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WELCOME TO ALBANY

On behalf of the local organising committee for the 2017 ASFB conference, I'd like to welcome you all to the beautiful coastal town of Albany on the south coast of Western Australia. Situated on the edge of Princess Royal Harbour and walking distance from the historic town centre, the Albany Entertainment Centre is a spectacular venue to host the first stand-alone ASFB conference since 2011. This has provided the organising committee with an opportunity to develop an exciting conference program that is a little bit 'out of the ordinary'.

With the overarching theme of *'Turning Points in Fish and Fisheries'*, we hope to get everyone thinking about all those influential moments or developments, small and big, that have changed the way we go about our research. After a few years of working hard to get both marine and freshwater contributions in as many sessions as possible, we are mixing (or rather un-mixing) it up for the Sunday, when two concurrent sessions will focus specifically on marine habitat-based topics and freshwater-related issues for the full day.

I wish to thank everyone for making the effort to travel all the way to Albany for this conference. Thank you also to the local organising committee and to ASN for helping with the planning of the event and to our sponsors for their contributions.

I wish everyone an enjoyable and rewarding conference and hope you enjoy your stay in Albany!

Gary Jackson
Conference Chair

We acknowledge the Noongar people, the traditional owners of this country and their continuing connection to land, sea and community.
We offer our respect to them and their culture, to the elders past and present, and to those who were removed as children.

WELCOME FROM ASFB

With great pleasure I welcome you to the 2017 ASFB Conference in Albany, Western Australia. A huge thanks to the Local Organising Committee and Conference Chair Gary Jackson for assembling an outstanding program around the theme of *Turning Points in Fish and Fisheries*.

We have three days of high quality presentations to showcase our endeavours in fish and fisheries, which is sure to generate lively discussions and networking opportunities for scientists and managers at all stages of their careers. We have also strived to engage with the local community during this conference, through a partnership with the local high school, and a public forum on topics relevant to the coastal communities of southwest Australia.

After the success of the *Women in Ichthyology* forum at ASFB 2016 Hobart, this year we kick off with a focus on early career development in fish and fisheries. The *Nurturing Fish Scientists* session will take us on a journey from the post-graduate (larval) phase to fully-recruited ichthyologists, with several speakers and a discussion forum allowing us to share our experiences and tips for making the most of the formative years in becoming a professional scientist or manager in this rewarding, but highly competitive field. We will also feature the popular Rapid Talks, where students will take to the stage to spruik their research in a short and sweet format. Thank you to our Conference & Workshop Convener Brendan Ebner and Education Committee Chair Stephen Beatty for guiding these fantastic sessions.

I hope that you enjoy the conference and take the opportunity to explore Albany and its surrounding areas during your visit. When you do, please take the time to engage with the locals and share your passion and knowledge for all things fish and fisheries!

Dr Chris Fulton
President, Australian Society for Fish Biology

Australian Government

Australian Fisheries Management Authority

The **Australian Fisheries Management Authority** (AFMA) is responsible for the efficient management and sustainable use of Commonwealth fish resources.

Did you know...

Commonwealth fisheries are sustainable and well-managed with decisions based on the best available science

Harvest strategies maintain commercial fish stocks at environmentally sustainable levels

Scientific ecological risk assessment processes identify and quantify impacts of fishing

Sustainable fisheries
No stocks subject to overfishing in AFMA solely managed fisheries for **3** consecutive years

afma.gov.au

DELEGATE INFORMATION

VENUE

Albany Entertainment Centre
2 Toll Place, Albany
WA, 6330
Phone: (08) 9844 5000
Website: www.albanyentertainment.com.au
Email: aec@ptt.wa.gov.au

ORGANISER'S OFFICE – ASN EVENTS

The conference registration desk, located in Harbour Side Foyer, will operate as per the times listed below:

Saturday, Sunday & Monday: 7:30 am – 5:30 pm

All conference related enquires should be directed to ASN Events staff at this desk. Accommodation queries should be directed to the relevant hotel reception desk.

INTERNET ACCESS

Free Wi-Fi is available to conference delegates at the venue. There are different networks for various locations and rooms within the building:

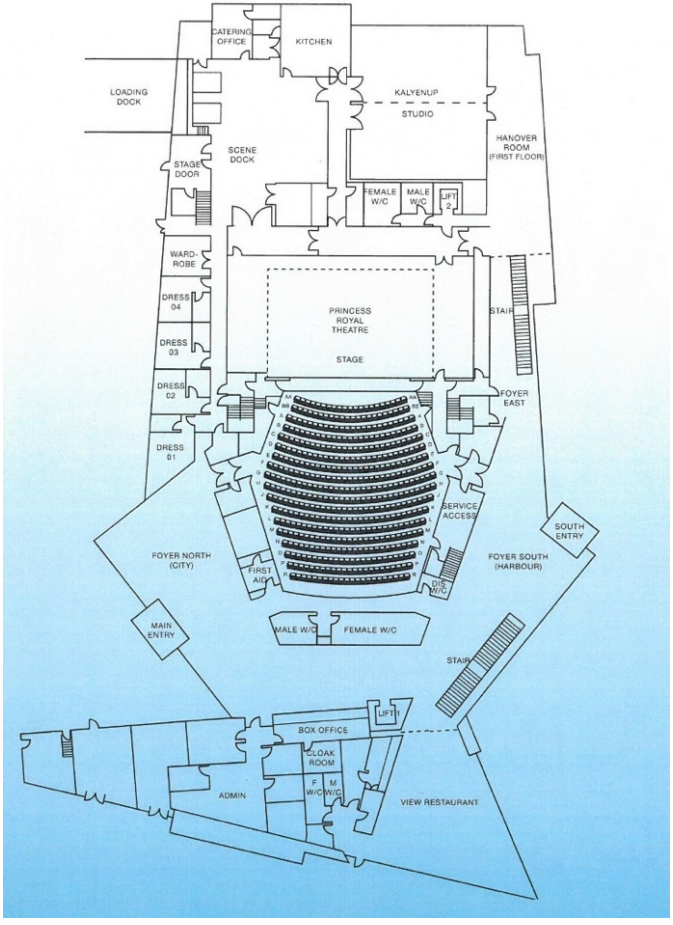
The Harbour Side Foyer
Network: VIEW Restaurant
Password: July#2017

Kalyneup 1:
Network Name: AECStudio 1
Password: Stud16za

Kalyneup 2:
Network Name: AECStudio 2
Password: Stud16hd

Unfortunately, there is no Wi-Fi in the Auditorium or the PRT Stage. Please contact ASN staff if you have any difficulties connecting.

MAP OF ALBANY ENTERTAINMENT CENTRE



CONFERENCE WEB APP

The official **ASFB 2017** web-based app will keep you organised during the meeting.

You can use the app to update your profile information and view:

- An up-to-date daily program
- Speaker abstracts
- Speaker bios
- Venue maps
- Sponsors & Exhibitors

Downloading the ASFB 2017 Conference Mobile App is easy!

INSTRUCTIONS FOR APPLE DEVICES

Step 1: Open asfb-2017.m.asnevents.com.au in your browser or use the above QR code.
Step 2: Tap the 'share icon' at the bottom centre of your screen then 'Add to Home Screen' – the conference icon will appear on your home screen for quick access.

INSTRUCTIONS FOR ANDRIOD DEVICES

Step 1: Open asfb-2017.m.asnevents.com.au in your browser or use the above QR code.
Step 2: Select the menu button, and add the page to your **bookmarks**. Then open your bookmarks using the menu button, and find the new bookmark you've just added. Press down and hold on the bookmark until you see an action menu. Select 'Add to homescreen' - the conference icon will appear on your home screen for quick access.

For further assistance please see ASN staff at the registration desk.

SOCIAL PROGRAM

WELCOME SUNDOWNER

Time: 6:00 - 8:00 pm
Date: Friday 21st July
Venue: Due South, 6 Toll Place, Albany

STUDENT-MENTOR MIXER

Time: 6:00 - 8:30 pm
Date: Saturday 22nd July
Venue: White Star, 72 Stirling Terrace, Albany

PUBLIC FORUM

Time: 6:00 - 8:00 pm
Date: Sunday 23rd July
Venue: Albany Entertainment Centre, 2 Toll Place, Albany

CONFERENCE BASH

Time: 7:00 – 11:00 pm
Date: Monday 24th July
Venue: The Boatshed, Princess Royal Drive, Albany

ANNUAL GENERAL MEETING

All society members are encouraged to attend the ASFB AGM. The ASFB AGM will be held after the lunch break from 2:00 - 3:30 pm on Monday 24th July in the Auditorium.

SPEAKER PREPARATION INSTRUCTIONS

It is the conference preference that ALL presentations must be pre-loaded onto the laptop in the relevant presentation room at least one full session in advance of your presentation session to allow for testing. Audio-visual equipment will be supplied, please bring your presentation to the meeting on a USB drive compatible with PC.

There will be a technician in the Auditorium and volunteers to assist with any enquiries.

DISPLAYING YOUR POSTER

You will be able to hang your poster from 9:00 am on Saturday 22nd July in the Harbour Side Foyer. Please affix your poster to the allocated board before 11:00 am on Sunday 23rd July ready for the poster viewing during the Sunday lunch break. Posters should be attached to the boards using the Velcro provided. Please visit the conference registration desk if you require additional supplies.

Posters should be taken down no later than 4:00 pm on Monday 24th July. Posters remaining after this time will be removed by conference staff. View more information about the presenter and their research by scanning the QR code displayed on posters – a new feature for this year!

NOTICEBOARD

Notices may be placed by delegates and trade participants on the board outside the main trade display.

RECYCLING YOUR NAME BADGES AND LANYARDS

If you do not wish to keep your name badge at the conclusion of the conference, please return it to the conference registration desk for recycling.

DAVID CARTER

Austral Fisheries
E: dcarter@australfisheries.com.au

David Carter graduated from Melbourne University in 1978 with a science degree in marine zoology and then went to sea as a deckhand on a prawn trawler out of Darwin immediately after that. David has worked in the same business for his whole career and has been exposed to most of what the fishing industry has to offer from science and policy through operations and management and marketing and sales. He has been CEO since 2006.

Austral Fisheries Pty Ltd has a strong commitment to science based fisheries management, believes strongly in recognition of sustainable fisheries performance through third party certification schemes such as the Marine Stewardship Council and is recognised locally and internationally as responsible and progressive. Austral has accumulated a number of awards and recognition over the years and in 2012 David was admitted to the Australian seafood industry 'Hall of Fame'.

BRONWYN GILLANDERS

University of Adelaide
E: bronwyn.gillanders@adelaide.edu.au

Professor Bronwyn Gillanders is based in the School of Biological Sciences at the University of Adelaide. She completed her BSc at the University of Canterbury (New Zealand), MSc at the University of Otago (NZ) and PhD at the University of Sydney (Australia). She has previously held ARC Fellowships and is now a Faculty member at the University of Adelaide. Her research focuses on freshwater, estuarine and marine systems including fisheries, ecological and environmental questions. Bronwyn uses calcified structures of aquatic organisms as innovative tools to understand past environments and biological processes, such as age, growth and movement patterns. Her broader interests include integrated marine management and understanding cumulative environmental impacts. She is past president of the Australian Society for Fish Biology and current President of the World Council of Fisheries Societies.

HUGH KEARNS

Flinders University
E: hugh@ithinkwell.com.au

Hugh Kearns is recognised internationally as a public speaker, educator and researcher. He regularly lectures at universities across the world and has recently returned from lecture tours of the UK and the US which included lectures at Oxford, Cambridge, Harvard, Berkeley and Stanford.

His areas of expertise include self-management, positive psychology, work-life balance, learning and creativity. He draws on over twenty five years of experience as a leading training and development professional within the corporate, financial, education and health sectors in Ireland, Scotland, North America, New Zealand and Australia. He has coached individuals, teams and executives in a wide range of organisations in the public and private sectors.

Hugh lectures and researches at Flinders University in Adelaide. He is widely recognised for his ability to take the latest research in psychology and education and apply it to high-performing people and groups. As a co-author with Maria Gardiner, he has published ten books which are in high demand both in Australia and internationally.

JASON THIEM

NSW Fisheries
E: jason.thiem@dpi.nsw.gov.au

Jason Thiem is a Fisheries Scientist with Fisheries NSW. His PhD research was undertaken in Canada and focussed on the effects of dams on lake sturgeon migration and reproductive behaviour, as well as the biomechanics and energetics of sturgeon passage through fishways. Over the past 10 years he has undertaken fisheries research in Australia, Canada, USA and the Bahamas. Jason has been based at the Narrandera Fisheries Centre since 2013. His current research program is focussed on the abiotic drivers of fish movement, spawning and recruitment within the Murray-Darling Basin, with a strong focus on riverine connectivity.

STEPHANIE BRODIE

National Oceanic and Atmospheric Administration
E: stephbrodie1@gmail.com

Stephanie Brodie is based at the University of California Santa Cruz and the National Oceanic and Atmospheric Administration (NOAA) in the United States. She completed her PhD and early post-doctoral research at the University of New South Wales researching the distribution, ecology, and eco-physiology of pelagic fish off the east coast of Australia. Stephanie has recently moved to the US to conduct post-doctoral research on dynamic ocean management, specifically focusing on marine fish and fisheries.

Enjoy...

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PROGRAM

FRIDAY 21ST JULY 2017

Welcome Sundowner & Registrations
6:00PM - 8:00PM Due South, 6 Toll Pl, Albany

SATURDAY 22ND JULY 2017

Registration Opens
7:30AM - 5:00PM Harbour Side Foyer

Welcome
8:30AM - 9:00AM Auditorium
Plenaries
Chair: Gary Jackson
9:00AM - 10:00AM Auditorium
9:00 AM David Carter
Much to be done. *abs# 1*
9:30 AM Bronwyn Gillanders
Ear bones of fish: turning points in fish and fisheries science *abs# 2*

Morning Tea
10:00AM - 10:30AM Harbour Side Foyer

Nurturing Fish Scientists – from Nursery to Broodstock
10:30AM - 12:45PM Auditorium
Chairs: Stephen Beatty & Brendan Ebner
10:30 AM Hugh Kearns
The Life Cycle of the PhD *abs# 3*
11:00 AM Steve McMullin
Preparing the Next Generation of Fisheries Professionals for Career Success *abs# 4*
11:30 AM John Koehn
Nurturing fisheries researchers: larvae and juveniles *abs# 5*

Lunch
12:45PM - 1:30PM Harbour Side Foyer

ASFB Award Plenaries and Student Talks

1:30PM - 3:00PM Auditorium

Chairs: Gary Jackson and Stephen Beatty

1:30 PM Jason Thiem

Move it or lose it: restoring movement pathways for fish in freshwater rivers *abs# 6*

1:45 PM Steph Brodie

Dynamic Ocean Management: a strategy to reduce conflict between ocean users *abs# 7*

2:00 PM ASFB Student Rapid Talks

2:30 PM Albany High School Marine Project Student Talks

An introduction to the Albany Senior High School Marine Science Program a short 4 minute video produced *by Taylor Smith.*

· *Colour preference of Squid. By Hayden Chandler, Peter Ebert and Taylor Smith*

· The abundance and distribution of Elongate Surf Clams *(Paphius elongate*) And Wedge Surf Clams *(Donacidae columbella)* in the Albany area. By Reuben Claughton and Jeremy Staude.

· The settlement of native flat oysters *(Ostrea angasi)* and other invertebrates in Princess Royal and Oyster Harbours. By Eleanor Barnett, Katie Valley, Indigo Bew and Indi Weeden.

· The biodegradability of soft plastic lures. By Eliza Driffill

· The abundance and distribution of juvenile Australian Salmon *(Arripis truttaceus)* in Oyster Harbour. By Hayley Hartwig, Bonnie Staude, Alyssa Ward and Sophie Lambert.

Afternoon Tea

3:00PM - 3:30PM Harbour Side Foyer

Hearing me, Hearing you, a-ha – Using acoustics to monitor fish & their habitats

3:30PM - 5:00PM PRT Stage

Chairs: Miles Parsons & Ben Scoulding

3:30 PM Ben Scoulding

A review of the use of echosounders for fish-stock assessment in marine and freshwater environments *abs# 8*

3:45 PM Ben Scoulding
Evaluating active-acoustic methods for assessing snapper (*Chrysophrys auratus*) spawning aggregations in Western Australia *abs# 9*
4:00 PM Iain Parnum
Imaging sonar mapping of river habitats and fish usage *abs# 10*
4:15 PM Miles Parsons
Passive acoustic monitoring of fish movement around the Swan River *abs# 11*
4:30 PM Miles Parsons
An introduction to Marine Soundscape Ecology: The highs and the lows (frequency) *abs# 12*

Turning Points & Agents of Change in Fish Biology Conservation and Fisheries
3:30PM - 5:00PM Kalyenup 1
Chair: Brendan Ebner
3:30 PM Timothy Emery
Electronic monitoring within longline fisheries in the western and central Pacific Ocean: implications for data collection and exchange. *abs# 13*
3:45 PM Rocio Noriega
The role of electronic monitoring in improving the quality of fishery dependent logbook data. *abs# 14*
4:00 PM Christopher Henderson
Integrating ecological processes into marine reserve design *abs# 15*
4:15 PM Ana Lara-Lopez
Measuring and understanding change: IMOS initiatives and tools relevant to fish and fisheries *abs# 16*
4:30 PM Stuart Little
Turning points, meandering or trending upwards - initiatives in the Murray Darling Basin for native fish *abs# 17*
4:45 PM Katie Ryan
Looking back and looking forward: water reform as an agent of change for native fish in the Murray-Darling Basin *abs# 18*

Beyond Biology: Social & Economic Dimensions of Fisheries
3:30PM - 5:00PM Kalyenup 2
Chairs: Emily Fisher & Emily Ogier

3:30 PM Emily Fisher
The role of fishery certification schemes in providing social licence for both industry and Government *abs# 19*
3:45 PM Emily Ogier
The 'social and economic' turning points in fisheries research and management *abs# 20*
4:00 PM Eva Plaganyi
A social revolution in fisheries science *abs# 21*
4:15 PM Kim Walshe
Turning the tide - demonstrating the sustainability of Western Australia's fisheries *abs# 22*
4:30 PM Timothy Emery
How do we prevent the economic benefit of fisheries being exported? *abs# 23*

Student Mixer
6:00PM - 8:30PM White Star, 72 Stirling Terrace, Albany

SUNDAY 23RD JULY 2017

Registration Opens
8:00AM - 5:00PM Harbour Side Foyer

Monitoring & Assessments
8:30AM - 10:30AM PRT Stage
Chair: Alex Hesp
8:30 AM Alastair Harry
Evidence for systemic age underestimation in shark and ray ageing studies *abs# 24*
8:45 AM Gary Jackson
Quantifying shark depredation encounters while commercial, charter and recreational fishing in Western Australia *abs# 25*
9:00 AM Andrew Prosser
Optimizing sample sizes for biological monitoring of sea mullet (*Mugil cephalus*) in Queensland *abs# 26*
9:15 AM Alissa Tate
Assessing variability in standardised harvest rates from shore-based recreational fishing surveys. *abs# 27*

9:30 AM Lenore Litherland
Tailor tales: 18 years of monitoring wild harvest fisheries in Queensland *abs# 28*
9:45 AM Kim Smith
Cruising along or collapsing: what is the status of WA's last cobbler fishery? *abs# 29*
10:00 AM Craig Noell
Reconstructing the footprint of an Australian penaeid-trawl fishery to support ecosystem-based management *abs# 30*

Marine Habitats 1

8:30AM - 10:30AM Kalyenup 1
Chair: Dianne McLean
The value of subsea infrastructure and artificial reefs to fish and fisheries
8:30 AM Krystle Keller
Multispecies presence and connectivity around a designed artificial reef off coastal Sydney, Australia *abs# 31*
8:45 AM Matthew Hammond
Ecological changes to the marine community after instalment of an artificial reef on the south-west coast of Western Australia. *abs# 33*
9:00 AM Michael Tropiano
Reef Vision: Recreational fishers monitoring artificial reefs using baited remote underwater video systems. *abs# 34*
9:15 AM Paul Lewis
Insights into fish associations with various artificial structures in southwest WA *abs# 35*
9:30 AM Todd Bond
A comparison of fish assemblages associated with two gas flowlines and the adjacent seafloor. *abs# 36*
9:45 AM Dianne McLean
Fish-habitat associations on subsea pipelines on the north-west shelf, Western Australia *abs# 37*
10:00 AM Benjamin Saunders
Sampling deep-water fish assemblages using ROV's *abs# 38*
10:15 AM Matt Rees
Seascape patterns and habitat differences explain spatial variability in nearshore temperate fish assemblages *abs# 39*

Freshwater: The Good, Bad and Ugly 1

8:30AM - 10:30AM Kalyenup 2

Chair: David Morgan

8:30 AM Mark Lintermans

The extent and adequacy of monitoring of Australian threatened freshwater fish *abs# 40*

8:45 AM Benjamin Ford

Using species distribution modelling to identify priority areas for conservation of freshwater fishes in southwestern Australia *abs# 41*

9:00 AM Mischa Turschwell

Multi-scale environmental processes influence juvenile recruitment success in a non-migratory fish *abs# 42*

9:15 AM John Koehn

Modelling population dynamics of fish in the MDB- from local to Basin-scale *abs# 43*

9:30 AM Krystle Keller

Habitat use of fishes in a perennial tropical Australian River *abs# 44*

9:45 AM Zeb Tonkin

Quantifying links between instream woody habitat and riverine fish populations *abs# 45*

10:00 AM Paul Close

River flows support key life-history events of spotted galaxias (*Galaxias truttaceus*) in south-western Australia *abs# 46*

10:15 AM Stephen Balcombe

Comparing fish body condition measures as indicators of fitness for two lowland fish species *abs# 47*

Morning Tea

10:30AM - 11:00AM Harbour Side Foyer

Life history & Connectivity

11:00AM - 1:15PM PRT Stage

Chair: Karissa Lear

11:00 AM Marianne Nyegaard

There be Giants! How a new species of ocean sunfish managed to hoodwink the world *abs# 48*

11:15 AM Tony Miskiewicz

Comparative assessment of morphological and pigmentation characters

during larval development of species of 10 genera of F. Gobiidae and two genera of F. Eleotridae *abs# 49*

11:30 AM Inigo Koefoed

Regional variation in life-history strategies of penaeids and their resilience to changing temperatures. *abs# 50*

11:45 AM Henry Wootton

Novel methods to assess long-term trends in size and age at maturity in fished stocks *abs# 51*

12:00 PM Richard Evans

Genomics reveals patterns of dispersal for two reef fish with differing reproductive characteristics along the ecologically significant coast of northwestern Australia *abs# 52*

12:15 PM Tom Barnes

Coast to coast: population structure and connectivity of southern Australia's only sciaenid, mulloway *(Argyrosomus japonicus) abs# 53*

12:30 PM Stuart Sexton

Spawning patterns of sardine (*Sardinops sagax*) off eastern Australia; further evidence for multiple spawning stocks? *abs# 54*

12:45 PM Sarah Hearne

Connectivity of fishes from the Kimberley region, Western Australia, using otolith geochemistry *abs# 55*

1:00 PM Daniel Gaughan

Revisiting the analysis and interpretation of otolith chemistry studies for determining stock structure *abs# 56*

Marine Habitats 2

11:00AM - 1:00PM Kalyenup 1

Chairs: Shaun Wilson & Chris Fulton

(Changes to macroalgal habitats – causes and consequences &
The Great Southern Reef: ecology, value and threats)

11:00 AM Shaun Wilson

Climatic conditions and seaweed habitat quality provide indicators of reef fish recruitment strength *abs# 57*

11:15 AM Michael Taylor

Ontogenetic shift of a commercially important endemic species, *Lethrinus punctulatus*, from nearshore macroalgal beds to offshore sessile invertebrate habitats *abs# 58*

11:30 AM Federico Vitelli
Angelfishes hybridisation in Christmas Island: ecological and biological aspects *abs# 59*
11:45 AM John Keane
Can commercial harvest of the long-spined sea urchin, *Centrostephanus rodgersii*, reduce the impact of destructive urchin grazing on macroalgae communities and associated fisheries? *abs# 60*
12:00 PM Ben French
Biology and dietary composition of the harlequin fish o*thos dentex* in south-western australia *abs# 61*
12:15 PM Gretchen Grammer
Fish ear bones record the bomb radiocarbon decline in an upwelling area off southern Australia *abs# 62*
12:30 PM Jack Parker
Geographic distributions and assemblages of labrids along the south west coast of Western Australian over the past decade *abs# 63*
12:45 PM Lachlan Mcleay
What is driving changes in size at maturity (L50) in Australia's largest Southern Rock Lobster fishery? *abs# 64*

Freshwater: The Good, Bad and Ugly 2
11:00AM - 1:00PM Kalyenup 2
Chair: David Morgan
11:00 AM Alison King
Wet and dry season flows influence juvenile fish abundance in a tropical river *abs# 65*
11:15 AM Brendan Ebner
Visual census, photographic records and the trial of a video network provide first evidence of the elusive *Sicyopterus cynocephalus* in Australia. *abs# 66*
11:30 AM Nicholas Ling
Estuarine specialist: the Stokell's smelt *abs# 67*
11:45 AM Charles Todd
Large scale population dynamics of a flow dependent enigmatic freshwater fish. *abs# 68*
12:00 PM Ben Broadhurst
Facilitating passage to spawning habitat for an endangered percichthyid *abs# 69*

12:15 PM Michael Hammer
Testing genetic models of dispersal and speciation in a tropical freshwater stream headwater-specialist, the Exquisite Rainbowfish (Melanotaeniidae: *Melanotaenia exquisita*) *abs# 70*
12:30 PM Peter Unmack
Hemi-clonal unisexual carp gudgeons (Eleotridae: *Hypseleotris*): systematic clarification of species boundaries and various hybrid lineages in southeastern Australia. *abs# 71*
12:45 PM Md Rakeb-Ul Islam
Extreme genetic structure has conservation implications for Australian smelt (*Retropinna semoni*) in Queensland, Eastern Australia *abs# 72*

Lunch & Poster Session
1:00PM - 2:00PM Harbour Side Foyer
The conference acknowledges the support of

What Drives Migration? 1
2:00PM - 3:30PM PRT Stage
Chairs: Adrian Gleiss & David Crook
2:00 PM Stephen Beatty
One-way traffic: Black Bream passage through a storm surge barrier. *abs# 73*
2:15 PM Daniel Gwinn
Freshwater catfish, *Tandanus bostocki,* move further and maintain larger home ranges during elevated flow in a regulated river, Western Australia *abs# 74*
2:30 PM Culum Brown
Environmental triggers of migration in an urban population of Australian Bass *abs# 75*
2:45 PM David Crook
Skipped spawning by diadromous fishes drives the direction and extent of material subsidies across marine-freshwater ecotones *abs# 76*
3:00 PM Daniel Yeoh
Acoustic telemetry reveals the contrasting ways in which four key fishery species use a south-western Australian Estuary *abs# 77*
3:15 PM Adrian Gleiss
Vertical Migrations in fishes: how novel sensors elucidate the drivers of daily migrations in freshwater and marine environments *abs# 78*

Marine Habitats 3

2:00PM - 3:30PM Kalyenup 1

Chair: Mat Vanderklift

Ningaloo Reef: biology and ecology of fish inhabiting an Australian icon

2:00 PM Anna Cresswell

Links between coral morphological assemblage and fish communities at Ningaloo Reef *abs# 79*

2:15 PM Renae Hoskins

Understanding how coral reef fish abundance and richness in Ningaloo Reef is influenced by habitat and other environmental predictors. *abs# 80*

2:30 PM Thomas Holmes

Considering multiple factors in assessing the effectiveness of a large-scale marine protected area for conserving targeted fish communities *abs# 81*

2:45 PM Julia Haberstroh

Baited video, but not diver video, detects a greater abundance of legal size target species within no-take areas at Ningaloo *abs# 82*

3:00 PM Cameron Desfosses

The significance of macroalgae to the diets of juvenile fish and ecosystem function in a tropical coral reef lagoon *abs# 83*

3:15 PM Cindy Bessey

Different factors predict the distribution of two sympatric urchin species along a fringing coral reef: Ningaloo, Western Australia *abs# 84*

Freshwater: The Good, Bad and Ugly 3

2:00PM - 3:30PM Kalyenup 2

Chairs: Ben Broadhurst & Alan Lymbery

2:00 PM David Morgan

The Wild West *abs# 85*

2:15 PM Dean Thorburn

Good golly it's a Molly! Did the mining downturn lead to the introduction of *Poecilia latipinna* to the Pilbara region of Western Australia? *abs# 86*

2:30 PM Brendan Hicks

Responses of the fish community and biomass in Lake Ohinewai to fish removal and a carp exclusion barrier *abs# 87*

2:45 PM Scott Raymond

Demonstrating the benefits of carp removal in the ovens river *abs# 88*

3:00 PM Alan Lymbery
Edwardsiella ictaluri is present in wild catfish in Australia *abs# 89*
3:15 PM Cindy Palermo
Molecular characterisation of a new species of *Cryptosporidium* in goldfish (*Carassius auratus*) *abs# 90*

Afternoon Tea
3:30PM - 4:00PM Harbour Side Foyer

What Drives Migration? 2
4:00PM - 5:15PM PRT Stage
Chairs: Adrian Gleiss & David Crook
4:00 PM Julianna Kadar
Accelerometry reveals diel activity patterns in Port Jackson sharks, *Heterodontus portusjacksoni* *abs# 91*
4:15 PM Barry Bruce
Broad-scale movements of white sharks in eastern Australia from acoustic and satellite telemetry *abs# 92*
4:30 PM Samantha Andrzejaczek
Temperature-structured vertical movement behaviours in oceanic whitetip sharks *abs# 93*
4:45 PM Mark Chambers
Albany a turning point for juvenile southern bluefin tuna? *abs# 94*
5:00 PM Mark Meekan
Vertical migration in the open ocean and its implications for the evolution of size in whale sharks *abs# 95*

Marine Habitats 4
4:00PM - 5:15PM Kalyenup 1
Chair: Mat Vanderklift
Ningaloo Reef: biology and ecology of fish inhabiting an Australian icon
4:00 PM Tim Langlois
Impact of recreational fishing on fish and shark assemblages within the Ningaloo Marine Park *abs# 96*
4:15 PM Jonathan Mitchell
Understanding and quantifying shark depredation in a recreational fishery *abs# 97*

4:30 PM Mat Vanderklift
Using stable isotopes to understand ecology of sharks and fish at Ningaloo Reef *abs# 98*
4:45 PM Peter Cowman
The biogeography of tropical reef fishes: endemism and provinciality through time *abs# 99*
5:00 PM Richard Pillans
Movement and diving behaviour of Whale Sharks *(Rhincodon typus)* tagged at Ningaloo Reef *abs# 100*

Freshwater: The Good, Bad and Ugly 4

4:00PM - 5:00PM Kalyenup 2
Chair: Katie Ryan
4:00 PM Justin A Benson
Freshwater mussels as ecological engineers in permanent water refuges in southwestern Australia *abs# 101*
4:15 PM Maggie Watson
A complicated symbiosis: understanding the parasitic-mutualistic continuum between Temnocephala and spiny crayfish *abs# 102*
4:30 PM Karl Moy
The invasion of Running River and the story of its refugees. *abs# 103*
4:45 PM Rita Yam
Variation of trophic dependence of different fish consumers in two mountain lake ecosystems from subtropical Taiwan *abs# 104*

Public Lecture

6:00PM - 8:00PM Auditorium, Albany Entertainment Centre
Assessing Fish Stocks (**Dr Malcolm Haddon**, CSIRO)
Tropical reef fish & climate change (**Prof. Morgan Pratchett**, James Cook University)
The Great Southern Reef (**Dr Thomas Wernberg**, University of Western Australia)
Freshwater fishes of WA (**Dr David Morgan**, Murdoch University)
Social and economic dimensions of fishing (**Dr Emily Ogier**, University of Tasmania)

MONDAY 24TH JULY 2017

Registration Opens
8:00AM - 5:00PM Harbour Side Foyer

Environmental Stress and its Effect on Fish 1

8:30AM - 10:30AM PRT Stage
Chairs: Chris Hallett & Kathryn Hassell

8:30 AM Sara Long
Environmental metabolomics provides insights into physiological responses of southern sand flathead in Port Phillip Bay *abs# 105*

8:45 AM Jarrad Baker
Health status of sand flathead (*Platycephalus bassensis),* inhabiting an industrialised and urbanised embayment, Port Phillip Bay, Victoria as measured by biomarkers of exposure and effects *abs# 106*

9:00 AM Marthe Monique Gagnon
The Montara oil spill, Timor Sea – two years of fish health monitoring *abs# 107*

9:15 AM Kathryn Hassell
Fish dissection 101 – fish sampling considerations and how to produce hundreds of response endpoints *abs# 108*

9:30 AM Kye Adams
Sharks, rays and abortion: the prevalence of capture-induced parturition in elasmobranchs *abs# 109*

9:45 AM Joshua Barrow
Environmental drivers of growth and predicted effects of climate change on a commercially important fish *abs# 110*

10:00 AM Jake Watsham
The influence of environmental factors on the habitat use of Black Bream A*canthopagrus butcheri* and the implications of artificial oxygenation in the Swan-Canning Estuary *abs# 111*

10:15 AM Karissa Lear
Accelerometers reveal thermal performance regimes in free-ranging elasmobranchs *abs# 112*

Diets and Trophic Interactions

8:30AM - 10:30AM Kalyenup 1

Chair: Ben French

8:30 AM Chris Fulton

The great escape: are marine blennies using land to avoid predation? *abs# 113*

8:45 AM Joni Pini-Fitzsimmons

Top shelf bottom feeders - Food provisioning in stingrays *abs# 114*

9:00 AM Tyson Martin

Habitat connectivity exerts opposing effects on piscivory and browsing *abs# 115*

9:15 AM Hayden Schilling

Latitudinal and ontogenetic variation in the diet of a pelagic mesopredator (*Pomatomus saltatrix*), assessed with a classification tree analysis *abs# 116*

9:30 AM Sherrie Chambers

Navigation and homing ability in a benthic shark *abs# 117*

Recent Advances in Stock Assessment and Management 1

8:30AM - 10:30AM Kalyenup 2

Chair: Malcolm Haddon

8:30 AM Andre Punt

Exploring model structure uncertainty using a general stock assessment framework: The case of Pacific cod in the Eastern Bering Sea *abs# 118*

8:45 AM Malcolm Haddon

Data-Poor Stock Assessment Options for Australia *abs# 119*

9:00 AM Brent Wise

The state of fisheries science in the early 21st century - A perspective from the future? *abs# 120*

9:15 AM Eva Plaganyi

Empirical harvest strategy and tier system for the Torres Strait tropical lobster fishery *abs# 121*

9:30 AM Richard McGarvey

Decision rules for quota setting to support spatial management in a lobster (*Jasus edwardsii*) fishery *abs# 122*

9:45 AM Alex Hesp

Addressing limitations with catch curve assessments applied to data-limited fisheries *abs# 123*

Morning Tea

10:30AM - 11:00AM Harbour Side Foyer

Environmental Stress and its Effect on Fish 2

11:00AM - 1:00PM PRT Stage

Chairs: Chris Hallett & Kathryn Hassell

11:00 AM Katherine Cure

Genomic signatures of local adaptation reveal source-sink dynamics in a high gene flow fish species *abs# 124*

11:15 AM Tanika Shalders

Climate-mediated changes to the distribution and density of reef fishes family pomacentridae in south-western australia *abs# 125*

11:30 AM Cassandra Thompson

The decline in abundance and diversity of Chaetodon butterflyfish and effects on sociality due to coral loss. *abs# 126*

11:45 AM Morgan Pratchett

Direct versus indirect effects of climate change on coral reef fishes *abs# 127*

12:00 PM Greg Ferguson

Monitoring the response of large-bodied fishes to flood and drought using fishery catch compositions to provide baseline data *abs# 128*

12:15 PM Nicholas Yabsley

Multiple and opposing effects of urbanisation on estuarine fishes *abs# 129*

12:30 PM Chris Hallett

Drivers and symptoms of environmental stress among estuarine fish communities of southern Australia *abs# 130*

Fish Ecology

11:00AM - 1:00PM Kalyenup 1

Chair: Samantha Andrzejaczek

11:00 AM Jordan Goetze

Collecting broad scale ecological data with stereo video technology *abs# 131*

11:15 AM Bryan Baker

Assessing the impact of macrophyte density on underwater video camera monitoring of fishes in tropical wetlands *abs# 132*

11:30 AM Brooke Gibbons
An assessment of fish assemblages in Moorea's marine reserve network using stereo-video techniques *abs# 133*
11:45 AM Hayden Borland
Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches *abs# 134*
12:00 PM Hamish Malcolm
Suitable surrogacy for decadal-scale conservation planning in a warming subtropical region with persistent patterns and shifting species *abs# 135*
12:15 PM Osmar Luiz
Advancing trait-based ecology of fishes by bridging the gap between marine and freshwater studies *abs# 136*
12:30 PM Tim Langlois
Case study of using national on-line services to annotate and analyse underwater imagery: SQUIDLE+ and GlobalArchive *abs# 137*

Recent Advances in Stock Assessment and Management 2
11:00AM - 1:00PM Kalyenup 2
Chair: Malcolm Haddon
11:00 AM Andre Punt
Spatial structure in stock assessments: results of simulation-estimation experiements *abs# 138*
11:15 AM Patrick Cavalli
Review of minimum legal size limits for finfish in Western Australia *abs# 139*
11:30 AM Fay Helidoniotis
Accounting for depletion levels in juvenile biomass when determining stock status *abs# 140*
11:45 AM Norman Hall
Accounting for sample size when estimating natural mortality from maximum age *abs# 141*
12:00 PM Jonathan Carroll
No tanking: estimating the age of pelagic fish eggs directly from field samples *abs# 142*
12:15 PM Marcelo Reis
Fisheries Interaction Index: A Method Based on Catch And Spatial Data *abs# 143*

12:30 PM Malcolm Haddon
Catch-per-unit-Effort: A Pig's Ear or a Silk Purse? *abs# 144*

Lunch
1:00PM - 2:00PM Harbour Side Foyer

AGM
2:00PM - 3:30PM Auditorium

Afternoon Tea
3:30PM - 4:00PM Harbour Side Foyer

Debate
4:00PM - 5:00PM Auditorium

Conference Bash
7:00PM - 11:00PM
Venue: The Boatshed, Princess Royal Dr, Albany

TUESDAY 25TH JULY 2017

Bus Depart Albany Entertainment Centre
Bus departs sharp at 8:45am arrives at Perth Airport at 2:30pm followed by Fremantle at 3:30pm.

Bryan Baker
Towards confident fish identifications – how many image pixels does it take? *abs# 151*

Benjamin M Ford
Stochastic processes dominate the assembly of marine fish communities, with variation in importance of dispersal limitation and deterministic processes along a latitudinal gradient. *abs# 152*

Kathryn Hassell
Taking estuarine eastern blue spot goby (Pseudogobius sp.) fish embryo testing (FET) out of infancy. *abs# 153*

Ross J Marriott
Comparing indices of abundance from standardised catch rates calculated using alternative imputation methods *abs# 154*

Lauren S Munks
Storm-induced changes in environmental conditions are correlated with shifts in temperate reef fish abundance and diversity *abs# 155*

Setareh Samadi
Phylogenetic relationships of Panulirus homarus, P. versicolor and Thenus orientalis from Persian Gulf and Oman Sea *abs# 156*

Setareh Samadi
Oocyte developmental stages of the Pontogammarus maeoticus Sowinsky, 1894 (Ponto-Caspian area amphipod) *abs# 157*

Peter Unmack
Are specific pops of key threatened MDB fishes native or introduced? *abs# 158*

Tzu-Dan Wang
Effects of seasonality, salinity and nutrients on trophic basis of omnivorous fishes in an urbanised estuary from subtropical Taiwan *abs# 159*

Danielle Davenport
Contemporary and retrospective genomic analysis of white sharks, Carcharodon carcharias *abs# 160*

CSIRO

Understanding our oceans is critical to Australia's future. Our ocean-based industries contribute over $42 billion a year to the Australian economy. Australia's marine and coastal resources often come under pressure from the competing demands of different sectors. Sharing our oceans for the benefit of all Australians requires a careful balancing act of planning, management and cooperation. CSIRO Oceans & Atmosphere provides the knowledge to manage Australia's marine estate and atmospheric environment, plan for and respond to weather and climate related natural hazards and ensure sustainable coastal development and growth of marine industries.
Website: www.csiro.au

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ECHOVIEW® is the world's premier software package for hydroacoustic data processing, delivering powerful and flexible capabilities for water-column and bottom echosounder and sonar data processing.
Website: echoview.com

FRDC

The Fisheries Research and Development Corporation (FRDC) is a co-funded partnership between its two stakeholders, the Australian Government and the fishing industry.
The FRDC's role is to plan and invest in fisheries research, development and extension (RD&E) activities in australia. This includes providing leadership and coordination of the monitoring, evaluating and reporting on RD&E activities, facilitating dissemination, extension and

commercialisation. The FRDC achieves this through coordinating government and industry investment, including stakeholders to establish and address RD&E priorities. In addition the FRDC monitors and evaluates the adoption of RD&E to inform future decisions.
Website: frdc.com.au

VEMCO

Vemco is the world leader in the design and manufacture of underwater acoustic telemetry monitoring and tracking systems. Our products are used by researchers worldwide for behaviour, migration and positioning studies of aquatic animals in fresh and saltwater environments.
Website: vemco.com

2017 ASFB CONFERENCE – ALBANY, WA

DRAFT PROGRAM OUTLINE

	DAY 1 - SATURDAY 22nd JULY				DAY 2 - SUNDAY 23rd JULY				DAY 3 - MONDAY 24th JULY			
	Auditorium				PRT Stage	Kalyenup 1	Kalyenup 2		PRT Stage	Kalyenup 1	Kalyenup 2	
8.30 - 10.00	Welcome & Plenaries			8.30 - 10.30	Monitoring & Assessments	Marine Habitats 1	Freshwater: The Good, Bad & Ugly 1	8.30 - 10.30	Special Session: Fish Stress 1	Diets and Trophic Interactions	Special Session: Stock Assessment & Management	
10.00 - 10.30	MORNING TEA *Harbour Side Foyer*			10.30 - 11.00	MORNING TEA *Harbour Side Foyer*			10.30 - 11.00	MORNING TEA *Harbour Side Foyer*			
	Auditorium				PRT Stage	Kalyenup 1	Kalyenup 2		PRT Stage	Kalyenup 1	Kalyenup 2	
10.30 – 12.45	Nurturing Fish Scientists			11.00 - 13.00	Life history & Connectivity	Marine Habitats 2	Freshwater: The Good, Bad & Ugly 2	11.00 - 13.00	Special Session: Fish Stress 2	Fish Ecology	Special Session: Stock Assessment & Managemnet	
12.45 – 13.30	LUNCH *Harbour Side Foyer*			13.00 - 14.00	LUNCH & Poster Session *Harbour Side Foyer*			13.00 - 14.00	LUNCH *Harbour Side Foyer*			
	Auditorium				PRT Stage	Kalyenup 1	Kalyenup 2		Auditorium			
13:30 - 15.00	Plenaries & Student Talks			14.00 - 15.30	Special Session: Migration 1	Marine Habitats 3	Freshwater: The Good, Bad & Ugly 3	14.00 - 15.30	AGM			
15.00 - 15.30	AFTERNOON TEA *Harbour Side Foyer*			15.30 - 16.00	AFTERNOON TEA *Harbour Side Foyer*			15.30 - 16.00	AFTERNOON TEA *Harbour Side Foyer*			
	PRT Stage	Kalyenup 1	Kalyenup 2		PRT Stage	Kalyenup 1	Kalyenup 2		Auditorium			
15.30 - 17.00	Special Session: Hearing me, Hearing you	Special Session: Turning Points	Special Session: Beyond Biology	16.00 - 17.00	Special Session: Migration 2	Marine Habitats 4	Freshwater: The Good, Bad & Ugly 4	16.00 - 17.00	Debate			
18.00 - 20.30	STUDENT MIXER – White Star			18.00 - 20.00	PUBLIC LECTURE – Albany Entertainment Centre			19.00 - 23.00	CONFERENCE BASH – Albany Boatshed			

1

Much to be done.

David Carter[1]

1. Austral Fisheries Pty Ltd, West Leederville, WA, Australia

The next 30 years promises changes on scales, and at a speeds, as yet unimagined by most of the 7 billion humans on this planet. For us to contain global warming to just 2 degrees by 2050, and deal with other climate change related issues, we will need unprecedented performance from our political leadership and governments, businesses, the science community, conservation groups, and individuals. I would like to share some of my insights following nearly 40 years in the commercial fishing industry, in relation to sustainable seafood management, science and conservation.
Austral Fisheries has been at the forefront of 'sustainable seafood' for over 20 years. In 2016, the company reached a turning point and took a world first step to fully offset our carbon emissions, to limit the impacts of our fishing operations on the marine and global environment. The journey which has allowed Austral Fisheries to take this leadership position has involved embracing best practice fisheries management through support for strong property rights, effective regulation, evidenced based stock assessments and ecological models, collaborative conservation actions, third party certification, and social responsibility.
The journey has been an evocative mix of drama and intrigue, of senate enquiries and death threats, of pirates and mountainous seas, of politics and collaboration. The common threadsare our reliance on the oceans, our respect for the scientific evidence-based process and our commitment to collaboration and leadership. But it's also about taking that extra step. For our offsets, we retained a focus taken from our sustainable seafoods journey, to utilise the best, most rigorous approach available. We decided on the Gold Standard approach, which is a certification group for carbon programs which follow Sustainable Development Goals are programs which are proven to be beneficial to the planet, positive for society, and zero harm, all while accurately measuring the carbon sequestration levels. Our hope is to move to some "blue carbon" Gold Standard programs in future, but they're still in the early stages of development, which we're now helping with.

We have looked closely at the concepts associated with earning and maintaining a social licence to operate, and obtaining some understanding of the drivers for outrage in the modern context. We explore the opportunity, indeed the responsibility, that progressive business has to make a positive contribution to the great societal challenges by offering goods and services that contribute in balanced terms to our Planet, People, and Profit.
I hope to encourage young scientists to apply themselves diligently to the job at hand, for there is indeed - so much to be done.

2

Ear bones of fish: turning points in fish and fisheries science

Bronwyn M Gillanders[1]

1. University of Adelaide, Adelaide, SA, Australia

History suggests that Aristotle (around 340 BC) was the first scientist to speculate that age could be determined from hard parts of fishes. Development of microscopes then allowed detailed ageing studies, initially using scales. It was not until 1899 that otoliths were used as an ageing structure, after difficulties were encountered with the use of scales. Other bony structures were investigated shortly thereafter. Almost 120 years since the first use of otoliths for ageing we have come a long way. Initially bony structures were used to estimate annual age and then more recently daily increments have been found in some structures. Similarly, chemical studies initially focused on the mineralogy of structures. Subsequent research then focused on trace and minor elements with significant developments often linked to advances or changes in instrumentation. As developments occurred there was a proliferation in the types of research and management questions that could be addressed. What were the pivotal developments in use of otoliths or other bony structures in fish and fisheries science and what were the key questions being addressed? Through a review of the literature as well as use of my own research spanning the last 20-30 years I will address these questions. In addition, I will provide insight into whether applications have reached their full potential and what I see as the next steps forward. Fish otoliths are likely to provide information not only on the species being investigated but also surrounding ocean conditions for years to come.

3

The Life Cycle of the PhD

Hugh Kearns[1]

1. Thinkwell, Glengowrie, SA, Australia

Based on my experience of working with thousands of PhD students and PhD supervisors I will describe the life cycle of the PhD from both the perspective of the student and the supervisor. As the student moves from novice to independent researcher what are the stages they go through? And what support can the supervisor provide at the various stages?

4

Preparing the Next Generation of Fisheries Professionals for Career Success

Steve McMullin[1]

1. American Fisheries Society, Fort Myers, FL, United States

We conducted a survey of American Fisheries Society (AFS) members to assess perceptions of the importance of knowledge in areas defined by the AFS certification program and how well students, university faculty members and employers felt graduates at the BS, MS and Ph.D. levels were prepared in those areas of knowledge and other job-related skills to succeed as entry-level professionals in fisheries. We received responses from 1,490 AFS members. All student and employer groups rated critical thinking, written communication and oral communication skills as most important in contributing to success of entry-level professionals. The ability to communicate effectively with nontechnical audiences and to work effectively in teams also tended to rate higher in importance than nearly all academic subject areas. Students had much greater confidence in the adequacy of their preparation to succeed as fisheries professionals than employers did in most areas of knowledge and skill. Faculty members expressed slightly greater skepticism than students about graduates' preparation to succeed, but faculty ratings of preparation generally exceeded those of employers significantly. The greatest disparities in perceptions of the adequacy of preparation of graduates occurred in written communication and critical thinking skills. Employers who hired entry-level fisheries professionals primarily at post-graduate levels (MS or Ph.D. degrees) generally assessed their new employees as better prepared to succeed as professionals than those employers who hired primarily at the bachelor's degree level. However, a significant gap in perceptions or preparedness by students, faculty and employers persisted at all education levels. We believe that universities and employers and professional societies all have important, but distinct, responsibilities to address perceived deficiencies in knowledge and skills of graduates.

5

Nurturing fisheries researchers: larvae and juveniles

John D Koehn[1]

1. Arthur Rylah Institute, Heidelberg, VIC, Australia

Learning from the experience of others (both good and bad things) is a valuable thing to do. It has served me well. It can teach you some of the things that you need to survive but are unlikely to learn at Uni. I have been around the block a few times and you can't survive without some tricks- so am happy to try to pass some survival tips on- either through this presentation and panel- or over a drink. Why would I be bothered?- Well, simply to give something back and lend a helping hand to assist you in a new fisheries career. My career in freshwater fishes is now over 35 years, mostly as a researcher but also with many iterations imparting knowledge into policy, and as a manager of up to 50 staff. Within a government department and institute we have been sliced, diced and on the verge of corporatisation and relocation several times. Any career in this field is a marathon not a sprint. It requires persistence, tenacity, patience and an ability to keep your eye on the ball. I have ten principles for my group: teamwork; excellence; work-life balance; focus; communications; time management; being fair and reasonable; being positive and proactive; improving yourself; and having fun. Other essential non-technical skills include: project, budget. personnel, organisation, time and stress management; negotiation skills, the ability to form collaborations, write project bids, have political nous and the ability to smell money. Finding good mentors and colleagues, not taking the whole show too seriously (don't blow up!) and drinking all help.

6

Move it or lose it: restoring movement pathways for fish in freshwater rivers

Jason Thiem[1]

1. Fisheries NSW, Narrandera, NSW, Australia

Widespread anthropogenic development has resulted in interruptions to key movement corridors for fish within freshwater ecosystems. This has contributed to numerous global, regional and local declines in both diadromous and potamodromous fish populations. The construction of additional dams, particularly in developing countries, further threatens fish populations. Major advances in engineering and construction techniques have been made over the past few decades, improving our ability to reconnect individual streams and watersheds. Additionally, novel techniques have been developed enabling us to elucidate the causes and consequences of passage success and failure past individual barriers. These include techniques to measure variables such as swimming performance, the application of field physiological tools and the remote measurement of activity rates. However, despite this progress there are very few documented examples of recovery of fish populations or communities in reconnected systems. Watershed-scale planning and cross-jurisdictional collaborations are required to achieve more meaningful outcomes across ecologically relevant scales. A number of regional case studies from south-eastern Australia will be presented that demonstrate the value of restoring movement pathways for both individual species and fish communities.

7

Dynamic Ocean Management: a strategy to reduce conflict between ocean users

Steph Brodie[1, 3, 2]

1. School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, NSW, Australia

2. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Monterey, California, US

3. University of California Santa Cruz, Monterey, California, US

Oceans are physically and biologically dynamic, yet strategies to manage oceans are often implemented at overly coarse spatiotemporal scales. Novel spatial management strategies that seek to reduce conflict between ocean users are gaining in popularity. One such approach is Dynamic Ocean Management (DOM) which is a management strategy that uses physical, biological, and socio-economic data to rapidly respond in space and time to the variability of the ocean and its users. DOM is an emerging field of research that has been demonstrated to have wide application to ocean users around the globe. DOM has typically been implemented on a near real-time basis, but improvements in ocean forecasting on time scales of weeks to decades

have provided additional approaches to resolving ocean conflicts. I will describe a number of case studies from around the world that highlight how DOM strategies can help achieve conservation targets, support economic viability, and sustain social sustainability. Case studies will range from a bycatch reduction tool in the Californian Drift Gillnet fishery, to a seasonal forecast of dolphinfish (*Coryphaena hippurus*) distribution in eastern Australia. The continued development and application of DOM will help ocean user groups and management cope with future uncertainty and variability in the distribution of motile marine species.

8

A review of the use of echosounders for fish-stock assessment in marine and freshwater environments

Ben Scoulding[1], Toby Jarvis[1]

1. Echoview software, Hobart, TAS, Australia

Some aquatic animals, most notably cetaceans, have evolved sophisticated echo-detection systems over millions of years for locating and identifying underwater targets such as their fish and squid prey. Perhaps inspired by nature, the first man-made echo-detection instruments (echosounders) were developed in the early 1900s, primarily for submarine detection and to measure water depth. Echosounders were used in commercial marine fisheries in the 1930s and 40s to detect fish, and fisheries scientists quickly realised the potential of echosounding for monitoring important fish stocks. The field of scientific fisheries acoustics was born in the late 1960s, and by the end of the 1980s echosounders had become widely trusted as a tool capable of delivering robust quantitative fish-stock estimates. In marine and freshwater environments around the world, echosounding is one of the primary fish-stock assessment tools employed by many state and federal government agencies, research organisations and private companies. We present a number of case studies to illustrate the range of approaches currently employed and the strengths and limitations of quantitative echosounding.

9

Evaluating active-acoustic methods for assessing snapper (*Chrysophrys auratus*) spawning aggregations in Western Australia

Ben Scoulding[1], Sven Gastauer[2], Miles Parsons[3], Brett Crisafulli[4], David Fairclough[4]

1. Echoview software, Hobart, TAS, Australia

2. Antarctic Climate and Ecosystem CRC, Hobart, Tasmania

3. Centre for Marine Science and Technology, Curtin University, Perth, WA, Australia

4. Department of Fisheries, Government of Western Australia, Perth, WA

Snapper (*Chrysophrys auratus*) is an important commercial and recreational species, in Australia and New Zealand. From late winter to early summer, adult snapper migrate the broader metropolitan waters of Perth Western Australia into the protected embayment's of Cockburn Sound, Warnbro Sound and Owen Anchorage to form spawning aggregations. In Cockburn Sound, they can be acutely exposed to anthropogenic (e.g. industry, fishing) and environmental factors (e.g. deoxygenation, elevated temperatures) that may affect numbers, spawning success and subsequent recruitment. Monitoring the status of these tightly-managed aggregations is particularly important as impacts of these stressors can be significant and rapid. To facilitate this monitoring, evaluation of commonly used methods for estimating spawning biomass (e.g. daily egg production method), against those that take advantage of developing methods (e.g. hydroacoustic), would be beneficial. To this end, active-acoustic data were collected from spawning aggregations of snapper in Cockburn Sound over two days in November 2016 to determine the packing density, vertical and horizontal distribution and length estimates of individuals (using a BioSonics DT-X single-beam echosounder at 38 and 120 kHz and a BlueView M900-2250 multibeam echosounder at 900 kHz). Length estimates were compared with historic fishery-independent length data. Acoustic data were analysed using Echoview software. Computed tomography scans of individual snapper were used to model the frequency-dependent acoustic backscatter and validate the BioSonics information from single targets. We approximated school shape and packing density using novel model approaches which can deliver estimates of school biomass, with accompanying error estimates. This study forms the first step towards an acoustic assessment of snapper in Cockburn Sound, which could be applied to other aggregations in Western Australia and elsewhere across its distribution.

10

Imaging sonar mapping of river habitats and fish usage

Miles Parsons[1], Iain Parnum[1], Steeg Hoeksema[2]

1. Centre for Marine Science and Technology, Perth, WA, Australia

2. Department of Parks and Wildlife, Rivers and Estuaries, Western Australia

The rivers and estuaries of coastal Australia provide habitat for numerous fish communities comprising various ecologically and recreationally important fish species. With concerns over the impacts of external pressures, such as fishing, hypoxic conditions or toxic algal blooms, mitigation methods involving habitat and stock enhancement have grown in recent years. However, monitoring system health and quantifying the effect of enhancing fish habitat relies on baseline knowledge of the existing fish assemblage and its habitat usage. Traditional sampling methods such as netting and video observation are very useful, but are also sometimes inhibited in rivers by local conditions, including complex cover (branches or man-made objects) or visibility (turbidity or tannins). High-frequency imaging sonar has recently expanded from monitoring subsea structures to fine-scale mapping of seafloor habitats and assessing the number, size distribution and behaviour of fish. To complement current surveys into the health of the Swan Canning Estuary, Western Australia, towed sidescan imagery of the riverbed was conducted to define

patches of topographic complexity, due mostly to changing river banks and submerged structures. At various sites of differing habitat (sand flats, centre of the river, sheer river bank, complex structure) within the Upper Swan Estuary, the imaging sonar was positioned 1 m above the riverbed, recording passing/surrounding fish for 45-minute periods. Sonar fish targets of different size classes were counted to investigate the length distribution and numbers within size classes, across the different habitats. This presentation will focus on the performance of the sonar and the differences in numbers and size classes of fish observed between the habitat types.

11

Passive acoustic monitoring of fish movement around the Swan River

Miles JG Parsons[1], Iain M Parnum[1], Sarah Marley[1], Syvlia K Osterrieder[1]

1. Centre for Marine Science and Technology, Perth, WA, Australia

Each summer adult mulloway (Argyrosomus japonicus) aggregate in areas of the Swan River each evening to spawn, producing a hours-long chorus each time. Passive acoustic monitoring has been used to observe the aggregation in Mosman Bay for several years, however, the chorus is not produced at exactly the same location each night, but varies with time. In October, 2016, 12 acoustic recording systems (8 OceanInstruments Soundtraps and 4 Centre for Marine Science and Technology Underwater Sound Recorders) were deployed at various sites around the Swan and Canning River system to record underwater sounds, from Fremantle Port to Belmont Racecourse and near Shelley Bridge. The SoundTraps recorded continuously for the duration of the deployment while the CMST recorders were set to a 4 of every 5 minutes duty cycle, sampling at 48 kHz and 8 kHz, respectively. The recordings included the choruses and calls of the mulloway at various sites, as well as signals from resident dolphins and passing vessels. The chorus levels have also been compared to previous years' data to investigate how the fish movement may relate to environmental factors, such as solar, lunar and tidal patterns, as well as salinity and temperature. This presentation will highlight the various received sound pressure levels attributable to the mulloway choruses over time to illustrate the ability of passive acoustics to map movements of vocal fish species.

12

An introduction to Marine Soundscape Ecology: The highs and the lows (frequency)

Miles Parsons[1]

1. Centre for Marine Science and Technology, Perth, WA, Australia

TBC

13

Electronic monitoring within longline fisheries in the western and central Pacific Ocean: implications for data collection and exchange.

Timothy Emery[1], Rocio Noriega[1], James Larcombe[1], Ashley Williams[1], Simon Nicol[1]

1. Department of Agriculture and Water Resources, Canberra, ACT, Australia

At-sea observer programs have historically been used to collect fisheries-dependent data, but the coverage (as a percentage of fishing effort) is often less than preferred or considered optimal. Through a combination of video and sensors, electronic monitoring (EM) is seen as having the potential to address some of the limitations within at-sea observer programs and facilitate adequate data collection to support management decision-making. In the western and central Pacific Ocean (WCPO) tuna longline fisheries, where observer coverage has historically been low, the advent of EM technology has been perceived by some countries as a way of meeting their at-sea observer coverage requirements (5% of total effort) under the Western and Central Pacific Fisheries Commission (WCPFC) Regional Observer Program (ROP) (CMM 2007-01). In implementing EM it is critical that data continuity is not compromised to avoid potential flow on effects in the provision of scientific analyses and advice. This paper will discuss the capability of EM to collect at-sea observer data required under the WCPFC ROP's accompanying Minimum Standard Data Fields and implications for international data collection and exchange.

14

The role of electronic monitoring in improving the quality of fishery dependent logbook data.

Rocio Noriega[1], James Larcombe[1], Timothy Emery[1]

1. Department of Agriculture and Water Resources, ABARES, Canberra, ACT, Australia

Fisheries electronic monitoring (EM) is a combination of hardware (including cameras, gear sensors and GPS) and software that collects and transmits fisheries information in an automated manner that is closed to external or manual input or data manipulation. Complete EM systems comprise both the on-board hardware for data collection as well as the onshore processes for data interpretation and use. In recent years, EM systems have been introduced in selected Australian Government managed fisheries with a key objective of facilitating fleet wide improvements in the quality and coverage of the data and information that is reported by fishing vessels through their logbooks. This compliance role is achieved through a feedback cycle where EM data are compared with the equivalent logbook data, then performance feedback is provided to individual fishers on the accuracy of their logbooks. We examine the effect of the introduction of EM on the accuracy of logbook reporting in two fisheries: the Eastern Tuna and Billfish Fishery (ETBF) and the Gillnet Hook and Trap (GHAT) sector. Direct comparisons are made between the levels

of catch reported through EM and through logbooks, coupled with an analysis of logbook catch reporting rates pre- and post-implementation of EM across the categories of target, byproduct, bycatch and protected species. Comparisons are made between the outcomes achieved in the two fisheries giving some important insights and lessons on the effectiveness of EM and its role in the improvement of fishery dependant data.

15

Integrating ecological processes into marine reserve design

Christopher Henderson[1], Tim Stevens[1], Andrew Olds[2], Ben Gilby[2], Joe Lee[1]

1. Griffith University, Queensland, Australia

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Ecological processes function to structure the species composition and dynamics of ecosystems . However, habitat destruction and fragmentation, eutrophication, and overharvesting can have detrimental effects on the scale and distribution of these processes and the species that provide them. Here we aim to demonstrate a method for prioritizing conservation efforts for the protection of critical ecosystem functions. Algae assays were deployed in seagrass beds across Moreton Bay, Queensland to determine herbivory. We found that the abundance of a commercially harvested herbivorous fish species was a suitable surrogate for herbivory in seagrass meadows within a disturbed coastal ecosystem. Species distribution models for this species highlight seagrass meadows closest to anthropogenic disturbance were the most important for the abundance of this species, and thus suppressing algal overgrowth within seagrass meadows through herbivory. Critical habitats were predominantly located outside of current conservation boundaries and therefore represent priority areas for conservation. This is the first study to highlight that conservation prioritization for ecosystem functions could be focused in areas that may receive the most anthropogenic disturbance and may have previous been deemed a poor choice for conservation prioritization.

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Measuring and understanding change: IMOS initiatives and tools relevant to fish and fisheries

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Changes in our marine environment are underway with increasing temperature, ocean acidification and deoxygenation affecting marine ecosystems. Monitoring has become particularly important in order to detect and help predict change, and Australia's Integrated Marine Observing System (IMOS) aims to address this need by providing the infrastructure to observe our oceans. As a marine observing system, IMOS has focused on building long-term time-series data, making all data openly available, thus ensuring IMOS observations are available for use by many stakeholders. The richness of these data streams has also enabled the creation of new initiatives of interest to the fish biology and fisheries community, such as:

- National Ichthyoplankton Monitoring and Observing (NIMO), which evaluates the value of long-term monitoring of ichthyoplankton at selected IMOS National Reference Stations;
- Zooplankton Ocean Observations and Modelling (ZOOM), which is beginning the process of systematically integrating zooplankton observations into biological and ecosystem models;
- Synthesis and national scale analysis of IMOS acoustic telemetry data, which is developing a national approach to synthesis and analysis of IMOS Animal Tracking Facility data.
- The Marine Sciences Cloud which will provide a virtual desktop support for marine and climate scientists to run analyses using a suite of online graphical and scripting tools and a national service to annotate and analyse underwater imagery (AUV and BRUVS) by leveraging existing software initiatives.
- Harmful Algal Blooms (HABs) forecasting initiative, which is exploring the possibility of creating a forecasting system for HABs to help fisheries and aquaculture

In addition to IMOS-led initiatives, IMOS data has contributed to the validation of a diversity of ocean models, including the *ETAS* model, used to study marine heatwaves along the east coast of Tasmania.

This talk will illustrate how these initiatives are contributing to measuring and understanding changes which impact on Australian fish ecology.

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Turning points, meandering or trending upwards - initiatives in the Murray Darling Basin for native fish

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Native fish management in the Murray-Darling Basin has taken a series of twists and turns since the River Murray Waters Agreement was signed over 100 years ago. Floods, drought, alien invaders and major human interventions have all had their impacts. Current, and future, generations of fisheries scientists and water managers now face an uphill battle to recover populations and build resilience in a heavily modified environment. Undaunted, well perhaps slightly daunted, managers and

scientists have worked together to develop and implement a range of initiatives over the past few decades, resulting in some significant turning points for native fish in the Murray-Darling Basin.

We will reflect on the legacy of the Native Fish Strategy, an initiative with lofty goals and a long-term vision, which was highly regarded but unfortunately short-lived. The benefits, and risks, of The Living Murray program will be discussed and we will demonstrate how it has shaped environmental water management in the River Murray System. The development of the Basin-wide Watering Strategy under the Basin Plan, and its continuing implementation through the Basin-wide Annual Watering Priorities is the latest step in water management to support native fish recovery. We will discuss the importance of science in the development of the Strategy and its continuing implementation through the Basin-wide Annual Watering Priorities. Finally, we will contemplate the risks and opportunities for native fish of possible future basin-scale interventions and how these may contribute to an upwards trajectory for native fish in the Murray-Darling Basin.

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Looking back and looking forward: water reform as an agent of change for native fish in the Murray-Darling Basin

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The Basin Plan was legislated in 2012, with an overarching aim of returning the Murray-Darling Basin to a healthy working basin. Thus, the Plan is intended as an agent of change for the environment, communities and economies. Poorly received by the public, the potential environmental benefits of the Plan received little attention in comparison with the potential impacts on communities and economies. Five years on, the initial evaluation of the Basin Plan provides opportunity to determine the value of the policy to date; to explore learnings and knowledge gaps; to identify what is necessary to achieve outcomes in the future; and to make linkages between environmental outcomes and social and economic benefits. In this presentation we will discuss how we are piecing together evidence of success, failure and learning to determine if the Basin Plan has been, or will be, an agent of change for native fish. The linkages between native fish outcomes and social and economic benefits will be discussed, and the opportunities to increase stakeholder support of the Plan through targeted communication of these linkages will be explored.

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The role of fishery certification schemes in providing social licence for both industry and Government

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Pressures are growing on fisheries to demonstrate their sustainability and unless they can adequately address perceptions and issues that concern the general public, they may become exposed to criticism that could lead to regulatory restrictions or fishery closures. It is no longer considered sufficient for scientists and managers to focus only on the ecological sustainability of fisheries but they also need to consider the views of the community and other stakeholders. Social licence has become a popular term to describe the level of community acceptance of fisheries, however, mechanisms for successfully gaining and maintaining such licence have not been thoroughly explored. In Western Australia, an approach has been taken to use independent assessments of fisheries against a globally accepted standard for sustainable fishing to improve public confidence in fisheries and their governance. This talk will focus on the role of fishery certification schemes like the Marine Stewardship Council (MSC) for providing social licence, both for industry through improving consumer awareness and perceptions, and Government by increasing community trust in science and management. It will specifically explore in which ways the MSC assessment process can facilitate this, and what the implications may be.

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The 'social and economic' turning points in fisheries research and management

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It started with the inclusion of economic concepts in biological models and reference points for harvest settings (bio economics). Now other concepts from a range of social sciences are entering the field of fisheries research and decision support, not the least of which is the challenge to the very social acceptability of the biological science supporting the management of Australian fisheries. Where will it end? And what led us to these turning points? The FRDC has funded a new Subprogram in Human Dimensions Research for fisheries and aquaculture, and this signals a significant opportunity to tackle some of the big issues where failure to take account of human dimensions, and how they interact with biological and ecological components, can have direct negative consequences for the ecological sustainability of fisheries, broadly defined. These issues include:

- Resource sharing and allocation, where we have a strong body of science knowledge on which to determine how many fish can be sustainably extracted, but a more limited body of knowledge as to what social and economic benefits different groups would derive from catching, or preserving, that fish, and under what conditions.

- Understanding drivers of fisher/industry behaviour, such as when and where to fish, drivers of compliance, and stewardship practices

- The role of fisheries science in influencing the social acceptability of fisheries

This presentation will offer an overview of new developments in human dimensions research for fisheries, and a discussion of the opportunities for adding value to fish and fisheries biological research.

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A social revolution in fisheries science

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We are no longer simply observers and users of natural systems, but integrated components. Our science is constantly evolving in a world that is changing rapidly both in terms of climate impacts and human influences and drivers in the modern Anthropocene Ocean, and hence a fundamental shift is necessary in how we do our science. Ecology and the human dimension are increasingly intertwined, and the sustainable management of the future ocean will increasingly depend on how we manage these interactions. Complementing sustainable management of natural resources with sustainable self-management, is key to future sustainability. Effective management may mean relying on more levers than in traditional management, such as socio-cultural and governance considerations. Here we focus on examples of how to extend the current toolbox of ecosystem approaches to extend beyond the biology. We focus on "Models of Intermediate Complexity for Ecosystem assessments" (MICE), which limit complexity by restricting the focus to those components of the ecosystem needed to address the main effects of the management question under consideration. Socio-ecological MICE are being extended to represent dynamically the two-way feedbacks between ecological systems and linked socio-economic systems. Specifically, we incorporate a dynamic feedback between ecosystem characteristics and peoples' sense of place, using a new Sense of Place Index (SOPI) to allow the quantitative integration of environmental psychology into socio-ecological models. We also outline current uses of socialised MICE models to inform on climate-smart-adaptation strategies in southern hemisphere hotspot regions.

22

Turning the tide - demonstrating the sustainability of Western Australia's fisheries

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Australian fisheries overall are well managed. For example Western Australia claims more than 95% of its fisheries are sustainable, and those that are not have rebuilding strategies in place.

However recent national surveys of Australian's perceptions indicate widespread concern about fisheries management performance and the sustainability of our fisheries. A 2015 Commonwealth Department of Agriculture funded survey concluded "…..current public opinion is 'thinly' positive. Benefits like employment are appreciated but potential negatives such as sustainability and overfishing come to mind quickly."

The Western Australian Government took a bold initiative to assure the public and the markets of the sustainability of WA's fisheries by promoting third party certification of the state's fisheries . The certification uses the Marine Stewardship Council and Aquaculture Stewardship Council standards, and the program is now in its fifth year of operation.

This presentation backgrounds the MSC approach and the implementation of the certification process, including several unique qualities of the Western Australian program. Western Australia's performance is compared with similar overseas initiatives. The presentation concludes with a discussion of the factors influencing Western Australian fisheries to join the program.

23

How do we prevent the economic benefit of fisheries being exported?

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Commercial fisheries rely on access to a public resource so it's reasonable for the public to expect to see a benefit. Commercial access is often justified by benefits of employment or provision of food for the local community, however these benefits are not always relevant in high-valued fisheries, such as the Australian examples explored in this paper. A large quantity of wild-capture seafood is exported so the public gets little consumption benefit, while employment is actively minimised using catch share management (ITQ) to promote technical efficiency and increase economic yield. This strategy has successfully reduced employment for example, in all Australian rock lobster fisheries, so that economic yield has typically increased several fold. This higher economic yield would theoretically benefit the public owners of the resource if it were retained in the community, through for example, royalty payments or the development of new industries. However, the economic yield of various Australian rock lobster fisheries is increasingly being exported, for example by companies outside the jurisdiction buying and leasing ITQs. This trend of Australian rock lobster fisheries exporting benefit has become a significant concern for industry groups but they typically question whether there are any solutions. In fact, there are numerous options available and some of these will be explored in this discussion. They include controls on foreign ownership, taxation approaches, and social structures.

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Evidence for systemic age underestimation in shark and ray ageing studies

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Numerous studies have now demonstrated that the most common method of ageing sharks and rays, counting growth zones on calcified structures, can underestimate true age. I reviewed bomb carbon dating (n=15) and fluorochrome chemical marking (n=44) age validation studies to investigate the frequency and magnitude of this phenomenon. Age was likely to have been underestimated in at least nine of 29 genera and 30% of the 53 populations studied, including 50% of those validated using bomb carbon dating. Length and age were strongly significant predictors of occurrence, with age typically underestimated in larger and older individuals. These characteristics suggest age underestimation is likely a systemic issue associated with the current methods and structures used for ageing. Where detected using bomb carbon dating, growth zones were reliable up to 88% of asymptotic length (L_{∞}) and 41% of maximum age (A_{Max}). The maximum magnitude of age underestimation, Δ_{Max}, ranged from five to 34 years, averaging 18 years across species. Current perceptions of shark and ray life histories are informed to a large extent by growth studies that assume ageing structures are valid throughout life. The widespread age underestimation documented here shows this assumption is frequently violated, with potentially important consequences for conservation and management. In addition to leading to an underestimation of longevity, the apparent loss of age structure associated with it may unexpectedly bias growth and mortality parameters. Awareness of these biases is essential given shark and ray population assessments often rely exclusively on life history parameters derived from ageing studies.

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Quantifying shark depredation encounters while commercial, charter and recreational fishing in Western Australia

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Shark encounters while fishing in marine waters in Western Australia are perceived to be increasing by some commercial fishers, charter tour operators and private boat-based recreational fishers. Lack of quantitative information remains a significant obstacle in determining the nature and magnitude of these encounters. A probability-based phone survey was designed to assess fisher attitudes and the level of shark encounters by recall during the previous 12 month period (September 2015 to August 2016). Of the 906 fishers who participated in the survey, 52% indicated they had experienced a shark encounter during the previous 12 months. The level of concern regarding shark encounters varied among the main bioregions fished. Multiple logistic regressions were used to assess the impact of activity type, bioregion and season fished on the occurrence of shark encounters while fishing. Results indicated that activity type and bioregion fished were the most important predictors for estimating shark encounters. The likelihood of different types of shark encounters varied among activity type. For example, the likelihood of fish loss above the surface was highest for recreational fishers while pelagic fishing. The North Coast and Gascoyne Coast were generally most susceptible to most types of shark encounters.

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Assessing variability in standardised harvest rates from shore-based recreational fishing surveys.

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Estimates of harvest rates for fisheries management are commonly used in a weight of evidence approach to provide an annual index capable of detecting variability in the thresholds set in harvest strategies. However, when using harvest rates to assess recreational fisheries, it is difficult to account for biological variation, changes in management or environmental conditions, and fisher behaviour. The use of nominal harvest rates can mislead stock assessments and subsequent management decisions. This study used a roving creel survey to determine the factors (survey year and month, targeting, fishing platform, fishers' avidity, time of day and day type) that influence variability in harvest rates of finfish species caught by shore-based recreational fishers in the Perth metropolitan region. The species of interest were Australian herring *Arripis georgianus,* School whiting *Sillago* spp and Garfish Hemiramphidae spp. Generalised linear models, including the zero-altered gamma (ZAG) and Tweedie models, were assessed for their suitability via a five-fold cross-validation to compare their performance. Results showed that the significant variables and performance of models varied among species with ZAG and Tweedie models having the best performance overall. For Australian herring and Garfish there was a decrease in the harvest rate from 2010 to 2016, while for School whiting there was a slight increase from 2010. Estimates of harvest rate were significantly higher for fishers targeting School whiting and Garfish, and for these species, targeting was the only influential variable. In contrast, for Australian herring, the type of fishing platform and time of day were also key contributors in addition to targeting. This variation in significant variables across species shows that a blanket approach to choosing a model is not appropriate and that the model choice, as well as explanatory variables, is species dependent.

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Tailor tales: 18 years of monitoring wild harvest fisheries in Queensland

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Tailor (*Pomatomus saltatrix*) is a popular food and sports fish found in isolated populations in temperate and subtropical waters around the globe. Off Eastern Australia, tailor has a history as an important species for indigenous, commercial and recreational fishers. In Queensland waters, the commercial and recreational tailor fishery grew throughout the mid 1900s. Increases in fishing effort and reductions in catch by the 1990s raised concerns regarding the sustainability of the tailor stock. A suite of new management arrangements were implemented to rebuild the stock with the aim of achieving long-term sustainability. To assess the efficacy of these new arrangements, a biological monitoring program was implemented in 1999. The goal of this monitoring program, now entering its 19th year, is to acquire biological samples for length and age determination (using age-length-keys) that are representative of the recreational and commercial fishery harvests. The program employs fishery-dependent sampling strategies and successfully samples more than 8000 lengths from over 700 catches and collects over 550 otoliths for fish ageing annually. This presentation provides insights into the challenges encountered in developing and maintaining a long term biological monitoring program. A summary of the recent trends in biological characteristics will be presented and the importance of integrating data from diverse sources to provide context for fishery-dependent biological monitoring results will be highlighted. The long time series of biological data for tailor has been a vital input into periodic stock assessments as well as biennial assessments of the stock's status at both state and national levels, facilitating the classification of this stock as sustainably fished.

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Cruising along or collapsing: what is the status of WA's last cobbler fishery?

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Prior to 1980, cobbler (*Cnidoglanis macrocephalus*) was an important commercial fishery species in southern estuaries in WA, with a combined annual catch of several hundred tonnes. Fishing pressure and habitat degradation led to stock declines in several estuaries. The biological characteristics (e.g. low fecundity, high parental care/nest guarding, specific habitat requirements, small discrete populations in each estuary) make cobbler inherently vulnerable to these threats. Today only one WA estuary, Wilson Inlet, continues to host a significant cobbler fishery.

In Wilson Inlet, a relatively large amount of fishery-dependent and -independent information has been collected since the 1980s (catch sampling, juvenile surveys, tagging, etc). Key indicators now strongly suggest the current stock status is unacceptable: i) declining recruitment; ii) very high mortality with increasing trend; iii) highly truncated age and length structure with increasing trend. Retrospective SPR estimates suggest the spawning stock level has been below 20% for at least a decade. However, despite the apparently dire state of the stock, the catch and commercial CPUE has remained stable for 3 decades. Why?

We discuss the lines of evidence and analyses used in the latest assessment, including sources of uncertainty that are common to many fishery assessments.

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Reconstructing the footprint of an Australian penaeid-trawl fishery to support ecosystem-based management

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Using GIS techniques, the trawl footprint of the eco-certified Spencer Gulf prawn fishery was estimated with the view of developing a cost-effective surrogate measure of the fishery's impact on the benthic ecosystem. Based on trawl midpoints recorded for ~40% of all shots from 2003–2016, and trawl distance, width and simulated direction, individual trawl paths (line segments) and swept areas (polygons) were reconstructed. Owing to a consistent spatial trawl pattern and relatively stable annual total effort during this 14-year period, random subsets of midpoints representing ~5.5 years with 100% coverage were obtained to describe and predict the change in trawl footprint. Two alternative estimates of trawl footprint were calculated: (i) a swept-area estimate, which is the amalgamated area of trawl polygons, and (ii) a trawl-intensity estimate, which is the total area of pixels at sufficiently high resolution and above a predetermined minimum trawl intensity (cutoff). The amalgamation of polygons resulted in a total swept-area (at ~5.5 years) of 4,282 km^2, with less new ground trawled each year. By comparison, the trawl-intensity estimate was 4,224 km^2 at a resolution of 30 × 30 m and cutoff of 0.5 h km^{-2} yr^{-1}. Exponential decay models fitted to swept-area and trawl-intensity footprint estimates with each additional year yielded projections of 4,468 and 4,253 km^2, respectively, which equate to <20% of the total area of Spencer Gulf. The pending introduction of electronic logbooks in the fishery theoretically should eliminate some positional errors that are, otherwise, undetectable. Until then, the trawl-intensity estimate is preferred since, not only can it be updated within a few hours (cf. days for the swept-area estimate), errors can partly be offset by adjustment to the intensity cutoff. We suggest that regular trawl-footprint estimates, supplemented with monitoring bycatch species of interest, should be considered in an ecosystem-based management context for this fishery.

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Multispecies presence and connectivity around a designed artificial reef off coastal Sydney, Australia

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A goal of designed artificial reefs (ARs) is to enhance fish abundance, species diversity and fishing opportunities through providing food and refuge for fishes. Quantifying the contribution of ARs to coastal ecosystems and fisheries productivity requires an understanding of fish presence at the structure and connectivity with surrounding habitats. The movements and presence of 10 Eastern Fiddler Ray (*Trygonorrhina fasciata*), 17 Port Jackson Shark (*Heterodontus portusjacksoni*) and 18 Bluespotted Flathead (*Platycephalus caeruleopunctatus*) were monitored using acoustic telemetry around a 700 m^3 designed AR in 38 m depth near Sydney, Australia. Fiddler Rays exhibited an average short-term presence of 43% at the AR, and 26% over the ~20 month monitoring period, which was significantly higher than the other two species. Fish tagged at the AR showed high affinity to the site at which they were tagged compared with fish tagged on natural reef. All three species moved frequently between the AR and the other reefs in the area, indicating strong connectivity throughout the mosaic of habitats. The relatively moderate presence at the AR suggests that these species may contribute to some biomass production at this AR, by incorporating this reef in their natural range. Our findings also indicate that this reef may increase the connectivity between adjacent habitats and aid the dispersion of a range of benthic species.

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Ecological changes to the marine community after instalment of an artificial reef on the south-west coast of Western Australia.

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Hard bottom habitat can be a primary limiting resource. Artificial structures are often used to alleviate this constraint and increase local marine populations. However insufficient research into the effects of artificial reefs on recruitment, species diversity, abundance and biomass make it difficult to determine the effectiveness of this technique. The following study employed multiple sampling methods to investigate the ecological changes undergone by fish assemblages, macroinvertebrate communities and macroalgae and seagrass cover after installation of an artificial reef. The Coogee maritime trial was installed on the south-west coast of Western Australia in July 2016. The trail comprises the existing Omeo ship wreck and a variety of differently designed concrete structures. The study incorporated a Before After Control Impact (BACI) approach to assess if the artificial reef influenced the diversity, abundance and size-structure of fish assemblages, diversity and abundance of macroinvertebrates and the diversity and cover of macroalgae and seagrass. Multiple control sites where surveyed including the southern breakwater at Port Coogee, the bay exhibiting mostly bare sand and the Omeo ship wreck. These sites where compared with the reef site before installation and at three and ten months' post installation. The results will be used to evaluate the effectiveness of the Coogee maritime trail in increasing species diversity, abundance and biomass. Insight into the practical applications of artificial reefs to achieve advancements in ecotourism and biodiversity conservation could help sustain the growing popularity of sports diving and provide a solution to the reduction in biodiversity observed in many coastal ecosystems around the world.

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Reef Vision: Recreational fishers monitoring artificial reefs using baited remote underwater video systems.

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With the deployment of artificial reefs there are legislative, social, environmental and ecological requirements to monitor the performance of these structures. While monitoring undertaken by governments and scientific organisations can be cost and time prohibitive, the use of citizen scientists' can cost effectively gather large spatial and temporal data sets as well as grow the social values of participants. In South Western Australia, local fishers were used to monitor artificial reefs in a program called '*Reef Vision'*. This program developed innovative technology, methodologies and a suite of engagement and management tools to effectively utilise fishers as citizen scientists. Between 2015 and 2016, twenty volunteer recreational fishers deployed custom designed Baited Remote Underwater Video systems (BRUVs) on two artificial reefs in Geographe Bay, Western Australia. Footage collected by these citizen scientists was analysed to see variations in fish assemblages over time and between the reefs as a measure to determine the performance of the reefs. Over 150 hours of footage was collected on the reefs over a year period which resulted in the detection of over 34,000 individual fish from 69 species including 13 elasmobranchs. This successful citizen science model has been accepted as a valid monitoring method by the federal government and highlights the ability of fishers to collect data to assist research and monitoring.

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Insights into fish associations with various artificial structures in southwest WA

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Artificial structures such as sunken ships and habitat enhancement structures have been deployed around the world with many shown to benefit local fish populations and hence fisheries. A number of different artificial structures are already deployed in southwest WA for a wide range of purposes, including; creating recreational fishing and tourism opportunities, aquaculture developments, shipwrecks, as infrastructure (e.g. breakwaters and jetties) and, in the past, for disposal of obsolete equipment and vessels.

One of the key questions for any artificial structure is how the various local fish species utilise or associate with the differing structures resulting in–concentration/redistribution of existing organisms and biomass, and/or changes in local productivity and biomass. After more than 10 years involvement in a range of projects surveying different artificial structures in southwest WA, a number of insights have been gained into addressing some of these key questions for particular WA species using underwater video techniques.

The talk will cover the various artificial structures surveyed in southwest WA, including the Southwest artificial reef trial, Augusta abalone mariculture lease site and various dive sites (e,.g Busselton jetty, *HMAS Swan* & *MV Lena*). Details of methods used and their value for assessing fish associations with underwater structures along with insights gained on how various WA fish species, such as WA Dhufish (*Glaucosoma hebraicum*) and Samsonfish (*Seriola hippos*), utilise these different structures at different life history stages will be discussed along with the potential benefits these structures, possible effects on the wider ecosystem and comparison with natural sites.

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A comparison of fish assemblages associated with two gas flowlines and the adjacent seafloor.

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2. Oceans Institute, University of Western Australia, CRAWLEY, WA, Australia

Large-scale marine infrastructure is a feature of many of the World's territorial seas, of which, much is associated with the extraction of oil and gas and the extensive array of its subsea pipelines. The North West Shelf region of Western Australia is no exception and its now ageing infrastructure will soon need to be replaced or decommissioned. Despite the extensive coverage of subsea pipelines, little is known of their influence on the fish community. We used remote baited video to assess the abundance and diversity of fish on two subsea pipelines in 130m of water on the North West Shelf and compared this to surrounding areas without subsea infrastructure. Preliminary review of footage revealed increased abundance and diversity of fish on the pipeline compared to off. Important commercial fish species (*Lutjanus malabaricus, Lutjanus sebae* and *Pristipomoides multidens)* appear to have higher abundance on the pipeline compared to surrounding areas. This work begins to understand the influence of subsea infrastructure on fish and commercially important fish species and should be considered in any discussions on decommissioning. Furthermore, we recommend a review on methods to sample fish on subsea pipelines in water deeper than 100m.

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Fish-habitat associations on subsea pipelines on the north-west shelf, Western Australia

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Remote Operated Vehicles (ROVs) are routinely used to undertake inspection and maintenance activities of underwater pipelines in north-west Australia. In doing so, many terabytes of geo-referenced underwater video are collected at depths, and on a scale, usually unobtainable for ecological research. We assessed fish diversity and abundance from existing ROV videos collected along Woodside Energy Ltd's 'Echo Yodel' pipeline on the north-west shelf at 130 m depth. The pipeline was characterised by a high abundance of commercially important snapper (Lutjanidae) and grouper (Epinephelidae) species. Fish assemblage composition varied across survey years and also from day to night with many fish species exhibiting day time peaks in abundance

on the pipeline. Complex deepwater epibenthic habitat forming invertebrates were observed including deepwater corals, crinoids (featherstars), Gorgonocephalidae (basket stars), hydroids, true anemones and sponges. Historically high trawling effort is thought to have extensively removed and modified complex epibenthic habitats in the region. These habitats were considered to be important to commercial target species and the modification or loss of these habitats is thought to have negatively impacted the valuable commercial fisheries in the region. However, the current study demonstrates that modern pipelines offer hard substrate for the development of epibenthic habitats and refuges for fish, potentially comparable in physical complexity, if not in extent, to the historical habitats lost to trawling. The study builds knowledge of deep-water coastal fish ecology in north-west Australia and will help to inform discussions regarding the ecological and fisheries implications of decommissioning.

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Seascape patterns and habitat differences explain spatial variability in nearshore temperate fish assemblages

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Coastal marine ecosystems and the habitats within them are among the most productive and ecologically important worldwide. Increasingly, however, coastal ecosystems and their biodiversity are under threat from a variety of anthropogenic activities. As result, knowledge on how nearshore habitats structure fish assemblages is critical to better understand the importance of coastal ecosystems and guide conservation strategies such as Marine Protected Areas (MPAs). In this study, we tested and quantified the influence of habitat classes; rocky reef, seagrass *(Posidonia australis*) and unvegetated sediment, in explaining the spatial variability in mid-water and demersal fish assemblages. We also assessed the importance of broad-scale seascape patterning of habitats (i.e. composition and area of habitats) on the abundance and diversity of nearshore fishes. Fish assemblages were surveyed using mid-water baited remote underwater video systems (BRUVS) as well as standard BRUVS positioned on the seafloor. Habitat had a significant effect on the demersal fish assemblage with a distinct composition of fishes observed among each habitat. This result was driven by differences in demersal fish diversity and total abundance, where rocky reef harboured a greater richness and abundance of fishes. Several taxa from the demersal assemblage also displayed strong habitat preferences. In contrast, habitat was not an important driver of the mid-water fish assemblage, with inconsistent and highly variable patterns in assemblage structure, abundance and diversity among habitats. Broad-scale seascape patterning also had a pronounced effect on both the demersal and mid-water fish assemblage. Rocky reef habitat connected to large areas of seagrass displayed a higher abundance and diversity of fishes compared to reefs isolated from seagrass. Our findings demonstrate that differences in habitat and seascape patterning are important drivers of the spatial variability observed in coastal temperate fish assemblages. This information could assist the design of MPAs to better represent and protect nearshore temperate biodiversity.

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The extent and adequacy of monitoring of Australian threatened freshwater fish

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As part of a national review of monitoring programs for Australia's threatened flora and fauna, the extent and adequacy of national monitoring programs for 57 threatened freshwater fish were reviewed against an evaluation framework with nine metrics (sampling periodicity; coverage of species range; management linkages; monitoring coordination; data availability & reporting; program design quality; Fit for Purpose?; inclusion of demographic parameters; monitoring longevity). State monitoring programs were not evaluated. Data on the 9 metrics were obtained from relevant experts on each taxon. The review included 38 taxa listed as threatened by the EPBC Act plus another 19 listed by the Australian Society for Fish Biology (and considered likely to be EPBC-listed in the near future). Only 31 taxa in total and 22 of the EPBC-listed taxa had national monitoring programs. The monitoring programs that do exist scored best for coverage, sampling periodicity and being fit-for-purpose. However, monitoring programs for threatened freshwater fish species in Australia are mostly poor in data availability and reporting, the inclusion of demographic parameters, longevity of monitoring program, and design quality (statistical power). EPBC-listed species have monitoring programs with better data availability, better design quality, and lean towards better monitoring periodicity and program longevity. Significant differences in monitoring extent and adequacy among the EPBC classifications were inconsistent but Endangered and/or Critically Endangered species have better coverage, data availability, coordination and longevity than Vulnerable species. Data availability for EPBC-listed taxa endemic to a single state was similar to that for multi-jurisdictional listed species, yet single state endemic species scored higher for all other evaluation metrics. Notably, Tasmania's galaxiid fauna returned higher scores overall compared to other groups or jurisdictions. There is still considerable room for improvement in monitoring efforts for fish, and unless this occurs management cannot be optimised, and conservation outcomes will be jeopardised.

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Using species distribution modelling to identify priority areas for conservation of freshwater fishes in southwestern Australia

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The biodiversity hotspot of southwestern Australia is predicted to experience considerable reduction in precipitation and increases in temperature as a result of climate change. This is likely to result in contractions and or shifts in species distributions for a number of taxa. Eleven species of freshwater fishes are known in southwestern Australia, nine of which are endemic to the region. It is anticipated that climate change will have pronounced effects on the climate envelopes of these species. In this study, we use species distribution modelling to identify priority areas for fish habitat restoration and conservation in southwestern Australia. Areas were identified by overlapping the future suitable climate envelopes of the species, with a greater number of overlapping areas indicating higher priority. Individual species' exposure to climate change was measured by proportion of occurrence records located within the area which current and future climate envelopes overlap, a low proportion indicating higher exposure to climate change. The implications of these priority areas for management of freshwater fish in the region are discussed.

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Multi-scale environmental processes influence juvenile recruitment success in a non-migratory fish

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The distribution and population structure of organisms is governed by a broad suite of biotic and abiotic variables, interacting across multiple spatial and temporal scales. Recruitment is a key spatially and temporally variable demographic process critical to the maintenance of successful populations. Isolating and quantifying the multi-scale environmental drivers of recruitment has proven to be difficult, especially in freshwater fishes. We built a Bayesian hierarchical model to quantify the relationship between juvenile northern river blackfish recruitment success, and environmental predictors across two spatial scales. We found a 0.995 probability that increased broad-scale stream temperature negatively affected juvenile recruitment success. We also found that there was a 0.968 probability that the fine-scale relationship between recruitment and riparian foliage cover was dependent on temperature. This suggests that broad-scale thermal conditions provide the template upon which at least one local environmental variable influences recruitment success. Isolating the drivers of key population processes and understanding the spatial and temporal scales at which they operate is critical to gain insight into likely changes in population persistence, along with the potential future impacts of habitat degradation and climate warming on freshwater fishes.

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Modelling population dynamics of fish in the MDB- from local to Basin-scale

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The Murray-Darling Basin (MDB) covers an area of over 1 million km2 and is subject to the Basin Plan which provides additional water and flow management for environmental purposes. Many MDB native fishes have suffered severe declines in abundance and there is an immediate need for current knowledge to inform both annual and longer-term watering plans. Flow management needs to occur at spatial scales that are most appropriate to the species of concern. This varies from local, site-based applications for species such as Southern pygmy perch to larger landscape (almost the whole basin) scales for Golden perch, which are widespread and highly migratory. These issues have been explored through the development of population models that can predict population outcomes for rehabilitative management actions. Southern Pygmy perch now consists of fragmented localised populations that are dependent on habitat and the absence of alien carp and redfin to survive. Key management actions are the protection of existing and the establishment of additional populations. The population model for management of golden perch incorporates recent research results including movements and recruitment and nursery sites. This species potentially needs to be managed at the landscape scale, covering most of the MDB; provision of connectivity is vital; high flows can enhance recruitment; smaller pulses promote colonization by juveniles; and efforts should be made to provide access and connectivity to key wetland nursery areas for recruitment pulses (such as Menindee lakes). More details on model outputs are provided in the accompanying Todd et al. presentation.

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Habitat use of fishes in a perennial tropical Australian River

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The rivers of northern Australia are some of the most un-impacted river systems in the world. These rivers also support Australia's most species rich freshwater fish assemblages, however basic biological knowledge of many species is limited. The Daly River is a perennial river system in the Northern Territory that supports a highly diverse native freshwater fish fauna, important recreational and commercial fisheries, and provides significant cultural value to its Indigenous people. This study examines the patterns of habitat use of several native fish species in the Daly River, by modelling their habitat use in the early and late dry season using a comprehensive 10-year dataset. Data were analysed using Boosted Regression Trees modelling and multivariate analysis approaches. Results highlight the importance of key habitat types in the river for various species, and include parameters such as water velocity, depth and substrate type. These findings will result in a better understanding of fish habitat use for a large number of species, and will contribute to better informed management activities such as environmental water protection to protect important fish habitats.

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Quantifying links between instream woody habitat and riverine fish populations

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Victoria's instream habitats are highly valued, broadly, because of their contribution to catchment health, biodiversity and supporting self-sustaining fish populations. There is increasing interest and investment in managing instream habitat, particularly improving instream woody habitat (IWH) because there have been major reductions of IWH in Victorian rivers. Such changes are a major contributing factor to declines in riverine productivity and diversity of aquatic ecosystems, including native fish. With a priority objective of many IWH programs being an increased abundance and diversity of fish populations, waterway managers require specific guidance on IWH restoration approaches to maximise benefits to a region's fish community for a given investment.

The vast majority of previous research demonstrates the links between IWH and riverine fish distribution and abundance at micro- and mesohabitat scales. Its role in governing species diversity and distribution across reach and basin scales has received far less attention, particularly within Australia. As such, we investigated the links between instream habitat parameters and fish populations at sub-reach scales in nine waterways across Victoria. This paper presents quantitative predictions of reach-scale responses in abundance and biomass by various fish species to changes in these habitat parameters (particularly IWH) in a variety of river types frequently targeted for intervention works across Victoria. Results are discussed in relation to habitat degradation and existing restoration programs across Victoria.

46

River flows support key life-history events of spotted galaxias (*Galaxias truttaceus*) in south-western Australia

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Western Australian populations of the spotted galaxias (*Galaxias truttaceus*) have recently been proposed as an 'ecologically significant unit'. Conservation of the species is supported by a recovery plan, however knowledge of recruitment dynamics constrains implementation of management strategies. Unlike the diadromous life cycle of most populations in south-eastern Australia, those in south-western Australia are landlocked and potamodromous: adults remain in rivers and migrate upstream to spawn in autumn, larvae drift downstream to lakes which they use as nurseries with juveniles undertaking upstream recruitment migrations in spring. Because rivers in south-western Australia are experiencing substantial changes in river flow, knowledge of the relationship between flow and key life history events will be critical for the development of appropriate management. In the case of *G. truttaceus*, this is poorly understood. This study examined the timing of spawning, downstream drift of larvae and upstream recruitment of juveniles in relation to river flows over two years. Each of these key life-history events occurred in response to specific seasonal flow conditions. Fish spawned once during autumn, although asynchronously depending on the timing and magnitude of elevated flow events. In winter, larvae drifted downstream 'en-mass' during elevated flow events, that presumably created sufficient velocity through pools to incorporate newly hatched larvae into the drift. Upstream recruitment migration by juveniles was protracted and occurred on lower flows in spring and early summer. This new knowledge regarding the relationship between specific flows and life-history events will benefit the conservation of this critically endangered fish in Western Australia.

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Comparing fish body condition measures as indicators of fitness for two lowland fish species

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Measures of fish body condition are often used to summarize the health or fitness of a population (or individuals within) at a point in time. These measures can be used as indicators of natural fluctuations by fish in response to their environment or to management outcomes, such as from environmental water delivery. Indicators of body condition can then be used to predict future population outcomes such as spawning and recruitment based upon the linkage between higher energy stores being translated into benefits for offspring. Hence, fish body condition may be used as a tool to represent the intermediate step between a management intervention (e.g. environmental flow) and an ultimate target (e.g. population growth). This assumes that

increased body condition will directly result in increased reproductive gains. However, even an increase in body condition may still be insufficient to lead to oogenesis or spermatogenesis due to a range of environmental or physiological constraints. This presentation will examine two specific aims. First, can indirect measures of body condition (e.g. length-weight indices) represent direct measures (e.g. tissue lipid content) consistently through time if at all? Second, can measures of body condition (direct or indirect) be used to predict positive population outcomes? This research ultimately examines the influence of body condition on both GSI and juvenile recruitment in two generalist species (golden perch and bony bream) in a lowland river.

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There be Giants! How a new species of ocean sunfish managed to hoodwink the world

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Humans have always been drawn to the weird and unusual and the ocean sunfishes (Family Molidae) are no exception. For hundreds of years they attracted the keen attention of naturalists and ichthyologists, who recorded their encounters in fantastical drawings and descriptions, wondering what kind of species they had in front of them. The sunfishes still attract our attention today, in a time of torrential Twitter feeds and easy information sharing. So how could a massive species of ocean sunfish escape detection and recognition all this time? Join me on a guided tour of fish forensics, starting in the surf of New Zealand where a stranded giant threw the case wide open, through the genetics lab and eerie museum vats, and onwards through dusty pages of old Latin biology books featuring merman and sea monsters, to the final conclusion that forgotten taxonomic confusion and human circumstances enabled one of the world's giants to hide right in front of us – in Australia, New Zealand and beyond.

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Comparative assessment of morphological and pigmentation characters during larval development of species of 10 genera of F. Gobiidae and two genera of F. Eleotridae

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The Gobiidei are a very diverse group of fish comprising nine families with about 270 genera and 2,210 species. There have been a variety of studies undertaken using morphological, osteological and molecular characters of adults to investigate phylogenetic relationships within the group. Larval developmental series collected from southern Australian waters of 10 genera of F. Gobiidae (210 genera, 1,950 spp) *Arenigobius, Afurcagobius, Favonigobius, Gobiopterus, Paedogobius, Psuedogobius, Redigobius*, *Nesogobius, Bathygobius* and *Tasmanogobius*, and two genera of F. Eleotridae (35 genera 155 sp) *Hypseleotris* and *Philypnodon* were assessed. For larval development series of species from these 12 genera, ontogenetic changes in morphometric characters and pigmentation patterns and the size at development of fins, notochord flexion and transition to juveniles for each genus will be described and compared. There was considerable variation in these larval characters between the two families and between genera. The larval development characters are assessed to determine similarities and differences between genera and then compared with the proposed lineages for these genera based on adult characters.

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Regional variation in life-history strategies of penaeids and their resilience to changing temperatures.

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Penaeid prawns (shrimps) are a high-value seafood commodity supporting large industrial-scale and artisanal fisheries around the world. This value, together with their predominantly tropical and sub-tropical distribution, has led to some prawn stocks being affected by overfishing and rising sea temperatures. Temperature is known to influence the life history of organisms, with the metabolic theory of ecology (MTE) and the temperature-size rule (TSR) both predicting warmer waters will cause ectotherms to grow faster, mature earlier, but reach a smaller size than they would in cooler waters. However, these predictions have seldom been investigated for penaeids, despite having implications for stock assessment and management, particularly in many tropical regions which are relatively data-poor. Here, I present some preliminary findings from my PhD research, in which I investigate the predictions of the MTE and TSR for penaeid prawns. A meta-analysis comprising of published life history data for 22 penaeid species (four genera) from around the world was used to evaluate how the life history parameters of penaeids vary with temperature (using latitude as a proxy), both between species and within species. This meta-analysis was then used to examine the predictions of two Beverton-Holt life history ratios; M/k and L_{mat}/L_{inf}. These ratios suggest that some life history parameters vary predictably together and can be used to provide parameter estimates during stock assessment modelling. Understanding how life history parameters estimated from these ratios compare to the results of empirical studies from different regions and temperatures can facilitate discussion on the use of the Beverton-Holt ratios for informing stock assessments in data-poor penaeid fisheries.

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Novel methods to assess long-term trends in size and age at maturity in fished stocks

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Age and size at maturation play key roles in determining the fitness of individuals and underpin population demography. Evidence is growing, however, that fishing and climate change can cause dramatic reductions in these key life history parameters by increasing overall mortality and imposing size selectivity on populations. Declines in size and age at maturity can in turn impact on stock productivity as well as result in the loss of valuable phenotypic variation that could buffer populations against environmental perturbations. Age and size at maturity are key parameters in fisheries models, but are currently assumed to be constant through time. Despite the importance of understanding change in maturity schedules, to date studies have largely been restricted to northern-hemisphere, high-value stocks where large observational datasets are recorded. Change in age and size at maturity is currently unassessed in Australian fisheries. However, recent developments in ontogenetic growth-modelling techniques potentially allow us to accurately model age and size at maturity from length-at-age datasets commonly collected by fisheries agencies. This new approach could facilitate the recreation of age and size at maturity over many decades, and drivers of any change then be investigated. I will present the modelling framework and explore its applicability to Australian fisheries. An understanding of current and past trends in maturity is important if we are to accurately estimate population dynamics and recommend future catch limits.

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Genomics reveals patterns of dispersal for two reef fish with differing reproductive characteristics along the ecologically significant coast of northwestern Australia

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An important ecological driver underpinning coastal marine management is dispersal, but it has proven difficult to directly measure in this setting. The coast of Northwestern Australia provides an emerging frontier for implementing new genomic tools, which allows testing of dispersal under a management framework given its diverse and extreme environmental conditions. This study compares the genetic diversity, population structure and adaptive genetic variation of two species with different life history characteristics, from the Northern Territory to Shark bay. The first species, Stripey Snapper (*Lutjanus carponotatus*), a spawning fish with pelagic larval duration (PLD) of 33-37 days(d), is important to recreational, charter-based, and customary fishers in coastal waters throughout the Indo-West Pacific. We collected 1016 *L. carponotatus* samples at 51 locations. The second species, Millers Damselfish (*Pomacentrus milleri*), is a typical inshore reef dwelling fish which broods its eggs before an 18-21d PLD. We sampled 847 individuals from 29 very similar locations between the Kimberley and Shark Bay. Using genome scans consisting of >4,400 SNP loci for each species, we demonstrated significant genetic sub-division illustrated in pairwise Fst and STRUCTURE plots between the Shark Bay Bioregion in the south and all locations within the five more northern IMCRA bioregions for both species. Between the northern bioregions, there were differences between the species in the scale of population subdivision, genetic diversity and adaptive genetic variation. Of particular interest, is the relatively reduced larval dispersal for both species and greater adaptive genetic variation for only one of the species in the Kimberley, potentially created by the region's complex bathymetry, and currents which are predominantly macro-tidal rather than along-shore. These results will be discussed in the context of long term conservation management initiatives of the unique marine environment in Northwestern Australia.

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Coast to coast: population structure and connectivity of southern Australia's only sciaenid, mulloway *(Argyrosomus japonicus)*

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Understanding population structure and connectivity is vital for managing and conservation of important fish. Discrete populations of conspecifics may respond differently to exploitation and habitat changes due to variations in growth rates, size at maturity, mortality rates, life history (etc.). Traditionally, demersal fish were suggested to be panmictic, due to pelagic early life stages and the connectivity of marine habitats. However, a growing body of evidence, in part unleashed by new scientific techniques, is suggesting otherwise. Large bodied sciaenids form traditional, recreational and commercial fisheries in many parts of the world. However, their life history makes them susceptible to human activities. Mulloway (*Argyrosomus japonicus*) is a large bodied sciaenid that has biology typical of members of this fish family (i.e. estuary association). In the southern hemisphere mulloway

has iconic status due to the accessibility to large fish from the beach and estuary, however, the species is poorly understood, particularly in southern Australia. To improve our understanding of mulloway we investigated genetic population structure across its Australian range. Whilst within South Australia (SA) we closely scrutinised mulloway populations using multiple approaches, including a combined approach incorporating genetics, otolith chemistry and morphology. Also within SA we utilised otolith chemistry to determine their use of estuaries and satellite telemetry to determine movement ecology and the interaction with protected area boundaries. The results have provided new information which could help manage and conserve mulloway; whilst furthering our understanding of population structure approaches and demersal fish in general.

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Connectivity of fishes from the Kimberley region, Western Australia, using otolith geochemistry

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Understanding the connectivity of fish populations is vital for the effective management of fish stocks, and otolith geochemistry has become a popular source of information for understanding population connectivity. The remote Kimberley region of Western Australia has been historically understudied, resulting in a lack of population data that has limited the ability to sustainably manage fisheries in the area. This project aimed to determine if population connectivity could be determined in two species of coral reef fishes common to the region, Lutjanus carponotatus and Pomacentrus milleri through the use of otolith geochemistry. A suite of geochemical analyses were used to analyse otoliths from both species: trace elements using LA-ICPMS (laser ablation inductively coupled plasma mass spectrometry), strontium isotopes using MC-ICPMS (multi-collector ICPMS) and oxygen isotopes using SIMS (secondary ion mass spectrometry). Preliminary results indicate that there is a statistically significant difference in trace element composition between L. carponotatus from the north and south of the collection area. P. milleri showed no statistically significant differences, however their geographical collection range was highly restricted compared to L. carponotatus. Preliminary strontium isotope results show no difference, indicative that the fish are fully marine throughout their lives. Preliminary oxygen isotope results for P. milleri are suggestive of sex-mediated movement. The trace element results indicate that there is population structure within L. carponotatus but this structure is only visible at the largest scale. However, this may be due to the relatively low resolution of the analysis. High resolution SIMS data detected subtle changes in isotopes indicative of ontogenetic movement and it may be than in the potentially homogenous waters off the West Australian coast these high resolution techniques are required for fine scale differentiation. These results suggest that SIMS may be a useful technique for studying finescale movements within marine populations.

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Revisiting the analysis and interpretation of otolith chemistry studies for determining stock structure

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Review of the analysis and interpretation of otolith chemistry studies in WA against defined objectives/hypotheses. Current understanding indicates that previous experimental design and analysis for otolith chemistry studies in WA cannot discriminate stocks, and particularly not without consideration of other information. As such the conclusions in some of these papers are not only outdated but are incorrect and hence misleading. It remains to be seen whether retrospective assignment analyses might provide estimates of, or insight in to, mixing rates for some of the marine index species in WA for which otolith chemistry methods have been applied.

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Climatic conditions and seaweed habitat quality provide indicators of reef fish recruitment strength

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Tropical macroalgal fields are important nurseries for fish of commercial and conservation significance. We investigated how local-scale variations in macroalgal habitat quality interact with large-scale climatic conditions (Southern Oscillation Index, SOI) to influence the recruitment of three emperor species (*Lethrinus* spp.) at Ningaloo. Fish recruits (<5cm TL) and juveniles (5-15 cm TL) of all three species were almost exclusively found in macroalgal habitats, while adults of two of these species (*L. nebulosus* and *L. atkinsoni*) were predominantly found on adjacent coral reefs. Annual supply rates of recruits was positively correlated with variation in the SOI (r^2 =0.9), La Nina conditions associated with higher recruitment. However, local rates of recruitment were generally poor predictors of older juvenile abundance. Instead, local juvenile abundance was more closely

related to structural characteristics of macroalgae nursery habitat quality (density, canopy height, canopy cover) and/or predator biomass, at the time of survey, with species-specific habitat associations apparent. Thus large scale climate and oceanic processes strongly influence the supply of recruits to Ningaloo, however distribution and persistence of juveniles is more closely related to the structure of local macroalgal patches. These results highlight the importance of macroalgal nursery habitats that maintain high canopy density, height and cover for supporting fish populations.

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Ontogenetic shift of a commercially important endemic species, *Lethrinus punctulatus*, from nearshore macroalgal beds to offshore sessile invertebrate habitats

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The Dampier Archipelago in north west Australia, has high marine diversity and one of Australia's busiest ports. In offshore waters adjacent to the archipelago is an important suite of demersal fisheries. The study aimed to build on the limited knowledge of the endemic blue spotted emperor, *Lethrinus punctulatus*, a short-lived, commercially important fish species in the region. To achieve this, the present study examines the distribution of *L. punctulatus* across a continuous depth gradient and its association with a variety of habitat and environmental variables using baited remote underwater stereo-video systems (stereo-BRUVs). Stereo-BRUVs were deployed across a continuous depth gradient, and a variety of substrata and habitat types, from inside the Dampier Archipelago and out into the offshore waters to 50 m depth and ~100 km offshore. Different size classes of *L. punctulatus,* showed strong associations with particular depths, shifting from shallow to deep water as they became larger, such that while abundance was fairly uniform across depths, biomass increased with increasing depth. In shallow coastal waters, juveniles of this species were found to be disassociated with complex reef habitat, where predatory fish maybe abundant, and instead were positively associated with macroalgal habitat. Our quantitative study validates historical fisheries legislation that acted to protect shallow water habitats, that were thought to be important to juvenile life stages of commercially important fish species in the Pilbara region.

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Angelfishes hybridisation in Christmas Island: ecological and biological aspects

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Coral reef fishes form the most diverse vertebrate communities on earth, and hybridisation has traditionally been considered rare in this group. However, recent studies have revealed that hybridisation is common. The angelfishes have the greatest proportion (~30%) of hybridising species with 26 species reported to hybridise. Hybrids between three species in the genus Centropyge (C. flavissima, C. eibli and C. vrolikii) have been reported from Christmas Island. The aim of this study was to test the terrestrial theory that rarity of parent species and niche overlap are important factors promoting hybridisation and to test the fitness of the hybrids and parent species in terms of growth rates and reproduction. All species and their hybrids showed a strong niche overlap, they were more abundant at 20 m compare to 5 m and shared the same microhabitat within harems. Parent species and their hybrids also had similar diets that comprised a mix of green, red and brown algae. Hybrids showed to be viable and had similar fitness to their parent species, with no differences in growth rates and reproductive activity. This study provides empirical support that hybridisation in reef fishes conforms to terrestrial-based theories, and thus advances our understanding of the concept in coral reef systems.

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Can commercial harvest of the long-spined sea urchin, *Centrostephanus rodgersii*, reduce the impact of destructive urchin grazing on macroalgae communities and associated fisheries?

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Range extension of the long-spined sea urchin*, Centrostephanus rodgersii*, to south-eastern Tasmania has resulted in overgrazing of macroalgae habitats as far south as the Tasman Peninsula. The increasing loss of macroalgae and the formation of extensive barrens is threatening reef biodiversity as well as lucrative reef dependent fisheries such as abalone and rock lobster. A commercial fishery for long-spined urchin in Tasmania was established in 2008 and to date over 400 tonnes has been harvested. Dive surveys show that with increased fishing pressure there is a significant decline in the in size and age structure in urchin populations, as well as decreases in total biomass. Macroalgae recovery is occurring in some heavily fished areas, while barrens continue to expand in unfished areas. Analysis of boat-based GPS data logger and depth logger technologies used by commercial urchin and abalone divers indicates that >50% of urchin fishing activity overlaps spatially with abalone fishing activity. The extent of direct spatial overlap between these fisheries suggests there is good reason to expect that urchin fishing as currently observed could have direct benefits for the abalone fishery in terms of reducing abundance of urchins within or adjacent to key abalone fishing grounds.

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Biology and dietary composition of the harlequin fish o*thos dentex* in south-western australia

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The Harlequin fish *Othos dentex* is a demersal teleost that is endemic to temperate Australian coastal waters, in which it is popular with recreational fishers and a valued incidental catch of commercial fishers. A number of demersal carnivores, which co-occur with *O. dentex* on the south coast of Western Australia, are long lived, reaching ages of over 60 years and are thus particularly susceptible to overfishing. *Othos dentex* were collected from the waters of this coast mainly by spear fishing. The 380 individuals thus caught were used to determine the length and age compositions, growth, reproductive biology and dietary composition of this species. The maximum recorded age was 37 years, which makes this species potentially vulnerable to the effects of exploitation. A lack of bimodality in sex based age-frequency distributions and the absence of testicular tissue within ovaries and of ovarian tissue in testes demonstrated that *O.dentex* is a gonochorist, only once previously recorded for an athiine serranid. This is not consistent with some contemporary theories of the evolution of gonochorism from protogony in the Serranidae. Analysis of stomach contents demonstrated that *O. dentex* was exclusively piscivorous. Stomachs either typically contained an entire, large fish prey, which filled the stomach, or more frequently were empty. The mouth gape of *O. dentex* was particularly large. The change in the dietary composition of O*. dentex* with length was related to the body size of the prey rather than to the family of those prey. The above data, together with underwater observations imply that *O. dentex* is a particularly efficient ambush predator that specifically targets large prey and thus feeds relatively infrequently, optimizing its foraging activities and dietary intake.

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Fish ear bones record the bomb radiocarbon decline in an upwelling area off southern Australia

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Biogenic carbonates are successfully used to track radiocarbon ($\Delta^{14}C$) evolution through time, and we use otoliths (ear bones) of fish to establish a new record of the bomb $\Delta^{14}C$ decline (since ca. 1980 to the present) in an upwelling area of the southeastern Indian Ocean. Marine surface waters were enriched with ^{14}C during the 1950-60s when thermonuclear weapons testing was at its zenith (bomb $\Delta^{14}C$). Upwelling events ventilate ocean surface waters with subsurface water lower in radiocarbon $\Delta^{14}C$ through a wind-driven, oceanographic process. We assayed otolith carbonate microsampled from ocean perch (*Helicolenus percoides*) for ^{14}C with accelerator mass spectrometry. The ocean perch otolith $\Delta^{14}C$ record extended from 1994 to 2012 and displayed a general decline of $\Delta^{14}C$ levels through time (mean $\Delta^{14}C$ 1994: 75.04‰; mean 2012: 7.57‰). Water depths represented by the otolith records ranged from 42.9 to 118.9 m, and age-based depth segregation between juvenile (<6 yrs old) and adult fish was not evident. Ocean perch $\Delta^{14}C$ values were lower (62.69 to 82.53‰) than reported seawater values (90.1 to 95.5‰) in depths <200 m in adjacent non-upwelling areas. Comparisons of ocean perch $D^{14}C$ with published Indo-Pacific coral records showed the ocean perch $\Delta^{14}C$ record was lower than $\Delta^{14}C$ values in coral of tropical surface water, but had higher levels than coral in areas of equatorial upwelling. The ocean perch $\Delta^{14}C$ record characterises temperate marine waters well mixed throughout the year by both upwelling and downwelling and with sources of upwelled waters being formed at higher latitudes. Documenting levels of $\Delta^{14}C$ in the marine environment along the coast of southern Australia has improved existing ^{14}C data relating to ocean circulation in the southeastern Indian Ocean.

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Geographic distributions and assemblages of labrids along the south west coast of Western Australian over the past decade

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This research sought to evaluate and compare the Labridae assemblages in the temperate and subtropical marine community's along the southwest of Western Australia, comprising seven regions along Western Australian Coastline from Geraldton to Esperance. Survey data was collected in 2006 and again in 2015 using diver operated stereo-video (DOV) transects focusing on the Labridae family which includes Scarine Labrids and Wrasse. Through a comparison of the Labridae assemblage from the two data collections it was determined that at every one of the 7 regions the Labridae assemblage had changed significantly. While the change in the Labridae assemblage was larger in the northern most marine environments, there were still significant changes in the temperate assemblages. Other notable trends along the coast were the increase in warmer temperate labrids and the appearance of labrids in locations 2015 that were not seen in 2006. While most labrids have increased in numbers, three temperate species that have instead declined. These changes in the assemblage could be attributed to several environmental changes. Since the 2006 data survey there was a large marine heat wave in 2011 and the canopy forming alga in the northern coastal areas have also been reduced. Sea surface temperatures have also increased at each region. This increase 4 years

after, a lack of recovery along the western coast and significant changes in Labridae assemblages over the entire survey area indicate a permanent change to Labridae communities. There has been reported changes to the cooler temperate waters of Albany, Bremer Bay and Esperance, however our results gathered in 2015, continued ocean warming and the predicted increase in frequency of large marine disturbance events, suggest that changes may be occurring on the south coast and may follow the environmental trends of the warmer sub-tropical waters of Western Australia.

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What is driving changes in size at maturity (L50) in Australia's largest Southern Rock Lobster fishery?

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Fisheries management requires that stock assessments account for perturbations that alter the way fish populations respond to fishing pressure. Southern Rock Lobster (*Jasus edwardsii*) are targeted by regional fisheries of Australia's southern continental shelf with an annual commercial catch of ~4000 tonnes valued at ~AUD $200 million. Estimates of size at sexual maturity (L50) are a key population parameter used in the management of Southern Rock Lobster (*Jasus edwardsii*) and provide a guide to setting minimum size limits and protecting egg production. However, estimates of L50 may vary spatially and temporally due to a range of factors that affect rock lobster growth, such as temperature or population density. In this study, we used data from stock assessment surveys between 1991 and 2015 to assess any changes in L50 in 5 regions of South Australia's Southern Rock Lobster Fishery. Increases in L50 were evident since 1991 in 4 out of 5 regions assessed, and may warrant the refinement of minimum size limits used in the fishery. Possible causes for increases in L50 are discussed, with a particular focus on changes in sea surface temperature (SST) and population density over the time period.

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Wet and dry season flows influence juvenile fish abundance in a tropical river

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The rivers of northern Australia contain a high diversity and abundance of freshwater fishes, and are relatively undisturbed compared to similar systems throughout the world. There is, however, increasing pressure to use the region's water resources to support agricultural and mining development. It is imperative that we understand the ecological water requirements of key biota before any such development occurs.

This study assesses the importance of both wet and dry season hydrological flow components on juvenile abundance of key fish species. We utilised a standardised electrofishing dataset spanning ten years that has sampled the freshwater fish assemblage at a number of sites in the Daly River, Northern Territory. Results suggest whilst juvenile abundance in the early dry season of many wet season breeding species was related to the magnitude and timing of wet season flows, their subsequent survival to the end of the dry season was also highly related to dry season discharge and duration. Interestingly, the abundance of species which breed in the dry season was also related to both the previous wet and dry season flow conditions. This study emphasises the importance of both wet and dry season flows on freshwater fish recruitment patterns, and also the need to place species-specific flow responses in the context of their life history. Our work will assist in environmental flow management decisions throughout Australian tropical rivers.

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Visual census, photographic records and the trial of a video network provide first evidence of the elusive *Sicyopterus cynocephalus* in Australia.

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Opportunistic encounters with an elusive large-bodied sicydiine goby in a single plunge pool led us to photograph and deploy three video cameras to detect individuals in that pool. Subsequently, a catchment-wide search indicated that the species, eventually identified as *Sicyopterus cynocephalus*, was confined to the single pool where it was originally detected. A network of ten video cameras was then deployed to estimate the number of individuals of that species and a congener, *Sicyopterus lagocephalus,* by non-destructive means. This study provides the first record of *Sicyopterus cynocephalus* in Australia, and

showcases the synergy of active snorkel searches and a remote camera network in counting individuals of two sympatric species of *Sicyopterus*.

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Estuarine specialist: the Stokell's smelt

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Stokell's smelt has an unusually restricted distribution confined to several large rivers of the Canterbury coast on the South Island of New Zealand. Previous descriptions of its life history assumed that it spawns in estuarine zones of these rivers and the larvae or juveniles then migrate to sea, spending most of their life in coastal marine habitats before returning as adults to the estuary to breed. Several questions arise from these assumptions such as whether adults home to natal rivers and why the species is not more widespread if it spends its adult life at sea. The life histories of Stokell's smelt from all the major rivers of the east coast of the South Island were investigated from patterns in the otolith microchemistry determined by laser ablation ICPMS. Fish from all rivers showed no evidence of prolonged marine residency as expected from ratios of strontium (high) and barium (low) to calcium in the otolith. Instead fish showed ratios consistent with long-term residency within the estuarine zone but with periodic changes indicating regular excursions into less saline waters. The remarkable periodicity of these movements is possibly associated with lunar tidal cycles. Variation in otolith microchemistry between populations fits with differences in estuary geomorphology. Stokell's smelt appears to be an estuarine specialist that occupies the saline boundary in the major rivers where it occurs. Estuarine philopatry possibly explains the species' restricted distribution and may result in significant genetic differentiation between river metapopulations. Individual populations may also be highly susceptible to any deterioration in the condition of their river such as alterations in flow regime or increasing nutrient and sediment loads.

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Large scale population dynamics of a flow dependent enigmatic freshwater fish.

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Golden perch are perhaps the most enigmatic species in the Murray-Darling Basin (MDB). Recent advances in understanding the ecology of the species has enabled the development of a general meta-population model to examine the influence of flow on golden perch population dynamics. The model has 6 sub-populations representing the northern and southern MDB. The model is underpinned by the consultative development of a contemporary conceptual model of the flow related life history of golden perch. The model is still being refined and results are preliminary; nevertheless, the broad concepts are in place from which numerous insights are gained. For example, exploring the inter-dependence of the southern basin fish population on movement from the northern basin will be instructive concerning the overall persistence of the species and the importance of connectivity.

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Facilitating passage to spawning habitat for an endangered percichthyid

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Reservoirs can serve as refuge habitats for endangered Macquarie perch *Macquaria australasica*, though this species requires access to the river habitats to spawn. Enlargement of Cotter Reservoir, Australian Capital Territory, has resulted inundation of existing riverine spawning grounds of the resident population of Macquarie perch. Natural barriers to passage have fragmented this population from spawning habitat, and for the first three years of filling there was recruitment failure, because of lack of access to suitable spawning habitat. The spawning movements of Macquarie perch (n = 40) were monitored using an acoustic array deployed at the head of the reservoir and in each pool upstream of perceived natural barriers. As expected, frequency of tagged adult Macquarie perch detected at the head of the reservoir and in the pools immediately upstream peaked from late October until early December (known spawning window of this species), when river temperatures exceeded 14.5 °C. Entry to the river by each individual was typically brief (minutes to hours), repeated across days and undertaken during low-light periods. A wet winter and spring meant that upstream reservoirs were largely operating unregulated and at higher discharge than regular releases from August until mid-December. These unregulated flows facilitated passage of tagged adult Macquarie perch to at least 500 m of river and past two instream barriers. Subsequent netting of the reservoir and river upstream of the reservoir

revealed recruitment to juveniles of a magnitude similar to that of the pre-filling era, confirming passage past natural barriers to suitable spawning grounds. This study provides important information of the spawning movement ecology of this species critical to long-term survival.

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Testing genetic models of dispersal and speciation in a tropical freshwater stream headwater-specialist, the Exquisite Rainbowfish (Melanotaeniidae: *Melanotaenia exquisita*)

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Various models have been proposed to explain the genetic structure of organisms in dendritic stream systems. The headwater and discrete population models describe patterns of genetic structure in organisms who's biological requirements limit their distribution to headwater sections of freshwater systems. The models predict little or no gene flow between populations as the norm, but with enhanced opportunities for crossing drainage divides by living close to upland divides geographically and with specific adaptations for dispersal and persistence biologically; so patterns can be predictably chaotic. The Exquisite Rainbowfish is unique in being one of the few widespread headwater specialist fishes occurring in northern Australia. It is restricted primarily to upland sandstone escarpment habitats in the Kakadu region of the Northern Territory and other small sandstone outcrops stretching into the Kimberley Western Australia. These sandstone escarpment areas are effectively ancient islands of distinct habitat, and are heavily divided by separate drainage systems (e.g. the Kakadu / Arnhem Land Escarpment drains several major river systems including the Daly, Mary, Alligator, Liverpool and Roper). We undertook a study to firstly better map the range of the Exquisite Rainbowfish working closely with Aboriginal ranger groups and land managers. We then undertook a molecular assessment to investigate the broad genetic structure in the species using bi-parentally inherited multi-locus nuclear markers, with a specific focus on taxonomic and evolutionary significant units to inform conservation and management. The results conform to model predications, flagging long isolation for habitat islands and most drainages (cryptic species and major genetic sub-structure) with some selective connectivity across drainage divides in the Kakadu region. Future work will focus on taxonomic descriptions and on highlighting the value of the Exquisite Rainbowfish complex as an aquatic indicator for managing sandstone escarpment habitats.

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Hemi-clonal unisexual carp gudgeons (Eleotridae: *Hypseleotris*): systematic clarification of species boundaries and various hybrid lineages in southeastern Australia.

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Carp gudgeons (Eleotridae: *Hypseleotris*) are the most abundant, widespread and biodiverse freshwater fishes in southeastern Australia, but the unacknowledged presence of multiple cryptic species and hemi-clonal unisexual lineages severely taints all research on this cornerstone group. Our goal is to help correct past taxonomic shortcomings and supply a valid framework for future study, by giving researchers a true picture of the group's biodiversity plus the means to accurately identify all sexual and unisexual forms in this key group. We used three genetic datasets including allozymes (52 loci), mtDNA (cytochrome b) and ddRADSeq (>10,000 SNP loci) to examine species and lineages across their entire range in southeastern Australia where most habitats contain 2-4 sympatric species and additional hemi-clonal lineages. One key finding was a single sexual population of Lake's carp gudgeon which is of critical conservation and research concern as every other population examined of Lake's carp gudgeon are F1 hemi-clonal hybrids. For more details all about this group you'll have to come and see my talk!

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Extreme genetic structure has conservation implications for Australian smelt (*Retropinna semoni*) in Queensland, Eastern Australia

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The isolating nature of freshwater systems may lead to expectations of substantial genetic subdivision among populations of obligate freshwater species. The freshwater fish, *Retropinna semoni* has a patchy distribution through coastal drainages of Queensland, eastern Australia. We examined the genetic structure and phylogeny of populations of the freshwater fish *R. semoni* using ten microsatellites loci and mtDNA markers. Ten South east coast Queensland (SEQ) populations and five from Central East Queensland (CEQ) populations were sampled to examine levels of differentiation within and between rivers at near, medium and broad scale. Very high levels of among population structure was observed (Fst = 0.21) and evidence for contemporary migration among rivers was rare and limited to sites within the same river. The present result revealed that Australian smelt populations had a high level of genetic diversity and distinct population structures. We report the existence of three monophyletic matrilineal lineages. High population structure and limited dispersal mean that recolonization of locally extinct populations is only likely to occur from closely situated populations within rivers. Limited potential for recolonization should be

considered as an important factor in conservation and management of this species. The fact that the widely spread species show limited dispersal highlights the importance of conservation in both group in Eastern Queensland.

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One-way traffic: Black Bream passage through a storm surge barrier.

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Storm surge barriers are structures created across rivers, estuaries or tidal inlets to prevent coastal flooding. However, along with halting upstream water movement, they also have the potential to impede the movement of fishes. The Vasse and Wonnerup estuaries are located near the City of Busselton, Western Australia. Both estuaries have downstream storm surge barriers to prevent the flooding of low-lying coastal land and have 'fish gates' integrated into them to enable fish passage during the low flow period. Owing to poor water quality that regularly occurs immediately upstream of the Vasse barrier, fish kill events have regularly occurred there during summer and autumn with Black Bream being particularly vulnerable. However, no information existed on the movement patterns of Black Bream in the system nor on how fish passaged through the fish gates. This study aimed to determine the movement patterns and spatial and temporal distribution of the Black Bream within the Vasse-Wonnerup system using acoustic tags that were internally implanted in 41 Black Bream. The study revealed that Black Bream are highly mobile within parts of the system. Key habitats identified include the Wonnerup Inlet and the Deadwater with habitat further upstream of the either surge barriers not often accessed even when passage through the gates was not impeded. Crucially, the study revealed that the Black Bream that passaged through the Vasse fish gate only did so down a gradient (head loss), and once upstream of the barrier, did not (or could not) return downstream. Therefore, the study indicated that instead of the gates allowing the fish to escape from poor water conditions that occurred upstream, the Bream appear to be 'stuck', which initiating a review of the management of the fishgates for the mitigation of fish kills.

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Freshwater catfish, *Tandanus bostocki,* move further and maintain larger home ranges during elevated flow in a regulated river, Western Australia

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Movement and migration of fish can be important to the completion of life cycles and the persistence of meta-populations. However, fish movement can be impacted by river regulation if it disconnects habitats and removes the hydrological cues required. Managed water releases, i.e., environmental flows, can be used as a restoration tool; however, their efficacious design and implementation requires a robust understanding of flow-ecology relationships. In this study we used radio telemetry to investigate whether river discharge influenced the movement of *Tandanus bostocki*, a plotisid fish endemic to south-western Australia and impacted by regulated river flows. Movement was assessed for 15 adult fish (males, females) at three temporal scales: bihourly, daily around a flow pulse and weekly. Movement of *T. bostocki* was strongly associated with elevated river flows, with fish moving downstream once flow exceeded 50 Ml/d, although the average distance travelled was relatively modest (< 800 m). While fish maintained larger home ranges during seasonally elevated baseflow, the linear distance moved by individuals per unit time did not vary with baseflow magnitude. We constructed flow-movement models that support a link between flow and movement of *T. bostocki*. The study highlights the importance of managing base-flow, and the magnitude, duration and recession rate of elevated flow events, to facilitate both localised and larger scale movements in regulated rivers.

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Environmental triggers of migration in an urban population of Australian Bass

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Many urban river systems are impacted by instream barriers which present significant obstacles for diadromous fish migration. Australian bass, Macquaria novemaculeata, typically occupy freshwater environments but make annual migrations to estuaries to spawn. In the Lane Cove River, Sydney, a weir demarcates the upper tidal limit and bass must overcome it to make their breeding migration. Here we examined the movement of bass in the river using acoustic technology. We show that half the tagged fish successfully migrated both downstream and returned upstream multiple times during the tagging period. Some migrated as far as the Sydney Harbour Bridge, which is very near pure sea water. Downstream migration was linked with heavy rainfall, whereas the return migration was associated with high tides. We suspect the fish return to the freshwater reaches by using a newly built fish ladder that is only accessible at high tide. Our data show that high water flow is a key environmental driver of spawning behaviour in this species and that most of the spawning behaviour occurs in June within the estuary near the mouth of the river.

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Skipped spawning by diadromous fishes drives the direction and extent of material subsidies across marine-freshwater ecotones

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The large-scale migration of diadromous fishes transports assimilated nutrients and energy across ecotones, providing material subsidies that support critical ecosystem processes. The most famous example of this is the migration of anadromous Pacific salmon (*Oncorhynchus* spp.). After several years living at sea, adult salmon migrate upstream into rivers to spawn. They die soon after spawning (i.e., they are semelparous) and, thereby, deliver an annual pulse of marine-derived nutrients and energy into freshwater and terrestrial food webs.

Although the anadromous, semelparous life histories of salmon dominate the food web subsidy literature, this migratory mode is by no means characteristic of all diadromous fishes. In fact, there is a range of diadromous migration strategies, including catadromy (growth in freshwater, spawning at sea) and amphidromy (juvenile growth at sea, spawning and maturation in freshwater). Within these broad categories, there is inter-specific variation in migratory strategies and individual variation in movement behaviour within species (i.e., partial migration, skipped spawning, etc.). The influence of inter- and intra-specific life history variation in fishes on food web subsidies has not been studied in detail to date.

In this presentation, we use otolith chemistry, acoustic telemetry and length-at-age relationships to estimate material subsidies in the catadromous mullet *Liza ordensis*. We then extend our subsidy model to different diadromous migration strategies and manipulate life history variables, including growth rate, mortality rate, rate of skipped spawning and age at first migration, to examine their effects on the direction and extent of material subsidies. Our results show that individual variation in migration behaviour, especially skipped spawning, has a profound influence on nutrient and energy subsidies across marine-freshwater ecotones. Human disturbances that influence the expression of migratory behaviours are therefore likely to have major ramifications for aquatic food webs and the organisms they support.

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Acoustic telemetry reveals the contrasting ways in which four key fishery species use a south-western Australian Estuary

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Four fishery important species were tracked in a permanently-open estuary on the south-coast of Western Australia, the Walpole-Nornalup Estuary, to quantify and compare their residency within the system and responses to various environmental drivers. Twenty three Black Bream (*Acanthopagrus butcheri*), 21 Southern Bluespotted Flathead (*Platycephalus speculator*), 10 Snapper (*Chrysophrys auratus*) and 10 Tarwhine (*Rhabdosargus sarba*) were implanted with internal acoustic transmitters between July 2014 and February 2016 and monitored using a fixed acoustic array for a period of up to 656 days. Marked differences in movement patterns, habitat preferences and spatial area use of the system were detected among species and between seasons of the year. *Acanthopagrus butcheri* were highly mobile and used vast areas of the system from the estuary mouth to the upstream extent of estuarine affinities. While two other sparids, *C. auratus* and *R. sarba*, were also highly mobile, their movements were largely confined to the marine-influenced middle and lower estuary, and more than half of individuals tagged left the system, with only the latter species displaying return movements. Comparatively, individuals of *P. speculato*r exhibited far higher site attachment and typically remained near their release sites within the estuary, although five fish undertook rapid one-way migrations out of the estuary. These results enhance existing knowledge of how these important species use estuaries and highlight areas where populations are potentially most vulnerable to fishing pressures.

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Vertical Migrations in fishes: how novel sensors elucidate the drivers of daily migrations in freshwater and marine environments

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Diel Vertical Migrations (DVM) are phenomena that occur throughout the world's aquatic ecosystems, where the transition from day to night results in drastic shits in the vertical distribution of organisms, from zooplankton to marine vertebrates. Current thought suggests that visual predation pressure drives prey species to depth, where darkness provides cover and foraging occurs during the day in surface waters. Despite this widely held believe, many of these ideas have rarely been tested in fishes, because quantifying the behaviour of individuals on a diel scale has remained challenging. Here we show how the use of accelerometers in animal tags can address how animal behaviour changes in relation to diel changes in depth. Moreover, we show how changing abiotic conditions can have contrasting impacts on DVMs and circadian rhythms, using examples such as estuarine black bream, epipelagic whale sharks and freshwater sawfish. Overall, the drivers behind DVMs represent a highly flexible response to diel changes in the biotic and abiotic environment and in many cases do not solely reflect a simple response to sheltering from predation.

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Links between coral morphological assemblage and fish communities at Ningaloo Reef

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Hydrodynamics and depth are key drivers of spatial differences in the morphological assemblages of coral. This is the case at Ningaloo Reef, North West Australia where different communities exist from the reef slope (high wave energy) to the shallower reef crest and flat where wave energy dissipates. Different geographic regions of the reef have exhibited temporal changes over the last decade, with some showing a clear decline in tabular corals and others remaining with relatively unchanged morphological assemblages. We have investigated the proportional makeup of categorized coral morphological groups at more than 300 sites and correlated these with fish functional groups and assemblages. Changes to coral assemblages predicted from a functional structural model are being used to consider how different fish functional groups may be affected by future climate impacts.

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Understanding how coral reef fish abundance and richness in Ningaloo Reef is influenced by habitat and other environmental predictors.

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Marine Protected Areas (MPAs) play an important role in protecting and conserving the world's coral reefs species and communities. Commonly monitoring only takes place at a few locations and models can assist with providing predictions for the entire coral reef system. Developing models to predict the spatial patterns of species at the reef scale, can provide valuable additional information to assist conservation managers further assessing the benefits from existing or future MPAs.

Using a habitat map of Ningaloo reef collected using HyMap airborne hyperspectral imagery, and a set of environmental predictors including sea surface temperature, salinity, chlorophyll, nutrients, dissolved oxygen concentration, and percentage of sediments, I will develop statistical models in R to assess how such variables might drive coral reef species richness and abundance patterns. Coral reef fish data was collected in 2013 by CSIRO across a range of sampling stations along the reef. Specifically, I will test if coral reef fish biodiversity is influenced by changes in environmental variables, and if abundance is directly correlated with specific habitats.

The predictions that will derive from my project will increase our understanding of the spatial distribution of coral reef species at the reef scale. Our results will provide conservation managers with information about the locations on the Ningaloo reef that have the greater number of species which could aid in ensuring marine protected areas are conserving areas of high diversity and significance.

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Considering multiple factors in assessing the effectiveness of a large-scale marine protected area for conserving targeted fish communities

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The Ningaloo Marine Park is situated on the mid-west coast of Australia and incorporates approximately 300km of tropical/sub-tropical fringing reef system. Originally gazetted in 1987, the park is a popular recreational location that has received steadily increasing visitation over the past two decades. Recreational fishing is one of the most common user activities, with spatial zoning and bag limits being the primary management strategies for the conservation of fish communities. However, despite the relatively large spatial coverage of no-take areas (NTA's; ~34% of the total area) and the length of time in which they have been in place (9-29 years), meta-analysis of surveys conducted over the past 29 years indicates that there has been no change in the effect size of NTA's on highly targeted fish communities through time. While the vast majority of surveys indicate higher target species abundance within NTA's, data collected at high use areas provides evidence for steady declines in the abundance of the primarily targeted fish group (Lethrinidae) both inside and outside of these protected areas. Here we investigate the potential causes of these patterns including the influence of fishing intensity, non-compliance, benthic habitat, reef zone, zoning design and recruitment supply. We scrutinise evidence to support each of these factors and conclude that it is a combination of many of the

aforementioned aspects influencing the abundance of target fish groups. Our results highlight the complex nature of drivers of marine populations and the need to consider multiple factors when assessing the efficacy of conservation and marine protected area management strategies.

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Baited video, but not diver video, detects a greater abundance of legal size target species within no-take areas at Ningaloo

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The inherent differences in baited video versus diver video survey methodologies may influence their ability to detect effects of fishing. Here the ability of no-take areas to provide sufficient protection for legal sized individuals from targeted species within the Ningaloo Marine Park (NMP) was studied using both baited remote underwater stereo-video (stereo-BRUV) and diver operated stereo-video (stereo-DOV). The relative abundance of four recreationally targeted fish species, Carangoides fulvoguttatus, Epinephelus rivulatus, Gnathanodon speciosus and Lethrinus nebulosus, were examined using both methodologies inside and outside no-take areas across the NMP. Additionally, the length-frequency distribution of the most targeted species, L. nebulosus, was investigated. Stereo-BRUVs found positive effects of protection from fishing on the relative abundance of C. fulvoguttatus, G. speciosus and L. nebulosus and larger sized L. nebulosus in no-take areas. Stereo-DOVs however did not detect any differences in relative abundance and size between areas open and closed to fishing. These contrasting results suggest that choice of sampling methodology can influence interpretations of the ability of no-take areas to provide adequate levels of protection for target species.

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The significance of macroalgae to the diets of juvenile fish and ecosystem function in a tropical coral reef lagoon

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Macroalgae are recognised as important nursery habitat, yet little is known about their contribution to juvenile fish diets. This project examined the significance of macroalgae and associated infauna, to the diets of juvenile fish in the Ningaloo lagoon, focussing on the contribution to juvenile diets and whether this varies seasonally.

Juvenile fish were collected from macroalgal beds in the Ningaloo lagoon during February and July, 2015. Stomach contents from 164 fish, representing 11 species, were identified to 37 taxa in 14 categories, and the percent volume of items was recorded. Multivariate analyses quantified similarities in the stomach contents to define 3 trophic groups (herbivore, zoobenthivore and carnivore). The variation in specialisation or generalisation of prey items was also assessed between species and seasons.

Macroalgae represented 34.2% of *Naso fageni* and 41.1% of *Siganus fuscescens* stomach contents in February, which increased in July as fish became larger (37.7% and 58.2% respectively). Specifically, *Sargassum* content increased by 10-fold in *Siganus* guts collected during winter, even though *Sargassum* biomass typically declines at this time. Infauna groups associated with macroalgal beds were the dominant components in the guts of juvenile Lethrinidae (*Lethrinus atkinsoni, Lethrinus nebulosus*), Lutjanidae (*Lutjanus kasmira, Lutjanus quinquelineatus*), and Mullidae (*Parupeneus barberinoides, Parupeneus spilurus, Upeneus* sp.). Intra-specific variation analyses found that smaller fish caught in February had a narrower trophic width and a more specialised feeding strategy than larger-bodied individuals of the same species in July.

These results highlight the importance of macroalgal beds to diets of the selected juvenile fish species and their contribution to trophic flows in the Ningaloo lagoon. These findings enhance our understanding of variation in diet with ontogeny, improve our understanding of fish diets and provided fundamental information to build an Ecopath with Ecosim food-web model to explore the importance of species interactions in the Ningaloo ecosystem.

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Different factors predict the distribution of two sympatric urchin species along a fringing coral reef: Ningaloo, Western Australia

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Sea urchins play an integral role in coral reef systems. As herbivores they mediate competition for space between corals and algae, as bioeroders they modify the reef substratum, and they are also a food source for some fish species. We quantified the abundance and distribution of the two most abundant sea urchin species along a fringing coral reef in Western Australia; the Ningaloo Reef. Urchin abundance was determined by evaluating 30 benthic photographs taken by divers along a 25m transect (representing an area of 10.5m^2) at a total of 126 survey sites. The survey sites encompassed both outer slope and inshore reef habitats, as well as different management zones (sanctuary and non-santuary). A measure of rugosity (site structural complexity),

substrate cover (percent algal cover), water velocity, and an index of predation were also determined at each survey site. *Echinometra mathaei* (the burrowing urchin) and *Echinostrephus molaris* (the mole urchin) were the two most abundant species in the study area, yet general additive models suggested that the ecological predictors that best explained the maximum variation in abundance were different for each of these two sympatric species. *Echinometra mathaei* abundance showed a positive relationship with food source and site structural complexity, and were more abundant in non-sanctuary compared to sanctuary zones. Interestingly, predatory fish biomass was significantly higher in these sanctuary zones. In contrast, the mole urchin, *Echinostrephus molaris,* was distributed predominantly on the outer reef slope, where they showed regional differences in their abundances. Since both these urchins can erode the reef through their burrowing behaviour, understanding their distribution and abundance will help to understand the role they play in shaping the reef substratum.

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The Wild West

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The Good (or is that bad?): With a highly endemic fish fauna and a number of recently discovered species, and some pristine wilderness areas, Western Australia is good. However, over 20% of the freshwater or diadromous fishes appear on threatened species lists under national or state regulations (including ~half of the Southwestern Province's fishes), and the list continues to grow. Long-term monitoring studies are assisting in the management of several species, including Balston's Pygmy Perch (*Nannatherina balstoni*), Spotted Galaxias (*Galaxias truttaceus*), Freshwater Sawfish (*Pristis pristis*) and cave fishes.

The Bad (or is that ugly?): The number of bad fish species in Western Australia is climbing at almost at annual rate, with at least one recent invader, the Pearl Cichlid (*Geophagus brasiliensis*) spreading through estuaries and invading adjoining catchments. Some control events, such as the complete eradication of Redfin Perch (*Perca fluviatilis*) from a water supply reservoir have led to dramatic recolonisation of native species, while control programs for feral Goldfish (*Carassius auratus*) and other species have had some success in management outcomes and increased public awareness.

The Ugly: Along with bad fish came ugly things. In particularly, several introduced parasites have had severe impacts on native fishes. Although some native fishes are quite ugly, e.g. adult male Pouched Lamprey (*Geotria australis*), they can be good indicators of bad habitats.

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Good golly it's a Molly! Did the mining downturn lead to the introduction of *Poecilia latipinna* to the Pilbara region of Western Australia?

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A recent survey of the upper Fortescue River, Western Australia, resulted in the capture of nineteen *Poecilia latipinna* from a 23 kilometre section of the main channel which represents the first record of an introduced fish species in that system. The variable size and maturity of individuals captured, and the distribution over which they were recorded, strongly suggested *P. latipinna* was breeding in the river as opposed to being the result of a single release. Based on the limited connectivity at the time of sampling, and that much of the channel downstream of the survey area was dry, the introduction was thought to be relatively recent with dispersal occurring in a downstream direction. The area through which the Fortescue River flows is known for its extensive iron ore reserves. Iron ore is the largest export commodity in Australia with 95% of this production occurring in the Pilbara. In recent years, the price of this commodity has dropped by almost 50%, and the 'downturn' had large implications for the regions labour market which saw the loss of over 23000 jobs from the region. This talk will subsequently discuss whether this economic affect indirectly resulted in an environmental effect and whether future changes in demographics and industry in remote regions of Australia may increase the risk of future fauna introductions.

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Responses of the fish community and biomass in Lake Ohinewai to fish removal and a carp exclusion barrier

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The objective of this research was to evaluate responses of water quality and fish biomass in the 16.8-ha Lake Ohinewai to removal of invasive fish species. Lake Ohinewai is a shallow (maximum depth 4.5 m), hypertrophic, riverine lake in pastureland in the Waikato Region, New Zealand. We hypothesised that reduction of invasive fish to below 100 kg/ha would improve water quality, so we removed koi carp (*Cyprinus carpio*), brown bullhead catfish (*Ameirus nebulosus*), goldfish (*Carassius auratus*) and rudd (*Scardinius erythrophthalmus*) during the recapture phases of four capture-recapture population estimations. We also installed a one-way barrier that allowed adult fish to leave but prevented re-entry of adult koi carp. In 2011, before fish removal, koi carp comprised 97% (308 kg/ha, 95% CL 211–466) of the total biomass of invasive fish (334 kg/ha). We reduced the biomass of koi carp to 39 kg/ha (95% CL 24–67) in 2012 and to 14 kg/ha (95% CL 7–27) in 2014 by a combination of fish removal and the one-way gate. Total invasive fish biomass in 2014 was estimated as 28 kg/ha, well below our target of 100 kg/ha. In 2016, after two years without fishing but with the one-way barrier still in place, koi carp biomass had increased to 94 kg/ha (95% CL 49–197)

and total invasive fish biomass was 157 kg/ha, partly because of a strong biomass response by catfish (12 kg/ha in 2011, 36 kg/ha in 2016). The native shortfin eel (*Anguilla australis*) also showed a strong biomass response (14 kg/ha in 2012, 41 kg/ha in 2016).

Water quality (Secchi depth, suspended solids, and concentrations of chlorophyll *a*, total nitrogen and total phosphorus) was evaluated before and after fish removal. None of these variables showed changes that were coincident with invasive fish removal except for chlorophyll *a*concentration, and the lake remained hypertrophic.

1. Tempero G, Hicks BJ. 2017. Responses of the fish community and biomass in Lake Ohinewai to fish removal and the koi carp exclusion barrier. Waikato Regional Council Technical Report 2017/10. Waikato Regional Council, Hamilton, New Zealand.

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Demonstrating the benefits of carp removal in the ovens river

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Native fish populations within the Murray Darling Basin (MDB) have dramatically declined in richness and abundance over the past century. This decline is partly attributed to river regulation and the pervasive impact of carp (*Cyprinus carpio*). The biology and ecology of this invasive species provides them with a competitive advantage over native fish and has contributed to their dominance of fish communities in many river systems of south-eastern Australia.

The Ovens River Demonstration Reach (ORDR) program (2008-2017) incorporated carp removal (via electrofishing) as a river rehabilitation strategy in 2014 to improve native fish populations within a 20km reach of the Ovens River. As the impact of carp removal on native fish could not be separated from the cumulative impacts of recent works, an investigation into the impact of carp removal on the ORDR carp population was undertaken. A total of 521 individual carp were removed over three years (2014 to 2016) from 10 sites. Greater numbers of carp were removed during years of high abundance; however, carp abundance across years was highly variable.

Our hypothesis that a '50% reduction in the total (captured and observed) abundance of carp in each sample year would result in a significant decline in carp numbers in consecutive years' was not supported. The impact of flows, native fish, wetland/channel connectivity, competition and cohort structure across years are discussed to explain our findings.

Engagement with the community and relationship building between ARI with CMA's, local landcare, fishing clubs, water operations managers, MDBA staff, Office of Water, Nutrisoil and community action groups has been a huge success throughout the ORDR program. These relationships have contributed to carp and international conference presentations, erection of educational signage, community meetings, carp musters, factsheets, electrofishing demonstrations, school and university presentations, production of nutrient rich fertiliser and numerous departmental reports.

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Edwardsiella ictaluri is present in wild catfish in Australia

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The bacterium *Edwardsiella ictaluri* is one of the most significant pathogens of farmed catfish in the United States of America, and has also caused mortalities in farmed and wild fish in many other parts of the world. Wild fish populations in Australia are considered free of this and many other diseases that impact fish elsewhere; although the bacterium has previously been detected in imported ornamental fish and native catfish held in Australian aquarium facilities, which may present a vector for invasion. A risk-based sampling model was constructed and wild catfish from 15 sites across the continental expanse of northern Australia were tested for *E. ictaluri*. The bacterium was isolated in eight Wet Tropics tandan (*Tandanus tropicanus*) from the Tully River, Queensland, and results were confirmed using conventional biochemical tests, and DNA sequencing. This is the first report of *Edwardsiella ictaluri* in wild fish on the Australian continent.

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Molecular characterisation of a new species of *Cryptosporidium* in goldfish (*Carassius auratus*)

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Cryptosporidium is a protozoan parasite that causes gastrointestinal illness in a wide range of vertebrate hosts, including humans. Relatively little is known of the epidemiology of *Cryptosporidium* in fish. This study investigated the prevalence of *Cryptosporidium* in goldfish (*Carassius auratus)* (n=216) which were purchased from a retail aquarium and a fish farm in Perth, Western Australia. All samples were initially screened at the 18S locus by quantitative PCR (qPCR) and positives further analysed by nested PCR and sequencing at the 18S and actin loci. Further subtyping was conducted on human-infectious species at the glycoprotein 60 (*gp60*) locus. The overall prevalence by qPCR was 30.1% (65/216). Sequencing and phylogenetic analysis at the 18S locus (n=23) identified *C. parvum* (n=2), *C. hominis* (n=10) and a novel species (n=11), which was genetically distinct and most closely related to *C. scopthalmi.* (genetic distance = 10.1%). Sequencing at the actin locus (n=6) also confirmed the validity of the novel species (genetic distance =14.1%). Subtyping of three *C. hominis* isolates at the *gp*60 locus identified subtype 1bA10G2, which is the main *C. hominis* subtype involved in human outbreaks of cryptosporidiosis. Further research is required to characterise the novel species at the histological level and to determine the clinical impact of *Cryptosporidium* in goldfish.

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Accelerometry reveals diel activity patterns in Port Jackson sharks, *Heterodontus portusjacksoni*

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Distinguishing the factors that influence movement variation within a species advances understanding of their behaviour and ecology. Acoustic accelerometers were used to investigate variations in activity patterns of male and female Port Jackson sharks (*Heterodontus portusjacksoni*) early and late in their breeding season. HD video was used to assign behaviour to root mean square (RMS) acceleration recorded by accelerometers. In order to quantify diel patterns of the sharks, we used linear regression to relate RMS acceleration output to the previously time-matched behaviours on video. To validate captive data, diel patterns from captive sharks were compared with diel movement data from free-ranging sharks. We then used linear mixed effects models to determine factors most influencing activity levels. Captive sharks showed nocturnal diel patterns, peaking in activity during the late evening before midnight and decreasing in activity before sunrise. Free-ranging sharks displayed comparable diel patterns showing captive studies can be used to understand behaviour in the wild. By directly relating RMS acoustic acceleration output to activity we show the diel, seasonal and sex-specific movement variation within this species and the corresponding activity levels of sharks in captivity.

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Broad-scale movements of white sharks in eastern Australia from acoustic and satellite telemetry

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The advent of electronic tagging has seen vast advances in our understanding of marine top-order predator movements over broad spatial scales. However, most studies are restricted to relatively short temporal scales. Recent improvements in battery life, combined with the surgical implantation of acoustic tags, has increased the opportunity to examine movements over time periods relevant to ontogenetic changes and at scales providing context to interannual variability. Herein we examine data from 43 juvenile white sharks (1.7 to 3.2 m Total Length) tagged with long-life acoustic tags and monitored by receiver arrays spanning a continental-scale and across international boundaries. The study registered approximately 182,000 detections of tagged white sharks on 287 receivers over seven years, with individual tracking periods of up to five years. We compare these to satellite tracking data collected on the same sharks over the same period. Data reveal complex movement patterns throughout the eastern Australian region over distances of thousands of kilometres with sharks ranging from the southern Great Barrier Reef, Queensland, to Tasmania and across the Tasman Sea to New Zealand. Juvenile white sharks showed a variety of movement patterns including annual fidelity to spatially restricted nursery areas in central NSW and southeast Victoria, directed seasonal coastal movements, intermittent areas of nearshore temporary residency and offshore excursions. Data support restricted movements of juveniles east and west of central Bass Strait further supporting a two-population model for the species in Australian waters. Female sharks were more commonly encountered in inshore waters than males and their latitudinal movements were more extensive. The data highlight the value of broad-scale, nationally and internationally collaborative acoustic receiver arrays and sustained monitoring of individual sharks over multi-year time periods.

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Temperature-structured vertical movement behaviours in oceanic whitetip sharks

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Patterns of vertical movement structure the ecology of sharks that inhabit the open ocean. We investigated the role of temperature in driving the vertical movements of 16 oceanic whitetip sharks (*Carcharhinus longimanus*) from which pop-up satellite archival tags were physically recovered in the western North Atlantic Ocean. The tags recorded depth and temperature continuously at a two minute sampling interval and were attached to the sharks for a mean 185 ± 23 days (range 21-331). These animals inhabited a seasonally changing water column, allowing us to use these seasonal changes as a natural thermal-choice experiment. We used spectral analysis, linear mixed modelling and segmented regression techniques to look at the effect of average sea surface temperature (SST) and mixed layer depth on a range of vertical movement behaviours. Oceanic whitetip sharks continually oscillated throughout the top 200 m of the water column. In summer months, when the water column became well-stratified with high SSTs, oscillations increased in amplitude and cycle length and sharks reduced the proportion of time spent in the top 50 m. In a well-mixed winter water column, these behaviours were reversed. A breakpoint of approximately 28^{o}C marked a distinct change in vertical movement behaviours and the potential onset of reverse thermoregulation strategies. These results have implications for overlap with human use activities, and for predicting the effects of future environmental change.

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Albany a turning point for juvenile southern bluefin tuna?

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Archival tagging studies of southern bluefin tuna (SBT*, Thunnus maccoyii*) have revealed that juveniles residing in the Great Australian Bight (GAB) over the austral summer undertake seasonal cyclic migrations to the southeast Indian Ocean and the Tasman Sea during winter. However, there remains disagreement about the extent of mixing between juvenile SBT regularly caught by longline fleets south of Africa and those observed in the GAB. Some researchers have argued that archival tag recoveries indicate most juveniles reside in the GAB over the austral summer. Others have suggested that recoveries of conventional and archival tags are better explained by a juvenile population consisting of separate groups on the eastern and western sides of the Indian Ocean with limited intermixing. We present analyses of catch and tag recovery data and re-examine archival tagging studies. The evidence provided strongly favours the hypothesis of separate juvenile subgroups, or contingents, with limited intermixing. We draw some tentative conclusions about the nature of the putative contingents and discuss some implications of these findings including their possible connection with the collapse of the surface fishery off New South Wales in the 1980s, repeated observations of dual spawning peaks in the tropical Indian Ocean and bimodal length frequency distributions of one-year-olds off Western Australia. We also provide the first evidence that the migration choices of juveniles that do summer in the GAB are influenced by fidelity to winter feeding grounds.

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Vertical migration in the open ocean and its implications for the evolution of size in whale sharks

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In the open ocean, migration of fishes occurs in both horizontal and vertical planes. Movement of the small fishes and crustacea that form the planktonic prey of whale sharks (*Rhincodon typus*) from the surface to deep, cool water (300-500 m) during the day (diel vertical migration; DVM) presents a major challenge for a species that filter-feeds using a gill. Using data-logging tags we have shown that whale sharks use a variety of behavioural strategies to access prey in deep water and to ensure cost-effective foraging. The costs of feeding in deep water and energy conservation advantages associated with a specialised body plan provide strong selective pressure for the development of large body size. Variation in these costs through ontogeny explains horizontal patterns in migration of these animals, notably the tendency to form aggregations in warm coastal waters at many tropical locations around the world. Recognition of these key selective factors also provide insights into the evolution of body size in filter-feeding marine vertebrates through evolutionary time.

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Impact of recreational fishing on fish and shark assemblages within the Ningaloo Marine Park

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The impacts of fishing within the Ningaloo Marine Park can be estimated by comparing sites inside and outside no-take sanctuary zones and sites across a gradient in recreational fishing pressure. We present data from baited remote underwater stereo-video (stereo-BRUV) and diver operated stereo-video (stereo-DOV) to estimate variation in the abundance distribution of fish and shark species and habitat composition across the region. We find that habitat composition, in particular the complexity of relief, to be a strong predictor of fish and shark assemblages sampled by stereo-BRUV and stereo-DOV. Only from stereo-BRUV data, we also found evidence of protection from fishing within no-take sanctuary zones for fish species and for shark species we found evidence of impacts of fishing where intensity of recreational fishing pressure was greatest. We suggest the differences in results from baited video and dvier video survey methodologies may be due to fish behaviour.

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Understanding and quantifying shark depredation in a recreational fishery

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Shark depredation, where a live hooked fish is consumed by a shark before it can be retrieved to a fishing vessel, can occur in recreational fisheries around Australia. This results in additional mortality to target species, potential injury to sharks from ingested fishing gear, and can negatively impact the recreational fishing experience. This research sought to quantify the spatial occurrence and frequency of shark depredation in a recreational fishery within Ningaloo Marine Park and Exmouth Gulf, Western Australia. A large-scale survey was conducted at four boat ramps in these areas, from July 2015 - May 2016, to collect quantitative data on shark depredation and the variables influencing it. For the 407 boats interviewed across the study area, 12.15 ± 2.08 % of hooked fish were depredated by sharks, with 39.8 % of fishing trips experiencing depredation. Generalised Additive Mixed Models (GAMMs) quantified the effect of fishing method and environmental factors on depredation rate, with results showing a positive effect of increasing fishing depth on depredation in Ningaloo Marine Park, and peak depredation occurring at 60m. Higher localised fishing effort led to increasing depredation rates, and time of year also positively influenced depredation in Ningaloo Marine Park. In Exmouth Gulf, cumulative spatial fishing pressure and decreasing latitude showed a positive effect on depredation rate, with the latter potentially reflecting a change in benthic habitat throughout the Gulf. This research was the first in-depth quantitative assessment of shark depredation in a recreational fishery in Australia, and determined the extent to which environmental factors and fishing methods influenced its occurrence and spatial variation. This information can be used to develop strategies for reducing shark depredation and mitigating potential negative impacts on target fish, sharks and recreational fishers.

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Using stable isotopes to understand ecology of sharks and fish at Ningaloo Reef

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Stable isotopes can yield powerful insights into the ecology of animals, providing windows into ecological processes that we cannot usually observe. But, like many methods, they are prone to misuse and misinterpretation. Seemingly simple patterns do not always give us the ecological insights that we think. The patterns that we see are the emergent property of complex interactions involving physiology and ecology, and patterns might be due to physiological influences. This talk will show how understanding physiology, chemistry, anatomy and ecology can help refine the insights we extract. Examples will be drawn from bulk stable isotopes from multiple elements (carbon, nitrogen, sulphur) and multiple tissues, and compound-specific stable isotopes of nitrogen. Examples will include discussion on the diet and trophic position of several species, notable the blacktip reef shark *Carcharhinus melanopterus* and the sicklefin lemon shark *Negaprion acutidens*, and several species of bony fishes.

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The biogeography of tropical reef fishes: endemism and provinciality through time

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The largest marine biodiversity hotspot straddles the Indian and Pacific Oceans, driven by taxa associated with tropical coral reefs. Centred on the Indo-Australian Archipelago (IAA), this biodiversity hotspot forms the 'bullseye' of a steep gradient in species richness from this centre to the periphery of the vast Indo-Pacific region. Complex patterns of endemism, wide-ranging species and assemblage differences have obscured our understanding of the genesis of this biodiversity pattern and its maintenance across two-thirds of the world's oceans. But time-calibrated molecular phylogenies coupled with ancestral biogeographic estimates have provided a valuable framework in which to examine the origins of coral reef fish biodiversity across the tropics. Herein, we examine phylogenetic and biogeographic data for coral reef fishes to highlight temporal patterns of marine endemism and tropical provinciality. The ages and distribution of endemic lineages have often been used to identify areas of species creation and demise in the marine tropics and discriminate among multiple hypotheses regarding the origins of biodiversity in the IAA. Despite a general under-sampling of endemic fishes in phylogenetic studies, the majority of locations today contain a mixture of potential paleo- and neo-endemic fishes, pointing to multiple historical processes involved in the origin and maintenance of the IAA biodiversity hotspot. Increased precision and sampling of geographic ranges for reef fishes has permitted the division of discrete realms, regions and provinces across the tropics. Yet, such metrics are only beginning to integrate phylogenetic relatedness and ancestral biogeography. Phylogenetic dissimilarity clustering of extant assemblages identifies a large Indo-West Pacific cluster, but also clusters distant Pacific island together based on peripherally isolated, but phylogenetically close lineages. Through time, clustering of estimated ranges reveals the dynamic nature of reef assemblages with provincial changes reflecting large scale tectonic rearrangement of the tropical belt.

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Freshwater mussels as ecological engineers in permanent water refuges in southwestern Australia

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More than half of the global river network is intermittent, shrinking to a series of isolated pools during periods of no-flow. More frequent or prolonged drying events associated with climate change will reduce the quantity and quality of these pools and impact their ability to support aquatic organisms during periods of no-flow. As filter-feeders, freshwater mussels clear the water column of suspended material, including nutrients, algae and sediment, and deposit them on the benthos, altering the distribution and abundance of essential resources for primary and higher order consumers including fish. They may maintain clear water conditions in enclosed systems by removing the accumulated wastes of organisms, suppressing toxic cyanobacteria and preventing algal blooms, so may be important in preserving the integrity of river-pool refuges. Many rivers have multi-species mussel assemblages, however, southwestern Australia has only one species, *Westralunio carteri*, which is likely to be particularly important to rivers in the region. The recent range decline of *W. carteri* may impair refuge-pool function and threaten the persistence of the unique aquatic fauna including fish. This presentation will highlight the potential role freshwater mussels play as ecosystem engineers by drawing on evidence from mussels in other regions around the world and preliminary quantitative evidence of filtration rates of *W. Carteri* in southwestern Australia.

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A complicated symbiosis: understanding the parasitic-mutualistic continuum between Temnocephala and spiny crayfish

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The survival of *Euastacus*, spiny crayfish, in Australia is under increasing threat due to land clearing, water pollution and climate change. The spiny crayfish is host to Temnocephala ectosymbiotic flatworms, and very little is known about the role they play in maintaining the health of their host and how it relates to water quality, apart from anecdotal evidence which suggests that crayfish living in poor water quality areas are host to fewer temnocephalans. In order to disentangle this question, we seek to understand Temnocephala on the Murray Crayfish *E. armatus* and the New Hairy Crayfish *E. neohirsutus* in a cross-disciplinary manner. We are using veterinary techniques such as THC (Total Haemocyte Counts), differential counts of haemolymph smears, and haemolymph protein, lactate and glucose levels, as well as ecological techniques such as removal and dietary experiments as tools for monitoring crayfish health and the effects of temnocephalans on these key indicators. Here we discuss the usefulness of these techniques and the evidence supporting the existence of a parasitic to mutualistic continuum in Temnocephala-crayfish interactions. We propose the use of the temnocephalan-crayfish as a model across fisheries biology to advance our understanding of how environmental change will influence the ecological outcomes of symbiotic relationships.

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The invasion of Running River and the story of its refugees.

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The Running River Rainbowfish (RRR) is a recently recognised taxa that is in urgent need of conservation action and is currently listed by the Australian Society for Fish Biology as critically endangered. Currently, there are at least three species of rainbowfish listed as threatened or critically endangered by the Australian Society for Fish Biology for which Eastern Rainbowfish is considered as the major threatening process due to potential hybridisation. The underlying processes of these invasions and subsequent hybridisation are not yet understood, but in most cases the root of the problem has been the translocation of eastern rainbowfish outside its natural range. A captive breeding and translocation stocking program was undertaken to save RRR. This situation provided an opportunity to examine the processes affecting introduction success, not only negative introductions such as the case of the Eastern Rainbowfish, but also conservation based introductions. These introductions also provided an opportunity to see how fast a rainbowfish species may spread throughout a new system. To do this we tested the effects of predator training on released fish, and conducted mate choice experiments to test the preferences Eastern Rainbowfish and RRR.

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Variation of trophic dependence of different fish consumers in two mountain lake ecosystems from subtropical Taiwan

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Mountain lakes are natural and remoted lentic water bodies with unique ecosystem structure housing high level of biological endemism. They are sensitive to environmental changes though most studies of the mountain lake ecosystems have been focused on the temperate region. Yet, only limited investigation has been undertaken in such ecologically important habitats in tropical/subtropical Asia. As the subtropical mountain lake ecosystems are strongly influenced by seasonal environmental perturbations, including periodic and stochastic hydrological disturbances due to heavy rainfall events, and the intense solar radiation during summer. It could be the major factor characterizing the energy basis for the lake food webs. In this study, the trophic structure and food utilization patterns of different fish consumers in two subtropical mountain lakes in Taiwan, including Lake Tsuifeng (TFL) and Lake Yuanyang (YYL) were investigated using stable carbon and nitrogen isotope analyses in association with gut content analysis. The two study lakes exhibited marked difference in riparian vegetation pattern, TFL was relatively unshaded with only sparsely distributed riparian vegetation whereas YYL was a densely shaded system with continuously distributed riparian forest. This resulted in distinct difference in the availability of different food sources to the food webs. Despite the high availability of the two most dominant allochthonous food sources including fine particulate organic matter and leaf litter in the densely shaded YYL, they were least utilized by most fish consumers. In contrast, fish consumers in the autotrophic TFL ecosystem showed strong dependence on autochthonous food sources (e.g. algae) which accounted for the major primary production supporting the food web. Our results will be further discussed.

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Environmental metabolomics provides insights into physiological responses of southern sand flathead in Port Phillip Bay

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Port Phillip Bay is located on the central south coast of Victoria, Australia. It is a large urbanised marine embayment encompassing an area of roughly 1950 km^2 with a coastline approximately 264 km; and hosts a population of over four million people on its catchment basin. The Bay receives waters from the Yarra River, discharges from sewage treatment plants and agricultural inputs. It is home to a wide range of fish species, with seagrass beds used as nursery sites. The southern sand flathead (*Platycephalus bassensis*) are long-lived carnivorous ambush predators that have a sedentary, non-migratory lifestyle. They conceal themselves in fine sediments, are not strong swimmers and are believed to be representative of the area from where they are collected. Consequently they are considered a suitable bioindicator species for their local environment. The aim of this study is to use metabolomics to investigate responses of sand flathead to different environments in Port Phillip Bay. Two year old female fish were collected from five sites within the bay. Assessment of the fish for general condition showed differences between fish from urbanised/industrialised sites (Corio Bay, Hobsons Bay, Mordialloc) compared to fish from low population density areas (Sorrento and St Leonards). For the metabolomics analysis, livers were subjected to polar metabolite analysis and free fatty acid analysis using gas chromatography mass spectrometry. The PCA results for polar metabolites showed that the samples from Sorrento separated from those of the other sites. Notably, fish from Sorrento and Mordialloc showed significant differences in amino acids, glycolytic and TCA intermediates. Interestingly, results for the free fatty acid analysis showed that samples from Corio Bay separated from those of other sites. The present study highlights the value of using metabolomics which can offer insights into sand flathead responses to different environments within Port Phillip Bay.

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Health status of sand flathead (*Platycephalus bassensis),* inhabiting an industrialised and urbanised embayment, Port Phillip Bay, Victoria as measured by biomarkers of exposure and effects

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Port Phillip Bay, Australia, is a large semi-closed bay with over four million people living in its catchment basin. Inflow into the Bay includes urban runoff, discharges of sewage treatment plants as well as petrochemical and agricultural chemicals. A 1999 study demonstrated that fish inhabiting the Bay showed signs of effects related to pollutant exposure, despite pollution management practices having been implemented for over a decade. To assess the current health status of the fish inhabiting the Bay, a follow up survey was conducted in 2015. A suite of biomarkers were measured to determine the health status of Port Phillip Bay sand flathead (*Platycephalus bassensis*); namely ethoxyresorufin-*O*-deethylase (EROD) activity, polycyclic aromatic hydrocarbons (PAH) biliary metabolites, carboxylesterase activity (CbE) and DNA damage (8-oxo-dG). The reduction in EROD activity in the present study suggests a decline in the presence of EROD activity-inducing chemicals within the Bay since the 1990s. Fish collected in the most industrialised/urbanised sites did not display higher PAH metabolite levels than those in less developed areas of the Bay. Ratios of PAH biliary metabolite types indicated fish collected at Corio Bay and Hobsons Bay were subjected to increased low molecular weight hydrocarbons of petrogenic origin when compared to PAH biliary metabolites in fish from Geelong Arm and Mordialloc. Quantification of DNA damage indicated a localised effect of exposure to pollutants, with a 10-fold higher DNA damage level in fish sampled from the industrial site of Corio Bay relative to the less developed site of Sorrento. Overall, integration of biomarkers by multivariate analysis indicated that the health of fish collected in industrialised

areas was compromised, with biologically significant biomarkers of effects (LSI, CF and DNA damage) discriminating between individuals collected in industrialised areas from observations made in fish collected in less developed areas of the Bay.

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The Montara oil spill, Timor Sea – two years of fish health monitoring

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The Montara incident which occurred in 2009 in the Timor Sea, resulted in the release of an estimated 23,000 barrels of oil and gas condensate over 74 days. Following the operational response, the scientific monitoring focussed on commercially important fish in order to ascertain the suitability for human consumption, as well as inform on the long term effects of the oil spill on fish health. Red emperor (*Lutjanus sebae*, n = 807) and glodband snapper (*Pristipomoides multidens*, n = 1531) were sampled over 2 years flowing the accidental release, and biopsies collected. A suite of physiological indices (condition factor, liver somatic index and the gonadosomatic index), biomarkers (EROD activity, biliary polycyclic aromatic hydrocarbon (PAH) metabolites, liver integrity measured by serum sorbitol dehydrogenase activity (SDH), oxidative DNA damage) were measured. While fish initially showed signs of exposure to petroleum hydrocarbons, biomarker of exposure in fish collected in the most impacted area have returned to reference levels within 24 months. Only liver somatic index in fish collected at the spill site remained elevated two years after the spill, relative to fish from other locations. Two years of monitoring following the oil spill in a tropical open sea provided information on biomarker tools that are suited to short-term, or long-term monitoring of effects from discharged light crude oil.

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Fish dissection 101 – fish sampling considerations and how to produce hundreds of response endpoints

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Destructive sampling is an integral part of many fish monitoring programs and fisheries surveys. Information can be gained on a wide variety of indicators, including, but not limited to: growth rates, reproduction, ageing, diet, nutritive and disease status. However, in general only a subset of samples will be taken from each fish that is removed, due to both the scope of the project, as well as budget and time limitations. Given the increasing ethical and sustainability concerns with the removal and killing of fish for research purposes, there is a need to maximise the value of each fish that is sampled, which can be achieved by standardising sampling strategies.

In this presentation I will discuss the response endpoints that can be measured in a variety of different fish tissues that we believe should be collected as standard in any sampling programs that require killing the fish. We currently collect samples from more than 10 different tissue types, and measure histological, morphological, physiological, biochemical (enzyme function, metabolite pathways) and genetic endpoints. Examples of this approach will be discussed in relation to various fish biomonitoring projects that our group have worked on over the last few years. Most of our research is conducted in the context of environmental monitoring for pollution assessment, but much of the information is equally as relevant for assessment of other ecological questions.

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Sharks, rays and abortion: the prevalence of capture-induced parturition in elasmobranchs

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The direct impacts of fishing on chondrichthyans (sharks, rays and chimeras) are well established. Here we review a largely unreported, often misinterpreted and poorly understood indirect impact of fishing on these animals — stress-induced parturition (either premature birth or abortion). Although direct mortality of discarded sharks and rays has been estimated, the prevalence of abortion/premature birth and subsequent generational mortality remains largely unstudied. We synthesise a diffuse body of literature to reveal that a conservative estimate of > 10% of live bearing elasmobranch species show stress-induced parturition in response to capture. For the 23 species with available data, we estimate capture stress-induced parturition events for 2 – 64% of pregnant females (average 20%). Stress-induced parturition was only observed in live-bearing species. We compile data on threat-levels, method of capture, reproductive mode and gestation extent of premature/aborted embryos. We also utilise social media to identify 42 social-media links depicting a stress-induced parturition events which provide supplementary visual evidence for the phenomenon. The mortality of embryos will have implications for elasmobranch populations, and there are limited options to deal with this problem. This review is the first to synthesize available data on stress-induced parturition in sharks and rays, and highlights an important ethical and management issue for fishers and managers deserving of much greater attention.

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Environmental drivers of growth and predicted effects of climate change on a commercially important fish

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Human-driven climate change and habitat modification are negatively impacting coastal ecosystems and the species that reside within them. Uncovering how individuals of key species respond to environmental influences is crucial for effective and responsive coastal resource and fisheries management. Here, using an otolith based analysis, we recreated the growth history of rock flathead (*Platycephalus laevigatus*) over a 32 year timeframe and related growth variation to changes in key environmental variables. Growth increased with higher temperatures during the fish growing season (December – May) and also increased with higher freshwater flow during the period important for seagrass growth (July-February). We hypothesise that fish are responding to enhanced productivity in the seagrass food web, driven by increased nutrient input from freshwater flows. Fish appear to also be responding to higher temperatures via a direct physiological pathway. We then predicted fish growth under three plausible climate change scenarios. Growth is predicted to increase across all our projections, because any predicted decrease river flow will likely be offset by rapid predicted increases in temperature. Our results highlight the value of understanding the drivers of long-term growth variation in harvested fishes as this allows for the prediction of future productivity under a range of environmental and management scenarios.

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The influence of environmental factors on the habitat use of Black Bream A*canthopagrus butcheri* and the implications of artificial oxygenation in the Swan-Canning Estuary

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Deoxygenation events within the Swan-Canning Estuary are severe and potentially lethal threats to aquatic fauna and an ongoing concern for management. Hypoxic conditions develop in the upper estuary following heavy rains that deliver influxes of freshwater into the system, stratifying the water column and creating barriers to vertical mixing. Organisms living within the bottom waters rapidly deplete oxygen reserves, causing this region to become hypoxic. The frequency and severity of these events are projected to increase due to climate change following reductions in surface run off and reduced river flows (a remediate of hypoxia). In response, artificial oxygenation plants have been installed in two regions of the upper estuary known to experience hypoxic conditions most frequently to maintain oxygen levels appropriate for fauna.

Using acoustic telemetry, we tracked fifty-five *Acanthopagrus butcheri* over a 116-day period over autumn and winter with the aim to relate patterns of movement (including residency and habitat use) to a suite of environmental variables commonly associated with the movement of fishes in estuaries, and determine whether the spatial residency of this species is influenced by the operation of the artificial oxygenation plants. The study revealed that detection of *A. butcheri* was significantly influenced by hypoxia, habitat complexity, salinity and flow, while operation of the oxygenation plants did not significantly influence *A. butcheri* detection. Although, due to the necessity for the plants to operate in a way that prevents hypoxia from forming, an effective study design to specifically answer this question wasn't able to be achieved.

Ongoing management of the Swan-Canning Estuary should aim to mitigate the factors exacerbating hypoxia within the system and incorporate protection of instream woody habitats and riparian vegetation given its importance to native fishes as refugia. More research will be required to accurately quantify the benefits of artificial oxygenation to estuarine species.

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Accelerometers reveal thermal performance regimes in free-ranging elasmobranchs

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Temperature is one of the most influential drivers of physiology and behaviour in ectotherms, and therefore understanding how temperature influences physiological performance is important to understanding an animal's ecology. Most previous studies of thermal performance in fish have been conducted under controlled laboratory settings as measuring physiological performance in wild systems has historically been a difficult task, creating uncertainty in how these laboratory measurements are realized in natural environments. Recent advances in technology have allowed performance of free-ranging fish to be quantified, producing a more cohesive and ecologically relevant picture of thermal performance. Here, we use body acceleration data collected from eight species of free-ranging sharks and sawfish at a range of temperatures to determine how these fish change their activity in response to temperature. We compare the sensitivity of this response between species and energetic strategies (buccal-pumping and ram-ventilating animals), and fit thermal performance curves to the activity data. The temperature sensitivity and thermal performance regimes of each species are examined in the context of climate change and biogeography.

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The great escape: are marine blennies using land to avoid predation?

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Ecological release from competition or predation is a common reason put forward to explain why animals make transitions into new environments. Supporting data for this phenomenon, however, is limited. Using a group of blennies who appear to be in the process of colonising land, we explored whether differences in aquatic versus terrestrial predation pressure may help explain the amphibious behaviour of these otherwise marine fishes. We found that amphibious blennies display a dynamic distribution within the intertidal zone, where they shift their peak abundance up and down the shoreline to remain above aquatic predatory fishes that periodically move into the intertidal on high tides. Deployment of blenny mimics confirmed a high risk of aquatic predation for blennies; significantly higher than levels of predation experienced by blennies above the waterline. Collectively, our evidence suggests that a differential in predation pressure may have played a key role in one of the most profound habitat shifts in the history of vertebrate biodiversity: the occupation of land by marine fish.

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Top shelf bottom feeders - Food provisioning in stingrays

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Food provisioning can have significant effects on marine wildlife, and may cause behavioural changes, alter population structure and trophic balance, and cause significant health impacts on target species. It is common practice for recreational anglers to discard fish waste back into waterways, yet the effects of incidental provisioning as a result of processing marine recourses have not yet been assessed, and are likely not being considered in the management of recreational fishing along Australia's coastline.

At the Woollamia boat ramp in Jervis Bay, local fishers have been incidentally provisioning short-tail stingrays through fish cleaning activities for >30 years. This provided an opportunity to investigate the influence of provisioning on a small scale. We used behavioural observations to assess site use patterns against provisioning intensity to determine if this level of provisioning has the potential to cause changes to the movements and behaviours of this large marine mesopredator.

Fifteen (adults, $N = 7$; sub adults, $N = 8$) female short-tail stingrays were found to use the provisioning site, including at least 5 gravid individuals. Their presence was significantly correlated to the intensity of provisioning events ($P < 0.001$) and significantly more stingrays visited post-provisioning than pre-provisioning ($P < 0.001$) during simulated provisioning trails at other sites. These data indicate a strong influence of provisioning on the stingrays' movements and use of the site. Based on the observed population structure, we also suggest the area may have reproductive significance for this species.

We provide a baseline of the effects of incidental provisioning as a result of processing marine recourses, on which monitoring and management programs can be built. This study has implications for recreational fisheries management and the management of marine provisioning globally.

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Habitat connectivity exerts opposing effects on piscivory and browsing

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Context Connectivity is an important property of landscapes that shapes populations and ecosystem functioning. We do not know, however, whether and how different types of spatial linkages influence ecological functions, and this hampers the integration of connectivity into conservation plans.

Objectives We used coral reef seascapes in eastern Australia as a model system to test whether habitat connections (between reefs) and seascape connections (among reefs and other habitats) exert similar effects on two key ecological functions (piscivory and browsing).

Methods We measured browsing (on macroalgae) and piscivory (on live prey fish) rates on reefs that differed in their level of connectivity to both other reefs and nearby mangroves and seagrass in Queensland, Australia.

Results The extent of habitat connectivity between reefs significantly influenced ecological function, but it did so in asymmetrical ways: isolated reefs supported high browsing but low piscivory, whilst, conversely, reefs that were closer to other reefs supported high piscivory but low browsing. This was not caused by browsers avoiding their predators, as the dominant piscivores (small predatory snappers) were too small to consume the dominant browsers (large rabbitfishes). Seascape features (e.g. distance to mangroves or seagrass) were less important in shaping function on reefs in this system.

Conclusions The way connectivity shapes ecological functions likely depends on both the type of spatial linkage and the type of ecological function in question. This has implications for conservation planning seeking to incorporate connectivity.

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Latitudinal and ontogenetic variation in the diet of a pelagic mesopredator (*Pomatomus saltatrix*), assessed with a classification tree analysis

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Pelagic mesopredators are abundant in many marine ecosystems and exert strong top-down influence on food webs. We explored the dietary niche of *Pomatomus saltatrix* in eastern Australia, using a classification tree analysis to identify key factors driving diet variation. *P. saltatrix* was shown to be an opportunistic generalist predator which exhibited increased baitfish consumption, and decreased crustacean consumption, with increasing size. The classification tree analysis showed that body size and latitude had the greatest influence on the diet of *P. saltatrix*, with significant ontogenetic diet shifts occurring at 8 and 30 cm fork length (FL). While piscivory is evident in the majority of *P. saltatrix* diets by ~8 cm FL, crustaceans are almost entirely absent from the diet after ~30 cm FL. The importance of latitude was likely related to the broad-scale oceanography in the study region, including the East Australian Current and its separation from the continental shelf. The classification tree analysis is a powerful framework for identifying important variables in diet composition.

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Navigation and homing ability in a benthic shark

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Many elasmobranchs undertake large-scale migrations to specific locations for events such as mating, pupping or feeding, and return regularly to these places throughout their lives. The Port Jackson shark is a small, benthic species that uses rocky reef habitat in NSW over winter for breeding and egg laying, and exhibits extremely high site fidelity between years. This study investigates homing ability and magnetic navigation in the Port Jackson shark by displacing animals from their 'home reef' and examining their movements. Sharks (n = 20) were captured in southern Jervis Bay, acoustically tagged, and translocated ~8kms north, half with strong magnets attached to their heads and half with a sham attachment. The time taken to return 'home' ranged from 3 hours to 13 days, with 3 sharks never detected back in the home reef. Whilst there was no significant difference between magnet and control groups, differences were observed based on sex; males returned more quickly than females. These results indicate that Port Jackson sharks have a well-developed homing ability but do not use a magnetic sense to navigate over short distances. This study raises further questions about how the sharks use space and other resources during breeding season, and provides important information on the spatial ecology of benthic sharks.

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Exploring model structure uncertainty using a general stock assessment framework: The case of Pacific cod in the Eastern Bering Sea

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An assessment framework is developed that allows analysts to conduct stock assessments for fish and invertebrate stocks based on age-, size- and age-size-structured population dynamics models. The size-structured model is nested within the age-size-structured model. The framework can use catch, discard, index of abundance, size- and age-composition, conditional age-at-length, mean length-at-age, and tagging data to estimate model parameters. It is used to explore the sensitivity of key model outputs for Pacific cod in the Eastern Bering Sea by applying model configurations that use the same data, same likelihood functions, and same data weighting schemes. Base model configurations using the three model types all fit the available data adequately, but the age-structured model fits the data better than the size-structured model. Variation in estimates of spawning biomass and the overfishing level was higher among model-types than within model-types. This result highlights the need for assessment analysts to focus more on applying and presenting results for multiple models.

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Data-Poor Stock Assessment Options for Australia

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There has been a great deal of recent research activity trying to develop methods to produce stock assessments, or at least management advice, for fisheries that can be characterized as data-poor. Data-poor often means that the only data available are catches. There are, of course, limitations, but not surprisingly, given the discussion is about data-poor species, the most promising options for progress are what can be termed 'model-assisted' methods. Essentially, these use a mathematical model, some of whose parameters are conditioned on what is known about the productivity of the species concerned, assumptions are made

about the current state of the fishery (these need not be highly informative), and then model parameters are trialed to search for those that predict plausible biomass trajectories. Obtaining management advice from such assessment models tends to remain focused on systems other than how things are done in Australia. This talk will illustrate the use of such methods and how they can be used at least with regard to the Australian Commonwealth Harvest Strategy Policy.

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The state of fisheries science in the early 21st century - A perspective from the future?

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Hindsight is said to be far more accurate than foresight, yet blurred memories and the mist of time often cause imperfections to be overlooked. In the year 2017, fisheries scientists were able to look back at progress that had been made through the previous century, a period during which the science-based approach to fisheries management had led to the development of sophisticated fishery models and stock assessment approaches and the indirect effects of fishing had become increasingly recognised. In the first decade of the 21st century, however, recognition that fisheries were still becoming overexploited had led to increased use of risk-assessment based harvest strategies and acceptance that broader ecosystem, social, and economic objectives needed to be considered. Fisheries management had moved from an autocratic to a more open, consultative approach, and removals by recreational fisheries had become a significant component of catches. At that time, i.e. in 2017, fisheries scientists were increasingly focused on resolving issues of the day and, with declining budgets, providing advice on immediate management issues. These immediate management needs precluded a detailed critical appraisal of the longer-term effectiveness of the science and management approaches currently being used. A perspective such as that provided by standing at a greater temporal distance and examining the broader picture was required. This presentation examines how, in 2050, fisheries scientists and managers view the effectiveness and shortcomings of those fisheries science approaches and strategies of the early decades of the 21st century. Was it an age of enlightenment, or an era of lost opportunity?

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Empirical harvest strategy and tier system for the Torres Strait tropical lobster fishery

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The Torres Strait tropical rock lobster (TRL) *Panulirus ornatus* fishery is a culturally and economically important fishery and the Australian Commonwealth has an obligation under the Torres Strait Treaty to protect the traditional way of life and livelihood of Islanders as well as promoting employment opportunities for Traditional Inhabitants. An empirical Harvest Control Rule (eHCR) has been developed to achieve the agreed ecological, economic and social management objectives of the fishery. Four alternative Operating Models are used in the testing process to capture consideration of a lower stock-recruitment steepness parameter, changing the assumption of a hyperstable relationship between CPUE and stock abundance, and a more conservative recruitment scenario. Simulations account for both observation error and different implementation errors for each of the three sectors. To accommodate potential changes in the amount of monitoring information available, and hence changes in the associated level of confidence in the scientific advice for decision-making, a hierarchical tier system is being developed. Tier systems broadly aim to reduce the risk when data are poorer, and ideally aim for risk equivalency such that different tiers have the same risk of depleting the stock below pre-specified levels. This talk provides an overview of the four Tier system under development for TRL, where each tier has its own eHCR based on the available data and assessment type.

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Decision rules for quota setting to support spatial management in a lobster (*Jasus edwardsii*) fishery

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The Northern Zone rock lobster fishery in South Australia is extensive, covering ca. 207 000 km^2. Managed under transferable quotas, the majority of the annual total allowable commercial catch (TACC) is taken on eastern inshore grounds, targeting the smaller redder lobsters favoured by Chinese buyers. The confined nature of fishing under the TACC system has led to concerns of localized spatial depletion and suggested a need for spatial management. A regional partition of the TACC was proposed. Formal prescriptive decision-rule tables for setting regional TACCs annually were constructed based on target exploitation rates. A target exploitation rate of 20% historically produced zero average yearly change in biomass and, in previous bioeconomic projection modelling, achieved near-optimal net economic return. Using an age-based fishery assessment model that fits to catch totals by both weight and number landed, conditioning on fishing effort and mean weights-at- age, we estimated harvestable biomass for three regions. The management response was to establish inner and outer subzones where separate TACC decision rules are now adopted. Basing the harvest strategy on a target exploitation rate underlies a simple direct method for constructing decision-rule tables for setting TACC using the indicator of previous year's catch per unit effort (cpue). In the normal cpue range, a constant target exploitation rate is applied. At lower levels of stock abundance, below a designated upper limit reference point of cpue, the exploitation rates used to assign TACCs are set to decline linearly from the normal target level, reaching zero at a designated lower-limit reference cpue point below which the fishery is closed. At higher levels of cpue, stakeholders agreed to a

TACC cap, under which exploitation rate decreases if biomass rises. This case study applies where formal harvest strategy decision rules for quota-based lobster fisheries are considered at finer spatial scales.

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Addressing limitations with catch curve assessments applied to data-limited fisheries

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When undertaking model-based fisheries stock assessments, the approaches that are adopted must be applicable to the type(s) and quality of data that are available. Non-equilibrium models (e.g. biomass-dynamic and statistical catch-at-age models) are recommended whenever sufficient, reliable data exist. For many fisheries with limited data, however, the only models suitable for assessment are those assuming the population is at equilibrium with respect to processes such as mortality and recruitment (e.g. equilibrium surplus production models, catch curve and per-recruit analyses). For fisheries that lack both a reliable time series of (total) catches and abundance indices, model-based assessments typically apply catch curve analyses, and often combined with simple equilibrium population models (e.g. per recruit analysis). That is, catch curve analyses are typically applied to age and/or length frequency data obtain an estimate of total mortality, which is then related directly to natural mortality or used in further analyses to provide a relative measure of yield or biomass.

Traditional forms of catch curve analysis (e.g. linear catch curve analysis or the Chapman & Robson method) make the above strong equilibrium assumptions, and other "simplifying" assumptions, such as knife-edge selectivity, all of which are unlikely to be true. It is possible, however, to avoid several of these assumptions, but at the cost of increased model complexity (i.e. requiring more parameters and potentially more data). To what extent can the considerable limitations of these analyses be overcome, and is the increased complexity associated with the required modifications always necessary, or even advisable? What else might be done to improve catch curve-based assessments for such data limited fisheries? With these questions in mind and using data for demersal finfish species in Western Australia, this presentation will describe the approaches we have used when attempting to address these issues.

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Genomic signatures of local adaptation reveal source-sink dynamics in a high gene flow fish species

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Understanding source-sink dynamics is important for conservation management, particularly when climatic events alter species' distributions. Following a 2011 'marine heatwave' in Western Australia, we observed high recruitment of the endemic fisheries target species *Choerodon rubescens*, towards the cooler (southern) end of its distribution. Here, we use a genome wide set of 14 559 single-nucleotide polymorphisms (SNPs) to identify the likely source population for this recruitment event. Most loci (76%) showed low genetic divergence across the species' range, indicating high levels of gene flow and confirming previous findings using neutral microsatellite markers. However, a small proportion of loci showed strong patterns of differentiation and exhibited patterns of population structure consistent with local adaptation. Clustering analyses based on these outlier loci indicated that recruits at the southern end of *C. rubescens'* range originated 400 km to the north, at the centre of the species' range, where average temperatures are up to 3°C warmer. Survival of these recruits may be low because they carry alleles adapted to an environment different to the one they now reside in, but their survival is key to establishing locally adapted populations at and beyond the range edge as water temperatures increase with climate change.

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Climate-mediated changes to the distribution and density of reef fishes family pomacentridae in south-western australia

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Changes in climate are leading to latitudinal shifts in the geographical distribution and abundance of many fish species. These shifts may be driven by both discrete and gradual climatic events, the effects of which are cumulative in nature. This study focuses on the abundance distributions of four species of Pomacentrid (*Pomacentrus milleri, Parma occidentalis*, *Parma mccullochi,* and *Parma victoriae*) on shallow complex rocky reefs located on Western Australia's temperate coastline. These species use similar algal habitats. However, they differ in sea-surface temperature requirements and therefore have differing population distributions. Diver operated stereo-video surveys were used to investigate changes in the distribution patterns of these Pomacentrid species between 2006 and 2015. The abundance of the warmer water affiliated species *P. milleri* and *P. occidentalis* increased in the north of the survey area, from Jurien Bay to Port Gregory. The abundance of *P. victoriae*, a cooler water species, decreased at Albany, while the cosmopolitan species *P. mccullochi* showed similar distribution and abundance

patterns in 2006 and 2015. The cumulative effects of an extreme temperature event (2 – 4°C warming over >10 weeks) across the survey area in early 2011 and gradual sea temperature warming has led to significant changes in the algal composition of south-western Australian reefs. The loss of *Ecklonia radiata*, and subsequent increase in turfing algae is likely to be a key factor in the changes of *P. milleri* and *P. occidentalis* distribution and abundance.

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The decline in abundance and diversity of Chaetodon butterflyfish and effects on sociality due to coral loss.

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Specialised fishes that have evolved close and critical relationships with scleractinian corals may be extremely vulnerable to widespread reef degradation and coral loss. Temporal changes in composition and abundance of butterflyfishes has been documented at Lizard Island in the northern Great Barrier Reef, which has been subject to several recent and major disturbances, including two intense cyclones and a severe coral bleaching event. The aim of this presentation is to discover if coral loss (in this case, extreme coral loss and disturbance) has sub-lethal effects on Chaetodon butterflyfish by causing them to travel further to find food and a mate. Particular interest is measuring whether there is a change to the social structure of these fishes when their habitat is reduced and individuals may be forced to cohabit or be further apart and expend more energy to find each other in order to reproduce. Sampling was undertaken in February 2017 to quantify the abundance of different coral-feeding butterflyfishes at multiple locations around Lizard Island, and then compared with previous surveys undertaken periodically since 1995. Specifically, data from 2017 was compared to data from 2002 and 2009. The survey method involved 5 x 50m transects in four habitat zones (base, slope, crest, flat) at four different sites. On each transect a visual survey was conducted, recording numbers of individuals, pairs, groups of three or more, and juveniles while a visual survey to quantify live coral cover was undertaken on the same transect lines. Data is currently being analysed for changes in Chaetodon sociality, while there is an unequivocal decline in the abundance and diversity of butterflyfishes shown by recent surveys. The full results will be ready for presentation at the Australian Society for Fish Biology conference in July 2017.

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Direct versus indirect effects of climate change on coral reef fishes

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Climate change is firmly established as the single greatest threat to coral reef ecosystems. Coral reef fishes are now being affected by changes in environmental conditions (mainly increasing temperature) as well as climate-induced habitat degradation. This study revisits and revises meta-analyses that were initiated following the 1998 global mass-bleaching phenomenon to explore the responses of fishes to sustained and ongoing climate impacts. Despite the emergence of direct environmental impacts on the distribution and performance of reef fishes, habitat degradation (including coral loss and topographical collapse) remains the principal causes of declining abundance, biomass, and biodiversity of reef fishes. Moreover, degradation of reef habitats reduces the capacity for fishes to mediate exposure to changing environmental conditions, making them even more vulnerable to climate impacts. The few species that appear to flourish in the aftermath of climate-induced changes in environmental conditions and habitat structure are small-bodied and short-lived. Sustained degradation of coral reef habitats due to increasing frequency and severity of mass coral bleaching episodes will, therefore, jeopardise the strcuture and function of reef fish assemblages.

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Monitoring the response of large-bodied fishes to flood and drought using fishery catch compositions to provide baseline data

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This study examined the species composition of commercial fishery catches in the terminal system of Australia's Murray River to evaluate their usefulness for understanding spatial and temporal variability of large-bodied fishes in response to restoration of flow and water levels following a period of drought. Over the period of the Millennium Drought (1998-2010) species structures differed in a large freshwater lake (Lake Alexandrina) with similarity between pre-, (1998-99 to 2001-02), and post-drought, (2010-11 to 2013-14), periods suggesting that recovery of these may have occurred in response to high freshwater discharge following the end of the drought. There was no evidence for such recovery in a smaller adjoining lake (Lake Albert) given variability in assemblage structures among years and differences between pre- and post-drought. During early- (2002-03 to 2005-06) and late- (2006-07 to 2010-11) drought, species structures were characterized by higher contributions from the exotic common carp and lower contributions from the native bony herring with the reverse occurring during pre- and post-drought. In estuarine habitat, trajectories of annual species compositions suggested that those from the post-drought period differed to those from prior to the drought in the Murray Estuary and South Lagoon but were broadly similar between these periods in the North Lagoon. These results updated a previous long-term study (1984/85 to 2008/09) which found that species with rapid growth and early maturation (opportunistic strategists), increasingly dominated catches while species with slow growth and late maturation (periodic

strategists) declined. Updated data from the recent period of prolonged flooding indicated increasing contributions to catches from periodic strategists and declining contributions from opportunistic strategists.

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Multiple and opposing effects of urbanisation on estuarine fishes

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Urbanisation has transformed natural landscapes globally, having detrimental effects on the distribution of biodiversity and ecosystem functions in most biomes. But there are many properties of urbanisation, which shape populations and important processes in different ways. We do not know, however, whether different components of urbanisation exert separate or combined effects on assemblages and the distribution of functionally important species. We examined how the structural and nutrient properties of urbanisation influenced the composition of fish assemblages and the diversity of functional groups in estuaries of southeastern Australia. We surveyed fish assemblages across 22 estuaries that differed in their level of human modification, habitat diversity and water quality. Our results show the structural and nutrient properties of urbanisation affect fish assemblages, but they influenced different components of assemblages, and can interact. Estuaries with high shoreline urbanisation supported greater functional group diversity than relatively natural shores; characterised by a higher abundance of omnivores (e.g. yellowfin bream), zoobenthivores (e.g. weeping toadfish), and detritivores (e.g. sea mullet). Whereas, estuaries with higher nutrients displayed a greater abundance of zoobenthivores (e.g. common toadfish), which were functionally replaced by zooplanktivores (i.e. estuary perchlet) in lower nutrient settings. Landscape context influenced the effects of urban structure and nutrients on the functional composition of assemblages; for narrow estuaries, there was little influence of shoreline urban structure, nutrients or mangrove extent. This difference was characterised by a lack of zooplanktivores in larger estuaries. This suggests the functional effects of urban structures on assemblages is likely contingent both on the nutrient status and landscape context within which the structure sits. These findings have implications beyond estuaries, because urbanisation is widespread and influences assemblages in all ecosystem types. This has important consequences for monitoring the effects of urbanisation and how we might consider engineering ecosystems or restoring habitats that are moderately degraded.

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Drivers and symptoms of environmental stress among estuarine fish communities of southern Australia

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Estuaries in the Mediterranean climate regions of southern Australia are vulnerable to the effects of anthropogenic pressures and climate change. Many of these systems are affected by eutrophication, water extraction, increased loading of fine sediments and organic matter, hydrological modification, and altered geomorphology and connectivity. In many cases these human pressures are exacerbated by significant declines in freshwater flows under a drying and warming climate. The effects of these pressures are manifested as altered environmental conditions, which can act as stressors of estuarine fauna such as fish. We provide a series of case studies to highlight the key environmental stressors that shape fish communities in the estuaries of southern Australia, including altered salinity regimes, harmful algal blooms, reduced hydrological connectivity and environmental hypoxia. The impacts of these stressors range from shifts in community structure and functional guilds to the loss of particular species, and in extreme cases, mass mortalities ('fish kills'). Although the literature documenting the ecological effects of these stressors continues to grow, in many cases our understanding of the mechanistic pathways between altered physico-chemical conditions and community-level effects remains limited. This uncertainty highlights the need to more effectively trace stressor impacts through various levels of biological organisation, from direct effects on the physiology, behaviour and biological performance of individuals, to consequent changes in population dynamics and, ultimately, community structure and function.

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Collecting broad scale ecological data with stereo video technology

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With a rapid increase in overfishing across the globe, it is becoming more important to collect accurate ecological data over broad spatial scales in a timely manner. This will facilitate broad scale synthesis over regional and/or global scales and provide information that can be translated into management outcomes in an attempt to reduce the impacts of overfishing. The use of video technology to monitor the marine environment, has facilitated the rapid collection of a broad range of ecological data over large spatial scales. In particular, methods such as stereo baited remote underwater video and diver operated video can provide information on the abundance, biomass, length and behaviour of marine organisms, simultaneous to habitat assessments reducing data collection time. Here I discuss the advantages and limitations of stereo video technology and give examples of broad scale projects such as Global FinPrint (the world's first global assessment of sharks and rays) that have used video data

to facilitate broad scale synthesis. Finally, I discuss the implications and potential advantages of using stereo video technology in the future.

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Assessing the impact of macrophyte density on underwater video camera monitoring of fishes in tropical wetlands

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Underwater video cameras are being increasingly used in freshwater environments to sample and monitor aquatic biota. Northern Australia has vast areas of unmodified freshwater habitats containing a large diversity of freshwater fishes. However, fish surveys in the region have been limited, as sampling in many of these habitats is inherently difficult, with challenging environmental conditions, remoteness, complexity of habitat, and safety issues including large predators.

Pop-net surveys have been used to monitor freshwater fishes in shallow vegetated billabongs around the Ranger uranium mine in Kakadu National Park for many years. However, this survey technique presents a human safety risk due to crocodile attack, and additional safety measures (such as barrier netting and crocodile spotters) can disturb habitats, affect catch rates, and lead to higher field costs. Underwater video cameras have been proposed as a viable alternative, however, dense macrophytes can impede visibility.

This study investigated the impact of macrophyte density on video surveys. We deployed cameras in three shallow billabongs that contained varying densities of macrophytes, and sampled fish assemblages using both video cameras and pop nets. Macrophyte density was also measured in each sampling location. This study constitutes a component of a larger project investigating the utility of underwater video cameras for monitoring freshwater fishes in wetlands of northern Australia, and will assist in the future utilisation of underwater video cameras for monitoring and research in the region.

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An assessment of fish assemblages in Moorea's marine reserve network using stereo-video techniques

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Marine ecosystems are facing threats ranging from ocean acidification to overfishing due to human impacts (Grorud-Colvert et al. 2014). Exploitation is causing changes to biodiversity, raising doubts over the long term sustainability of fisheries (Lauck et al. 1998, Roberts et al. 2005, Worm et al. 2006). As a result, no-take marine reserves are gaining popularity as a method to conserve biodiversity and preserve ecosystem function (Grorud Colvert et al. 2014). Marine reserves have been shown to increase fish density, size and species richness and reduce wariness within their boundaries (Januchowski-Hartley et al. 2013, Lindfield et al. 2014, Januchowski-Hartley et al. 2015). It is important to consider multiple indices when assessing the effectiveness of fisheries/conservation strategies as sensitivities of indicators to fishing pressure is not consistent across all indicators (Nash & Graham 2016). The marine reserve network surrounding Moorea, French Polynesia is currently under review, and past studies have not demonstrated any clear differences between reserve and fished areas. Fish behaviour in response to fishing pressure is an emerging field with very little data. We used diver operated stereo video systems to determine if wariness is lower and abundance and biomass is higher inside Moorea's eight marine reserves compared to outside fished areas. Secondly, we aimed to determine the effects that habitat, tourism, fish feeding, poaching, and reserve size have on fish behaviour, and to what extent abundance, biomass and fish behaviour is affected by these impacts, either positively or negatively. The results and conclusions of this study are not yet finalized, however are near completion.

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Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches

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The surf zones of ocean beaches are prime fishing sites and provide habitat for a diversity of fish species. The spatial composition of seascapes shapes fish abundance and diversity in most coastal ecosystems, but it remains untested whether seascape effects operate on ocean beaches. This study used the surf zones of sandy beaches in eastern Australia as a model system to contrast fish assemblages between the two main surf habitats, nearshore troughs and offshore bars, and test how habitat partitioning changes with beach exposure, wave conditions, seascape connectivity (i.e. proximity to estuaries and rocky headlands) and tide. Fish were sampled with Baited Remote Underwater Video Stations (BRUVs) from the surf zones of 18 sandy beaches in southern Queensland and northern New South Wales. Habitat type and beach exposure combined to shape fish abundance and diversity in the surf. Fish assemblages always differed between nearshore trough and offshore bar habitats; beach exposure was also important to surf fishes, but did not alter the priority effects of habitat partitioning. Beach exposure is an important predictor of faunal assemblages on ocean beaches, and is often used as a surrogate in conservation planning. Our results show, however, that surf zones are not single uniform spatial units, but are composed of topographically and hydrodynamically distinct habitats that support correspondingly distinct fish assemblages. Because fishing effort also differs between surf habitats, fisheries management and spatial conservation planning need to reflect these spatial nuances in the surf zones of ocean beaches.

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Suitable surrogacy for decadal-scale conservation planning in a warming subtropical region with persistent patterns and shifting species

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Faced with climate change and associated species range shifts, effective conservation strategies that suitably represent biodiversity need to account for both present and future species distributions and be robust to future warming. We consider this principle in relation to the Solitary Islands Marine Park (SIMP), a warming region in subtropical eastern Australia. Over the last decade, the habitat-forming kelp *Ecklonia radiata* has markedly declined in this region, corresponding with changes in herbivory and a tropicalisation of fish communities. Further evidence of tropicalisation includes a southwards extension of anemonefishes and host sea anemones since the mid-1990s. In light of these changes, can conservation planning for biodiversity representation be undertaken for decadal time-scales, the scale at which zoning plans in multiple-use Marine Protected Areas often operate? In support that it can, strong cross-shelf patterns in reef fish assemblages (inshore, mid, offshore) have been maintained over the decadal scale in the SIMP. These patterns have been used to help refine a Habitat Classification System (HCS) for application in conservation planning (e.g. using Marxan) through surrogate biodiversity representation. Loss of kelp habitat on mid reefs reduced heterogeneity of the habitat mosaic present in the region, impacting diversity and thereby affecting representation. However, persistence in broad assemblage patterns indicate that a well-designed HCS is a robust and informative tool for representing biodiversity in conservation planning in the face of climate change. Likewise, predictive models of species/functional group distributions and abundances have considerable utility for longer-term planning, although caution is required in their interpretation. Predictive models support the importance of distance from shore and depth as categories in the HCS. Marxan analyses using predictive models versus HCS categories indicate advantages and disadvantages in both approaches. If possible, a combination of both approaches is preferred, especially when also incorporating local knowledge of sites with exceptionally high biodiversity.

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Advancing trait-based ecology of fishes by bridging the gap between marine and freshwater studies

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Trait-based approaches, which focus on using species' traits to explain ecological phenomena, are being used increasingly by fish ecologists to investigate linkages between species life history, assemblage structure and ecosystem functioning. Trait-based approaches have also been applied to biogeography, conservation and management, revealing new insights on dispersal, invasiveness, and extinction risk, to name a few. Researchers working with marine and freshwater fishes have distinct approaches and perspectives toward trait-based studies, but also have much to learn from each other. Here, we summarize those studies, identifying major similarities and gaps. We identify the major ways in which fish traits have been used as an ecological currency, the type of aquatic environment in which they were conducted (freshwater, marine, estuarine) and the traits they used. Traits are grouped into major categories: morphological, ecological, behavioural and life-history traits. Despite similar approaches being applied across different aquatic environments, our analysis reveals major differences between marine and freshwater studies related to the types of traits they used. Ecological and behavioural traits dominate in marine studies, whilst morphological and life-history traits prevail in freshwater studies. We believe that these differences are caused, in part, by variability in trait availability, research practices, and disciplinary norms. Traits of marine fishes are mostly derived from underwater observations using scuba. On the other hand, freshwater studies often involve fish collecting and direct measurement or estimation of trait values. These differences are unfortunate because it hampers the integration needed for advancing research, yet are also opportunities for broaden perspectives in the future. Our aim is to promote the integration between these two 'cultures' by showing how some traits used in freshwater studies can greatly improve marine studies and vice-versa. Finally, we identify information gaps and propose solutions to broadening the scope of traits used to answer ecological questions.

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Case study of using national on-line services to annotate and analyse underwater imagery: SQUIDLE+ and GlobalArchive

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Fish image annotation data, is currently collected by various research, management and academic institutions globally (+100,000's hours of deployments) with varying degrees of standardisation and limited formal collaboration or data synthesis. We present a case study of how national on-line services, developed within the NeCTAR Marine Sciences Cloud, have been used to annotate habitat images and synthesise fish annotation data sets collected using baited remote underwater stereo-video (stereo-BRUV).

In our case study we have used GlobalArchive to synthesise existing stereo-BRUV data sets. GlobalArchive is designed to be a centralised repository of aquatic ecological survey data with design principles including ease of use, secure user access, flexible data import, and the collection of any sampling and image analysis information. To easily share and synthesise data we have implemented data sharing protocols, including Open Data and synthesis Collaborations, and a spatial map to explore global datasets and filter to create a synthesis. To extract data, we have implemented a flexible querying protocol that allows relational database-like querying of any data stored as a flat file (e.g .txt file) with associated spatial metadata and sampling information.

In our case study we have used SQUIDLE+ to sample the habitat composition and complexity of images of the benthos collected using stereo-BRUV. SQUIDLE+ is an online platform designed for exploration, management and annotation of georeferenced images & video data. It provides a flexible annotation framework allowing users to work with their preferred annotation schemes. For this study, we have imported a CATAMI-based scheme that has been modified to allow the annotation of forward-facing images of the benthos (see http://catami.org and https://github.com/TimLanglois/HabitatAnnotation).

We demonstrate how the flexible querying protocol of GlobalArchive is used to combine habitat and fish annotation data to allow the synthesis of multiple data sets and a time-efficient and reproducible data analysis workflow.

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Spatial structure in stock assessments: results of simulation-estimation experiements

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Most stock assessments are spatially-aggregated owing to a lack of data and the lack of a platform for conducting spatially-structured stock assessments. Moreover, it is unclear how poor estimates of quantities of management interest are when either spatial structure is ignored when conducting stock assessments or the assumptions or the assessment model underlying the assessment are mis-specified. A simulation-estimation experiment based on the stock assessment package Stock Synthesis is undertaken to explore these issues. The operating model considers three regions and is based on pink ling, *Genypterus blacodes*, off the east coast of Australia. Fishing pressure varies spatially for pink ling and it is unlikely that there is substantial post-recruitment movement, which implies that the sub-populations of pink ling will differ in their demographic structure spatially. A

range of estimation models ranging from aggregating data spatially, to applying the areas-as-fleets approach to handling spatial heterogeneity, to applying fully spatially-structured models is considered. In addition, simulation scenarios consider the possibility that one of the region is closed to exploitation. Non-spatial assessment configurations that aggregate spatially-structured data provide more precise, but nevertheless biased estimates of initial and final spawning biomass, as well as biased estimates of the ratio between initial and final spawning biomass. A spatially-structured assessment configuration that correctly matches the structure of the model used to generate the simulated datasets is unbiased but imprecise. The bias in estimates of spawning stock biomass associated with spatially-aggregated assessment methods increases in the presence of closed areas while these biases can be reduced (or even eliminated) by applying appropriately constructed spatially-structured stock assessments. The performance of spatially-aggregated assessments when estimating spawning stock biomass is found to depend on the interactions among spatial variation in growth, in exploitation rate, and in knowledge of the spatial areas over which growth and exploitation rate are homogeneous.

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Review of minimum legal size limits for finfish in Western Australia

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In late 2016, following representation from the peak industry bodies for recreational fishing (Recfishwest) and commercial fishing (Western Australian Fishing Industry Council (WAFIC)) to amend the minimum size limits for a range of key finfish species, Department of Fisheries (Department) developed a formal policy on the application of fish size limits in Western Australia (Policy).

In consultation with Recfishwest and WAFIC, the Department then carried out a review of current finfish size limits against the Policy. In November 2016, the Department released a discussion paper that reviewed all current legal size limits for finfish in Western Australia.

The review used a risk based approach underpinned by a range of scientific data to assess the appropriateness of the current legal size limits that apply to finfish. Outcomes of the review included recommendations to amend size limits and proposals for a number of size limits to be abolished.

This paper will discuss the drivers that led to the development of the Policy, the subsequent review of size limits, the feedback from public submissions and the final decisions regarding the size limit review recommendations.

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Accounting for depletion levels in juvenile biomass when determining stock status

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Estimating depletion levels of stock biomass are important for preventing recruitment overfishing. For many fisheries, fishing occurs on both the juvenile and mature portion. In many assessments however, depletion level estimates are limited to the spawning biomass while depletion levels in the juvenile portion is overlooked. A simulation framework was developed to examine stock depletion in both the mature and juvenile portion and the implications on stock status. Two fishing scenarios were explored 1) fishing above the size at maturity and 2) fishing on both the juvenile and mature portion. In both scenarios the spawning biomass was depleted to 20% of the unfished state. Results show that when fishing occurs above the size at maturity, and the spawning biomass is depleted to 20%, the depletion level of the entire stock is only 49%. However when fishing occurs below the size at maturity and both the spawning and juvenile biomass is depleted to 20%, the depletion level of the entire stock might be as low as 36%. Limiting the reporting of depletion levels to just the spawning biomass and overlooking the juvenile biomass may underestimate stock depletion and have implications for stock recovery.

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Accounting for sample size when estimating natural mortality from maximum age

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A key parameter that is required for stock assessment is an estimate of the instantaneous rate of natural mortality, *M*, for the stock. This parameter is frequently estimated by substituting the maximum age recorded for the species into a regression equation that relates estimates of mortality for lightly-fished stocks to the maximum ages recorded for those stocks. Since Hoenig (1983) first published such a relationship, his approach has been cited over 1100 times, and estimates derived using his equation have been employed in numerous stock assessments. The approach has received criticism on occasion, however, as the equation does not include sample size and greater values of maximum age are likely to be observed as sample size increases. For many species, as time passes and the cumulative number of fish that have been aged increases, maximum age has crept upward. At the same time, fishing mortality has increased and the probability of survival has decreased. It is thus not possible to determine the size of an 'equivalent' random sample from the stock that, if the stock had remained at an unfished equilibrium, would have yielded a similar maximum age to that now employed when calculating *M* from the regression equation. Hoenig (2017) considers the criticism, and justifies continued use of equations estimating *M* from maximum age without accounting for sample size. It is interesting, however, to consider how the uncertainty associated with the observed value of maximum age varies with sample size and to explore an estimation approach that relates *M* to both maximum age and sample size. This presentation describes

results from a preliminary exploration of this topic, which uses the probability mass function for the distribution of the maximum for a sample from a geometric distribution.

1. Hoenig, J.M. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin, 82: 898–903.
2. Hoenig, J. M. 2017. Should natural mortality estimators based on maximum age also consider sample size? Transactions of the American Fisheries Society, 146: 136-146.

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No tanking: estimating the age of pelagic fish eggs directly from field samples

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This study establishes procedures which allow the daily egg production method (DEPM) to be applied to species for which descriptions of egg development stages have not been established and temperature egg development experiments have not been conducted. A method is described for staging pelagic fish eggs that can be applied to a wide range of species, negating the need for species-specific stage descriptions. The morphological characteristics used to distinguish stages are easily recognised in the laboratory and are present in the pelagic eggs of a large number of fish species. Individual stages are of similar duration and larval development through stages is approximately linear over time. Methods are also established for estimating spawning time and egg age directly from data obtained from ichthyoplankton surveys. A key benefit of this approach is that instead of assigning each egg stage a specified age for each temperature range based on model outputs from incubation studies, each individual cohort in each sample is assigned an age that aligns most closely with the age predicted for that cohort from the field data. The approach is simple, cost effective, and eliminates the potential for "tank effects" associated with laboratory-based incubation experiments.

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Fisheries Interaction Index: A Method Based on Catch And Spatial Data

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The maintenance of biodiversity is a fundamental priority in wildlife conservation. Analysis of key threats can help to identify priority areas and species for management. Chondrichthyans have their highest biodiversity in the Indo-West Pacific and endemism is particularly high for this group in Australia, with almost 50% of the species being found within Australia's EEZ. Fishery impacts are recognized as a threat not only to target species populations, but also to by-catch species. According to IUCN Red Lists, of the 322 Chondrichthyans described in Australian waters, over 200 species have by-catch and fisheries listed as major threat. Moreover, the choice of priorities for conservation can be undermined by inaccurate catch records or driven to more charismatic species. In more recent years, agencies are implementing ecological knowledge to manage fisheries, and this type of approach is essential when issues like by-catch of undesired or protected species are involved. One of the many aspects of this approach is based on the spatial distribution of species and the impacts that influence aspects of population dynamics such as survivorship. In this study we tested if it is possible to highlight priorities of conservation based on spatial overlap between species and fisheries and the weight of exploitation. Therefore, we developed the Fisheries Interaction Index (FII) and explored the relation between FII and a standard indicator formally established. The method was applied to by-catch Chondrichthyan and target species stocks of the Southern and Eastern Scalefish and Shark Fishery Sector (SESSF) of Australia's Exclusive Economic Zone. Furthermore, we compare our results with reported IUCN's Red List Categories of the assessed species.

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Catch-per-unit-Effort: A Pig's Ear or a Silk Purse?

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In Australia, catch-per-unit-effort (CPUE) is the only index of relative abundance in the majority of fisheries; many smaller, data-poor fisheries have none at all. For CPUE to be even partially successful as an index of relative abundance it obviously needs to have some relationship with a stock's abundance. This need not necessarily be linear but as abundance goes up and down so too should CPUE. Because there can be many influences on CPUE other than a stock's biomass, statistical standardization is now becoming the accepted practice. Such analyses of CPUE tend to focus on extracting the up and down trends through time in the hope of improving our understanding of a stock's dynamics. Instead of examining trends, here we will conduct an empirical exploration of the properties of CPUE across a number of fisheries. Gaining an understanding of these properties provides insights into how best to analyze CPUE without expecting more than it can give.

The reporting of CPUE in logbooks usually involves estimating the catch of each species caught and the effort expended to catch them. Mistakes can be made at many stages of the process leading to outliers, errors, and misleading data and estimates of catch and effort are often rounded off rather than measured precisely. Not all such potential problems can be solved by judicious selection of data but awareness, acknowledgement, and documentation of their existence means that analyses can proceed without unreasonable expectations. We examine some of the main issues with the use of CPUE, compare some of the major methods of statistical standardization, and conclude by attempting to list some generalized guidelines for how best to use CPUE. In the end we should obtain something useful for fisheries management rather than either a pig's pinna or a silken bag.

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Towards confident fish identifications – how many image pixels does it take?

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1. Charles Darwin University, Casuarina, NT, Australia

Underwater video camera surveys are a well-used technique to collect information on the distribution and abundance of fish species. Using baits to attract fish can cause bias and may limit the number of species observed. When cameras are used without baits to sample fish assemblages the distance from camera can affect identification for various species, particularly as turbidity levels increase. Image resolution can be used to overcome distance from camera problems by recording at high resolution and digitally zooming during playback. However, recording at high resolutions can reduce battery life and produce large amounts of video data that subsequently requires manipulation, storage and maintenance. Therefore determining the lowest resolution required to correctly identify fish can reduce file size, lower storage costs, improve handling time and improve battery life.

To determine the most efficient resolution to identify fish species, we propose a survey asking participants to correctly identify a range of fish species from photos at differing resolutions (low, medium, high). Participants will self-assess their identifications skills placing themselves in one of three categories (no experience, limited experience identifying fishes, and a high level of identifying fishes). Images of fish species will be selected and categorised based on features that alter the difficulty of identification including shape, pattern, colour, background, and difficulty in differentiating from similar species. The minimum number of pixels required to identify fish species can then be used to determine the appropriate video resolution. The study will also inform the maximum distance a fish can be identified and how changes in turbidity will affect detection rates of different sized species.

The poster will promote this aspect of my PhD and provide an opportunity to recruit participants.

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Stochastic processes dominate the assembly of marine fish communities, with variation in importance of dispersal limitation and deterministic processes along a latitudinal gradient.

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The partitioning of beta (β) diversity according to spatial and environmental variables is a tool to elucidate the processes involved in the assembly of ecological communities. We compared the relative effects of spatial and environmental variables on the assembly of west Australian marine fish communities along a temperate – tropical gradient. Null models were used to account for the effect of species pools on β diversity of marine fish from three bioregions, An hierarchical variation partitioning approach was applied to test for the effects of scale and spatial and environmental variables on the β diversity of fish assemblages. Results were compared among bioregions to identify latitudinal changes in the relative importance of processes operating in the assembly of marine fish communities. After accounting for the effects of alpha (α) diversity, small differences were found in β deviations among sampled locations, with β deviation values typically positive, although not large. Fine scale variables explained more β diversity variation than coarse scale variables. Spatial variables explained greater variability in β diversity in tropical locations, and environmental variables explained greater β diversity variation in temperate locations. Our results find support for stochastic assembly of marine fish communities regardless of bioregion. The strong effect of stochasticity in structuring the communities is suggested by small β deviation values and low variability explained by independent variables. Superimposed upon the stochastic nature of marine fish community assembly, a change in importance from dispersal limitation to deterministic processes was found from tropical to temperate environments.

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Taking estuarine eastern blue spot goby (*Psedudogobius* sp.) fish embryo testing (FET) out of infancy.

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The use of fish embryo testing (FET) is strongly being encouraged to replace acute and chronic toxicity testing with juvenile fish. Much of the work that has been conducted using FET has been to evaluate chemical safety and effluents with guidance proposed and developed by OECD in 2006 and ISO in 2007. The current literature typically uses one of three model freshwater fish species, zebrafish (*Danio rerio*), the Japanese medaka (*Oryzias latipes*) or the fathead minnow (*Pimephales promelas*). These species are commonly used since information pertaining to physiology, embryonic development, and sensitivity are abundant. However, none of these fishes occur naturally in Australia, and therefore lack environmental realism (in an Australian context). Therefore, for Australian environmental monitoring and ecotoxicological research there is a need to establish equivalent tests in locally relevant species (freshwater, estuarine and marine). This presentation will showcase some of the fish embryo endpoints currently being assessed (heartbeat/min, cumulative hatch rates, survival, size at hatch) in the eastern blue spot goby (*Pseudogobius sp.*) a small, estuarine species native to south-eastern Australia. Specifically, this presentation will discuss some of the strengths and limitations of this embryo assay as it pertains to culturing, testing setup and methodology (for both water and sediments) as well as the species sensitivity and environmental realism/relevance.

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Comparing indices of abundance from standardised catch rates calculated using alternative imputation methods

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An index of fish abundance is typically calculated from the estimated marginal means predicted from a generalised linear model fitted to fishery catch rate data and suitable explanatory variables. However, fishing grounds can change, because fleets often shift their activity to target different areas of a fish population over time, which can create gaps in the dataset and lead to biases in the index. It has been shown that such biases can be reduced by using imputation methods to fill the gaps. Some published methods impute a constant relative abundance over the period with missing data. Our simulations demonstrated that imputations accounting for a possible increase in relative abundance over time generally resulted in less biased estimates. Here, we follow on from that work by applying these methods to real fisheries datasets to explore if, and how, the use of alternative types of imputations can affect results. Catch rate data for indicator species of several Western Australian demersal scalefish fisheries were obtained from commercial fishing logbook returns. We compared the standardised catch rates that were calculated for each of these species using different imputation methods and statistical models. Results show that, at least for some datasets, the choice of imputation method can have an important effect on the imputed index trend, and on the estimated relative fish abundance in the most recent year. This poster provides a brief summary of those findings.

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Storm-induced changes in environmental conditions are correlated with shifts in temperate reef fish abundance and diversity

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We studied the effects of regularly occurring non-destructive storm events on a temperate Australian reef fish assemblage. We collected 78 remote underwater stereo-video samples during four storms. The relative abundance and species richness of fishes were compared to environmental data (significant wave height, water motion, temperature, light intensity and mean surface level pressure) collected during each storm. As wave height and water motion increased, there was a general decline in abundance of fishes and species richness within the assemblage. The variation in the total number of individual fishes was best explained by a combination of water motion, mean surface level pressure, and temperature. Species richness decreased at the height of the storms, and was best explained by significant wave height and mean surface level pressure. Certain fish species were observed to be highly sensitive to fluctuations in different environmental variables, while others proved more resilient to the changing conditions. Sensitive species such as Austrolabrus maculatus disappeared from the recorded assemblage when wave height reached ~3 m. In contrast, more resilient species such as Parma mccullochi persisted until the occurrence of more severe conditions (wave height > 5 m). In addition to wave height and water motion, temperature, light intensity and mean surface level pressure all contribute to models explaining variation in the abundance of fish species during these storm events. We suggest that environmental changes during stormevents have an influence on the behaviour of fishes depending on their morphological and physiological characteristics, and that sensitive species may migrate from the area or seek refuge in the reef substrate to weather the storm. Our results suggest that it may be important to consider meteorological conditionswhen conducting fish surveys, and furtherwork should examine the susceptibility of different species to rapid changes in environmental conditions.

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Phylogenetic relationships of *Panulirus homarus, P. versicolor* and *Thenus orientalis* from Persian Gulf and Oman Sea

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4. Faculty of Marine Science and Technology, Islamic Azad University, North Tehran Branch, Iran, Tehran, Iran

The reconstruction of evolution phylogeny of lobster species are necessary for revealing stock identity that can be used for the management of fisheries industries in Iran. Phylogenetic relationships among lobster species, from Oman Sea, Persian Gulf were examined with nucleotide sequence data from cytochrome oxidase subunit I (COI). The previous works on phylogeny showed that the mitochondrial COI gene in crustacean is a good discriminative marker at both inter- and intra-specific levels. For this purpose, DNA extraction using phenol- chloroform method (HILLIS and MORITZ, 1990) was done. The evolutionary relationships among these species of the lobster were examined using 610 bp of mitochondrial (mt) DNA from the cytochrome oxidase subunit I gene. The result completely agrees with the previously defined species using morphological characters. The resulted phylogenetic trees supported the monophyly of these species. The results imply that Iran's species' origin is Indo-west pacific. Iran's species, which were grouped with the other Lobster taxa seem to always form a sister clade with Indo-west pacific species with bootstrap support of around 80%.

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Oocyte developmental stages of the *Pontogammarus maeoticus* Sowinsky, 1894 (Ponto-Caspian area amphipod)

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In the present study, oocyte development stages of the amphipod *Pontogammarus maeoticus* were determined based on gross morphology and histological appearance. For this purpose, the sampling was taken from the southern coasts of the Caspian Sea (Jefroodbeache, Guilan, Iran). Amphipods were transferred to a laboratory with some of their native sediment. Thirty pairs in 3 aquariums were maintained in controlled laboratory conditions with a temperature of 25±1 ºC, salinity of 9± 0.5 ppt and a 12:12 light:dark regime. Gravid females and females in precopula were prepared, processed and embedded in paraffin sectioned at 5 µm thickness and further stained by the hematoxylin-eosin general method. Based on the histological study, the oocyte development during the reproductive cycle has been classified into four different stages: 1) oogonia, 2) primary oocyte, 3) secondary oocyte (contains two substages: previtellogenic oocyte and vitellogenic oocyte) and 4) mature oocyte.

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Are specific pops of key threatened MDB fishes native or introduced?

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Many Murray-Darling Basin (MDB) freshwater fishes have experienced extreme declines, with around a quarter of the freshwater fishes threatened with extinction. Here we target three native fishes that were once widespread across the MDB, but today have all had significant declines (Purple Spotted Gudgeon, Olive Perchlet and Darling Hardyhead). Remnant populations are extremely geographically limited, with some recently discovered populations occurring outside of the perceived natural range of the species. Existing genetic data have been unable to clarify whether these populations are endemic or translocated. Recovery actions for remnant populations are consequently very difficult to prioritise. We are now applying genetic data from thousands of loci from next generation double digest RAD sequencing, coupled with comprehensive sampling from all potential source populations. Together this should unequivocally distinguish the native status of each population. It will also provide key information regarding each populations genetic diversity, divergence between populations and whether any loci appear to be related to potential local adaptations. These results can then be used to guide reintroduction efforts and conservation strategies.

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Effects of seasonality, salinity and nutrients on trophic basis of omnivorous fishes in an urbanised estuary from subtropical Taiwan

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Estuaries as the coastal habitats connecting rivers to the sea are important carbon and nutrient sinks of the surrounding systems and highly productive ecosystems with multiple ecosystem services. However, most estuarine habitats have been intensively modified and highly degraded due to urbanisation for the purposes of enhancing flood control and increasing human land use. Engineering work such as channelisation and straightening of the estuary-associated rivers commonly result in salinity intrusion and increased tidal influence to biotic community. Eutrophication caused by various anthropogenic activities could lead to changes in assemblages of primary producers in urbanised estuaries and could alter the food web structure. Due to the limited studies on the influence of such salinity intrusion and eutrophication on the biological community structure, little is understood for the shift of trophic basis of urbanised estuary ecosystems in response to human impacts. The strong seasonality of subtropical precipitation pattern could also complicate the effects of salinity and nutrient enrichment on the estuarine food web structure. In this study, three study sites were selected along the tidal main reach of the urbanised Danshuei River estuary in the highly developed northern Taiwan. Stable carbon and nitrogen isotope analysis and gut content analysis were used to determine the trophic basis of the omnivorous fishes which represented the most dominant group of consumers and could be directly/indirectly affected by the change of primary producer assemblage in response to effects of salinity, nutrient enrichment and seasonality. Thus, the stable isotope mixing model (SIAR) was employed to evaluate the relative contribution of various basal energy sources assimilated by the omnivorous fish consumers. Our results will be further discussed to address the effects of anthropogenic impacts on food web structure in an urbanised estuary.

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Contemporary and retrospective genomic analysis of white sharks, *Carcharodon carcharias*

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The white shark, *Carcharodon carcharias*, is an apex predator that occupies a cosmopolitan distribution throughout temperate waters. Conservative life history traits and high anthropogenic pressures have contributed to the listing of C. carcharias in Appendix II of the Convention on International Trade in Endangered Species (CITES) and as 'vulnerable' by the International Union for Conservation of Nature (IUCN, Category VU A1cd+2cd). Historical and contemporary abundance estimates for *C. carcharias* are suggested to be low with declines of up-to 99% identified within some populations. To date genomic resources have contributed to the evaluation of some *C. carcharias* populations including those from the Mediterranean, Atlantic and Pacific and provided evidence for fine scale population structure. Given the importance of *C. carcharias* within the ecosystem, and increasing anthropogenic induced change in the marine environment, estimates of genetically based adaptation, population connectivity, genetic diversity and gene flow is needed to improve our understanding of global *C. carcharias* populations. Targeted capture is the parallel enrichment of pre-selected genomic regions of interest and has been used in the past to estimate the strength of selection in populations, infer local adaptation and identify signatures of selective sweeps. This project will use targeted capture on DNA extracted from contemporary and archival *C. carcharias* skeletal material held in museum and trophy collections around the world to (1) estimate the genetic effective population size and population connectivity; and (2) investigate signatures of adaptive evolution and selective sweeps across white shark populations.