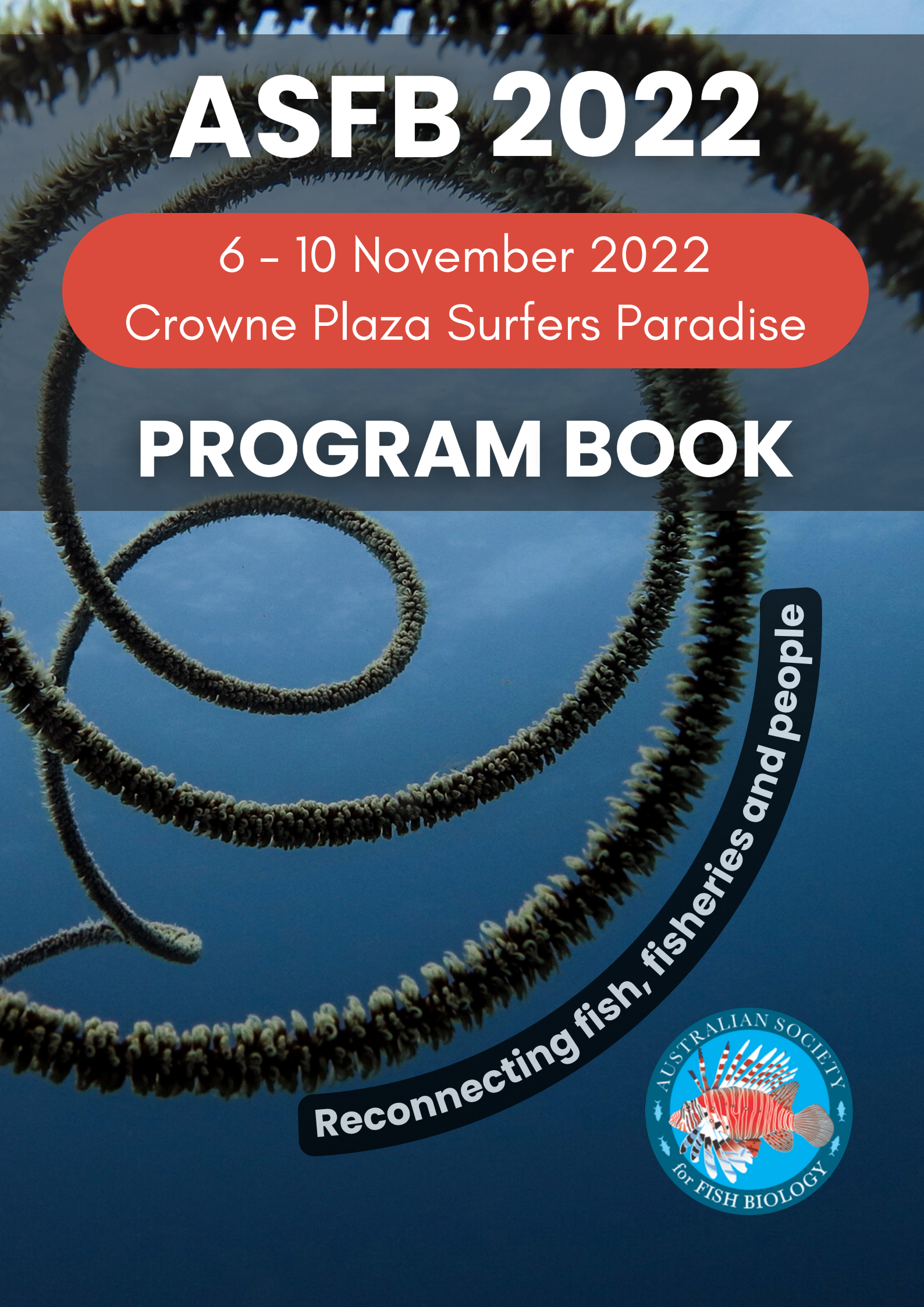
ASFB 2022

6 – 10 November 2022
Crowne Plaza Surfers Paradise

PROGRAM BOOK



Reconnecting fish, fisheries and people

AUSTRALIAN SOCIETY for FISH BIOLOGY

SPONSOR LISTING

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The Queensland Government aspires to be a world leader in sustainable, high-value fisheries and fishing experiences. We work with the community, industry and Traditional Owners to foster economic prosperity through the innovative, sustainable and responsible management of Queensland's fisheries resources. We ensure our fisheries remain sustainable and productive through monitoring and assessment, evidence-based regulatory frameworks for recreational and commercial fishing, community education and fair, transparent and consistent enforcement of fisheries legislation.

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Queensland, Australia

Griffith University was created to be a different kind of university—challenging conventions, creating bold new trends and pioneering solutions. Ranking in the top 2% of universities worldwide, Griffith is an Australian leader in the science of rivers, estuaries and coasts. Its high-quality fisheries and aquatic ecosystem research is designed collaboratively with industry, using cutting-edge technology.

WORKSHOP SPONSORS

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Integrated Marine Observing System

Since 2006, IMOS has been routinely operating a wide range of observing equipment throughout Australia's coastal and open oceans, making all of its data accessible to the marine and climate science community, other stakeholders and users, and international collaborators. Australia's Integrated Marine Observing System (IMOS) is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent.

INNOVASEA

Innovasea is a pioneer in acoustic telemetry, helping researchers worldwide conduct behaviour, migration and positioning studies of aquatic animals in fresh and saltwater environments. Our products include various types and sizes of acoustic transmitters, automated receivers for long term behavioural studies, systems that deliver high-resolution position information, and environmental monitoring data loggers.

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NSW DPI works hand-in-hand with producers – through droughts, floods, fires and biosecurity challenges – to drive stronger primary industries.

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Australia's tropical marine science agency: The Australian Institute of Marine Science's research supports the sustainable use and protection of our oceans.

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SPOT X™ UNDERWATER VISION

Spot X designs and builds commercial real-time drop camera, tow camera, and ROV video systems. Utilising the latest technology in GoPro Hero cameras, mini-production HD-SDI cameras, versatile 4K IP network cameras, or simple to use streaming hardware, Spot X thrives on tackling any underwater video challenge, in any market sector.

EXHIBITORS

CLS OCEANIA

CLS Oceania is a subsidiary of CLS France, a global company and pioneer of satellite-based tracking and data collection services. Applications range from wildlife tracking (marine, terrestrial, avian), oceanography and monitoring of commercial fishing vessels for compliance purposes. CLS is a value added reseller of Argos/Kineis and Iridium satellite systems.

infofish AUSTRALIA

Infofish Australia first partnered with Biosonics Inc in Seattle to conduct Biomass Surveys in Impoundments in 2017. Since that time Infofish has covered more than 450,000 acres in over 50 locations for Local and International Clients, working closely with Humminbird and Garmin to deliver the most comprehensive and cost effective Surveys using echosounders.

"FishID is an online platform that transforms environmental monitoring of aquatic ecosystems through automated detection and counting of animals using computer vision. Robust and efficient monitoring with FishID makes science accessible and can help to support sustainable fisheries. It is part of a software suite by the Global Wetlands Project (GLOW) addressing issues facing aquatic ecosystems"

E-Fish Specialise in the design and production of equipment to assist with electrofishing, survey work and fisheries management.

The Victorian Fisheries Authority (VFA) is an independent statutory authority established to effectively manage Victoria's fisheries resources, services all fisheries and aquaculture sectors and provides advice to government on a range of initiatives and opportunities. We work closely with many stakeholders and partners to deliver three core outcomes:
-Sustainable fishing and aquaculture
-Clear resource access and sharing arrangements
-Increased economic, social and cultural value.

Wildlife Computers is the leading provider of advanced wildlife telemetry solutions. Propelled by our mission to promote sustainable use of our global environment, we create innovative tags that empower data-driven decisions while providing unique consultations, an unsurpassed quality commitment, and impeccable customer service to get you the data you need. Learn more at WildlifeComputers.com

Austral Research and Consulting provides environmental services throughout Australia and internationally, providing solutions for a range of clients from local water authorities to multinational mining companies. We volunteer time and resources to conservation projects and provide work experience opportunities to university students, supporting honours, masters and PhD research projects.

SUNDAY 6 NOVEMBER

9:00 AM - 4:45 PM Phoenix Room (level 1)	**9:15 AM - 3:15 PM** Ecosciences Precinct Dutton Park	**4:00PM - 6:00PM** Boardroom
Workshop: Tracking movements of aquatic species using acoustic telemetry	**Otolith Workshop**	**ASFB Executive Committee Meeting**

6:00 PM - 8:00 PM | WELCOME FUNCTION AT THE POOL DECK (canapes and drinks provided)

MONDAY 7 NOVEMBER

8:45 AM - 10:15 AM	**Session 1**			
8:45 AM	**Welcome to Country and Yarn by Uncle John Graham** **Conference Welcome & President's Address**			
9:30 AM	**Invited Plenary 1: Rod Connolly** Fish-n-Chips: supercharging fisheries science with computer vision			
10:15 AM - 10:45 AM	**MORNING TEA**			
10:45 AM - 12:30 PM	**Session 2**			
10:45 AM	**K Radway Penary: Gretta Pecl** Connections over scales and disciplines to support transformation of marine socioecological systems			
11:15 AM	**ECR Excellence Award Plenary (2021): Curtis Champion** Aspects of seafood vulnerability to climate change			
11:35 AM	**ECR Excellence Award Plenary (2020): Zeb Tonkin** Linking processes to populations to understand the drivers and dynamics of freshwater fish populations in south-eastern Australia			
12:30 PM - 1:30 PM	**LUNCH AND ASFB SUB-COMMITTEE MEETINGS**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
1:30 PM - 3:00 PM	**Session 3.1 - Change**	**Session 3.2 - Community**	**Session 3.3 - Sensory ecology and behaviour**	**Session 3.4 - Connectivity and Movement**
1:30 PM	**John Morrongiello** Rapid warming, regional climate and fishing all drive fish growth variation in SE Australian waters	**Jonathan Smart** Regionalising South Australia's Marine Scalefish Fishery based on stock boundaries, fishery dynamics and ecosystem structure	**Thomas Clarke** King Neptune: influence of shark tourism on the behaviour and physiology of yellowtail kingfish Seriola lalandi at the Neptune Islands	**Tim Marsden** Fish Passage in streams of the Gulf of Carpentaria, unique life histories driven by highly variable flow regimes
1:45 PM	**Sarah Willington** Fishing and warming combine to affect expressed size-at-age in commercially fished species	**Alise Fox** Stock assessments on the "other species" in the Reef Line Fishery	**Lachlan George** First insight into the fine-scale swimming and diving behaviour of the southern eagle ray (Myliobatis tenuicaudatus)	**Jason Thiem** Regional and inter-regional fish movement responses to river discharge
2:00 PM	**Felicity Osborne** Changes in size and distribution of dolphinfish Coryphaena hippurus on the Australian east coast	**Grant Johnson** Assessing sustainability of data deficient bycatch species in a north Australian trawl fishery	**Robert Perryman** Network-based analyses of elasmobranch behaviour	**Dwi Atminarso** Evidence of fish community fragmentation in a tropical river upstream and downstream of a dam despite the presence of a fishway

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
2:15 PM	**Katherine Ollerhead** The impacts of climate change on the physiology of school sharks in Southeast Tasmania	**William Collins** The role of nocturnal fishes on coral reefs: A quantitative functional evaluation	**Laura Solon** An initial description of the peripheral electrosensory and mechanosensory systems of five deep-sea chondrichthyans (Holocephali & Elasmobranchii)	**Kaitlyn O'Mara** Alien invasions: the ecology and movement of tilapia during a new incursion
2:30 PM	**Patricia Koh** Going with the flow (and the heat): Growth of brown trout (Salmo trutta) along thermal and hydrological gradients	**Mark Kennard** There's more to fish than just food: Exploring the diverse ways that fish are useful to society	**Pooventhran Muruga** Forensic odontology: Assessing bite wounds to determine the role of teeth in piscivorous fishes	**Doug Harding** Time to Move? Golden perch and Murray cod movements in the Queensland Murray-Darling Basin
2:45 PM	**Faith Ochwada-Doyle** Monitoring interannual variation in recreational fisheries under the influence of drought, bushfires, floods and a global pandemic	**Reniel Cabral** Have your fish, earn from them, and eat them too	**Flavia Berlinghieri** Does parental predator exposure influence offspring personality and behaviour laterality?	**Laura Michie** Dispersal of early life-history golden perch in the northern Murray-Darling Basin
3:00 PM - 3:30 PM	**AFTERNOON TEA**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
3:30 PM - 4:30 PM	**Session 4.1 - Change**	**Session 4.2 - Community**	**Session 4.3 - Sensory ecology and behaviour**	**Session 4.4 - Connectivity and Movement**
3:30 PM	**Daniela Ceccarelli** Long-term changes in the reef fish communities of the Great Barrier Reef Marine Park	**Genevieve Phillips** The multiple values attained through partially-protected areas	**Gemma Walker** Acute eucalyptus leachate exposure affects the reproductive behaviour and spawning of a native freshwater fish	**Fabrice Jaine** A continental-scale acoustic telemetry network to monitor movements and distributions of Australian aquatic species
3:45 PM	**Christopher Hemingson** Are fish communities on coral reefs becoming less colourful	**Ben Gilby** Using fish assemblages to help improve restoration planning	**Leia Rogers** Effect of fluke metacercariae on Murray cod survival behaviour	**Leanne Currey-Randall** Elucidating broad-scale movements of marine species using a state-wide acoustic telemetry array
4:00 PM	**Elliott Schmidt** Do we see evidence of local thermal adaptation in a coral reef fish?	**Craig Noell** Discovering the potential for increased catches in a prawn trawl fishery with a problematic past	**Brendan Ebner** Field-based behaviour of Lorentz's grunter, Pingalla lorentzi: flee, fight and refuge	**Amy Smoothey** Large-scale movements of a coastal predator
4:15 PM	**Jasmine Cane** The role of transgenerational thermal plasticity on the development of coral reef fish under ocean warming and acidification	**Sushmita Mukherji** In too deep: Challenges of managing a basket of data poor deepwater species	**Wayne Koster** Deep dives, long rides, and sudden endings: the challenges and encounters of anguillid eels during their single life-time spawning quest	**Carley Kilpatrick** Marine reserve use by the migratory coastal shark Carcharias taurus
4:30 PM - 6:30 PM	**POSTER FUNCTION**			

Queensland Government

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TUESDAY 8 NOVEMBER

8:45 AM - 10:30 AM	Session 5			
8:45 AM	**Welcome**			
9:00 AM	**Invited Plenary 2: Marian Wong** Environmental disturbances and their dynamic impacts on the social behaviour of marine and freshwater fishes			
9:30 AM	**Invited Plenary 3: Gavin Butler** Reproductive behaviour of the Murray cod (Maccullochella peelii) in the wild			
10:00 AM	**Q&A**			
10:30 AM	**MORNING TEA**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
11:00 AM - 12:30 PM	**Session 6.1 - Change** Norfolk Room	**Session 6.2 - Connectivity and Movement** Kauri Room	**Session 6.3 - Helping Hands** Phoenix Room	**Session 6.4 - Scales** Monaco II Room
11:00 AM	**Cassandra Peters** Fish Ageing Experts Collective (FASC) and otolith workshop outcomes	**Sofia Gabriel** Fine-scale spatial usage of a coastal beach area by white sharks (Carcharodon carcharias) as estimated by a Hidden Markov Model informed by acoustic array data	**Greg Ringwood** The Basin Plan: Water recovery and Water for the Environment all working for native fish	**Robert Streit** Fine-scale spatial data to validate behavioural traits of iconic reef fishes
11:15 AM	**Sam Lewis** Assessment and applicability of fish otoliths as in-situ monitors of chronic sub-lethal hypoxia	**Nicolas Lubitz** Testing the waters: context-dependence of movement behaviour in marine predators – the bull shark (Carcharhinus leucas) as a model organism	**Nicholas Pawsey** An Analysis of Farmer Intentions to Install Fish-Friendly Irrigation Pump Screens	**Alexandre Siqueira** Rising from the ashes: the biogeographic origins of modern coral reef fishes
11:30 AM	**Angela Russell** Is otolith magnesium a useful tool to support age estimation?	**Hannah Calich** Investigating animal movement and behaviour with statistical physics methods: A primer for ecologists	**John Conallin** Sustaining fisheries within irrigated landscapes - How motivations and abilities of different stakeholders influence the implementation of fish friendly infrastructure	**Sterling Tebbett** The functional roles of surgeonfishes on coral reefs
11:45 AM	**Irwan Jatmiko** Otolith shape as an alternative method to identify small bigeye tuna (Thunnus obesus) and yellowfin tuna (Thunnus albacares)	**Alexia Graba-Landry** Opportunities and impacts of range-extending scalefish species: Understanding population dynamics, ecosystem impacts and management needs	**James Walker** Reintroduction of threatened murray hardyhead to a managed wetland in southwest NSW	**Lucy Goodridge Gaines** Seascape context matters more than habitat condition for fish assemblages in coastal ecosystems
12:00 PM	**Christine Dudgeon** Eastern School Whiting genetic stock structure for cross-jurisdictional management	**Isabelle Ng** Do currents shape global patterns of hybrid richness in coral reef fishes?	**Ivor Stuart** Native fish recovery post environmental water delivery in the lower Darling River 2020-2022	**Joel Williams** Fine-scale bathymetry data explains variability in fish assemblages on mesophotic reefs in the Hunter Marine Park

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
12:15 PM	**Michael Mottley** Detecting the Invasive Jaguar Cichlid in the Pioneer River using a Non-invasive Environmental DNA Approach	**Nils Krueck** How valuable are metrics of population connectivity for area-based marine management?	**Jarod Lyon** Population recovery for key threatened species – an update on Victoria's 'Conservation Hatchery' program	**Shenae Willis** No protection effect isn't all bad news - changes in mesophotic fish assemblages in the Tasman Fracture AMP reflect protection and good fisheries management
12:30 PM - 2:00 PM	**LUNCH & AGM (NORFOLK ROOM)**			
2:00 PM - 3:00 PM	**Session 7.1 - Techniques, technology and tools** SPOTX	**Session 7.2 - Connectivity and Movement**	**Session 7.3 - Helping Hands**	**Session 7.4 - Scales**
2:00 PM	**Gary Jackson** Testing the effectiveness of deterrent devices in reducing shark depredation	**Asia Armstrong** Reef manta ray movement ecology and connectivity along a continental coastline	**Peter Rose** The Mid-Murray Floodplain Recovery Reach: Bringing back the 'Magnificent Six'	**Alyssa Marshell** Ten years of fishery-independent monitoring of Tasmanian sand flathead abundance and population characteristics
2:15 PM	**Jonathan Mitchell** Spot the shark! Using drones to monitor sharks and improve the safety of ocean users at Queensland beaches	**Adam Barnett** Post-release survival of black jewfish Protonibea diacanthus	**Andrew Norris** Medium-term ecological response to river rehabilitation efforts in the Dewfish Demonstration Reach	**Qifeng Ye** Spatio-temporal variations in fish assemblages and environmental drivers in a large temperate estuary in Australia
2:30 PM	**Jason Earl** A drone-based application for assessing abundance of a pelagic fish in shallow coastal water	**Koster Sarakinis** Extreme philopatry in an estuarine-dependent fish	**Anna Garland** A codend of crabs: Fishery-independent monitoring of pre-recruit blue swimmer crabs in Moreton Bay	**Alysha Chan** Spatio-temporal distribution and trophic niche of Australian cownose rays (Rhinoptera neglecta) off eastern Australia
2:45 PM	**Johan Gustafson** Sea Change: Habitat suitability of juvenile scalloped hammerhead sharks (Sphyrna lewini) in Queensland coastal waters, Australia	**Daniel Hewitt** Mesoscale oceanographic features drive divergent patterns in connectivity for co-occuring estuarine portunid crabs	**Nur Un Nesa** Use of dissociated aquaculture to enhance reproduction in redclaw crayfish	**Daniel Yeoh** Determining the spatial distribution and temporal variability of fish and invertebrates in Cockburn Sound
3:00 PM	**AFTERNOON TEA**			
3:30 PM - 5:00 PM	**Session 8.1 - Techniques, technology and tools** SPOTX	**Session 8.2 - Physiology , Cell Processes and Health**	**Session 8.3 - Helping Hands**	**Session 8.4 - Scales**
3:30 PM	**Jaeden Vardon** Identifying shark species responsible for fisheries depredation off Queensland Australia	**Jennifer Donelson** The influenced of food availability on the capacity for thermal plasticity in a coral reef fish	**Lauren Stoot** Environmental variables that influence distribution and movement of blue salmon catfish Neoarius graeffei in a coastal river catchment in northern NSW Australia	**Christopher Henderson** Anthropogenic disturbance shapes functional diversity and ecosystem functioning in coastal ecosystems

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
3:45 PM	**Stefan Sawynok** Hydroacoustic survey methods for assessing aquatic habitat and fish biomass and behaviour	**Alice Harford** Mitochondrial scope? A novel approach to assessing the interactive effects of thermal stress and oxygen limitation on mitochondrial performance in banded wrasse (Notolabrus fucicola) heart	**Belinda Goddard** Connectivity of south-eastern Australian yellowtail kingfish (Seriola lalandi) informed by the world's longest-lived, citizen-science saltwater tagging program	**Abigail Campbell** Assessing fisheries interactions population demographics and residency of the protected oceanic whitetip shark carcharhinus longimanus through citizen science and photo identification
4:00 PM	**Leo Cameron** Establishment and biology of barred grunter (Amniataba percoides) beyond their natural range in the Clarence River, Australia	**Adrienne Gooden** Does the increase in shark activity during wildlife tourism lead to higher energy expenditure	**Veronika Biskis** Sawfish spotters fill data gaps critical for sawfish protections in Queensland, Australia	**Amy Tims** Population genetics of Tablelands rainbowfishes
4:15 PM	**Zoe Ross** Chronic hypoxia in the Murray-Darling basin: Can fish acclimate through physiological and behavioural plasticity?	**Oliver Jewell** Consistent circadian rhythms across populations and life stages of a globally-distributed marine predator	**Paolo Panizzon** Effect of the environment on the development of laterality and personality in the Three-spined Sticklebacks	**Alison King** A Tale of Two Sities [sic]: Long-term Patterns of Fish Communities at Lindsay-Mulcra-Wallpolla and Hattah Lakes, Lower Murray River
4:30 PM	**Michelle VanCompernolle** A global threat index for marine megafauna (TIMM)	**Victoria Camilieri-Asch** Cartilage under pressure: what can we learn from deep-sea chondrichthyans?	**Nina Wootton** Microplastic in oysters: A review of global trends and comparison to southern Australia	**Megan Porter** Assessing stock structure and environmental influence on a popular sciaenid using parasites as biological tags
4:45 PM		**Barbara Nuic Vidigal** Acute hypoxia combined with high temperatures significantly reduces Atlantic salmon aerobic scope	**Matt Rees** Multiple human stressors impact an endangered seagrass population and alter fish communities	**Nathan Ning** A comparison of the effectiveness of three fishway designs for use in a large tropical river system
7:00 PM - 11:00 PM	**STUDENT NIGHT - BROADBEACH SURF CLUB**			

infofish SURVEYS

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ABOUT US

Infofish Australia first partnered with Biosonics Inc in Seattle to conduct Biomass Surveys in Impoundments in 2017. Since that time Infofish has covered more than 450,000 acres in over 50 locations for Local and International Clients, working closely with Humminbird and Garmin to deliver the most comprehensive and cost effective Surveys using echosounders.

Biomass

Fish Biomass Surveys via Biosonics 200kHz Scientific Transducers. Garmin Live technology used for high detail validation.

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Habitat and Riparian Surveys via Humminbird Sidescan and Digital Camera still imagery or 4k video.

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- Fish mapped out individually for GPS location, Length/Weight and position in the water column.
- Up to two vessels available for combined high detailed surveys that incorporate species id.

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FISH BIOMASS
BEHAVIOUR, AND
HABITAT PREFERENCES

WEDNESDAY 9 NOVEMBER

8:45 AM - 10:30 AM	Session 9			
8:45 AM	**Welcome**			
9:00 AM	**Invited Plenary 4: Katherine Cheshire** Charting recovery during extreme and uncertain times - the role of science, leadership and a diversity of voices			
9:30 AM	**Invited Plenary 5: Michael Hammer** Taxonomy as the foundation and synapses for fish biology			
10:00 AM	**Q&A**			
10:30 AM - 11:00 AM	**MORNING TEA**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
11:00 AM - 12:30 PM	**Session 10.1 - Techniques, technology and tools**	**Session 10.2 - Physiology , Cell Processes and Health**	**Session 10.3 - Helping Hands**	**Session 10.4 - Species and Population**
11:00 AM	**Patrick Reis-Santos** Reading the biomineralized book of life: Expanding otolith chemical research and applications for fisheries and ecosystem-based management	**Shokoofeh Shamsi** The doors are closed, but the windows are open: Fish parasites bypassing Australia's biosecurity measures	**Tom Rayner** Getting modern fish-protection screens in rivers: principles for effective stakeholder engagement	**Gretchen Grammer** How precise are estimates of spawning area and spawning biomass of sardine off southern Australia?
11:15 AM	**Matthew McGee** Whole genome sequencing can transform Australian fish biology	**Patrick McSweeney** How much screen time is too much for baby golden perch?	**Craig Boys** Nineteen year study into the ecological succession of an estuarine wetland following the staged opening of floodgates	**Bailee Woolley** Life history of the vulnerable Melbourne skate to inform fisheries management and conservation
11:30 AM	**Maggie Watson** Using DNA barcoding to identify undersampled and threatened alpine freshwater crayfish species	**Raf Freire** Neophobic behavioural responses of parasitised fish to a potential predator and baited hook	**Joachim Bretzel** Performance of a fish protection screen at a gravity-fed irrigation diversion	**Erica Durante** The first age data for the commercial octopus species, Octopus berrima
11:45 AM	**Madeline Green** Using environmental DNA to reconstruct target and by-product catch composition for fisheries vessels	**Nathan Miles** Heating up cold-water fish to improve fishery outcomes in the NSW trout fishery	**Geoffrey Collins** Fish passage in the Australian tropics	**Lenore Litherland** Queensland's commercial shark catch: monitoring insights and catch characteristics
12:00 PM	**Sharon Appleyard** Big fish, small fish, no fish; when size (and quality) matters for genetic species identifications of fishes?	**Max Mallett** A systematic review of fish health assessment methods to inform research and management	**Iain Suthers** Recent advances to lift fish safely across barriers with Tube Fishways	**Laura Smith** Sailfish science: building collaborations to delineate the global population structure of a migratory pelagic fish
12:15 PM	**Alexander Vaishampayan** Developing an eDNA tool for fish population monitoring in streams	**Di Barton** Parasites of larval & juvenile freshwater fish of the Murray Darling Basin	**Michael Hutchison** Susceptibility of fish to entrainment through different irrigation infrastructure in the Fitzroy Basin	**Kate Masci** Carcharhinus tilstoni and Carcharhinus limbatus: An exploration of SNP markers in blacktip shark species in Queensland
12:30 PM - 1:30 PM	**LUNCH & ASFB SUB-COMMITTEE MEETINGS**			

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
1:30 PM- 3:00 PM	**11.1 - Techniques, technology and tools**	**Session 11.2 - Extreme events**	**Session 11.3 - Recreational Fishing**	**Session 11.4 - Community**
1:30 PM	**Shane Griffiths** EASI-Fish – A Flexible Catch-Independent Approach for the Quantitative Assessment of the Cumulative Impacts of Fisheries on Bycatch in Data-Limited Settings	**Jason Hartog** Forecasts of marine heatwaves for marine industries: reducing risk, building resilience and enhancing management responses	**Keynote: Andy Moore** Keynote: The National Recreational Fishing survey: a new way forward	**Joshua Dennis** Going beyond the effects of wildlife tourism on target species: does white shark cage-diving change the spatiotemporal distribution of silver trevally (Pseudocaranx georgianus)
1:45 PM	**Leslie Roberson** Leveraging fishers' bycatch avoidance skills to reduce impacts on elasmobranchs in industrial longline fisheries	**Helen Yan** The persistence of a key coral reef ecosystem function in a post-bleached world	**Justin Bell** Utilisation of creel surveys, boat ramp cameras and recruitment monitoring to inform the development of a harvest strategy for the Victorian recreational snapper fishery	**Thiago Fiuza** Effects of phylogeny and co-occurrence on the colour divergence of coral reef fishes
2:00 PM	**Casey Bowden** A 3D perspective on sediment turnover and feeding selectivity in blennies	**David Booth** Weedy (common) sea dragon strandings in Sydney in April 2022: causes and population impacts	**Peta Schofield** Diving into digital data collection: the Fish MoDE app story	**Tiffany Sih** Marine life and fisheries associated with offshore oil and gas structures in southeastern Australia and possible consequences for decommissioning
2:15 PM	**Neil Loneragan** Using conceptual models to build ecosystem understanding of an exploited embayment in Western Australia	**Jessica Randall** The acute and legacy impacts of marine heatwaves on fish growth in the Pacific Ocean	**Alexia Graba-Landry** The impact of management changes on the recreational fishery for Sand Flathead in Tasmania	**Mischa Turschwell** Spatially structured relationships between white banana prawn catch and riverine flow in the Northern Prawn Fishery, Australia
2:30 PM	**Henry Wootton** Predicting basin-scale population responses of Golden Perch to flow management using a stochastic metapopulation modelling approach	**Jason Lieschke** Northeast Victoria bushfire recovery monitoring	**Tonia Sankey** Moving from paper to digital data collection for recreational fishing: the Fisheries Queensland Boat Ramp Survey experience	**Iain Suthers** Reconsidering the impossible: a size-based approach to the recruitment potential of larval fish cohorts
2:45 PM	**Robin Hale** Is my model fit for purpose? Validating a stochastic population model for predicting freshwater fish responses to hydrological scenarios	**Matthew Beitzel** Black Summer Blackfish - rain is not enough	*Session supported by* NSW GOVERNMENT Department of Primary Industries Department of Regional NSW	**Bonnie Holmes** Key research priorities for the future of Australian fish and fisheries research
3:00 PM - 3:30PM	**AFTERNOON TEA**			

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
3:30 PM - 5:15 PM	**Session 12.1 - Techniques, technology and tools**	**Session 12.2 - Extreme events**	**Session 8.3 - Session 12.3 - Recreational Fishing**	**Session 12.4 - Community**
3:30 PM	**Montana Wickens** Model complexity in Moreton Bay bug and saucer scallop stock assessments	**Elka Blackman** Desiccation tolerance of river and floodplain mussels in Australia's Murray-Darling Basin	**Keynote: Karina Ryan** Keynote: Does survey mode matter? Four cases studies comparing fisher demographics and fishing activity from telephone and web-based recreational fishing surveys	**Adam Kerezsy** The luckiest catchment in the mdb: resilience lessons from the paroo
3:45 PM	**Tom Barnes** Forgoing the distance: Assessing the suitability of new model-based multivariate analysis for fisheries science via an NSW ocean prawn trawl elasmobranch bycatch case study	**Luke Carpenter-Bundhoo** Fish in the wallum – a story of drought, fires and aliens	**Keynote: Ashley Fowler** Keynote: Integrating recreational fishing into harvest strategies: what do recreational fishers want and do we have the data to achieve it?	**Samuel Amini** Systematics, hybridisation and biogeography of Mogurnda in the Wet Tropics of Queensland
4:00 PM	**Matthew McMillan** Habitat partitioning and machine learning help map species distributions in an iconic crustacean	**Karen Danaher** Finding water: locating the remaining refuges for fish in Western NSW at the peak of the 2018-2020 drought	**Simon Conron** Facing up to the challenges of assessing Victoria's recreational fisheries	**Michael Raeder** Fishpass Design of the Xayaburi Hydroelectric Power Plant, Laos
4:15 PM	**Alexander Rigg** Diel behaviour change and ontogenetic shifts of vagrant coral reef fish	**Iain Ellis** Menindee fish kill response activities and native fish recovery in the Lower Darling-Baaka	**Manuela Mendiolar** Estimating recreational catch	**Lee Baumgartner** Installing fish detection systems within the Xayaburi Run of River Power Plant
4:30 PM	**Stacy Bierwagen** Enhancing efficiency and robustness for BRUVS monitoring – a spatially balanced approach	**Stuart Little** Three years of the Native Fish Recovery Strategy – what have we achieved and what is to come?	**Barrett Wolfe** Post-release survival of swordfish (Xiphias gladius) in the southeast Australian recreational fishery	**Thanasak Poomchaivej** Developing quality assurance practices for PIT tagging in the Mekong River
4:45 PM	**Susannah Leahy** Multi-method approach to advance provenance determination for stocked fish	**Peter Unmack** No time to lose, throwing caution slightly to the wind if we wish to conserve freshwater fishes	**Jessica Baker** Queensland fisheries interactive dashboards on recreational fishing and economics	**Wayne Anthony Robinson** A pilot study of migrating fish in the Mekong river using acoustic tagging technology in southern Laos PDR
5:00 PM	**Lauren Hawkins** The Australian Fish Chorus Catalogue: a collection of spectrographic and audio fish chorus records	**Mitch Turner** Opportunism and revitalising of purple-spotted gudgeon (Mogurnda adspersa) populations following emergency rescue of an inland population	**Simon Conron** Factors motivating participation and satisfaction of recreational fishers in Port Phillip Bay, Victoria	**Nicolette Duncan** How useful?: A review of three fish-friendly irrigation guidelines written for the Lower Mekong

This session will be followed by networking drinks at Broadbeach Tavern (5:45PM)

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THURSDAY 10 NOVEMBER

8:45 AM - 10:30 AM	**Session 13**			
8:45 AM	**Welcome**			
9:00 AM	**Invited Plenary 6: Charlotte Birkmanis** Sharks and where to find them			
9:30 AM	**Invited Plenary 7: David Schoeman** Tropicalisation and the homogenisation of global marine biodiversity: observations, projections and implications			
10:00 AM	**Q&A**			
10:30 AM	**MORNING TEA**			
11:00 AM - 12:30 PM	**Session 14: The Great Debates** **Great Barrier Reef (Team GBR) v Great Southern Reef (Team GSR) and Northern v Southern Freshwater Fishes**			
12:30 PM	**LUNCH**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
1:30 PM - 3:00 PM	**Session 15.1 - Science Communication**	**Session 15.2 - Community**	**Session 15.3 - Species and Populations**	**Session 15.4 - ASFB Fish Welfare Workshop**
1:30 PM	**Leanne Roulson** Who are you talking to? How to plan for better communication in the sciences	**Stephen Newman** How robust is the indicator species management approach in multi-species (mixed) fisheries, insights from the assessment of a secondary species, the yellowspotted rockcod	**Mark Lintermans** Insights into the ecology of the critically endangered Short-tail galaxias Galaxias brevissimus	**ASFB Fish Welfare Workshop**
1:45 PM		**Hector Lozano-Montes** Building ecosystem understanding of an exploited embayment in Western Australia	**Charles Todd** Conservation management of the threatened Australian lungfish Neoceratodus forsteri using a stochastic population model	
2:00 PM	**Lindsay Marshall** Commissioning Illustration for Science: an introduction	**Jennifer Smith** Spiny lobsters prefer native prey over range-extending invasive urchins	**David Crook** Multi-decadal trends in the relative abundance of large-bodied native fish in the NSW Murray-Darling Basin	
2:15 PM		**Michael Sievers** Fish use of restored mangroves unrelated to habitat maturity	**Sam Williams** Resolving the population biology of black jewfish (Protonibea diacanthus) in North-eastern Australia	
2:30 PM	**Discussion and Q&A**	**Hayden Schilling** Cross-jurisdictional larval supply essential for east Australian spanner crabs	**Julian Hughes** Movement patterns of an iconic recreational fish species, mulloway (Argyrosomus japonicus), revealed by cooperative citizen-science tagging programs in coastal eastern Australia	

	Norfolk Room	Kauri Room	Phoenix Room	Monaco II Room
2:45 PM	**Discussion and Q&A**	**Yuri Niella** Environmental Drivers of Fine-Scale Predator and Prey Spatial Dynamics in Sydney Harbour, Australia, and Adjacent Coastal Waters	**George Giatas** Ontogenetic diet shifts by Murray cod in the lower River Murray	**ASFB Fish Welfare Workshop**
3:00 PM - 3:30PM	**AFTERNOON TEA**			
	Norfolk Room	**Kauri Room**	**Phoenix Room**	**Monaco II Room**
3:30 PM - 5:00 PM	**Free Afternoon**			**ASFB Fish Welfare Workshop**
5:00 PM - 6:00 PM				**ASFB Fish Welfare Sub-Committee Meeting**
7:00 PM - 11:00 PM	**CONFERENCE DINNER - NORFOLK ROOM**			

Scan the QR code to view the full program in the Conference App and schedule your day

CONTENTS

AUTHOR LISTING

ABSTRACTS

1

Fish-n-Chips: supercharging fisheries science with computer vision

Rod Connolly[1]

1. Griffith University, Ashmore, QLD, Australia

The revolutionary use of automation combining computer vision and big data analytics is finally coming in to land in fisheries science! The presentation will explain opportunities and challenges that researchers and managers face in automated monitoring of fish abundance, biomass, and behaviour. Computer vision on robust and inexpensive camera systems can be particularly valuable for increasing efficiency and reliability in monitoring that is currently difficult, dangerous or prohibitively expensive. It can supercharge science. It can improve management – of wild fisheries and aquaculture. Increased automation is helping in stock assessments, and in monitoring to detect trends in the abundance and biomass of fish and benthic animals. Computer vision is also enabling more efficient monitoring of the extent and condition of fish habitat, of the presence of invasive species, and of interactions among species. New analytics are being developed as we move from the traditional scenario of having samples sizes that are often too small to be reliable, to a scenario of having far more data than fits on a hard-drive! So automation is creating new training needs and opportunities. There is a need for mentoring of graduates in statistics, for QA-QC, and for coping with embedded pseudo-replication. And always there is the imperative to sharpen our focus on outputs that inform actions.

2

K Radway Penary - Connections over scales and disciplines to support transformation of marine socioecological systems

Gretta Pecl[1]

1. Centre for Marine Socioecology, University of Tasmania, Hobart, SA, Australia

2. Institute for Marine and Antarctic Studies, Hobart, TAS, Australia

Over the years, the focus of my research has shifted from examining specific biological and ecological processes at various temporal and spatial scales, toward seeking a more integrated and interdisciplinary socio-ecological understanding of natural systems. The questions that inspire and drive me have also changed, becoming broader in nature and more human-focussed. My recent work has a focus on seeking to understand the impacts of climate change, how we can constructively respond to these changes, and on developing evidence-based approaches to communication and engagement with the public, marine industries and communities. Climate change poses a serious threat to marine ecosystems and the industries and human societies that depend on them. However, there is often a fundamental mismatch between the reality of what lies ahead and both the level of public or industry understanding and/or concern, and the committed actions required to adapt to the impacts of climate change. “The ocean we need for the future we want” requires scientists and decision-makers to identify how to facilitate the use of available science and encourage uptake of behaviours and implementation of policies—at individual, local and global scales—that will leverage greater environmental benefit. Ultimately, navigating pathways to sustainable global ocean use and conservation requires a diverse range of actors and stakeholders across a wide range of scales to work together towards a shared purpose. This process needs to be underpinned by mechanisms to support and strengthen society’s stewardship of, and connection to the oceans, and the co-creation of collective visions for our future oceans. This presentation will highlight some of the local, national and international projects and networks I have led or collaborated on with the aim to leverage interdisciplinary knowledge to improve society’s capacity to purposefully shape the direction of marine social-ecological systems over the course of the UN Oceans Decade.

3

ECR Excellence Award Plenary (2021) - Aspects of seafood vulnerability to climate change

Curtis Champion[1]

1. NSW FIsheries, Coffs Harbour, NSW, Australia

Understanding the vulnerability of fished species to climate change is a priority for climate impact and adaptation research that intersects biological, economic and social spheres. Aspects of seafood vulnerability to climate change include shifts in species geographic distributions and alterations to the condition and quality (i.e. nutritional and sensory properties) of fished species. This presentation encompasses research integrating species environmental sensitives with their historical and future exposure to environmental change to assess vulnerability across coastal-pelagic and estuarine systems throughout eastern Australia. These case studies include: 1. climate-driven changes to the distribution and condition of prized coastal-pelagic fishes, and 2. impacts of environmental change on the nutritional and sensory qualities of fished estuarine species. Emerging societal implications associated with the impacts identified include altered access to fished resources, changes to the nutritional benefits that human consumers derive from seafood and shifts in seafood consumer appeal that may affect future harvesting priorities. Working towards assessments of the relativity vulnerability of fished species to climate change is crucial for prioritising the development and implementation of adaptation strategies capable of capitalising on emerging opportunities and minimising adverse impacts.

4

ECR Excellence Award Plenary (2022) - Linking processes to populations to understand the drivers and dynamics of freshwater fish populations in south-eastern Australia

Zeb Tonkin[1], Jarod Lyon[1], Wayne Koster[1], Justin O'Connor[1], Ivor Stuart[1, 2], Charles Todd[1], Jian Yen[1]

1. Arthur Rylah Institute, Department of Environment, Land, Water and Planning, Heidelberg, VIC, Australia

2. Gulbali Institute, Charles Sturt University, Albury, NSW, Australia

The magnitude and rate at which fish populations change is determined by key population processes related to recruitment, mortality and migration. To understand the population dynamics of species, scientists and managers require knowledge of how these processes are influenced by key intrinsic (e.g. growth, spawning, survival, genetic structure, competition and predation) and extrinsic factors (e.g. rainfall, temperature and connectivity). Globally, fisheries science literature has many examples of that relate the drivers of key processes to the dynamics of fish populations. This is particularly relevant for species supporting large commercial fisheries (especially marine). Freshwater fishes however, have far fewer examples which adhere to these principles. For many Australian freshwater fish species, knowledge is often limited to specific aspects of biology or a specific process, with studies which take a holistic approach in considering potential population drivers being rare. This limits our ability to effectively manage fish populations or develop strategies that optimise the ecological benefits of rehabilitation activities such as environmental flow delivery, habitat restoration, or fish stocking. Moreover, a lack of links between process specific research and population dynamics can also lead to doubt by managers and stakeholder groups on the relevance of the research we do. In recent years, researchers have increasingly addressed such shortfalls, culminating in several large monitoring and research programs that capture multiple data types and evaluation approaches. Importantly, these programs have fostered strong collaborations between individual researchers, agencies and waterway managers. This talk presents a variety of examples that draw links from specific investigations of processes and intrinsic factors to the dynamics of populations for several freshwater fish species across south-eastern Australia. Our examples demonstrate how this whole of life-cycle framework is being used by managers to enhance populations of important species such as Murray cod, Macquarie perch and Silver perch.

5

Rapid warming, regional climate and fishing all drive fish growth variation in SE Australian waters

John R Morrongiello[1]

1. University of Melbourne, Parkville, VIC, Australia

South-east Australian waters support both unique biodiversity and major commercial fisheries, but the region and its natural resources are increasingly being exposed to rapid oceanic warming. Here, I present the results of a large-scale project investigating the environmental drivers of fish growth variation using a data set of unprecedented spatial, temporal, and biological coverage. Otolith-based growth time series for over 30 species and stocks, each up to 100 years in length, from across nearly 3000km of coastal SE Australia and a range of habitats were analysed using dynamic factor analysis and generalised additive models. Long-term growth patterns for many species displayed strong temporal synchrony, pointing to universal ecosystem drivers of change. Directional trends in modes of growth variation were indicative of ubiquitous warming impacts (via direct and/or indirect pathways) that either promoted or inhibited growth depending on a species' habitat and distributional range. Quasi decadal oscillations in observed growth rates reemphasised the importance of Zonal Westerly Winds and the Southern Annular Mode in driving regional recruitment and system productivity variation. Overall, growth variation was also sensitive to regional fishing effort. This finding corroborates other work in identifying the larger-scale impacts of fishing on fish assemblages. Together, our work highlights the valuable information stored within otoliths and their potential to provide unprecedented levels of spatial and temporal resolution into the drivers of productivity change in our oceans.

6

Fishing and warming combine to affect expressed size-at-age in commercially fished species

Sarah Willington[1], Stephen Swearer[1], Alan Baudron[2], Ralf van Hal[3], Paul Spencer[4], John Morrongiello[1]

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2. School of Biological Sciences, University of Aberdeen, Aberdeen, UK

3. Wageningen Marine Research, IJmuiden, The Netherlands

4. Alaska Fisheries Science Center, NOAA, Seattle, USA

Selective harvesting, like fishing, can erode size diversity in wild fish populations by truncating population size-structures and homogenising growth rates. Many important population and fishery metrics are influenced by size, including reproduction, recruitment success, stock biomass and mortality regimes. Reductions in trait variation (within the population portfolio) can lead to altered population dynamics, with stocks becoming more synchronous within a region and hence more susceptible to environmental perturbations. Understanding the capacity to which exploited populations can buffer environmental disturbances through portfolio effects is becoming increasingly important due to the impacts of climate change. To test whether fishing and climate warming have eroded trait variation in commercially fished stocks, we analysed time series (up to 55 years) of size-at-age data for 20 species from two large marine ecosystems (LMEs), in relation to life stage (juvenile or adult), fishing pressure and temperature. We measured three different metrics to quantify changes in size-at-age: the mean, maximum and variance in size-at-age. We found clear evidence that size-at-age changed through time in both LMEs and that these temporal changes could be attributed to both temperature and fishing. The magnitude of change was dependent on life stage, with results suggesting that warming waters can result in a reduction in adult body size but that this effect is potentially mitigated by a fishing-induced relaxation of density-dependent controls. Our results provide novel insight into the importance of addressing the synergistic

impacts of fishing and climate on body size. Such knowledge will improve predictions of population vulnerability to disturbance leading to more sustainably managed fisheries, especially in the face of rapid environmental change.

7

Changes in size and distribution of dolphinfish *Coryphaena hippurus* on the Australian east coast

Felicity E Osborne[1], Julian G Pepperell[2], Ross G Dwyer[1], Andrew D Olds[1], Daniel J Smith[3], Samuel M Williams [3, 4], Ben L Gilby[1]

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2. Pepperell Research & Consulting Pty Ltd, Noosaville, QLD , Australia

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4. The University of Queensland, Molecular Fisheries Laboratory, School of Biomedical Sciences, St Lucia, QLD , Australia

Rapid changes in ocean characteristics have caused changes in species geographical range, as marine species are forced to acclimate or shift to more suitable conditions. Dolphinfish *Coryphaena hippurus* are highly migratory coastal-epipelagic species, whose temporal and spatial movements have been linked to changes in water temperature and are an important target for both recreational and commercial fishers. We assessed past and present distributions of dolphinfish by assessing the effects of ocean attributes (like sea surface temperature and primary productivity) on the distribution and movement of dolphinfish over time. Dolphinfish catch data was derived from the NSW DPI Game Fish Tagging Program from 2002-2020. We found that records of dolphinfish captures are changed in non-linear directions over time, being most northerly in 2010; this was possible related to SST. The average size of dolphinfish captured has increased over time, with larger fish typically recorded in locations with higher sea surface temperatures, lower primary productivity, higher velocity current flow and in water depths between 2000 and 3000 m. Understanding how marine species utilise ocean attributes in response to climate change and the implications the effects of climate change have on marine species is vital for the management of current and future fisheries and ocean health.

8

The impacts of climate change on the physiology of school sharks in Southeast Tasmania

Katherine M Ollerhead[1], David A Moreno[1], Tyson J MacCormack[2], Andrea J Morash[3], Jayson M Semmens[1]

1. Institute for Marine and Antarctic Studies, University of Tasmania, Taroona, TAS, Australia

2. Chemistry and Biochemistry, Mount Allison University, Sackville, New Brunswick, Canada

3. Department of Biology, Mount Allison University, Sackville, New Brunswick, Canada

Due to strengthening wind systems that have driven the East Australian Current farther south, Tasmania is a climate change hotspot and is one of the world's fastest warming marine regions. The Pittwater Estuary in the state's southeast is part of a designated shark refuge area and the largest known Australian nursery for the 'critically endangered' school shark (*Galeorhinus galeus*), providing for high survival and growth of neonates before migration into deeper waters. However, the estuary experiences regular acute environmental variations during the summer/autumn period when sharks inhabit the area. This research aims to understand how acute changes in temperature and salinity impact the physiology of neonatal and juvenile school sharks, given that more-frequent extreme weather events are predicted under climate change scenarios. Captive animals were exposed for 48 h to conditions simulating both a hot/dry (22°C and 40‰) and a cold/wet (14°C and 25 ‰ salinity) summer/autumn followed by 24 h recovery. Blood samples were collected every 24 hours and haematocrit, haemoglobin, lactate and glucose, and plasma osmolality were measured. Oxygen consumption was also measured prior to experimentation, after 48 hours of acute exposure, and during recovery. Both simulated acute changes to hot/dry and cold/wet weather conditions elicited a physiological response for both life stages, with neonates generally more tolerant to the changes than juveniles. This suggests that neonates may have specialisations for inhabiting the estuary from birth until migration into deeper waters, which juveniles no longer possess. However, if these extreme events become more regular, as predicted, neonates may not be able to continue to tolerate the highly variable conditions, which may outweigh the benefits provided by the nursery. This could result in under-developed neonates moving into unprotected waters, which could have major implications for early life stage mortality and impact the recovery of this conservation dependant species.

9

Going with the flow (and the heat): Growth of brown trout (*Salmo trutta*) along thermal and hydrological gradients

Patricia Koh[1], John Morrongiello[1], Matt West[1]

1. University of Melbourne, Brunswick, VIC, Australia

Australia's naturally variable environment is projected to become more extreme and unpredictable with human-induced climate change. In south-eastern Australia, declining rainfall and warming temperatures driven by climate change threaten freshwater species. Coldwater fish are particularly vulnerable as changing environmental conditions reduce the amount of suitable habitat and shift their ranges to higher elevations. Understanding how coldwater fish respond to variable environmental conditions is critical for determining the viability of populations in a warmer and drier future. This knowledge is especially important for species that form economically and culturally important recreational fisheries.

We examined how the environment such as fluctuations in temperature and hydrological flow can influence somatic growth in a non-native coldwater species, brown trout (*Salmo trutta*). Otoliths were collected from brown trout across 14 wild populations in

Victoria, encompassing a range of climatic and hydrological conditions. We used these otoliths to create growth biochronologies to model the growth dynamics of trout with temperature and river flow as key variables. We found that there were spatial and temporal differences in growth rates and that these were modulated by hydrology and climatic variables. Our findings indicate that the growth of brown trout is not robust to environmental variation suggesting reduced resistance and resilience to predicted future climate change scenarios.

10

Monitoring interannual variation in recreational fisheries under the influence of drought, bushfires, floods and a global pandemic.

Faith Ochwada-Doyle[1], Nathan Miles[2], Julian Hughes[1], Jeffery Murphy[3], Kate Stark[4], Michael Lowry[5], Laurie West[6], Matt D. Taylor[5]

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4. Institute of Marine & Arctic Studies, University of Tasmania, Hobart, Tasmania, Australia

5. NSW Department of Primary Industries, Taylors Beach, NSW, Australia

6. Kewagama Research, Doonan, Queensland, Australia

As social and ecological systems, recreational fisheries often show temporal variation in response to changes that affect either ecological processes or human behaviour. Using a time-series of recreational fishing data collected in synchrony with a series of extreme climate-related events and the COVID-19 pandemic, we demonstrate the utility of off-site surveys in monitoring the variability in recreational fishing that can co-occur with environmental and societal change. We show how annual freshwater fishing effort, total catch and species-specific catch were successfully estimated across New South Wales, Australia during 2013/14, 2017/18 and 2019/20 and examine these metrics in relation to a severe drought period; the “Black Summer” bushfires; heavy widespread flooding and the spread of COVID-19, which impacted human mobility and travel. Statistically significant variation in recreational effort, overall finfish catch and species-specific catch was detected between 2013/14, the period that preceded these events, and the latter years. This variation is discussed in relation to the ecological shifts and changes in human behaviour induced by the events. Societal and climate-related changes pose ongoing threats to aquatic systems and necessitate adaptive measures to manage both inland and coastal recreational fisheries. This type of targeted monitoring and analyses enable policy makers and scientists to identify problematic trends in recreational fisheries, and guide adaptation. Future studies that include reference locations not subject to extreme weather events or societal disruptions may support inferences about a causal relationship between atypical events and patterns of recreational fishing.

11

Regionalising South Australia’s Marine Scalefish Fishery based on stock boundaries, fishery dynamics and ecosystem structure

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The Marine Scalefish Fishery (MSF) is South Australia’s most complex fishery as it includes multiple species (including finfish, crustacea and molluscs) and multiple gears, and can be accessed by commercial, recreational and first nations fishing sectors. Over the past 30-40 years, both total commercial catch (tonnes) and fishing effort (fisher days) has declined significantly, and several fish stocks have deteriorated, with some key stocks now classified as depleted. The commercial sector has also had declining economic performance during this period with business profitability becoming an issue for many commercial fishers. As a result, the fishery has recently undergone a historic reform funded by the State Government ($24.5 million) that included licence buy-outs, tiered species management, unitisation of four key “Tier 1” stocks (namely snapper, King George whiting, garfish and southern calamari) through individual transferable quotas and the creation of four new fishing zones. The fishery’s regionalisation was a key focus of the reform and four zones of management were created based on the biological stock structures of key species, regional fishery dynamics and ecosystem boundaries. These were 1) the West Coast, 2) Spencer Gulf, 3) Gulf St Vincent/Kangaroo Island, and 4) the South-East. Fishers were consulted extensively during this process and their feedback was considered in the final decisions. While the fishery has been regionalised in terms of access to Tier 1 species, MSF licences retain state-wide access, and fishers can operate in any zone on the proviso that they own the necessary quota for Tier 1 species. Zone boundaries were determined such that the fishing grounds of most individual licence holder were not unnecessarily split between fishing zones. Each of the four zones of management selected also aligned well with the stock structure of key Tier 1 species.

12

Stock assessments on the "other species" in the Reef Line Fishery

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Queensland's Reef Line Fishery operates largely within the Great Barrier Reef Marine Park (GBRMP), extending from the northern tip of Cape York to south of Brisbane. Coral trout is the primary target of this fishery, comprising about 60% of the average annual catch, followed by redthroat emperor. Within the fishery, each licensed commercial fisher is allocated a number of quota units—a percentage of the total allowable commercial catch for coral trout, redthroat emperor and "other species". This "other species" category contains around 100 different species. Three of the most dominant species in this category (saddletail snapper, crimson snapper and red emperor) recently had their east coast stocks assessed for the first time. Several modelling challenges were encountered when assessing these species, including the definition and quantification of targeted effort or incidental catch, and handling significant catch reporting changes around the introduction of individual transferable quota, which coincided with the rezoning of the GBRMP. To understand these issues, we consulted scientists and managers with expertise in the fishery, as well as key fishers who target these species, to develop a suite of modelling scenarios. These modelling challenges culminated in the abundance indices (standardised catch rates) that were input to the model. We included the weight of co-caught species as covariates in the standardisation model, and considered the inclusion of 0 kg catch records. We also explored the effect of separating the catch rates into two standalone time series, before and after the introduction of quota and rezoning of the GBRMP. Ultimately, there was not a "one size fits all" solution across the stock assessments of the three species, but the learnings from each assessment helped to inform the next, which greatly reduced uncertainty by the final assessment.

1. Campbell, A.B., Fox, A.R., Hillcoat, K.B. and Sumpter, L., 2021. Stock assessment of Queensland east coast saddletail snapper (Lutjanus malabaricus), Australia.
2. Fox, A.R., Campbell, A.B., Sumpter, L. and Hillcoat, K.B., 2021. Stock assessment of Queensland east coast crimson snapper (Lutjanus erythropterus), Australia.
3. Sumpter, L.I., Fox, A.R. and Hillcoat, K.B., 2022. Stock assessment of Queensland east coast red emperor (Lutjanus sebae), Australia, with data to June 2021.

13

Assessing sustainability of data deficient bycatch species in a north Australian trawl fishery

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7. College of Science and Engineering, Flinders University, Adelaide, South Australia

Trawl fisheries are often criticised for their indiscriminate nature, catching a broad range of target, bycatch, and byproduct species. In these fisheries, research and management are often directed towards ensuring sustainability of the most economically-important species, with evaluation of the sustainability of byproduct species often considered a lower priority. The Northern Territory Demersal Fishery, the Northern Territory's largest in terms of catch and value, is no exception.

The target species in this fishery, Saddletail (*Lutjanus malabaricus*) and Crimson Snapper (*L. erythropterus*) have robust stock assessments, but there remain fundamental gaps in our knowledge of catch rates, biology, and stock connectivity for the over 200 bycatch species. These knowledge gaps preclude the use of traditional stock assessments, but the risk this growing fishery poses to the bycatch species it interacts with needs to be assessed to meet the fisheries' obligations to implement ecosystem-based fisheries management.

Contemporary risk assessment approaches such as Sustainability Assessment for Fishing Effects (SAFE) offer a way forward. This data poor risk assessment technique allows the fishing impact of a large number of bycatch species to be relatively quickly assessed. In this project, we used the Northern Territory Demersal Fishery as an example of how SAFE can be used to assess the sustainability of the large number of diverse bycatch species this fishery interacts with. Results suggest that risk to bycatch species in this fishery is currently low, although some elasmobranch species maybe approaching medium risk thresholds and as the fishery grows the impact on these species will need to be carefully monitored. To mitigate this impact we suggest that these species should be prioritised for future research, enabling higher levels of stock assessment, so that there is greater certainty that catches of these species remain sustainable into the future.

14

The role of nocturnal fishes on coral reefs: A quantitative functional evaluation

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4. Branco Weiss Fellow École Pratique des Hautes Études Université Paris Sciences et Lettres, Perpignan, France

The ecological functions of nocturnal coral reef fishes are poorly known. Yet, nocturnal resources for coral reef consumers are theoretically as abundant and productive, if not more so, than their diurnal counterparts. In this study, we quantify and contrast the energetic dynamics of nocturnal and diurnal fishes in a model coral reef ecosystem, evaluating whether they attain similar levels of biomass production. We integrated a detailed dataset of coral reef fish counts, comprising diurnal and nocturnal species, in sites sheltered and exposed to wave action. We combined somatic growth and mortality models to estimate rates of consumer biomass production, a key ecosystem function. We found that diurnal fish assemblages have a higher biomass than nocturnal

fishes: 104% more in sheltered sites and 271% more in exposed sites. Differences in productivity were even more pronounced, with diurnal fishes contributing 163% more productivity in sheltered locations, and 558% more in exposed locations. Cardinalfishes (f: Apogonidae) dominated biomass production within the nocturnal fish assemblage, comprising 54% of total nocturnal fish productivity, which is proportionally more than any diurnal fish family. The substantially lower contributions of nocturnal fishes to biomass and biomass production likely indicates constraints on resource accessibility. However, taxa that are able to overcome these constraints may thrive, as evidenced by apogonids. This study highlights the importance of nocturnal fishes in underpinning the flow of energy and nutrients from nocturnal resources to reef communities; a process driven mainly by small, cryptic fishes.

15

There's more to fish than just food: Exploring the diverse ways that fish are useful to society

Mark Kennard[1], J Vitule[2], J Cucherousset[3], J Olden[1, 4]

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2. Departamento de Engenharia Ambiental, Universidade Federal do Paraná, Curitiba Paraná, Brazil

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4. School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington, USA

Fish are one of the most biodiverse vertebrate groups on the planet, playing important roles in ecosystems, supporting considerable commercial and recreational fishing industries, and providing a major source of protein and nutrients for much of the world's human population. The multiple intrinsic, ecological, socioeconomic and cultural values of fish are relatively well-recognised. Indeed, most people rarely think about fish other than as pets, a recreational prize, a basis for inspiration or worship, or as a source of protein or income. Much less appreciated are the diverse additional ways that fish have contributed to human societies over multiple millennia. This paper explores the many uses of freshwater and marine fishes, focusing on their contributions to manufacturing and industry, technology, health and sexuality, tools and weapons, apparel and jewelry, musical instruments, and as curios, souvenirs and attractions. The examples presented in this paper demonstrate that the relationship between humans and fish is much more than food, and the different ways people use fish continues to grow rapidly, posing new questions and challenges. Rising concern about environmental sustainability related to overfishing and intensive aquaculture production has prompted increased interest in reducing waste and maximizing use of by-products of the fishing industry – this is leading to novel and creative uses of fish. We hope that increasing awareness of the ways in which fish are used by our societies will help to promote the conservation, sustainable management and ethical treatment of fish now and into the future.

16

Have your fish, earn from them, and eat them too

Reniel B Cabral[1]

1. James Cook University, Townsville, QUEENSLAND, Australia

Discourse about marine protected areas (MPAs) typically centers around fisheries and biodiversity but rarely considers tourism. This is surprising given that marine and coastal tourism contributes four times the value of fisheries to the global ocean economy. Here, I will demonstrate the potential of placing dive sites in MPA to simultaneously generate ecological and economic benefits, while also improving the tourism experience. By developing a fully parameterized bioeconomic model, I will show that placing all the dive sites in MPAs yields large ecological and economic benefits.

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King Neptune: influence of shark tourism on the behaviour and physiology of yellowtail kingfish *Seriola lalandi* at the Neptune Islands

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Marine wildlife tourism is increasing in popularity, with operations targeting a wide range of taxa globally. While previous studies have mostly focused on assessing the effects of provisioning from tourism on focal species, non-focal species that unintentionally feed on supplemental food sources are often overlooked. We used acoustic tracking to determine the effects of shark cage-diving tourism on the behaviours (residency, space use) and physiology (activity, body condition) of 18 yellowtail kingfish (*Seriola lalandi*) around a cage-diving site at the Neptune Islands, South Australia. We revealed that cage-diving did not affect the overall or weekly residency and space use of kingfish, although daily time spent at the islands and location of kingfish was influenced by the presence of operators. Acoustic attractant did not affect kingfish behaviours, but time spent at the site increased by ~27% (from 230.6 ± 6.8 to 293.8 ± 5.5 min) when food-based provisioning occurred. Kingfish were also observed closer to operators using food-based attractants (217 ± 4.82 m from vessel) compared to an acoustic attractant (412 ± 29.5 m). Kingfish activity (m/s^2) was raised by 18% when operators using food-based attractants were present compared to days without provisioning, with burst-swimming events increasing by 60%. Despite increased activity and burst events, the physiological condition of kingfish (measured using bioelectrical impedance analysis) at the tourism site remained consistent with kingfish from a control site not exposed to tourism (n = 113). These findings highlight that the effects of wildlife tourism provisioning can extend beyond changes in focus species and can influence the movements and energetic condition of non-focal animals through increased activity. However, supplemental food or changes in natural foraging may be sufficient to compensate for the increased energy expenditure and lessen the effects of tourism on individual fitness and health.

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First insight into the fine-scale swimming and diving behaviour of the southern eagle ray (*Myliobatis tenuicaudatus*)

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Advances in biologging technology have enabled researchers to monitor the fine-scale movements and behaviour of numerous elasmobranchs (sharks, skates and rays), improving our understanding of how these animals behave and the biomechanics associated with specific behaviours. With this said, there is very little information detailing the fine-scale behaviour of Batoids through the use of biologgers. In this study, we attached a multi-sensor biologging package to southern eagle rays (*Myliobatis tenuicaudatus*) in southeast Tasmania to investigate their fine-scale swimming and diving behaviour. A total of 12 eagle rays (892 ± 141 mm; mean and ± SD) were successfully tagged with a biologging package in 2014 (*n*=4) and 2020 (*n*=8), recording over 952 h of triaxial acceleration, depth and temperature data and >7 h of video footage. When not stationary on the benthos, eagle rays oscillated through the water column similar to pelagic sharks, descending and ascending at relatively shallow angles (-5.53 ± 4.45° and 9.42 ± 6.33° respectively) and occasionally making dives to depths >38 m. Gliding behaviour (the cessation of wingbeats) was also observed during the descent phase of most dives. This oscillating behaviour is likely a combination of searching for prey and/or predator avoidance, and an energy efficient mode of transport that utilises gliding during descent to reduce the cost of locomotion. This study is the first to describe the swimming and diving behaviour of the southern eagle ray, highlighting that this species is not confined to the benthos and regularly makes vertical oscillations through the water column.

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Network-based analyses of elasmobranch behaviour

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Knowledge of spatial ecology is vital for the conservation of wide-ranging marine species. Network-based analyses of movements and social interactions are increasingly used to provide biologically realistic, quantitative descriptions of the behaviour of individuals, groups and populations. In the marine environment, the most practical and economical method for simultaneous tracking of large numbers of individuals is passive acoustic telemetry (PAT), which records the presence of individuals at aggregation sites. We discuss different methods for network-based analysis of PAT data, and demonstrate application of these to a range of phylogenetically and behaviourally distinct elasmobranch species.

We compare the prevalence and longevity of interactions, and dynamics of co-occurrence patterns in whale sharks *(Rhincodon typus)* and white sharks *(Carcharodon carcharias)*. We test the extent to which the structure of associations between sharks depends on passive aggregation (due to environmental factors), versus active social grouping, by randomization of movement tracks within individuals at a range of temporal scales.

We employ a different method using Bayesian inference to study the social dynamics of reef manta rays (*Mobula alfredi*). Here we found that social affiliations were assorted into spatially-defined communities that remained stable over time periods of weeks to months. Inter-individual variability in detection profiles was correlated with social network metrics, suggesting that certain individuals, groups and locations are likely to be important to the integrity of social networks.

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An initial description of the peripheral electrosensory and mechanosensory systems of five deep-sea chondrichthyans (Holocephali & Elasmobranchii)

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Cartilaginous fish rely on an array of sensory modalities for feeding, breeding and predator avoidance. Electroreception and mechanoreception are two non-visual senses mainly used for orientation and feeding at close range. Such modalities may become more important for survival in deep-sea environments, where sunlight is absent and food sources are scarce. Yet, the ampullary and lateral line systems have been described in very few deep-sea species to date, hindering our understanding of their ecological and evolutionary adaptations compared to shallower counterparts. This study aims to describe the histo-morphological organisation of these two sensory modalities in five 'deep-sea' chondrichthyans (three sharks, two chimaeras).

Pore distribution and abundance were assessed via digital mapping of the two sensory pore types and their corresponding canals. DiceCT imaging was used to increase mapping accuracy for both systems, especially to confirm size and position of ampullary clusters and the extent and orientation of canals. Pore sizes were measured from a random subset of ampullary pores per cluster and mechanosensory pores using light microscopy. Ampullary canal length was estimated using the average distance between pores and the corresponding cluster's centre on the resulting map. The anatomical and cellular organisation of peripheral sensory

organs were determined using histology. Preliminary results indicate interesting differences from previous literature and could suggest a combination of both shark and ray histo-morphological traits for the pore, canal and cluster morphometrics observed in the chimaera study species.

This study is the first to characterise both the electro- and mechanosensory systems in several deep-sea chondrichthyans from two subclasses, using a range of techniques including bioimaging, macro- and micro-morphology, and histology. Such knowledge will increase our understanding of the sensory ecology of these lesser-known species, and has the potential to discover new morphological aspects for these sensory modalities, which may shed light on key evolutionary adaptations.

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Forensic odontology: Assessing bite wounds to determine the role of teeth in piscivorous fishes

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Teeth facilitate the acquisition and processing of food in most vertebrates. However, relatively little is known about the functions of the diverse tooth morphologies observed in fishes. Piscivorous fishes (fish-eating fish) are crucial in shaping community structure and rely on their oral teeth to capture and/or process prey. However, how teeth are utilised in capturing and/or processing prey remains unclear. Most studies have determined the function of teeth by assessing morphological traits. The behaviour during feeding however, is seldom quantified. Here, we describe the function of teeth within piscivorous fishes by considering how morphological and behavioural traits interact during prey capture and processing. This was achieved through aquarium-based performance experiments, where prey fish were fed to 12 species of piscivorous fishes. Building on techniques in forensic odontology, we incorporate a novel approach to quantify and categorise bite damage on prey fish that were extracted from piscivore stomachs immediately after being ingested. We then assess the significance of morphological and behavioural traits in determining the extent and severity of damage inflicted on prey fish. Results show that engulfing piscivores capture their prey whole and head-first. Grabbing piscivores capture prey tail-first using their teeth, process them using multiple headshakes and bites, before spitting them out, and then re-capturing prey head-first for ingestion. Prey from engulfers sustained minimal damage, whereas prey from grabbers sustained significant damage to the epaxial musculature. Within grabbers, headshakes were significantly associated with more severe damage categories. Headshaking behaviour damages the locomotive muscles of prey, presumably to prevent escape. Compared to non-pharyngognaths, pharyngognath piscivores inflict significantly greater damage to prey. Overall, when present, oral jaw teeth appear to be crucial for both prey capture and processing (immobilisation) in piscivorous fishes.

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Does parental predator exposure influence offspring personality and behaviour laterality?

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Parental influences on offspring phenotype occurring through pathways other than inherited DNA are known as parental effects (i.e. epigenetic modifications). Such effects have been demonstrated to affect two traits that are very widespread and of fundamental importance in the animal kingdom with clear fitness consequences: laterality of brain and behaviour and personality traits. For example, reproducing groups of adult sticklebacks exposed to predation cues produce offspring with decreased antipredator behaviour and reduced activity levels. This study investigated the impacts of parental effects on the development of brain lateralization, personality traits and somatic growth of offspring. Groups of reproducing sticklebacks were treated with a combination of several predator cues or lack thereof during egg production. Soon after laying, eggs were removed and a part of the clutch was reared in standard conditions until 12 weeks post hatching, whereas the other part was used for maternal hormone analyses of steroid in the androgenic and cortisol pathway. Results are currently being analysed. So far we found that offspring from predator-exposed parents were smaller than control offspring likely due to the ecological stressor of the predation consistent with the possibility that these eggs contained elevated levels of corticosteroids. We expect to find that our results support the hypothesis that stickleback parents influence the development of lateralized behaviour, personality traits and growth of their offspring via eggs to match their future environment.

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Fish Passage in streams of the Gulf of Carpentaria, unique life histories driven by highly variable flow regimes

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Throughout streams of the Gulf of Carpentaria (GOC) the passage of migratory fish is critical to the ongoing maintenance of fish populations. The highly irregular nature of flows within these systems creates a diverse range of permanent and intermittent fish habitats. Fish populations need free movement within and between these habitats, with adults needing to reach suitable spawning habitats, often in the sea, and juveniles needing to disperse into nursery habitats to grow or to recolonise previously dry habitats.

The construction of several fishways on tidal barriers and fish community sampling within streams of the GOC has provided an opportunity to examine the migratory behaviour of many species that have previously been poorly studied. Results from fishway sampling has demonstrated that a wide range of species previously thought to be non-migratory are undertaking migrations within these systems, often as both juveniles and adults. While fish community sampling has pinpointed specific life histories adapted to the wet/dry conditions within the catchment. These results link the diverse flow regimes of these intermittent streams to the migration requirements of the local fish communities and highlights the highly important role fish passage maintenance/remediation at barriers plays to maintaining fish communities in these systems.

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Regional and inter-regional fish movement responses to river discharge

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Movement of freshwater fish throughout the environment is essential for population persistence and is fundamentally linked to river hydrology. In this study we collated fish movement data comprising a time series spanning several decades from existing i) telemetry, and ii) otolith datasets, to analyse regional (>5 km) and inter-regional (>100 km) fish movements in relation to river discharge in the Australia's Murray-Darling Basin. Data were compiled for two native freshwater fish species, with a combined sample size of 2696 individual tagged golden perch (*Macquaria ambigua*) and Murray cod (*Maccullochella peelii*), and a separate sample of 1126 individual otoliths. Telemetry data indicated that event-based river discharge metrics had a significant positive effect on the probability of regional movement of both species, although the effect size was substantially smaller for Murray cod. Analysis revealed that every 1-unit increase in standardised discharge was associated with a 4.86-fold increase in the odds of golden perch moving compared with a 1.44-fold increase for Murray cod. Similarly, otolith data revealed that river discharge had a significant positive effect on inter-regional movement (emigration/immigration) for both species. This effect was greater for golden perch than Murray cod and was mediated by fish age and location. While our sample size was limited for Murray cod, analysis of golden perch data revealed that every 1-unit increase in standardised discharge was associated with a 2.6-fold increase in the odds of emigration occurring. Our results demonstrate the value of integrating multiple datasets to broaden the spatial and temporal application and relevance of flow-movement relationships. In the context of managing water for the environment, we used the flow-movement relationships generated from the current study to predict regional and inter-regional movement under a range of flow scenarios to demonstrate the utility of this approach.

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Evidence of fish community fragmentation in a tropical river upstream and downstream of a dam despite the presence of a fishway

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Rapid human population growth has increased demand for water supply, food security, electricity, and flood mitigation worldwide. To address these challenges, governments have invested heavily in the expansion of water infrastructure. However, there is substantial evidence that globally, this infrastructure impacts aquatic ecosystems and can have a significant impact on the persistence of migratory fish species. Despite being well understood globally, the impacts of dams on migratory fish have been given scant attention in Indonesia. Thus, considerations for fish are rarely included in river development planning frameworks. To document the impact of riverine barriers on Indonesian freshwater fish, we surveyed multiple sites, using three different gears (gillnets, castnets, and bait traps), upstream and downstream of Perjaya Weir in the Komering River. The study revealed 13 of 36 species were found only downstream of the weir and five of 36 species were found only above the weir. The local extirpation of many species from upstream areas suggests that the Perjaya Weir hinders fish migration. Despite containing a fishway, the results indicate that fish are not successfully recolonizing upstream reaches.

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Alien invasions: the ecology and movement of tilapia during a new incursion

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Tilapia are a tropical freshwater fish from the Cichlidae family, native to Africa and the southwestern Middle East. In Queensland, Australia, many eastern draining catchments have been invaded by Mozambique and spotted tilapia. Recently, an incursion of these species was detected in the western draining Mitchell River catchment. Ecological impacts of invasion are not well documented despite the potential for tilapia to negatively impact ecosystems. We studied the spread, population establishment, movement ecology, and habitat and diet preferences of the tilapia in the Mitchell catchment to better understand the ecology of new invasions. To do this we employed a combination of electrofishing surveys, habitat assessments, strontium isotope analysis of otoliths, stomach contents analysis, and stable isotope analysis of tilapia and common native fish. We found that tilapia were present only in one area of the upper catchment with fish found in three distinct locations in the area (two of which were weirs). These locations were rich in macrophytes and had deeper pools. A habitat similarity assessment identified off-channel habitats on the floodplain as high-risk areas for spread and further population establishment. The preference for macrophyte-rich areas is reflective of the herbivorous diet of tilapia, with plant material found to be the dominant food in the study region. Stable isotopes of common native fish showed that food webs in weirs were more similar to those in off-channel habitats than river channels, suggesting that off-channel habitats could support tilapia dietary requirements. Strontium isotopes of tilapia otoliths showed that movement varied between the three locations, with evidence of dispersal to one of the locations from both of the other locations. Overall, the key finding of active dispersal to ideal habitat for rapid population growth provides important insight that can be used to inform monitoring and control strategies.

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Time to Move? Golden perch and Murray cod movements in the Queensland Murray-Darling Basin

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Migration for spawning or dispersal is common among freshwater fishes. Migration is often integrally linked to environmental factors such as water temperature and flow regime. Water infrastructure such as dams and weirs can alter flows and impact migration opportunities for many species. We used acoustic telemetry and flow records to inform migratory movements and barrier passage for two iconic fish species of the Murray-Darling Basin (MDB): golden perch (*Macquaria ambigua*) and Murray cod (*Maccullochella peelii*). Over a four year period we tagged 264 golden perch and 40 Murray cod, and tracked their movements using 62 acoustic receivers installed along 850 km of the Condamine-Balonne Rivers in the Queensland MDB. Between May 2018 and July 2022 over 11.9 million detections had been recorded on the array. A total of 22% of golden perch and 65% of Murray cod migrated from their 'home pool' in both upstream and downstream directions. Analyses revealed the maximum distance moved on any one flow event for golden perch was 68 km and for Murray cod 80 km. The average movement distance for golden perch was 3.52 km and for Murray cod was 3.21 km. The mean daily flow for golden perch movement was 34.92 m^3s^{-1} and for Murray cod was 39.82 m^3s^{-1}. Golden perch movements were more frequent between October and May, coinciding with increased river discharge. Murray cod movements, however, were equally likely throughout the year. Although the weirs within the study area 'drowned out' on some flows, theoretically enabling unhindered fish passage, only a small number of individuals passed the weirs. Our approach of using a long-term movement study, across extensive river reaches has provided detailed life history flow information and highlighted the impact of instream barriers for these species. The outcomes of this project will inform water planning in the Queensland MDB.

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Dispersal of early life-history golden perch in the northern Murray-Darling Basin.

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Dispersal of fish, whether active or passive, plays an important role in driving species distributions, supporting successful recruitment and promoting gene flow and genetic diversity between sub-populations. In this study we sampled larval and young-of-year (YOY) golden perch over ~1800 km in the Barwon-Darling River, the Lower Darling Baaka River (LDBR), the Menindee Lakes system and three northern tributary inputs to the Barwon-Darling (the Moonie, Culgoa and Warrego Rivers) to identify patterns of movement and quantify spatial distances travelled by early life-history golden perch in the region. The natal origins of YOY golden perch captured in the Menindee lakes and LDBR could be classified to three distinct upstream regions based on strontium isotope ratios ($^{87}Sr/^{86}Sr$) measured at the otolith core. The majority (56%) had performed no significant dispersal having been spawned in the Darling River in the immediate upstream vicinity of the Menindee Lakes. The remaining fish had dispersed longer distances, having originated from upstream stretches of the Barwon-Darling mainstem and its tributaries, with 5 individuals (3.4%) having dispersed >1600 km from their natal region. Using genetic analysis of the kinship relationships (siblings) between

YOY and larval golden perch, individuals captured in the Menindee Lakes and the LDBR (Spring 2020) were able to be linked to larval cohorts captured in March 2020 in the Moonie, Culgoa, Warrego, Barwon and Darling Rivers. Our results demonstrate vast connectivity between sub-catchments of the northern Murray-Darling Basin and highlight the complexity of golden perch early life-history dispersal. Developing our understanding of dispersal strategies in fish, and the factors that may impact these processes such as hydraulic and geomorphic diversity within river systems, is an essential step towards effectively implementing coordinated management strategies for their protection over appropriate spatial scales.

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Long-term changes in the reef fish communities of the Great Barrier Reef Marine Park

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Estimated at over 1,600 species, the GBR's reef fish community is diverse, productive, relatively intact and of immeasurable value to the functioning of the ecosystem and to the nutrition and enjoyment of Australian people. The AIMS LTMP has monitored these fish communities for 30 years across the entire latitudinal and cross-shelf span of the GBR, on representative reefs of both fished (blue) and no-take (green) zones. Over this time period, reefs in different shelf positions (inshore, midshelf and offshore) have shown distinctive temporal dynamics in overall fish abundance and species richness. The largest influence on fish assemblages have been disturbance events, while fishing impacts are restricted to a few primary (*Plectropomus* and *Variola* spp.) and secondary (e.g. *Lutjanus* spp. and *Lethrinus* spp.) target species. These species have benefited from no-take zones in that both their abundance and biomass are higher than in fished zones, with increasing evidence of spill-over into blue zones. Fish species composition varies significantly according to shelf position, with different species representing each functional group across the inshore-offshore gradient. Species composition also varies by latitude, but has remained relatively stable in most sectors over the monitoring period. Inshore reefs have a distinctive and less varied species assemblage than midshelf and offshore reefs, but remain productive, with green zones providing adequate protection to target species and acting as a buffer to disturbances. We explore the relationships between the fish community and elements of the benthos, consider the inclusion of novel community metrics, and discuss the consequences of changes to the trophic composition of fishes on the GBR.

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Are fish communities on coral reefs becoming less colourful

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An organism's colouration is often linked to the environment in which it lives. The fishes that inhabit coral reefs are extremely diverse in colouration, but the specific environmental factors that support this extreme diversity remain unclear. Interestingly, much of the aesthetic and intrinsic value humans place on coral reefs (a core ecosystem service they provide) is based on this extreme diversity of colours. However, like many processes on coral reefs, the relationship between colouration and the environment is likely to be impacted by global environmental change. Using a novel community-level measure of fish colouration, as perceived by humans, we explore the potential links between fish community colouration and the environment. We then asked if this relationship is impacted by human-induced environmental disturbances, e.g. mass coral bleaching events, using a community-level dataset spanning 27 years on the Great Barrier Reef. We found that the diversity of colours found within a fish community is directly related to the composition of the local environment. Areas with a higher cover of structurally complex corals contained fish species with more diverse and brighter colourations. Most notably, fish community colouration contracted significantly in the years following the 1998 global coral bleaching event. Fishes with colouration directly appealing to human aesthetics are becoming increasingly rare, with the potential for marked declines in the perceived colour of reef fish communities in the near future. Future reefs may not be the colourful ecosystems we recognize today, representing the loss of a culturally significant ecosystem service.

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Do we see evidence of local thermal adaptation in a coral reef fish?

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Disparate thermal regimes and selective forces across species' distributions can drive local adaptation within populations creating differences in vulnerability to warming oceans. To predict responses to warming oceans across latitudinal gradients, it is necessary to determine underlying population-level thermal performance differences (i.e., local adaptation) via the integration of physiological experiments with genetic sequencing. Local adaptation arises when selective forces overcome the homogenizing influences of gene flow and is therefore most common in species with low dispersal ability and/or high self-recruitment. The coral reef damselfish (*Acanthochromis polyacanthus*) lacks a pelagic larval phase and the ability to easily disperse between reefs yet maintains a large latitudinal range stretching from the Indo-Pacific to the southern Great Barrier Reef; across a (summer) thermal range of ~26°C - 32°C, creating favorable conditions for local adaptation. Within this study, three different populations from the southern (i.e., leading-edge; 27°C summer average temperature) and middle (i.e., core; 28.5°C summer average temperature) regions of *A. polyacanthus*'*s* range on the Great Barrier Reef were collected and sampled to create population based thermal performance curves. Population based thermal performance curves were created for aerobic physiology (i.e., standard metabolic

rate, maximum metabolic rate, net aerobic scope) and cellular enzymatic (i.e., lactate dehydrogenase) metrics, in addition to inter- and intra-regional population comparisons in immunity metrics. Data from these experiments were integrated with genetic sequencing data from each sampled population to provide a comprehensive understanding of local adaptation and the underlying thermal landscape across the species' distribution.

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The role of transgenerational thermal plasticity on the development of coral reef fish under ocean warming and acidification

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Coral reefs are being increasingly exposed to multiple environmental stressors including ocean warming and acidification. From previous single and multi-stressor studies we know that in general warming negatively effects a broader range of traits (e.g. physiology, growth, behaviour) than elevated CO_2, which largely influences behavioural traits. When exposed to both environmental stressors simultaneously within a single generation, a negative relationship was found between a performance trait associated with elevated temperature, and another predominantly associated with CO_2 for the coral reef damselfish (*Acanthochromis polyacanthus*). However, with projected climate change most coral reefs will experience warming well before acidification and this earlier experience of warming may allow thermal plasticity to occur. In this study, two generations of *A. polyacanthus* were exposed to either present-day control (+0°C) or elevated temperature (+1.5°C) at various life stages, allowing for both development and transgenerational plasticity to occur. Using the third generation, this study investigated how this thermal plasticity in previous generations influences the sensitivity of the current generation to the same elevated temperature (+1.5°C) and CO_2 (825 ppm) both independently and combined. After developing in these environmental conditions for 16 weeks, aerobic physiology (resting metabolic rate, maximum metabolic rate, and net aerobic scope), behaviour (activity and boldness), and growth (length, weight, and condition) of juveniles was measured and the relationship between these performance traits explored.

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The multiple values attained through partially-protected areas

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Preserving areas of natural habitat and reducing destructive activities within the ocean is important to protect the world's biodiversity. No-take MPAs are aimed at limiting a reduction in biodiversity in the oceans, act as a valuable scientific reference area, and can provide sources of productivity to wild fisheries, thereby increasing social and economic benefits to a particular region. However, no-take MPAs can be costly to maintain and negatively impact extractive industries, including fisheries. Consequently, there is growing interest in the benefits associated with partial protection from human activities extractive activities while allowing tourism-based activities like diving, snorkelling, and low-impact fishing.

Worldwide, there is a considerable lack of quantitative evidence on the potential benefits of partially protected areas (PPAs). One of the reasons for this is the lack of consistent terminology and definition of a 'partially protected' MPA, and the wide range of protection levels this phrase covers. This year, "The MPA Guide" was released: a comprehensive document outlining standardised definitions to be used in MPAs worldwide.

This project aims to classify MPAs within Australia according to the clear guidelines within The MPA Guide and investigate the benefits of partially protected MPAs through a systematic literature review. The review will outline the types and forms of partial protection available, and the factors affecting the likelihood of attaining mutually beneficial outcomes for all users.

The project will utilise ecological and sociological datasets, as well as commercial and recreational fisheries data to fully understand the gamut of partial protection in Australia's marine landscape. The project will develop, in consultation with marine resource managers, clear, easy-to-understand advice and information, and a quantitative decision-support tool. These tools will allow resource managers to make informed decisions on implementation of PPAs to manage important marine areas within areas of high natural value in Australia.

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Using fish assemblages to help improve restoration planning

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International agreements increasingly mandate restoration at landscape scales. Restoration actions are expanding for coastal seascapes globally, but planning is challenging because they are comprised of a heterogeneous and highly connected mosaic of ecosystems. This requires that seascape-scale coastal restoration programs prioritise actions both spatially (i.e. which ecosystems to restore, and where?) and temporally (i.e. should ecosystems be restored in a particular sequence?), and to what level of ecosystem condition. We surveyed fish assemblages, and the condition and context of six coastal ecosystems, including

mangroves, seagrass, and oyster reefs, in 13 southeast Queensland estuaries over multiple years and used this data to prioritise restoration. Fishing is a key socio-economic driver of restoration in the region, so the abundance of common harvestable fish is the focus of this prioritisation. Results show that co-restoration of multiple coastal ecosystems has synergistic benefits for fish within this region. We use temporally dynamic spatial models to show that the choice of 'starting' ecosystem/s in restoration programs has implications for subsequent choices. Finally, we show how progressive change in the distribution of ecosystems across seascapes as they are restored proliferates into change in fish abundance. Consideration of both time and space is crucial in optimising the outcomes of seascape-scale restoration for key restoration objectives.

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Discovering the potential for increased catches in a prawn trawl fishery with a problematic past

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The Gulf St Vincent Prawn Fishery (GSVPF) in South Australia has undergone substantial change over its 50-year history. The fishery has endured periods of steady or increasing catches and catch rates, subsequent declines in fishery performance, and complete closures leading to several parliamentary enquiries. In 2014, an effort-based quota system was introduced. Traditionally, total allowable commercial effort (in nights) has been determined according to a decision matrix based on trends in commercial and survey CPUE. Outputs from a newly updated bioeconomic model have informed recent revisions to the harvest strategy and revealed unexpected findings. Despite the problematic history of the fishery, including clear evidence for overfishing in the last century, the model fits indicated that the resource has been lightly fished for some time and the relative biomass has fluctuated at or above 60% of unfished levels with no long-term downward trend. Given these findings, the bioeconomic model was then used to predict the effort and CPUE (commercial and survey) that would on average hold the stock at a conservative target level of 60% unfished biomass levels, with a limit level conservatively set at 40% of unfished levels (and estimated MSY). A relatively low risk strategy consisting of these revised reference levels and maximum number of nights was subsequently adopted resulting in a potential increase in the nights available to be fished. Industry has acknowledged that this strategy will lead to lower average catch rates in the fishery, but the trade-off is that it will result in higher average (although still fluctuating) total catches. Overall, the risk to the stock should still be low because the harvest strategy still requires that effort be quickly reduced if the stock declines.

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In too deep: Challenges of managing a basket of data poor deepwater species

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Sixteen deepwater sharks caught in southeastern Australia are managed as a basket of species group within the Australian Southern and Eastern Scalefish and Shark Fishery (SESSF). Deepwater sharks are known to be highly vulnerable to exploitation with many populations rapidly depleted following intensive fishing and have slow recovery rates that requires ongoing assessment of population status to enable management. Additionally, management for these species is difficult due to the challenge of identifying many deepwater sharks to species level, and a general lack of reliable records of catch due to the high prevalence of unreported discards. Given the low gross value of production of the deepwater shark basket within the fishery, it is unlikely that the quality of available data will improve. As such, robust analytical assessments to provide estimates for total allowable catch are unable to be conducted. This study aims to confront these limitations by assessing these data poor, highly vulnerable, basket of species. We will compare the pitfalls of applying analytical methods in a data-limited context with empirical methods that would produce indicators which are proxies of abundance. This information will be assessed in the context of providing advice based on the Australian Fisheries Management Authority harvest strategy framework. Specifically, we will investigate the use of limited data in analytical methods that inherently violate the assumptions of these assessments and the cost of collecting improved data to inform them. This will be compared to empirical approaches that require far less data but produce indicators that result in a high level of uncertainty for management under the harvest strategy framework. Finally, we propose potential options to overcome these challenges when assessing data-poor, low gross-value basket species like deepwater sharks.

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Acute eucalyptus leachate exposure affects the reproductive behaviour and spawning of a native freshwater fish

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Endocrine disrupting chemicals (EDCs) can alter key life history traits and biological processes in wild animals by mimicking the action of natural hormones. While considerable attention has focused on understanding the impact of anthropogenic EDCs introduced into the environment, naturally occurring chemical compounds that can emulate EDCs may also be harmful. Plant secondary metabolites are one such group of chemicals, and while they play a primary role in herbivory defence, they can also cause a range of impacts for non-target species when leached into freshwater environments. Existing research shows that these plant-derived compounds like polyphenols and tannins can reduce growth, compromise development, impair reproduction, and alter communication pathways for a range of freshwater taxa. The effects of plant secondary metabolites on animal behaviour are, however, generally unknown. Here, I explored the effects of eucalyptus leachate on the mating behaviour and reproductive

potential of a native freshwater fish species. Murray River rainbowfish (*Melanotaenia fluviatilis*) were exposed to two concentrations of eucalyptus leachate (5mg/L 'low' or 15mg/L 'high') for five weeks in total. I conducted mating behaviour assays prior to exposure and following two weeks of exposure to leachate, and fish were allowed to spawn at the end of the five-week exposure period. While male courtship and total female association time were unaffected, I found that 'high' treatment females spent more time associating with males that courted more. This result indicates a reduced capacity in exposed females to distinguish between male courtship effort. Additionally, 'high' treatment females had a reduced propensity to spawn following five weeks of leachate exposure. Collectively, my findings show that acute exposure to eucalyptus leachate can trigger negative behavioural changes and reduced spawning capacity. In turn, they demonstrate the potential for naturally occurring chemicals to cause drastic shifts in reproduction under elevated levels of eucalyptus leachate.

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Effect of fluke metacercariae on Murray cod survival behaviour

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In natural and artificial aquatic environments, parasites are ever-present in the body systems of fish. Parasites can jump from a variety of hosts in an ecosystem, moving to different species to develop into the next stages of their life cycle. Parasites can influence the behaviour of their infected host in various ways, such as through the exhaustion of the host's energy stores and adaptive manipulation but can also be seen in fish behaviour depending on what body system the parasite has targeted. In order to determine if parasites cause changes in behaviour, infection status need to be manipulated in the laboratory. We first investigated if a keystone native freshwater fish species, Murray cod, can be infected in a laboratory environment with a recently discovered parasitic fluke species found in the Murray-Darling basin. Secondly, we examined the effect of parasite infection on the fish's survival behaviour by running a series of four behavioural tests; latency to emerge, latency to explore, habitat choice and predator avoidance from fish-eating birds and fish. The parasitic load and locations of the parasite were then analysed in the fish, and parasite-induced changes in behaviour were determined. Revealing this parasite's lifecycle and influence on host behaviour and physiology has given a better understanding on the costs of parasite infection to a fish host and its ecosystem. The information gathered will additionally aid in providing information to Murray-Darling Basin Fisheries who release high numbers of these fish into the basin's ecosystem annually.

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Field-based behaviour of Lorentz's grunter, *Pingalla lorentzi*: flee, fight and refuge

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Grunters of the family Terpontidae are important agents in tropical and subtropical freshwater ecosystems of the Australian continent and in a subset of lakes and streams of other Pacific islands. There has been progress in select aspects of grunter science in recent times (i.e. taxonomy; feeding ecomorphology, behaviour, diet; sound communication), but negligible attention given to a wider array of their behaviours and ecology. During surveys (including by baited underwater video) in the Jardine River catchment and adjacent smaller catchments on Cape York Peninsula, observations were made of a little studied endemic species, Lorentz's grunter. Notable behaviours included fleeing and posturing behaviour in the presence of predators and intraspecific displays and aggression. This research serves to showcase benefits of direct observation in wild fish assemblages in clear water (aquifer-fed) ecosystems. We integrate these observations and our fish assemblage survey data into a conceptual model of the ecology of Lorentz's grunter focussing on predator-prey and intraspecific-competitive interactions. The conceptualisation captures context of aquatic community composition as mediated by local aquatic habitat features (e.g. low turbidity/high visibility, fringing macrophyte and rock bars). In turn, this conceptualisation becomes usable information for furthering societal understanding and discourse including for potentially protecting the near pristine catchments in Apudthuma country. We also use this process to discuss prospects and challenges for informing the protection and recovery of fishes elsewhere, including recovering species in heavily modified landscapes, such as in the temperate/subtropical Murray-Darling Basin, in the biogeographic range of the critically endangered silver perch, *Bidyanus bidyanus.*

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Deep dives, long rides, and sudden endings: the challenges and encounters of anguillid eels during their single life-time spawning quest

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Anguillid eels are globally distributed in temperate, tropical, and subtropical areas. Numerous anguillid species are under threat globally, and a better understanding of their life history is needed. A critical stage in their life cycle is the migration of mature adults from freshwater habitats and estuaries to tropical marine spawning grounds. For many anguillids, especially those in the southern hemisphere, mystery still shrouds their spawning migrations. This talk presents a series of case studies on the migration behaviours of adult eels from coastal river systems in Victoria, south-east Australia. Eels were tagged using acoustic and pop-up satellite archival tags, and their movements monitored throughout freshwater habitats and the marine environment. We explore the environmental drivers associated with the downstream migration of tagged eels in freshwater habitats, including links to water levels/river flow, and their vertical movement behaviour, migration routes, and predation in the ocean.

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A continental-scale acoustic telemetry network to monitor movements and distributions of Australian aquatic species

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Over the last 15 years, the Animal Tracking Facility of Australia's Integrated Marine Observing System (IMOS, www.imos.org,.au) has collected data on the movements and presence of commercially and recreationally important aquatic species as well as species of conservation concern, using a continental acoustic telemetry network. Over 10,730 transmitters have been deployed on 162 aquatic species and tracked over a range of scales from hundreds of metres to thousands of kilometres, yielding over 127 million occurrence records around coastal Australia. The receiver network includes a permanent array of IMOS acoustic receivers deployed at strategic locations, complemented by hundreds of receivers owned and deployed by co-investment partners, with all resulting data centralised into a national database owned and managed by IMOS for the research community. Much of this work has derived from, or been driven by, state agencies' or conservation needs. In recent years, the IMOS Animal Tracking Facility has focused on optimising the continental infrastructure network, producing tools to facilitate data management, visualisation and analysis, and integrating with other data providers such as the Atlas of Living Australia and the EcoCommons online species distribution modelling platform to facilitate uptake of IMOS publicly available data by decision-makers. As marine environments continue to change, understanding the occurrence and movements of marine species and populations has become crucial to effective and sustainable management. The IMOS Animal Tracking Facility plays a strategic role in coordinating efforts to monitor aquatic species of national relevance at the continental scale.

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Elucidating broad-scale movements of marine species using a state-wide acoustic telemetry array

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Over the past three decades acoustic telemetry has become a standard tool in the marine ecologist and fisheries scientist's toolbox. In this time, acoustic receiver array designs have evolved from relatively small and localised arrays to covering much larger spatial scales including continental-scale and cross-boundary arrays. These arrays can act as collaborative networks through coordinated efforts and data sharing. Maintaining such broad-scale arrays is costly and time consuming, often requiring multiple collaborators, which can influence array design. With broad-scale arrays, more extensive movements can be detected, enabling researchers to address questions about species connectivity, stock structure and drivers of movement and migration. In 2020, the Integrated Marine Observing System (IMOS) Queensland Acoustic Telemetry Array was set up along the Queensland coast (spanning 16.7 degrees of latitude) to generate detailed insights into regional to broad-scale movements of marine species. This collaborative installation enhances the continental IMOS Acoustic Tracking Network infrastructure and involves the maintenance of receivers by 20 collaborators, with data hosted in a central database maintained by the IMOS Animal Tracking Facility. Since its inception, the new telemetry array has recorded over 2.5 million detections at 224 sites across Queensland waters, from over 920 animals and 40 marine species. Here we analysed Queensland-wide, multi-species and multi-project data to assess the efficacy of the new state-wide array configuration in capturing detailed, broad-scale movement data for species of management importance. We highlight examples of movements that would remain undetected without such an extensive regional network, and record movements of some species greater than previously recorded on the east coast of Australia. Data generated by this program demonstrate the ability for broad-scale, single receiver, telemetry arrays to provide important information on regional connectivity, critical for spatial management of priority marine species and ecosystems.

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Large-scale movements of a coastal predator

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Knowledge on the movements of marine predators is important for effective conservation and management given the increasing threats of human and climate induced changes. Bull sharks, *Carcharhinus leucas*, are apex predators, globally distributed throughout rivers, estuaries, near-shore areas and continental shelf waters of tropical to temperate regions. Substantial knowledge of movements and distribution have been gained through acoustic telemetry, however, detections are limited to areas of acoustic array deployments with little knowledge on how these sharks utilise the water column and depth profiles whilst travelling or foraging in coastal waters. Here we examined the horizontal movement and habitat use of seven bull sharks (185 to 283 cm total length) using MiniPAT pop-up satellite archival tags between 2021 and 2022. During their time at liberty, sharks travelled through tropical and temperate waters, where for the first time, we tracked a male bull shark (195 cm) in continental slope waters off the Lakes Entrance area, Victoria. This is the southern-most record of a tagged bull shark and potentially new distribution range for this species, that may be associated with climate induced changes. The findings of these large-scale latitudinal movements and the environmental drivers will be presented. Resolving environmentally driven variation in latitudinal movements of bull sharks, using data from satellite tagging, informs knowledge gaps and may support the development of future management strategies.

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Marine reserve use by the migratory coastal shark Carcharias taurus

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Networks of small no-take marine protected areas (MPAs) are a popular approach to protect mobile marine species at key sites along their migration routes. Understanding how individuals vary in their use of these sites is needed to ensure MPA networks are optimised to offer maximum protection benefits. Using diver-led surveys, coded acoustic tags and a continental-scale collaborative network of acoustic receivers, we investigated variation in the use of three Australian MPAs by aggregating grey nurse sharks, *Carcharias taurus*. The Wolf Rock MPA was used year-round by *C. taurus* as a gestation site, with mature females spending on average 108 d (max = 254 d) at the site interspersed with 6 h–69 d absences from the MPA. In contrast, Flat Rock and Cherubs Cave-Henderson Rock MPAs were used as a transitory aggregation site with both males and females occurring at the site between June–January, only. Migratory movements ranged up to 1,500 km along the coastline, intersected 17 MPAs and/or recognised *C. taurus* aggregation sites, and connected temperate waters at Montague Island (31.26° S) with that of the southern Great Barrier Reef (23.40° S). Our study demonstrates how local receiver arrays and national collaborative acoustic telemetry networks are powerful tools to reveal use and connectivity of MPA networks by marine migratory species. As the east

Australian *C. taurus* population is critically endangered and at particular risk of anthropogenic threats, ongoing monitoring of the species' movement behaviour and complementary management outside protected area boundaries, is warranted to safeguard its protection.

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Environmental disturbances and their dynamic impacts on the social behaviour of marine and freshwater fishes

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Human activities have profoundly changed the environment, which in many cases has resulted in the deterioration of natural ecosystems. This ongoing global problem requires collaborative efforts between academics, managers and local communities if we are to preserve the remaining biodiversity. Here I will discuss the application of behavioral ecology to the conservation of social fishes in the face of environmental disturbances. In particular, by melding both pure and applied research questions related to sociality, my lab has shown that the modulation of individual-level social traits caused by environmental stressors could act as useful indicators of the impact of human activities on aquatic ecosystems. Further, by applying entrenched behavioural theory, scientists may be able to predict how sociality is related to the responses, resilience and recovery of species to environmental challenges. While most of my work has focused on coral-dwelling fishes that have been severely impacted by multiple cyclone and coral bleaching events, I will also discuss ongoing work on freshwater fishes, namely how abiotic factors and sociality can mediate the impact of invasive species on natives. Finally, I will highlight our ongoing collaboration with the NSW Department of Primary Industries and Local Land Services NSW, aimed at protecting the very last population of a critically endangered freshwater crayfish. This research mission demonstrates the importance of maintaining external partnerships for the implementation of research findings and successful long-term protection of endangered aquatic species.

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Reproductive behaviour of the Murray cod (*Maccullochella peelii*) in the wild.

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Despite Murray cod *Maccullochella peelii* (Mitchell) being of immense societal and ecological value in south eastern Australia, the reproductive ecology of the species remains largely unknown in a riverine context. From 2015 to 2019 we used a combination of bio-telemetry and underwater imagery to quantify the behaviour of Murray cod across their breeding cycle in each year in the Northern Murray-Darling Basin, Australia. In most years, breeding behaviour (including nest site selection) was observed from early-August, with the population spawning period spanning late-August until the end of October. The onset of breeding behaviour was positively correlated with week-of-year and spawning was related to moon-phase. Most nesting occurred in shallow water on hard substrate underneath undercut banks. Nests were most often located in disconnected pools essentially in the absence of flow, indicating a lack of flow dependence for spawning. Larvae demonstrated active swimming and retention to the nest until a stage of dispersal, which was not dominated by downstream movements. Unintended disturbances to nests in some cases resulted in negative impacts on egg and larval survival. Current regulations warrant refinement to accommodate these recent findings to safeguard the long-term conservation of the species across all its biogeographic range.

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Fish Ageing Experts Collective (FASC) and otolith workshop outcomes

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The processing, interpretation and associated data analysis of otoliths, vertebrae and spines is a specialised area of fisheries science. Small numbers of experts in this field are scattered throughout fisheries agencies and research laboratories around the world. Currently, little formal inter-agency collaboration, networking or knowledge sharing occurs within this space. This may be due in part to resource limitations and/or factors including a lack of awareness of the type of work and individuals working within this area. Previous, formal collaboration between agencies in Australia ended in approximately 2014.

Fisheries scientists from the Department of Agriculture and Fisheries and the University of Tasmania are creating an exciting, virtual space to bring together a 'Society of Fish Ageing Experts' (SoFAE). The aim of this group is to facilitate networking whilst providing an avenue to share ideas and advice, problem solve issues and create opportunities for meaningful mentorships. It has the potential to create a powerhouse of information and expertise spanning a broad range of fish species and environments.

Currently the group is focused on three main areas of fish ageing research: Technical processes (e.g., otolith extraction, processing techniques, storage), QA/QC aspects (e.g., protocols, interpretation methods and training, reference collections, imaging) and analysis of age information (e.g., turning otolith data into estimates of age and calculating growth parameters).

Current members include biologists, technicians and researchers from across Australia and New Zealand working on a range of temperate, tropical, salt and freshwater fish species. This presentation will provide a brief overview of SoFAE including the participating organisations, their areas of expertise and the groups future goals and aspirations. A summary of the outcomes from the 2022 otolith themed workshop that was held at the start of the 2022 ASFB conference will also be presented.

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Assessment and applicability of fish otoliths as in-situ monitors of chronic sub-lethal hypoxia

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Many Australian inland waterbodies experience extreme variations in hydrologic and water quality conditions, with high rainfall periods often being separated by extended drought. Large-scale drought conditions over recent decades in the Murray-Darling Basin (MDB) have resulted in declining water quality and aquatic habitat availability, and acute hypoxic events and associated 'fish kills'. These events are highly visible to the public and have come under increasing public scrutiny and media attention. Despite this recent attention, there is little understanding about the effects of chronic sublethal exposure of fish to hypoxic conditions. Otolith elemental concentrations have proven to be a useful and convenient tool for reconstructing past environmental conditions experienced by fish. Several recent studies from the northern hemisphere have identified the potential use of otolith Manganese (Mn) concentrations as an indicator of marine hypoxia.

In a pilot study, we analysed trace elemental concentrations in otoliths from individuals of three common fish species from the northern MDB, to investigate the utility of Mn as a proxy to identify hypoxia histories in the Australian freshwater context. Two proxies were explored: Mn:Ca and Mn:Mg (with magnesium (Mg) concentrations thought to reflect metabolic activity but not hypoxia). We used generalised linear models to predict hypoxia proxy concentrations against an environmental proxy for hypoxia (annual cease-to-flow (CTF) days). Models showed significant differences between individuals, species and locations; suggesting little synchrony exists between individuals of each species even at the same locations. However, Mn concentrations generally increased as CTF days increased, though this relationship was not statistically significant. While our study suggests there is potential for otolith chemistry to trace hypoxia histories, further research with observed dissolved oxygen concentrations is needed. A greater understanding of hypoxia and fish responses in dryland rivers will improve the future management of fish and ecosystems under drought conditions.

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Is otolith magnesium a useful tool to support age estimation?

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Otolith (ear bone) microchemical analysis (or otolith chemistry) is an effective fisheries management tool to reconstruct environmental histories, infer natal origins, identify movement patterns, delineate stocks; and in more recent times to validate age estimates. Accuracy of age estimations is critical to stock assessments and monitoring of exploited populations, particularly where reductions to size structures occur due to fishing pressure. Elemental chemistry has been explored as an alternative means to validate age estimates and may be particularly useful in species whose otoliths are hard to age visually. We use Mulloway to demonstrate the relatively novel use of otolith chemistry to inform aging studies, as Mulloway growth increments are clear, generally easy to quantify with high repeatability, and incremental age estimates have previously been validated for Mulloway. Otolith Magnesium (Mg:Ca) is shown to be influenced by temperature in this species. Thus, we explored an alternative method to estimate age using counts of lifetime Mg:Ca oscillations, as a proxy for seasonal increment deposition to estimate annual age. Quantifiable comparisons in precision and repeatability among the traditional age estimation approach (i.e. visual counts of otolith growth increments) and the otolith chemistry approach were made. We discuss the challenges associated with this novel age estimation approach using otolith chemistry, in turn, contributing to future otolith chemistry-based life history studies.

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Otolith shape as an alternative method to identify small bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*)

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Fish identification is one of the important aspects of fisheries management. This process is occasionally challenging for small/juvenile bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) due to their similar characteristics in size and external appearance. Morphometric and meristic techniques are difficult to apply if the fish has been damaged caused by the interaction with the fishing gear. The genetic approach requires a specific laboratory and analysis process which is very time-consuming and expensive. One method to identify fish quickly and cheaply is by otolith shape analysis. This study uses otolith shape analysis to identify small bigeye and yellowfin tuna. A total of 115 bigeye tuna otoliths and 186 yellowfin tuna otoliths were collected from several fishing ports in Indonesia, i.e.: Padang, Palabuhanratu, Bitung, and Sorong. The shape of the otolith was obtained using a qualitative analysis which was transformed by wavelet. Statistical analysis of the otolith shape using multivariate analysis in eight classifications based on locations and length class. There is a significant difference between the shape of otolith bigeye tuna and yellowfin tuna in all eight classifications (p<0.05). The difference in the otolith shape of this otolith is detected in the rostrum and antirostrum. This difference is present in all locations, particular locations, and in several length classes. The

results of this study indicate that otolith shape analysis had the potential to use as a method to identify small bigeye tuna and yellowfin tuna.

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Eastern School Whiting genetic stock structure for cross-jurisdictional management

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The Eastern School Whiting (*Sillago flindersi*) is an inshore demersal species that is endemic to south-eastern Australian ocean waters to a depth of about 100 m, from southern Queensland to north-eastern Tasmania and west along the mainland coast to Anxious Bay in South Australia. Previous work examining genetic stock structure with allozyme markers suggested a weak division in the vicinity of Forster, central NSW. However, the hypothesis of a single, genetically diverse panmictic stock could not be rejected, and the species has been assessed as a single biological stock. Given the complex spatial fisheries management arrangements for trawl fisheries in south-eastern Australia there is a need to resolve stock structure for cross-jurisdictional stock assessments and harvest strategy management. Here we re-examine the genetic structure of S. *flindersi* across its range, with next-generation sequencing of highly variable single nucleotide polymorphism (SNP) markers. The findings are not concordant with historical results. Rather there is strong support for all locations in NSW and eastern Victoria forming a single panmictic population, a clear division between the mainland and Tasmanian samples, and a weak indication of a second division within the Victorian coastline.

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Detecting the Invasive Jaguar Cichlid in the Pioneer River using a Non-invasive Environmental DNA Approach

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Invasive species are a key concern for managers of freshwater ecosystems across Australia. Traditional detection approaches however, have a number of practical limitations, particularly in aquatic environments. Environmental DNA (eDNA) has emerged as a sensitive and non-invasive detection tool which enables potential early detection and effective monitoring. This method uses DNA that organisms naturally shed into their environment to target and detect specific taxa, or communities. This study addressed issues surrounding the flow management of the Pioneer River in Mackay, Queensland, which recently had an establishment of the invasive jaguar cichlid (*Parachromis managuensis*), a piscivorous fish species native to South America. The detection of this potential environmental menace led to closures of several fishways across the catchment, preventing the natural dispersal of both invasive and native fish species alike. The aims of this study were to develop detection protocols for *P. managuensis* in the region using an eDNA approach, use this to determine the species distribution across the catchment and finally, to provide this information to stakeholders so that management actions could be taken based on eDNA outcomes. Samples from 41 sites were collected then processed using a species-specific qPCR approach, with primers and probe sequences developed specifically to target *P. managuensis*. The assay had a 98% chance of detection given the species was in fact present. *P. managuensis* had spread well beyond managers' predictions, with the species present upstream of both the Dumbleton and Marian Weirs, as well as having spread to some adjacent tributaries. This study highlighted a number of implications for the management of *P. managuensis* and other invasive fish species in Queensland, having shown eDNA's effectiveness and applicability as a detection and monitoring tool in Queensland waters. eDNA methodologies represent a powerful monitoring tool which managers and policy should endeavour to incorporate into standard practice.

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Fine-scale spatial usage of a coastal beach area by white sharks (*Carcharodon carcharias*) as estimated by a Hidden Markov Model informed by acoustic array data

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White shark (*Carcharodon carcharias*) movements are typically observed over large spatial scales (100s-1000s km^2). However, observation of fine-scale movement behaviour of white sharks is necessary to improve our understanding of their usage of near-shore coastal areas where there is an increased probability of interactions between sharks and humans. Based on passive acoustic data from a dense, but non-triangulating, array we investigated the fine scale movement of white sharks at a coastal beach within a nursery area off Hawk's Nest, New South Wales from 2010-2015. Using a spatial Hidden Markov Model (HMM) we were able to estimate white shark movement tracks during each shark visit to the array based on detection binning over 5-minute time intervals. The HMM also enabled direct estimation of the probability of detection as a function of distance from shark to acoustic receivers. The HMM-estimated movement tracks predict heavy utilisation of very shallow water close to the high-

water mark by the sharks. Additionally, the southern end of the beach appears to be a focus for short term white shark residency at the beach. The movement tracks estimated here allowed the first high-resolution investigation of white shark movements in the Hawk's Nest nursery area and demonstrate the potential for estimation of fine-scale position data from non-triangulating passive acoustic monitoring arrays deployed in other coastal marine areas.

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Testing the waters: context-dependence of movement behaviour in marine predators – the bull shark (*Carcharhinus leucas*) as a model organism

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Mobile marine predators connect habitats and can exert spatially varying predation pressure through seasonal movements. Nonetheless, movement patterns in most taxa are highly variable, with residents and long-distance migrants present in the same population. This complexity has obscured a clear understanding of causes and consequences of individual movement decisions. Here, we apply a context-based approach to study movement drivers of bull sharks by comparing movement patterns of acoustically tagged sharks at the centre of distribution vs. the range limit in Southern Africa. We utilised remote-sensing/in-situ environmental data, tracking of prey species as well as reproductive data on bull sharks. Results show that complex interactions between environmental factors, prey dynamics and reproduction create a distinct distribution of movement strategies along the coast of Southern Africa that may have strong consequences for connectivity and population structure. Additionally, while bull sharks are predicted to expand their distribution poleward in Australia under future climate change scenarios, climate change driven intensification of cold-water upwelling systems at the range limit in Southern Africa is likely to retract their distribution in the future. Overall, this highlights the importance of considering context when making inferences about the impact of global change on mobile predators and resulting habitat connectivity

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Investigating animal movement and behaviour with statistical physics methods: A primer for ecologists

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Technological advancements are enabling ecologists to collect telemetry data at unprecedented rates. As the quantity and quality of telemetry data improve, these data can help answer fundamental ecological questions about animal behaviour and identify scenarios exposing species to anthropogenic threats. Analytical methods derived from statistical physics can be used to describe species' movement strategies and suggest underlying drivers. However, these methods are not standard in movement ecology, likely because most resources assume readers have a background in physics, presenting a barrier for ecologists. To help facilitate the use of these methods in ecology, we introduce a statistical physics-based R package, PhysMove, that includes ten core methods for describing species' collective movements, search strategies, space-use patterns, and intraspecific movements. We demonstrate these methods using satellite telemetry data from bull, great hammerhead, and tiger sharks. Results indicate that each species follows a unique movement strategy, and we discuss how these strategies may help support their co-existence. We hope to inspire the community to explore these methods and assist with advancing knowledge of the key movement drivers and fundamental properties of animal movement to better support conservation management.

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Opportunities and impacts of range-extending scalefish species: Understanding population dynamics, ecosystem impacts and management needs

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The biology and diet were quantified for three key range shifting species in Tasmania with both recreational and commercial fishery value—Yellowtail Kingfish (*Seriola lalandi*), Snapper (*Chrysophrys auratus*) and King George Whiting (*Sillaginodes punctatus*). The project was heavily reliant on engagement from the recreational fishing community and multiple citizen science initiatives. Our primary approach was a state-wide fish frame donation program which was implemented in 2019, with a network

of 16 drop-off locations along most of coastal Tasmania. This data set was also supplemented with historical data from the IMAS archives, and with fishery-independent sampling for fish outside of the legal size limits. These data were used to quantify life-history parameters (age, population structure, growth, reproduction, mortality), and diet for the three species. This information was then used in both species distribution modelling and Atlantis ecosystem modelling to predict how suitable habitats for each species may shift under future climate change projections and indicate the potential changes to the ecosystem (i.e. food web) if and when they do shift. The species distribution modelling was in part reliant on citizen science data, specifically species occurrence records, reported to the Range Extending Database and Mapping Project (Redmap), survey data from the Reef Life Survey, and historical occurrence records from the Atlas of Living Australia. The results provide important baseline and predictive information on these species for effective management of these emerging fisheries in Tasmania.

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Do currents shape global patterns of hybrid richness in coral reef fishes?

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Among the world's most speciose vertebrate groups, coral reef fishes have been shown to commonly form hybrids, which tend to accumulate in specific geographic areas called hybrid-rich zones. Yet, the potential mechanisms underpinning these stand-out regions remain unclear. Here, we aimed to: 1) determine the taxonomic and global prevalence of hybridisation in coral reef fishes, and 2) investigate whether coral reef fish hybrids coincided with phylogenetic relatedness, biogeographic barriers, species richness, geographic isolation, endemism, and oceanic currents. Through a systematic literature review, we found 143 unique interspecific coral reef fish hybrids involving 204 species – which accounts for approximately 7% of all coral reef fish species, indicating that hybridisation is as common in the sea as it is on land. Characteristic coral reef fish families were not homogeneously represented in our dataset, with particularly colourful groups standing out. Mapping our dataset revealed that coral reef fish hybrids are found worldwide, though some regions (e.g., the Christmas and Cocos (Keeling) Islands, South Kuroshio, Hawaii, and Eastern Philippines) are more hybrid-rich than others. Using a full-subsets modelling approach, we found that mean surface current velocity, phylogenetic relatedness (between hybrid parent species), and geographic isolation were the best predictors of hybrid richness in a given region. These results suggest that phylogenetic distance between coral reef fish species may serve as a pre-condition for hybridisation to occur, laying between introgression and reproductive incompatibility. We also propose a novel mechanism, with oceanic currents driving long-distance larval dispersal events, transporting stray species to geographically remote sinks to maintain hybrid-rich zones.

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How valuable are metrics of population connectivity for area-based marine management?

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The dispersal of fish larvae by ocean currents is likely to be an increasingly important driver of marine population connectivity across fragmented habitats. A boost in availability of larval dispersal data from biophysical simulations has therefore led to routine calculations of population connectivity metrics that are used to support area-based marine management decisions, including the placement of Marine Protected Areas (MPAs). However, simulation-derived data on larval dispersal remains highly variable and uncertain because field measurements for empirical validation are notoriously difficult to implement. Here I present a case study on coral reef fishes which confirms that consideration of larval dispersal could be critical for area-based management to help recover both fish populations and fisheries from depletion, thereby mitigating potentially severe impacts on coastal communities. Importantly, I further show that site selection for management or protection can be effective in achieving multiple objectives even if based on simple and empirically measurable metrics of population connectivity. Maximizing larval export contributions from MPAs to surrounding areas, for example, is likely to be a broadly beneficial site prioritization approach. Across investigated fish families with diverse life histories, this strategy was found to increase catches by a factor of 1.3 ± 0.3 (mean ± SD) and total fish biomass by a factor of 3.2 ± 0.3 compared to conditions without effectively managed or protected areas. These findings are relevant for both the implementation and impact evaluation of global conservation policies, specifically in tropical biodiversity hotspots, where coral reefs are often overfished and increasingly threatened but local communities highly dependent on sustainable fisheries. However, as long as simulation-derived larval dispersal data remains highly uncertain it might best be considered as an additional (albeit potentially critical) rather than primary criterion for site prioritization in the context of area-based marine management.

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The Basin Plan: Water recovery and Water for the Environment all working for native fish.

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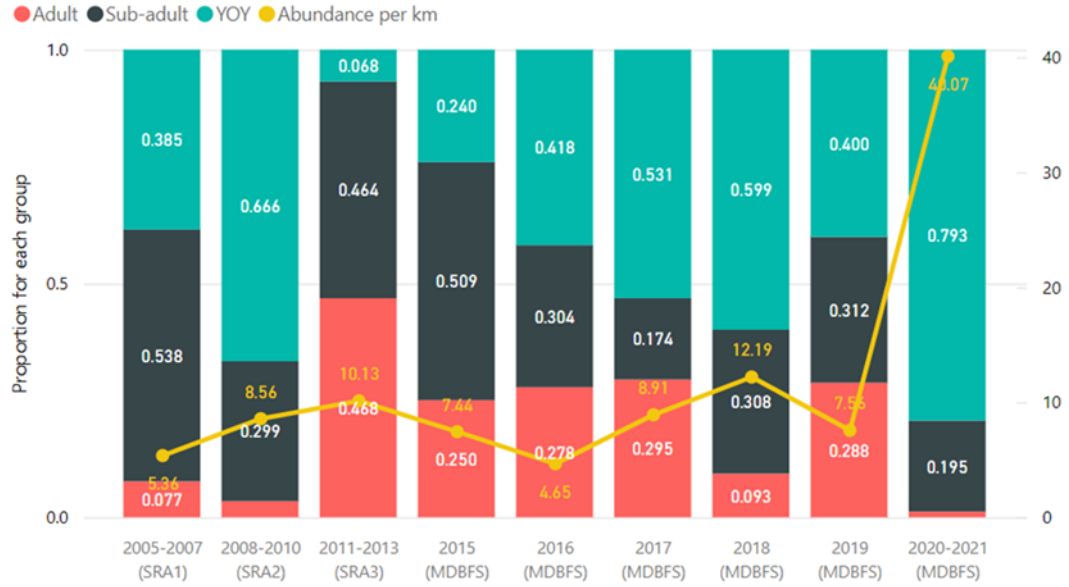
Native fish are a target to show the achievement of Basin Plan environmental outcomes, which rely on levers and mechanisms including, but not limited to, Sustainable Diversion Limits, Water Recovery, used as Water for the Environment, Compliance actions to protect flows and Complementary Measures through the Toolkit & SDLAM projects.

2017-2019 saw the worst three years of drought on record across much of the northern Murray-Darling Basin. This contributed to cease to flow conditions, the drying of refuge waterholes and over 60 fish death events including the Menindee fish

deaths. Critically during this extreme drought, the Commonwealth Environmental Water Office and Basin States were able to deliver over 69 GL of recovered Water for the Environment, topping up waterholes and keeping breeder adult fish alive along the Barwon-Darling System. The three events were:

- **2018 Northern connectivity event** provided water to 2000 kms of river to
- **2019 Northern fish flow** provided water to 1500 kms of river.
- **2020 Northern waterhole top-up** combined with natural flows to provide water all the way to Menindee.

Once natural flows and floods returned to the northern Basin native fish recovery began with fish breeding. Over 300GL of Water for the Environment has been delivered to support this native fish recruitment. Annual fish monitoring has shown the mass recruitment of Golden perch across much of the northern Basin, down the Darling River and into Menindee Lakes nursery habitat. These fish are moving out of the lakes downstream into the Murray River and upstream into the Darling River. By helping keep breeder adult fish alive through the drought with Water for the Environment has aided the mass recruitment of Golden perch and supported the basin scale Golden perch population recovery.



Graph showing the mass recruitment of golden perch in the Condamine-Balonne.

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An Analysis of Farmer Intentions to Install Fish-Friendly Irrigation Pump Screens

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Fish-friendly irrigation screens are designed to protect native fish and support irrigation farmers to operate efficiently. Despite the potential ecological and financial benefits, the adoption rate of fish-friendly irrigation screens by Australian irrigation farmers has been relatively limited and there have been few attempts to understand attitudes towards the technologies. This study addressed this gap through a NSW-wide fish-friendly irrigation screen survey which captured current screening practices and experiences and irrigation farmer attitudes towards the technologies. Whilst most irrigation farmers currently have some form of pump screen, less than 10% of installed screens were fish-friendly. Of those which do not currently have a fish-friendly screen, 8% indicated that they would be likely/very likely to install such a screen in the next two years.

Few survey participants indicated that they experience regular fish or debris blockages within their irrigation systems. Despite this, most participants agreed that the installation of fish-friendly screens would help to protect native fish, enhance the irrigation industry's environmental reputation, and prevent irrigation system blockages. There was also strong backing for further government and industry support to enable irrigation farmers to install fish-friendly screens.

The results of further empirical analysis, which drew on the Theory of Planned Behaviour and Diffusion of Innovation theory, revealed how screening intentions were significantly impacted by irrigation farmer attitudes towards the benefits from screening, perceived social pressure to install screens, farmer abilities (i.e. knowledge, financial, time) to screen and current experiences with irrigation system debris blockages. Collectively, these results provide valuable insights for government and fisheries agencies across the Murray-Darling Basin which are actively seeking to enhance fish-friendly screen adoption rates.

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Sustaining fisheries within irrigated landscapes - How motivations and abilities of different stakeholders influence the implementation of fish friendly infrastructure.

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Implementation failure is widely acknowledged as a major impediment to the success of water resource plans and policies, yet there are very few proactive approaches available for analysing potential implementation issues during the planning stage. The motivations and abilities (MOTA) framework was established to address this planning stage gap, by offering a multi-stakeholder, multilevel approach to evaluate the implementation feasibility of plans and policies. MOTA is a stepwise process focusing on the relationship between trigger, motivation, and ability.

This project applied MOTA in the context of understanding the motivations and abilities of different stakeholders to implement and institutionalise fish friendly infrastructure (fish passage) in Laos, Indonesia, and Cambodia. Fish passage is a critical consideration across these South East Asian countries as the development of irrigation infrastructure, whilst supporting rice production, can imped fish migration and lead to declines in freshwater fish stocks. This presents a food security risk given the status of freshwater fish as a staple dietary requirement. This nexus of irrigation negatively impacting fisheries provides a risk for countries to meet both their food security and sustainability targets.

In-depth, semi-structured interviews with 19 key informants have been conducted at the regional Southeast Asian level to better understand different stakeholders such as donors, irrigation managers, fisheries managers, engineers, consulstants and researchers. These results will be presented. The end result of the MOTA analysis will be to provide direction on what is needed to implement and institutionalise fish passage in the three countries.

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Reintroduction of threatened murray hardyhead to a managed wetland in southwest nsw

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The Murray hardyhead (*Craterocephalus fluviatilis*) is a small and short-lived (1–2year) native freshwater fish, with a tolerance for highly saline waters. As a result of habitat loss, river regulation and pest species, Murray hardyhead have diminished in abundance and distribution and are currently absent across much of their former range. In November 2018, approximately 800 individuals were successfully translocated from managed South Australian wetlands into a salt affected wetland in southwest NSW. Salinity in the translocation wetland was regulated via the delivery of environmental water to manage predators, pest fish, and stimulate productivity and breeding. Subsequent monitoring indicates regular annual breeding and recruitment success following translocation. This translocation represents the first attempt in NSW to re-establish a regionally extinct native fish, and is founded on strong collaboration between NSW, South Australian and federal agencies, environmental water managers and the owner/managers of the relocation wetland.

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Native fish recovery post environmental water delivery in the lower Darling River 2020-2022

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Since the 2018-2020 devastating fish deaths on the lower Darling River (LDR), a series of environmental flows have been implemented to sustain and recover native fish populations. The fish recovery hydrograph is designed to incorporate four key elements: (i) a late winter/spring increase in discharge to inundate Murray cod spawning and rearing habitats, (ii) a spring and early summer sharp increase in discharge to 1500 ML d^{-1} to enhance survival of larval Murray cod and, (iii) to stimulate golden perch spawning and dispersal, and (iv) a gradual recession summer/autumn recession to a lotic winter baseflow. Monitoring between 2020-2022 has included boat electrofishing, larval and juvenile netting and acoustic tagging. Results demonstrate recruitment of Murray cod and golden perch in the LDR with the later species originating from spawnings upstream of the Menindee Lakes. We highlight that Murray cod populations can be recovered and protected with lotic baseflows, perennial flowing conditions, hydraulic complexity and prevention of protracted cease-to-flow conditions. While to maintain golden perch populations in the southern MDB, protection of flow events from the northern Murray Darling Basin into the Menindee Lakes with

subsequent downstream dispersal of recruits must occur. Our fish recovery hydrograph provides a much-needed template to support post fish-death population recovery and highlight a pathway to rebuild the resilience of the LDR ecosystem.

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Population recovery for key threatened species – an update on Victoria's 'Conservation Hatchery' program

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Freshwater species face a range of threats, many of which are only increasing in intensity and frequency. While management actions (e.g. environmental flows and invasive species management; habitat restoration and rehabilitation) have been effective in ameliorating these threats in some cases, many freshwater species are continuing to decline. Several freshwater species now only persist in small, isolated populations, which are at risk of further decline as threats increase in the future, or at risk of extinction from episodic events such as bushfires.

For species that exist in small, isolated populations, conservation translocations are likely needed to bolster natural populations, and improve the likelihood they can persist in the future. However, the small size, limited distribution, and poor genetic diversity of some populations may mean they are not capable of supporting the removal of individuals for the purpose of wild-to-wild translocation. Captive breeding for these species may be the only way to produce sufficient individuals for translocations. In addition, captive breeding has other potential advantages, such as providing the opportunity to house captive 'insurance' populations for particularly vulnerable species and to conduct genetic mixing experiments between populations and closely related species that are particularly vulnerable due to severe bottleneck events and inbreeding.

Here we discuss recent investment that will support construction and operation of a fit for purpose 'conservation hatchery' which will be Victoria's newest captive breeding facility and will be specifically dedicated to protecting highly endangered freshwater species. One of the first tasks for the hatchery will be to increase freshwater species numbers that were impacted by the 2019-20 bushfires including Macquarie perch and critically endangered galaxiid species from Gippsland, in addition to species such as purple spotted gudgeon, river blackfish and South Gippsland spiny crayfish. The hatchery is expected to open in April 2023.

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Fine-scale spatial data to validate behavioural traits of iconic reef fishes

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If we want to understand or predict future ecosystem composition, it is important to validate whether well-known traits of animals remain ecologically relevant. Highly specialised species, for example, may die or be forced to relocate, as habitats change. But what about more nuanced shifts or adjustments to new circumstances? Obligate coral-dwelling damselfishes on coral reefs are known to depend on live branching coral to survive. However, in recent studies, they were observed to survive the localized extinction of their primary habitat following coral bleaching. To address this apparent paradox in the trait of coral dependence, we documented the fine-scale spatial behaviour of obligate coral-dwellers in relation to habitat quality. We found very little effect of habitat quality on space use. Thus, obligate coral-dwelling fishes may *prefer* branching live coral, but their 'obligate' *dependence* may be more flexible and context dependent. As ecosystems reconfigure, plasticity in behavioural traits may be critical for the persistence of fish populations. Likewise, plasticity may be required of us – attempting to quantify ecology using traits. Rather than relying on pre-existing measurements and retrofitting ecological relevance to them, the key may be to invert the process, i.e. to identify context-specific ecological processes *first* and *then* identify traits as quantifiable proxies.

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Rising from the ashes: the biogeographic origins of modern coral reef fishes

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During the excavation of Mayan tombs, little did the archaeologists know that the fossils they discovered in the tomb stones would fundamentally alter our understanding of the earliest origins of coral reef fishes. Located just 500 km from the point where an asteroid impact reconfigured the world's biological systems 66 million years ago, we find the earliest origins of three typical reef fish groups. Their presence in Mexico just three million years after this impact finally reconciles the conflict between the fossil and phylogenetic evidence for the earliest origins of reef fishes. The incorporation of these fossils into a global reconstruction of fish evolutionary history reveals a new picture of the early biogeography of reef fishes, with strong Atlantic links. From locations associated with biological destruction and societal collapse, we see evidence of the origins of one of the world's most diverse and spectacular marine ecosystems: coral reefs.

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The functional roles of surgeonfishes on coral reefs

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Surgeonfishes have had over 50 million years of evolutionary history in close association with coral reef ecosystems. Today, these fishes make up a core component of reef fish assemblages and contribute to a range of ecosystem functions. However, as coral reefs are being reconfigured by a suite of stressors, the relative importance of surgeonfish functional roles may be changing, and we must now understand these roles in this context of change. To do this, our work explores how functional frameworks can be applied to clarify how fishes interact with their environment. In the case of surgeonfishes, clustering based on morphological and behavioural traits results in six broad functional groups: browsers, brushers, croppers, concealed croppers, sediment-suckers, water-column feeders. Based on these functional groups, we outline how the functional roles of surgeonfishes on coral reefs have evolved over the past 50 million years in different biogeographic locations. In addition, we highlight how surgeonfishes from different functional groups contribute to several key ecosystem functions (e.g., macroalgal removal, algal turf removal, detritus removal, sediment dynamics, plankton harvesting and cross-habitat trophic linkages), while also considering how the nature and importance of these roles may change in the future. Specifically, we focus on the interactions between surgeonfishes and algal turfs, a group of algae expected to typify coral reefs in the Anthropocene. Importantly, these interactions can be shaped by stressors such as sediments, with flow-on consequences for the services that surgeonfishes provide to people.

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Seascape context matters more than habitat condition for fish assemblages in coastal ecosystems

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Ecosystems are increasingly degraded, fragmented and lost because of human activities globally. These impacts cause changes in the distribution of biodiversity and key ecological functions, modifications to food webs, and reductions in ecosystem condition and seascape connectivity. Understanding whether, and how, the spatial context (i.e. extent, position) and condition (i.e. structure and condition of patches, including habitat forming species) of ecosystems coalesce to support their function as animal habitats is critical for effective and cost efficient coastal management. These potential combined, or interactive, effects of spatial context and habitat condition on fish assemblages are, however, rarely quantified. We sampled fish assemblages from six different ecosystems (mangrove, seagrass, saltmarsh, log snag, rocky outcrop and unvegetated sediment) across 13 estuaries in eastern Australia and quantified the relative importance of spatial context and habitat condition variables for fish assemblage composition. Spatial context variables were consistently more important than habitat condition in structuring fish abundance and diversity. Sites that were closer to smaller vegetated habitats (i.e. mangrove and seagrass) and key seascape features (i.e. estuary mouth and intertidal flats) typically supported diverse fish assemblages in high abundance. While the composition of fish assemblages was primarily linked to spatial context variables, habitat condition variables that index food availability were also important for fish in mangroves, seagrass and rocky outcrops. Our results show that fish abundance and diversity are intimately linked to seascape connectivity and heterogeneity, and have important implications for conservation planning and fisheries management decisions in coastal ecosystems. We highlight the importance of quantifying the influence of the combined effects of habitat condition and spatial context for biodiversity across multiple ecosystems, and expect the outcomes to lead to more efficient and effective management planning.

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Fine-scale bathymetry data explains variability in fish assemblages on mesophotic reefs in the Hunter Marine Park

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Temperate mesophotic reefs are located at depths of 30-150m and are a transition zone from algal dominated reefs to sessile invertebrate dominated reefs. It is expected that the structure of the fish assemblage would also change with depth. There's a large knowledge gap of inter and intra reef variability in fish assemblage structure, including seasonal patterns of abundance of fish at mesophotic depths. Several of the newly established Australian Marine Parks recognised these mesophotic reefs as key ecological features. Through the support of the NESP Marine Biodiversity Hub we collected baseline mapping, habitat and fish abundance data for the Hunter Marine Park on the mid-north coast of NSW. Using joint species distribution models, we were able to investigate assemblage level seasonal variability, environmental drivers, species-species interactions, and trait-based patterns of fish distribution at mesophotic depths. We found minimal seasonal variability in the fish composition of rocky reefs in the Hunter Marine Park. Species composition was primary associated with reef structure, with upper mesophotic high relief reefs being biodiversity hotspots. These results highlight the need for monitoring programs to stratify sampling across depths and habitats if trends in biodiversity through time are the core metrics of interest to marine park managers.

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No protection effect isn't all bad news - changes in mesophotic fish assemblages in the Tasman Fracture AMP reflect protection and good fisheries management

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Marine protected areas (MPAs) such as the Tasman Fracture Australian Marine Park (AMP), are widely used to assist conservation and resource management. Effective monitoring and management of these areas is underpinned by understanding the ecosystems they aim to protect. Knowledge of deep, mesophotic ecosystems has been limited to date. However, the increasing development of video-based surveying provides a quantitative sampling tool for previously inaccessible areas, with multibeam sonar mapping followed by baited remote underwater videos (BRUVs) becoming widely adopted as a typical survey method.

This study uses BRUV imagery from a series of 2021 deployments in the Tasman Fracture AMP to build upon a 2015 study of the region to quantify changes in abundance, length, and biomass within demersal fish assemblages in the AMP. It aims to assess protection effects on demersal reef fish, further develop understanding of spatio-temporal variation in the fish communities, and identify drivers of this variation to aid monitoring of the reef system.

Spatially balanced sampling of 100 sites was undertaken using stereo-BRUVs in the Tasman Fracture AMP Marine National Park Zone (MNPZ) and adjacent fished areas. Impacts of protection alongside environmental drivers (rugosity and depth) on the distribution and composition of assemblages were assessed using a range of recognised indicator metrics at both community and species-specific levels. These metrics revealed no significant influence of the MNPZ, with implications that low fishing pressure in the region may prevent observation of significant park effect; however, indications of recovery in fished areas correlated with regionally decreased fishing effort over this period. Total demersal fish abundance was significantly related to depth and habitat complexity, with responses varying at a species-specific level. This study highlights the importance of understanding both environmental and external drivers within mesophotic ecosystems and how this knowledge may be used to better inform sampling designs.

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Testing the effectiveness of deterrent devices in reducing shark depredation

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Shark depredation is a major issue for many commercial and recreational fishing operations around northern Australia. A recent FRDC workshop highlighted the issue's complexity, the lack of dedicated research on depredation and its impacts and discussed potential options for mitigation. Following on from technological developments to reduce risk to water users from shark bite, deterrent devices designed to protect fish-catch are increasingly being developed and marketed to mitigate shark depredation. However, as with bite-protection devices, the effectiveness of specific deterrent technologies is often poorly demonstrated and the claimed efficacy is typically not based on independent and scientific testing. We tested three deterrent devices (electrical, magnetic, acoustic) while line fishing for demersal scalefish in the Pilbara region, Western Australia. We conducted an *a priori* power analysis to develop a sampling design that would determine the devices to be "effective" if they resulted in a 50% reduction in the number of fish depredated. Field testing involved rod-and-line fishing during daylight in separate one-hour fishing sessions, in which one of the four deterrent treatments (three devices and no device i.e. control) were deployed in randomised order. Testing occurred in water depths mostly between 20-50 m, with 1-5 km separating each site. Video from underwater cameras mounted on the fishing lines was used to (1) identify the species of fish caught and sharks involved, (2) examine the behaviour of sharks when approaching hooked fish and (3) determine the length of time for sharks to initiate depredation. While acknowledging the inherent challenges in running experimental trials in the marine environment, we offer results of this study as a starting point for developing guidelines that could be used to test similar deterrent devices that will developed in the future such that commercial and recreational fishers will have confidence in their adoption as effective mitigation measures.

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Spot the shark! Using drones to monitor sharks and improve the safety of ocean users at Queensland beaches

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The beaches of Southeast Queensland have good water clarity and a high level of year-round visitation, making them an ideal location to test drones for detecting sharks and improving the safety of ocean users. The Queensland SharkSmart drone trial operated drones at five beaches in Southeast Queensland over a 12-month period. Flights occurred on weekends, public holidays and school holidays, covering a 400m transect behind the surf break. Across the five beaches, 3,369 drone flights were conducted and 174 sharks were sighted, including 48 large sharks. Of these, eight bull sharks and one white shark were detected, although no tiger sharks were sighted. Beaches were evacuated on four occasions when large sharks were sighted. The mean shark sighting rate was 3%, with North Stradbroke Island (NSI) having the highest sighting rate (17.9%) and Coolum the lowest (0%). Data analysis indicated that location, the presence of other fauna, season and flight number (a proxy for time of day) were the

most important factors influencing shark sightability. Shark sightings were most likely at NSI and Burleigh Beach, possibly because there was a high density of potential shark prey species at the former and because the latter is close to the mouth of a creek, where higher nutrient levels can stimulate greater productivity and attract sharks. Sightability was also higher during summer and for the first flight of the day. This project has demonstrated that drones can be a reliable tool for detecting sharks at some Queensland beaches and improving the safety of ocean users. It is recommended that drones are trialled at other locations throughout Queensland and emerging technologies such as artificial intelligence and advanced camera technologies (e.g. hyperspectral cameras) are tested to improve the detection of sharks.

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A drone-based application for assessing abundance of a pelagic fish in shallow coastal waters

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Reliable estimates of relative abundance are fundamental to fishery stock assessments. Fish abundance indices derived from fishery-dependent data have some utility but are often confounded by changes in fishing practices, fleet dynamics and other factors (e.g. markets). Fishery-independent sampling of fish populations can provide useful abundance data but is often expensive and logistically challenging to undertake. The recent proliferation of unmanned aerial vehicles (UAVs, drones) in wildlife research has provided a promising new platform for aerial surveys of coastal populations of pelagic fish, especially those that spend part of their life near the surface. Western Australian salmon (*Arripis truttaceus*) is an abundant medium-sized schooling pelagic fish species, endemic to the temperate coastal waters of south-western Australia where it supports important commercial and recreational fisheries. Large schools of salmon migrate from South Australia to Western Australia. This study investigated the utility of aerial surveys using a low-cost, consumer grade drone for determining relative abundance of WA salmon. Aerial surveys were undertaken along 3-km transect at twelve beaches on the west coast of South Australia in August and November 2021. *Post hoc* analysis of drone video footage revealed that schools of salmon of varying sizes and densities could be reliably sighted in multiple survey habitats using the UAV. Water depth, turbidity and wind speed significantly impaired detection of salmon schools. Our preliminary findings suggest that drones could provide a cost-effective aerial survey tool to reliably estimate relative abundance for fish populations in shallow coastal waters.

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Sea Change: Habitat suitability of juvenile scalloped hammerhead sharks (*Sphyrna lewini*) in Queensland coastal waters, Australia

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Conservation of marine species is challenging, especially for threatened species that are data deficient, to inform accurate trends and condition of marine populations. The scalloped hammerhead shark (*Sphyrna lewini*) is classified critically endangered (IUCN), with little to no information on the habitat use and marine park protection of juvenile hammerheads in Queensland. To address this critical knowledge gap, we used sightings and recreational catch information and environmental variables to model (Maxent) the suitable habitat distribution of juvenile scalloped hammerhead sharks across ~11,330 km^2 of the Queensland coastline. The study area included three major marine parks (Great Barrier Reef, Great Sandy and Moreton Bay Marine Parks). We used low-level protection (multi-use zones) and high-level protection ("no-take" zones) for suitable habitats within MPAs. Modelling results showed highly suitable habitats accounted for 15.75% of the study area, occurring in nearshore coastal and wetland areas and urban centres. Only 11% of these occurred in no-take MPA zones, while the majority of high suitable habitats occurred in multi-use zones (41.93 %) or outside MPAs (46.98 %). Our results showed most suitable habitats for juvenile scalloped hammerhead sharks do not fall within protected zones in Queensland waters, exposing juvenile sharks to higher anthropogenic pressures, potentially further endangering this species.

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Reef manta ray movement ecology and connectivity along a continental coastline

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Elasmobranchs are facing an extinction crisis globally, with over one-third of shark and ray species threatened by overfishing. Species with conservative life history traits, such as manta rays, are especially vulnerable to targeted fisheries pressures. Reef manta rays are found throughout tropical and sub-tropical oceans, and are listed as Vulnerable to Extinction on the IUCN Red List of Threatened Species. On the east coast of Australia, their distribution has been confirmed from the Solitary Island Marine Park in the south (30°S), to Tijou Reef in the north (13°S). It is not known whether these animals move outside of this range into international waters and neighbouring jurisdictions where they might be subjected to targeted threats and differing levels of protection. Additionally, there is a knowledge gap about whether their distribution along this coastline represents one connected population of rays or several isolated sub-populations. Using a range of telemetry approaches, including acoustic tracking, satellite tagging and photographic identification (photo-ID), this study set out to determine the movements and connectivity of reef manta rays in eastern Australian waters. Manta rays were found to make overlapping movements between the southern and northern regions of their range, make dives off the continental shelf to over 350 m depth, and movements across marine park boundaries, including into international waters in the far north. Rays appear to use reef environments as an interconnected network of cleaning stations and shallow habitats for daytime basking, surface "snacking" and reproductive activity. These findings provide insight into potential threats facing manta rays at the northern extent of their range, and can be used to inform management of their populations and habitat in eastern Australian waters.

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Post-release survival of black jewfish *Protonibea diacanthus*

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Black jewfish *Protonibea diacanthus*, have recently experienced large increases in targeting by commercial fisheries throughout Australian waters due to strong demand and value for their swim bladders in the Chinese wellness market. The large swim bladders of black jewfish also make them highly susceptible to barotrauma, and as a result they have been associated with high post-release mortality rates for fish captured in waters deeper than 10m. Current survival estimates are based on assumed fate derived from barotrauma associated injuries observed during necropsy, and low recapture rates in recreational tag and release programs. Targeting jewfish for catch and release fishing has been, therefore, discouraged and some jurisdictions have removed minimum size limits to reduce the number of releases fish. Jewfish are currently being acoustically tracked as part of the Integrated Marine Observing System Queensland-wide acoustic telemetry array project. Using the data available so far, we evaluated the post-release survival of jewfish. Preliminary results suggest much higher survival rates than previously reported. Releasing the fish as fast as possible after capture and using a release weight are likely key factors for increasing fish survival and welfare. Tagging and tracking jewfish is ongoing, but so far results suggest that this project will provide improved estimates of post-release mortality, that can be incorporated into stock assessments. Results will also provide recommendations for best handling and release practices, in particular regarding the use of release weights.

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Extreme philopatry in an estuarine-dependent fish

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Processes regulating population connectivity are complex, mediated by species movement and gene flow, and play a key role in shaping fisheries and environmental management actions. The estuarine-dependent black bream (*Acanthopagrus butcheri*) exhibits partial migration and is distributed across southern Australia, from Western Australia to New South Wales, including Tasmania. Yet, we still have a limited understanding of this species genetic connectivity among estuaries. The aim of this study was to assess population structure and genetic connectivity across the entire species distribution range. Black bream were sampled from 26 sites across Western Australia, South Australia, Victoria, New South Wales and Tasmania to determine (1) if populations differed genetically and (2) the degree of gene flow present across all southern Australia. Next-generation RAD-sequencing was utilised to target Single-Nucleotide Polymorphisms (SNP) genetic markers. To assess population structure and gene flow a combination of PCAs, admixture models and isolation-by-distance tests were completed. Results show clear population structure across southern Australia, including at regional and local scales. The strong genetic variation and reduced gene flow across black bream populations suggests a location-specific approach to managing this commercially important species may need to be considered.

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Mesoscale oceanographic features drive divergent patterns in connectivity for co-occuring estuarine portunid crabs

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Larval dispersal and connectivity have important implications for fisheries management, especially for species influenced by ocean boundary currents. Giant Mud Crab (*Scylla serrata*) and Blue Swimmer Crab (*Portunus armatus*) are two estuarine portunid crabs (Family: Portunidae) that support significant commercial and recreational harvest in eastern Australia. Giant Mud Crab migrate to coastal waters to spawn, and while Blue Swimmer Crab spawn primarily within estuaries they occasionally migrate to coastal waters to spawn. Spawning is followed by larval dispersal in the East Australian Current (EAC). Here, we coupled a high-resolution oceanographic model with a Lagrangian particle tracking framework to simulate larval dispersal and determine the extent of population connectivity in this region. Our simulations indicate broad-scale connectivity (~40–400 km), characterised by high inter-estuary connectivity. Overall, our results suggest a north-to-south source-sink structure for both species, with contributions of particles from the north ranging from 51– 99 %. Recruitment to a given estuary is dependent on the proximity of mesoscale oceanographic features of the EAC. Most notably, the EAC separation acts as a barrier to recruitment between spawning and settlement to the north/south of this region. This significantly limits inter-jurisdictional connectivity for these species, especially Blue Swimmer Crab, likely due to a shorter pelagic larval duration than Giant Mud Crab. Our results provide evidence to inform the assessment and management of these species.

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The Mid-Murray Floodplain Recovery Reach: Bringing back the 'Magnificent Six'

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The Mid-Murray Floodplain Recovery Reach Program was established as part of the MDBA's Native Fish Recovery Strategy, and has a strong focus on recovering threatened floodplain specialist fish including southern purple-spotted gudgeon, southern pygmy perch, olive perchlet and flat-headed galaxias. Through the program, the Murray NRM Tri-State Alliance has established strong partnerships to undertake captive breeding, habitat restoration, conservation stocking and monitoring at numerous sites across three states in the Murray River Corridor. This presentation will showcase the works and results to date, and highlight key challenges, opportunities and knowledge gaps in threatened small-bodied fish recovery.

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Medium-term ecological response to river rehabilitation efforts in the Dewfish Demonstration Reach

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The Dewfish Demonstration Reach (DDR) was established in 2008 under MDBA's Native Fish Strategy, with the purpose of demonstrating to the community the benefits delivered by strategic river rehabilitation. A wide range of intervention activities were undertaken between 2008-2015 to improve the river health in the DDR. Structured monitoring and evaluation of the outcomes formed an essential component, using an MBARCI framework. Significant improvements in local native fish populations were identified until formal monitoring ended in 2015. However, the impacts of rehabilitation activities can take years or even decades to fully develop, much longer than typical project timeframes. Monitoring of the same sites conducted 5-10 years post rehabilitation efforts has provided extremely valuable information on the durability and persistence of rehabilitation activities and medium-term ecological responses. A two-year record level drought resulted in extremely low water levels in the period preceding the monitoring. Despite this, the overall riparian condition had continued to improve, but relapse to less environmentally optimal land management practices may have occurred in some areas. The presence of many small-bodied fish species remained closely linked to the abundance of aquatic and overhanging riparian vegetation. Structural instream habitat enhancements have all remained in place and continue to provide valuable habitat complexity. Recovery of large-bodied native fish populations has also continued strongly, particularly for Murray cod. This has been closely linked to the long-term increase in instream habitat complexity, particularly large woody structures. Pest fish abundance has remained low. The results demonstrate how most of the intervention activities continue to deliver significant ecological benefits for no ongoing effort. The cumulative impact of all intervention activities is likely to continue to develop in future years.

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A codend of crabs: Fishery-independent monitoring of pre-recruit blue swimmer crabs in Moreton Bay

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Blue swimmer crab (*Portunus armartus*) is widely distributed around the Australian coastline. In Queensland, this species is found on sandy and muddy substrates in shallow coastal and estuarine waters along the entire coast. Targeted by commercial and recreational fishers using pots and caught as a permitted by-product in commercial demersal trawls, the Queensland blue swimmer crab fishery primarily operates in the states southeast. Concerns of heavy fishing pressure, an expanding fishery and limited research prompted monitoring to help ensure a continued sustainable harvest. Fishery-independent monitoring of pre-recruit blue swimmer crabs in Moreton Bay was identified as a suitable tool to investigate and better understand changes in

population structure through time. The design of the fishery-independent survey is based on methods from published research. It captures the pulse of pre-recruit blue swimmer crabs resulting from the spring spawning event, conducted during the optimal period in Moreton Bay, where recruitment is at its peak and there are limited impacts of dispersal, reduced catchability and harvest. Monitoring of pre-recruit blue swimmer crabs commenced in 2006 and apart from a hiatus in 2016 has been conducted annually. Resulting biological data is analysed using a GLM with negative binomial distribution to estimate an index of pre-recruit abundance. The index has been calculated 15 times over the monitoring period, offering a long time series of data from a consistent design. An important piece of empirical evidence used in state and national stock status and periodic assessments of the north-eastern Australian biological stock. Logical next steps would be to increase the value of the survey through investigation into potential further data uses. But what does this look like?

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Use of dissociated aquaculture to enhance reproduction in redclaw crayfish

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Abstract

Redclaw, *Cherax quadricarinatus,* is a tropical freshwater species, endemic to Northern Australia and is a promising species for global aquaculture development. However, the commercial expansion of redclaw is hindered by low female fertility. Our aim was to investigate if pre-exposure of female redclaw to males can induce spawning and enhance reproductive performance. The study was conducted in two phases: A dissociated phase (111days) where crayfish, were either isolated (Control, n = 36) or were exposed to either 6 (6M, n = 36 females) or 12 (12M, n = 36 females) males suspended in the uppermost row of a vertically arranged, recirculation system; an associated phase (34 days) where females were maintained at a sex ratio of 1M:1F. During the dissociated phase, the spawning rate was less in the control compared to the 6M group but similar between the 12M and other groups (2.8%, 22.2%, and 13.9%, respectively; $p=0.048$). However, the moulting rate was greater in the control compared to the 6M and 12M groups (22.2%, 5.6%, and 5.6%, respectively; $p=0.034$). During the associated phase, there were no significant differences in spawning rate, mean days to spawning, hatching rate, and moulting rate between treatments. The mean number of eggs produced during the associated phase was >30% greater in the 6M and 12M groups compared to the control group. We conclude that pre-exposure of female redclaw to males in a dissociated, vertical recirculation system, increases spawning rate during the dissociated phase, improves egg production, and has the potential to increase hatchery productivity.

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Ten years of fishery-independent monitoring of Tasmanian sand flathead abundance and population characteristics

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Sand flathead (*Platycephalus bassensis*) are the most commonly caught species by recreational fishers in Tasmania. Annual fishery-independent surveys conducted since 2012 using the fishing gear and targeting practices typical of recreational fishers in areas of significant effort of the fishery, and at the time of year of highest catchability (January - March), suggest relatively low abundances of legal-sized fish, particularly in south-eastern Tasmania where populations are subject to heavy fishing pressure. While an increase in minimum size limit (300 to 320 mm) and reduction in bag limit (30 to 20 sand and tiger flathead combined) in 2015 seemed to reduce catch, current levels of fishing pressure are likely to cause the stock to become recruitment impaired. The latest stock assessment report indicates that the stock is depleting and that there is strong evidence of growth overfishing.

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Spatio-temporal variations in fish assemblages and environmental drivers in a large temperate estuary in Australia

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The Coorong is the unique estuary of the Murray-Darling Basin, located at the terminus of the Murray–Darling River. Freshwater flow plays a pivotal role in maintaining estuarine habitat and functionality and influencing fish population dynamics. This study incorporated 15 years field data (2007–2022) from the Coorong, to investigate spatio-temporal variations in fish species richness/diversity, assemblage structure, and the abundance and distribution of key species. The long-term period encompassed varying hydrological conditions (including drought and flood/high-flows), allowing to explore the effect of flow regime on fish species of different life-histories and assemblage changes, and to determine key environmental drivers.

Along the increasing salinity gradient in the Coorong (fresh/brackish to hypersaline), fish species richness decreased; similarly, the abundances of key species decreased, except for smallmouth hardyhead (*Atherinosoma microstoma*), a highly salt-tolerant species. The overall fish abundance was primarily driven by two small-bodied species, with sandy sprat (*Hyperlophus vittatus*) and smallmouth hardyhead dominating the northern and southern Coorong, respectively. Large-bodied fish (e.g. yelloweye mullet (*Aldrichetta forsteri*), congolli (*Pseudaphritis urvillii*), and bony herring (*Nematalosa erebi*)) were most abundant in the Murray estuary.

Flow and salinity were the primary drivers shaping fish assemblage structure in the Coorong. During drought/lack-of-flows (2007–2010) with higher salinities, fish assemblages were dominated by marine species in the Murray estuary, and the South Lagoon became unsuitable fish habitat due to its extreme hypersalinity (>4x seawater). Under high-flows (e.g. 2011–2013, 2016-17, 2021-22) with lower salinities (more freshwater–brackish conditions), fish assemblage changed with increased species richness and greater contributions of freshwater, estuarine and diadromous species. Salinity strongly influenced fish distribution in the Coorong, with a pronounced abundance decrease for most species when salinities exceeded 50 ppt. This study improved the understanding of flow and salinity effects on estuarine fish and will inform management to improve population resilience in estuaries.

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Spatio-temporal distribution and trophic niche of Australian cownose rays (*Rhinoptera neglecta*) off eastern Australia

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Pelagic myliobatiform rays are important mesopredators within marine ecosystems, yet major knowledge gaps currently exist regarding the biology and ecology of some species within this group. The Data Deficient Australian cownose ray (*Rhinoptera neglecta*) commonly occurs along the coast of eastern Australia, however, its distributions and trophic ecology remain unresolved. In this study, over 1300 sightings of cownose rays, collected during systematic aerial surveys, were analysed using a generalised additive modelling framework to identify trends and drivers of the species' occurrence and estimated group size in the New South Wales (NSW) region. Latitude and sea temperature had the largest effect on cownose ray presence/absence and group size, with the species occurring most frequently and in the largest groups in northern NSW, when sea temperatures were warmer. Additionally, stable isotope analyses of cownose ray fin clips (n = 29) were conducted to estimate the species' isotopic niche and compare to that of co-occurring whitespotted eagle rays (*Aetobatus ocellatus*; n = 21). Species was identified as the main factor contributing to variation among $\delta^{15}N$ (p <0.01) and $\delta^{34}S$ values (p <0.01), whilst disc width influenced $\delta^{13}C$ (p <0.05), indicating these species may be foraging in similar areas but are likely using different prey sources. The isotopic niches of these species overlapped substantially (57 to 75%), with the trophic niche of cownose rays being smaller and more constrained. Results from this study provide first insights into the distribution, relative abundance, and trophic ecology of Australian cownose rays at their southernmost distribution range and contributes important baseline information that will facilitate further research efforts and aid future population assessments.

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Determining the spatial distribution and temporal variability of fish and invertebrates in Cockburn Sound

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Cockburn Sound (CS) is a diverse and ecologically important marine embayment in the Perth metropolitan region, which is heavily utilised for a multitude of recreational, commercial and industrial activities. In 2021, the State Government announced plans to develop a new port for Perth within CS, and a project initiated to collect rigorous contemporary data to inform design and underpin necessary environmental impact assessment. To assess potential impacts on fisheries and aquatic resources several government agencies and universities are working on a collaborative research program to investigate species distributions, stock connectivity, trophic dynamics, invasive species, and effects of suspended solids and climate change on biota.

This presentation focuses on methods used to determine the distribution and abundance of the various life stages (larvae, juvenile and adult) of fish and invertebrates throughout CS during different times of year. These data will be used quantify relationships of communities and key species with various habitats and environmental variables, allowing the development of predictive distribution models and maps. In turn, outputs from this research will support mitigation advice to limit the effects of port construction on various species, and form a baseline for on-going monitoring of populations into the future. Building on several existing sampling regimes, a comprehensive two-year field program began in mid-2021, with monthly sampling occurring using a diverse range of methods (including trawls, seines, BRUVs, crab traps, bongo nets, squid jigging, light traps and hydro-acoustics). An overview of the first year's sampling, highlighting innovative survey techniques, findings and spatio-temporal trends, and the successes and challenges encountered so far will be presented.

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Identifying shark species responsible for fisheries depredation off Queensland Australia.

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Anecdotal reports from fishers in Queensland, Australia suggest that shark depredation is a significant issue, however little is known about which species are responsible for depredating catches. This research aimed to identify depredating species in Queensland line based fisheries, by undertaking a genetic analysis of depredated samples collected by commercial, charter and recreational fishers. The genetic analysis successfully identified at least nine depredating shark species, mostly from the genus *Carcharhinus*. The species identified using mitochondrial DNA included *C. leucas* (bull sharks), *C. plumbeus* (sandbar sharks), *C. amboinensis* (pigeye sharks), *C. brevipinna* (spinner sharks), *C. amblyrhynchos* (grey reef sharks), *C. sorrah* (spot-tail sharks), *C. limbatus/tilstoni* (blacktip sharks), *C. falciformis* (silky sharks), *C. obscurus* (dusky sharks), *Sphyrna mokarran* (great hammerhead sharks) and an unconfirmed *C. plumbeus*/*C. altimus* (bignose shark). While several species of *Carcharhinus* have been found to depredate catches in Australia, *C. leucas* has not been highlighted until this research as a potential problematic species. The optimised protocol allowed for the confident identification of shark species responsible for depredation in fisheries, using a citizen science approach combining the collection of frozen fish samples and swabs taken off depredated fish remains and donated by fishers.

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Hydroacoustic survey methods for assessing aquatic habitat and fish biomass and behaviour

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Hydroacoustic technology has been used in a wide range of applications since the early 1900's. The technology is available globally and is often used by recreational fishers to make qualitative assessments informing decision making. However, historically, this tool has also proven sufficiently powerful to perform quantitative scientific assessments of physical and biological underwater resources. Hydroacoustic technology operates on a level of efficiency unmatched by more conventional survey methods such as netting or electrofishing. In this assessment, four methods are examined for separate technologies – scientific split beam echosounders, recreational sidescan imaging, traditional 2D sonar and the more recent live scanning sonar. Each is considered for applications in habitat mapping and assessment, fish biomass estimates and fish behaviour assessments. Applications of vertical (down through the water column) and horizontal (across the water column) methods are compared. We discuss practical methods for planning surveys, collecting and cleaning data, and post processing and analysis suitable for monitoring, management and research applications. Samples of results from completed surveys are presented to demonstrate real-world applications.

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Establishment and biology of barred grunter (*Amniataba percoides*) beyond their natural range in the Clarence River, Australia

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Accidental and deliberate translocation of native fish outside their endemic range occur all too frequently in Australian freshwater ecosystems, with more often than not, detrimental outcomes. The barred grunter (*Amniataba percoides*) is a small-bodied teraponid fish that is found naturally throughout the freshwater streams and rivers of tropical and subtropical Australia. Through translocation, the species is also now found in several rivers and impoundments well outside its natural range, including in the Clarence River system, north-eastern NSW. We sampled barred grunter monthly within the Clarence River system over an 18-month period to determine their distribution, age, growth, reproduction and diet. Individuals were captured regularly throughout the freshwater reaches of the lower Clarence system, ranging from 76–197 mm fork length, 7–123 g in weight and we aged them from 0+ to 6+ years. The population structure and gonadosomatic index (GSI) values were indicative of annual spawning and recruitment since their introduction. The contents of stomachs revealed an omnivorous diet dominated by aquatic plants and to a lesser degree, micro- and macro-crustaceans. Our study has confirmed that the introduced barred grunter has successfully established in the Clarence River system. We discuss the potential future impact of barred grunter on the Clarence system, and suggest possible management options for this and other incursions of translocated fishes in Australian rivers.

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Chronic hypoxia in the Murray-Darling basin: Can fish acclimate through physiological and behavioural plasticity?

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During protracted drought periods in the Murray-Darling Basin, native fish persist in refuge waterholes which can become hypoxic and undergo significant warming. These conditions compromise fish physiological function by simultaneously elevating metabolic demand (warming) and reducing the availability of oxygen (hypoxia) required to fuel aerobic processes. This study investigated whether juvenile golden perch (*Macquaria ambigua),* could mitigate the deleterious effects of hypoxia and warming through mechanisms of physiological phenotypic plasticity and behavioural changes. Juvenile golden perch were acclimated to either normoxic (100% air saturation) or hypoxic waters (50% air saturation) warmed to 30°C for six weeks. Following acclimation, metabolic physiology, blood oxygen carrying capacity, hypoxia and thermal tolerance and behavioural responses to hypoxia and predation were assessed for both acclimation groups under normoxic and hypoxic conditions. Prolonged exposure to moderate hypoxia improved the overall hypoxia tolerance and additionally produced cross-tolerance to elevated temperatures in golden perch. Physiological plasticity of the heart and spleen also resulted following hypoxia acclimation, with both increasing in size to

support an elevated haematocrit. The improved blood-oxygen carrying capacity facilitated the maintenance of aerobic scope in hypoxia-acclimated fish despite conditions of low environmental O_2. Fish behaviour was also modulated by hypoxia acclimation, reducing their preference for normoxic environments but not improving their resilience to aerial predators. Golden perch were ultimately capable of adjusting their physiology and behaviour to offset moderate chronic hypoxia stress. The results of this study have implications for developing habitat suitability models to guide the management of crucial waterhole habitat and predict fish-kill risk.

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A global threat index for marine megafauna (TIMM)

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The global oceans are at risk of anthropogenic threats resulting from climate change, overexploitation, and habitat degradation. Speeding the process of quantifying the risk of these threats in a standardized manner is needed to better assess risk across spatial and temporal scales. Previous indices have used a global approach to evaluate the cumulative impacts of anthropogenic threats to marine ecosystems, which is difficult to apply to species that move between ecosystems, such as highly migratory marine megafauna. We developed an index to quantitatively evaluate the risk of existing anthropogenic threats to over 250 marine megafauna (representing birds, fishes, mammals, and reptiles) across the global oceans, considering species' full geographical distributions, conservation status, functional traits, and relative risk from 23 anthropogenic threats in four major categories (climate change, coastal impacts, fishing, and maritime disturbances), and using expert knowledge was used to determine the relevant vulnerability of each taxonomic group to each threat. This index will be key to evaluate the level of impact imposed by current threats to marine megafauna across a wide range of ecosystems and regions. Although applied here for the global oceans at 1-degree spatial resolution, this index offers a framework for researchers across all aquatic ecosystems to evaluate areas of high risk for species overlapping with anthropogenic threats.

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The influenced of food availability on the capacity for thermal plasticity in a coral reef fish

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While many tropical fish species and populations exhibit high sensitivity and negative impacts from acute ocean warming, with development and cross-generational exposure to warming thermal acclimation can occur. One reason why beneficial plasticity or acclimation to environmental change does not always occur is due to the expected costs of making phenotypic changes. In laboratory experiments, fish are generally fed to satiation and therefore have ample energy to produce phenotypic changes. This research explores whether reducing food resources to the current generation influences whether and how thermal plasticity occurs. This research found that food availability interacts with developmental thermal conditions, and the effect of food was greatest at elevated temperatures. The effects of grandparental fish's thermal experience on the current generation differed depending on the temperature and food conditions experience by the grand offspring (i.e., transgenerational plasticity). Furthermore, the effects of developmental warming and food availability differed depending on trait.

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Mitochondrial scope? A novel approach to assessing the interactive effects of thermal stress and oxygen limitation on mitochondrial performance in banded wrasse (*Notolabrus fucicola*) heart

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What kills animals as they approach thermal limits? Does oxygen (O_2) availability limit aerobic scope, is it an intrinsic metabolic failure, or a combination of both? The heart is the most metabolically active organ, and the first to fail as ectotherms approach critical thermal limits (T_{crit}). Just below T_{crit}, we found that fish heart mitochondria (*mt*) increase O_2 demands, yet respiration becomes less coupled, which should limit ATP synthesis. We explore interactions between *mt* O_2 consumption efficiency, *mt* membrane potential (*mt*MP) and ATP dynamics as O_2 supply declines. High-resolution-respirometers were coupled with fluorometric measures to assess O_2 uptake, *mt*MP, ATP synthesis (supply) and ATP hydrolysis (demand) rates, both in "steady states", and in the transition into anoxia. Mitochondria within permeabilised myocardium from New Zealand banded wrasse (*Notolabrus fucicola*) acclimated to 18^{o}C, were examined across a range of temperatures (18-30^{o}C), which span and exceed habitat temperatures. Importantly, we developed a novel approach to assess *mt* function through minimum and maximum O_2 consumption rates, similar to the whole organism measure of "aerobic scope". At low temperatures with excess O_2, *mt* appear tightly coupled, with stable *mt*MP and ATP production exceeding metabolic demands. However, as temperatures increase above 25^{o}C, these processes become impaired, with an uncoupling of oxidative phosphorylation, and increased *mt* respiration despite a loss of *mt*MP. This was reflected in an increase in *mt* "work" with temperature. In the transition into anoxia, *mt* scope and O_2 binding affinity increased with temperature, however, resulted in higher non-phosphorylating respiratory rates, and declines in ATP synthesis efficiency. Mitochondrial function appears to be fully impaired at 26^{o}C. Overall, we have developed a novel framework to assess the effects of thermal stress on *mt* function in the context of diminishing O_2, ie *mt* scope.

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Does the increase in shark activity during wildlife tourism lead to higher energy expenditure

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Wildlife tourism is expanding globally, as is the need to quantify its potential impacts on the species targeted. Studies on the effects of marine tourism on wildlife have focused on documenting behavioural changes, but whether changes affect the energy budgets and ultimately the survival prospects of these animals is largely unknown. This is particularly acute for large predatory sharks that are difficult to study but economically and ecologically important. To assess the effects of cage-diving on white shark energy expenditure, animal-borne cameras and accelerometer loggers were deployed on 18 white sharks (*Carcharodon carcharias)* at a cage-diving site (Neptune Islands Group Marine Park, South Australia) and recorded shark activity for 489.7 hours. A random forest machine learning algorithm was used to predict their behaviours based on 38 hours of acceleration data with behaviours confirmed from the animal-borne cameras. The presence of cage-diving vessels led to white sharks being more active and spending more time undertaking high-energy swimming (vectorial dynamic body acceleration [VeDBA] 0.04 ± 0.03 g; doubled) and bursts of acceleration (VeDBA 0.44 ± 0.38 g; seven-fold increase) while decreasing low-energy swimming (1.5-fold). However, once put in the context of daily energy budget and accounting for the duration of cage-diving activities (~6 hours per day), energy expenditure was not substantially affected by wildlife tourism, with the presence of cage-diving vessels leading to a 0.4 – 0.7 % increase in field metabolic rate. Our findings show that while food-based tourism can influence white shark behaviour and increase energy expenditure, the overall impact on field metabolic rates and daily energy budget is minimal.

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Consistent circadian rhythms across populations and life stages of a globally-distributed marine predator

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Circadian rhythms are innate responses to cyclic daily changes in the environment (e.g. night and day) allowing physiological and behavioural processes such as feeding or resting to occur at the most suitable times. Given that circadian rhythms are thought to be an adaptive response to prevailing conditions, it raises the question of whether globally-distributed species display adaptative routines in response to local conditions. Here, we tested if the circadian rhythm of the white shark, Carcharodon carcharias, a circumglobally-distributed marine predator, differs among four populations and across eight aggregation sites in three of the world's oceans. We derived the diel activity of 104 sharks through motion-sensitive biologgers that collected over 2,500 hours of activity data. Overall, we found that diurnal circadian rhythm was conserved across all populations but found site-specific differences in this diurnality, with the activity of some populations peaking before noon, while others peaked in the afternoon. Our results suggest that despite diverging thousands of years ago, the circadian rhythm of white sharks has largely remained consistent with only minor local adaptation. We suggest that maintenance of this diurnality is a result of sensory specialisation, while the minor variations of the timing of activity is an adaptive response to the availability of prey.

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Cartilage under pressure: what can we learn from deep-sea chondrichthyans?

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Cartilaginous fishes have evolved a unique skeletal system consisting mainly of unmineralised cartilage, a tissue that resembles the articular cartilage found in the joints of other vertebrates. Compared to other vertebrate taxa (including other fish groups), most of their skeleton is 'tessellated', i.e., made up of an unmineralised core covered by a thin layer of mineralised 'tiles' or tesserae. While deep-sea species are able to withstand high hydrostatic pressures, ranging from 10 to 300 times greater than

sea level depending on the depth they inhabit (typically <3000m), such extreme pressures would inevitably produce serious mechanical stress resulting in acute tissue damage when applied to the cartilage of terrestrial mammals.

We hypothesise that the extracellular matrix (ECM) secreted by cartilage cells (chondrocytes) within the skeleton of species found at different depths would show interspecific differences in microstructure, composition, and mechanical properties, and even site-specific differences in mineralisation and biophysical properties, to maintain tissue integrity according to functional load. The study uses a multimodal and multiscale approach to cross-correlate 2D histo-morphological and immunohistochemical data with 3D bioimaging, and biomechanical testing, in two main skeletal regions of interest (vertebrae and neurocranium) across representative species that occupy different depth profiles. Preliminary results reveal marked histological differences in the level of tissue mineralisation between areas, as well as varying collagen and proteoglycan contents in the ECM of unmineralised cartilage, potentially indicating characteristics adapted to an environmental gradient. Whether these observations are depth-related remain to be tested.

Ultimately, our characterisation and better understanding of such adaptations, in the structure, composition and mechanical properties of skeletal systems, which are exposed to high hydrostatic pressures, may inform future applications in cartilage tissue engineering and regenerative medicine, in addition to elucidating how many species are able to make large vertical movements within their depth range and maintain skeletal integrity.

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Acute hypoxia combined with high temperatures significantly reduces Atlantic salmon aerobic scope

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Background: Rising ocean temperatures and concurrent hypoxic events pose a threat to Tasmanian Atlantic salmon (*Salmo salar*) aquaculture. These conditions have been increasing in severity and frequency over the past decades, pushing this species to its physiological limit. Increasing environmental temperatures increases the oxygen demand of fish (metabolic rate), while hypoxia reduces oxygen availability. Together, these stressors can reduce the oxygen available in the organism (aerobic scope, AS) for aerobic activities such as digestion, leading to poor growth and physiological performance. Digestion can occupy a significant amount of the AS and competes with other fundamental aerobic demands. Consequently, decreased feed intake, growth and mortality have been observed at elevated temperatures and during periods of hypoxia. Therefore, the loss of appetite at high temperatures and low aquatic oxygen levels could be a protective mechanism to preserve the available AS.

Aims: To investigate the impact of environmental stress – chronic high temperature and acute hypoxia - on Atlantic salmon's aerobic capacity and digestion.

Methods: AS and SDA were measured by intermittent flow respirometry at 15°C and 21°C, at normoxia (above 75% air saturation) and hypoxia (1.5h exposure; ~50% air saturation).

Results and conclusion: There were no differences in the AS between temperatures under normoxia. In contrast, hypoxia significantly reduced the AS at both temperatures. As a result, digestion occupied a significantly higher proportion of the AS under hypoxia at both temperatures than under normoxic conditions. Thus, acute hypoxia exposure compromised Atlantic salmon digestion at both optimal and high temperature by limiting the AS and increasing the relative (proportional) energy costs associated with digestion.

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Environmental variables that influence distribution and movement of blue salmon catfish *Neoarius graeffei* in a coastal river catchment in northern NSW Australia

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Coastal river systems are highly complex and serve as important corridors for diadromous fish species that rely on habitats in both marine and freshwater environments to complete their lifecycles. Movement between these environments is important as it provides access to different habitats to optimise growth, survival and reproduction. In this study, we used acoustic telemetry to quantify the relative importance of abiotic stimuli in relation to seasonal movement patterns in blue salmon catfish, *Neoarius graeffei* throughout an unregulated coastal river catchment, the Clarence River in northern New South Wales, Australia. Thirty individuals were surgically implanted with acoustic coded tags and movements were recorded passively by a linear array of 32 acoustic receivers, encompassing approximately 164 km of river throughout the lower reaches of the Clarence River and selected tributaries. Movements were monitored over a period of approximately 12 months. We found that blue salmon catfish in the Clarence River catchment are mostly confined to lower Clarence reaches and move between the upper estuary to freshwater habitats well beyond the saltwater and freshwater interface. River flow was influential in *N. graeffei* seasonal movements with fish moving downstream in during high flow events. Our results provide a better understanding of the movement corridors that *N.graeffei* use in a coastal river at the southern extent of its range. Human impacts to coastal systems, particularly changes to the natural flow regime as a result of river regulation, have the potential to alter the movement patterns of species like *N.graeffei*, that use flow to cue their movements in unregulated coastal systems.

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Connectivity of south-eastern Australian yellowtail kingfish (*Seriola lalandi*) informed by the world's longest-lived, citizen-science saltwater tagging program

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Yellowtail Kingfish (*Seriola lalandi*) are a large, pelagic, highly mobile species of considerable commercial and recreational importance in Australia. The "Eastern Australia" stock, recognised to be genetically distinct from the West Australian population, spans several fisheries jurisdictions in southern and eastern Australia, however empirical movement data to inform stock structure at an ecologically-relevant time frame are currently limited. In this study, we describe distribution and connectivity of the Eastern Australia kingfish stock using over 40,000 tagged and released kingfish and 3,000 subsequent recaptures spanning 1973-2022 as part of the New South Wales (NSW) Game Fish Tagging Program, the world's longest-lived, citizen-science saltwater recreational fishing tagging program. Broad-scale network analysis of 337 tagged kingfish revealed connectivity across five main bioregions across coastal and offshore southern and eastern Australia, as well as New Zealand (NZ). Connectivity also exists between state fishery jurisdictions, with extensive movements (n = 76) identified between NSW, South Australia (SA), Queensland, Victoria and NZ. Seasonal variability was evident in both releases and recaptures, with most states having a higher proportion of kingfish tagged and released in summer and autumn. Whilst spawning-sized kingfish (>83 cm fork length) were consistently caught and recaptured by recreational anglers in NSW waters, strong seasonality was evident for kingfish in SA, that exhibited both broad-scale connectivity with NSW as well as yearly spring availability in coastal SA. In contrast, juvenile kingfish (<50 cm FL) were mostly tagged in NSW and during summer months. Despite broad-scale coastal and offshore movements recorded, most individuals were recaptured within 5km and 60 days of their release location, indicating some degree of site fidelity. Our findings provide important new insights into the structure and connectivity of kingfish across eastern and southern Australian waters and highlights the need for multiple fisheries jurisdictions to collaborate in assessing and managing this stock.

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Sawfish spotters fill data gaps critical for sawfish protections in Queensland, Australia

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In Australia, effective management of critically endangered sawfishes is a difficult task, in part due to remaining habitat being extremely remote and expensive to reach. Since the federal recovery plan was put in place in 2015, field investigation in Queensland has been limited to few river systems, not allowing for a full-scale species distribution assessment.

In 2017, Sharks And Rays Australia launched a public sightings campaign targeted at recreational fishers to fill knowledge gaps in population abundance and spatial ecology. Since then, over 1150 submissions have been received Australia-wide from members of the public. Data from Queensland encounters reported to have taken place between 1998 and 2022 were analysed, representing equal temporal distribution before and after federal protection.

Sighting locations were analysed for association with commercial and recreational fishing pressure and environmental protection measures. Size and year of capture were negatively correlated, even over a relatively short time span of 20 years. In addition, while *P. zijsron* and *A. cuspidata* are both present on the east coast of Australia, species composition fluctuated drastically moving south, with only *A. cuspidata* recently confirmed in Southeast Queensland. Spatial data coupled with release condition of each species, suggests where levels of fishing pressure have the greatest potential impact on surviving populations.

This study provides first insights into key habitat for different life history stages on the Queensland coast since becoming federally protected. Additionally, findings highlight the importance of citizen science as a reliable data source, and a platform for the direct involvement of the recreational fishing community in protecting critically endangered species.

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Effect of the environment on the development of laterality and personality in the Three-spined Sticklebacks

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Laterality of brain and behavior has been found to be widespread among animal species. Recently, laterality has been found to be correlated to personality. In addition, the development of both personality and laterality in fish can be influenced by environmental factors: e.g., high perceived predation leads to bolder and more lateralized individuals. Also, in fish, bolder and more lateralized individuals tend to swim in a safer and energetically more favorable position than other individuals while schooling. However, whether this correlative evidence indicates a causal relationship between laterality and personality is yet unclear. Such a causal link will have consequences for evolution, as selection on one may constrain evolution of the other.

The aim of this experiment was to manipulate rearing conditions to see to what extent both laterality and personality are affected together, which would indicate a causal relationship between the two. Three-spined stickleback larvae were therefore reared under predation cues or in the absence of it in small or large groups for 3 months in a two-by-two design, after which their behavior during schooling, social interacting, and predator inspection was recorded in standard tests. We expected that the fish reared under high predation perception and/or in large groups will show a higher tendency to school, a bolder behavior and more lateralized behavior than the control group reared under low predation pressure and small group size.

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Microplastic in oysters: A review of global trends and comparison to southern Australia

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Microplastics have been documented in a plethora of marine environments and organisms. These small plastics threaten ecosystem health, with implications for seafood species' health. Oysters are an important cultural and economic aquaculture species globally. Due to their filter feeding mechanisms, oysters act as a key indicator species by serving as a proxy for environmental contamination. This makes them the ideal organism for investigating microplastic pollution. Here, we first systematically reviewed the global literature investigating microplastic in oysters. Globally, 94.4% of all oysters had microplastics, with an average of 1.41 ± 0.33 pieces per gram of soft tissue wet weight (gww). The review found that wild-caught oysters contained more than double the amount of microplastic than aquaculture raised specimens, likely reflecting the clean and productive waters in which oyster aquaculture systems are commonly located. Second, we quantified microplastic presence and polymer type in commercially farmed oysters (*Crassostrea gigas* and *Saccostrea glomerata*) across a broad spatial scale, covering eight sites in southern Australia. Microplastics were present in 49.4% of all sampled oysters, with specimens from all locations containing microplastics. On average, whole oysters contained 0.83 ± 0.08 microplastics per individual or 0.09 ± 0.01 microplastics gww. Using Fourier-Transform Infrared Spectroscopy, we identified that 62% of the verified microplastics were vexar plastic netting, a low-density polyethylene commonly used in aquaculture production. Understanding the abundance and source of microplastic in these key seafood species is essential to determine if oysters are vulnerable to these contaminants and pose a risk to the oyster aquaculture industry which is an important food resource.

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Multiple human stressors impact an endangered seagrass population and alter fish communities

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Estuaries are becoming increasingly threatened by human activities and there is growing appreciation that the management of estuaries must consider impacts of multiple human stressors. Cumulative impact maps have become a popular tool to identify the distribution and intensity of multiple human stressors in estuaries. Few studies, however, have demonstrated strong correlations between cumulative impact maps and changes in ecosystem condition questioning their use for management. Here, we developed a cumulative impact map for *Posidonia australis* in Pittwater, NSW, Australia, using spatial data on known stressors to seagrass including water quality, boat moorings, jetties and vessel traffic. We then tested how well cumulative threat scores explained changes in *Posidonia australis* cover between 2005 and 2019 measured using aerial imagery. *Posidonia australis* cover increased in areas where cumulative effect scores were low (<4), while declines were observed in areas where cumulative effects scores were high (>4). Using baited remote underwater video we surveyed fishes over seagrass and bare sediments to quantify how changes in seagrass area may be influencing estuarine fish assemblages. As expected, seagrass contained a distinct assemblage of fishes compared to bare sediments. On bare sediments the abundance of sparids (yellowfin bream, tarwhine and snapper) were positively associated with distance to seagrass. Our results demonstrate the negative impact of multiple stressors on *Posidonia australis* area in Pittwater, which has consequences for estuarine fish biodiversity and the abundance of targeted fishes. Our results suggest that management actions aimed at reducing or limiting cumulative effects to low and moderate levels will help conserve *Posidonia australis* populations and their associated fishes in Pittwater.

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Anthropogenic disturbance shapes functional diversity and ecosystem functioning in coastal ecosystems

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Human impacts to biodiversity are pervasive and have led to widespread changes in the abundance, variety and functional traits of plant and animal assemblages. These impacts alter the roles of species in ecosystems, erode ecological resilience and productivity, and undermine the delivery of ecosystem services. Their ecological consequences are, however, often poorly understood in coastal oceans because of historical overfishing, eutrophication and urbanisation, and the absence of empirical data to describe changes in most food-webs. Here, we show a precipitous decline in functional diversity of coastal fish assemblages due to human disturbance across multiple coastal ecosystems throughout eastern Australia. This food-web simplification follows reductions in the abundance and diversity of iconic, endangered, and functionally significant coastal fishes, and the loss of variety, complementarity, and redundancy in functional trait space. These changes resulted in significant declines of all aspects of functional diversity. Our results demonstrate how human disturbance in coastal ecosystems can have fundamental consequences for ecosystem functioning, and highlight the focus management must take in conserving these ecosystems to avoid negative functional consequences.

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Assessing fisheries interactions population demographics and residency of the protected oceanic whitetip shark c*archarhinus longimanus* through citizen science and photo identification

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Oceanic whitetip sharks (*Carcharhinus longimanus*) were listed as threatened under the Endangered Species Act in 2018, and stock assessments indicate that populations in the western and central Pacific are historically and currently overfished. Yet, large data gaps remain in relation to the basic biology, ecology and population structure of this species. Photographic identification is a common and non-invasive method used to evaluate metrics of elasmobranch population demographics, abundance, residency and movement, and social behaviors. The main Hawaiian Islands are a known 'hotspot' for *C. longimanus* where they typically exhibit seasonal residency, a finding that is also supported by local fisher knowledge. This study describes the results of the Hawaii Community Tagging Program, a citizen science initiative in which fishers, divers and snorkelers submitted images of *C. longimanus* interactions around the main Hawaiian Islands beginning in 2008. These interactions include the tagging of 114 individuals between 2015 and 2022. Over 2000 images of *C. longimanus* were analyzed, and dorsal fin patterns were used to determine the number of unique and resighted individuals. To date, this study has identified 337 unique individuals with 21 confirmed resights; the sex ratio of females to males is approximately 2:1 (169 females and 81 males identified). We identified 45 females (~26%) with scarring or injuries from potential mating interactions and 85 individuals (~34%) carried evidence of previous fishing interactions. The information obtained from this study can help provide necessary baseline information regarding the population demographics, residency and fishery interactions of *C.longimanus* around the main Hawaiian islands to help inform conservation and management measures for this protected species.

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Population genetics of Tablelands rainbowfishes

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The Atherton Tablelands region in Queensland is home to exceptional rainbowfish species diversity, including the Endangered Lake Eacham rainbowfish (*Melanotaenia eachamensis*) and the Critically Endangered but undescribed Malanda rainbowfish. These species are known from only a small number of populations and are threatened by the risk of hybridisation with the widespread eastern rainbowfish (*Melanotaenia splendida*). Understanding the genetic history of these populations is therefore critical to understanding their evolutionary history, accurately delineating species boundaries, and implementing appropriate conservation management. We develop species networks - which allow for both population splits and gene flow between populations - to examine the evolutionary history of Tablelands rainbowfishes. We reveal multiple instances of gene flow between *M. splendida* and populations of both *M. eachamensis* and Malanda rainbowfish. We also find gene flow between Malanda rainbowfish and the now-extinct population of *M. eachamensis* in Lake Eacham, the type locality of this species. These results have important implications for species delineation, description, and conservation in fishes.

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A Tale of Two Sities [*sic*]: Long-term Patterns of Fish Communities at Lindsay-Mulcra-Wallpolla and Hattah Lakes, Lower Murray River.

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The Lindsay-Mulcra-Wallpolla (LMW) and Hattah Lakes (HL) Icon Sites are part of The Living Murray (TLM) Condition Monitoring Program. The TLM condition monitoring program aims to measure the long-term ecological benefits of environmental flows and other management activities at Icon Sites along the Murray River. Condition monitoring has been undertaken annually since 2006, with the exception of 2015, due to a lack of program funding. Since 2010, fish monitoring has occurred in Autumn at fixed sites, stratified by macrohabitats within each Icon Site: Riverine, Anabranch, Channel (LMW only) and Wetland (HL only). Fish sampling uses standardised methods and effort, including: electrofishing (boat/backpack), seine hauls and fyke nets. All fish collected are identified, measured and returned to the water. The aim of this project was to undertake a range of analysis approaches to explore (i) population differences among years and macrohabitats, (ii) long-term population trends and change-points, and (iii) the influence of suspected key drivers of population changes.

Although derived from the same species pool, fish communities at LMW and HL are remarkably different between the Sites, among macrohabitats, and have exhibited significant shifts due to higher flows and drying periods. The presence and abundance of large-bodied native species has undergone distinct periods of fluctuations due to the effects of blackwater (2011, 2016), high flows (2010–12, 2016, 2022) and low flow/dry years (<2010, 2014–16, 2017–21). There are also key differences in species responses given their life history attributes. The abundance of common small-bodied native species fluctuates significantly across years, while many other small-bodied species remain at low or sporadic detection. This analysis describes important variability in fish communities and establishes a baseline to set realistic future restoration targets for native fish in the region.

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Assessing stock structure and environmental influence on a popular sciaenid using parasites as biological tags

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For any exploited fish population, like the black-spotted croaker, studies on the dynamics of the population need to begin with determining the biological identity of the species in relation to neighbouring populations of the same species. Parasites represent ideal indicators of host population variance and movements, and the present study has utilised the parasite assemblages affecting the black-spotted croaker as biological tags to understand the basic biology and population structure of the fish. Given the predicted consequences of climate changes on marine species richness and ecosystem functionality, the aim of this presentation was to also review the potential environmental impacts on the marine parasite-host systems. Complex analysis using the parasites as biological tags confirmed the presence of four distinct fish populations off the northern Australian study area. In addition to deciphering the stock structure of this important fish, multivariate analysis provided significant insight into both the direct climate-induced pressures placed on the sciaenid, and the indirect influences of climate on the marine ecosystem. The sciaenid demonstrated small scale movements and behaviour alterations depending on the spatial and temporal measures of the study, with environmental changes confirming the potential influence of future climate changes on the survivability of the large teleost and its parasites. It is with accelerated importance that biological studies on important marine species such as the sciaenid are done, and with the results from this study highlighting the seasonality impacts on parasite-host systems, there is no doubt that parasitic organisms represent an integral role in future fish biology and climate studies.

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A comparison of the effectiveness of three fishway designs for use in a large tropical river system *(Speed Talk)*

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5. Living Aquatic Resources Research Centre, Vientiane, Lao PDR

The development of dams and other infrastructure is placing significant pressure on the diverse and productive fisheries in many tropical river-floodplain systems, especially in systems like the Mekong River, where the fisheries are crucial for food security. Such structures prevent fish from accessing important feeding, spawning and nursery habitat. Fishways are becoming increasingly important for alleviating the impacts of barriers; however, there is still scant knowledge regarding their effectiveness for tropical river systems. We investigated the efficacy of three low-cost fishway designs for restoring degraded floodplain fisheries in the Lower Mekong Basin (LMB) in Laos: (1) vertical slot; (2) submerged orifice — 150 mm square opening; and (3) submerged orifice — 300 mm square opening. Field experiments were performed during the day and night to compare the abundance, biomass, species richness and size range of fish able to pass through the three designs. Passage of a total of 73 species was supported by each of the three fishway designs at a similar abundance, biomass, species richness and size range of fish, during both the day and night; though, the vertical slot design supported a different suite of fish species to that of the other two designs

during the day. Our results suggest that each of these fishway designs could be effectively used to support the restoration of fisheries in the LMB and potentially other large tropical river systems with relatively diverse migratory fish communities and variable hydrological characteristics. Nonetheless, the vertical slot provides greater design and operational flexibility over the submerged orifice designs particularly in tropical systems with inherently variable hydrology. The final choice of fishway design ultimately rests on the fish species and size classes being prioritised for restoration and the hydrological features of the site.

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Charting recovery during extreme and uncertain times - the role of science, leadership and a diversity of voices

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As fisheries scientists and managers, we marvel at the complexity and beauty of the ecosystems we work and live on. But we also know all too well that these systems are in significant trouble. Over centuries we've lost many of our fish as a result of the changes we've made to natural systems. As science leaders it is on all of us to ensure that broader society is equally conscious of this beauty and the threats, and is engaged to partner with us in the recovery. To this end, we dedicate our careers to understanding the biology and ecology of our rivers and oceans. Just as important (although often neglected) is fostering an equally deep understanding of what connects all of us, as people, to our environment. If the current pandemic and recent bushfires, droughts and floods have taught us anything, it is how important connections are to us as humans - both with each other and our environment. Relationships with those around us and our environment nurture us. These connections will be critical as we chart a recovery for communities and the environment that sustains them. Throughout this conference you'll see many talks by colleagues, some who are friends, outlining results from their research. This is not one of those talks. Instead, I want to share a bit of my journey. How I look these imperilled ecosystems and what I bring to leading a research group. How working with people, whether connected to rivers intellectually, financially or spiritually brings a diversity of perspective and knowledge that has not only enriched how I view rivers, but more importantly shapes the way we research and manage NSW freshwater fisheries.

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Taxonomy as the foundation and synapses for fish biology

Michael Hammer[1]

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The diversity of life can provide a source of amazement and wonder, being especially pronounced for fishes through variety in shape, colour and biology. Species are the unit of measurement for biodiversity that best connects scientists, managers and the community, and the ongoing task to document and understand species is critical given accelerating anthropogenic environmental change. But the science of taxonomy to define species remains in the background, often perceived as dry, technical, specialised and somewhat confusing. This presentation aims to explore why resolved taxonomy is a principal foundation of all biological research and provide ideas on how to change its perception, to reinvigorate taxonomy, and encourage growth and better integration within fish biology. A first key pillar for this lies with a combined lines of evidence approach to defining species, where morphological, genetic/phylogenetic, biogeographical, ecological and cultural information form a picture of how a taxon can be defined within the environment. In short good taxonomy creates good science, and striving for a better understanding of what defines species should spark ideas and collaborations between disciplines, to drive a positive feedback loop that in turn supports collections based research. The second key pillar is science communication, to provide modern and appealing tools, imagery and stories to inspire stakeholders to develop an eye for detail. This discussion will be underpinned by different examples of species discovery, ID tool-development, reflections of time on Country, and citizen science.

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Reading the biomineralized book of life: Expanding otolith chemical research and applications for fisheries and ecosystem-based management

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10. University of Hawaii at Manoa, , HA, USA

11. University of Southampton , , UK

12. Atlantic Technological University, , Ireland
13. Department of Primary Industries, , Narrandera, NSW, Australia
14. Charles Sturt University, , Albury, NSW, Australia
15. University of California, , Santa Cruz, CA, USA
16. National Taiwan University, , Taiwan
17. University of California, , Davis, CA, USA
18. Swedish University of Agricultural Sciences, , Sweden
19. State University of New York, , Syracuse, NY, USA
20. Texas A&M University, , Corpus Christi, TX, USA

Chemical analysis of otoliths and other calcified structures continues to thrive. Analytical advances allow us to tap into the chemical and isotopic composition of otoliths, but also of many other archival structures, to reconstruct fish life histories at ever greater resolutions. More and more, biogeochemical tracers are being applied to enhance age estimation and interpretation, and to chronicle responses to environmental conditions and stressors, linking these to ecological, physiological, and life-history processes. Here, we review innovative approaches in the chemistry of archival tissues, highlighting our current work and case studies focusing primarily on otoliths and their outstanding value for fisheries and ecosystem-based management. We summarise recent milestones and future challenges, turning the spotlight on areas where otolith chemistry is rapidly expanding to further support decision-making. We do this across application-oriented research areas that combine biogeochemical analysis with a host of disciplines. Overall, emerging research directions that apply hard part chemistry to unravel past food webs, combat seafood fraud, as well as resolve and integrate growth, thermal and metabolic stress, movement, or reproductive life histories provide a clear-sighted focus to examine how harvesting and global change may impact fish health and fisheries productivity. Ultimately, these emerging approaches on otoliths and calcified structures provide a wealth of information that can be harnessed to strengthen fisheries and ecosystem-based management.

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Whole genome sequencing can transform Australian fish biology

Matthew McGee[1]

1. Monash University, VIC, Australia

Whole genome sequencing has the potential to radically improve our ability to understand and manage the exceptional biodiversity of Australian fishes. Here, I illustrate the specific utility of whole genome sequencing in Australian fish biology via a series of collaborative multi-institution projects integrating conservation, taxonomy, and evolutionary biology. I show how genome sequencing of Australian fish species can improve our ability to manage threatened biodiversity, resolve taxonomic challenges at a variety of evolutionary timescales, and facilitate the study of broad-scale evolutionary patterns across vertebrates. I also showcase how performing both sequencing and bioinformatic analyses within the country can build capacity while enhancing the influence and impact of Australia's next generation of fish biologists.

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Using DNA barcoding to identify undersampled and threatened alpine freshwater crayfish species

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Australia is home to many endemic genera of freshwater crayfish, including the cold-water adapted spiny crayfish, *Euastacus*. A recent study examining the species identities of *Euastaus,* including the mountain spiny crayfishes (Alpine crayfish *E. crassus* and Riek's crayfish *E. rieki*), suggests that the species assigned to these crayfish by range maps are questionable and there may be three or four species of mountain spiny crayfish rather than two currently recognised (Austin et al. 2022). Suprisingly, there are little to no samples of *Euastacus* crayfish from Kosciusko National Park available, so again, it is unclear what species are present in the Park, nor what conservation actions are necessary to prevent their further decline. The first step in conservation action is identification of the units of conservation concern. Therefore, we collected 18 crayfish samples from the three river catchments of Kosciusko National Park (5 from creeks within the Snowy River catchment, 2 from creeks within the Murray River catchment and 11 from creeks wihin the Murrumbidgee River catchement) and conducted sequence analysis of the mitochondrial cytochrome c oxidase subunit (COI) gene to identify the species located within the Park using DNA barcoding based off of sequences deposited in GenBank and species identies from Austin et al. (2022). The species identifications and locations, implications for conservation and biogeography of these mountain spiny crayfishes are discussed.

1. Austin, C., Whiterod, N. S., McCormack, R., Raadik, T. A., Ahyong, S. T., Lintermans, M., Furse, J.M., and Grandjean, F. (2022). Molecular taxonomy of Australia's endemic freshwater crayfish genus Euastacus (Parastacidae), with reference to priority 2019–20 bushfire-impacted species – 2022 update. A report supported by the Australian Government's Bushfire Recovery for Wildlife and their Habitats. Deakin University and Aquasave–Nature Glenelg Trust, Victor Harbor.

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Using environmental DNA to reconstruct target and by-product catch composition for fisheries vessels

Madeline Green[1], Denise Hardesty[1], Pascal Craw[1], Bruce Deagle[1], Chris Wilcox[1]

1. CSIRO, Hobart, TAS, Australia

Fisheries are an important source of food, income and cultural connection for millions worldwide. The pressure from fishing activity can have detrimental impacts on marine ecosystems and coastal livelihoods if not properly managed. Establishing appropriate management measures relies on understanding specific aspects of the fishery, for example what species were caught and recorded in logbooks. There are a wide range of reasons for wanting to reconstruct catch data from fishery independent data. Logbook records may be unavailable or inaccurately report landed species and biomass. Vessel operators or crew may take unregulated or prohibited species, either for sale or for personal consumption. Policy makers during international conventions (CMS, CITES) may make significant binding decisions and treaties with incomplete data. Unfortunately, trained observers who collect crucial independent data onboard vessels cover only a small percentage of total fishing activity. This leaves a significant opportunity for Illegal, Unreported and Unregulated (IUU) fishing practises, the likes of which pose a risk for the management and protection of vulnerable species.

This presentation will introduce a novel eDNA method for forensically reconstructing catch stored in the brine tanks of commercial fishing vessels. Our method allows for a small volume of water to be collected, sequenced and analysed to identify species and rank order abundance. The eDNA collected on-board fishing vessels represents animals that have been in the hold since it was last emptied, providing a time-integrated record of species catch and transport. We propose the application of our eDNA sampling protocol is a cost-effective tool for monitoring and surveillance, particularly for protected or quota species and in under-resourced regions.

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Big fish, small fish, no fish; when size (and quality) matters for genetic species identifications of fishes?

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Natural history collections are repositories of biodiversity. In the 'omics' era, collections provide critical access to a wealth of molecular information inherent in collection specimens. In this presentation, we outline several published studies (Appleyard et al. 2021, https://doi.org/10.1111/jfb.14687; Appleyard et al. 2022, https://doi.org/10.1016/j.jembe.2022.151763) and highlight an ongoing research collaboration, that are all built on the CSIRO Australian National Fish Collection. In Appleyard et al. (2021), we compared DNA barcoding and identification success for frozen and formalin-fixed tissues obtained from adult specimens. Using 230 samples from adult fishes (consisting of >160 fish species), in good quality DNA (without exposure to formalin), up to 88% of the specimens were correctly matched at the species level, whereas up to 58% of the specimens exposed to formalin for less than 8 weeks were also correctly identified to species. In Appleyard et al. (2022), whole larval specimens (and single eyeballs <1mm in diameter) from controlled and in-field 5% formalin exposure experiments were analysed. DNA barcoding and genetic species identification was 100% successful in cultured yellowtail kingfish fixed in formalin for up to 6 months, while barcoding of wild caught fish larvae enabled species identification of 93% of up to 8-weeks formalin fixed specimens. Additionally, with collaborators from SARDI, the ANFC is using tagged molecular assays in a current study evaluating the potential of DNA meta-barcoding to harvest ecological data from broad scale ichthyoplankton surveys.

Collectively these studies highlight, that within parameter constraints, single sourced and bulked DNA samples of fishes (irrespective of size), combined with a variety of extraction methodologies and sequencing approaches results in accurate genetic identifications. Success however relies on reference sequences from vouchered adult specimens deposited in publicly available databases such as those in our extensive sequence library from Classes Actinopterygii and Elasmobranchii in the Barcode of Life Datasystem, BOLD.

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Developing an eDNA tool for fish population monitoring in streams

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Aims

This project aims to develop an environmental DNA (eDNA) tool to detect and estimate the biomass of both native and non-native fish species in Victoria's streams. The specific objectives of this experiment are to determine if there is a measurable difference in the eDNA concentration relative to the biomass of fish present, to assess whether that difference is large and consistent enough to form the basis of population models, and to examine how stream flow rates may alter the distance in which fish DNA is detectable.

Methods

This project consisted of two parts, the collection of water samples for eDNA analysis and a standard electrofishing survey for measurement of fish biomass. A site consisted of a 250m stretch of steam sectioned into five 50m zones with stop nets. Each zone had an eDNA sample taken at its downstream end at three locations, each stream bank and the midstream. At these same locations, stream depth and water velocity measurements were taken to measure stream flow rates. Starting from the most downstream zone, an electrofishing survey made three electrofishing passes. Individuals of the three target species (brown trout, rainbow trout and river blackfish) were counted, measured, and weighed to determine the biomass of each fish species in each zone. The process was repeated moving upstream in each of the other 4 zones. For eDNA measurement, a single-species primer will be used to find the eDNA concentration. eDNA concentration will be compared with fish biomass using ANOVA analysis.

Results

Field work was undertaken in May 2022 at three sites around Lake Eildon, Victoria. We collected 17 brown trout, 48 rainbow trout and 227 blackfish. eDNA analysis is planned for July, 2022.

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The doors are closed, but the windows are open: Fish parasites bypassing Australia's biosecurity measures

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Australia's freshwater systems are globally important for their biodiversity however they face numerous challenges and one of the worst extinction records in the world. Australia's biodiversity conservation plans usually are not inclusive of parasites nor on their impacts on freshwater fish populations. Parasites play a key role in shaping community structures through their effects on trophic interactions, food webs, competition, and keystone species. With an increased decline in the relevant expertise in Australia, leading to limited investment in research on parasites of native freshwater fish species, it is likely that many parasites will remain ignored in broader conservation management discussions. In this presentation, evidence on the impact of introduced invasive species on Australia's iconic freshwater fish are provided. Despite limited resources, in the last five years research has found:

-new species, previously unknown to scientists,

-new parasites previously not reported in Australia,

-host switch of invasive parasites from introduced animals to native species, and

-evidence of parasites spill over and spill back.

These findings suggest that many parasites still pass Australia's strict biosecurity border, successfully establish themselves in Australia and impact population of Australian animals, many in vulnerable status.

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How much screen time is too much for baby golden perch?

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Fish protection screens are increasingly being used in Australian rivers to prevent native fish from being lost at water diversions. Australian specifications for their design have been produced prescribing that approach velocity (the perpendicular flow 8 cm in front of the screen) should not exceed 0.1 m sec^{-1}. This specification is based on data of swimming performance of juvenile fish and it is uncertain to what degree it provides protection for larvae. The swimming performance of golden perch larvae at three developmental stages (protolarvae, postflexion and metalarvae) was observed in front of a fish protection screen in a specialised swimming flume. Approach velocity and temperature was varied, and we collected data on the likelihood of impingement and the time it took for impingement to occur. We also quantified what type of swimming behaviour fish employed to avoid impingement. Protolarvae were most susceptible to impingement with around 100% becoming impinged at 0.1 m sec^{-1}. While protolarvae have a relatively poor sustained swimming ability, by seeking hydraulic refuge afforded by surface roughness, they could still avoid impingement for 10-25 seconds (depending on water temperature). Ability to avoid impingement improved substantially as larvae developed, with only 40% of postflexion larvae and 0% of metalarvae being impinged at 0.1 m sec^{-1}. Body development of these older stages enhanced their use of burst swimming behaviour to avoid impingement. This burst behaviour was further enhanced at 25^{o}C when compared to 20^{o}C. The current Australian specification for fish protection screen design, which recommends approach velocity not exceed 0.1 m sec^{-1}, will provide protection for larval golden perch, with protection improving significantly as the larvae move beyond the protolarvae stage.

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Neophobic behavioural responses of parasitised fish to a potential predator and baited hook

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Many juvenile fish show essential avoidance of predators but are also faced with the need to show risky asset-acquiring behaviour such as trying new food sources. Here, we investigated the links between parasite infection, predator avoidance and neophobia towards a novel food presented on a baited hook in fish. Juvenile Spangled perch (*Leipotherapon unicolor*) undertook two behavioural tests in our laboratory, before being dissected and examined for external and internal parasites. We used an adapted conditioned place avoidance (CPA) paradigm to examine avoidance of the side of the tank where a larger predator fish was visible and in a separate test, we examined neophobia of a baited hook. Of the 69 Spangled perch studied, 27% of fish were uninfected and at least one of nematodes, metazoa or Monogenea were found in the remaining fish. Fish spent less time in the side of the tank after encountering the predator there, than before encounters, indicating that fish can learn to avoid locations where predators were previously observed. Fish infected with metazoa and camallanid nematodes avoided entering the side of

the tank with the predator compared to uninfected fish, suggesting increased predator avoidance in infected fish. However, both metazoa-infected and camallanus-infected fish bit the baited hook sooner than uninfected fish, indicating less neophobia of the baited hook in fish with these infections. Additionally, fish infected with Monogenea spent less time in the side of the tank with the predator fish, perhaps indicating reduced predator inspection. Avoidance of predators yet reduced neophobia to novel foods in some infected fish suggest that parasites do not exert a general, overall, effect on risk aversiveness. Instead, changes in neophobic behaviour appear complex and we discuss the possibility that parasite-induced changes in fish behaviour may be modulated by altered hunger levels and reduced locomotion brought about by illness.

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Heating up cold-water fish to improve fishery outcomes in the NSW trout fishery

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In Australia, rainbow trout are limited to the cooler temperate waters in the south-east and south-west. Government stocking supports much of the recreational fishery throughout this range. A key limiting factor for this reduced distribution are the high summer temperatures experienced in Australia. In contrast, Gaden Trout Hatchery at Jindabyne experiences some of the coldest winter weather in Australia, and the associated low water temperatures (<4ºC) slow the development of embryos and early growth of rainbow trout, limiting production. As a result, rainbow trout fingerlings are not stocked until the end of summer, when water levels are at their lowest and temperatures at their highest. This study examines the potential benefits for the fishery of artificially warming hatchery water to improve development and early growth and to optimise the fingerlings return when released. Rainbow trout raised in warmer water were typically ~20% larger than those hatched and raised in river water. In addition, return rates to the spawn run in the Thredbo River and angler catches in Lake Jindabyne for rainbow trout were higher for the fish raised in warmer waters than those grown in ambient river water. Rainbow trout raised in warmer water also maintained a larger average length and returned to the spawn run a year earlier than fish raised in river water. However, fish raised in warmer water appeared to exit the fishery within 3 years. The outcomes of this research will be used to develop adaptive stocking strategies in NSW.

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A systematic review of fish health assessment methods to inform research and management.

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The health status of individual fish can provide vital information on potential causes of changes in fish populations in response to natural and anthropogenic stressors. Disturbance can cause declines in individual fish health and consequently affect reproductive output with potential implications for population persistence. Fish health is a broadly used term, commonly encompassing assessments of energetic status (condition) as well as other underlying physiological functions that can be considered as components of overall fish health. While there have been previous reviews of particular health components and how they are measured, there is a need for review and synthesis of fish health assessment methods that can be used as rapid indicators of fish health, while providing a mechanistic understanding of the interaction between environmental stressors and fish health. This talk presents the results of a systematic literature review and topic modelling study based on a corpus of 1430 papers. The literature review: (1) summarises current methods for assessing different components of fish health, 2) identifies key research themes and knowledge gaps, and (3) summarises potential mechanistic links between various components of fish health and key environmental stressors. A decision tree is also presented to assist future researchers in choosing the most appropriate methods to meet particular study objectives and improve management interventions.

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Parasites of larval & juvenile freshwater fish of the Murray Darling Basin

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Infection with parasites is known to increase with age, but few studies have documented the start point for these infections. Freshwater fish in the Murray Darling Basin (MDB) have been found, through recent research conducted by the Parasitology Laboratory at Charles Sturt University and the Narrandera Fisheries Centre, to be infected with a range of parasites, both endemic and introduced (such as *Lernaea* and *Bothriocephalus*). No studies, however, have looked at infection levels in larval or juvenile fish. Collection of larval & juvenile freshwater fish occurs in river systems across the MDB through annual monitoring surveys. After identification to species (primarily Murray cod, carp gudgeons and the introduced European carp), these fish are dissected and examined for parasites to determine levels of parasitism across the fish species. The information collected in this project will have direct benefit to freshwater biologists and fisheries managers. Infections of larval fish with parasites has potential impacts across the entire ecosystem. This will be the first study in Australia to document the level of parasitism in larval and juvenile fish and will provide information regarding the incidence of parasitism across both native and introduced fish.

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Getting modern fish-protection screens in rivers: principles for effective stakeholder engagement

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Governments have invested over $30 million in screening programs in NSW. A strong understanding of stakeholder motivations and abilities is required to ensure that these programs can be delivered successfully. In this presentation I: (1) review the key principles for effective stakeholder engagement that have progressed modern screening in Australia to date; (2) identify the key barriers to adoption that need to be addressed to facilitate uptake in the Northern Murray-Darling Basin; and, (3) make recommendations for communication activities and engagement approaches that can be used to improve water user consent and capacity. I discuss results of interviews with 120 farmers across NSW, plus a series of face-to-face meetings. I show that water users share three main motivations: to protect fish, to save money and to save water. Over 60% agree that governments should provide support and that the technology should not be made compulsory. This information is then used to recommend communication approaches that can support widespread uptake and realisation of screening benefits in Australia.

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Nineteen year study into the ecological succession of an estuarine wetland following the staged opening of floodgates

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Tidally active wetlands are important nurseries for fish and crustaceans; however, urban development and flood mitigation works have fragmented and destroyed much of this habitat, often leading to losses in fisheries productivity. In this talk I report on the results of a 19 year study (2004-2022) which demonstrates that many of these impacts are reversible with proper management. Eight floodgates that restricted tidal flushing of the Ramsar listed Hexham Swamp (Hunter River NSW) were incrementally opened to facilitate tidal flushing and nekton passage. Ecological succession and rehabilitation was evaluated under a full rehabilitation model (using treatment, control and reference sites), encompassing pre-floodgate opening, opening of one gate, three gates and finally all eight gates. Floodgate opening enhanced both water quality and nektonic assemblages relative to a control creek whose barrier remained in place. At rehabilitated sites we observed a doubling in species richness and significant increase in abundance of many commercially important species, including Eastern king prawn (15 times more), Yellowfin bream (62 times more), mullet (10 times more) and Silver biddy (19 times more). Recovery to a condition similar to ungated reference creeks was achieved once all eight gates were opened and tidal infiltration was maximised. The recovery has been sustained over the nine years that followed and largely resilient to both natural and anthropogenic forces. The study illustrated that reinstating tidal flushing can recover nursery habitats and enhance populations of economically valuable species.

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Performance of a fish protection screen at a gravity-fed irrigation diversion

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Publish consent withheld

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Fish passage in the Australian tropics

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Rivers and wetlands of Australia's eastern tropics have been heavily impacted by decades of land-use change. Many fish species migrate within freshwater environments, or between fresh and saltwater systems to feed and spawn, yet their capacity to migrate has been diminished through changes to habitat, water quality and physical barriers to fish passage. There are thousands of constructed barriers to fish passage in Australia's north-eastern tropics and these include pipes and culverts, urban drains, earthen bunds, causeways, weirs and irrigation infrastructure. The net effect of these changes on the productivity of fish stocks is largely unquantified for many catchments but is likely to be substantial.

Fishways are increasingly being constructed in the Australian tropics to improve the capacity for fish migration and to increase the extent of available habitat, yet there is limited data on their efficacy in tropical river systems. Here, we present results from two seasons of fish monitoring in the wet and dry tropics of north-east Queensland. We discuss our findings in the context of contemporary habitat quality and condition, and factors contributing to differences observed within and between catchments.

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Recent advances to lift fish safely across barriers with Tube Fishways

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Dams and weirs fragment riverine ecosystems and disrupt natural fish migration leading to a depletion of fish populations. Fishways are installed to allow upstream fish migration, with proven success for low-head barriers. These fishways are expensive, limiting the number of barriers with installed fishways. Very few large barriers such as dams have fishways installed because available solutions such as fish lifts are often unreliable and very expensive. An innovative Tube Fishway was developed by a multidisciplinary research team from UNSW Sydney as a cost-effective alternative to enable fish migration across low- and high-head barriers. Laboratory trials have demonstrated fully automated operation of the Tube Fishway.

The Tube Fishway operates cyclically via: (a) attraction of fish into the transfer chamber, (b) lifting of fish with an unsteady surge at near-atmospheric pressure, and (c) an enabling sequence of valve operations. Large numbers and different sizes of Australian native fish (silver perch *Bidyanus bidyanus* and Australian bass *Percalates novemaculeata*) have been reliably attracted and lifted safely vertically by 4 m. A systematic study investigating fish condition in closed conduit systems is developing guidelines for safe operation of Tube Fishways for fish. Field trials are currently underway.

The Tube Fishway and its implementation continues to develop and improve with focused laboratory and field research, providing considerable promise for solving a global problem for river ecosystems.

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Susceptibility of fish to entrainment through different irrigation infrastructure in the Fitzroy Basin

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Entrainment of fish through different types of irrigation infrastructure was investigated in the Fitzroy Basin, Queensland. The Fitzroy Basin contains a mix of tropical species typical of more northern catchments and species that occur in the Murray-Darling Basin and south-east coastal catchments. Types of infrastructure investigated included pumped and gravity fed diversions from Fairbairn Dam and riverine irrigation pumps on the Nogoa, Comet and Mackenzie Rivers. Riverine pump intakes included deep bankside intakes, shallow bankside intakes, deep mid-river channel intakes and intakes from the end of short, shallow channels excavated perpendicular to the river. Riverine pumping rates ranged from 14 ML/day to 164 ML/day.

The gravity fed diversion entrained more fish than the pumped diversion with mean values of 196.9 fish/ML and 9.1 fish/ML respectively. Riverine pumps had daily entrainment rates ranging from 0.6 fish to 137.2 fish /ML with a mean entrainment rate of 29 fish/ML. Bankside shallow intakes stood out as having much lower entrainment rates than the other riverine pump inlet types, such that a large (150 ML/day) bankside shallow intake was entraining fewer fish than smaller pumps on the other intake types. The most susceptible species to entrainment through the riverine pumps were olive perchlet and spangled perch. It is thought these species may have been actively swimming into pump intakes, looking for access to off-stream wetland habitats. Some entrained catches of these fish were biased towards larger adults compared to the riverine population. Data from this study can be used to help prioritise irrigation infrastructure for screening.

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How precise are estimates of spawning area and spawning biomass of sardine off southern Australia?

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Previous studies have shown that Sardine (*Sardinops sagax*) abundance is strongly correlated with spawning area (*A*). Application of the daily egg production method (DEPM) to Sardine off southern Australia between 1995 and 2019 confirmed that *A* is a good proxy of adult abundance for this stock. Ward et al. (2021) showed that spawning biomass could be calculated most precisely using estimates of all parameters, except *A*, that were calculated from historical (cf. annual) data. Using this approach, inter-annual fluctuations in estimates of spawning biomass are driven entirely by changes in *A*. Like most other DEPM studies, Ward et al. (2021) did not estimate the precision of *A*. The precision of *A* is critical to understanding the precision of estimates of spawning biomass. This information is needed because spawning biomass is the key biological performance indicator for the South Australian Sardine Fishery. During recent DEPM surveys off South Australia, a second plankton sample was taken in each sampling grid at a randomised distance from original sampling site. Two gear types were tested: a CalVET net, which was the standard sampling gear for the surveys, and a bongo net, which filters more water per tow than a CalVET net and provides different estimates of *A* (higher) and mean daily egg production (P_0, lower). Estimates of *A*, P_0 and total daily egg production obtained using each sampling method for each survey are compared to evaluate the precision of the estimates of these parameters.

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Life history of the vulnerable Melbourne skate to inform fisheries management and conservation

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Due to their large size, slow growth and late maturity, skates are some of the most vulnerable exploited marine fish species. The Melbourne skate (*Spiniraja whitleyi*), a large skate endemic to the continental shelf of Australia, has experienced localised depletion, a trend attributed to sustained trawling activity over recent years. This, combined with a complete lack of basic knowledge of the species' biology and ecology, has led to its listing as vulnerable on the International Union for Conservation of Nature (IUCN) red list. Furthermore, the Action Plan for Australian Sharks and Rays (2021) has recommended the assessment of Melbourne skate age, growth and reproduction as high priority. This study therefore aims to address current knowledge gaps by providing data on key life history parameters to inform effective fisheries and conservation management. Reproductive information including sexual maturity and reproductive cycle status was obtained by examining seasonal plasma concentrations of sex hormones (testosterone, oestrogen, and progesterone) using radioimmunoassay. Growth and age parameters were estimated using sagittal cross sections of vertebrae from 40 Melbourne skate individuals ranging in size from 22 cm to 135 cm total length. Yearly growth rings were subsequently counted with transmitted light under a dissecting microscope. Multiple sex specific growth models were applied to determine the curve of best fit for length at age data, with the best model determined using Akaike information criteria. Age, growth and reproductive estimates will be translated into management actions to ensure the sustainability of this vulnerable species.

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The first age data for the commercial octopus species, *Octopus berrima*

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Determining the sustainable harvest of a fishery requires data on growth, maturation, mortality, and recruitment, all of which are underpinned by age data. Age data have been used to develop stock assessments for *Octopus pallidus* and *Octopus* cf. *tetricus* in the Tasmanian and Western Australian octopus fisheries respectively, but not in South Australia. The South Australian fishery is predominantly composed of *Octopus b*errima, or the southern keeled octopus, and this is the first study to estimate age. Growth increments were observed on the stylet, internal vestigial shell, and the beak. Increment periodicity was determined by injecting the live octopus with a fluorescent stain that would be absorbed by the stylets and beak. After a certain number of days, they were euthanised and days passed were compared to the number of increments formed since the stain. Beaks did not absorb the stain and increments varied from larger (width) to smaller (width) with no apparent pattern nor correlation with body size, therefore discarding the beak as an ageing method. The stylet proved to be the better ageing method of the two, but still had some limitations. Further results and conclusions will be discussed.

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Queensland's commercial shark catch: monitoring insights and catch characteristics

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The Queensland Government's Sustainable Fisheries Strategy has afforded an opportunity for Fisheries Queensland to improve public understanding of the level of impact by net fisheries on shark stocks. To complement the existing routine catch monitoring (i.e. logbooks, unload reports and vessel tracking) Fisheries Queensland has implemented a biological monitoring program for sharks. Between 2018 and 2020 the focus of the program was to deliver improved catch composition data and advance our understanding of shark species interacting with net fisheries. The program's current focus expands on this work and integrates the diverse data streams that are now available, to enhance the species assemblage data and refine hotspots of fishery

interaction. This presentation will provide an overview of the shark monitoring program and discuss catch characteristics for the retained and non-retained shark catch within the East Coast Inshore Fishery and the Gulf of Carpentaria Inshore Fishery.

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Sailfish science: building collaborations to delineate the global population structure of a migratory pelagic fish

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The sailfish (*Istiophorus platypterus*) is a highly mobile epipelagic billfish whose range extends across the world's tropics and sub-tropics. Once thought to be different two species in the Indo-Pacific and Atlantic, molecular techniques revealed a single global species in the 1990s. Its patchy but widespread distribution in the open ocean means that it can be challenging to study. Our current understanding of the global population structure of sailfish is limited due to the low number of molecular markers used in previous studies and the difficulty in sampling across the extensive range of the sailfish. Collaboration with fisheries researchers and organisations has been a key element in building an extensive tissue sampling collection.

The high dispersal and movement ability of marine pelagic species, along with the lack of obvious barriers in the marine environment, can result in dilute genetic signal from population differentiation. Advances in next-generation sequencing technologies used a genome-wide approach to reveal population structuring for pelagic species at finer scales than previously detected using other methods. This research aims to determine structure and connectivity among sailfish populations across its circumtropical range in the Indian, Pacific, and Atlantic oceans using high-throughput genomic techniques. Novel genomic population structure will provide a baseline and inform future stock assessment and management, particularly where this information is lacking for the Indo-Pacific.

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Carcharhinus tilstoni and *Carcharhinus limbatus*: An exploration of SNP markers in blacktip shark species in Queensland

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In a Sustainable Fisheries Strategy funded project, Fisheries Queensland investigated species composition of commercially retained and discarded shark from Queensland waters using a mitochondrial DNA (mtDNA) marker. It was determined that 44% of the commercial harvest was made up of a species complex including the Australian blacktip shark (*Carcharhinus tilstoni*) and the common blacktip shark (*Carcharhinus limbatus*). Despite having different biological characteristics, the two species are difficult to distinguish morphologically in the field. There is also the added difficulty in that there is evidence of hybridisation between the 2 species in their mtDNA (Ovenden *et al*. 2009). Single nucleotide polymorphism (SNP) markers were used to investigate this species complex across its Queensland distribution to look at the stock structure of each species and to explore whether hybridisation is an ongoing or historical relationship.

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Leveraging fishers' bycatch avoidance skills to reduce impacts on elasmobranchs in industrial longline fisheries

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Oceanic sharks are under increasing pressure from pelagic fisheries, particularly tuna longlines. Silky sharks (*Carcharhinus falciformis*) and blue sharks (*Prionace glauca*) dominate global pelagic shark catches. Silky sharks are a vulnerable to overfishing due to their slow growth, late maturation, and low fecundity, and are listed as Vulnerable by the IUCN and on Appendix II of CITES and the CMS. Despite bans on finning—and in some cases retention—implemented by some Regional Fisheries Management Organizations, these measures fall short of scientific advice, and evidence of compliance and effectiveness is lacking. Although blue sharks are more fecund than silky sharks and a good candidate for sustainable fishing, retention (and probably targeting) has increased substantially, stock assessments are limited, and overall blue sharks are afforded fewer protections.

Catch of non-target species is typically managed with fleet-level controls on fishing, such as time-area closures, technology requirements, fleet-wide bycatch quotas, or retention bans. These approaches overlook the potential role of individual operators in driving fleets' bycatch rates. We posited that avoiding bycatch is a skill, which varies across individual operators. To test this hypothesis, we analyzed vessel-level variability in protected species bycatch using observer datasets from Australia, including the pelagic longline sector. We found the "vessel effect" was a dominant driver of bycatch variability across a range of bycatch types, including hammerheads in prawn trawls (bycatch) and shortfin makos in tuna longlines (byproduct). However, the data

were completely anonymised, precluding exploration of what aspects of the individual vessels drive the observed effect on bycatch rates.

Here, we further explore variable operator performance using observer and logbook data from the foreign tuna longline fleet operating in the Republic of the Marshall Islands' Exclusive Economic Zone. The data were collected as part of an ongoing trial of electronic monitoring systems implemented by the Nature Conservancy. We test whether 1) there is an operator effect for shark catch that is independent of the physical characteristics of the vessel and 2) if the registered company drives the performance of individual vessels.

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A 3D perspective on sediment turnover and feeding selectivity in blennies

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Sediments in algal turfs can modify a wide variety of key ecological processes on coral reefs. While some larger reef fishes can remove these turf-bound sediments, the role of small, yet abundant, cryptobenthic fishes is currently unclear. To address this knowledge gap, we explored the extent to which the blenny, *Ecsenius stictus*, can shape sediment dynamics on coral reefs by quantifying their sediment ingestion and space use. Per unit body mass, *E. stictus* process sediments at comparable rates to key parrotfish and surgeonfish species. However, in absolute terms, *E. stictus* has a negligible influence on net sediment dynamics, despite their abundance. Behavioural observations and 3D photogrammetry reveal that *E. stictus* preferentially feed and rest on elevated surfaces; potentially because of low sediment loads on these surfaces. Overall, *E. stictus* may be responding to sediment loads rather than manipulating them; it is a passenger rather than a driver in reef processes.

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Using conceptual models to build ecosystem understanding of an exploited embayment in Western Australia

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Cockburn Sound is one of the most intensively used marine areas in Western Australia and has a history of major industrial development and nutrient pollution. This has contributed to significant losses of seagrass meadows between the 1950s and early 2000s. However, the Sound retains high ecological values and is regarded as an important area for recreational and commercial activities such as fishing, diving, aquaculture, tourism and shipping. The WA government is examining the potential impact of developing a major port facility in the Sound. This study investigates its potential impacts on food webs and species of interest to conservation (Little Penguin *Eudyptula minor*), commercial (Pink Snapper, Scaly Mackeral *Sardinella lemuru*), and recreational groups (Blue Swimmer Crabs and Pink Snapper). Conceptual and qualitative models were developed through workshops and consultation for each of these species to summarise their life-cycles and use of the Sound, and evaluate the impact of different cumulative factors on the species such as climate change, habitat loss, changes associated with port development, and management. The qualitative model for Little Penguins showed that their populations are positively influenced by management actions on land, where breeding colonies are negatively impacted by nest site degradation through increasing temperatures in a warming climate. Other factors influencing Little Penguins include changes in populations of forage fish such as White Bait (*Hyperlophus vittatus*) and Scaly Mackeral and increased mortality from vessel-strike. They highlight the complexity of cumulative impact assessment. The Pink Snapper qualitative model predicted positive effects of seagrass on Pink Snapper juveniles, flowing through to adults, due to an association with seagrass by the early juveniles. The conceptual and qualitative models have helped to summarise information on the species, communicate on the ecological understanding of the Sound and identify knowledge gaps. They have also informed the development of a quantitative ecosystem model.

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Predicting basin-scale population responses of Golden Perch to flow management using a stochastic metapopulation modelling approach

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Connectivity between rivers and their adjacent wetlands and floodplains is an important feature of healthy, functioning freshwater ecosystems. Globally, this connectivity is often lost or compromised, leading to the loss of health and function in riverine systems. To help restore the health of Australia's Murray-Darling Basin, the NSW Reconnecting River Country Program (RRCP) is considering the relaxation of flow limit constraints in the Murray and Murrumbidgee rivers, to allow water for environmental to be periodically delivered at higher levels to improve connectivity of rivers with wetlands and low-lying floodplains and thereby support a range of and potential environmental benefits.

We quantified these benefits using a stochastic population model developed for Golden Perch (*Macquaria ambigua*). The project considered four differing flow management scenarios: current operational limits and four scenarios with relaxed constraints and

therefore increased flows. The model's spatial extent spanned the southern connected Murray-Darling basin including the Murray, Edward, Darling and Murrumbidgee Rivers, represented as 8 connected populations where discreet population responses were analysed over 124 years utilising modelled flow and temperature data inputs. The model considered the best available knowledge of the ecology and biology of Golden Perch.

Modelling predicted significant benefits to Golden Perch populations under all relaxed constraints options (average increase of 20% in population size), with the highest benefits predicted under the highest level of relaxed flow constraints (30% increase in population size). The modelling also provided important insights into the population dynamics of this species, where some populations are sinks while others drive the dynamics of the whole metapopulation, highlighting the importance of source populations.

Our approach represents a significant step forward in the spatial and temporal extent of population modelling on Australian fish species. This project also demonstrates the predictive utility of population modelling as a tool to answer management questions.

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Is my model fit for purpose? Validating a stochastic population model for predicting freshwater fish responses to hydrological scenarios

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Population models can help inform management decisions but like all models they do not perfectly reflect reality. A key challenge is to show that a model is sufficiently realistic to meet its intended purpose(s), ideally by comparing model predictions to trends observed in independent empirical datasets. Unfortunately, this is often not possible, which can lead to uncertainty about the reliability of models, and their use in the conservation-decision making process.

We will present work undertaken to validate a stochastic population model that was developed to predict responses of the native Golden Perch (*Macquaria ambigua*) to different flow management scenarios in the Murray and Murrumbidgee River catchments in the southern Murray-Darling Basin. We compared population model predictions (population size and growth rate, movement rate) to empirical datasets from across the study region that were independent of the model fitting process.

We found good alignment between model predictions and observed datasets, with the model generally predicting key trends observed in empirical datasets. Where misalignments between model predictions and empirical datasets were observed, these are likely due to factors not currently considered in the model construction (e.g. blackwater events and stocking), or mis-specified parameters (e.g. movement rates), which directly informs updates to the model structure. Some misalignments could also be due to factors causing variability in the empirical datasets, such as changes in fish detection as a function of changes in flow.

Model validation is critical but is rarely undertaken, often due to a lack of independent data sets to compare model predictions against. Our approach highlights the importance of model validation, how the outputs can be used to help understand when population models can be interpreted with more confidence or when more caution is needed, and how the model might be updated in the future.

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Forecasts of marine heatwaves for marine industries: reducing risk, building resilience and enhancing management responses

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Ocean use has always been risky because of uncertain and dramatic ocean conditions and modern businesses continue to experience risk due to environmental extremes. A changing physical environment due to anthropogenic climate change and increased frequency of extreme events such as marine heatwaves (MHWs) makes past experience less valuable. This risk can be reduced by utilising seasonal forecasts that provide early warning of climate events several months ahead of time. We demonstrate a number of heatwave forecast products that we have developed. However, to benefit from a forecast, a marine business will need to be agile to respond to changing information and response options. The management agility of different marine businesses in fisheries, aquaculture, and tourism can influence their ability to use seasonal forecast information effectively, and potentially modify the usual negative relationship between resilience and the frequency of the stress event, thus reducing the impact of extreme events. Engagement between forecast developers and marine users can also improve responses, while at the same time, improving the agility of businesses can enhance overall resilience to extreme events and lower their risk.

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The persistence of a key coral reef ecosystem function in a post-bleached world

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As multiple stressors continue to impact coral reefs, understanding the changes in ecosystem functioning is imperative to protect key ecosystem services. We used a 26-year dataset of benthic reef fishes to identify multi-decadal trends in fish biomass production on a degraded coral reef. Following the first mass coral bleaching event in 1998, the abundance, standing biomass, and productivity of fish communities remained remarkably constant through time, despite the occurrence of multiple stressors,

including extreme sedimentation, multiple cyclones, and additional mass coral bleaching events. Species richness declined following the 1998 bleaching event, but rebounded to pre-bleaching levels and also remained relatively stable. Although the species composition of the communities is changing, these new community configurations are still able to maintain a steady level of fish biomass production. Consequently, these transitioning systems can still provide some critical ecosystem functions and services, despite increasing degradation.

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Weedy (common) sea dragon strandings in Sydney in April 2022: causes and population impacts

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Weedy seadragons (*Phyllopteryx taeniolatus*) are iconic inhabitants of Australia's Great Southern reef. Our long-term monitoring and sampling research (since 2001) has indicated population fluctuations and some declines in SE Australia over the last two decades, and that there is high spatial genetic and morphological structuring. Climate-change impacts are expected, particularly at northern range limits, via loss of kelp habitat and also mysid shrimp depletion.

In February-April 2022, a series of severe climate-related East Coast Lows battered SE Australia, and in April local beach walking citizens reported patchy strandings of over 150 weedy seadragons on shorelines from Gosford to Wollongong. Images of the stranded dragons were used to check on previous live sightings, and carcasses were examined to check sex and body size. Long term monitoring by researchers and citizen-scientism suggest densities of weedys at some reef sites may have declined as a result, indicating this acute impact of climate change is of concern for this species. Also, beachcomber observations can be a useful monitoring tool for impacts on coastal marine species.

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The acute and legacy impacts of marine heatwaves on fish growth in the Pacific Ocean

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The increased frequency and intensity of global marine heatwaves in the past century has led to greater awareness of how extreme events can shape ecosystems. While these acute warming events cause a wide range of impacts, the most common observations are often the lethal effects on marine life, as a result of starvation or exceeding a species' thermal tolerance or changes in distribution. However, few studies have assessed the sub-lethal impacts of heatwaves on fish such as growth. I aim to assess the impact of marine heatwaves on Pacific fisheries by examining the immediate and legacy effects on fish growth. Specifically, I have 1) identified patterns in fish growth responses to heatwaves among species groups and/or regions and 2) if growth was impacted, examined how long growth was altered by heatwaves both during and after the event. I calculated a suite of annual heatwave parameters from satellite-derived daily sea surface temperatures from 1981-present. Additionally, I used otolith-based growth biochronologies from commercially-harvested species to generate models to partition observed changes in growth to heatwaves, as well as determine which event and species life-history attributes have the best explanatory power. Preliminary results from five species in Southeast Australia show a range of responses to heatwaves with growth best predicted by different event attributes. The frequency, rate of onset, and event intensity of heatwaves were the best explanatory parameters for growth in species positively impacted by heatwaves. Other responses included no effect on growth and variation in growth between life stages in response to heatwaves. Our ability to anticipate fish growth sensitivity to heatwaves is not only important for predicting responses under future climate events but is also essential for understanding the legacy effects of these events which may alter food webs and assemblages well after the event subsides.

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Northeast Victoria bushfire recovery monitoring

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The black summer bushfires ravaged across New South Wales and Victoria in late 2019 and early 2020. Within northeast Victoria, the Cudgewa Creek, Nariel Creek and Thowgla Creek catchments were impacted with the fire front hitting the catchments on 29th December 2019. A large rainfall event occurred on 20th January 2020, which resulted in mass amounts of sediments and ash entering the streams. Subsequently fish kills occurred. The fish killed ranged from large Murray cod to exotic Carp, as well as smaller (unidentified) species. This presentation will look at the community response to aid the recovery of the fish community such as riparian fencing, weed control, instream habitat erosion and control, revegetation and cultural heritage assessments. The presentation will then document the results from initial surveys post fire (February 2020) as well as follow up surveys in November 2020, April 2021 and April 2022. It will highlight the recovery of Murray cod (and Platypus) in the Cudgewa Creek as well as the mixed recovery of trout in the Nariel and Thowgla creeks. It will also highlight some interesting responses by Two-spined blackfish and Climbing galaxias (a native not endemic to the upper Murray system) within Nariel Creek.

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Black Summer Blackfish - rain is not enough

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Black Summer Blackfish - rain is not enough.

As climate change impacts the waterflow and fire regimes of upland areas, extreme environmental conditions and catastrophic events are likely to become more frequent. In January and February 2020, the Orroral Valley Fire in impacted approximately 60% of the range of the threatened Two-spined Blackfish, *Gadopsis bispinosus,* within the ACT water supply catchment area in Namadgi National Park. This resulted in a reduction of 80-90% in the blackfish population. This wasn't the first time this population has been impacted by fire and drought. Monitoring has shown rapid declines in the Blackfish populations from at least four events in the last two decades the 2003 fires, the millennium drought, a prescription burn and the most recent 2020 fire and drought. Recovery from the pre 2020 impacts was reasonably rapid however, recovery from the 2020 bushfires has been very slow. Despite abundant river flows there has been a loss of juvenile and small adult fish from the river directly after the fire and limited successful breeding in the seasons since the fires.

Repeated population declines have the potential to impact genetic health. Managing recovery from these events and promoting resilience will require understanding of the genetic health and habitat to enable timely effective active management. Habitat assessment pre and post fire have highlighted the impact that sedimentation from the burn has had on blackfish habitat. Additional research is looking at genetic change spatially and temporally and the potential for assisting recovery through both artificial habitat structures and assisted translocation.

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Keynote: The National Recreational Fishing survey: a new way forward

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1. AWE, Not Specified

The first National Recreational and Indigenous Fishing Survey in 2000-01 was a significant breakthrough, for the first time providing a comprehensive national picture of participation, effort, catch, and expenditure. The standard sampling methodology developed at the time was based on a randomised survey of the Australian telephone directory. Due to declining land line use this sampling frame has become non-representative of the Australian population, and rapid change in availability of alternative sampling frames highlighted a need to explore alternative sampling approaches. The National Recreational Fishing Survey has investigated the use of blended sampling that recruits people using more than one sample frame and sampling method in order to ensure coverage of all types of recreational fishers. This included exploring the use of non-probability based sample recruitment methods, with a focus on ensuring random selection and high quality design of sampling when using non-probabilistic approaches. The survey trialled multiple methods of recruitment and assessed whether model-based weighting could be used to generate robust estimates of social and economic aspects of recreational fishing. The outcomes offer new insights into recreational fishing survey design for the future.

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Utilisation of creel surveys, boat ramp cameras and recruitment monitoring to inform the development of a harvest strategy for the Victorian recreational snapper fishery

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With the removal of most inshore commercial fisheries in Victoria, traditional monitoring and assessment approaches are no longer applicable for many key target species. This includes snapper, which represent Victoria's most important marine target species for recreational fishers, particularly in Port Phillip Bay, with recreational snapper landings far exceeding commercial landings even before commercial buyout schemes.

Creel surveys have been used at various stages historically to investigate aspects of the snapper fishery and now form an ongoing monitoring regime as they inform targeting practices, catch rates, angler satisfaction and motivational factors. Coupled with broadscale recreational fishing effort monitoring using activity sensing cameras at boat ramps and recruitment monitoring, researchers are well placed to understand the fishing practices, fishing effort, landings, stock abundance and socio-economic factors that are influencing the recreational snapper fishery.

The above information is currently being utilised to form the basis of a recreational snapper fishery harvest strategy in Victoria, with the perception that performance indicators familiar to recreational fishers will be better able to be understood, and hence accepted rather than a more traditional population dynamic model based approach relating to spawning biomass and egg production. Performance indicators, such as current and forecast recreational catch rates, angler satisfaction and fishing effort measures are being explored with stakeholders for incorporation into the strategy, along with the stakeholder's perception of how recreational fishers would like the fishery to perform into the future on behalf of the broader recreational fishing community.

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Diving into digital data collection: the Fish MoDE app story

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Fisheries Queensland routinely collects a range of data to help assess the status of key fish stocks. For more than 20 years, their scientific monitoring team have used traditional paper datasheets to record data from a variety of fishery-dependent and -independent sampling activities. The resulting mountains of datasheets would undergo a labour-intensive process of data verification, entry into a central database, and final checking for any errors.

Under the banner of the Sustainable Fisheries Strategy 2017-2027 and its emphasis on developing novel technologies, the Fishery Monitoring team worked with Telstra Purple to develop an app for recording data electronically. Staff combined expertise with software designers and developers to create and test the app, known as Fish MoDE which features four forms tailored to different types of data collection. The boat ramp survey form is used to record biological, social and economic data from recreational fishers returning to boat ramps. The length frequency survey form is used when sampling recreational and commercial catches in the field for length and sex information. The catch sampling survey form is used when collecting additional biological information such as multiple lengths, weight, otoliths and genetic samples. The fishery-independent survey form is used to record data during scientific surveys for scallops, crabs and prawns.

The most obvious benefit of Fish MoDE is the rapid availability of quality assured data, even when surveys are carried out in remote areas, including at-sea. Data can be uploaded straight after a survey is completed, with internet connectivity. Quality assurance is assisted by features built into the app including validation rules and subsequent alerts to the user. Other potential errors are flagged once data are uploaded, using pre-defined business rules. The investment and transition to Fish MoDE for recording data better supports the assessment and management of Queensland's fish stocks.

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The impact of management changes on the recreational fishery for Sand Flathead in Tasmania

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Sand Flathead represent the mainstay of Tasmania's recreational fishery, being the most commonly caught species (>1.6 million fish in 2017/18) and accounting for around 70% of the total marine finfish catch (by numbers) taken by recreational fishers. In the 2014/15 Tasmanian Scalefish Fishery Assessment they were classified as Transitional-Depleting and in response the minimum size limit was increased, and bag limit decreased in late 2015. Despite this management response, the stock status has declined further and has been considered depleted in the last 3 assessments. State-wide recreational fishing surveys conducted in 2013/14 and 2017/18 provide the opportunity to assess the impact of the 2015 management changes on the recreational fishery and potentially predict the response to further management changes currently under consideration.

The number of retained flathead declined slightly in 2017/18, however the numbers released increased by 52% from estimates in 2013/14, to comprise 56% of the total catch in 2017/18. This was driven by size restrictions with the proportion of the catch released due to being under size increasing from 0.45 to 0.60. Bag limits were rarely met in either survey (less than 2% of successful fisher-days), and fish were rarely released due to bag limit restrictions (0 in 2013/14 and less than 0.4% of released catch in 2017/18). Effort did not change substantially between surveys, with a small and non-significant decrease in the total number of fisher-days (line fishing in inshore and estuarine waters). The proportion of successful fisher-days increased slightly (0.33 to 0.41) however the average catch rate of those successful days declined from 5.41 to 4.17 retained fish. The persistence of fishers to target flathead despite diminishing returns is consistent with motivational survey results showing that non-catch motives relating to relaxation, socialising and environment are more important than catching and consuming fish.

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Moving from paper to digital data collection for recreational fishing: the Fisheries Queensland Boat Ramp Survey experience

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We present Fisheries Queensland's experience in replacing paper-based data collection with a digital data collection App within a large, diverse casual workforce across Queensland. We explain how the rollout was performed and what the keys to successful uptake were.

Fisheries Queensland employs over 40 casual workers to conduct boat ramp surveys at 48 boat ramps across Queensland. The Boat Ramp Survey Program has been running for over 15 years and collects recreational fishing data that supports stock assessments and contributes to the sustainable management of Queensland's fisheries. The Boat Ramp Survey casual work force is diverse in age and background and technical ability. It is currently managed remotely by three staff, one based in Cairns and two in Brisbane.

To address the challenge of accurate, timely, consistent data reporting, Fisheries Queensland developed an electronic data collection platform called "Fish MoDE" (Fishery Monitoring Data Entry) to replace paper-based data collection. Fish MoDE collects data on recreational fishing and uploads to databases in close to real time. During 2021, Boat Ramp Survey staff across the state were trained in Fish MoDE, and paper data sheets were retired.

The successful rollout of Fish MoDE has improved data quality and reduced staff time spent chasing and checking paper data sheets manually. Boat Ramp Survey interviewers conduct data verification in Fish MoDE via data checking prompts and outlier

flags. They can link fish photographs with fisher interviews, further improving species identification. The streamlining of on-site data quality mean that data are uploaded and arrive at databases with reduced errors, and post-upload data checking time has been substantially reduced in the process.

Electronic data collection is a priority for many monitoring programs. Fisheries Queensland has implemented an electronic data collection platform that has resulted in improved accuracy and improved timeliness.

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Going beyond the effects of wildlife tourism on target species: does white shark cage-diving change the spatiotemporal distribution of silver trevally (*Pseudocaranx georgianus*)

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Many wildlife tourism industries use food to attract charismatic megafauna within view of the participants. While food-based attractant can impact the target species of tourism operations, there is limited understanding of its effects on the typically smaller, non-target species. At the Neptune Islands Group Marine Park, South Australia, bait and berley are used to attract white sharks (*Carcharodon carcharias)*. Previous studies have shown that the food used by the cage-diving industry affects the behaviour and activity of the pelagic yellowtail kingfish (*Seriola lalandi*), but whether it also influences other teleosts, including benthic species is currently unknown. We used acoustic telemetry to monitor the position, depth, and activity of 25 silver trevally (*Pseudocaranx georgianus*) over 34 months in relation to the presence and location of cage-diving vessels. Our results show that weekly activity space (km^2) was not affected by cage-diving operators, but trevally spent extended period close to the surface (~5 m vs. ~25 m) and increased activity (m/s) when operators were present. Weekly residency decreased from ~0.9 in summer to ~0.2 in winter months and was positively correlated with water temperature and number of days operators were present. Such changes to natural behaviours have the potential to affect health, metabolic rate, energy budget, and overall fitness of individuals. Our findings will contribute to a better understanding of the effects of wildlife tourism on non-target species and will support the ongoing management of Australia's only white shark viewing tourism industry.

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Effects of phylogeny and co-occurrence on the colour divergence of coral reef fishes

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Coral reefs are one of the most diverse ecosystems found on Earth, even though they only comprise a small fraction of the ocean. Marine fish species found on coral reefs display a wide variety of colours and patterns. Most of the reef fishes we recognise today are geologically recent, and their main ecological functions were developed around 20 Ma. From the late Miocene onward, many common reef fish lineages were still diversifying, although the sole innovation appears variations in their colour patterns. Research has shown that some related species that coexist in sympatry tend to be more different to one another than those that are allopatric. I examined the prediction that bigger differences in colour patterns would be detected in phylogenetically related reef fishes living in sympatry compared to those that live in allopatry. I selected seven clades, comprising 36 species, from four families of characteristic reef fishes (Grammatidae, Pomacanthidae, Lutjanidae and Labridae). Clades were selected based on whether or not they had both sympatric and allopatric species. Images of each species were compiled and measured differences in colouration and pattern using image analysis software. Colordistance and Patternize scores were significantly higher in sympatric species than in allopatric species for all but one of the studied clades, indicating higher dissimilarity in colour patterns within the same clade. As expected, the level of species relatedness affects colour divergence in reef fishes, likely because of phylogenetic conservatism. However, even among sister-species, there appears to be a larger dissimilarity in colouration when they coexist in sympatry. Colour divergence among sympatric species may have originated to facilitate better species recognition, which reduces aggression and helps locate a mate but also prevents hybridisation of closely related sister-species.

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Marine life and fisheries associated with offshore oil and gas structures in southeastern Australia and possible consequences for decommissioning

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The Gippsland Basin is the location of Australia's oldest offshore oil and gas (O&G) structures, with hydrocarbon production beginning in the 1960s. The Bass Strait flows over this area with fisheries providing seafood for the major population centers of Melbourne, Sydney and beyond. Since Australia's maritime legislation restricts activities to outside of 500 meters from O&G structures as a security exclusion zone, these O&G structures may serve as *de facto* marine protected areas that may have flow-on effects to local fisheries. It is essential to understand the habitat value of O&G infrastructure to marine life in the Bass Strait and how decommissioning of these structures affect local marine ecosystems and fisheries. We analyzed industry-collected remotely operated vehicle (ROV) imagery from 2008-2018 and compared this data with reported catch data from fishing vessels operating in this region collected by the Australian Fisheries Management Authority (AFMA) from 2008-2018. We assessed species richness and abundance on two platforms and two pipelines and compared the species composition with retained catch reported by commercial fishers operating in Commonwealth fisheries. We found diverse communities of fishes and invertebrates around O&G structures, with a different subset of species inhabiting pipelines than platforms. We found little overlap between the species that were targeted by commercial fishers and found around O&G structures (10% overlap), however, species composition data from fisheries often groups species making the data coarse and under-representative of true species diversity. Fishery-independent data from ROV imagery or other methods greatly augments our understanding of deepwater marine communities, including those around O&G structures. Combining data sources provides a holistic look at these novel ecosystems and provides better insight into future decommissioning scenarios.

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Spatially structured relationships between white banana prawn catch and riverine flow in the Northern Prawn Fishery, Australia

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Water resource development can lead to the significant alteration of natural flow regimes, which can have impacts on the many aquatic species that rely on both freshwater and estuarine environments to successfully complete their lifecycles. In tropical northern Australia, annual catches of commercially harvested white banana prawns (WBP) are highly variable in response to environmental conditions, namely rainfall and subsequent riverine flow. However, little is known about the spatial extent to which flow from individual rivers influences offshore WBP catch. In this study, we quantify how the relationship between WBP catch in the Gulf of Carpentaria is influenced by flow from the Mitchell River, Queensland Australia. We used a Bayesian framework to model both prawn presence and catch per unit effort, and found evidence that multiple components of the flow regime contribute to fishery catch. We also found evidence to suggest that the relationships between prawn presence and flow were spatial structured across the fishing ground. Our results suggest that attributing fishery catch to a single river remains challenging, though highlights the importance of maintain natural flow regimes to support a highly valuable commercial fishery species in the face of potential water resource development.

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Reconsidering the impossible: a size-based approach to the recruitment potential of larval fish cohorts

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Inter-annual variability in the supply of young fish to the fishery remains a significant problem, if not an impossible problem. Hjort's (1914) foundational hypothesis concerning a critical period for larval feeding stimulated various bio-physical hypotheses, some of which include the interaction of growth (G) and mortality (M) during the larval stage. Both M and G require estimates of age, arduously obtained from daily growth increments, at fine spatial and temporal scales. To compound the problem, predation tends to remove the starving and the slow growers, highlighting the interdependence of growth and mortality, which is sometimes described as the "single process".

Building on the theory of size structured populations and the size-frequency distribution of zooplankton, we show that the descending slope of the biomass size-frequency distribution of a particular species of larval fish is the ratio of M to G (known as the recruitment potential). Numerical simulations show that a size-based estimate of M/G performs as well as various traditional (and newer) age-based methods, and with smaller sample sizes (>50 larvae). Additional metrics to the size spectrum slope, could include the abundance or elevation of the spectrum, and the geometric mean size. Our method can eminently be applied to many long term surveys of commercially important larval fish, where larval lengths are routinely collected, where otoliths have degraded, and where recruitment outcomes are known. We report on some new methods to convert length to larval biomass, consistent with optical technologies to potentially quantify larval fish in situ. Our method has relevance for assessing oceanographic features, by explicitly and routinely incorporating the competing effects of growth and mortality for the first time. Our new view of the recruitment problem will re-invigorate fisheries oceanography, particularly with regard to the ephemeral frontal eddies of boundary currents, adjacent to the substantial coastal fisheries.

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Key research priorities for the future of Australian fish and fisheries research

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In Australia, the health of our marine, estuarine, and freshwater ecosystems is of critical importance. Each of these aquatic environments play a significant role in our countries ecological, economic, cultural and societal wealth. Burgeoning threats including climate change, resource over-exploitation, invasive animals and diseases, and habitat degradation are just a few of the issues that researchers and managers must consider. To identify the key research priorities using a bottom up process we surveyed researchers, policy makers and academics to determine the research priorities that they perceive as the most important for furthering fish and fisheries research in Australia. The survey responses covered eight thematic fields of study. Preliminary results indicate that fisheries, environment and climate, and resource management were the top three themes respondents posed questions about, followed closely by freshwater ecosystems and biosecurity. Around 70% of respondents were researchers, and representation from all Australian State and Territories was achieved. A follow up consolidation and prioritisation process was undertaken to narrow the broad range of research priorities received and allow for a list of key priorities to be developed. The priorities identified will enable researchers and policy makers to identify critical knowledge gaps, promote collaborative programs (both within and across management jurisdictions), develop novel approaches and technologies, promote resource pooling to achieve common goals, and to improve transparency around decision-making processes.

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Model complexity in Moreton Bay bug and saucer scallop stock assessments

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Stock assessments require a convoy of mathematically and realistically sound decisions to build a model that successfully represents the true condition of the fishery. The major decisions are often guided by three main types of complexity: knowledge complexity, mathematical complexity and computational complexity. Knowledge complexity refers to what we know about the biological systems governing the stock, for example, how species interact. Moreton Bay bugs feed on scallops but also become the primary target when scallop stocks are low. Quantifying and even qualifying these effects is difficult but understandably plays a major role in stock abundance. Mathematical complexity refers to the mathematical model itself and how difficult it is to build equations which accurately represent the true dynamics of the population. For example, most models assume a constant virgin biomass. However, environmental changes over the past century such as rising temperatures and changing currents undoubtedly affect the equilibrium abundance of fish stocks. Alongside this, data science is limited by computational resources. Incorporating additional data and discretising the temporal and spatial range into smaller grids, significantly increases the runtime of the model which increases the overall investment required in time and/or cost. So how do scientists choose which complexities are worth researching, worth investing in, worth modelling? How do we determine what 'worth' means? Is it accuracy of results? Is it capturing as many effects as possible? Is it statistical significance? Or is it a more holistic characterisation of risk? In this talk I will step through these considerations using Queensland Moreton Bay bug and saucer scallop populations as a case study, and outline how it is possible to develop a better understanding of the true trade-offs behind questions of data availability and model complexity.

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Forgoing the distance: Assessing the suitability of new model-based multivariate analysis for fisheries science via an NSW ocean prawn trawl elasmobranch bycatch case study

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The transition to model-based multivariate analysis from distance-based is important for fisheries research as this type of data is often overdispersed and therefore sometimes not suitable for traditional approaches. We present both our experience in transitioning to model-based analysis and the results of elasmobranch bycatch research (NSW ocean prawn trawl bycatch quantification as part of the Marine Estate Management Strategy Initiative 5.5). The relatively user friendly model-based analysis showed there was significant spatial differences but not seasonal and depth in elasmobranch assemblages. This result is an important early step in determining future monitoring priorities for a fishery that has a broad bycatch but has not seen regular monitoring and assessment. Importantly, this project recorded low catch rates of a diverse community of elasmobranchs with more species (and similar catch rates) recorded by the present study, than the former, which shows that the fishery is of relatively low risk to elasmobranchs.

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Habitat partitioning and machine learning help map species distributions in an iconic crustacean

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Knowledge of species' distributions is critical to many aspects of marine science and management. However, distribution data are often lacking, requiring modelled interpolations to 'fill in the gaps'. In the case of benthic animals, relationships between habitat type and abundance are often strong and can be used to inform such models. Two species of Moreton Bay bugs, or bay lobsters, are not differentiated in historical fisheries records, complicating efforts to assess long-term trends in their abundance. We used Random Forest models to map sediment properties for the entire Queensland east coast and inform species habitat preferences based on existing and newly collected data. These preferences informed a Boosted Regression Tree model used to predict and map distributions of each species. We found strong habitat partitioning with smaller *Thenus parindicus* preferring shallower inshore areas and finer sediments and larger *T. australiensis* preferring deeper areas with coarser sediments. As a result, both species could be differentiated in the historical catch records, allowing the assessment of long-term trends in their abundance. Similar approaches may offer potential to map distributions of other benthic species with strong habitat preferences.

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Diel behaviour change and ontogenetic shifts of vagrant coral reef fish

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Coral reef fish expatriated to temperate receiving areas (vagrants) are subjected to suboptimal conditions that impact physiological performance and behaviour. Little is known about the ontogeny of vagrant fish, especially as they mature into the austral autumn and winter. This lab study evaluated diel patterns of behaviour and physiological performance of two size classes of common vagrant, *A. vaigiensis* (sergeant major damselfish). Fish were filmed at morning, midday, afternoon, and night (infrared camera at night) and were exposed to the following treatments: normal, plus food, plus simulated predator, and post-predator. The behavioural characteristics (alertness, water column position, aggressiveness, area of shoal, activity, and habitat usage) and performance (burst speed and bite rate) were quantified at each treatment. Preliminary findings show larger fish were more reliant on habitat through all treatments, whilst smaller fish relied on shoaling mechanisms. Smaller fish had a higher bite rate and schooled at a higher volume when feeding compared to larger fish, but a difference occurred in the morning, where larger fish had an increased bite rate. The latency from the predator response followed a similar trend across all treatments, but larger fish recovered sooner, demonstrated by high activity levels and an increased area use after the predator simulation. Larger fish used the upper part of the water column at night under normal conditions and feeding, and smaller fish showed signs of stress by abrupt swimming and decreased area being utilised. This study highlights the shifts that occur as vagrant fish mature in novel ecosystems and the behaviours that underpin ontogeny. Understanding of vagrant fish and the mechanisms that drive ontogeny will play an important role in assessing the impacts of invasive fish in temperate marine ecosystems under climate change.

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Enhancing efficiency and robustness for BRUVS monitoring – a spatially balanced approach

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Increased demand for Baited Remote Underwater Video (BRUV) survey use as a monitoring tool has brought forward long-contended questions surrounding their capability to detect change. Lack of sampling standardisation, ecological variance, and temporal concerns are some potential limitations of BRUV survey for repeated sampling. The influence of this variability on the presence and number of fish is recognised, and approaches exist to address some of these issues to optimise sampling for monitoring purposes. The Australian Institute of Marine Science (AIMS) has extensively used BRUV survey across many habitats and regions in Australian waters and carries a strong capability to use legacy data to determine '*how'* and '*what'* to best monitor considering the time and costs associated with this method.

We applied a spatially balanced probabilistic sampling design to previously surveyed sites on the Great Barrier Reef to optimise performance in sampling fish communities. Randomised drops were created in MBH Design and weighted with inclusion probabilities using known depth, habitat features (e.g. hard coral), and include a subset of productive legacy sites based on fish abundance and diversity. Trends in distribution and abundance of key species and fish communities were determined with univariate and multivariate representation respectively to show differences in efficiency between previous sampling design and a spatially balanced approach. We used common fish metrics to determine within and between year effects of both natural variation and sampling optimisation. This approach was also compared to other AIMS repeated sampling surveys across sites in Australia. By optimising the sampling to a better-informed design, some of the variability typically linked with BRUV survey is reduced. With these considerations, BRUV surveys remain the optimal method (particularly for monitoring in deep-water offshore areas and predatory species) compared to other available technology and can be considered a viable approach to repeated monitoring.

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Multi-method approach to advance provenance determination for stocked fish

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Fish stocking occurs in aquatic systems around the world for conservation purposes, to create or enhance recreational fisheries, and to enhance wild-catch commercial fisheries. Identifying and quantifying the contribution of stocking efforts to the wild population is crucial to informing these management objectives. Existing provenance determination methods trade off accuracy, replicability, and cost-effectiveness at fishery-relevant scales.

Extensive stocking of unmarked barramundi (*Lates calcarifer*) fingerlings into Queensland waterways has been a challenge for accurate stock assessment. We present results of an extensive, multidisciplinary approach to provenance determination using a case study of >800 barramundi in the Dry Tropics region of northern Australia. The performance of a novel application of Near Infra-Red Spectroscopy (NIRS) is compared to two established methods for fish provenance: otolith microchemistry and genetic parentage analysis using microsatellites.

As a result of distinct differences in the trace element composition of wild and hatchery environments, the otolith microchemistry method was able to provide extremely high provenance resolution (>99% accuracy) using just four trace elements (manganese, magnesium, barium, and strontium). The microsatellite parentage analysis method had a lower overall accuracy (95%), likely as a result of genetic introgression in this system. Provenance determination using otolith NIRS was not successful in this instance. We propose that the provenance-related differences in otolith microchemical composition, or their proxies, fell below the detectability limit of the NIRS hyperspectral sensor used in this study, or that the sample size was insufficient to resolve provenance related spectral differences from spectral “noise”. We identify directions for future research to improve the accuracy of NIRS of otoliths for provenance determination, in particular regarding sensor specifications and spectral noise. Once these limitations are addressed, otolith NIRS has exciting potential for cost-effective, scalable application to provenance determination.

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The Australian Fish Chorus Catalogue: a collection of spectrographic and audio fish chorus records

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Fish choruses significantly contribute to aquatic soundscapes. Choruses occur when many individual fish vocalise continuously for a prolonged period, increasing background noise levels within a characteristic frequency band. Hundreds of fish choruses have been reported around the world since the mid-1940s; however, an effort to collate fish chorus records in a publicly accessible format has yet to be made. The Australian Fish Chorus Catalogue is the first of its kind. The catalogue contains the spectrographic and audio records of 279 fish choruses taken from 76 recording locations around Australia. These records were obtained through the manual observation and extraction of records using the Centre for Marine Science and Technology's custom-built Characterisation of Recorded Underwater Sound MATLAB toolbox. The catalogue is an open-access depository, available on the Australian Ocean Data Network. The Australian Fish Chorus Catalogue is intended to be used as a reference for future studies to gain a greater understanding of how fish contribute to Australian aquatic soundscapes, to help identify fish chorus source species, and contribute to the future monitoring and management of Australian fish populations. Future work on this catalogue will involve the inclusion of any new choruses and the classification of choruses to identify the extent of their geographic distribution.

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Desiccation tolerance of river and floodplain mussels in Australia’s Murray-Darling Basin

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1. Freshwater mussels provide a range of ecosystem services but are globally imperilled. Mass die-offs, reduced species richness and local extinctions of freshwater mussels have resulted from river drying events which often co-occur with high ambient temperatures. These events are predicted to increase in occurrence and severity under the influence of climate change. We studied the desiccation tolerance of two freshwater mussel species (*Alathyria jacksoni* and *Velesunio ambiguus*) in Australia’s Murray-Darling Basin across a range of upper temperatures to better understand the potential impact of drying events and climate change on these species.
2. During laboratory trials, freshwater mussels buried in sediment were exposed to 29, 32, 35, 38 and 41°C, simulating drying events during drought conditions at these temperatures. Lethal temperatures and lethal times at which 50% mortality occurred were used to infer species-specific tolerances.
3. The lethal time for 50% of mussels to reach mortality was significantly shorter for *A. jacksoni* (14 days) than *V. ambiguus* (58 days) in the drying sediment conditions at 29°C but did not differ markedly at higher temperatures. Over short-term exposures to drying, the lethal temperatures that 50% of mussels could survive were similar between species, ranging from 39-40°C at 1 day to 29-31°C at 10 days.

4. We confirm freshwater mussel tolerance to desiccation is highly temperature dependant. Our results suggest that the species-specific difference in desiccation tolerance between *A. jacksoni* and *V. ambiguus* diminishes as their upper thermal limit is approached. Thus, even the more desiccation-tolerant *V. ambiguus* may be at increasing risk from drying events of greater magnitude and severity.
5. Management interventions aimed at reducing sediment temperatures, such as providing shade via riparian vegetation and maintaining and optimising the timing of environmental flows, could help alleviate the impact of drying events and climate change on these species and freshwater mussel populations in general.

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Fish in the wallum – a story of drought, fires and aliens

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Acid wetlands of coastal wallum and dune systems are critical habitat for multiple threatened fish species. Much of this habitat was recently affected by severe drought and wildfires. The extent of aquatic habitat degradation and impacts on threatened species populations is poorly understood, given the last extensive surveys of these systems occurred more than 30 years ago. Prompted by the potential localised extinctions of species we know little about (Oxleyan pygmy perch and honey blue-eye), we conducted surveys of the distribution and abundance of freshwater fish in more than 100 eastern Australian wallum wetlands, investigating the extent and severity of threats to habitats and populations. Our results provide up to date information on the distribution and population status of several fish species of conservation concern and expand the known range of several others. Alien fish species (Poeciliidae) were widespread, occurring at over 1/3 of survey sites and were considerably more prevalent at fire affected sites than native species. A number of localised extinctions occurred at heavily burned sites, however these sites were also subject to extended periods of drought, possibly drying before the fires. While the direct impact of fire alone was likely minimal at most locations surveyed, it is difficult to disentangle the concurrent and likely compounding effects of other stressors, including drought, riparian degradation, and invasive species. This project has established an updated baseline for future monitoring of freshwater fish, habitats and threats in coastal wallum ecosystems.

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Finding water: locating the remaining refuges for fish in Western NSW at the peak of the 2018-2020 drought

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In early 2020 during the peak of the most recent drought across the Murray-Darling Basin, major rivers in Western NSW had stopped flowing and were reduced to disconnected pools. At the time, NSW DPI Fisheries used satellite and aerial imagery to identify pools in which fish were at risk of succumbing to poor water quality or drying. This process also assisted in guiding related extreme event management response actions, including artificial aeration and fish rescues, which were implemented through the NSW Native Fish Drought Response framework. In preparation for future drought events, identification of the remaining refuges has been extended to more than 7,000 kilometres of river channels in Western NSW. Several rivers had reaches in excess of 200 kilometres with no available habitat for fish. We present the methods used to identify the fish habitat using available satellite imagery, the limitations of the methods and the results.

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Menindee fish kill response activities and native fish recovery in the Lower Darling-Baaka

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In the summer of 2018–19 mass fish kills occurred in the Lower Darling (Baaka) River in south-eastern Australia. The fish kills had a significant negative social and cultural effect on local communities, particularly the traditional Baakandji people. In response to the Menindee Fish Kills NSW DPI Fisheries, in collaboration with state and commonwealth agencies and local communities, initiated of a range of actions to preserve as many native fish as possible during the unprecedented low flow conditions. These actions included mapping of refuge pools, mechanical aeration of key refugia, rescue and relocation of stranded native fish, water quality monitoring and substantial community engagement. The Australian government also committed to develop the Native Fish Recovery Strategy. A key feature of the implementation of this Strategy is the concept of Recovery Reaches and the use of Recovery Coordinators to develop and maintain the community partnerships. We present here on NSW Fisheries responses to the mass fish kills that occurred near Menindee and recovery activities since.

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Three years of the Native Fish Recovery Strategy – what have we achieved and what is to come?

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During the summer of 2018-19, widespread fish deaths occurred across the Murray-Darling Basin. In response, $5 million of joint government funds were allocated towards the development and implementation of a Native Fish Recovery Strategy for the Murray-Darling Basin.

The vision of the Native Fish Recovery Strategy (the Strategy) is to "Recover native fish for future generations". To progress towards this vision the Strategy outlines a set of Foundational Actions and Investment Areas. These actions and investment areas complement the current water reform activities and aim to mitigate the threats to native fish in the Murray-Darling Basin.

Following the development of the Strategy in the first year, remaining funds have been invested in the five Foundational Actions over the past two years. These actions include on-ground works at four "Recovery Reaches"; communications and awareness raising; developing a status assessment of native fish populations; and actions for threatened species. The Strategy also calls for greater involvement of First Nations Peoples and Recreational Fishers in native fish recovery actions.

Our successes include the work undertaken at the Recovery Reaches, and our communications and awareness raising. The challenges we have faced include involving First Nations Peoples appropriately; engaging high-level water managers; and implementing projects during a challenging time.

We will provide an update on the progress of the Strategy's Foundational Actions to date; what our final products will be and how they can progress native fish recovery; and our plans for the next phase of Strategy implementation. We will also discuss the integration of the work of the Strategy into our long-term planning to meet the ecological objectives of the Basin-wide Environmental Watering Strategy and the Basin Plan.

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No time to lose, throwing caution slightly to the wind if we wish to conserve freshwater fishes

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It seems clear to me that many of our freshwater fishes in southeastern Australia are essentially stuffed in the near future. In my lifetime I've seen a steady decline in populations of small native fishes. In some cases, creeks no longer have water in them consistently, others have lost their fishes during bad times, but none have been able to recolonise when conditions improved. The 2019 drought, fires and floods had a huge impact on fish populations. Some river basins lost their entire population of fish species due primarily to the 2019 events. For example, Gwydir River lost its Darling Hardyhead, along with the probable loss of its Mountain Galaxias and River Blackfish and possibly Purple Spotted Gudgeon is gone. Many additional populations of species like Purple Spotted Gudgeon were lost across their range in NSW, with creeks completely drying up for the first recorded time. It is not clear if water will simply return to these systems that will provide a suitable habitat for future restoration of some of these creeks post drought. We desperately need to take hands-on action now, which begins with becoming less averse to risk assessments in conservation actions. If we only talk about problems and do not take action, or only make limited changes, then these populations are essentially doomed. Currently, many species appear to exist based on good fortune rather than active conservation management. We need to be more open to considering mixing of genetic stocks, putting fishes into novel places, trying new approaches, and reducing red tape, etc. Some inspiring positive examples exist (e.g., Tri-state alliance). Although there are risks in taking swift and strong action, these risks are quite low relative to the likelihood these species will still exist in 50 years.

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Opportunism and revitalising of purple-spotted gudgeon (*Mogurnda adspersa*) populations following emergency rescue of an inland population

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State government fisheries agencies frequently possess greater capacity for hatchery-based production of fingerlings of large-bodied species, whilst producing and recovering small-bodied fishes is often ad hoc or lacking as a function of funding availability. During the 2017–2019 drought and immediately prior to the 2019 bushfires, two consecutive collections of purple-spotted gudgeon were made from the Mole River in inland Northern New South Wales, as a safeguard against local extinction. In the preceding months it became apparent there was opportunity to learn and breed the captive individuals. Challenges that were met included minimising aggression and housing issues, sex bias and inaccurate sex determination, and domestication. Broodfish representing 28 males and 19 females have been bred regularly during the 2-year period to date, based on a practice of rotating male-female pairings from October until March at the Grafton hatchery. To this end, hatchery quality assurance measures and records have been implemented ensuring genetic integrity is preserved. Progeny have primarily been released into Tenterfield Creek, and the upper Macintyre and Gwydir river systems. Follow up surveys have revealed at least one successful population has been re-established in the wild. The education and adaptive management facets of the project have included indigenous involvement, a school aquarium-based project and a community organisation led habitat restoration in association with the re-stockings. The program has evolved rapidly into a mature community centric species recovery process that has come from developing reliable means for producing this species in captivity.

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Keynote: Does survey mode matter? Four cases studies comparing fisher demographics and fishing activity from telephone and web-based recreational fishing surveys

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Surveys have an important role in providing reliable recreational fishing data to inform fisheries policy. Globally, studies have highlighted the increasing difficulty in locating participants along with declining interest in survey participation. While the data collection tool (survey mode) can influence the potential for errors, there is an increasing expectation to adopt digital technology for the recreational sector. Digital platforms, including PCs, tablets and mobiles, are becoming widely used and it is important to test whether these approaches introduce bias and can be integrated with current surveys. Four case studies are presented to compare traditional telephone surveys with a variety of contact methods to invite participants to complete a web-based survey for boat-based, rock lobster, marron and abalone licensed recreational fisheries in Western Australia. Each study compares response rates, fisher demographics and fishing activity as reported using telephone and web-based survey modes. These studies demonstrate web-based surveys can achieve a high number of completed interviews with comparable fisher demographics, but with lower response rates and varying levels of coverage of the target population. The potential benefits and limitations of web-based surveys requires further attention to ensure digital survey modes can be adopted in a manner than provides reliable survey data from which robust estimates can be obtained. Potential benefits of web-based surveys, such as lower cost and efficient resourcing, should be considered along with potential limitations, such as lower response rates, self-reporting, higher respondent burden and accessibility to digital platforms. These case studies have broad application to recreational fishing surveys conducted in other regions, particularly when evaluating the impact of contact methods on survey data, or when transitioning data collection approaches in ongoing surveys.

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Keynote: Integrating recreational fishing into harvest strategies: what do recreational fishers want and do we have the data to achieve it?

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Recreational fishing (RF) is a popular activity that has substantial ecological, economic and social impacts and benefits. Yet, inclusion of RF in fishery harvest strategies is limited, because the sector's objectives are poorly understood, as are the data requirements for monitoring their performance. The result is a constrained ability to develop equitable management arrangements that reflect the activities of all sectors participating within a fishery. We addressed these knowledge gaps through numerous studies based within the Australian state of New South Wales (NSW), which has a large RF sector. The studies aimed to: 1) identify RF objectives, 2) define whether they could be addressed within harvest strategies, 3) link them to existing and emerging RF data sources in NSW, and 4) develop quantitative performance indicators for monitoring and assessing fishery performance within a harvest strategy. Literature searches and workshops with experienced recreational fishers identified a broad range of RF objectives, many of which were social and lie outside the scope of a traditional harvest strategy. However, RF ecological objectives often overlapped with other fishing sectors and could indirectly achieve some RF social objectives (e.g. 'trophy' fishery), potentially allowing consolidation of RF objectives within harvest strategies. Numerous RF data sources were available in NSW to monitor ecological objectives, providing time-series and potential reference points for key indicators such as catch-per-unit-effort. However, the precision of these data sources varies considerably among stocks. Research to date supports the need for early engagement with the RF sector, to identify their objectives, and a step-wise approach for reviewing the suitability of existing RF data for harvest strategies.

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Facing up to the challenges of assessing Victoria's recreational fisheries

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Recreational, commercial and Indigenous fishing provide a wide range of social and economic benefits. In recent times, access and impacts on finfish stocks have also become weighted towards the recreational sector. This provides additional challenges for assessment of fish population status, because in general catch and effort for recreationally dominated fisheries is not routinely reported. In the 2014 and 2018 Victorian state elections, the elected government committed $81 million towards recreational fishing, in the hope to grow participation to one million anglers by 2020.

To ensure that resources are managed sustainably, a strong evidence base, informed by knowledge of the stock status, is required. In the 1990's Victoria's fisheries management agency recognised that phasing out of commercial fishing activities over time, combined with population growth and increasing recreational fishing would mean that fisheries assessment and management could not rely solely on commercial fishery data. Further, there was a need to include recreational fishery data into assessments to fully capture fishing effects on stocks. Consequently, angler-based monitoring programs were developed and implemented, and have been operational since the late 1990s. In considering Victoria's recreational fisheries and the most cost effective methods to collect data, "face to face" creel/catch surveys are focused on the largest fisheries where species with high vulnerability. The timeseries sampling approach has allowed catch survey information to be used by:

- Track changes in stock abundance and by target species
- Measure the performance of the fishery across a range of groups with various fishing experience and expectations
- Assess the performance of current and proposed bag and size limits
- Provide the necessary recreational fishery catch data for the implementation of the fishery management plans, harvest strategies and stock assessment reporting

Over the last two decades there have been many challenges and learnings from delivering this data collection and assessment approach.

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Estimating recreational catch

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Understanding recreational catch and effort is important for sustainably managing the world's fisheries. However, collecting annual, high-resolution, recreational catch and effort data can be cost-prohibitive. As a result, some governments only conduct state-wide surveys of recreational fish catch once every several years. In this work, we present a methodology to estimate recreational catch during the years in between state-wide surveys. The method analyses information from more frequent surveys of recreational catch at select boat ramps. Using well-established statistical techniques, we provide an index of recreational catch derived from both the infrequent state-wide survey data and the frequent annual boat ramp data. All methods presented can be applied to estimate kept or released catches of fish. The approach adopted is flexible and does not assume any underlying distribution of the data. We illustrate the method with examples for three fish species with significant recreational catch: grass emperor (*Lethrinus laticaudis*), snapper (*Pagrus auratus*) and pearl perch (*Glaucosoma scapulare*).

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Post-release survival of swordfish (*Xiphias gladius*) in the southeast Australian recreational fishery

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Swordfish (*Xiphias gladius*) are large, economically and ecologically important predatory fish with a wide circumglobal distribution. While swordfish are coveted by anglers, development of recreational fisheries has been limited historically, due in part to the species' tendency to migrate into the mesopelagic zone during the day (effectively out-of-reach of typical game fishing methods). Recently, however, the adoption of 'deep-dropping', targeting swordfish during day-time with baits at >300 m depth, has expanded access to the fish and led to the emergence of new regional fisheries. In 2014 a deep-dropping recreational swordfish fishery emerged in temperate southeast Australia and attracted international attention after yielding several swordfish line-class weight records. However, information is needed to guide best practices for emerging deep-dropping swordfish fisheries. Here, we present the first assessment of capture-related morbidity and post-release survival of swordfish caught by deep-dropping in southeast Australia. Overall, the survival rate for landed swordfish was 44% (95% CI 25.1–64.8%; n = 25). Severe peritoneal distension, and deep/gill-hooking injury were strong predictors of reduced survival (ORs = 0.008 and 0.015 respectively), while angling duration and fish weight did not have a discernible effect on mortality. Among swordfish assessed to be in suitable condition for release, affixed pop-up satellite archival tags indicated 85.6% (57.8–95.7%; n = 13) survived after release. While the swordfish fishery is superficially similar to more common istiophorid billfish game fishing, the unique physiology and behaviour of swordfish and depths at which they are targeted present a unique challenge for stewardship since the typical catch-and-release billfish game fishing ethos may not be appropriate; these results suggest swordfish caught deep-dropping are a poor candidate for purely catch-and-release angling. Predictors of post-release mortality are readily observable, so fishers should be prepared to humanely dispatch fish exhibiting internal hooking injuries or severe peritoneal distension.

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Queensland fisheries interactive dashboards on recreational fishing and economics

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Monitoring the recreational fishing sector is a significant component to the Queensland fishery to help sustain healthy fish populations for the future. State-wide surveys are conducted every 4-5 years requiring participants to record a diary of important information on fishing catch and effort over a 12-month period. Additional to state-wide surveys, boat ramp surveys are conducted across 48 ramps through-out Queensland all year-round recording catch and effort data as well as lengths of kept fish. To showcase the results from the surveys, Queensland Fisheries has a novel, interactive dashboard on the Department of Agriculture

and Fisheries website that presents raw data obtained from the surveys that the public can filter through. Specific data requests on different aspects of recreational fishing are commonly requested from institutions such as universities and conservation organisations for studies on impacts of fishing. Additionally, information is used by Fisheries Queensland in stock assessments. Economic and social data is collected from charter, commercial and recreational fishers to determine social and economic benefits of fishing to Queensland. The economic results are displayed on a separate interactive dashboard. Fisheries Queensland is committed to making information publicly available and is providing novel interactive dashboards presenting current information on recreational fishing.

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Factors motivating participation and satisfaction of recreational fishers in Port Phillip Bay, Victoria

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As a popular leisure activity, recreational fishing plays a key socio-economic role in Australia, especially in regional areas where it also provides economic benefit to local businesses. Port Phillip Bay (PPB) is the largest marine recreational fishery in Victoria. The motivational reasons for recreational fishing in PBP have, to date, not been explored, nor has angler satisfaction been investigated in detail. To this end, using long-term satisfaction and motivational information collected during creel surveys at 20 boat ramps in PPB during a 10-year period, we evaluate a variety of socioecological and fishing related reasons of anglers' engagement in fishing. We also assess spatiotemporal patterns in motivation and satisfaction from regional and annual perspectives as well as the influence of key target species, including catch rate. Thus, this research provides insight into the behaviour of anglers and factors that influence their overall satisfaction, with the ultimate goal being the formation of performance indicators that can be used to both understand and monitor angler satisfaction into the future. In the case of snapper, the most important target species in PPB, these performance indicators will form a key component of a recreational snapper harvest strategy being as how social objectives are an important component of recreational fisheries. More broadly, the study also provides insight into how management interventions will impact angler satisfaction, therefore making it more likely that the needs and concerns of recreational fishers are considered in decision making processes.

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The luckiest catchment in the mdb: resilience lessons from the paroo

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The Paroo occupies a unique niche within the Murray-Darling Basin. Located in the arid north-west, it behaves and presents in a similar way to thousands of years ago, with unpredictable floods and flows driving booms and busts of predominantly native fauna and flora. The Paroo has consistently ranked amongst the healthiest catchments in the Murray-Darling Basin in ecological audits, with lack of large-scale river regulation and isolation underpinning its individuality. Repeated monitoring of the aquatic fauna of the Paroo since 2019 represents the most comprehensive and complete study of the wildlife of this comparatively unknown catchment, and has included many previously unsurveyed areas, as well as ephemeral lakes and waterholes. Following a succession of wet seasons, the aquatic fauna of the Paroo appears to be in remarkably good condition, with population booms of most native fish and notably small populations of introduced species. The Paroo has the potential to provide useful insights that may be applicable when remediating more regulated catchments. The results suggest that if the effects of river regulation can be minimised, native populations of fish and other aquatic fauna may be able to compete effectively with alien species and maintain healthy populations if patterns of flows and flooding can be provided, restored or imitated.

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Systematics, hybridisation and biogeography of M*ogurnda* in the Wet Tropics of Queensland

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Delimiting cryptic species is important in understanding the true biodiversity of an ecosystem and subsequently reflecting these cryptic species in conservation, management and policy. Current molecular evidence suggests that the broadly distributed genus of fish *Mogurnda* harbours high levels of cryptic biodiversity. The present study uses a large single nucleotide polymorphism (SNP) dataset to clarify taxonomic uncertainty, patterns of introgression and biogeographic patterns of *Mogurnda* within the Wet Tropics region. PCoA analysis separated taxa into two divergent Northern and Southern groups. Stepwise analysis revealed six taxa were present in the two groups. Heterozygosity values were variable by individual based on their taxa but were informative for the exclusion of eight introgressed individuals. Both maximum likelihood and SVDqaurtets trees supported these taxa, with high bootstrap support for all nodes (> 95%). Fixed differences were high between all taxa but were greater between taxa from different groups when compared to those within groups. All analyses support the delimitation of *Mogurnda* in the Wet Tropics into six new putative species, with four species being endemic to a single drainage. Based on this analysis, morphological appraisal is recommended to describe these six taxa as species within the genus *Mogurnda*. Biogeographically there was evidence for shared faunal exchange between the Herbert and North Johnstone catchments. It is likely that the genus *Mogurnda* across northern Australia has high levels of cryptic biodiversity and requires morphological comparison to revise their taxonomy.

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Installing fish detection systems within the Xayaburi Run of River Power Plant

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Productive fisheries in the Lower Mekong Basin (LMB) are threatened by river development outcomes. One of the first dams, at Xayaburi, in Lao PDR, had significant investment to provide for fish passage in the final designs. The level of investment, and the complexity of the fish passage facilities, are unprecedented anywhere in the tropical or sub-tropical world. Nevertheless, the facilities need to be rigorously assessed to determine if they meet the design specifications. There are a wide range of mark-recapture techniques available for assessing fish movement patterns in and around dams. The use of passive integrated transponders (or PIT tags) has been widely accepted globally. PIT tagging has been found to be especially effective for examining the movement patterns of freshwater fish largely owing to the fact that the tags (1) are relatively inexpensive, (2) are powered electromagnetically and do not need a battery, and (3) can be applied to both large- and small-bodied fishes. The success of any PIT tagging system in a fish pass is highly dependent on a suitably configured PIT antenna system. PIT tags have never been applied in the Mekong before and there is no effective method for safely collecting fish for tagging studies (i.e. most efforts involve gill netting, which can lead to mortality). This presentation reports on a short research project which designed and assessed an antenna system for potential installation at the site and discusses the logistical process for the actual installation. Antenna design tests led to the establishment of a design that had sufficient read range and pings-per-second which were within the expected swim speed ranges of selected target species. The design was effectively installed in the field and performed well when tested in situ. It forms a template for considering the installation of PIT systems at other large tropical fishways.

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Developing quality assurance practices for PIT tagging in the Mekong River

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The barrier effect of dam construction can limit fish migrations and threaten the ability for fish to complete essential life history stages by limiting access refuge, feeding, spawning or dispersal habitat. The importance of understanding the fish movement is to understand the role fish play in broader ecosystem processes. The aquatic monitoring technology has a substantial role to play in this progression. Critical to collecting the fish movement data is developing cost-effective, accurate and scientifically robust technology. Traditionally, tagging has been used to understand movements in and around dams. A technology with significant promise for application in the Mekong is Passive Integrated Transponder (PIT) tagging as a method to quantify fish migrations. But the technology has been rarely used in the Lower Mekong Basin, only two species from the Mekong River have been previously assessed to determine the suitability and there have been no large-scale field trials. Furthermore, no studies have been undertaken to validate whether the critical requirements for tagging studies (Tag retention, Low mortality, Low impact on behavior) are valid for PIT tags in the region. there is little information on the potentially negative biological impacts of the tags themselves to Mekong fish species. If tagging influences fish survival or behavior, then the results can be called into question. Here I report on the results of a PIT tag retention trial was performed for selected Mekong species. A range of species, from different sizes, were implanted with different-sized tags to determine any influences on growth or survival. The results indicated that survival and retention rates increased proportionally with fish size. We also determined that survival and retention was influenced more by fish length, than weight. The data provides an excellent basis for the practical application of fish, in large tropical rivers, to enhance maximum survival of tagged fish.

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Fishpass Design of the Xayaburi Hydroelectric Power Plant, Laos

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The Xayaburi project was the first run-of-river hydropower plant built on the Lower Mekong River and is now in operation since the end of 2019.

It was particularly challenging to design the Fish Passing Facilities since no direct references and only very little data were available in the initial design phase. Therefore, the developer Xayaburi Power Company Limited (XPCL) carried out a number of fish studies to design and optimise the Fish Passing Facilities of the hydroelectric power plant. XPCL carried out these studies addressing questions related to fish species, biomass and fish swimming abilities.

The design comprises:

Downstream migration: Dedicated facilities with minimum flow requirements to provide constant, all year-round downstream migration for egg, larvae and fish. Provision of a complex system of entrances, channels and a hydraulically modeled exit chute. To ensure flexible operation a series of gates and a dedicated pumpstation are provided to minimize losses in energy production during the low flow season.

Upstream migration: Optimisation of the complete system including a large fish ladder to consider the specific swimming abilities of a wide range of migrating Mekong fish species. The system was adapted in an early phase to provide the right flow velocities for fish to migrate upstream and resulted in a hybrid system where a fish ladder is combined with two vertical fish locks.

The dimensions are designed such to provide sufficient capacity for the expected biomass and to be large enough to allow the largest fish like the Mekong Giant Catfish to pass.

The operation of the permanent Fish Passing Facilities commenced in late 2019. This presentation gives an overview of the design philosophy, first results and the special challenges to provide fish passage for a wide variety and number of species in a large tropical river like the Mekong.

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A pilot study of migrating fish in the Mekong river using acoustic tagging technology in southern Laos PDR

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The Mekong River Commission (MRC) set up the Joint Environment Monitoring (JEM) Programme to monitor potential impacts from Mekong mainstream hydropower projects. The Australian Water Partnership through the Australia Mekong Water Facility and Charles Sturt University is providing expertise to support the design and trialing of fish passage monitoring as part of JEM. This pilot project aims are to guide and provide recommendations for sustainable fish pass monitoring methodologies in the future JEM.

The pilot study using acoustic tags commenced in February 2022 in the Mekong River in “the 4000 islands” region of southern Laos. The study location includes Khone falls, the largest waterfall in the world (10.9 km across), a 260 MW hydro power station and a strongly braided river network with considerable variation in substrates and river discharge between wet and dry seasons. The acoustic system includes a 34-receiver network, approximately 130 tagged fish from 11 species and an international collaboration with a team working on the Wonders of the Mekong (WOM) project in neighboring Cambodia. Early results highlight the value of using tag retention trials to assess local fish species and the importance understanding rainfall, water level variation and river discharge effects on the read range and detection probabilities associated with different receiver deployment methods and tag types. The project has been extremely successful in capacity building in our in-country partners and played a particularly important role in empowering women in fisheries sciences in Lao PDR and other member countries.

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How useful?: A review of three fish-friendly irrigation guidelines written for the Lower Mekong

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Guidelines are a ubiquitous management and training tool, however there is a dearth of guideline evaluation in the literature, especially in the water management sector. Water management is a contentious issue in which some resource uses necessarily trade-off against others, such as the trade-offs to inland fisheries of irrigation. The present study aimed to review three fish-friendly irrigation guidelines written for the Lower Mekong Basin in the past five years. Through document analysis and key informant interviews, insights into similarities and differences between these guidelines were obtained. While the guidelines were similarly recent, and shared a topic of focus, each approached fisheries in irrigated landscapes from a different perspective. Reviewed guidelines shared other traits including structure and content components which, if improved, could enhance their impact and utility. Five recommendations for guideline enhancement were determined, namely: improve target audience definition; involve target audience in guideline design and production; improve definition of guideline scope; improve recommendation specificity; and build in evaluation measures. The present study not only adds to water management guideline evaluation literature but has implications relevant to guideline creation and assessment more generally. The findings support multi-sectoral communication and collaboration for the advancement of fish-friendly irrigation structure concepts in the Lower Mekong Basin.

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Sharks and where to find them

Charlotte Birkmanis[1]

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Many of the world's shark populations are in decline due to overexploitation and habitat loss. A better understanding of their population status, distribution and habitat requirements is vital to maintain viable populations. However, as many pelagic shark populations occur in remote offshore locations, understanding their habitat requirements, distribution and population status at a regional level is crucial to manage and protect long-lived shark species. Dr Charlotte Birkmanis highlights one way to find out where sharks are, why they are there and how climate change may impact them in Australian waters and the adjacent high seas. She also shares effective techniques to highlight the wonders of the oceans and help more people to become ocean ambassadors.

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Tropicalisation and the homogenisation of global marine biodiversity: observations, projections and implications

David Schoeman[1]

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As marine organisms respond to a warming ocean, we have observed a rapid redistribution of marine biodiversity, globally. The most common consequence has been a trend toward increasing representation within communities of species with affinities to waters warmer than the historical norm for the given location, a phenomenon now known as “tropicalisation”. Driven by differing dynamics at leading and trailing range edges of the species comprising the local community, tropicalisation leads to the progressive homogenisation of marine communities. These interactions between changing environmental conditions and the development of new, more homogenous communities challenges our understanding of how marine ecosystems function. Although much is left to learn, the rapid accumulation of evidence from observational, experimental, and modelling studies provides insights into what topicalisation might mean for marine communities and the people who depend on them as we progress through the 21st century.

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Who are you talking to? How to plan for better communication in the sciences

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In the world of science communication, we often talk about getting to know your audience before you plan your presentation. But, how does this work? I will present some examples of science communication tools including the Message Box and the And, But , Therefore (ABT) structure. The examples will demonstrate how you can structure your presentation to connect with a given audience and ensure that your message and content are better understood. In addition, these tools help us as scientists to view our work from different perspectives and understand how what we do may connect with people outside of the academic and research community.

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Commissioning Illustration for Science: an introduction.

Lindsay Marshall[1]

1. Stick Figure Fish Illustration, Peregian Beach, QUEENSLAND, Australia

Illustrations and graphics add immense value to your publications. They help to communicate ideas clearly and concisely, often better than words alone. They draw attention to your work and help people remember it. We live in a visual world and journals are increasingly requesting the submission of a graphical abstract alongside the body of the article. However, creating high-quality illustrations requires a lot of work, consideration from the artist, and communication with the client. Many scientists approach commissioning an illustration as an afterthought and don’t fully appreciate what is involved or what "usage" and "contracts" mean. Indeed most artists are still getting to grips with this! This presentation is intended to explain what is involved in commissioning an illustration, what "usage" is, where the value lies, and what contracts are. Foremost, it will guide you on some important things to consider if you are thinking about commissioning some art to bring your science to life.

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The Ornate Rock Lobster that took two years of my life (and I don't want them back): an (scientifically accurate) artistic journey

Lindsay Marshall[1]

1. Stick Figure Fish Illustration, Peregian Beach, QUEENSLAND, Australia

In November 2020 I received an email requesting a commission for a large painting of an Ornate Rock Lobster (*Panulirus ornatus*). Follow me down the rabbit hole as I describe a two-year-long journey where I wrestled with paint mix-ups, a tiny leg cast, a pandemic, motherhood, pandemic-motherhood, and my frustrating artistic punctiliousness. It has pretty paintings.

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How robust is the indicator species management approach in multi-species (mixed) fisheries, insights from the assessment of a secondary species, the yellowspotted rockcod (*Epinephelus areolatus*).

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Multi-species (mixed) fisheries in WA are managed based on the status of ‘indicator species’. This approach seeks to manage the entire resource (all exploited species) in a given bioregion by ensuring that management responses are aligned with the most

at-risk species (indicator species). This robust precautionary approach recognises that while several species are likely to be 'targeted', a plethora of species are landed by the gears used (e.g., trawls, traps, lines). The indicator species approach has been used to successfully alter individual effort allocations in WA to reduce or maintain the catches of indicator species as required, which has also reduced overall catches of other species in the resource and has thus allowed stocks to be maintained at or to be rebuilt to target biomass levels. To ensure that the indicator species approach is robust across all species, an assessment of the stock status of a secondary species (*Epinephelus areolatus*) was undertaken. Catches of *E. areolatus* are the largest of all epinephelids in the multispecies tropical fisheries across north-western Australia. The relative exploitation levels of *E. areolatus* populations was assessed by comparing values of fishing mortality (F) to standard reference points based on ratios of M. Values of F indicated that harvest rates are at an acceptable level in this region and multiple lines of evidence confirmed that current levels of F are unlikely to cause overfishing on the spawning biomass of *E. areolatus* in Western Australia. The sustainable harvest of *E. areolatus* in north-western Australia is due to the effectiveness of the indicator species management approach, and their life history traits, making them one of the few reported epinephelids to have sustained long periods of exploitation. The stock status of *E. areolatus* further supports the utility and robustness of the indicator species approach to management of multi-species (mixed) fisheries.

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Building ecosystem understanding of an exploited embayment in Western Australia

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Cockburn Sound is one of the most intensively used marine areas in Western Australia and has had a history of major industrial development and nutrient pollution which contributed to significant losses of seagrass meadows (~80%) between the 1950s and early 2000s. However, Cockburn Sound remains highly valued by the community as an important area for recreation and commercial activities such as fishing, aquaculture. It continues to support major marine infrastructure through the operations of trade, defence and heavy industry such as shipbuilding. In this study, we developed a quantitative ecosystem model using Ecopath with Ecosim (www.Ecopath.org) to elucidate how the Sound functions, including (1) biomass flow in the food web; (2) identify keystone species; (3) the ecological role of benthic producers (e.g., seagrass and macroalgae); and (4) the ecological role of high trophic level species. The model represents the food web of commercial and recreational fishing species (e.g., Pink Snapper, Blue Swimmer Crab, Southern Garfish, Sandy Sprat), charismatic species (Little Penguin, Bottle-nose dolphin, Australian Sea Lion, Cormorants, migratory Waders), demersal and pelagic fish assemblages, invertebrates and primary producers. We defined 70 functional groups (representing ~110 species) based on biological surveys and expert consultation. This model is a tool for testing hypotheses with respect to trophic interactions of different species and fishing pressures. The analyses undertaken in this study have shown the great complexity of this system and they have improved our understanding of potential ecological flow-on effects from impacts associated with industrialisation of Cockburn Sound.

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Ontogenetic diet shifts by Murray cod in the lower River Murray

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For fishes, recruitment and cohort strength are influenced by survival through early life stages, which, in part, is determined by food availability. As such, knowledge of diet and key prey trophic interactions during early life stages, and how these are influenced by environmental parameters (e.g. river flow), are crucial for understanding population dynamics. We used a combination of traditional microscopy and DNA metabarcoding to investigate the diet of Murray cod (*Maccullochella peelii*) from the lower River Murray during several stages of early ontogeny (larvae to ~18 months old) and also temporal variability in diet for specific life stages (larvae and ~150 days old) across a seven-year period. Results were generally consistent between methods. Prey contributing greatest (by number of individuals or DNA reads) to larval diet were specific copepods, cladocerans and rotifers, and the shrimp *Paratya australiensis*. Larvae demonstrated selection (Strauss index) for calanoids *Boeckella triarticulata* and *Calamoecia* spp., the cyclopoid *Acanthocyclops australis* and rotifers of the genus *Trichocerca*. Diet from 60 days to 18 months was dominated by decapods, with lesser contributions by isopods and fish. With increasing age from 60 days to 18 months, there was a shift in diet from dominance by *P. australiensis* to the larger decapod *Macrobrachium australiense*, and increasing contribution of *Cherax destructor*. The diet of ~150-day-old Murray cod was temporally consistent across 2015–2021 and dominated by decapod shrimp. In contrast, larval diet varied across years under different river flow conditions due to differing contributions of copepods and cladocerans. Our findings have improved understanding of the key food resources of early life stage Murray cod in the lower River Murray and will inform flow management. Flow regimes that promote abundance of preferred prey species may enhance recruitment of Murray cod, and in turn promote population resilience.

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Spiny lobsters prefer native prey over range-extending invasive urchins

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In Tasmania, the continued expansion of the Longspined Sea Urchin (*Centrostephanus rodgersii*) is one of the biggest challenges facing marine scientists and fisheries. As the urchin population shifts southwards in response to climate change, valuable and diversity-sustaining kelp habitat is rapidly destroyed, leading to the desertification of underwater landscapes. The resulting urchin barrens are unable to support populations of commercial fishery species such as abalone and rock lobster and the transformation to barren can see the loss of up to 150 native species.

The Southern Rock Lobster (*Jasus edwardsii*) has long been lauded as a potential predatory control mechanism for these urchins on the East Coast of Tasmania. However, with the conversion rate of reef to barren increasing at around 10% a year, it is critical we review the efficacy of current control methods.

Using experimental feeding trials, we investigated lobster prey preference to determine how likely lobsters are to prey on Longspined Sea Urchins when offered a choice of other native prey species. We found that the invasive Longspined Sea Urchins were the least preferred prey type for Southern Rock Lobsters (3.8% predation events), when compared to three local species: Black-lipped Abalone (*Haliotis rubra;*36.6%), Shortspined Sea Urchins (*Heliocidaris erythrogramma;*32.6%) and Periwinkles (*Lunella undulata*;27%). On top of this, we also found that habitat origin and potentially naivete of lobsters to the Longspined Sea Urchin affected urchin consumption with 85% being consumed by lobsters collected from extensive urchin barrens.

Low predation rates on Longspined Sea Urchin suggest that resident lobsters are unlikely to control further barren expansion unless a behavioural shift occurs. Results imply that control potential of Longspined Sea Urchins by Southern Rock Lobsters has previously been overestimated. Additional control methods are needed to safeguard ecological communities and important commercial fishery stocks from this climate change-induced, range-extending pest species.

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Fish use of restored mangroves unrelated to habitat maturity

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Mangrove loss and degradation have triggered global restoration efforts to support biodiversity and ecosystem services, including fish stock enhancement. As mangrove restoration accelerates, it is important to evaluate outcomes for species that play functional roles in ecosystems and support services, yet this remains a clear knowledge gap. There is remarkably little information, for example, about how fish use of mangroves varies as restored vegetation matures, limiting the theoretical links that can be made between restoration and fish stock enhancement. We used unbaited underwater cameras within two distinct zones of mangrove forests – fringe and interior – at five pairs of restored-natural mangrove sites in southeast Queensland, Australia. We used deep learning to automatically extract data for the four commonest species: yellowfin bream (*Acanthopagrus australis*), sea mullet (*Mugil cephalus*), common toadfish (*Tetractenos hamiltoni*) and common silverbiddy (*Gerres subfasciatus*). The relative abundance of all species (i.e., restored relative to paired natural) was highly variable among sites and zones. Despite younger restored sites having much lower structural complexity, we discovered no trend of greater fish abundance within more mature restored mangroves. In fact, silverbiddy show the opposite with greater relative abundance at younger sites. Further, yellowfin bream and sea mullet were more abundant in the fringe zone, and we observed similarities in how fish used fringe and interior zones across all sites. Our paired, space-for-time design provides a powerful test of restoration outcomes for fish, highlighting that even newly restored sites with immature vegetation are readily utilised by several species.

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Cross-jurisdictional larval supply essential for east Australian spanner crabs

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The spanner crab (*Ranina ranina*) stock of eastern Australia is distributed across two state jurisdictions and as a non-migratory species with a pelagic larval phase, connectivity within this stock likely occurs via larval dispersal, driven by ocean currents. To understand connectivity and patterns of larval supply in the east Australian spanner crab stock we used Lagrangian particle tracking methods to simulate larval transport around the key spanner crab fishing regions in eastern Australia. Results show that spawning off central Queensland (QLD) supplies a large proportion of recruits, supporting both the QLD and New South Wales (NSW) fisheries. Lagged larval settlement showed significant correlations to catch-per-unit-effort and the proportion of total harvest taken within the NSW fishery, providing evidence to suggest the NSW fishery may be reliant on spawning activity in Queensland. The QLD and NSW fisheries are highly connected, and the broad-scale patterns identified by the current modelling approach could provide an indicator of potentially good or bad recruitment years, particularly as finer resolution, and refined reproductive biology knowledge on spanner crabs becomes available. The QLD and NSW fisheries are highly connected with a source-sink structure and it is recommended that a co-management strategy be adopted.

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Insights into the ecology of the critically endangered Short-tail galaxias *Galaxias brevissimus*

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The Short-tail galaxias *Galaxias brevissimus* is a newly described species in the *Galaxias olidus* complex and is one of several species listed as critically endangered. The species was impacted by the Black Summer fires of 2019-20, and prior to that the severe drought in NSW in 2017-2019. Almost nothing was known of its distribution, abundance and ecology apart from its type locality and some subsequent random spot records. The species is only known from two locations approximately 30-40 km east of Cooma: one is on a handful of private agricultural properties in the Upper Tuross River catchment around Countegany, and a second is in a single isolated stream in Wadbilliga National Park. Ecological knowledge is essential if the species is to be managed and recovered.

Under funding provided by the Commonwealth Bushfire Recovery Program, investigations into distribution and reproductive ecology were conducted in 2021 and 2022. Surveys of the species' distribution in the Jibolaro/Guinea Creek sub-catchment have expanded its known range to approximately 18 km, with the upstream limits of the distribution now largely quantified. A new subpopulation was discovered in Lantooley Creek (Guinea Creek tributary) and the downstream population limit (the barrier that prevents upstream trout invasion) in the Jibolaro/Guinea creek system is now known. In Bumberry Creek in Wadbillaga National Park, the extremely rugged and isolated nature precluded survey work but studies on the reproductive ecology of the species were possible at a single site. *Galaxias brevissimus* is an isochronal spawner with ripe individuals recorded from July-September. Fecundity varied from 155 to 1035 depending on fish size, with mean mature or ripe eggs oocyte diameters of 0.79 to 1.60 mm (depending on individual). The spawning site remains to be described.

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Conservation management of the threatened Australian lungfish *Neoceratodus forsteri* using a stochastic population model

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The Australian lungfish, *Neoceratodus forsteri*, is one of the world's oldest living vertebrate lineages, and is listed as a threatened species and requires immediate conservation management. Lungfish are a large-bodied species (1.5 m in length and 48 kg), in the wild may live up to 100 years maturing at around 10 years of age. We developed a stochastic population model that has been applied to each endemic population of lungfish in Australia and one introduced population, to provide insights into the appropriate management options and priorities for such a long-lived species as well as to help direct future research opportunities. The model has been developed as both a single population construct and as a metapopulation construct with up to three interacting populations to characterise the different river systems in which lungfish are found. For each location and each population, flow, spawning and movement rules were developed to capture the ecological and biological response of lungfish to its environment. The models use a common 80-year class matrix for this long-lived fish, informed by estimates of survival and fecundity rates, density-dependence, and habitat loss from variable river flows that impact eggs, larvae, and young-of-the-year fish. The models assess flow and flow-related effects on lungfish life-stages, where flows in spawning habitats drive population dynamics and determine rates of movement between populations. The model construct is most sensitive to survival estimates for juveniles, particularly 1- and 2-year-olds. Reproductive value is highest across ages 20 to 40 years, indicating that fish in these age classes make the greatest reproductive contribution to the population(s). Our modelling approach substantially advances conservation management of this iconic fish species as it integrates recent scientific knowledge and can be used to assess responses to management actions and recovery plans.

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Multi-decadal trends in the relative abundance of large-bodied native fish in the NSW Murray-Darling Basin

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Native fish populations in Australia's Murray-Darling Basin (MDB) are in a highly degraded state, with an estimated decline in native fish abundance of >90% since European settlement. Much of this decline has been attributed to historical and contemporary human disturbance, including changes to land use, impacts of river flow regulation and consumptive use of water, over-fishing, invasive species, drought, large-scale bushfires and blackwater-related hypoxia. To date, most estimates of native fish population decline have relied heavily upon expert knowledge due to a lack of long-term data on fish population trends. While incorporation of expert knowledge is a critical input to fish management and conservation, there is also a need for quantitative estimates of fish population status to facilitate formal analysis of temporal trends. The aim of this study was to analyse an extensive fish monitoring database to examine multi-decadal trends (1997 – 2022) in the relative abundance of key large-bodied fish in the NSW portion of the MDB. Using mixed models, in a two-step modelling process, we analysed both overall and region-specific relative abundance trends across the NSW MDB for six key large-bodied species. We found evidence of regional specific trends including, for example, evidence of increasing relative abundance of Murray cod in the Namoi and Murrumbidgee regions and possible declines in other catchments. These region-specific trends in species abundance highlight the importance of using long-term to contextualise the current condition of fish populations and emphasise the need to manage species at appropriate spatial and temporal scales.

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Resolving the population biology of black jewfish (*Protonibea diacanthus*) in North-eastern Australia

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The black jewfish (*Protonibea diacanthus*) occur in tropical coastal waters throughout the central Indo-Pacific. They have long been valued as an important recreational and artisanal species in fisheries, but have become increasingly targeted by commercial fisheries due to demand for their swim bladder. This rise in targeted fishing has led to uncertainty around the sustainability of some stocks, and in Queensland waters it resulted in the implementation of highly restrictive management arrangements. To better understand how changes in fishing pressure may impact the sustainability of *P. diacanthus* populations throughout Eastern Australia, we evaluated the population biology of the species. The results provide new insights into the spawning periodicity, fecundity, age and growth, and connectivity of *P. diacanthus* populations, which will help improving the assessment and management of the species.

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Movement patterns of an iconic recreational fish species, mulloway (*Argyrosomus japonicus*), revealed by cooperative citizen-science tagging programs in coastal eastern Australia

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Information on the movements and population structure of exploited fish is vital for determining the appropriate spatial scale at which management should occur. However, such information exists for very few exploited species. Large-scale patterns and drivers of movement were examined for an iconic recreational sciaenid species, mulloway (*Argyrosomus japonicus*), in coastal eastern Australia using an angler-assisted tag-recapture dataset. Over 4300 individuals were tagged and released across 1005 km of coastline over three decades (1988–2017). Six-hundred and fifty-seven individuals were subsequently recaptured at a rate of 15.1% over the same time period. Average time at liberty was 216 (±9) days (range: 0–1954 days), with distances moved ranging from 0 to 355 km. Median movement distance was 4 km, and a large proportion of individuals (73%) were recaptured within 10 km of release locations. Thirty one percent of individuals were recaptured at release locations (< 1 km) and 81% in the same estuary. However, 7% moved distances of > 100 km. Generalised additive modelling revealed that release latitude, body size and time at liberty were significant predictors of distance moved. Greater distances moved were observed for fish tagged at lower latitudes, at larger sizes and over longer periods at liberty. Results indicate that *A. japonicus* are primarily restricted to small movements (< 10 km) in eastern Australia and display strong site fidelity, despite being capable of movements over larger scales (100s of km). This spatial scale of movement is also much smaller than the current 'jurisdictional' scale of management in this region (~1000 km). Assessment and management of *A. japonicus* in eastern Australia may therefore need to be re-examined considering these findings. This study also highlights the importance of citizen science in the cost-effective generation of a sufficiently broad spatio-temporal dataset required to detect the movement patterns revealed here.

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Environmental Drivers of Fine-Scale Predator and Prey Spatial Dynamics in Sydney Harbour, Australia, and Adjacent Coastal Waters

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Greater Sydney is the largest coastal city in Australia and is where bull sharks (Carcharhinus leucas) are present every summer and autumn. A decade of acoustic telemetry data was used to identify drivers of space use for bull sharks and their potential prey, according to standardised 6-h intervals using dynamic Brownian bridge movement models. Influences of environmental, physical, and biological variables on the areas of space use, location, and predator–prey co-occurrence were investigated with generalised additive mixed models. Rainfall in the catchment affected space use for all animals (i.e. teleost species and both sexes of sharks), with varying temporal responses. Male sharks responded most promptly to high rainfall moving upstream in < 1 day, followed by teleosts (2 to 7 days), and female bull sharks after 4 days. Environmental luminosity affected male shark dispersal and space use, possibly indicating use of visual cues for foraging. Physical characteristics of habitat were important factors driving spatial overlaps between predator and prey in estuarine areas. In sandy embayments < 10-m deep, males and female bull sharks overlapped with different species, whereas males and silver trevally (Pseudocaranx georgianus) co-occurred in deep holes (> 30 m). Shark size influenced overlap between sexes, with smaller females less likely to co-occur with larger males (~ 50 cm). Variability in space use suggests spatial segregation by sex and size in bull sharks, with individuals targeting similar prey, yet either in different areas or at different times, ultimately enabling them to exploit different resources when in the same habitats.

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Forecasting swordfish quality for dynamic industry adaptation

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Meat quality is of paramount importance for high-value fisheries, but the quality of fish can be affected by environmental variability and change. Reports from fishers operating in Australia's Eastern Tuna and Billfish Fishery (ETBF) suggest fishing for swordfish in anomalously warm waters is linked with myoliquefaction ("jellymeat"), mediated by parasitic infection. Jellymeat renders the meat unsuitable for export, reducing profits and increasing wastage. If there is a thermally-sensitive mechanism underpinning jellymeat progression, there may be a concomitant increase in future jellymeat events, since the waters off Eastern Australia are a hotspot of marine climate change. However, the links between physical seascape conditions and the mechanisms underpinning jellymeat are unknown. Using microscopy, multi-omics and dynamic spatial modelling, we are investigating the biophysical mechanisms underpinning the occurrence of jellymeat in swordfish harvested in the ETBF, and developing predictive models of spatiotemporal risk zones over the fishery domain. In partnership with industry, we are co-creating a prototype tool that provides automated seasonal forecasts of the likelihood of harvesting swordfish likely to become jellied, to inform best handling practices when fishing in conditions conducive to jellymeat. We aim to reduce wastage along the supply chain, and support proactive industry adaptation under ocean climate variability and change.

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Genetic population structure of great hammerhead sharks (*Sphyrna mokarran*) in Australia.

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The great hammerhead (*Sphyrna mokarran*) is considered a semi-solitary and highly migratory species, with a circum-global distribution. The species is listed as critically endangered on the IUCN Red List of Threatened Species, and global trade is restricted under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS). Despite this, commercial harvest and export for meat and fins across their range in Australia, Papua New Guinea and Indonesia still occurs. Within Australia, *S. mokarran* is listed as vulnerable and despite reports of overfishing and depletion, this allows for commercial fishing of the species within set regions operating under a strict total allowable commercial catch (TACC) limit. Currently little information exits for population structure of *S. mokarran* in Australian waters, despite an understanding of genetics being a major consideration to appropriate stock assessment modelling and subsequent fishery management arrangements. This research aims to identify the population structuring and connectivity of *S. mokarran* with a focus on Australian Exclusive Economic Zone (EEZ) waters. Population genetics has been an important tool in fishery management, previously revealing strong population differentiation for other species in the *Sphyrnidae* family (*S. lewini* and *S. zygaena*) with a multi-use approach of genetic markers (microsatellites and single nucleotide polymorphism (SNPs)). SNPs allow for fine-scale population structure detection among Australia's TACC zones. Results from the study presented here will be subject to a more appropriate sample size, a factor insufficient in previous research, so adequate conclusions can be made on the structuring of *S. mokarran* within the Australian EEZ. Outcomes from such research will be useful in delineating *S. mokarran* populations in Australia to manage the commercial economic viability and their continued conservation in fisheries management.

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The impact of foraging and predation on the shoaling behaviours of tropical vagrant fish and their potential for range expansion

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Rising sea surface temperatures and concurrent strengthening of poleward boundary currents are driving the redistribution and expansion of tropical marine organism's ranges into novel temperate habitats, resulting in a restructuring of ecological interactions in recipient communities. An increasing number of temperate marine ecosystems globally have become regions of tropicalisation, an example is the seasonal displacement of coral reef fishes from natal lower latitude tropical ecosystems. This arrival of low-density populations of juvenile tropical fish (termed 'vagrant' fishes) results in changes to local fish communities, as critical behavioural functions such as shoaling are potentially comprised as the trade-offs (foraging and mitigating predation) that define such functions are altered. Over-winter survival rates of vagrants however still remain low due to cold water exposure, restricting the successful establishment of populations in temperate habitats. Previous research has shown that the vagrant tropical damselfish *Abudefduf vaigiensis* benefited from shoaling with temperate species through the mitigation of predation risk, allowing increased foraging opportunities and attaining larger body sizes than when shoaling with conspecifics. This study aims to compare how different shoaling forms influence shoaling of *A. vaigiensis* and how this impacts their fitness. Preliminary results suggest physiological and behavioural plasticity by *A. vaigiensis* juveniles when shoaling with conspecifics or heterospecifics. At a shoal ratio of 80% conspecifics, *A. vaigiensis* juveniles exhibited a significant increase in somatic growth rate compared to 100% conspecifics. Results from predation and foraging trade-off lab experiments have also indicated that novel predators can induce risk-aversive behaviours that can compromise feeding rates, as we found dramatically reduced boldness when exposed to a live predator (*Sepia plangon*). Shoaling strategies may be predominant factor in the range expansion potential of tropical fishes, and therefore it is imperative that we better understand how they are employed and what factors exert the greatest influence over them.

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Accelerometers and animal-borne cameras reveal behavioural plasticity in white shark predatory strategy

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Predation is one of the key forces driving animal evolution, with predator-prey interactions being fundamental to the survivorship of both participants. Animal-borne cameras and accelerometer loggers are increasingly used to study marine predators *in-situ* to record behaviours that would otherwise remain largely unseen. White sharks, *Carcharodon carcharias* are assumed to aggregate at the Neptune Islands Group Marine Park to prey on seals and sea lions. We deployed animal-borne cameras and accelerometers on 18 white sharks and used 17 observed burst events and a random forest machine learning model to characterise predatory behaviour of white sharks. Overall, we identified 33 bursting events primarily taking place in midwater (20 – 40 m) and had an ascent phase smaller than starting depth, suggesting that the burst events did not finish at the surface and that sharks did not breach. Burst events mostly took place during the day or at night (12 and 17 events respectively), with the fastest swim speed during burst event being 6 ms^{-1}. Our study suggests that white sharks might be using different predatory strategy at the Neptune Islands compared to other locations where predatory behaviours are frequently observed (i.e. False Bay, South Africa). These sub-surface night-time predatory tactics might explain the low number of natural predations observed at the Neptune Islands and highlights the plasticity in predatory strategy across white shark populations or aggregation sites.

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"Project Kingfish": a collaboration with recreational anglers to research and inform the management of yellowtail kingfish (*Seriola lalandi*) off eastern Australia

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Highly regarded for their great taste and awesome fighting abilities, yellowtail kingfish (*Seriola lalandi*) are one of Australia's most iconic recreational species, and support important commercial fisheries. Despite forming a single genetic stock throughout southern and eastern Australia, major knowledge gaps exist regarding their movements, connectivity, spawning locations and recruitment. "Project Kingfish" is a new, multi-year research program funded by the New South Wales (NSW) Recreational Fishing Trust to help address these knowledge gaps. Over the next few years, the team will work closely with the recreational fishing community to boost scientific data collection from spawning-sized kingfish throughout eastern Australia. Using nationwide citizen science data generated via the NSW Game Fish Tagging Program, the team will analyse data from over 40,000 kingfish tagged and released between 1973-2022 to identify and describe connectivity between fishery jurisdictions over the geographical extent of the stock. Tapping into their countless years of experience and knowledge, Project Kingfish will also team up with specialist recreational anglers to deploy satellite tags on mature-sized kingfish to gain insights into movements and important habitats for the spawning stock. Through a series of dedicated fishing competitions and a science communication campaign on social media, Project Kingfish will also engage with recreational anglers to promote sustainable fishing practices and highlight research results that will feed directly into informing the management of the east Australian kingfish stock.

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Guess who? Identifying the source species of fish choruses recorded along the Australian southern continental shelf

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Soniferous fish can vocalise continuously over prolonged periods. In doing so, they raise background noise levels, producing a phenomenon known as a chorus. Fish produce choruses in association with life functions. Each chorus type typically displays a unique set of spectral characteristics and spatiotemporal patterns. Long-term passive acoustic monitoring of fish choruses can provide information on fish distribution, courtship, spawning behaviours, habitat use, and in some circumstances, the abundance of populations. For this to be successful, the source species producing the chorus needs to be known. Many fish choruses have been reported in Australian waters, yet very few source species have been identified. This pilot study was the first step in an attempt to identify the source species of three fish choruses recorded in the Bremer Bay Canyon, in south-west Western Australia. A hydrophone and an unbaited underwater video recorder were deployed simultaneously for four hours over dusk and dawn within a 24-hour period in December 2019. The underwater video recordings captured the presence of a variety of fish species, including large schools of fish. Two of three previously recorded fish choruses were detected on the hydrophone recordings; however, both choruses were low in intensity and no individual fish calls could be discerned. This suggested the source of the

choruses was calling a distance away from the deployment location. Future research will incorporate the use of hydrophone and underwater video recorder arrays to more effectively localise where the choruses are being produced in the canyon, at what depth within the water column, and match those vocalisations to fish species captured on underwater video recorders.

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eDNA as a Method for Detecting Invasive Mosquitofish (*Gambusia holbrooki*) in a Desert Spring System

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The introduced eastern mosquitofish (*Gambusia holbrooki*) poses a great threat to the delicate ecosystem of Edgbaston Springs in central Queensland, home to the critically endangered, red-finned blue-eye (*Scaturiginichthys vermeilipinnis*). Here, competition for food and space is high, leading to direct competition among species, and as is often the case, the invaders are displacing natives. While earlier mosquitofish eradication programs have been successful, continued vigilance is necessary due to the potential for reinvasion after periods of intermittent inundation. This is difficult however, as early detection of new invasions (i.e. when initial density of invaders is small) can be problematic when relying on traditional monitoring methodologies. Furthermore, these methods are not desirable given the precarious nature of the habitat and its vulnerable endemics. As such, this study evaluated the efficacy of eDNA approach for noninvasively detecting mosquitofish at Edgbaston. Water samples from several springs, representing different times since eradication, were collected along with samples from pools where mosquitofish had never invaded. Extracted eDNA were subjected to PCR amplification and Illumina® Miseq sequencing, allowing us to potentially detect all species present in the sampled waterbodies. We were able to identify where mosquitofish DNA were present, however this included pools where they had been eradicated up to 6 months previously. We interpret this outcome as sensitivity of the sequencing method and that we were seeing residual eDNA persisting after mosquitofish removal. However, it was determined that with regular PCR, using *Gambusia* specific primers, we were able to detect current populations, while the method being not so sensitive as to amplify DNA > two months. However, casting a wide sequencing net using the Illumina platform has provided a data set that potentially contains representative DNA from all species that exist in this spring system – a very useful resource for continued conservation management at Edgbaston.

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A chain reaction - dietary shifts of an apex predator, the tiger shark (*Galeocerdo cuvier*), along the eastern coast of Australia

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Apex predator movements, fine-scale habitat use, and the drivers influencing these factors in a changing marine environment are not well understood. Along the eastern coast of Australia, a climate change hotspot, the diet composition of the tiger shark is a major influential factor that follows both ontogenetic and bioregional shifts. The literature has shown variation in diet between Queensland and New South Wales, and between young and mature individuals. As ocean temperatures warm facilitating year-round residence of tiger sharks in NSW waters, changes to historic trophic webs from direct and indirect influence by the species will occur. The impact of this shift, for both tiger sharks and prey species, remains unknown. Using HD video cameras fitted on state-of-the-art CATScam tags and analysed in conjunction with stomach content and cloacal swabs (genetic metabarcoding), the generalised feeding mode of this species will be stratified by prey type, shark size, and location captured along the Australian east coast. These data will facilitate predictions on how their movements are influenced by, and have influence on, prey movement and ecosystems along the Australian east coast. As waters continue to warm, accurate predictions of shifts in shark home ranges, and their chain reactions, are critical for fisheries, shark control, and broader ocean systems management across southeastern Australia.

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Assessing multiple paternity in spinner shark (*Carcharhinus brevipinna*) litters from southeast Queensland, Australia

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Globally, anthropogenic activities such as targeted fishing and habitat modification have posed great threat to elasmobranchs. As species' resilience to these pressures is largely determined by key life-history parameters, and elasmobranchs tend to exhibit low fecundity, late maturation and slow growth, it has become apparent that knowledge of reproductive characteristics and mating strategies is important for accurately monitoring populations. Whilst the anatomy and embryonic development modes of elasmobranchs are relatively well characterised, little is known of the link between reproductive mode and reproductive strategy (e.g., multiple paternity), or how this may be influenced by a species' ecology. To date, multiple paternity has been identified in seven elasmobranch orders. Of this, the carcharhinids (Carcharhinidae) are the most represented family, with nine out of 11 assessed species confirmed to exhibit some degree of multiple paternity. The spinner shark (*Carcharhinus brevipinna*) is a wide-ranging species of carcharhinid, and is an important component of commercial fisheries worldwide. In this study, we provide the

first assessment of multiple paternity in this species, through an analysis of single nucleotide polymorphisms (SNPs) drawn from two mother-litter groups from the coast of southeast Queensland, Australia. Given the paucity of reproductive information on this species, this research advances our knowledge of this species and may aid to advance effective conservation and management of this commercially important species.

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Predicting bull shark (*Carcharhinus leucas*) presence in Southern Queensland waters and the probability of human – shark incidents

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Shark-human interactions are disturbing and often traumatic for everyone involved (Curtis *et al*., 2012). As a preventive measure, the Queensland Shark Control Program (QSCP) makes use of nets and drumlines alongside popular beaches on the Queensland coast (Holmes *et al.*, 2012). However, this strategy is lethal for marine wildlife (Adams *et al.*, 2020; Gibbs *et al.*, 2019), and many have also incurred a large by-catch of non-target species, including threatened and endangered species. (Gribble *et al.*, 1998; Gibbs *et al.*, 2019). To contribute with the use of non-lethal strategies to avoid shark-human interactions, including public education, this study will use rainfall and sea surface temperature (SST) as environmental variables to predict the presence of bull sharks in southern Queensland waters based on 26 years of catch data from the QSCP. We then relate catch data to reported shark incidents in the Taronga Shark Incident File. We focus on SE Queensland because the stretch of coast is heavily populated. We predict that as rainfall increases the chances of bull sharks moving into shallow waters will also increase, particularly in the vicinity of rivers, resulting in higher probability of human – shark incidents. These data will contribute to a public education program run by Queensland Fisheries highlighting the increased risk of shark incidents after heavy rainfall.

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Habitat partitioning in Moreton Bay bug species to inform Queensland fisheries management

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Moreton Bay bugs have been enjoyed as a trademark of Australian cuisine since 1888 and the value of the commercial fishery has only continued to rise recent years. Despite this, little is understood about the ecology and distribution of these animals critical in ensuring effective fisheries management. This study aims to investigate habitat partitioning and drivers of distribution in Queensland Moreton Bay bug species *Thenus parindicus* and *Thenus australiensis* for the benefit of management decisions of the *Thenus* spp. fishery. These lobsters spend most of their lives buried within benthic sediment, but next to nothing is known about what factors drive the distributions of each species. In this study, a fishery independent survey is conducted in a key commercial trawling area off the coast of Townsville to sample *Thenus* species distributions and habitat preferences. Burying invertebrates have intimate relationships with the sediment in which they live. Analysis of sediment grainsize through wet and dry sieving as well as determination of calcium carbonate content provided a range of sediment parameters used to compare distributions of the species and understand potential drivers of this distribution. These species have significantly different distributions influenced by a suite of variables including depth, mean grain size, calcium carbonate content, skewness, kurtosis, and sorting of sediments. Multivariate analyses suggest that sediment sorting and depth could be the strongest drivers of habitat partitioning between the species. This contrasts previous findings that considered mean grain size to be the most important sediment parameter influencing *Thenus* distributions. There is evidence of habitat partitioning between *T. parindicus* and *T. australiensis* but not habitat exclusion. This information, along with the likely drivers of species' distributions will help better understand the habitat ecology of these organisms and inform sustainable management decisions for the Moreton Bay bug fishery.

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Cone Fishways, the development of fishway hydraulics through in-fishway fish movement behaviour.

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Cone fishway are a relatively new version of a pool and weir fishway developed in Australia to facilitate the passage of a broad range of migratory species and life stages, particularly small and juvenile fish (<300 mm long). Despite having a relatively narrow headwater operating range, the cone design has been favoured in a number of locations for its fixed minimum headwater level, compact footprint, high discharge at rising headwater levels and success at passing very small fish (i.e. 15 mm long). Cone fishways have commenced rolling out in all eastern Australian states as well as in Laos, Cambodia and Thailand. The cone design has been very successful and is now recognised as a viable alternative at structures up to 4 m high. The success of the cone design centres around the internal flow dynamics of the cone ridges and pools. The faceted cone shape creates short high velocity transition zones with close fish approach positions; the pools also provide improved hydraulic conditions for small fish. Recent Computational Fluid Dynamic (CFD) modelling of a number of cone fishways has visually highlighted these hydraulic benefits. Both field trials and CFD, highlight the complex interaction of water velocity and turbulence that govern fish ascent pathways and success when navigating fishways. We present results from both fieldwork and CFD to demonstrate how fish behaviour and movement drove the initial cone concept and discuss further design improvements to support fish migration and population recovery.

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Depredation of spanner crabs (*Ranina ranina*) by endangered batoids off the east coast of Australia

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Cryptic mortality in fisheries relates to the unobserved or unrecorded mortality in a target ecosystem and is becoming increasingly important for fishery managers to consider. Depredation is a key, observable form of cryptic mortality that relates to predators consuming a targeted species being caught within a fishing industry. This is particularly problematic in the spanner crab fishing industry, where additional unobserved or unrecorded mortality through depredation of catch could restrict the effectiveness of strategies to rebuild the population. High-resolution cameras were deployed on 178 baited crab dillies to investigate cryptic mortality, species interactions, and depredation within the spanner crab *Ranina ranina* fishery in Queensland, Australia. Physical parameters including current speed, temperature, depth, and time of soak were recorded. Depredation events were observed in the fishery by two species of endangered batoid species, the bowmouth guitarfish *Rhina ancylostoma* and wedgefish *Rhynchobatus spp*. However, rates of depredation in the fishery were low, with only 3.82% of crabs depredated. Fishing losses were calculated by comparing the total crabs on retrieval of a dilly, against total crabs observed while still soaking (MaxN) and at the beginning of retrieval. Overall, there was a loss of 37% in potentially harvested crabs through a combination of cryptic mortality and inefficient fishing practices. However, 27% of the losses could be reduced through shorter deployment times. We identified a significant relationship between the rate of depredation and current speed (~0.6-0.8 knots), soak time and depth (<35m). We also report spanner crab shell damage caused by mantis shrimp interactions, that likely contribute to an increase in spanner

crabs discards due to unmarketable product. By identifying the species and drivers involved in spanner crab depredation, this study provides insights into ways that depredation events can be mitigated and managed.

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Driven to Dumping: intentional release drivers for ornamental species

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The inability to incorporate human-mediated release drivers is a pervasive flaw in ornamental risk assessments in Australia and internationally. The success of accurately determining invasive potential is centred on the suitability of the risk assessment tool for the focal group and requires tailoring to ornamental trade features for reliable outcomes. Review of international risk assessment models indicates post-border risk assessments using ornamental trade lists are largely unexplored and limited in their consideration of the human influence on ornamental invasion, incorporating eight drivers of varying functionality related to trade, pathway, and biology. We have identified an additional seven trade, biology, and care characteristics from the literature that are reported to influence human mediated release and subsequent invasiveness of ornamental species. Here we review these ornamental drivers on ability to be quantified and contribute to ornamental invasiveness for suitable inclusion in ornamental risk assessment tools.

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Seeing red in a blue world: unique body pigments require unique vision

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Labridae (Actinopterygii, Perciformes) are a polyphyletic family of over 500 species of fish in 60 genera of wrasses (labrids) and parrotfish (scarids), that includes iconic large fish such as the humpead parrotfish, *Bulbometapon muricatum* (1.3 m total length (TL)), and the pygmy possum wrasse, *Wetmorella tanakai* (0.04 m TL). Labridae are very colourful fishes that are found in almost all marine environments. Their phylogeny is well-resolved, and they represent a diverse range of reproductive and behavioural ecologies, including variation in colour morphs at different developmental stages.

Their evolutionary biology has generated considerable interest, and in previous work we uncovered high visual diversity, including multiple duplications of long wavelength sensitive (*LWS*) opsin genes. The evolution of diverse visual capabilites may explain why these families of fish are able to rapidly speciate. Specialising in longer wavelengths of light is particularly interesting in the coral reef environment where shorter wavelength sensitivities (*SWS, RH2*) tend to dominate.

We assembled new data and re-analysed published data on labrid visual opsins to determine sequences and relative expression variability of opsin gene duplications. We then resolved duplication events across the labrid phylogeny using maximum likelihood (ML) trees with the known opsin sequence structure. Finally, we used estimates of *LWS* visual pigments spectral absorbance (based on sequence structure) to unravel whether *LWS* duplications may facilitate a functional mechanism for spectral tuning in the red. We have also modelled colour patterns within a labrid colour space to identify whether 'labrid-specific' colours are indeed 'labrid-specific'.

Here we show that both *LWS* and *RH2A* opsin duplications likely aid in seeing the unique 'labrid-specific' red and green colour patterns found within this group. Our results lend support to the theory that visual diversity is linked to specific functions within coral reef fishes.

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The development of survival behaviour in hatchery reared Murray cod

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The exposure to artificial environments with low-risk conditions has caused a domesticated behavioural trait seen in adult hatchery-reared Murray cod. Domesticated fish are bold in behaviour compared to their wild conspecifics and have lower chances of survival in wild situations. Stocking programs release hatchery-reared Murray cod at 10 weeks of age into the Murray-Darling Basin (MDB) with the behaviour of these fish being crucial to their survival. This project aims to identify if there is a significant behavioural shift to a domesticated behavioural trait in the early developmental stages of hatchery-reared Murray cod that are destined for release in MDB stocking programs. We collected 247 Murray cod at various ages significant in early development and hatchery procedures (1, 3, 6, 10, 16 and 20 weeks old). Fish were observed through four behavioural tests; latency to emerge from a shelter, exploration of a novel area, suitable habitat preference and predator avoidance. Our results display various behavioural changes across the ages of rapid development, with fish of 6 and 16 weeks of age displaying traits most suitable for survival. There is no evidence from these findings that the domesticated phenotype of hatchery-reared Murray cod develops in the stages of early development.

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Age and growth of the estuarine stonefish (*Synanceia horrida*) in Singapore

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The age and growth of *Synanceia horrida* (Linnaeus, 1766) were investigated using otoliths. Otoliths are useful tools in the estimation of fish age and growth. We applied the estimation method to *S. horrida*, one of the species from the venomous stonefish genus *Synanceia* present in the Indo-Pacific region. Little is known on the species and the present study is the first to determine the species' age and growth using sectioned otoliths. Samples were collected using local traps (*bubus*) at depths of 5–10 m in the southern coastal waters of Singapore. Age and growth were estimated by annual growth increment counts (annuli) from the sectioned otoliths of 33 specimens ranging from 48.3–241 mm in standard length. Age estimates were taken from two readers and its precision was tested by applying both the average percent error (APE) and the mean coefficient of variation (CV). The oldest sample recorded was 12 years old. Three different growth models (Von Bertalanffy, Gompertz and logistic) were fitted to the data for comparison. Despite the small sample size, the study provides a new insight into the growth of a species of scorpaenids in tropical waters.

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Stable Isotopes: a rapid method to determine lobster diet and origin?

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While working on methods to determine lobster diet in the wild, we learnt of a need by industry to be able to identify the source location of Southern Rock Lobster (Jasus edwardsii) from post-harvest/market samples. Stable isotope analysis is one suggested method of achieving this. If location is identifiable from isotope signature it will prove a valuable tool for commercial catch control and management of fisheries; for example product recalls or resolving trade disputes. Given rock lobster stable isotope research is currently underway to investigate lobster diet in Tasmania, the research team identified scope to expand the current program from eastern Tasmania to south eastern Australia in an attempt to meet the industry's interest. The collection of rock lobster stable isotope data across this distributional range will identify if stable isotopes can be used post-hoc to determine catch location.

Previously, application of stable isotope analysis has suggested that spatial variation in carbon and nitrogen isotope values at the base of the food chain are reflected in predator isotope signatures. If this is identifiable in lobsters, and we are able to distinguish between locations of foraging, it would be a feasible method to determine lobster catch origin.

Stable isotope analysis could be a valuable method because it: (a) Provides a long-term view of lobster diet – which is likely to differ between locations, (b) allows estimation of the proportion of prey contribution to the diet – which will allow for investigation into consumption rates and inferences about predation pressure, and (c) only requires a very small, potentially non-lethal sample of lobster tissue (0.5mg), meaning it will not affect the market value of the fishery's catch.

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Detecting non-random temporal variation in fish growth

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length-at-age (LAA) information acts as an essential part of integrated stock assessments, including directly impacting estimates of productivity. LAA data is often available at multiple stages in a fishery's history and can be specified as such in most modern (integrated) assessment models. Specifying LAA data as a time series acknowledges that LAA changes in a non-random manner over time and is therefore non-stationary (i.e., varies over time). Non-stationary LAA data may reflect important fluctuations in stock productivity that if left undetected could result in biases in the stock assessment that may have implications for the sustainable management of the stock. LAA is known to change over time due to non-linear density-dependent (e.g., recruitment and fishing pressure) and independent (e.g., water temperature) drivers for several fish species. Arguably, LAA data should only be specified as non-stationary if sufficient evidence exists that temporal variation in LAA is non-random, with or without identifying the driver(s). Such evidence was obtained in 2007 for eastern Tasmanian banded morwong (*Cheilodactylus spectabilis*) supported by a general linear model describing non-random increases in mean length at several important age classes over time. LAA data has since been specified as non-stationary in the assessment model. However, it is unclear whether this specification remains appropriate since the observed non-stationarity in LAA has not subsequently been re-evaluated considering data available since 2007. The additional data may not have maintained the increase over time implied by the general linear model and may instead have fluctuated in a non-linear way. This study investigates the current evidence for non-random temporal variation in LAA of eastern Tasmanian banded morwong provided the updated data set. The general linear model approach and two non-linear approaches (generalized additive model and Gaussian process model) are applied to evaluate their relative utility for identifying non-random variation of mean length at key age classes over time. Contrary to the analysis in 2007, the general linear model now suggests LAA variation is random over time. Both non-linear models suggested otherwise and fit the data better according to residual plots, suggesting LAA data should continue to be specified as non-stationary in the stock assessment. Overall, this study found that non-linear models are more appropriate for evaluating the stationarity of LAA and advises which non-linear model may be more advantageous depending on the situation. This method can be applied to any fishery where an evidence-based decision needs to be made whether to specify LAA as a stationary process or not within an assessment model.

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Using otoliths chemistry to understand fish migrations in the Ayeyarwady River

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Fish migrations are an important characteristic of the Ayeyarwady River, Myanmar. There are estimated to be 600 species in the basin, and all need to move between critical habitats to complete their life cycle. Unfortunately, migration behaviors of most fish species are poorly understood. Without greater knowledge, many migratory species are threatened by hydropower and irrigation dams by blocking their migration routes and altering flow patterns. To address these critical knowledge gaps, Catfish species (*Pangasius pangasius* and *Pangasius* sp.) were collected from a range of environments in the Ayeyarwady River, to examine their life history. An otolith microchemistry approach (Laser Ablation – Inductively Coupled Plasma Mass Spectrometry and Scanning X-ray Fluorescence Microscopy) was used to determine natal origin of multiple species. Ratios of otolith Sr:Ca and Ba:Ca are used as proxies to reconstruct their historical habitat experiences across salinity. Our results suggested that most of these catfish regularly migrate between freshwater and marine waters. Therefore, any activity disrupting these migratory pathways and disconnecting these environments must be carefully considered.

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The Redmap Australia report card: a nationwide assessment of climate-driven species redistribution using citizen science data

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Climate-driven changes in species' distributions can affect ecosystem function, fisheries and conservation, presenting challenges for management. A recent review of the scientific literature1 revealed 198 species shifting in Australian waters along with gaps in our knowledge and highlighted a role for citizen science data to yield insight into these phenomena. Over the past decade, several citizen science programs have collected large amounts of species observations that could be used to help address these gaps, but these databases have not yet been systematically searched and analysed to characterise species redistributions. We used a qualitative decision tree analysis [2] to assess potential extensions of marine species distributions around Australia, with data from three citizen science projects (Redmap; iNaturalist Australasian Fishes project; and Reef Life Survey). This analysis considers historical (i.e., recognised as of 2012) distribution limits, along with species traits (e.g., migratory behaviour, detectability) and evidence provided by citizen scientists' data (e.g., possible overwintering and/or multi-year observations) to assess confidence in redistributions occurring among a list of 200 species tracked by Redmap over the past decade. Of 197 species represented in the citizen science databases, we identified 77 as having been detected out-of-range by citizen scientists (31 were classified with high confidence, eight with medium confidence, and 43 with low confidence). The mean extent of extensions assessed was 316 km (max. 1474 km). Our findings suggest priority species and regions where targeted scientific research may be appropriate. Further, results of the assessment have been incorporated into report cards — four-page print and web versions for NSW, TAS, and WA, and this A1 poster summarizing the results across the Australian marine estate. The report cards provide communication tools for dissemination to demonstrate the scientific value of citizen science and engage with the broader public on climate change, using their own observations.

1. 1 Gervais, Champion and Pecl 2021 https://doi.org/10.1111/gcb.15634