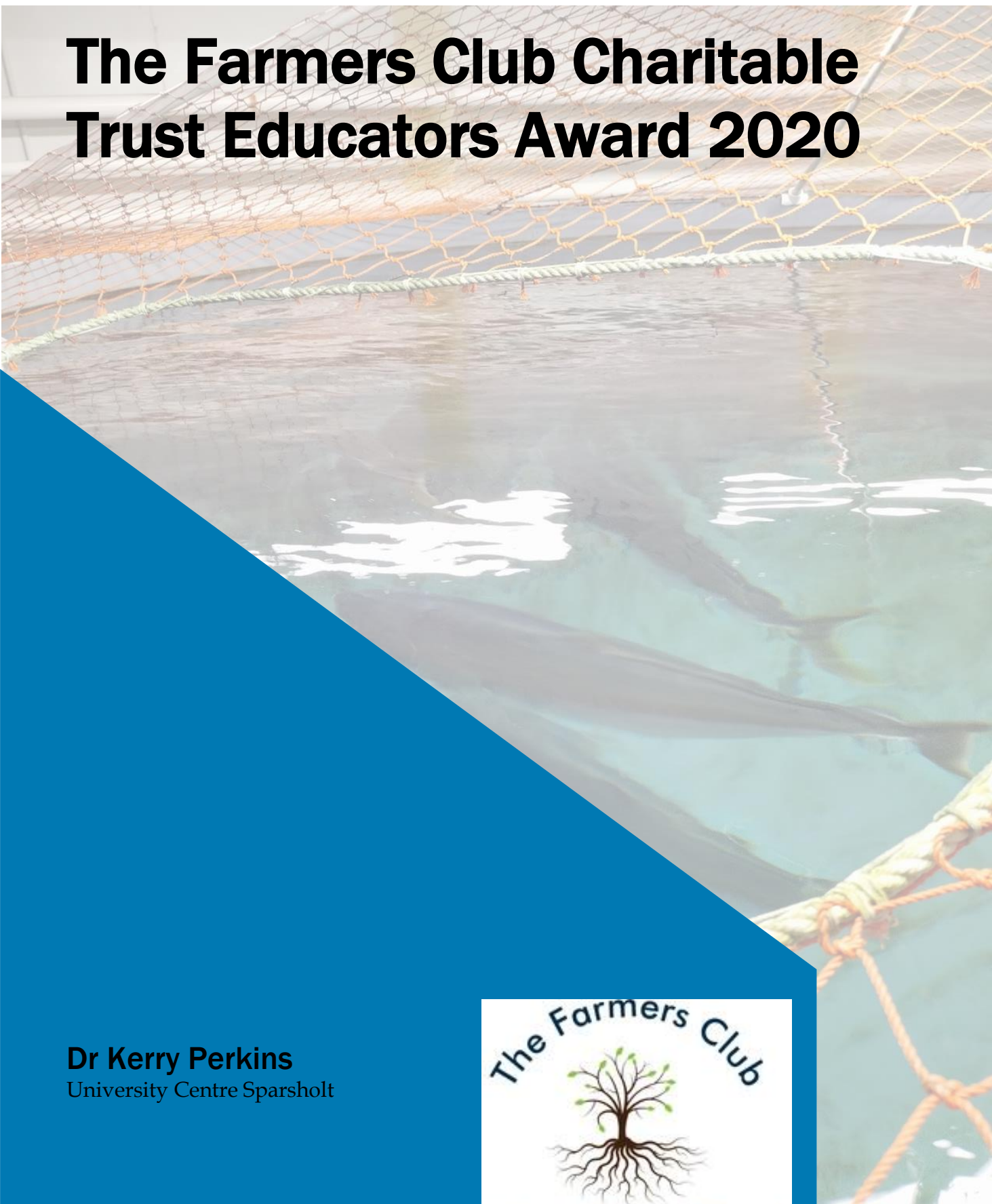


The Farmers Club Charitable Trust Educators Award 2020



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A comparison of kingfish and mussel production in Europe and New Zealand with the incorporation of current techniques and developments into an undergraduate educational program

Introduction

Over the last 30 years aquaculture has diversified, expanded and intensified particularly within Europe. As the global demand for protein and food increases so has the number of aquaculture facilities. Although there is still a considerable demand for wild caught fish, aquaculture has become more mainstream with sustainable and ethical consideration of the consumer becoming more prominent. Within Europe the UK is one of the top five producers of aquaculture with the three main areas of production being marine fish, shellfish and freshwater. Shellfish production alone accounts for 50% of Europe's aquaculture production with the main product being mussels.

In respect to fish production salmon have a large market share of aquaculture species produced in the UK, but there is future production potential of high value species such as Kingfish, that are currently being produced through recirculating systems in Europe. With the opportunity for new species production in the UK market investigation into new emerging species and current trends in existing species are important for the future of aquaculture domestically.

Educators award

Due to the importance of aquaculture and its future development, providing up to date education to future aquaculture workers and managers is vital. As part of their Aquaculture and Fisheries degree at the University Centre Sparsholt (Sparsholt College) students are taught various different culture and production techniques.

It was thereby proposed that visits to New Zealand and the Netherlands would allow increased knowledge and the opportunity to build good relations with aquaculture facilities and other educational and research institutions. (Figure 1)



Figure 1: Locations of visits within New Zealand and the Netherlands

Kingfish Production

New Zealand

Kingfish production in New Zealand is produced solely by the National Institute of Water and Atmosphere (NIWA). It is sold under the brand of Haku Kingfish. The production was set up at NIWA's Ruakaka site in 2002 for research and development. A complete full life cycle production and proof of concept has now been achieved. The site is currently developing areas for investment with a desire to promote the New Zealand Aquaculture industry.

The facility is built on an old powerplant site which allows for a large amount of water intake and discharge with room for further development. They have three cohorts of broodstock which allows them to have year round production with fish reaching market size within one year. This is important as it allows quick return on investment and meet demand all year round.


The market for Kingfish has been dominated by Asian countries, with Japan being the main consumer. NIWA have been trying to increase demand in the domestic market by working with high profile chefs and restaurants to increase market presence. By ensuring a good domestic market it is hoped that greater investment interest would be generated.

Fish are market size at around 3.5Kg and can fetch up to the £8 per Kg making them a high value fish. Fish are produced in recirculating systems with the ability to grow up to 600 metric tonnes currently. While at the site I was shown the current expansion project which will allow them to 3000 metric tonnes creating a potential revenue of £28,000,000.

A large amount of innovation was evident at the site with repurpose of everyday objects being modified for aquaculture purposes, allowing a bespoke solution for problems that arose during research and development stages. This approach has meant good refinement and a better product overall.

The mixture of research (the main focus of the site) and commercial development allowed me an interesting insight into how to bring a new species to the consumer market.

Kingfish-Seriola lalandi lalandi



Alternative name:
Yellowtail Kingfish.

Schooling fish

Found in 5-24C

Grow up to 2m in length

The Netherlands

The Kingfish Company is based in the Zeeland area of the Netherlands. Built on an old oyster aquaculture site it is provided with water from the North Sea and is a recirculating aquaculture system (RAS). The site is for commercial production with a small number of research and development projects.

All commercial kingfish for the company are currently produced in the Netherlands, however they do also have a secondary site within Maine, USA. There are plans to provide the American site with broodstock which would then allow easier access to the American market.

The current site has been producing Kingfish from 2017 with 25% of the fish being sold to the domestic market. They have four cohorts which they spawn on a rotation of 3 months. Current production is around 500 metric tonnes. This will expand to close to 2000 metric tons when the 2nd phase of building work is completed.

I was shown around both the existing facility and the new almost complete 2nd phase. The 2nd phase had incorporated a number of improvements from the initial site. Firstly, they had removed the raceways between the circular rearing tanks which originally would have allowed movement of fish between tanks. By using new innovation such as a fish movement pump they were able to fit more tanks into the new area and potentially reduce stress or damage within the fish.

Secondly investment into Artificial Intelligence for grading and identifying malformities within the stock, would reduce manual handling and fish exposure to air. While being predominantly a commercial site, research and development is still part of the overall vision. Projects often around creating solutions to ongoing problems or improving welfare. There are plans to increase the overall scope of their research with bigger research facilities being built on site.

Comparison between facilities

Although both producing kingfish for the market the two countries differ in their approach to production. New Zealand’s approach has been more focused on research and development of the species with proof of concept. The Netherlands has greater focus on commercial production with research and development assisting in their production targets.(Table 1)

Table 1: Comparison between the two facilities

	NZ	NL
Current Production (mt)	600	500
Future Production (mt)	3000	2000
Number of Breeding cohorts	3	4
Type of Aquaculture	RAS	RAS
Number of employees at site	30-60	50-100

Overall, the Kingfish Company has a greater presence and production into the market. Due to them being located in the Northern Hemisphere it allows easy access to European markets without large transport overheads. In contrast NIWA have additional costs if trying to sell to international markets due to being in New Zealand.

Both have a bright future as reliance on aquaculture for protein increases. The main challenge both companies will face will be increasing public awareness of Kingfish and its desirability within the market.

Mussel Production

New Zealand

The native New Zealand species of mussel is the Green Lipped Mussel (*Perna canaliculus*). It is considerably larger than the blue mussel (*Mytilus edulis*) found in Europe. New Zealand is the 3rd largest exporter of *P.canaliculus* with estimate value of £175 million in 2019. Production of the mussels is dominated by eight main producers.


Mussels are produced on longlines within sheltered bay areas, juveniles for stocking the lines being partially supplied by hatchery production and wild stocks. I was given the opportunity to visit the main hatchery for mussel production in New Zealand (SpatNZ) and a shellfish research facility (Cawthron Institute). Both were located on an aquaculture park which allowed for multiple species to be reared in close proximity.

Reliability of spat (juvenile mussels) is vital for success and increased production for the country. Previously wild spat would be collected in the North Island of New Zealand and distributed to Mussel production facilities. Due to increasing environmental uncertainty wild spat has become less reliable in more recent years. As a result alternative methods for sourcing spat were investigated through research grants. SpatNZ was a resulting company from one such grant and is now a commercial business supplying spat to mussel producers.

SpatNZ are in bespoke facilities and continue their research as well as producing spat for the commercial market. Due to the requirements of the spat they have a large phytoplankton

and zooplankton facilities. This allows for good nutrition to the growing spat but also room for growth within the facility.

Cawthron were initially working with SpatNZ on the rearing of the spat within their facility. Since SpatNZ has moved into their new facilities Cawthron has continued research into mussel production. Considerable research is being conducted on how global warming will affect the reliability within the reproduction and resilience of warmer temperatures.

Green Lipped Mussel- <i>Perna canaliculus</i>	
	Grows up to 24cm
	Temp 6-30C
	Salinity 30-35psu

At the Cawthron facility I had the opportunity to not only see the research being conducted but also to give a talk to the scientists about the UK shellfish industry (Figure 2). This allowed for in depth discussions about the differences between the NZ and UK industries

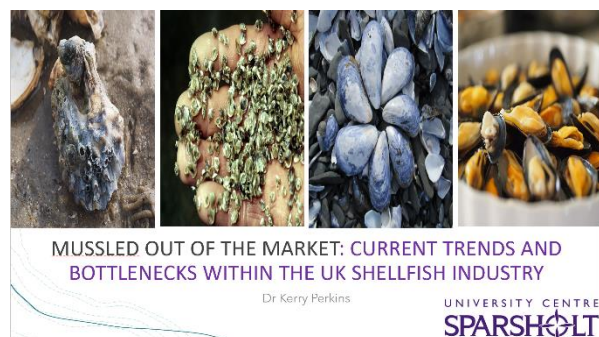



Figure 2: Lecture slide of given talk to Cawthron scientists

The Netherlands

In the 20/21 year 32 thousand tons of blue mussel were landed in the Netherlands. Mussels and mussel production have been a long tradition within the country and particularly in the Zeeland region.

Blue Mussel – <i>Mytilus edulis</i>	
	Marketable at 4cm
	Temp 5-20C
	Salinity 18-35psu

There are several large processing facilities within Yerseke in addition to a facility for Wageningen University and Research. The town itself has many restaurants and tours promoting the mussel and oyster industry.

I was unfortunately not able to visit any of the production facilities but did visit the Wageningen University’s research facility. The facility provides development and research on many aquaculture species. Due to location most of their research however is on mussels.

Many of the concerns currently are on the genetic diversity with the stocks. As such they are using real time DNA monitoring to see which stocks are doing well with the current ocean conditions. The laboratory facilities also have the ability to monitor for potential pathogens and conduct long term experiments.

Comparison between countries

Despite being two different species there were several similarities between the two

countries. Both have large research facilities investigating many aspects of mussel production. One of the key investigation topics is the sustainability of production with increasing ocean temperatures. If mussels are not tolerant to the increasing temperatures then there is a high possibility that the industry will face challenges of supply.

In addition, the increasing prevalence of storm events have had an impact on spat availability. This results in a reduced number of juveniles to supply mussel farms. If this continues than the cost of supply and therefore the overall margins may be affected. This is particularly problematic in New Zealand where there has always been a high reliance on wild spat and difficulty in spawning brood stock.

With the formation of companies providing aquaculture produced spat for Green Lipped Mussel the risk of the fishery collapsing from lack of spat is reduced. In Europe we still rely heavily on wild collected spat and it would be advised that some facilities are set up to help advance spat production but also to research resilience to warming oceans.

Within the U.K lessons from other markets could be implemented. It is only in the last year we are starting to implement longline production rather than bottom dredging. Conducting this approach would open up more areas of production. In addition to this better genetics and pathogen management could be future directions for the industry.

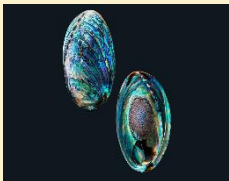
Additional Aquaculture Production

Abalone

In New Zealand abalone (*Haliotis iris*) is a popular and traditional food. Several universities are studying how to improve production, along with small production facilities.

I was able to visit New Zealand Abalone Company in Bluff which is housed in a previous slaughterhouse. This has allowed local residents employment in an area with high unemployment. The site is very self sufficient often building their own tanks. It is believed within the next year they will be able to start being able to provide product to the market.

Abalone - *Haliotis iris*



Alternative name:
Paua

Grow up to 18cm

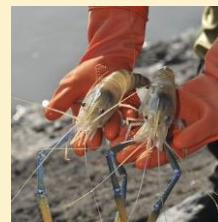
Takes 2-3 years to full size

Prawn

In 1987 the giant Malaysian river prawn (*Macrobrachium rosenbergii*) was imported into New Zealand. Although a tropical species it was considered an opportunity to produce a sustainable prawn. Due to the geothermal region within the North Island there was an opportunity to produce the prawn using the geothermal properties to warm the water.

By 2002 the farm could produce 5 tons of shrimp per year. In addition to the prawn production the farm has now added additional family activities to create a destination as well as a production facility. During the visit to the farm the combination of tourism and production showed how a facility can increase awareness of aquaculture but also generate additional revenue. This was important due to the farm currently having problems with genetics within their stock, resulting in reduced production.

Malaysian river prawn- *Macrobrachium rosenbergii*



Tropical species

Can grow up to 30cm

Live in both brackish and freshwater

Trout

A small visit was made to the National Trout Centre. It is a small facility which provides restocking rainbow trout for anglers. The facilities are also open to the public and includes a small aquarium and hatchery. The public are able to tour the centre and learn about how the fish are produced which helps increase awareness of aquaculture as an industry.

Rainbow Trout-*Oncorhynchus mykiss*



Can weight up to 9KG

Found in 45 countries

Educational Institutions

Due to similar species being found in New Zealand visits to universities that deliver aquaculture content were included within the trip. The focus was on delivery of content and future course structure.

Auckland University



Located in the North Island of New Zealand it has a long history of delivering Marine Science Degrees. In addition to central city campus they also have a marine lab at Goat Island which I was able to visit. There are no dedicated aquaculture facilities but dissertation projects can cover aquaculture topics.

Within the course content there are two modules that cover aquaculture. One is at undergraduate level with the other a masters module. After speaking with Prof Andrew Jeffs the direction of aquaculture within their degrees were heading to more postgraduate and international courses.

Auckland University of Technology



Having originated from a technical college practical application is an important value for the university. Within their central campus they have small aquaculture facilities to help deliver research. Due to restructuring of degrees there are no specific undergraduate aquaculture degree. There is however a module specifically covering aquaculture.

In addition to this a specialized aquaculture biotechnology group is present at the university. I had the opportunity to talk to a number of the group during my visit. The discussions

highlighted their current research interests but also knowledge exchange particularly around the shellfish industry and the current challenges both countries face.

Nelson Marlborough Institute of Technology (NMIT)



Based at the top of New Zealand's South Island NMIT is a practical tertiary institution. Their current degree courses and certificates have similar deliverability and practical components to University Centre Sparsholt.

The facilities are split between a small teaching facility in Nelson and a larger teaching lab and culturing facilities out at the Aquaculture park. The aquaculture park also includes SpatNZ and Cawthron Institute.

Due to similarities within the delivery and content, further discussions and connections with NMIT are ongoing. It is hoped that both groups of students could benefit from the knowledge exchange.

Otago University



The oldest university within New Zealand is located towards the bottom of the South Island. The university offers undergraduate and postgraduate study in the marine sciences. Students can take aquaculture at an undergraduate and postgraduate level.

There is a dedicated research laboratory located 30 minutes from the central campus. At the laboratory students are able to use wet lab facilities for research and laboratory classes. I had the opportunity to sit in on undergraduate

lectures. This allowed me to see content delivery and student engagement. In addition I helped deliver a practical lab with their 1st year students. It helped me gauge the level of the students understanding and gave me ideas for additional aspects of my own practical delivery.

Benefits to my teaching

Overall impact

The mixture of visiting aquaculture and educational facilities has allowed me to bring a broader aspect to my teaching. Being able to build relationships with aquaculture business allows additional options for student placements and keeps my skills up to date with industry.

Potential dissertation projects were also discussed with several of the aquaculture facilities giving a possible avenue for students and the university to contribute and progress the industry.

By visiting different countries, I was able to draw similarities but also differences which allows me to give more than just a U.K point of view within my teaching. As our students are not just from the U.K and they may travel anywhere in the world after their degree it is important that they are exposed to aquaculture that might not just be based just in the U.K.

Incorporating Kingfish and Mussels into teaching

Within my teaching I deliver a marine fish farming module to our students. In the module we already cover mussel

production. The information that was gathered by visiting research institutes has helped update my existing material. Identifying future issues within production has also been added to stimulate conversation.

Kingfish production has been added as a new lecture for this year. This helps not only expose the students to a new upcoming species but also broaden the number of species the students cover.

I feel by being able to give a broader and more in depth perspective, students can fully engage with the material and inspire them within their future careers.

Course structure

By visiting different universities I was not only able to see some of their teaching but how they deliver aquaculture teaching and at what level. In most cases there were only one or two modules in respect to aquaculture. The exception was NMIT which provides a similar course to Sparsholt.

Because of the similarities future discussions with NMIT about possible collaborations or studentships are ongoing. Without having the opportunity to visit it is unlikely that these discussions would have taken place.

Overall the benefit of FCCT educators award will not only impact my teaching this year but for years to come. It has been a amazing opportunity to update our courses but also to engage in knowledge exchange with industry.

Itinerary

Date	Activity	Location
15/7/22	Arrive New Zealand	In transit
19/7/22	NIWA	Ruakaka
20/7/22	AUT Auckland Uni	Auckland
23/7/22	Huka Prawn park Tongariro National trout centre	Rotorua
25/7/22	NMIT	Nelson
26/7/22	Cawthron	Nelson
27/7/22	SpatNZ	Nelson
3/8/22	New Zealand abalone	Bluff
4/8/22	Otago university	Dunedin
5/8/22	Otago University	Dunedin
8/8/22	Fly out to UK	In transit
15/8/22	Fly to the Netherlands	In transit
16/8/22	The kingfish company	Zeeland
17/8/22	Wageningen University	Yerseke
19/8/22	Return to UK	In transit