Master Classes/Visiting Scientist:

Dr. Paw Dalgaard

(Danish Technical University, Lyngby, Denmark)

"Predictive Microbiology for Seafood Safety and Quality"

Project Number: 2010/765

AUSTRALIAN SEAFOOD COOPERATIVE RESEARCH CENTRE

prepared by

Tom Ross

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Report Summary

Dr. Paw Dalgaard of the National Food Institute of Denmark (formerly the Danish Institute for Fisheries Research, Lyngby) is internationally recognized for his expertise in the microbiology of seafoods and how that affects seafood quality, shelf-life and safety.

From 29 May to 10 June 2011, with the support of the Seafood CRC's Visiting Expert/Master Class program, Dr. Dalgaard visited Australia and held meetings with seafood researchers and producers, and regulatory bodies. He also conducted two workshops (Adelaide, Hobart) on 'predictive microbiology' technologies and their application in the seafood industry for value maintaining seafood quality and safety. Dr. Dalgaard's visit was also partially funded by Meat and Livestock Australia (MLA): (*n.b.,* processed ready to eat meats and processed ready to eat seafoods are at risk from contamination with the food-borne pathogen *Listeria monocoytognes*, an area in which Dr. Dalgaard has made a major contribution internationally.)

During the visit, approximately 80 stakeholders in the Australian seafood industry interacted with Dr. Dalgaard, and a further ~100 other food safety managers in government, retail, consultants etc. attended lectures by Dr. Dalgaard at a national *Listeria* management symposium organized by MLA.

The workshops and visits increased awareness of technologies to assist in maintaining product integrity and quality through supply chains and those same technologies can be used to allow more innovative approaches to seafood processing that achieve the same, or better, microbiological outcomes than existing technologies.

Workshop participants were trained in the use of the SSSP, and introduced to the CRC-funded Oyster Refrigeration Index, which will enable them to pro-actively estimate shelf-life and safety parameters for raw and value-added seafood products. Participants have improved knowledge of the technologies used to process and package such products, especially with respect to determining packaging atmospheres and product formulations to achieve specified shelf lives. Workshop participants expressed a very high level of satisfaction with the workshops.

Meetings with technical staff and QA managers of processors of minimally processed seafoods provided them with access to the latest international thinking on *L. monocytogenes* risk management and microbiological shelf life and management both within the production facility and within product. One seafood processor is likely to implement changes based on information derived from Dr. Dalgaard visit.

2010/765 Seafood CRC Visiting Expert and Master Classes – Dr. Paw Dalgaard – SSSP and related food safety and quality software.

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ORIGINAL OBJECTIVES

To conduct a series of training workshops with international seafood spoilage and safety expert Dr. Paw Dalgaard in three Australian centres to equip Australian seafood processors to extend shelf life more reliably, without compromising safety.

To conduct a national forum with representatives from food industries affected by the pathogen *Listeria monocytogenes*, and relevant regulatory authorities, on how predictive microbiology software can be used to exploit the benefits of new EC and Codex Alimentarius Commission guidelines on management of *L. monocytogenes* in foods.

MODIFIED OBJECTIVES

Following discussions and feedback from CRC staff on the original proposal, it was suggested that Dr. Dalgaard conduct two workshops and undertake visits to selected seafood business, research and regulatory organisations. These included Janet Howison's team at Curtin University, Perth; Safefish Committee (met in Canberra), TASSAL in Huonville, Tasmania, Sydney Fish Markets, Sydney and New South Wales Food Authority. The two workshops were conducted at SARDI's Waite campus and University of Tasmania's Hobart campus.

The national meeting on control of *Listeria monocytogenes* was also conducted in Sydney.

NONTECHNICAL SUMMARY

OUTCOMES ACHIEVED TO DATE

The workshops presented background information on the idea of predictive microbiology models, background about the significance of *Listeria monocytogenes* and potential methods for its control, and instruction in the use of the Seafood Spoilage and Safety Predictor and Oyster Refrigeration Index. Collectively, 38 people received training. Anonymous feedback from the meetings was very positive with several attendees indicating that they would be likely to use the models in their operations. Other outcomes of the visits included assistance to CRC projects and PhD projects being undertaken by Curtin University, in refinement of predictive models, and probable adoption of Listeria management strategies by a large seafood processor. The involvement of Dr. Dalgaard at the Safefish meeting assisted in determining national priorities for the next two years.

Dr. Paw Dalgaard of the Danish Technical University is internationally recognised for his work on microbial quality, spoilage and safety of fish. His research studies are made accessible to industry through internet software that can be used to predict the growth of bacteria of interest on seafoods from measurements of temperature, pH. salt-in-water, organic acids and gaseous atmosphere in the case of modified atmosphere-packed seafood. Those computer models can be accessed, free-of-charge, and are known as the Seafood Spoilage and Safety Predictor ('SSSP'; www://sssp.dtuaqua.dk/). They are widely used in Europe and internationally.

Dr. Dalgaard has conducted training workshops in the use of SSSP in many nations, but mainly in the northern hemisphere. Dr. Dalgaard's visit was an opportunity to deliver the workshops in Australia, and to showcase the newly developed Australian Oyster Refrigeration Index (an analogous tool to assess microbiological safety and quality of oysters) developed in Australia with Seafood CRC funding

The visit occurred from 29 May to 10 June 2011, with the following itinerary:

- Tues, 31 May, 2012, visit and discussion with staff at Curtin University on
- Wed, 1 June. Meetings with SARDI staff
- Thurs, 2 June, 2012 workshop on Predictive Microbiology for Seafood in Adelaide
- Fri, 4 June 2012 meeting and presentations with Safefish Committee, Canberra
- Monday, 6 June, meeting with TASSAL, Huonville, Tasmania
- Tues, 7 June 2012 workshop on Predictive Microbiology for Seafood in Hobart
- Thurs, 9 June 2012 meetings with Sydney Fish Market and New South Wales Food Safety Authority.
- Friday, 10 June 2012 Symposium on management of *Listeria monocytogenes* in ready to eat foods (sponsored by Meat and Livestock Australia), Sydney.

Overall, approximately 80 stakeholders in the Australian seafood industry interacted with Dr. Dalgaard, and a further ~100 other food safety managers in government, retail, consultants etc. attended lectures by Dr. Dalgaard at the Listeria management symposium.

Acknowledgements

We would like to acknowledge:

- Emily Mantilla for contributions to the preparation and distribution of publicity material and, with Jayne Gallagher for assistance in the preparation and submission of the proposal for this project
- Deb Daloia for managing the financial aspects of the project
- Cath McLeod of SARDI for invaluable assistance in the development and co-ordination of Dr. Dalgaard's itinerary, and organization of the Adelaide and Canberra meetings
- Jo Slade of SARDI for organizing travel and accommodation for workshop and seminar presenters, for organization of venues and catering for the Adelaide workshop, and for managing workshop registrations
- Janet Howison (Curtin University), Mark Bolton (Sydney Fish Market), and Rob Chandler (Simplot Australia) for unequivocal and demonstrable support for the proposal and for local arrangements for Dr. Dalgaard's visits in Perth and Sydney
- Ian Jenson and Julie Cassar of Meat and Livestock Australia for financial support and leadership in the organization of the *Listeria monocytogenes* risk management symposium in Sydney

Background and Need

This application was developed in response to a call for applications from the CRC and in consultation with Ms Jayne Gallagher, Mr Bob Fleming and Mrs. Emily Mantilla. The initiative was discussed with, and was endorsed by, Mr. Mark Boulter of Sydney Fish Markets, Dr. Rob Chandler of Simplot and Dr. Janet Howieson of Curtin University's Centre of Excellence for Science, Seafood and Health.

It was part of the Education and Training program and relates to post-harvest technologies for assurance and improvement of microbiological quality and safety of all seafood.

The planned outcome was “awareness raising” of microbiological factors affecting seafood quality and safety and new technologies and tools that will allow innovative processes for shelf life extension to be developed more rationally. Participants were trained in the use of several software tools for process design and evaluation, particularly for minimally processed seafoods including refrigerated, pre-packaged seafood presentations which have been identified by the Seafood CRC as a way of increasing industry productivity.

The project was primarily concerned with improving skills and productivity of the Australian seafood processing and retailing industry as a whole.

The Seafood CRC had identified chilled, pre-packaged, seafood presentations as a way of increasing industry profitability. Such products, by virtue of the greater handling and longer shelf-life, are potentially at higher risk of contamination with unacceptable levels of microbial pathogens requiring higher skills and technology for management of the risk. Similarly, longer shelf life relies on means to reduce initial contamination with spoilage organisms or packaging system or product formulations that reduce the growth rate of spoilage bacteria. Coupled with rapid diagnostic technologies, predictive models and quantitative knowledge of the microbial ecology of seafoods form a strategic platform for expansion into new markets based on these value-added products. Such products are already well established in Europe.

Dr. Dalgaard is an international expert in seafood microbiology, being a long-term member of the National Food Institute (DTU Food) (formerly: Danish Institute for Fisheries Research), at Lyngby. The Food Safety Centre has collaborated with Dr. Dalgaard on various predictive microbiology projects over the last 15 – 20 years but few have specifically involved seafood applications due to sources of funding within Australia. With our involvement in the Seafood CRC we considered that useful synergies would arise, particularly in the areas of histamine contamination of seafoods, and *Listeria monocytogenes* control in long-shelf life, mildly-preserved, fish products – a market that the Australian industry has to develop to increase profitability.

This Visiting Expert/Master Class series supports the > $2million investment of the Australian seafood industry (through the CRC) into new retail and foodservice presentations with longer shelf life and employing novel processing/preservation technologies. It provided a means to develop new products and processes, but with far less reliance on costly and time consuming challenge trials.

Objectives

1) To conduct a series of training workshops with international seafood spoilage and safety expert Dr. Paw Dalgaard in three Australian centres to equip Australian seafood processors to extend shelf life more reliably, without compromising safety.

2) To conduct a national forum with representatives from food industries affected by the pathogen *Listeria monocytogenes*, and relevant regulatory authorities, on how predictive microbiology software can be used to exploit the benefits of new EC and Codex Alimentarius Commission guidelines on management of *L. monocytogenes* in foods.

Ultimately, the objectives were modified after discussion with Seafood CRC staff to two workshops and visits to selected seafood business, research and regulatory organisations. These included Janet Howieson's team at Curtin University, Perth; Safefish Committee (met in Canberra), TASSAL in Huonville, Tasmania, Sydney Fish Markets, Sydney and New South Wales Food Authority. One workshop was conducted at SARDI's Waite campus and the other at University of Tasmania's Hobart campus. Both workshops had participants from other States who travelled to the meeting.

The national meeting on control and risk management of *Listeria monocytogenes in ready to eat* also was also conducted in Sydney.

Results

The final itinerary for Dr. Dalgaard's visit was:

- Tues, 31 May, 2012: visit and discussion with staff and students at Curtin University's Centre for Excellence in Science, Seafood and Health, Perth
- Wed, 1 June: Meetings with SARDI staff, Adelaide
- Thurs, 2 June, 2012: first workshop on Predictive Microbiology for Seafood in Adelaide
- Fri, 4 June 2012: meeting and presentations with Safefish Committee, Canberra
- Monday, 6 June: meeting with TASSAL, Huonville, Tasmania
- Tues, 7 June 2012: second workshop on Predictive Microbiology for Seafood in Hobart
- Thurs, 9 June 2012: meetings with Sydney Fish Market and New South Wales Food Safety Authority.
- Friday, 10 June 2012: Symposium on management of *Listeria monocytogenes* in ready to eat foods (sponsored by Meat and Livestock Australia), Sydney.

Planning and logistics were undertaken by Tom Ross (UTas), Cath McLeod (SARDI) and Jo Slade (SARDI). A detailed itinerary is shown in Appendix 1.

A story was prepared and published in Seafood Stories (December, 2011; Page 24, 25; see Appendix 2) to generate interest in the workshops as well as email-outs and contacting potential participants directly. A flier for the meeting is shown at Appendix 3.

Results of the various visits and workshops were collated from testimonials of groups visited or from solicited feedback from the two workshops.

Center of Excellence for Science, Seafood and Health

Dr. Janet Howieson provided a report on Dr. Dalgaard's meetings with her staff and students, and a representative from MG Kailis, in Perth. The full report is shown in Appendix 4.

Initially, Dr. Dalgaard met with Dr Janet Howieson (CESSH) Assoc Prof Hannah Williams (Curtin University, Food Science), Rachel Tonkin (CRC PhD student), Felicity Denham (CESSH research assistant) and Dr Wendy Hunt (CESSH researcher). Discussions concerned developing a new warm-water predictive model initially using data collected as part of CRC Project 2009/709. There was some discussion that Felicity Denham may like to do a PhD in this area, and Professor Dalgaard agreed that if that evolved he would be happy to take a mentoring role.

Later in the day, Dr. Dalgaard met with a representative from MG Kailis (industry partners on CRC 2009/709). Professor Dalgaard presented a general summary, and protocols specific to MG Kailis were then discussed. Some of these suggestions will be progressed in the implementation phase of 2009/709.

TASSAL

Dr. Dalgaard and Dr. Ross visited the TASSAL processing plant at Huonville, Tasmania and had discussion with senior managers of the processing plant. The discussions began with presentations on epidemiology and behavior of of food-borne *Listeria monocytogenes,* a topic of particular relevance of to producers of long-shelf life, perishable, ready to eat foods, including value-added seafoods such as cold-

smoked fish. Dr. Dalgaard then gave a presentation of methods for its control in ready-to-eat seafoods. After the meeting, Ms Kaylene Little (Head of QA, HR & Safety) wrote that the knowledge her team had taken from the visits (and workshops) had "*unlocked significant future potential for our company and in turn the industry. For example, I have now been able to have dialog with one of our key retail customers working on a solution that has previously escaped both parties, this has been as a direct result of the information provided by yourself and Dr Paw.*" A vopy of Ms. Little's letter is presented at Appendix 5.

Predictive Microbiology and Seafood Masterclasses

Two masterclasses were held to introduce, and train, the Australian seafood industry in latest developments in predictive microbiology. The masterclasses were 'built' around Dr. Dalgaard and his Seafood Spoilage and Safety Predictor Software. The masterclasses were highly interactive, both in terms of presentation-style with presenters actively encouraging discussion, as well as all participants working through exercises using computers to learn to use the software. Dr. Dalgaard made two presentations: one on the use of the SSSP software for prediction of shelf life and quality of fish/seafoods and the second on the use of SSSP for understanding the risk from food-poisoning bacteria, especially *Listeria monocytogenes*. Other presentations included an overview and introduction to the ideas and application of predictive microbiology (Dr. Tom Ross) and presentation of the Oyster Refrigeration Index software (Prof. Mark Tamplin). The program for the masterclasses is shown at Appendix 2.

The masterclasses involved many exercises that required participants to using the SSSP software. Participants were provided with a full set of bound lectures notes that including the exercises, enabling all material to be kept together. A copy of the masterclass lecture and notes book has been forwarded to Seafood CRC.

For the Adelaide masterclass, participants were encouraged to bring their own computers, and to have loaded the SSSP software before coming to the workshop. Specific instructions were given and participants were encouraged to correspond with Dr. Ross or Dr. Dalgaard prior to the workshops if they were experiencing problems loading or using the software. For the Hobart masterclass a computer laboratory was able to be used (provided gratis by the University) and the SSSP software was preloaded onto those computers prior to the masterclass. This ensured that there were few problems and disruptions to the masterclasses on the day, which was necessary because the program was quite full.

Both masterclasses were conducted over a day, with morning and afternoon teas and lunches provided to participants.

Twenty three registrants attended the Adelaide masterclass, conducted at the Waite campus of SARDI. Fifteen registrants attended the Hobart masterclass, conducted at the University of Tasmania, Hobart campus.

Workshop participants were overwhelmingly positive about the workshops and in questionnaires anonymously completed after the workshops several indicated that they would use the tools in the work/business. The workshop was assessed against these criteria:

- the advertising of the workshop was an accurate reflection of the content
- the information presented at the workshop was useful and relevant
- the presenters were well organised and communicated the important messages clearly
- the presenters generated a good working atmosphere for asking questions and sharing ideas, opinion and experience
- I would recommend the workshop to others in the the seafood industry

Against the above questions the following average responses were received, where are score of '5' means "Strongly agree" and a score of "1" means "strongly disagree"

Adelaide workshop responses* (23 participants): 4.7; 4.8; 4.8; 4.6; 4.9
Hobart workshop responses (15 participants): 4.6; 4.4; 4.8; 4.5; 4.6

Full details of the participants responses are shown in Appendix 6a (for Adelaide masterclass) and Appendix 6b (for Hobart masterclass).

As suggested by these scores, the participant responses were strongly positive. Apart from complimentary comments, several respondents suggested that more time was need to allow participants to become better acquainted with the tools. Specific comments included:

- *"It was a fantastic day - really glad to have participated and will definitely be using the content"*
- *"Extremely constructive and yet lucid"*
- *"Like to have more of them"*

(* at the Adelaide workshop two questionnaires gave overwhelmingly negative responses - with scores of 1 or 2 throughout. This seems incongruous as instructors at the workshops were at pains to talk personally to all participants to gauge their responses as well as relying on the questionaires, but no strongly negative comments were received. Also, for those two responses there were no additional comments made on the form to explain the reason for this negative assessment. Accordingly, it seems possible that these two respondents misunderstood the scoring system and scored '*strongly agree*' with a '1' and '*strongly disagree*' with a '5'. Given this, these two responses were omitted from the above calculations. If they are retained, the scores for Adelaide are reduced by about 0.3 for all questions).

On the outcomes of the workshops Dr. Catherine McLeod, Chair of Safefish wrote:: "*The strong industry, scientific and regulatory based attendance at the Adelaide and Hobart workshops has assisted in disseminating the SafeFish objectives and work programme with key seafood sector stakeholders. This has led to numerous inquiries into SafeFish's role in providing technical input into the Codex standard setting fora and raised new ideas for further potential technical work to support industry*."

Safefish Meeting, Canberra

The SafeFish meeting was held at the DAFF building, (Canberra) to prioritise seafood safety and market access R&D to support national standard setting processes and industry access into key markets. As part of this meeting Dr Dalgaard

delivered a presentation to ~30 stakeholders on state-of-the-art tools to assist in the control of pathogens of high concern to the seafood industry. Dr. McLeod, Chari of Safefish advised that: “*Dr Dalgaards contribution was highly regarded by regulatory and industry participants alike and has assisted in determining national priorities for the next two years*."

Extensions

The masterclasses and visits were, in essence, extension activities to:

i) raise awareness of the benefits of existing predictive microbiology technologies,
ii) increase understanding of microbial ecology of foods and its relevance to seafood quality and safety
iii) increase capability of the Australian seafood industry to use predictive microbiology technologies (e.g. SSSP, Oyster Refrigeration Index) to design product formulations, processing step, packaging systems and distribution protocols to optimize shelf life and safety of seafoods so as to reach more lucrative, and more distant, markets.

Several workshops participated indicated that more, similar, workshops would be useful. Follow up articles in CRC publications (e.g. Seafood Stories) possibly from beneficiaries of Dr. Dalgaard's visit, would also further extend the benefits and interest in applying the technologies.

Project Outcomes

The workshops and visits increased awareness of technologies to assist in maintaining product integrity and quality through supply chains and those same technologies can be used to allow more innovative approaches to seafood processing that achieve the same outcomes.

Workshop participants were trained in the use of the SSSP, and introduced to the Oyster Refrigeration Index, which will enable them to pro-actively estimate shelf-life and safety parameters for raw and value-added seafood products. Participants have improved knowledge of the technologies used to process and package such products, especially with respect to determining packaging atmospheres and product formulations to achieve specified shelf lives.

Meetings with technical staff and QA managers of processors of minimally processed seafoods provided them with access to the latest international thinking on *L. monocytogenes* risk management and microbiological shelf life and management both within the production facility and in product. One large seafood processor has begun to implement some of those technologies to manage the risk of *L. monocytogenes* potentially present in their product, and complementary benefits are expected to flow to project 2009/709.

Predictive microbiology is now well established as a credible, science-based, tool to evaluate the quality and safety of foods in distribution where loss of temperature control has occurred, or to gauge the safety of product formulations (e.g., cheese production). By quantitiative analyses of the best available scientific data, it has been used to overturn, or avert, regulations proposed by retailers or government that were not science-based.

Wider understanding of these technologies by both industry, regulators and retailers provides improved ability for seafood processors to negotiate with retailers and regulatory authorities through a shared understanding of the relevance science. To this end, it was important that all sectors of the industry were represented at the workshops.

The training provided, and general awareness raising, will hasten adoption by Australian food safety regulators of the more progressive approach now adopted in Europe, and similar regulations now ratified by the Codex Alimentarius Commission. This has the opportunity to reduce testing costs, and to lessen the chances of recalls, for some products.

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4. **Letter concerning outcomes of the Perth visit.**
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6. **a. Feedback from participants at the Adelaide Predictive Microbiology workshop**
   b. Feedback from participants at the Hobart Predictive Microbiology workshop

Appendix 1. Complete Itinerary for Dr. Dalgaard's visit.

Date	Location	Key Contact	Activity
28 – 29th May	Travel from Copenhagen to Perth		
Monday 30th May	Perth		Down-time
Tuesday 31st May am	Perth	Janet Howieson	Discussions with Curtin University re finfish micro results and potential modelling applications
Tuesday 31st May pm	Perth	Janet Howieson	Workshop with Seafood Industry representatives to demonstrate how the models can be used to add value to existing micro results.
Wednesday 1st June am	Travel from Perth to Adelaide		
Wednesday 1st June pm	Adelaide	Tom Madigan	Discussions with SARDI staff re oyster micro results from recent storage trials and potential input into models
Wednesday 1st June pm	Adelaide	Cath McLeod	Dinner hosted by the SA Research and Development Institute
Thursday 2nd June	Adelaide	Cath McLeod	Workshop – Draft Itinerary of Workshop attached*
Friday 3rd June am	Travel from Adelaide to Canberra		
Friday 3rd June	Canberra	Cath McLeod SA Research and Development Institute	SafeFish Meeting. Presentation on Listeria Models for RTE Seafood (emphasis on Codex requirements and meeting trade & market access requirements). 1.5 hr speaking slot.
Saturday 4th June	Travel from Canberra to Hobart		
Sat/Sun 4th and 5th June	Hobart		Down-time
Monday 6th June	Hobart	Tom Ross	
Tuesday 7th June	Hobart	Tom Ross	Workshop – Draft Itinerary of Workshop attached*
Wednesday 8th June am	Travel from Hobart to Sydney		
Wednesday 8th June pm	Sydney		Down-time
Thursday 9th June am	Sydney	Mark Boulter Sydney Fish Market	Tour of Sydney Fish Market and informal discussions with SFM about potential application of models to their business needs.
Thursday 9th June am	Sydney		NSWFA discussion
Thursday 9th June pm	Sydney	Julie Cassar Meat & Livestock Australia	Dinner hosted by Meat & Livestock Australia
Friday 10th June	Sydney	Julie Cassar Meat & Livestock Australia	*Listeria* Workshop

Appendix 2. Seafood Stories Article

SOFTWARE HELPS
prevent food poisoning

You have just picked up a pack of cold-smoked fish from the supermarket chill cabinet to serve your family for lunch on Sunday. On its way from the factory to the lunch table, the product has been exposed to varying temperatures. Now, how can you be sure the product is still good to eat when you take it out of the refrigerator to make your sandwiches? **Professor Tom Ross** from the University of Tasmania provides the answer with a piece of software you can learn how to use with a Seafood CRC Master Class.

The scenario presented above.....well the answer depends on how long and at what temperature the food has been stored, characteristics of the product including, for example, how strongly it was salted, and how strongly it was smoked and how many "good" bacteria it contains! The interaction of these factors is complex but predictable, and what our brains cannot easily make sense of, free software from the Danish Technical University (DTU) can.

The software helps producers of seafood, including fresh and lightly preserved products such as cold-smoked salmon, MAP fish fillets, etc. to ensure that their products are suitable for consumption right up until the sell-by date and to prevent unacceptable growth of human pathogenic bacteria.

The Seafood Spoilage and Safety Predictor (SSSP) software, as the software from DTU is called, can read specific temperature measurements and use these to evaluate the effect of those temperature variations (e.g. from processing to the supermarket chill cabinet). In other words, the software makes it possible to identify ways to improve shelf-life and food safety.

The software is an example of the applications of "predictive microbiology" a branch of food science/technology that has been de-

downloaded by more than 4,000 companies, food inspectors, organisations and consultants from 105 countries around the world.

"We had completed extensive laboratory studies, developed mathematical models to predict shelf-life and safety of seafood and published our findings in all the right places. However, industry and the food authorities often don't have the time to seek information in that form. We therefore decided to do something else - to develop a piece of user-friendly software which provides easy access to all the information. The difficult bits, (i.e. the mathematical models), have been kept out of sight, and the predictions are easy to obtain and ready to use", explains Paw,.

Predicts Whether the Number of Bacteria in Seafood will Grow

SSSP v. 3.1 includes an extensive model to predict if the human pathogenic bacterium *Listeria monocytogenes* can grow in seafood products. 'This model has made the program popular in many parts of the world', says Paw .

Listeria monocytogenes is a serious problem because high doses of the bacterium can cause listeriosis, a potentially fatal bacterial disease, in consumers. Listeria can be present in lightly preserved seafood, meat, salad and some dairy products. This is due, in part, because it can be difficult to remove the bacterium completely from processing equipment, despite careful cleaning and disinfection.

Low concentrations of *Listeria monocytogenes* in ready-to-eat food (e.g. < 100 cells per gram) are not considered to pose an unacceptable food safety risk, but it is essential to prevent growth of the bacterium to high concentration and this is where predi ctions and software becomes most helpful.

Also Works for Meat Products

The SSSP software has been developed for seafood products, but growth of *Listeria monocytogenes* can also be predicted in other types of food.

Paw adds, "We get quite a few enquiries from people wanting to use the program for various ready-to-eat foods. As part of a large-scale international study undertaken in collaboration with scientists from Tasmania, Denmark, France and the Netherlands, we have therefore tested our *Listeria monocytogenes* growth model by comparing data from almost a thousand trials involving meat, seafood, poultry and dairy products. The results, which were published recently in the international literature, con firmed that our model holds - even outside our own laboratory - and that it is reliable for both seafood and meat products."

The SSSP software also includes models for predicting the loss of quality due to the growth of spoilage bacteria on fish products and also contains models for histamine formation in seafood.

Want to Learn How to Use This Software? In 2011, the Seafood CRC will be bringing Dr Paw Dalgaard to Australia to run a series of Master Classes through our Visiting Expert and Master Class scheme. If you want to reserve your seat to this interactive and exceptional training opportunity, contact Professor Tom Ross at tom.ross@utas.edu.au or Emily Mantilla at emily.mantilla@seafoodcrc.com

Appendix 3. Publicity material for the Dalgaard workshops

The Seafood Shelf-Life & Safety Predictor Master Class has been proudly brought to you by the Australian Seafood CRC's SafeFish Program

Mark is Leader of the Food Safety Centre. He specialises in food and environmental microbiology, as well as predictive microbiology. Mark has served on various national and international food safety committees over his 26 year career, and was manager of the USDA Pathogen Modelling Program. He is also a co-founder of the on-line resource ComBase.

Tom has been a member of numerous expert groups on food safety risk assessment and risk management convened by the Australian government and industry organisations and, internationally, by FAO and WHO. In addition to basic food microbiology research, Tom's contributions include development of software and decision support systems that are used in the food industry and by government to improve food safety.

When & Where?

Adelaide: Thursday 2nd June 2011
Hobart: Tuesday 7th June 2011

A Taste of What You'll Discover

Time	Topic	With.....
08:45 - 9:00	Registration	
09:00 - 09:10	Welcome	Tom Ross & Cath McLeod
09:10 - 10:25	Predictive modelling - Concept, application and software	Tom Ross
10:25 - 10:45	MORNING TEA	-
10:45 - 12:30	Seafood shelf-life prediction - Relative rate of spoilage model and time-temperature integration & Microbial spoilage models	Paw Dalgaard
12:30 - 13:10	LUNCH	-
13:10 - 15:10	Seafood safety prediction - Histamine fish poisoning & *Listeria monocytogenes*	Paw Dalgaard
15:10 - 16:00	Prediction and growth of *Vibrio parahaemolyticus* in oysters	Mark Tamplin
16:00 - 16:30	General discussion	-
16:30 +	Further opportunities to use the software and class feedback	Mark Tamplin, Paw Dalgaard and Tom Ross

What's Included in This FREE, ONE DAY Master Class?

Participants will use their own laptop computers for the PC-exercises included in the workshop. Instructions on how to download the software will be mailed to participants prior to the start of the class. Catering and course notes will all be provided.

For Questions About the Master Class and How To Register.....

Contact Jo Slade at jo.slade@sa.gov.au or phone Jo on 08 8303 9664

UTAS DTU SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE Australian Government Fisheries Research and Development Corporation Government of South Australia AUSTRALIAN SEAFOOD COOPERATIVE RESEARCH CENTRE

Appendix 4. Letter from Janet Howieson concerning outcomes of the Perth visit.

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Curtin University

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Outcomes of Visit by Professor Paw Dalgaard to the Centre of Excellence for Science (CESSH), Seafood and Health, Curtin University.

Professor Paw Dalgaard visited CESSH on June 1st 2011.

At the morning session Professor Dalgaard met with Dr Janet Howieson (CESSH) Assoc Prof Hannah Williams (Curtin University, Food Science), Rachel Tonkin (CRC PhD student), Felicity Denham (CESSH research assistant) and Dr Wendy Hunt (CESSH researcher).
The purpose of this meeting was to

- Gain understanding of the principles of the seafood predictive model development
- Input temperature and microbiological data collected in CRC 2009/709: Improving the Supply Chain for Selected WA Seafood Products to the predictive models developed by Professor Dalgaard.
- Input temperature and microbiological data collected by Rachel Tonkin in her PhD studies into the predictive models.
- Develop Expertise in the use of the model by the researchers was another planned outcome.

It was clear during the morning that the temperature and microbiology results differed from what would be expected using the warm water fish predictive models developed by Professor Dalgaard. Discussions were then held about developing a further warm-water predictive model using initially data collected as part of 2009/709 and then what extra data would be necessary to ensure validation. There was some discussion that Felicity Denham may like to do a PhD in this area, and Professor Dalgaard agreed that if that evolved he would be happy to take a mentoring role. Finally planning and/or development of some articles for peer reviewed journals combining the case study results of 2009/709 with the predictive modelling were undertaken.

In the afternoon, there was an industry meeting with a representative from MG Kailis (industry partners on CRC 2009/709). Professor Dalgaard presented a general summary and then protocols specific to MG Kailis were discussed. Some of these suggestions will be forwarded in the implementation phase of 2009/709.

The meetings with Professor Dalgaard resulted in knowledge and confidence in predictive modelling for seafood safety. Opportunities for collaborative effort evolved. The industry presence was disappointing but the opportunity to progress new protocols in the industry projects did occur.

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Appendix 5. Letter from Kaylene Little concerning outcomes of the TASSAL (Huonville, Tasmania) visit.

Sunday, 10 July 2011

Tom Ross
C/- University of Tasmania

Dear Tom,

I would like to pass on our sincere thanks for the recent meetings and workshops conducted by yourself and Dr Paw Dalgaard.

The issues addressed and information provided in the workshops was of an international standard and touched on subjects such as Listeria, product formulation and shelf life - all extremely critical and current in our industry today.

We are the largest Aquaculture organisation in Australia and the knowledge my team has taken from the workshops has unlocked ***significant*** future potential for our company and in turn the industry. For example, I have now been able to have dialog with one of our key retail customers working on a solution that has previously escape both parties, this has been as a direct result of the information provided by yourself and Dr Paw.

I would like to acknowledge that the opportunity was made possible with the assistance of CRC sponsorship. From our perspective the investment has been invaluable. I would like to pass on our thanks to the CRC, University of Tasmania, Dr Paw and yourself.

Looking forward to working with you in future.

Yours sincerely

Kaylene Little
Head of QA, HR & Safety

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Appendix 6a. Feedback from participants at the Adelaide Predictive Microbiology workshop

Question							
	The workshop was well organised	The advertising of the workshop was an accurate reflection of the content	The information presented at the workshop was useful and relevant	The presenters were well organised and communicated the important messages clearly	The presenters generated a good working atmosphere for asking questions and sharing ideas, opinion and experience	I would recommend the workshop to others in the seafood industry.	Comments
	5	5	4	3.5	4	5	
	4	5	5	5	5	5	The '4' for organisation was because of the lack of power points for the laptops. Everything else was great and very interesting.
	5	4	4	4	5	4	
	5	5	5	5	5	5	
	4	5	5	5	5	4	Lots of material covered meant that some sections were quite rushed. There is a great deal of scope for further extension work which could/should be considered.
	5	5	5	5	4	5	I like to have more of them.
	5	5	5	5	4	5	
	4	4	3	5	4	4	
	5	5	5	5	5	5	
	5	5	5	5	5	5	
	5	5	5	5	5	5	
	5	5	5	5	5	5	
	5	5	5	5	5	5	Time constraints restricted further discussion.
	5	5	5	5	5	5	Excellent.
	5	5	5	5	5	5	i. More time for extended practice would have been good - a bit rushed. ii) Slightly larger room with more powerpoints and less cables. iii) Need to do more of this - we don't receive enough of this exposure in South Australia.
	5	5	5	5	5	5	
	5	5	5	5	5	5	got a lot out of the listeria talk - very informative.
	5	5	5	5	5	5	
	5	5	5	5	5	5	
	1	1	1	1	1	1	
	2	1	2	2	2	2	
Mean	4.434782609	4.347826087	4.478260870	4.477777777	4.347826087	4.565217391	
Mean (ex outliers)	4.714285714	4.666666667	4.761904762	4.775	4.619047619	4.857142857	(In these values, the 'unusual' scores are not included)

Appendix 6b. Feedback from participants at the Hobart Predictive Microbiology workshop

Question	Hobart	The workshop was well organised	The advertising of the workshop was an accurate reflection of the content	The information presented at the workshop was useful and relevant	The presenters were well organised and communicated the important messages clearly	The presenters generated a good working atmosphere for asking questions and sharing ideas, opinion and experience	I would recommend the workshop to others in the seafood industry.	Comments
		5	5	5	5	5		Vibrio content did appear to be a bit, unstructured and out of place/fast
		4	4	4	4	4		5 minute compared to the bulk content. Otherwise very good program
		5	5	4	5	5		interested to see feedback from participants coming from a 'zero
		5	5	4	5	5		3 knowledge' background
		5	5	5	5	5		5
								the presenters encouraged questions and discussion. Working through the
								exercises was very useful in order to increase understanding of the
								concept. Yes, I would recommend the workshop to people working in other
		5	5	4	5	5		4 industries.
								good sessions, probably more focus on how to use the tools as opposed to
		5	4	5	5	5		5 the background
								It was a fantastic day - really glad to have participated and will definitely
								be using the content (and the SSSB) - even though in a research
		5	5	5	5	5		5 capacity.
		5	5	5	5	5		5 Extremely constructive and yet lucid
		5	5	5	5	5		5
		4	5	4	4	4		4
		5	5	5	5	5		5
		5	5	5	5	5		5
		4	4	4	4	4		4
		5	5	5	5	5		5 too short a time for information, but examples in book help
	4.866666667		4.642857143	4.4	4.8	4.533333333	4.642857143	