the Nord-Ostron project.

In order to create a sustainable oyster industry in Scandinavia, there are a few challenges that will need to be addressed by the consortium.

Challenges in the hatchery:
Broodstock conditioning, importance of temperature
How to separate good larvae from bad ones
How to produce good feed for larvae
Large scale production of micro algae
Water chemistry
Minimize microbial infection and prevent spreading of diseases
Establish families for selective breeding

Challenges for out-growth in the sea:
Equipment
Location and densities
Minimize biofouling
Harvesting and processing for maximal oyster quality

The first step in tackling these challenges is to learn form other countries with similar conditions.

Danish Shellfish Centre

Carsten Formsgaard Nielsen

The mission of Danish Shellfish Centre is to promote sustainable exploitation of animals and plants in coastal areas, to investigate the possibilities of exploiting unused resources, to serve as a knowledge center and a forum for the shellfish business, and to provide guidance to new and existing farmers. DCS also initiates and assists in research and development projects in collaboration with other research institutes and organizations.

The Limfjord is the largest fjord in Denmark, 4,9 mean depth. It has large population of *Ostrea edulis.*
DSC has four research localities in the Limfjord. A Canadian long line system for out growth is used, where practically nothing is visible on the surface.

Previous periods of oyster research with the purpose of developing new cultivation techniques to provide sustainable production of oyster spat and consumption-oysters, and to supply the commercial growers with a stable delivery of oyster spat.

June 1999 – July 2001 (SIL)
Results
Breeding stock: Fine spawning
Larvae: Poor survival (under 1%)
Spat (hatchery): Poor survival (under 1 %)
Spat (fjord cultivation): - Fine survival in the summer period.
- Poor in the winter period
Consumption-oysters (fjord cultivation): Fine survival

July 2001 – July 2004 (DSC)
Result:
The reason for the low survival does not appear to be nutritional conditions

2005-2007 (DSC)
Because of the high mortality of larvae and no clear food-related context of settling and survival, it was decided to focus on diseases.
Result:
No clear relation between the observed bacteria, vibrio etc.

Oyster experiments in 2010:
Mother oysters
– Water quality is monitored by measuring oxygen and pH level daily. Nitrate, nitrite and ammonium measured once a week.
– Changes from the past: All water is UV treated.
– Will introduce weekly cleaning/chlorination of pipes etc.

Larvae experiment
– Water from the Fjord-broodstock (small-scale experiments, 5-liter glass bottles).
Purpose: Is there anything harmful in the hatchery water?

– Experiments with the use of antibiotics (we must have a permission to use antibiotics).
Purpose: To eliminate harmful bacteria.

– UV water from new UV-systems - UV water from the broodstock. Experiments in 400-liter containers.
Purpose: Is the old UV-system efficient enough?

– Larval growth in cola bottle system with UV-treated water (French studies).
Purpose: Study of larval density in new farming units.

– Experiments with specially fabricated algae (Norway).
Experiments where larvae are fed with specially prepared algae and normal algae.
Purpose: To investigate the importance of dietary

– Introduction of "new" algal species . French studies have shown very good results with the use of Skelatonema.

– Centrifugation experiments. Algae are centrifuged to remove bacteria (3000-5000 rpm for a few seconds.
Purpose: Clean algae

Experimental set up:
For small scale experiments we used approx. 15,000 larvae per L. Food concentration 400,000 cells per mL. in mixing ratio 3:28:69 (using Tetraselmis, Isochrysis, Chaetoceros. Utting and Spencer, 1991).

Production processes for flat oysters in Western Norway

Thorolf Magnesen

Arctic oysters AS, Vågstranda
Poll system. Adult oysters from Holland in 1930. Spat collection started in 1940s. Spat was exported to Limfjorden and to Spain.
Scalpro, Bergen. Established in 1995. Scalpro has worked with clams, *Ostrea edulis,* scallops and *Ostrea gigas*. 2009-2010 scallops and oysters.

Nursery Espevik, Tysnes
Indoor upwelling system. Outdoor raceway. Pond used to produce food, high temperature early in spring.

Vågen nursery
Water from pond, prefiltered to remove predators.
Have been working with broodstock conditioning
Upwelling cylinders
Growth rate 10% per day

In 2009 and 2010 there was a 75% survival rate in the larval stage.

Bømlo skjell is a floating up-welling poll nursery.
Kvitsøy Edelskjell AS, lantern or soft nets on longlines. Have also tried outrgrowth on the bottom of the sea with good results.

A semi-automatic washing machine is used to get rid of fouling.

Collection or hatchery production? Both according to Thorolf Magnesen.

The SETTLE project

Gyda Christophersen

Bivalve conditioning and settlement – keys to competitive hatchery production
Focus key events in aquaculture of *Ostrea edulis* and *Pecten maximus.*
Participating countries: Spain, France, Norway and Ireland
10 partners in total (five SMEs and five RTDs)
The SETTLE project is a two-year project within the SP7. Ends in 2010.

The **SETTLE** project focuses on key events during hatchery production of flat oyster (*Ostrea edulis*) and great scallop (*Pecten maximus*). The overall objective of the project is to foster year-round production of spat in hatcheries by controlling gonad development and maximising larval metamorphosis and settlement.

Purpose: Conditioning procedures for broodstock of oysters and scallops. Environmental parameters on sex-change and /or conditioning.
Culture techniques for maximized settlement and larval survival of oysters and scallops

Most of the project publications are restricted until one year after the end of the project.
http://settleproject.com/

Oyster production at Ostrea Sverige AB

Johanna Valero

Indoor nursery an outdoor nursery and outgrowth
Capacity to produce 1200 litres microalage/day. Algae from England.
Three production systems: bag systems (40L and 300L), biofence and bioreactor (600 L).

Broodstock conditioning
100 oysters per tank
2 month conditioning and 1 month spawning
Increase temperature by 1 degree a week up to 18 degrees. Gain: 50 million larvae/season.
In 2009 the temperature was increased by 1 degree a day – but that resulted in bad larvae quality.

At Ostrea they have had spawning at 13 degrees. Do not know if it is good or bad.

Larvae are reared in batches. When 50% have eye spots they are moved to settlement drums. Larval survival is 2%.

At Ostrea 40-70% of the larvae settle. Then the larvae are 500 µm and approximately 21 days.

The indoor nursery consists of an upwelling system. The goal is to have a 70% survival. 2010 the survival is 50%. Last year it was only 1%. The larvae died one week after settlemen. Now try not to handle the oysters more than necessary to avoid stress.

Outdoor nursery: flupsy under construction. Upwelling system. From 4 mm seeds to 20 mm seeds in 10 -12 months and 8 cm in 3 or 4 years.
Outgrowing has not started yet but expect 50% survival. The goal is 60 tons of oyster/year.

Tests performed at Ostrea:
Water quality, sand filter loop and UV
Different algae cultivation in biofence

Broodstock conditioning
Handling practices changed for larvae rearing
Handling practices changed for settlement
Epinephrine B tested on settlement

Challenges for the future:
Good quality of algae
High density of algae – low concentration of bacteria
High nutritious content

Broodstock conditioning
Good larvae quality
Better control of spawning (more synchronized)
Optimisation of number of oysters/seawater volume
Optimisation of handling to decrease stress
Genetic selection

Good quality larvae
Water quality
Broodstock conditioning
Visual identification of good larvae vs bad
Handling practices

Good quality spat
Eyed-larva quality (food quality)
Handling practices

Outgrowing
Techniques adapted to nordic environment, physical and social
Risk for parasitic infection

Oyster farming in Norway – spat collection and on-growing

Trond Sveen
Sunnhordland Havbruk Westcoast of Norway
Established in 2000 started with scallops
2010 provides 80% of Norwegian oysters

One hatchery Scalpro
Capacity of 10 000 000 spat from polls and hatchery at Scalpro

50 000 oysters/year most of it goes to restaurants

Kvernepollen almost a closed pool 4-8 meters deep a couple of 100 meters in diameter. Trees surround the poll and a lot of fresh water enter the poll. Up to 25 degrees in the poll. The poll is closed during spat growth and opened again when more algae is needed.

Spat collector bands with lime, cement and sand.
About 800 adult oysters in the poll.

Will use French collectors for next season.

Long-line system for out-growth in the sea. And basket system with baskets stacked on top of each other. Washing and tumbling of the oysters to get deeper oysters.

Single basket system where the water has access from all sides decreases the growth period by one year.
A project with tasting of 2000 oysters revealed that they are at their best in December with a sweet and metallic taste.

Challenges for oyster production in polls:
To secure access to the oyster spat polls since they are also areas for vacation.
How to get more out of the polls. Need help from scientists to gain knowledge about adding nutrients for algae.

FLUPSY – best management practices

Keith Reed

19 years ago Keith Reed started shellfish farming in Brittish Columbia to have something to do in winter time. He realised the incredible potential in shellfish farming. Now he produces and sells 4 million oysters a year and his company has between 35 and 40 employees.

After hatchery there is no equipment that is more efficient in growing seeds than a Flupsy. Rafts for deep water grow out are used after the flupsy. 14 rafts are chained on a long-line. The rafts can be removed one by one. 80 stacks of trays on each raft. The trays hang at different depths to increase the amount of water used. Black and green lines show the different lengths.

A machine grades the oysters. Cameras take pictures from top and from side to grade oysters in size.
Keith Reed have found over the years that animals do best in size categories of their own.

Tumble the oysters to grow a nice cup. 10-15 dozen oysters per tray. Market size 5 cm.

The oysters are cleaned for 48 hours by putting them in water from 25 m that is filtered through a sand filter, UV treated and with air added in bubbles.

Flupsy – Floating up welling system

Keith Reed's company buys seeds from three different hatcheries: Hawaii, Washington state and California. The seeds are 2-3 mm and the density 50 000 - 70 000 oysters per litre.
Since 1993 the flupsy is the single most important factor for the success in the oyster production.

The flupsy consists of a bin of 1,2 m x 1 m deep that fits into a centre channel up-welling system. A paddle wheel pumps water constantly.

Most important: screen and clean. If the carrying capacity is exceeded all the animals will suffer and will never recover and the whole bin is lost. The limit is 70 000 oysters/L for 2-3 mm oysters and 2500 oysters/L for 8 mm oysters. It is important to screen and sort oysters in size, and to always be on the safe side and try to keep the densities at 20% under the capacity.

The mortality in the flupsy is 20%. 100 000 L of oysters during a season. 10% growth per day. It is important to always keep it clean and manage the oysters all the time because when the bin is full you need to know where the oysters will go.

Keith Reed produces the Pacific oyster. He used to grow flat oysters, but stopped because he did not want to take the risk of having Bonamia on site.

Keith Reed is licenced to grow 200 tons per hectar per year but is nowhere near this.

No financing from banks or investors. Needed to build an efficient business in order to be able to invest back approximately 400 000 Euros per year into the business. The result of today's business is the result of 10-15 years of financing.

Two summers are required to get the right meat quality. The size can be achieved in one summer.

Development of the shellfish industry in Scandinavia.

An open discussion on different grow-out techniques for Scandinavia.

Alyssa Joyce
Stages in grow-out
Hatchery production of spat (reproduction and larval settlement)
Nursery (FLUPSY or other land-based tanks) – in some countries this is done by growers, but only where huge volumes can justify individual growers maintaining nurseries
What techniques are most suited to the environmental conditions in Scandinavia?

Factors to consider are:
Sea ice in winter, visual/navigation conflicts
Near shore vs off shore productivity
Predators and fouling
Temperature and salinity vary throughout the water column

Australian estuarine "basket" system. Baskets clip on ropes. Can be dropped down when there is a fresh water flush or when the surface water is too warm.
Wooden trays in raft systems. Not nice to look at.

Scallop lantern nets used in Alaska, Japan and Chile. Might work for oysters. Height adjustment possible to meet variation in temperature and fresh water. Excellent for juveniles, but less efficient overall in total handling required. Works well in areas where marine predators (seals/sea otters) are a not a problem. Height can be adjusted easily as the lanterns get heavier with growing oysters. In open water conditions, can take advantage of phytoplankton sea between 1 and 5m deep (hang up to 6m). Relatively visually unobtrusive (only one surface float necessary per basket array)

Raft -based systems with plastic or wire trays – Canada, US, Chile

Most efficient system but visually unappealing. Self-contained system, with no need for onshore handling or infrastructure unless desired.

Offshore deep water system NZ and US
Only two surface buoys. Not as convenient to handle as rafts.

Offshore submerged systems – NZ
Sub-surface long line systems expensive to anchor systems.
New and experimental technology for co-culturing of oysters, scallops, mussels in offshore environments – excellent results
Suspended 10-35m below the surface
No surface infrastructure
1000+ hectares/site, huge production volumes, highly mechanized
Completely submerged – no visual impacts
Requires more technology (larger boats for harvest, deep-water divers for maintenance) and is thus expensive to install but is very efficient, less costly to maintain – reduced fouling, reduced disease/contamination risk, less environmental red-tape in permits.

Carrying capacity is slightly less because less plankton in deep water. Maybe overcome by increasing the area. Less density. Less problem with fouling at depth. Works well in NZ maybe more plankton there.

Additional infrastructure to support grow-out sites
FLUPSY (floating upwelling systems) for nurseries.
Tumblers/graders – oysters need to be tumbled (flat oysters tend to prefer vibrating water tables rather than traditional tumblers)
Testing for fouling and predators! Know patterns of barnacles, sea stars, crabs, flat worms
How to remove fouling – hot dipping, lowest temperature – wait a week - don't remove the seaweeds before the barnacles set – when the barnacles have set, go in and remove all the fouling.
Water quality monitoring and ability to drop gear in case of vibrio outbreaks. What systems for DSP?

Quality and large-scale production of microalgae at UMB

Hans-Ragnar Gislerød
Strategy for spat production
Today: Larvae and algae are produced in the same place.
In the future: Production of micro algae and oyster larvae will be on different places and/or companies.
Consequence:
Specialization of production of both of oysters and microalgae required.

What is quality?
Find/grow the actual microalgae
Define the conditions that gives the best and stable quality during months of production.
Regularity. Often the production is very unstable.
Storing results in quality change?

Theoretical maximum capacity in lab is 30 kg/m^2/year

Under natural conditions 2kg/m^2/year

Need a high production per m^2. How do that without having to build big facilities such as green houses with a high energy consumption?

Experiment: Temperature and salinity. Effects on Tetraselmis? 50/50 fresh water/sea water best growth in 25 degrees. Fatty acid content C16-C20 maximum in 50/50 fresh water/sea water.

Different algae like different percentages of salinity.

Tetraselmis is easy to grow but easily contaminates the other algal cultures.

Will store a certain amount at 4 degrees as a reserve to have a starting material. Also check stability regularly. Study effects of temp, light, salinity to see quality and growth.

PhD project
Environmental factors for content of PUFA and the genetic responses.
Has found that growth rate and production of fatty acids is surprisingly high at 5 degrees not much less than at 20 degrees.
Patented system with three bags of ten litres each.
Examine effects of artificial light vs natural light.

New photobioreactor technology for production of microalgae

Roald Flo – Biopharmia
Life Science company offices in Oslo and Åheim. Daughter company in Arizona.
Biosciences, biotechnology and biopharmacy.
Twelve products on the market.
Mostly interested in omega 3 production

Accordion Photobioreactor
Designed for biomass production of algae and other cell cultures
Patented technology developed in cooperation with university in Arizona.

In comparison with other known photobioreactors, it is documented that the Accordion`s production result in species grown in it, having higher oil content
Other important goals were to dramatically reduce the

Goals with Accordion:
– Provide optimal growing condition for algae to enable the species to reach its maximum genetic potential for productivity even at large scale.
– Species grown in the Accordion have a higher lipid content than those grown in other photobioreactors.
– Reduce investment, production, maintenance and production change costs, together with up- and downscaling costs.

The Accordion uses CO2 in from carbon emitting industries and waste water from wastewater remediation

The Accordion photobioreactor: Flat plates with variable size plates. At the bottom the floating biomass. Nutrients are pumped up to the top and gravity is used to let it fall down. Reduces the amount of energy used. Light adjusted according to the species' needs that is programmed into a computer that regulate the light. Experiment with different wavelengths.

The Accordion photobioreactor is designed for growing photosynthetic cells/tissues as well as completely heterotrophic and non-photosyntetic cells/tissues, and everything that comes in between (mixtrophic cultures). The Accordion could be used also for production of other aquacultral organisms, possibly oysters.

Some of the advantages:
Economical
easy to install and operate
easy to scale up and down
maximum light harvesting
maximum algal growth rate
harvesting is easy
the angel of each plate can be regulated

Accordion has broken through a barrier for economic viability for algae production. The technology can be used all over the world, not only for the algae industry, but also for chemical, agricultural, food processing, pharmaceutical, cosmetics and medicine.

Micro algae can be involved in solving all three main challenges for the future; climate, energy and public health according to the Lund declaration 2009.

Biopharmia's business idea is to produce the equipment and make it work for the specific needs by consulting.

How can we handle the risk of diseases, what are the threats and can we prevent them?

Anders Alfjorden

Issues in oyster farming with regard to spreading of diseases:
Water transmits infections easily.
Not easy to see if an oyster is infected. Only see it when they are weekend and have problems closing the shells. Some diseases are vertically transmitted.
Only few hatcheries. It is important that they have a high security level.
Farmed animals will be in close contact with wild animals.

The currents in Scandinavian waters might be a risk in transferring diseases.

Regulations for infectious disease control was started in 1960 by the Swedish Board of Fisheries by introducing licensing for fish farming and transports of live fish and eggs. Among other important regulations that has been introduced since then are the new fish directive 91/67 from 1994 when Sweden became a member of EU, and the 2008 new directive 2006/88 that regulates all aquatic industry. All aquaculture sites within EU need to be registered. Movements have to be registered. High mortality events should be investigated – early warning system.

Great Britain has been importing oysters for a long time without any demand for quarantine. Due to this they now have big problems with several introduced diseases resulting in decreased production. Introduced quarantine and movement control and has succeeded in delaying Bonamia spreading to England.

Statens Veterinärmedicinska Anstalt have meetings every year in France with reference labs. Now the main topic is high mortality in pacific oysters due to oyster herpes. In France poor knowledge on movements of oysters. Oyster herpes now in France, Ireland and Southern England.

Bonamia found in Norwegian wild oysters in 2008, no new findings in 2009. Mothers can spread Bonamia to larvae during the time they are kept in the mantel space. Larvae can thus spread Bonamia. New findings from France.

Martelios found in blue mussel farm between Orust and Tjörn. *M refringens* type M was found in 5 out of 30 mussels.
Because of this it is prohibited to move animals in and out of this area. Despite this they can still be used for consumption.
Martelios makes the mussel week and it shrinks due to destruction of the digestive gland.

Supply-side management of the Scandinavian oyster industry

Alyssa Joyce
The key linkages in market supply chain management are eg harvest methods, packaging and transportation. Most important are marketing and branding.
Marketing of seafood can occur at different levels:
Farm level: Oyster festivals, farm-direct sales, oyster cruises etc.
Hotel, Restaurant and Institutional trade (HRI): identifying needs of packaged and prepared products.
Retail: Large volume, packaging and branding required, several layers of wholesalers, possibly the hardest and final market.

How to get a high prize for the oysters.
Production – supply – market – demand

Undeveloped market: characterized by small producers, local markets, profitable for a few players who can establish as price-setters, high prices depend on product differentiation and direct links to markets (niche marketing, not necessarily wholesalers). Flat oysters are unique product, but domestic markets still need to be developed in order to be receptive to a “new” product, particularly in HRI

Mature market: characterized by large vertically integrated companies, global markets, profit margins smaller and linked to competitiveness and economies of scale.
Note: French and Spanish **mature** oyster markets are very seasonally cyclical – timing of harvests very important to coincide with market demand. Peak demand at X-mas, low in summer. Probably will be the opposite in Sweden.

Where to start? Scandinavia is currently an undeveloped market. Therefore niche marketing directly to restaurants and consumers may get premium prices as industry develops. Prices will fall as more entrants to the industry, at which point, can begin looking outwards to European or Asian markets (still very good prices for flat oysters due to their scarcity, but need market know-how and a solid plan)

What buyers want:
Confidence in vendor – The buyer needs to have confidence in delivery and product consistency. Which means:
Timing – Harvest timing, quality control, availability will depend on cooperation between farmers to meet consistency of supply?
Volume (depends on market) – Volume in certain sectors is very important, also standards development, good grading/sorting and packaging techniques
Ability to enhance value – Able to market safe and healthy product (focus on Omega 3s, Sweden's environmental attributes?)
Price – cut processing costs by sharing costs of processing, marketing especially branding.

Trends in the seafood industry
– Demand for processed seafood is increasing, but unprocessed seafood decreasing. Post-processing & branding of seafood generally results in higher prices & wider range of markets (some exceptions).

– World demand for seafood increasing (in Asia and Europe demand far exceeds supply) – but industry increasingly willing to pay more for prepared, specialty seafood

– In mature industry = need for processing / marketing boards aimed at generic marketing for export (individual firms unlikely to invest independently in this during start-up)

European oyster industry: is this a good market?
Flat oyster production unique in Scandinavia, but other countries such as Australia, New Zealand, Spain, Chile also produce flats. Mature European markets –France, Spain and Netherlands (also Portugal, Italy). Are there other interesting markets? (Germany, eastern Europe?)
Good market data for Pacific oysters and salmon in Europe - where to start in determining applicability (e.g. European Seafood Exhibition Brussels) OR is domestic market better to start? High profit margins on direct sales to restaurants/oyster bars

Norshell is a good example of a company that stated producing but with no idea on how to sell the product. Had focus on volume to European wholesale markets - which are seasonal, cyclical and in some cases, saturated. Between 2001 and 2002, Norway's reported export of live blue mussels tripled but Greece & Ireland also dramatically increased production that year, all aimed at European markets = wholesale market glut, prices fell 50% . Lessons: Being able to produce good seafood without a coordinated market approach does not equal profit. Wholesalers are dangerous without first establishing solid local markets, a generic brand, and clear understanding of market potential.

Alaska is a success story in oyster production. Have to fly out the oysters and still have a good price. Oysters in Alaska spawn later due to cold water. Can supply good oysters to the US during summer. Important to be able to market healthy and safe products.

Trends in oyster production and market
Asia has largest producers and largest markets for shellfish products by far

French and Spanish disease outbreak (Pacific oysters) decimated recruitment in 2007-2008 → sharp price increases in Europe for oysters anticipated from 2009 onwards. *Will Scandinavia be ready to profit?*
Significant growth in oyster production since 1990s in Canada, Chile, China, Ireland, Scotland among others. Also now increasing in New Zealand. Australia exporting flat oysters
Where are the most promising (also new and emerging) markets? *How can Scandinavia be competitive in new markets?*

Branding is important to what price you can demand.
Year round supply is important. Ice winters will be a problem. In summer the oyster spawn and the meat quality is poor and the taste is not so good. Grow out systems in deeper, colder water is perhaps a solution.

Canadian industry – comparative with a mature industry
Eastern Canadian industry developed largely in response to government employment initiatives in rural areas, eg after collapse of cod stocks
Almost no prior well-established mussel or oyster industry, few international examples to follow → trial and error in developing production cycle
Canadian industry focused heavily on penetrating new markets in the US for both mussels and oysters, very different target than Scandinavia where a European mature market is already established.
Similar to New Zealand, but Canada did not initially focus on packaged pre-prepared product (closer to markets)
Oyster and mussel prices in North America generally lower than Europe.

In contrast with Scandinavia, both NZ and Canada have:
– long-term established shellfish producer and marketing groups
(also some government subsidies to processing and marketing boards during initial start up stages)
– producer diversity and multi-species hatcheries
– high degree of capital investment in post-processing with focus on processed product, shipping networks
– branded, consistent, distinctive product
– focus on supply-chain management & value-added production aimed at non-mature markets (PEI mussels for instance, focused on creating market demand rather than dumping on existing markets)

Eventually: Russia/Asia as alternatives to European markets?
– China, Korea currently the fastest growing markets for Norwegian salmon (imports of Norwegian seafood to Korea increased by 40% from 2007-2009 after EFTA treaty ratified, to China by 52% since 2002)
– Russian seafood imports have increased 400% over the past 10 years; Russia had highest prices of any buyers for French oysters in 2007 (€6.56/kg)
– Asian and Russian markets have few trade restrictions, less obstructive to price setting, year-round market demand (while export to mature European markets needs to be carefully controlled and timed)

Directions for growth:
– Capitalize on success of other Scandinavian seafood product branding (e.g. in new and emerging salmon markets), focus on price setting in new markets

– IF shellfish are an export product, carefully control access to European markets and eventually move away from these
– Open discussions about new forms of production, e.g., develop diversity through value-added processing, other species (scallops?) and other cultivation methods (integrated and offshore aquaculture, specialty markets)
– Link small growers through producers and marketing boards → how to develop cooperation between farmers towards consistent branding and post-processing activities?

Suggested action strategies:
– Promote environmental certification/socially desirable attributes including green-labeling/public education about the environmental benefits of shellfish production.
– Promote concept of industry diversity as insurance and risk management to buffer against disease/product gluts/price fluctuations → multi-species operations have longevity, as do multi-layered markets.
– Promote value-added production and post-processing activities. Support needed for marketing and producer's boards – this is not a subsidy to growers, rather an investment in the profitability of an entire industry.

What next?
Researchers can't market products – but can start developing knowledge of markets/supply chains.

Need to determine supply chain (processing, quality assurance, relationship with buyers) before product goes to market. Failure to develop a clear plan and distinctive brand will backfire for the industry – research on markets urgently needed. One Scandinavian oyster brand is probably the best way to market. Maybe European market is not the best one to concentrate on. Necessary to know your competitors. Ireland and Scotland are producing flat oysters.

Inaction is worst action! Oysters have limited storage characteristics – is more research needed on storage techniques, processing and handling?

Most important learn from other countries who have done this before and succeeded. No need to do all the mistakes they have done.

Industrial needs, future research and collaborative efforts – round table discussion

Keith Reid: Site selection is important. You need to learn your site, like for example monitoring temperature. Growers need to collaborate to speak with a common voice to authorities. You need to lay a good foundation from the beginning. 180 members in the British Columbian aquaculture association where Keith was the president for ten years.

Alyssa Joyce: Learn from Norwegian oil off shore industry. Test for fouling in different areas. Off shore growing decreases disease problems and fouling. OysterGro – Floats that can easily be turned over to dry them in order to get rid of fouling. In ice winters the air can be taken out of the floats to put the whole device on the bottom.

Susanne Lindegarth: Are there disposable nets that you don't need to clean?

Keith Reid: I know of a scallop grower who only uses the nets one growing season but he still has to take them out and get rid of the fouling.

Susanne Smith: There will be difficulties having a permit for these submerged systems since it will interfere with the trolling area.

Susanne Lindegarth: The point is to promote the industry inshore to work for the environment by removing nutrients. The authorities support this.

Thorolf Magnesen: We have used lantern nets on submerged long-lines and it works for both oyster and scallops. We keep them at 20-40 meters in winter and bring them up to the surface in spring.

Alyssa Joyce: Off shore only means submerged not way out in the ocean. You have to learn from the off shore industry to use the right cables and so on, that can withstand the forces in the open sea.