

FINAL REPORT (DEVELOPMENT AWARD)

2008/328.20	FRDC People Development Program: 2014 FRDC Visiting Expert Award – Associate Professor Dale Leavitt
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AWARD RECIPIENT: Prof Dale Leavitt

ADDRESS: Feinstein College of Arts and Sciences
Roger Williams University
1 Old Ferry Rd
Bristol, RI 02809
United States

HOST ORGANISATION: Select Oyster Company (SOCo)

DATE: October 30th 2014

ACTIVITY UNDERTAKEN:

During the course of Dr Dale Leavitt's two-week visiting expert trip in July-August 2014, he presented 8 farmer workshops and 1 keynote address and toured 15 oyster farm locations including regions in New South Wales, South Australia and Tasmania. Dale directly presented to approximately 193 oyster farmers and 38 governmental, university and other interested parties, where he participated in focused one-on-one conversations with many of the participants over the extensive contact hours spent with the industry.

At the workshops, Dale addressed a number of different key topics (as recommended by SOCo and the FRDC) to assist the Australian oyster industry with improving production and long-term sustainability. These topics included:

- An overview of the shellfish farming industry in the northeastern area of the United States,
- A survey of upweller systems used in the U.S. for nursery culture of clams, oysters and scallops,
- Details on the construction and management of a floating upweller nursery system (FLUPSY),
- An overview of clam culture in the northeastern U.S. region,
- A summary of the oyster restoration activities currently underway in Rhode Island, USA,
- Risk management strategies for shellfish farms.

In addition, Dale meet with industry members, university parties, and government representatives on a one-to-one basis for direct discussion and consultation.

OUTCOMES ACHIEVED TO DATE:

A total of approximately 200 oyster growers and stakeholders met Dr Dale Leavitt during his Australian visit. Information sharing with the Australian oyster industry took place via 8 farmers' workshops, 15 oyster farm visits and 2 public seminars in regions of NSW, SA and TAS.

Associate Professor Leavitt noted that

“Australian innovations in oyster grow-out are highly effective methods for the final stages of grow-out, while the US strategies for nursery culture seemed better suited for high output production than their counterparts in Australia. Therefore, my visit to Australia provided information on alternative nursery systems that could enhance spat growth and reduction of time to market.

It was obvious throughout my travels in Australia that oyster farmers were highly interested in learning of new technologies and were very receptive to considering how new technology could be adapted to their specific business. Hence, visiting expert awards like this brings overseas technology to Australian growers in an effective way.”

All information provided by Dale throughout his workshops has been made available to the industry so that it can be implemented and adopted. This has been the case already, and within 3 months of his visit, a number of growers have started the planning and/or construction of FLUPSY systems and observed positive results for their oyster stocks.

The limited information flow within the oyster growing regions suggests there is a role for governmental agencies to become more involved with technology transfer and outreach to the oyster industry. From his visit to Australian oyster industries, Dale believes that Australia could make a significant leap in developing a stronger shellfish culture industry by developing a government-sponsored technology outreach program, possibly modelled after the USA's Agricultural and Sea Grant Extension Programs, where trained extension agents provide technology transfer and industry support across the industry.

Links to PowerPoint presentations; video; photos and other resources are provided as appendices.

Acknowledgments

As an FRDC Visiting Expert to the oyster farmers of New South Wales, South Australia and Tasmania, I am deeply indebted to many individuals and organizations for providing a seamless and most enjoyable introduction to the many participants in the Australian oyster industry. In particular, I need to acknowledge the Fisheries Research and Development Corporation (FRDC) for their support of my travels and the Select Oyster Company (SOCo) for making the visit happen. I also am indebted to the many individuals, who organized the complex arrangements to send me on my way across southeastern Australia. In particular, I thank Ana Rubio, Emma Wilkie, and Ian Duthie for organizing my itinerary and coordinating to shepherd me from Port Macquarie to Coles Bay with many stops in between. Their hospitality and generosity was above the call and I greatly appreciated their assistance. As I travelled, I met a wide array of wonderful people and organizations who helped me and that I must thank. These include, in the order with which I met them:

- Geoff Diemar – Diemar's Oysters, Port Stephens, NSW
- Wayne O'Connor and Mike Dove – Port Stephens Fisheries Institute, NSW
- Tony Troup – Camden Haven Oyster Supply, Laurieton, NSW
- Jane Clout – Koorinal Oysters, Moreton Bay, QLD
- Andy Myers - Ocean Watch Australia, Pyrmont, NSW
- Jill & Michael Coates – SAOGA, Port Lincoln, SA
- Trudy McGowan – SAORC & SAOGR, Port Lincoln, SA
- Tony Shutz and the BST folks, Cowell, SA
- Geoff Turner – Turner's Oyster Farm, Cowell, SA
- Jan Potter, Michael Barker & Rolly Rush – Cowell Area School Aquaculture Program, Cowell, SA
- Brendan Guidera – Pristine Oysters, Coffin Bay, SA
- Lincoln Marine Center, Port Lincoln, SA
- Carl Laeschke - , SA
- Mark Gluis & Li Xiaoxu - PIRSA- SARDI, Adelaide, SA
- Hayden Dyke – Oyster Bay Oysters, Little Swanport, TAS
- Giles Fisher - Freycinet Oyster Farm, Coles Bay, TAS
- Ben Cameron – Camerons of Tasmania, Dunalloy, TAS
- Sally Dakis – ABC Rural Radio, Hobart, TAS
- Institute of Marine and Antarctic Studies, Hobart, TAS
- John Purser & Scott Marston– University of Tasmania, Launceston, TAS
- Jillian Harrington - Oysters Tasmania, Hobart, TAS
- Scott Parkinson, Andy Day and Michel Bermudes – Shellfish Culture Limited, Clifton Beach, TAS
- Chris Carter - TAFI Marine Research Laboratory, Taroona, TAS
- Jillian Keating & Adam Gietzelt, South East Local Land Services, Nowra, NSW

- Sid Paschalidis - Pearly Oysters, Clyde River/Batemans Bay, NSW
- Kevin McAsh – McAsh Oysters, Clyde River, NSW
- Chris Munn – Kingtide Oysters, Shoalhaven, NSW
- Leon and Angela Riepsamen - Goodnight Oysters, Greenwell Point, NSW
- Paul Hick - University of Sydney, Sydney, NSW
- Dave Maidment – Australian Native Shellfish, Narooma, NSW
- Shane Buckley – Buckley’s Oysters of Wapengo, Bermagui, NSW
- Brett Weingarth – Black Bull Pastoral, Ltd, Merimbula, NSW
- Sue McIntyre & Greg Carton – Broadwater Oysters, Pambula, NSW
- Sapphire Coast Oyster Wilderness, Pambula, NSW
- Pambula Fishing Club, Pambula, NSW
- Gio Braidotti – Fish Magazine, Coretex, Melbourne, VIC

Abbreviations

FRDC – Fisheries Research and Development Corporation, Deacon West, ACT	SAORC – South Australia Oyster Research Council, Stirling, SA
IMAS – Institute of Marine and Antarctic Studies, Hobart, TAS	SARDI – South Australia research and Development Institute, Urrbrae, SA
JOD – Juvenile Oyster Disease (USA oyster disease)	SCL – Shellfish Culture Limited, Clifton Beach, TAS
LLS – Local Land Services of NSW	SOCo – Select Oyster Company, Pambula, NSW
MSX - Multinucleated Sphere Unknown (USA oyster disease)	SSO – Seaside Organism (USA oyster disease)
PIRSA - Primary Industries and Resources South Australia, Adelaide, SA	TAFI – Tasmanian Aquaculture and Fisheries Institute, Taroona, TAS
POMS – Pacific Oyster Mortality Syndrome	
RWU – Roger Williams University	
SAOGA – South Australia Oyster Growers Association, Stirling SA	

Background

Oyster farmers are increasingly trying to diversify their seed sources by purchasing hatchery-sourced oyster spat in addition to wild-caught oysters. In order to take full advantage of the increase in commercially available hatchery spat, farmers want to be able to purchase seed directly from hatcheries as well as purchasing larger seed from land-based nurseries. Currently, hatchery-produced spat is held in a land-based commercial nursery for up to 6 months until it reaches a size that can be handled (>4mm) by oyster farmers using conventional trays, baskets, and tumblers. Floating Upweller Systems (FLUPSYs) are a proven technology that provides farmers overseas an alternative form of infrastructure required to grow delicate nursery stage oyster seed, while taking advantage of natural environmental conditions, and producing spat often at a significantly faster rate than sock/tray and land-based nursery methods. By enhancing the husbandry of nursery oysters, growers will cultivate a more robust crop and will reduce the cultivation time, increasing profitability. FLUPSYs can also be solar powered, which is a practical, affordable and sustainable technology that would significantly benefit oyster farmers that wish to diversify and grow their businesses but are limited in their land-based access. An expert was brought to Australia to assess the feasibility of FLUPSYs in Australian waters, including the application and construction of FLUPSYs within the Australian oyster husbandry systems. FLUPSY technology has been pioneered and developed extensively among oyster farms in the USA and Canada, supplying an increasingly affordable, sustainable and accessible technology for oyster businesses of varying scales. Therefore, the latest information about the application of FLUPSYs is of interest within the Australian oyster industry.

Need

This proposal was developed in response to interest communicated by a number of oyster industry groups, in particular groups from NSW, that expressed a desire to learn about alternative and innovative technologies to enhance oyster spat growth. The oyster-seed market in particular is rapidly expanding with improvements in hatchery production technologies and the breeding programs which are supplying oysters with levels of disease resistance and fast growth at a commercial scale. At present, the demand for hatchery seed among the Sydney Rock Oyster industry is ~20% of growers and is projected to contribute up to 50 % of seed supplies within the next 5 years. Furthermore, the Pacific Oyster industry relies almost entirely on hatchery seed supply. Oyster growers in Australia have extensive experience in growing juvenile oysters through the use of infrastructure including fine mesh bags and inserts in their trays and baskets, and they are interested in applying alternative methods to enhance production and compare the advantages of using alternate methods.

However, Australian oyster growers currently use a complex series of techniques to nursery cultivate oyster spat in comparison with their counterparts in the USA. For example, nursery systems in Australia are predominantly land based, which require capital in the form of land with suitable water access, electricity, infrastructure and necessary permits. The current method for the nursery culture of oyster spat in Australia is comprised of a number of short steps using technology starting with bottle upwellers in the hatchery and progressing to in-tank upwellers or field-based seed trays followed by field-based fine-mesh bag culture. The end result is a sequence of culture steps requiring multiple handling events using varied technologies. In contrast, in the USA farmers are quickly adopting in-water upweller nursery methods that do not require land based sheds/tanks or multi-stage equipment transitions. These highly efficient floating upweller systems, or FLUPSYs, are proving to be very beneficial in shellfish seed on-growing and accelerating production yield among the Eastern Oyster (*Crassostrea virginica*) and other mollusks. What's more, FLUPSYs can be fitted with photovoltaic power devices; therefore the benefits of the technology can extend to very remote areas that would otherwise not have access to these upwellers.

Such upwelling devices optimize oyster spat growth by providing a high level of food flux in an evenly distributed flow to the bed of oyster spat. This is accomplished in a concentrated production facility, the FLUPSY, with a relatively small footprint that is comparatively easy to maintain. The end result is to reduce nursery time and hence, to reduce time to market leading to a significant increase in productivity. In the USA, where much of the oyster aquaculture industry is challenged with a number of slowly progressing endemic diseases, upwelling technology has allowed the oyster farmers to gain in their race with the diseases such that their oysters can be grown to market size before the oyster stock enters the disease window of mortality.

The Select Oyster Company (SOCo) was keen to assist the Australian oyster industry to gain knowledge in such husbandry techniques so that farmers could effectively manage spat at their farm, and diversify their husbandry techniques in order to handle smaller seed to on-grow at a later stage of development. As such, SOCo identified an expert (Dr. Dale Leavitt, Roger Williams University, Bristol, Rhode Island, USA) in the USA with extensive experience in upweller technology and with a proven track record in developing innovative improvements to FLUPSY design and operations. Dr. Leavitt was invited to visit local oyster farms to address their specific needs in relation to the use of upweller technologies for growing hatchery seed Sydney Rock Oysters and Pacific Oysters. During his tour, he visited a variety of oyster growing sites and farms to understand the specific requirements and resources that each grower had in order to assist in developing systems that would be suitable for their conditions.

In addition to upwelling techniques, Dr. Leavitt was also capable of addressing other topics of interest to Australian shellfish growers. For example, alternate shellfish species cultivation and specifically in the USA, the hard clam (quahog, *Mercenaria mercenaria*). In Australia, the oyster industry has potential to expand into cultivation of other species. For example, numerous growers are diversifying their operations to include the native flat oyster (*Ostrea angasi*) and there is, in fact, a keen interest among growers in NSW to produce other species. With the current infrastructure used in Australia, this is certainly a realistic possibility. Therefore, Dr. Leavitt was asked to also include information on alternate species cultivation and the USA experience with respect to cultivating alternate mollusk species, in particular hard clams. Diversifying the shellfish crop on a farm is a proven means to counter the high risk strategy of cultivating one species, which may be susceptible to catastrophic losses due to disease or other adverse events.

Objectives

1. Knowledge transfer of the applicability and benefit of FLUPSYs in the Australian oyster industry via a series of interstate workshops.
2. Identify specific uses of FLUPSYs as a means to 1) efficiently cultivate single seed oyster spat than current sock/tray methods; 2) diversify business techniques; 3) improve handling techniques and spat condition.
3. Build-up collaborations between Australian and USA oyster industries.
4. Long-term industry intention to increase use of hatchery-sourced spat as a result of uptake FLUPSY technology.
5. Development of a comprehensive, user-friendly FLUPSY manual, specific to Australian environmental systems.

Methods

Dale Leavitt's visit involved workshop presentations and site visits to oyster farms, hatcheries and departmental bodies in New South Wales, South Australia and Tasmania. The workshop seminars to oyster farmers offered the following subjects:

- 1) An overview of oyster growing industry and the technology commonly used in the Northeast U.S.
- 2) Upweller technology - a general overview of upweller technology and the options for upweller installations, including introducing floating upweller systems (FLUPSYs).
- 3) FLUPSYs - details on construction, including tips on improvements made to the standard design, along with details on the solar powered FLUPSY recently designed, built and evaluated.
- 4) Details on hard clam (quahog) growing technology along with other species that are emerging in the Northeast U.S. (softshell clams, razor clams, bay scallops).
- 5) Outreach tools - including details on a shellfish grower's hazards guide, best management practices, a research farm network, recreational aquaculture permitting, oyster gardening/restoration, and shellfish farmer start-up training programs.
- 6) Development of disease-tolerant oyster stocks.
- 7) Current problems affecting the shellfish growers in the Northeast U.S., such as *Vibrio* management, regulatory permitting, overdevelopment, etc.

Each workshop group was asked to select what materials they wanted Dr. Leavitt to address in the two-hour workshop presentation. Each presentation was followed by an extended question and answer period to allow farmers to pursue any details where they wanted more information.

In addition to the workshop format, Dr. Leavitt was guided through a hatchery/farm tour at each visited region where he was able to survey current growing strategies in the region and had an expanded opportunity for one-on-one interactions with farmers.

A timeline and summary of Dr. Leavitt's activities during his visit to southeastern Australia:

- 20 July – Arrived in Sydney, NSW; Toured city with Ana Rubio including introduction to local oysters at the Sydney Fish Market.
- 21 July – Drove to Port Stephens with Ana Rubio; Visited oyster nursery and farm of Geoff Diemar for consultation; Toured Port Stephens Fisheries Institute with Mike Dove and Wayne O'Connor; Presented a farmer's workshop at the Fisheries Institute; Drove to Port Macquarie with Emma Wilkie for dinner with Tony Troup and Jane Clout of the Select Oyster Company Advisory Board.
- 22 July – Visited the shellfish hatchery and oyster farm of Tony Troup in Port Macquarie; Presented a farmer's workshop at the Port Macquarie Bowling Club.
- 23 July – Flew to Port Lincoln, South Australia. Briefly met with Jill Coates (SAOGA) at the Port Lincoln Airport before driving to Cowell, SA; Arrived at BST facility in Cowell for an informal evening barbecue with local growers and families followed by a workshop with local oyster farmers in the evening.
- 24 July – Spent the morning participating in a farm tour with Tony Shutz and Geoff Turner; Stopped at the Cowell Area School Oyster Aquaculture Program and met with Principal Jan Potter, Instructor Michael Barker and Farm Manager Rolly Rush to discuss aquaculture education; Returned to Port Lincoln for lunch with Jill Coates (SAOGA) then drove to Coffin Bay to meet with Brendan Guidera of Pristine Oysters to discuss his efforts to grow the Angasi oyster; Returned to Port Lincoln for an evening workshop at the Lincoln Marine Science Centre followed by dinner with many of the growers attending the workshop.
- 25 July – Flew from Port Lincoln to Hobart, Tasmania; While *en route*, I met with Mark Gluis and Li Xiaoxu from PIRSA- SARDI at the Adelaide Airport to discuss current research efforts in shellfish aquaculture and breeding oysters for disease resistance; Arrived at Hobart and was met by Ian Duthie, who took me to Orford, Tasmania as my base of operations on the island.
- 26 July – A free day: spent the day touring Hobart with Ian Duthie, including visiting the Salamanca Market, the Museum of Old and New Art, and a drive up Mount Wellington.
- 27 July – Drove to Little Swanport to visit Hayden Dyke of Oyster Bay Oysters for a farm tour; Continued on to Freycinet Oyster Farm in Coles Bay to meet with Giles Fisher along with two other oyster farmers from the region (Craig Lockwood and Murray Rutherford); Had lunch at Freycinet's take-out restaurant and toured Freycinet's mussel and oyster farms; Had an in-depth discussion following a presentation on FLUPSYs with farmers at the Freycinet oyster shed.
- 28 July – Drove to Dunalley for a farm tour with Ben Cameron at Cameron's of Tasmania; Visit with two farmers Mike Webb and Max Cunningham at their oyster sheds in Blackman Bay; Lunch at Barilla Bay oyster farm; Joined with Ian Duthie for a radio interview with Sally Dakis of ABC Rural Radio; Conducted a farmer workshop at the Institute for Marine and Antarctic Studies in Hobart (also video linked to the University of Tasmania in Launceston for a group of students under the direction of Prof. John Purser) followed by dinner with many of the participating farmers.
- 29 July – Visited Cremorne Pacific Oysters (Mike Webb's second farm) at Pipeclay Lagoon; Toured Shellfish Culture Limited's hatchery at Clifton Beach with Michel Bermudes (SCL's Bicheno Hatchery Manager), Andy Day and Scott Parkinson (SCL Breeding Manager); Had lunch with Dr. Chris Carter, the Director of the Fisheries, Aquaculture and Coasts Centre at TAFI's Marine Research Laboratory in Tarooma; Flew to Sydney then drove to Nowra with Emma Wilkie.
- 30 July – Drove to Bateman's Bay and presented a farmer's workshop using Sid Paschalidis' oyster shed on the Clyde River, in collaboration with South East Local Land Services NSW; Toured the Clyde River oyster farms with Kevin and Ewan McAsh.

- 31 July –Presented a farmer’s workshop in Shoalhaven, NSW, in collaboration with Local Land Services of NSW at Chris Munn’s oyster shed; Toured the Shoalhaven oyster farms and their oyster hatchery with Leon and Angela Riepsamen from Goodnight Oysters; Met with Paul Hick (Faculty of Veterinary Sciences) and two graduate students from the University of Sydney to discuss shellfish disease issues.
- 1 Aug – Drove to Narooma to visit Dave Maidment and toured his oyster farm, growing Angasi oysters, with Ana Rubio; Had lunch at the Bermagui Oyster Room and talked with owner Shane Buckley, producer of Wapengo Rocks oysters; Drove to Merimbula/Pambula region; Had a farm tour of the Merimbula oyster farms with Brett Weingarth and the Pambula Lake oyster farms with Greg Carton and Sue McIntyre of Broadwater Oysters; Presented the keynote lecture on oyster restoration to the Sapphire Coast Wilderness Oysters AGM in the evening.
- 2 Aug – Presented a farmer’s workshop to the Sapphire Coast oyster farmers at the Pambula Fishing Club; Provided a phone interview to Gio Braidotti for Fish Magazine; Returned to Sydney via Canberra for departure.

Results

During the two-week tour of oyster growing areas in south eastern Australia, Dr. Leavitt was introduced to the wide array of regions and farms where shellfish aquaculture was currently underway. As he toured the area, he completed a series of farmer workshops as well as provided numerous opportunities for one-on-one consultations and discussions with active oyster farmers. A summary of each workshop event and his interactions with farmers, on-site, are included below.

1) Port Stephens, NSW Workshop

- a) Location: NSW Port Stephens Fisheries Institute, Port Stephens, NSW.
- b) Schedule:
 - i) 12:30 to 1:00 PM - lunch provided
 - ii) 1:00 to 1:15 PM - Wayne O’Connor provided an overview of recent developments in oyster farming in the region,
 - iii) 1:15 to 3:15 PM - Introductory comments by Dr. Leavitt followed by the farmer-selected presentations on upweller technology and clam culture techniques.
- c) Estimated Attendance: 30 oyster farmers from the Hawkesbury, Brisbane Waters, Port Stephens and Wallis Lakes with 10 Fisheries Institute staff/outside observers.
- d) Farm Tour: preceding the workshop, in the morning, a tour of Geoff Diemar’s oyster nursery with an in-depth discussion of current practices, including observation of a land-based upweller nursery.
- e) Other interactions: A tour of the Post Stephens Fisheries Institute with Wayne O’Connor and Mike Dove with a discussion of research activities directed at current problems in local oyster aquaculture; dinner with Emma Wilkie, Tony Troup and Jane Clout (SOCo Manager and Board members).

2) Port Macquarie, NSW Workshop

- a) Location: Port Macquarie Bowling Club, Port Macquarie, NSW
- b) Schedule:
 - i) 2:00 to 4:00 PM - Introductory comments by Dr. Leavitt followed by the farmer-selected presentations on upweller technology and detailed information on FLUPSY construction and management.
- c) Estimated Attendance: 19 oyster farmers from Laurieton and Port Macquarie and 1 government representative
- d) Farm Tour: Preceded workshop in the morning with a tour of Tony Troup’s oyster hatchery and field operations with detailed discussions on hatchery operations.

- 3) Cowell, SA Workshop
 - a) Location: BST Office, Cowell, SA
 - b) Schedule:
 - i) 6:00 to 7:30 PM - barbecue with oyster farmers
 - ii) 7:30 to 10:30 PM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management. Concluded with a lengthy discussion of various issues associated with oyster culture.
 - c) Estimated Attendance: 10 oyster farmers.
 - d) Farm Tour: The following morning, toured Tony Shutz's farm (Tondari Fisheries) as well as visits to Tondari Fisheries and Turner Oyster Farm operations (shed, sorter/grader, materials handling practices, etc.)
 - e) Other Interactions: Following the farm tour, Dr. Leavitt stopped at the Cowell Area School to meet with the Principal Jan Potter, Instructor Michael Barker and Farm Manger Rolly Rush to discuss aquaculture education practices.

- 4) Port Lincoln, SA Workshop
 - a) Location: Lincoln Marine Science Centre, Port Lincoln, SA
 - b) Schedule:
 - i) 6:00 to 8:00 PM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management.
 - ii) 8:00 to 10:00 PM – Informal dinner with workshop participants for more informal and directed discussion.
 - c) Estimated Attendance: 20 oyster growers and 4 outside observers.
 - d) Farm Tour: Preceding the workshop, Dr. Leavitt visited with Brendan Guidera at his shed on Coffin Bay to discuss Pristine Oyster's efforts with growing and marketing the Angasi oyster.

- 5) Hobart, TAS Workshop
 - a) Location: Institute for Marine and Antarctic Studies, Hobart, TAS
 - b) Schedule:
 - i) 6:00 to 8:00 PM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management.
 - ii) 8:00 to 10:00 PM – Informal dinner with workshop participants for more informal and directed discussion.
 - c) Estimated Attendance: 37 oyster farmers joined by video link with 13 participants in John Purser's University of Tasmania group.
 - d) Farm Tour: Participated in numerous farm and hatchery tours throughout Tasmania, including Coles Bay, Dunalley, Blackman Bay, Pipeclay Lagoon, and Clifton Beach (see timeline above).
 - e) Other Interactions: Conducted a radio interview with Sally Dakis and Ian Duthie to discuss oyster aquaculture and contrasts between Tasmanian industry and that in the U.S.A. (<http://www.abc.net.au/news/2014-07-29/shellfish-oyster-rhode-island-tasmania/5631084>)

- 6) Clyde River, NSW Workshop
 - a) Location: Sid Paschalidis' oyster shed on the Clyde River, NSW
 - b) Schedule: Workshop held in conjunction with South East Local Land Services workshop on "Enhancing Your Oyster Business"
 - i) 9:00 AM to 12:00 PM - LLS Workshop
 - ii) 12:00 to 1:00 PM - informal lunch with shellfish growers
 - iii) 1:00 to 3:00 PM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management.

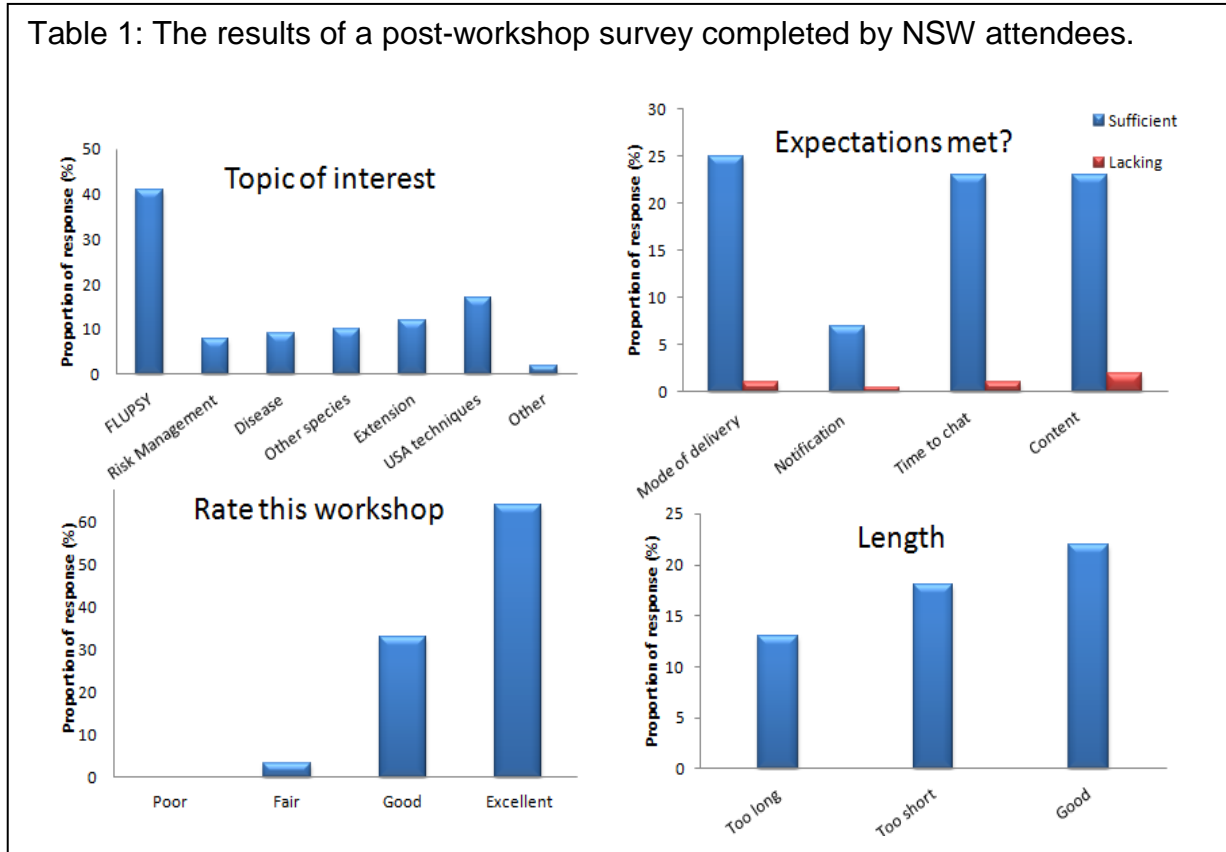
- c) Estimated Attendance: 10 oyster farmers
 - d) Farm Tour: Following the workshop, Kevin McAsh toured Dr. Leavitt and Emma Wilkie about the oyster growing area in Clyde River.
- 7) Shoalhaven, NSW Workshop
- a) Location: Chris Munn’s oyster shed
 - b) Schedule: Workshop held in conjunction with South East Local Land Services workshop on “Enhancing Your Oyster Business”
 - i) 9:00 AM to 12:00 PM - LLS Workshop
 - ii) 12:00 to 1:00 PM - informal lunch
 - iii) 1:00 to 3:00 PM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management.
 - c) Estimated Attendance: 20 oyster farmers, 5 government representatives and 3 university representatives.
 - d) Farm Tour: Following the workshop, Leon and Angela Riepsamen toured Dr. Leavitt, Emma Wilkie, Paul Hick and two Univ. Sydney graduate students about the oyster growing area in Shoalhaven.
 - e) Other Interactions: During and after the farm tour, Dr. Leavitt discussed oyster disease research with Paul Hick (Faculty of Veterinary Sciences) and two graduate students from the University of Sydney.
- 8) Sapphire Coast Wilderness Oyster AGM
- a) Location: Wheeler’s Oysters Restaurant
 - b) Schedule:
 - i) 6:00 to 8:00 PM – informal dinner with oyster growers from Sapphire Coast area
 - ii) 8:00 to 9:00 PM – Dr. Leavitt provided the AGM keynote address on oyster restoration activities in Rhode Island, with a discussion of volunteer oyster gardening, oyster restoration and ecological services of oysters to the ecosystem.
 - c) Estimated Attendance: 32 oyster farmers
 - d) Farm Tour: In transit from Nowra to Pambula, Dale Leavitt and Ana Rubio stopped at David Maidment’s farm to tour his oyster hatchery and the oyster growing area of Narooma.
 - e) Other Interactions: We also stopped to have lunch at Shane Buckley’s new oyster bar in Wapengo, NSW and to have a quick chat with him about his oyster farm.
 - f) Farm Tour: Upon arrival in the Merimbula/Pambula region, Dr. Leavitt toured the Merimbula oyster area with Brett Weingarth and the Pambula Lake growing area with Sue McIntyre and Greg Carton to perform a feasibility assessment of potential sites for FLUPSYs
 - g) Other Interactions: Dr. Leavitt was interviewed over the phone by Gio Braidotti for an upcoming article in FISH Magazine (FRDC).
- 9) Pambula, NSW Workshop
- a) Location: Pambula Fishing Club, Pambula, NSW
 - b) Schedule:
 - i) 9:00 to 11:00 AM - Introductory comments by Dr. Leavitt followed by the farmer selected presentations on upweller technology and detailed information on FLUPSY construction and management.
 - c) Estimated Attendance: 15 oyster farmers

The content for each workshop presented is included in Appendix 1, at the end of this report.

As a component to the workshops in NSW, a feedback questionnaire on the farmer’s impressions of the workshop was distributed as a follow up. The results of that survey are included in Table 1. Feedback information was received from 61 surveys that were completed. The majority of respondents were oyster farmers (92%) while there were 2 respondents from universities and 3 from

state governmental organizations.

Table 1: The results of a post-workshop survey completed by NSW attendees.



Discussion

Much of the grow-out technology developed by the Australian oyster industry is now well known in the USA and is recognized as consisting of high quality and well-conceived methods for on-growing oysters. Since introduction of the Australian long-line hanging basket technology in the early 2000's, northeast USA oyster growers have readily adopted that technology where appropriate and have imported the specialized equipment from Australian suppliers. Therefore, I was intrigued with visiting the Australian oyster industry to observe how these technologies were being applied in the land of origination. At the same time, I was hopeful that I could assist the Australian oyster industry with applying some oyster nursery innovations from the USA.

As it turns out, my preconceptions of the contrasts between Australian and USA oyster production technologies held true, in that the Australian innovations in oyster grow-out were highly effective methods for the final stages of grow-out while the US strategies for nursery culture seemed better suited for high output production than their counterparts in Australia. Therefore, my visit to Australia could provide potential advantages to the oyster nursery culture strategies of growers if technologies could be shared for the nursery culture stage.

The primary advantage with simplifying oyster nursery technology is to allow for the spat production to be transferred from the hatchery to the individual grower, thereby potentially reducing the hatchery production cycle, placing more control of spat production in the hands of the individual grower, increasing the growth rate of young spat and reducing the overall cost to the grower of spat production by allowing them the option of purchasing their spat at a smaller and less costly stage. The current nursery practices where oyster spat are reared from 500 microns through to 8-10 millimetres, as observed at both hatcheries and nurseries throughout my Australian tour, consists of numerous technologies resulting in transfers of spat from setting downwellers to bottle upwellers to land-based upwellers to seed trays to fine mesh bags or baskets. This sequence often requires not

only numerous handling events but also transfers that consist of significant transport to various locations where the next stage of technology is set up. Based on operations in the USA, this sequence of culture technologies could be replaced with a two-stage process consisting of bottle upwellers (500 μ m to 2 mm) and a floating upweller system (2mm to outplant size).

In the USA, a nursery will receive the spat from the hatchery at a size that allows for retention on a 1mm mesh screen. At that size, the spat can be transferred directly into a FLUPSY, where it will remain until the seed is ready to be outplanted in baskets or mesh bags. In the USA, the outplanting does not usually occur until the seed reaches a nominal size of 25 mm. The rationale for this strategy is focused on holding the seed in the nursery system until they can be transferred to a bag or basket mesh size that reduces the need for fouling maintenance. This strategy for nursery culture could easily be integrated into the current production practices of the farmers in all of the sites that I visited during my tour.

Australian oyster growers have already experienced the limitations of focusing their efforts on one species of shellfish, where they have witnessed catastrophic losses due to species-specific diseases (POMS and winter mortality) infecting their monoculture of oysters. USA growers have also had to weather similar situations with the combined impact of numerous oyster diseases, such as MSX, SSO, dermo and JOD. In both Australia and the USA, one answer to the problem is to diversify the shellfish crop such that they are not carrying all of their eggs in one basket! To that end, some of our USA oyster growers also plant other mollusc species to have a partial fall-back resource should something impact one of their crops. We, as USA researchers and outreach specialists, are continuously working to develop alternate species culture strategies and to extend that technology to our shellfish growers. While the oyster is king in terms of demand and pricing, there are alternate species of bivalves that are marketable and where adaptation of existing technologies from other regions could be applied by the shellfish growers in southeastern Australia. Species such as the pipi or Goolwa cockle (*Plebidonax deltoides*), the vongole (*Katylesia* spp.), surf clam (*Dosinia caerulea*), cockles (*Anadara* spp.) or the razor clam (*Pinna bicolor*) could be candidate species for expanding the product line for shellfish growers in the region, particularly if technology can be developed that will allow the grower to use methods similar to their current culture practices. (Another candidate may be the Queensland scallop (*Amusium balloti*) or other scallop species but I did not explore these species as candidates for expanding the shellfish culture industry.) Currently, technology exists for commercially culturing a few clam species, such as the quahog (*Mercenaria mercenaria*) and the manila clam (*Ruditapes philippinarum*) and these technologies should be explored for adaptation to native species in the southeastern Australia region.

It was obvious throughout my travels in Australia that the farmers were highly interested in learning of new technology and were very receptive to considering how that new technology could be adapted to their specific business. At every workshop, you could see their thoughts developing as the farmers considered my information and their questions (then and through email as follow-up) were/are clear indications of their intention to try to adopt some of the information provided. The very positive reception to me (over and above the natural hospitality of the Australian citizen) and their interest in improving their industry coupled with their (sometimes) expressed frustration with information flow in the region suggests there is a role for governmental agencies to become more involved with technology transfer and outreach to the oyster industry. From my limited observations, it appears that the bulk of the outreach occurring in the region is either generated by the industry members themselves, e.g. SOCo, or from a small number of state-sponsored institutions, e.g. NSW Marine Fisheries Institute. I believe that Australia could make a significant leap in developing a stronger shellfish culture industry by developing a government-sponsored technology outreach program, possibly modelled after the USA's Agricultural and Sea Grant Extension Programs, where trained extension agents provide technology transfer and industry support across the industry. I believe that an effort such as that would be a positive game-changer in the continuing improvement of the Australian shellfish culture industry.

Conclusion

During the course of my two-week stay, I presented 8 farmer workshops and 1 keynote address and I toured 15 oyster farm locations, ranging from New South Wales to South Australia to Tasmania. I directly presented to approximately 193 oyster farmers and 38 governmental, university and other interested parties, where I participated in focused one-on-one conversations with many of the participants over the extensive contact hours I spent with the industry. Based on the surveys conducted at the workshops in New South Wales (Table 1), I would conclude that the workshops were highly successful with a large proportion of the participants indicating that the workshops were good to excellent and that we overwhelmingly met their expectations for the meeting. For the bulk of the farmers, their interests were focused on nursery technology and specifically on the application of the FLUPSY to their business.

Benefits and Adoption

To date, the benefits and adoption of the project includes numerous requests for more information and a move towards adoption of the information on FLUPSY technology presented to the oyster growing industries of NSW, SA and TAS. It must be noted that the timing of the workshops, during the winter season when culture activities are at their minimum, precluded immediate adoption of upweller technology. However, following the workshops, there was an observable increase in activity of oyster farmers soliciting information and discussing plans for the construction of FLUPSYs in the region. For example, oyster farmers of NSW requested more information about the FLUPSY upweller systems and how they can build their own. They also discussed how they can adapt the system to their infrastructure and conditions of their rivers. As of now, there have been at least 6 oyster businesses, including hatchery operators, in NSW that have requested further information and Dr. Leavitt has reviewed plans for a modified FLUPSY, submitted to him by a Tasmanian oyster grower. Dr. Leavitt has provided a series of pdf presentations with extensive information on the topics he discussed in his workshops, including a FLUPSY manual, and links to these presentations can be found in the appendices, and on the SOCo website, as per Objective 5.

At least one of the NSW growers has already built a proof of concept solar powered FLUPSY, which is being used to grow seed. Evidence suggests that the NSW FLUPSY system is producing Sydney Rock Oyster seed with a more agreeable and potentially marketable shape than oysters from conventional systems on their leases. They have produced a short video of the development of their FLUPSY, the link to this video is included in the appendices and will be available on the SOCo website, and emailed to industry groups and academic institutes who have expressed an interest in receiving more information on building FLUPSYs. Any more information, such as drawings and construction information, and updates on the research and development of the FLUPSY system in the USA will be made available via the SOCo website as they arise. Based on my observations, Australian oyster farmers have developed innovative and effective methods for on-growing oysters, from 10 mm through to market size and have greatly influenced the global oyster growing industry with their technology. However, their former reliance on wild caught seed (primarily Sydney rock oysters) has placed the industry at a disadvantage in the hatchery and nursery stages of oyster production. The Australian oyster growers need to continue their efforts to improve early stage oyster production by increasing local availability of hatchery seed, primarily through the development of more hatcheries providing seed, and by expanding the capacity of the growers to handle small seed in nurseries, independent of the hatcheries. The advantages of promoting an expanded farmer-oriented nursery capacity include reducing operating (seed) costs to the farmer, increasing the efficiency and effectiveness of the nursery stage by reducing the necessity to transport/cultivate seed through multiple nursery stages, and providing more control of the grow-out cycle to the farmers to adapt to their unique circumstances. Of course, there are disadvantages resulting from the need for new specialized equipment and added work requirements to maintain the small seed.

The series of workshops supported by FRDC through SOCo and conducted by Dr. Dale Leavitt, provided information to the regional oyster growers on an innovative nursery strategy (the floating upweller system) that is very well suited for the industry in the NSW, SA and TAS region. Based on the level of interest demonstrated by the attendees at the series of workshops, the FLUPSY will become another viable option for oyster growers to improve their businesses, reduce costs, and generate an oyster seed product that is suited to their unique grow out strategy.

Further Developments

- Continuous communication between the Australian oyster industry and Dr. Leavitt will ensure that the latest advancements in FLUPSY technology that are being applied in the USA, including for example drawings, operations manuals, and construction plans for FLUPSYs, will be shared with the Australian oyster industry. All material will be communicated via the SOCo website, various newsletters and email notifications, with interested parties.
- The oyster industry has started to move forward on FLUPSY installations across the region.
 - Oyster growers in the Shoalhaven River and Pambula NSW have either proposed to build a FLUPSY or expressed their interest in building a pilot system in each of their rivers, and several representative growers have solicited more information directly from Dr. Leavitt and through SOCo.
 - There has been consideration by SOCo, some state departments and university bodies to source additional funding that will see the future application and development of FLUPSY technology, including pilot study systems, in Australia.
 - Gary and Sam Rodley from Tathra Oysters (Tathra, NSW) have built a “proof of concept” small FLUPSY to test the technology on their farm for growing Sydney Rock Oysters based on information provided by Dr. Leavitt at the workshops (see appendices, D).
 - Warwick Hastwell from Dover Bay Mussels Pty Ltd. (Dover, TAS) sent a modified FLUPSY design to Dr. Leavitt for review and comment.
- As an off-shoot of discussions with a series of small start-up oyster hatcheries during my visit to Australia, I have initiated setting up an international Shellfish Hatchery Discussion group through a list-serv process. The purpose of the list-serv will be to provide a forum for discussion among shellfish hatchery operators to address problems and observations collected by individuals but applicable to the industry as a whole. Depending on the level of expressed interest by hatcheries across the USA and Australia, the list-serv will be on-line within the month.

Appendices

- A. Pdf's of the presentation powerpoints: <http://www.selectoysterco.com.au/news.aspx?newsID=73>
- B. SOCo's You Tube video: https://www.youtube.com/watch?v=D8A_i4povIs&feature=em-upload_owner
- C. Sally Dakis radio interview and web article: (<http://www.abc.net.au/news/2014-07-29/shellfish-oyster-rhode-island-tasmania/5631084>)
- D. Video: 'Proof of Concept FLUPSY' by Gary and Sam Rodley, Tathra Oysters NSW. <https://www.dropbox.com/s/g4v8si2992oxhyo/flupsy%20proof%20on%20concept%20for%20emma%20medium%20res.m4v?dl=0>
- E. A portfolio of selected photographs <https://www.dropbox.com/sh/omr94x4ibjr7xc2/AAAlgedDaZ6Tn3zuAFQnc6y4a?dl=0>