

## FINAL REPORT (DEVELOPMENT AWARD)

### AWARD CODE and TITLE

2008/314.28

2012 FRDC International Travel Bursaries: Dr Christopher Izzo – Attendance at the 3<sup>rd</sup> International Sclerochronology Conference 2013

**AWARD RECIPIENT:** Christopher Izzo

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**HOST ORGANISATION:** The University of Adelaide

**DATE:** 30<sup>th</sup> June 2013

### ACTIVITY UNDERTAKEN

Attendance at the 3<sup>rd</sup> International Sclerochronology Conference and 1<sup>st</sup> International Sclerochronology Fieldweek held in North Wales in May 2013.

### OUTCOMES ACHIEVED TO DATE

Five key outcomes were achieved as a direct result of the 2012 FRDC International Travel Bursary to the applicant:

1. I presented research findings at an international conference that showcased fisheries science undertaken in Australia. This research was an example of a high level collaborative research effort between the University of Adelaide and SARDI Aquatic Sciences.
2. I received training from world leaders in the field of sclerochronology. I am now proficient in the practical skills required to age species of molluscs and undertake sclerochronological analyses of these species. These skills are highly specialised and novel among Australian fisheries researchers. As such, a future objective is to share the training attained among the broader Australian fisheries community.
3. I was granted a significant opportunity for career development by:
  - i. Presenting my research to the international science community and being able to received feedback and hold constructive discussion with world leaders in the field in person
  - ii. Attending presentations from world leading international researchers from a diverse range of fields.
4. I have been able to forging of collaborative research ties with international fisheries researchers and have initiated a number of projects.
5. I was able to promote and reiterating the FRDCs position as an internationally relevant fisheries science funding body.

## Acknowledgments

My attendance at the 3rd International Sclerochronology Conference in Caernarfon, North Wales was made possible by the 2012 FRDC International Travel Bursary. I did not receive additional financial support to attend the conference.

I would like to acknowledge the conference organising committee, particularly the members of the Sclerochronology and Scleroclimatology Group at the School of Ocean Sciences in Bangor University, Wales, for organising such an interesting and successful meeting and associated workshops, as well as to take considerable time out to discuss all things bivalve with me.

## Background

For the 2012 FRDC International Travel Bursary, I attended the 3rd International Sclerochronology Conference (ISC2013), which was held in Caernarfon, North Wales in May 2013 [<http://isc2013.bangor.ac.uk/index.php.en?menu=0&catid=0>].

In the aquatic environment, the calcified structures of organisms (e.g. otoliths, vertebrae, bivalve shells, coral skeletons, and teeth) form analogous growth increment patterns to tree-rings. The analysis of the growth increment patterns in calcified tissues (sclerochronology) provides a powerful tool for examining synergistic relations between organisms and their aquatic habitat.

Growth increments form as a result of seasonal variations in growth rates and have been utilised as a means of determining population age structures for fish. Asynchronous patterns in the widths of growth increments have been correlated to indices of climatic and oceanographic variability, enabling the environmental sensitivity of increment patterns to be utilised as a means for developing sclerochronologies for a range of aquatic organisms, e.g. bivalve shells, teleost otoliths, and coral skeletons. Sclerochronological data sets provide a means of examining the effects of climate on the growth patterns of fish, the reconstruction of past aquatic climates, and provide a means of assessing species-specific responses to climate change.

The funds obtained through the FRDC International Travel Bursary provided me the financial support necessary to attend and present my research at ISC2013. While originally intending to present my research as an oral presentation; due to the volume of abstracts submitted and the single session format of ISC2013, I was invited to present a poster instead.

The research findings presented are the outcome of a collaborative project between researchers at the University of Adelaide and the South Australian state fisheries organisation (SARDI) on a commercially important teleost species – the mulloway (jewfish) *Argyrosomus japonicus*. The title, abstract and author list for the poster are as follows:

**TITLE:** Otolith increment chronologies of estuarine and non-estuarine populations of South Australian mulloway

**AUTHORS (and affiliations):** Christopher Izzo (presenting), Bronwyn Gillanders, Thomas Barnes & Zoe Doubleday (the University of Adelaide); and Greg Ferguson (SARDI Aquatic Sciences).

**ABSTRACT:** Estuarine habitats are important for aquatic fauna, with the abundances of several estuarine-associated species of fish correlated with environmental flows of freshwater. The River Murray estuary and adjacent coastal waters off South Australia provide habitat for the greatest abundances and supports the largest catches of mulloway in Australia. The mulloway population in this region are estuarine associated and show strong year classes that correlate with freshwater inflows into

this system. Mulloway also occur on the far west coast of South Australia, where there are no estuaries with substantial freshwater inflow. We developed chronologies of growth from otolith increments for both populations and correlated these with local environmental conditions. Our results show variation in growth between populations, indicating that mulloway are sensitive to localised environmental fluctuations. These findings also suggest that these populations are spatially discrete, which is consistent with assessments of stock structure of the species. Otolith chronologies from these contrasting sub-populations of mulloway (i.e. estuarine versus non-estuarine associated) provide a unique opportunity to make inferences about the relative effects of environment and demography on patterns of otolith increment formation. In addition, these modern day chronologies can be broadly compared to chronologies developed from indigenous midden otoliths to determine if patterns of growth seen today are similar to the past.

Find attached to the final report a copy of the poster presented at ISC2013.

## Need

As an early career researcher (ECR), attending and presenting at this international conference provided me with an exciting opportunity to develop professionally, by broadening my knowledge base within the field, as well as in assisting in identifying gaps for future research.

My attendance at ISC2013 allowed me to meet world leading researchers in the fields of sclerochronology, paleoclimatology and aquatic ecology, where I was able to communicate with them in an informal atmosphere, which provided a more effective means of gaining insights into their respective fields of expertise. In addition, my attendance at ISC2013 enabled me to forge new collaborative ties with international researchers from a range of different fields that I would not have otherwise come into contact with.

For ECRs there are few opportunities available to attain financial support to attend meetings. By combining this conference attendance with attendance at the fieldweek, I was able to maximise the funding provided by the FRDC. Integrating these events in this one overseas trip provided a means of having access to innovative research groups in order to develop research skill sets that are novel within the Australian fisheries science community. This will no doubt be of great benefit to my professional development as an ECR and provides an opportunity to bring new skill sets back to Australia.

## Objectives

The original objectives as outlined in my application for the FRDC International Travel Bursary were:

1. Attend the 3rd International Sclerochronology Conference, where I will present our research findings entitled: "*Otolith increment chronologies reflect year class strength of the South Australian mulloway*"
  - Amendments to the objective:
    - I had originally intending to present my research as an oral presentation; due to the volume of abstracts submitted and the single session format of ISC2013, I was invited to present a poster instead.
    - The finalised title of the research presented was: "*Otolith increment chronologies of estuarine and non-estuarine populations of South Australian mulloway*"
2. Visit with the members of the Sclerochronology and Scleroclimatology Group at Bangor University
3. Attend at the 1st International Sclerochronology Field Week

## Methods

The 3rd International Sclerochronology Conference, held in Caernarfon, North Wales, was as diverse as it was interesting. Overall, the meeting was attended by approximately 100 international delegates, presenting a range of research themes that included biomineralisation, paleoclimatology and aquatic ecology, with a diverse range of organisms represented, from bivalves to otoliths to llamas. The conference was arranged with a single session format, which enabled me to attend all presentations. This provided the opportunity to attend talks within research themes that I might not have generally chosen.

The conference also hosted a number of high profile, keynote presenters in the fields of sclerochronology, palaeoceanography and climatology, including Thomas Brey (Alfred-Wegener-Institut, Germany), Fred Andrus (University of Alabama), Linda Ivany (Syracuse University), and Bernd Schöne (Johannes Gutenberg University Mainz). The keynote presenters were insightful (and inspiring) in their often frank summations of the progress that each speaker and their colleagues' had made to their respective research fields. However, the keynote speakers were also refreshingly blunt in outlining the knowledge gaps that currently exist and outlined future research directions in which the field was heading and where it needed to go.

In regards to my research, I was able to present our findings (in poster format) across four dedicated poster sessions held throughout the meeting. Our research findings presented at ISC2013 were well received and I generated a significant amount of positive feedback throughout the duration of the conference. The dedicated poster sessions allowed me to better interact with the other attendees at the conference than what I have previously done so at other meetings when just giving an oral presentation. The more 'intimate' interaction that I was able to have with the audience viewing my poster, resulted in my being able to better network within the conference; and has allowed me now to pursue future collaborative projects with researchers in the northern hemisphere that will expand upon the research that I presented and potentially lead to new projects being developed.

In addition to the conference attendance, the funding obtained from the FRDC International Travel Bursary enabled me to attend the 1st International Sclerochronology Fieldweek, which was run immediately after the conference [<http://isc2013.bangor.ac.uk/fieldweek.php?menu=8&catid=10239&subid=0>].

The fieldweek was devoted to the practical application of sclerochronology and took place in the Sclerochronology and Scleroclimatology Group laboratories at School of Ocean Sciences in Bangor University, Menai Bridge, Wales. The fieldweek consisted of two concurrent sessions, the first dedicated to chronology construction, climatology and geochemistry, which was jointly led by Prof Bryan Black (The University of Texas) and Prof Al Wanamaker (Iowa State University). The second session provided a comparison of shell processing techniques, and was led by researchers from School of Ocean Sciences at Bangor University and Johannes Gutenberg University Mainz.

I took part in the latter session and was instructed in a range of approaches to prepare and interpret the increment patterns of bivalve shells for age determination and the development of biochronologies. In addition, we also underwent some fundamental training in the development of a bivalve based biochronology (i.e. cross-dating – increment pattern alignment among individuals within a single population), using a range of specialised computer software programs (e.g. ShellAligner) and some not so specialised pieces of software (e.g. Excel).

The fieldweek also provided an opportunity to work intensively with the other attendees from a varied number of international institutions and research backgrounds. As such, I was able to discuss alternate aspects of sclerochronological research, I was able to form some promising future collaborations on a range of projects (refer to *Results/Discussion* section).

At the time of my application for the FRDC International Travel Bursary, I had tentatively arranged to have a brief (1-day) laboratory placement/visit with the Sclerochronology and Scleroclimatology Group (SSG) from Bangor University. However, due to time constraints that arose due to the SSGs conference organising commitments, I could not spend a dedicated day working in their laboratories. That said, I was still able to meet with the

members of the SSG throughout the conference and fieldweek to discuss technical aspects of working with commercially exploited Australian molluscs, e.g. cockles/pipis, abalone, mussels, scallops and razor fish; which I hope to initiate in the near future. The members of the SSG (in particular Prof Chris Richardson, Dr Paul Butler, and Dr David Reynolds) were able to provide me with a wealth of practical information that will aid me in successfully reaching viable research outcomes that will feed into the management of these species. In addition, as part of the 1st International Sclerochronology Fieldweek, I was afforded the opportunity to get access to and work in the SSGs laboratories (albeit as part of a group).

## Results/Discussion

- *Attendance at the 3rd International Sclerochronology Conference:*

The conference was excellent at providing a state of the art summation of where sclerochronological research is now and is heading in the future. However, the conference had a strong northern hemisphere bias and I went away with the general perception that there was a paucity of sclerochronological and increment based research (i.e. age and growth studies) on Australian molluscs in general. The conference suggested that there were a number of key knowledge gaps on the biology and ecology of Australian mollusc that require investigating, especially when a number of molluscan species form the basis for highly lucrative fisheries, i.e. abalone, oysters, scallops, mussels, and cockles/pipis. Refer to the *Further Developments* section.

- *Attendance at the 1st International Sclerochronology Fieldweek:*

The technical and practical skills that I were exposed to at the fieldweek are easily transferable to the laboratory environment here at the University of Adelaide. In fact, within the first week of returning to Australia, we have initiated an honours project that will analyse the shell chemistry and increment patterning of the Goolwa cockle; relating the shell chemistry and increment patterning to environmental and biological processes. In order to ensure the successful completion of this honours project, I will be imparting the necessary laboratory based skills that I developed during the fieldweek, i.e. shell sampling, preparatory techniques, and shell increment interpretation.

This honours project will also act as a proof of concept for transferring the shell increment skills learnt at the fieldweek to Australian bivalve species – specifically the commercially harvested Goolwa cockle (*Donax deltoides*). I will look to modify where appropriate the methodology used by our current honours student, to develop an ageing protocol for the Goolwa cockle, for which one does not currently exist. The inability to estimate ages of Goolwa cockles is considered a significant knowledge gap by the current fisheries scientists in South Australia, and acts to impede the biologically appropriate management of the species. Hence, this line of research (population age structures, rates of growth, mortality and reproduction) is considered of high priority to the long-term sustainability of the species.

- *Career development:*

Presenting our research findings at the conference and my attendance at the fieldweek provided a significant opportunity for my career development and granted me exposure to a broader aquatic science community than what I have done so in Australia.

In addition, I was able to forge strong collaborative links with a diverse range of international researchers. The conference was attended by a number of high profile fisheries scientists, including Alexander Arkhipkin (Falkland Islands Fisheries), Melita Peharda (Institute of Oceanography and Fisheries, Croatia), and Roger Mann (Virginia Institute of Marine Sciences, USA); which provided me the opportunity to contrast approaches and views to common research themes in fisheries management. Surprisingly, the researchers were not all fisheries based scientists, instead having a range of research backgrounds (i.e. biomineralisation, dendrochronology, palaeontology). This turned out to be beneficial, as it provided alternate views on how to answer fisheries related

questions that I have been perusing, e.g. understanding population age structures, temporal changes in fish assemblages, and the identification of phenotypic changes in fish populations as a result of exploitation.

- *Potential future collaborations with attendees at ISC2013 include:*
  - Elise Dufour (Muséum National d'Histoire Naturelle, France):  
Northern—southern hemisphere comparisons of the biology and ecology of commercially important Sciaenid fishes
  - Cory Matthews (University of Manitoba, Canada):  
Ageing commercially exploited harp and ringed seals from the Alaskan pinniped fishery  
Northern—southern hemisphere comparisons of pinniped biochronologies
  - Bryan Black (University of Texas at Austin, USA):  
Developing a dendrochronology baseline for the Marry-Darling River system – on which to better understand centennial time scale changes in the hydrology and climate of the Murray - Darling River and its impacts on native fish populations
  - Susana Galante-Oliveira (Universitário de Santiago, Portugal):  
Developing approaches to age Australian aquatic gastropods
  - Anindya Sarkar (Indian Institute of Technology, India) & Sang-Tae Kim (McMaster University, Canada):  
Methodological development of isotope analysis in teleost otoliths and elasmobranch vertebrae – applications for understanding population structure and patterns of movement, habitat use, and trophic structure

## **Benefits and Adoption**

- *Commercial and recreational fishing sectors:*

The skills that I have developed as part of this professional award activity have the potential to benefit Australian commercial and recreational fishers that target molluscan species. To date, there are few Australian fisheries researchers that examine the population age structures and, or rates of growth of molluscs; two key biological parameters are fundamental to the successful, sustainable management of fished populations. The lack of research in these areas are primarily due to the limited success that Australian fisheries researchers have had in developing methods that enable the interpretation of the incremental patterns in the shells of molluscs.

Attendance at the sclerochronology fieldweek provided me the practical skills to prepare and interpret the increment patterns of various mollusc species. Further development of these technical approaches may be required to best fit Australian mollusc taxa; therefore, initial trial studies are currently underway at the University of Adelaide.

Ultimately, I intend to use the knowledge that I have accrued to work in collaboration with state based molluscan fisheries researchers and managers to fill important knowledge gaps on the biology and ecology of exploited mollusc species (refer to the *Further Developments* section).

- *Australian fisheries science community:*

I aim to develop an Australian orientated mollusc ageing training course – loosely based around what I undertook at the 1st International Sclerochronology Fieldweek. The overall goal of this training course is to disseminate the practical knowledge that I was fortunate enough to have been given the opportunity to attain, with the broader Australian fisheries community. This training course may be run as a workshop in at one of the upcoming annual meetings of the Australian Society for Fish Biology.

## Further Development

- *Sclerochronological research in Australia:*

Given that a number of molluscan species are exploited in Australia (i.e. abalone, oysters, scallops, mussels, and cockles/pipis); it would seem appropriate to gain a better understanding of the biology (i.e. population age structures, rates of growth, mortality and reproduction) and ecology (i.e. synergies between intrinsic and extrinsic factors) of these species. This will ensure that appropriate management strategies are set in place, safeguarding the long-term sustainability of these species and the fisheries based upon them.

That said, a number of key research themes/questions can be broadly proposed for species in this group:

- Establishing population age structures
- Determining rates of growth, mortality and reproduction
- Understanding the seasonality of patterns of growth and reproduction
- Understanding temporal changes in these key biological parameters over extended periods of time (at decadal to centennial time scales, which can be achieved through the examination of indigenous midden samples)
- Understanding the influence of environmental indices (climatic and hydrological) on the biology of these species
- Understanding long-term effects of harvesting on these populations
- Using relations developed above to aid in predicting species' responses to environmental variability (both climatic and hydrological)

I would imagine that some, if not all of these research themes/questions already exist as key research priorities for Australian molluscan fisheries managers. However, it would seem that by gaining a better understanding of the well established northern hemisphere approaches to answering these questions, specifically through sclerochronological approaches, answering these research questions would be feasible.

Through collaboration with state based molluscan fisheries researchers and managers, I intend to pursue some of the outlined research themes/questions detailed above as future project applications to the FRDC.

- *Disseminating technical knowledge gained:*

I intended to refine and teach the technical and practical skills that I developed at the 1st International Sclerochronology Fieldweek to better fit key Australian molluscs, i.e. mussels, cockles/pipis, and abalone. Currently, I am training an honours student in all of the key practical aspects learnt in regards to bivalve shell preparatory techniques. I plan to use this opportunity to develop an Australian orientated mollusc ageing training course, with the intention to share this information with the broader Australian fisheries community, e.g. potentially as a workshop in at one of the upcoming annual meetings of the Australian Society for Fish Biology (ASFB). Running a course such as this in conjunction with an ASFB annual meeting would potentially maximise the dissemination of the knowledge that I have accrued among the relevant Australian fisheries researchers and managers who are generally in attendance at these meetings.

## Appendices

Find attached a copy of the poster presented at ISC2013, entitled: *Otolith increment chronologies of estuarine and non-estuarine populations of South Australian mulloway.*

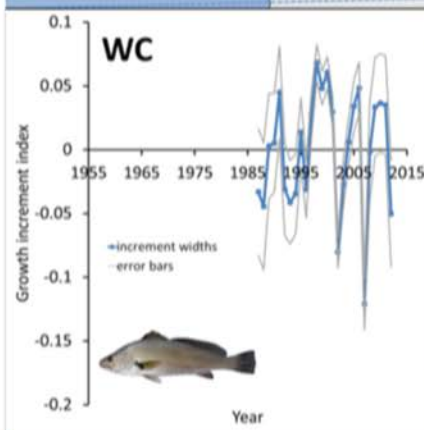
# OTOLITH INCREMENT CHRONOLOGIES OF ESTUARINE AND NON-ESTUARINE POPULATIONS OF SOUTH AUSTRALIAN MULLOWAY

Christopher Izzo<sup>1</sup>, Greg Ferguson<sup>2</sup>, Thomas Barnes<sup>1</sup>, Zoe Doubleday<sup>1</sup> & Bronwyn Gillanders<sup>1</sup>

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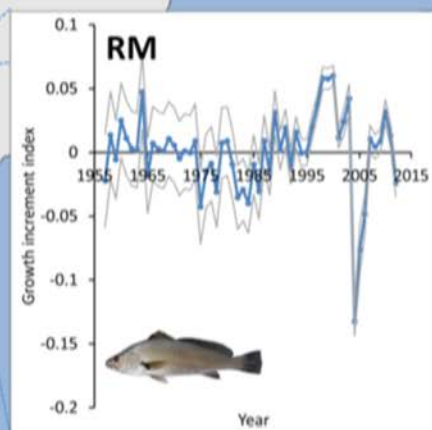


**Background/Aims:** The River Murray (RM ★) estuary & adjacent coastal waters off South Australia provide habitat for the greatest abundances of mulloway in Australia. Mulloway also occur on the West Coast (WC ☆) of SA, where there are no substantial freshwater inputs. We contrast chronologies for WC & RM mulloway to make inferences about the relative influence of environment and demography on fish growth.

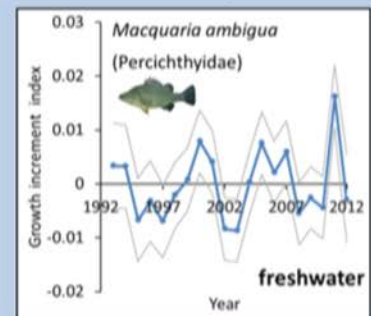
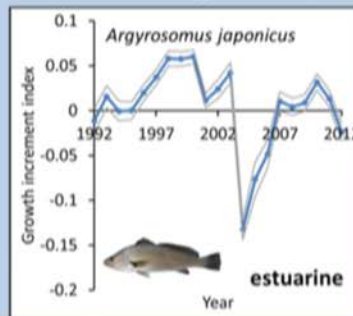
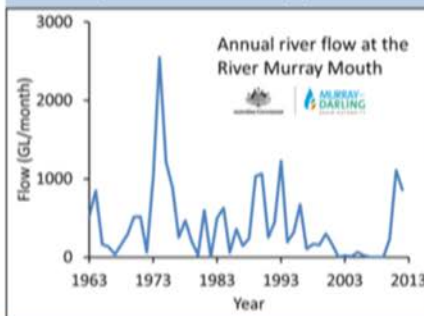


**Method:** Chronologies based on mixed effects models of increment widths for WC & RM mulloway (*Argyrosomus japonicus*: Sciaenidae).

**Population level differences**

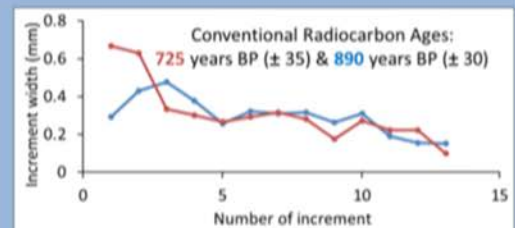


**Pervasive freshwater signal...** Marine & freshwater teleosts inhabiting the Murray River estuary and adjacent waters appear to have a **freshwater signature** in their otolith chronologies.



## Reconstructing flows using midden otoliths...

We have otoliths from Aboriginal middens that will allow us to go back in time



**Acknowledgements** Thanks to M. Disspain (UoA) for access to midden otoliths. Research funded by an ARC-DP & FF to BMG. Travel support for CI provided the Fisheries Research and Development Corporation International Travel Bursary on behalf of the Australian Government.

