Institution: University of Glasgow

Unit of Assessment: Unit 5; Biological Sciences

Title of case study: Revision to codes of practice in commercial langoustine industry – improving yields, quality and sustainability

1. Summary of the impact

The UK fishing industry for *Nephrops norvegius* (Norway lobster or Scottish langoustine) is estimated to be worth £100 million annually. Caught animals are either maintained for live transport to Europe or frozen for use in food products; however, survival rates and meat quality were poor, respectively. University of Glasgow research has provided key insights into the basic biology and survival of *Nephrops* after capture and driven pioneering reform of the codes of practice of two major UK seafood companies. This reform has directly resulted in improved yields and quality, and led to a Scottish fishery being the first in the UK to be granted an internationally recognised sustainability accreditation.

2. Underpinning research

The University of Glasgow Langoustine Lab offers support to the fisheries and seafood industries that exploits over 25 years of research expertise in the population biology and health status of *Nephrops*. Working under the direction of animal physiologist Professor Douglas Neil, the Langoustine Lab has collaborated with colleagues at the University Marine Biological Station Millport (UMBSM), University of London and the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) to investigate (i) the recovery potential of *Nephrops* destined for the live transport market in association with Scotprime Seafoods Ltd and (ii) the post-capture handling of tail meat for the raw product market with Young's Seafood Ltd.

Recovery potential of product destined for the live transport market

Research by the University of Glasgow led team conducted in the mid-2000s compared stress-related metabolic parameters in creel (lobster pot)-caught and trawl-caught *Nephrops*. Two established indicators of stress within skeletal muscle were quantified: i) the adenylate energy charge (AEC) ratio, which describes the balance of energy sources ATP, ADP and AMP within biological cells and ii) the pH level. Significantly lower AEC ratios and pH values were observed in trawl-caught than in creel-caught animals,[1,2] indicating rapid development of extensive muscle stress with a switch to anaerobic metabolism (i.e. without oxygen) while the animals struggled to escape from the net. In addition, trawl-caught animals exhibited significantly greater physical damage than did creel-caught specimens.[3] Due to the labour intensiveness of creel-capture methods, Scotprime Seafoods Ltd were routinely employing the trawl-capture process to meet the market demands for *Nephrops.* Commonly, the first catches of the day were reserved for meat products whilst the later catches were maintained on deck in air for the live transport market as these animals were perceived to be the strongest. A follow-on study by the team rapidly placed freshly trawl-caught animals into on-board tanks with continuously circulating seawater and measured stress parameters at varying times post-submersion.[4] These experiments showed that the AEC ratio returned to pre-submersion levels within 4–6 hours, showing for the first time that *Nephrops* can recover from the extreme metabolic stress of trawl capture. Crucially, measurements taken after the animals had been transferred to local on-shore tanks for 24 hours indicated that recovery was maintained after capture, thus confirming the metabolic stabilisation of the animals.

Post-harvest handling of tail meat destined for the raw product market

Parallel research on early post-mortem *Nephrops* characterised product deterioration and spoilage between capture and the onset of ice storage. In two papers published in 2011, the University of Glasgow led team quantified microbial spoilage in tail meat from fresh carcasses over a range of delay times (0, 4, 8 and 24 hours) at a holding temperature of 16^{o}C (the mean air temperature

during the *Nephrops* fishing season).[5,6] Measurements were taken over the subsequent week of ice storage to quantify relative deterioration; findings at each time-point were correlated with meat quality data obtained from an expert trained panel from the Food Innovation Institute (Roslin, UK), a commercial enterprise providing consultancy services to the UK food and drink industry. Tail meat that was frozen after 4 hours rather than immediately following capture showed no significant detriment to quality 5 days after freezing. By contrast, meat that was kept at 16°C for more than 4 hours after capture showed substantial biochemical degradation and increased bacterial load, making it unpalatable.

Bycatch composition

Due to the small mesh size of the nets used for trawl-capture of *Nephrops*, bycatch of at-risk species (such as doc haddock rays) is a significant issue. At 2-month intervals over an 18-month period (2009/2010), the research team measured and recorded the details of the entire catch of a Young's Seafood Stornoway fisheries vessel, yielding a highly focussed and geographically mapped inventory for monitoring bycatch composition. These data were then logged into the 'YoungsTrace' system (an existing on-board GPS system to monitor the position of the vessel when trawling). Further amendments to this resulted in the adaptation of the 'YoungsTrace' system into a validated self-assessment system which the skippers could routinely use to monitor bycatch.[SE reports (i)&(ii)]

Key University of Glasgow researchers: Douglas Neil (Senior Lecturer [1975–2006]; Professor of Animal Physiology [2007–2011]; honorary staff [2011–present]); Graham Coombs (Professor of Biochemical Parasitology [1974–2006]; moved to University of Strathclyde in 2007); Amaya Albalat (Postdoctoral Research Assistant [2005–2010]); Simon Sinclair & Sebastian Gornik (Research Assistants [2005–2010] and [2004–2007] respectively). **External collaborators:** Jim Atkinson (Professor of Marine Biology, UMBSM) and Grant Stentiford (Director, Crustacean Disease, CEFAS, Weymouth)

3. References to the research

1. Ridgway ID *et al*. Morbidity and mortality in Norway lobsters, *Nephrops norvegicus*: physiological, immunological and pathological effects of aerial exposure. *J. Exp. Mar. Biol. Ecol.*, 2006; 328, 251–264 doi:10.1016/j.jembe.2005.07.015.
2. Albalat A *et al*. Effect of capture method on the physiology and nucleotide breakdown products in the Norway lobster (*Nephrops norvegicus*). *Mar. Biol. Res.* 2009; 5, 441–450. doi:10.1080/17451000802603637.
3. Milligan RJ *et al*. The effects of trawling on the physical condition of the Norway lobster *Nephrops norvegicus* in relation to seasonal cycles in the Clyde Sea area. *ICES J. Mar. Sci.* 2009; 66, 488–494 doi:10.1093/icesjms/fsp018.
4. Albalat A *et al.* Targeting the live market: Recovery of Norway lobsters *Nephrops norvegicus* (L.) from trawl-capture as assessed by stress-related parameters and nucleotide breakdown. *J Exp. Mar. Bio. Ecol.*, 2010; 395, 206–214 doi:10.1016/j.jembe.2010.09.002.
5. Albalat A *et al*. Quality changes in chilled Norway lobster (Nephrops norvegicus) tail meat and the effects of delayed icing. *Food* Sci Technol Int. 2011; 46, 1413–1421 doi:10.1111/j.1365-2621.2011.02650.x.
6. Gornik SG *et al*. The effect of temperature on the bacterial load and microbial composition in Norway lobster (Nephrops norvegicus) tail meat during storage. *J Appl Microbiol.* 2011; 111, 582–592 doi:10.1111/j.1365-2672.2011.05081.x.

Grants: The research above was supported by over £1 million from the European Union (EU) Financial Instrument for Fisheries Guidance (now the European Fisheries Fund) schemes. These grants have resulted in a series of reports, which were returned to the Scottish Executive including:
(i) Neil DM *et al*. The Scottish *Nephrops* Survey Phase II. A joint venture to generate high quality *Nephrops* products from a sustainable fishery (2008)
(ii) Milligan R & Neil DM. The Scottish *Nephrops* Survey Phase III. Evaluation of measures for reducing bycatch and discards in a *Nephrops* fishery (2013)

4. Details of the impact

The Nephrops fishing industry

Once considered part of the cod 'bycatch' (that is, caught unintentionally), *Nephrops* have become increasingly popular among consumers over the past 50 years. *Nephrops* are delivered to the food chain as either live animals or raw meat for subsequent freezing or cooking. The increased demand for *Nephrops* has led to the use of mass-fishing methods such as trawl-capture using nets, which is largely unregulated within the commercial industry. Boats commonly collect sequential trawl catches over an 18-hour day with little standardisation of methods and frequently no understanding of *Nephrops* biology or the damage exerted by capture methods.

Scotprime Seafoods Ltd.

Lack of understanding of the consequences of trawl-capture were highlighted when one of the major UK commercial seafood exporters, Scotprime Seafoods Ltd attempted to branch into the lucrative live *Nephrops* market.[a] This company found wide variations in the survival rates at destination of the *Nephrops* exported by live "vivier" transport to continental Europe. The company partnered up with University of Glasgow whose research showed that the animals caught later in the day were in fact exhausted and near physiological collapse from the trawl methods used but crucially that the potential existed to allow them to recover by resting in seawater tanks. As a direct result of these findings, recommendations were made to Scotprime Seafoods Ltd to reform their post-capture handling and transport working practices.

> *"[The] benefits of collaboration between our company and the University of Glasgow have been numerous and diverse. [The] results of trials at sea have shown the need to physically alter the set-up of catching vessels in order to make them more successful at capturing and maintaining live Nephrops. To date approximately 15 vessels have invested in this way and have boosted their income as a result. This is ongoing with the latest being completed in April 2013."…*General Manager, Scotprime Seafoods Ltd.[a]

Following the installation of the on-board recovery tanks on boats in the Scotprime Seafoods Ltd fishing fleet, the first catch of the day, instead of the last, is now placed to recover for the remainder of the day. Following a short transport (<1 hour) to an on-shore facility, animals are placed into recovery tanks overnight for further physiological stabilisation prior to transport to market. University of Glasgow research also revealed that there is a minimum time which animals should be kept in the holding facility before onward shipping to customers. This allows animals the best chance to recover to pre-capture physiological state and affords them the greatest chance of arrival in good condition. The University of Glasgow research also showed that it was possible to relate the physiological status of *Nephrops* to visual cues in the behaviour of the animals. This finding allowed the development of a "Vigour Index"; training staff to spot these cues has allowed animals to be graded more efficiently and with a greater degree of accuracy. Since 2008, this practice has been used by all Scotprime Seafoods Ltd staff and all new staff are trained in its use.[a]

These improvements in handling at source saw survival rates at destination of *Nephrops* following transport increase, with marked improvements in product quality (as reported by customers) leading to uniformity in supply. Production at Scotprime Seafoods Ltd prior to University of Glasgow involvement was on average 65 tonnes per year; this value has since risen to 100 tonnes (years 2008–2012).[a] This has reflected an increase in live department profits by a similar percentage increase and the live animal handling department now employs an additional two members of staff in response to increased production.[a]

Young's Seafood Ltd.

Young's Seafood Ltd has a 55% share of the UK *Nephrops* market and is the leading brand for frozen fish, which includes a breaded scampi range. The raw *Nephrops* tail product – predominantly sourced from the company's Stornoway fishery – is highly susceptible to post-mortem spoilage, and wastage levels in the company were high owing to poor handling practices. In an attempt to reduce wastage and improve product quality, the University of Glasgow Langoustine Lab demonstrated that deterioration of *Nephrops* meat depends on initial storage

temperature. In 2006, the researchers recommended a 'handling window' to Young's in which the raw product must be sorted, tailed and iced within less than 4 hours of capture. Prior to this recommendation, many of the boats in the Young's fishing fleet did not even carry ice and the product was only iced at port or within the processing facility. Data obtained from Young's confirm the successful implementation of the 'handling window' showing that the mean on-board storage temperature has reduced from 5.6°C in 2006 to a steady 2.5°C in 2012.[b] A spokesman from the company states:

> *"Professor Neil's work clearly established the benefit of icing the freshly caught product as soon as possible after landing which saw an improvement in the quality of the product being landed. This brought with it several benefits. One, the fishermen had less product rejected for poor quality therefore providing a more stable income for their efforts and secondly there was a gain in processing yields as the product had deteriorated less prior to processing and so there was less wastage through rejects and quality of the meat being produced improved as it remained firmer."*

Improving sustainability

In 2009, Young's Stornoway fisheries successfully attained the Marine Stewardship Council (MSC) certification of sustainable good practice.[c] The MSC is a world-recognised, international body that aims to improve practices of the seafood industry and promote sustainable fishing of existing stocks. This was the UK's first award for a trawl fishery and the University of Glasgow's input was instrumental in its successful recognition. Assessment, certification and annual surveillance audits on the Stornoway Nephrops fishery have since been conducted by the independent assessors Moody Marine Ltd.; the University of Glasgow studies are cited throughout the annual reports clearly demonstrating their influence on the maintenance of the MSC certification. The 'YoungsTrace' self-assessment system was implemented across the Stornoway fleet in 2010 contributing to the maintenance of the certification.[d] The MSC certification had a positive impact on Young's ability to expand their customer-base.

> *"Attaining the MSC certification allowed Young's to attract business from other UK markets for scampi and European markets for langoustine for MSC designated products." and "there is no doubt that certain European customers would not have purchased product from us without the MSC certification [it] was of primary importance to them"…*General manager, Young's Seafood[b]

5. Sources to corroborate the impact

a. Statement from Scotprime Seafoods Ltd. (available on request)
b. Statement from General Manager, Young's Seafood Ltd. (available on request)
c. Public announcement of MSC accreditation gained by the Young's Seafood Ltd Stornoway *Nephrops* Fishery, 2009
d. Assessment, certification and annual Surveillance audits on Stornoway *Nephrops* Fishery by the independent assessors (Moody Marine Ltd.) which cite the University of Glasgow/UMBSM research throughout:
   - Public Certification Report on Stornoway *Nephrops* Fishery, 2009
   - Annual Surveillance Report 1, June 2010
   - Annual Surveillance Report 2, June 2011
   - Annual Surveillance Report 3, March 2012