SHELLFISH REEF RESTORATION NETWORK

INTERNATIONAL CONFERENCE ON SHELLFISH RESTORATION

Photo: Cayne Layton

Australian Shellfish Reef Restoration Network & 19th International Conference on Shellfish Restoration

19 – 21 February 2018

University of Adelaide, South Australia

The Nature Conservancy Australia

Government of South Australia
Department of Environment, Water and Natural Resources

THE UNIVERSITY of ADELAIDE

TropWATER

Marine Biodiversity Hub
National Environmental Science Programme

CONTENTS

Contact Details

If you have questions please email the Conference Manager **events@plevin.com.au** or call Laura Chippendale on: 0437 826 420

Dinner Venue
7.00pm Wednesday, 21 February

The Stag Hotel
299 Rundle St, Adelaide
08 8311 0392

Acknowledgments

On behalf of all delegates, the Conference Organising Committee Acknowledge that the land on which this conference is held is the traditional lands for the Kaurna people and that we respect their spiritual relationship with their Country. We also acknowledge the Kaurna people as the traditional custodians of the Adelaide region and that their cultural and heritage beliefs are still as important to the living Kaurna people today.

The Conference Organising Committee would like to thank: Paul Dee and Steve Bowley, Mayor Ray Agnew, Cr Naomi Bittner, Stephen (Goldy) Goldsworthy, Andrew Cameron, Colin D'arcy, Jason Quinn, Peri Coleman and the following conference financial sponsors, supporters and organisers:

Conference Organising Committee

Chris Gillies, Ian McLeod, Anita Nedosyko, Dom Mcafee, Boze Hancock, Andy Myers, Dorothy Leonard and Rick DeVoe
The Committee sincerely recommends Plevin and Associates for your next function.

QUICK GUIDE PROGRAM

TIME	TITLE	SPEAKER	CHAIR
Day 1: Monday, 19 February 2018			
8:00am	Registration opens		
Opening plenaries			Chris Gillies
9:00am	Welcome to Country	Karrl Smith	
9:10am	Welcome to Conference	Chris Gillies	
9:15am	Welcome to South Australia	Hon. Ian Hunter MP	
9:30am	Keynote: Developing an Oyster Mariculture Business Case (in NC) that Delivers Sustained Economic Development and Ensures Success	Tom Looney	
10:10am	Keynote: Restoring Oysters in North Carolina (USA): A Blueprint for Action	Todd Miller	
10:30am	Morning tea		
Enabling restoration and case studies: South Australia			Boze Hancock
11:00am	Loss, optimism and restoration of oyster reefs in South Australia	Sean Connell	
11:15am	Laying the foundations of South Australia's Blue Infrastructure Initiative: Windara Reef Stage I	Sarah-Lena Reinhold	
11:25am	Strengthening South Australia's blue economy: Windara Reef expands in Stage 2 and beyond	Anita Nedosyko	
11:35am	Oyster optimism bridges cultural barriers to restoration	Dom Mcafee	
11:45am	Port River Shellfish Restoration Project	Catherine McMahon	
12:00pm	Technical talk: Peopling WaterPlaces	Mary Gardner	
12:15pm	Poster 'spruiker session'	Benjamin Freeling Catherine Larkin	
12:20pm	Technical talk: How to shoot videos from the field on your mobile phone	Ian McLeod	
12:35pm	Lunch		
Research and development			Dom Mcafee
1:30pm	The timing and type of substrate deployment influences recruitment of Sydney rock oysters, Saccostrea glomerata and associated communities	Maria Vozzo	
1:45pm	The mechanisms by which oysters facilitate invertebrates vary across environmental gradients	Melanie Bishop	
2:00pm	Complementary technologies and shared concerns of oyster farming and reef restoration	Wayne Hutchinson	
2:15pm	Optimal oyster reef restoration on soft sediments benefits from substrate addition and prolonged grow out in South-East Australia	Ben Cleveland	
2:30pm	Faunal communities associated with Ostrea angasi oyster reefs in Tasmania	Christine Crawford	
2:45pm	Exploitation and supply of European flat oyster (Ostrea edulis Linnaeus, 1758) seeds	Bérenger Colsoul	

TIME	TITLE	SPEAKER	CHAIR
3:00pm	Afternoon tea		
Enabling restoration			Ian McLeod
3:15pm	Reintroducing native oysters in the German North Sea: An offshore field study	Verena Merk	
3:30pm	Assessment of conservation metrics for oyster reef restoration at Hab River Delta, Balochistan, Pakistan	Sadar Aslam	
3:45pm	Developing a consistent approach to monitoring shellfish reefs in Australia	Simon Reeves	
4:00pm	The efficacy of eco-engineering interventions in enhancing native shellfish communities on seawalls across the globe	Melanie Bishop	
4:15pm	Technical talk: A prototype mobile application for documenting remnant shellfish reefs	Elisa Bone	
4:30pm	Oyster reefs in NSW: a new opportunity	Kylie Russell	
4:45pm	Technical talk: Making modern middens at Ningi Ningi (Place of Many Oysters)	Ben Diggles	
5:00pm	Session close		
5:30–7:30pm	BBQ and drinks, The University of Adelaide		

Day 2: Tuesday, 20 February 2018		
	Gulf St Vincent Oyster Restoration Field Trip	Adelaide International Bird Sanctuary, Dolphin Sanctuary and Saltfields
Meeting time	8:00 am	9:00 am
Meeting/drop off Location	University of Adelaide, Gate 9 Victoria Drive	University of Adelaide, Gate 9 Victoria Drive
Itinerary	• Ardrossan township • Ardrossan Lookout • Stansbury oyster growers • Dalrymple Hotel	• Adelaide Saltfields and Bird Sanctuary • Semaphore • Port Adelaide Dolphin Cruise
Drop off time	5:30 PM	5:00 PM

TIME	TITLE	SPEAKER	CHAIR
Day 3: Wednesday, 21 February 2018			
8:00am	**Registration opens**		
Opening plenaries			Chris Gillies
8:55am	Housekeeping	Chris Gillies	
9:00am	*Keynote*: The development of oyster habitat restoration in Chesapeake Bay leading to the world's biggest oyster restoration project to date- Harris Ck. Sanctuary	Boze Hancock	
9:15am	*Keynote*: Large-scale Oyster Restoration in the Piankatank River, Chesapeake Bay (USA)	Andrew Lacatell	
9:30am	*Keynote*: Seventeen Years of Restoring the Eastern Oyster in Virginia's Atlantic Coastal Bays	Bowdoin Lusk, Jr.	
9:45am	Restoring the Bay Scallop (*Argopecten irradians*) to Virginia After Restoring Its Eelgrass (*Zostera marina*) Habitat	Bowdoin Lusk, Jr.	
9:50am	Half Moon Reef – A Socio-Economic Analysis of Recreational Fishing Benefits of a Restored Reef in Texas	Mark Dumesnil	
10:05am	From little things big things can grow again: Pumicestone Shellfish Habitat Restoration	Susie Chapman	
10:20am	Pioneering shellfish reef restoration in Australia: from ground zero to reality	Simon Branigan	
10:35am	**Morning tea**		
Restoration case studies (cont.) and community engagement			Simon Branigan
11:00am	Bringing Oyster Reefs Back to Oyster Harbour	Peter Cook	
11:15am	Oyster restoration in urbanised estuaries	Victoria Cole	
11:30am	Historical baselines for shellfish reefs, from 100 million years ago to present	Heidi Alleway	
11:45am	Past Aboriginal exploitation of Tasmanian's marine fisheries: using historical baseline data to track and explain change in shellfish/crustacean distribution over the last 8,000 years.	Richard Cosgrove	
12:00pm	Restoring a lost ecosystem: citizen scientists helping restore what they did not know existed!	Kade Mills	
12:15pm	Maximising the benefits of oyster reef restoration for finfish and their fisheries	Ben Gilby	
12:30pm	**Lunch**		
Research and development			Anita Nedosyko
1:30pm	Oyster reefs as fish habitat in NSW	Francisco MartÃnez Baena	
1:45pm	Would ocean acidification affect the defence strategy of *Saccostrea cucullata*?	Camilla Campanati	
2:00pm	Assessing the biological feasibilities of oyster restoration in Hong Kong	Sally Lau	
2:15pm	Quantifying the Water Quality, Benthic Macrofaunal Community, Nitrogen and Phosphorus Assimilation, and Fisheries Benefits of Oyster Aquaculture in the Chesapeake Bay (USA): Implications for Restoration and Science Communication	Andrew Lacatell	
2:30pm	Valuing Australia's oyster reefs	Ian McLeod	

TIME	TITLE	SPEAKER	CHAIR
2:45pm	The efficacy of suspended broodstock cages as a restoration strategy for the European flat oyster *Ostrea edulis* Linnaeus, 1758: A case study in the Solent, UK	Luke Helmer	
3:00pm	**Afternoon tea**		
Globalizing the recovery of shellfish habitats			Heidi Alleway
3:15pm	Oysters of Hong Kong: ecology, distribution, and cultural aspects	Marine Thomas	
3:30pm	State of knowledge on Australian shellfish ecosystems	Chris Gillies	
3:45pm	The expanding network of native oyster habitat restoration in Europe	Philine zu Ermgassen	
4:00pm	Historical distribution and current conditions of oyster habitats in China	Jun Cheng	
4:15pm	Shellfish restoration in New Zealand	Peter van Kampen	
Closing plenary			
4:30pm	*Keynote:* Is my receiving an Order of Australia for services to coastal Australia next week enough?	Colin Creighton	
4:50pm	Thank you and wrap up	Chris Gillies	
5:00pm	**Conference Close**		
7:00–9:00pm	**Dinner: The Stag Hotel, 299 Rundle St, Adelaide**		

CONFERENCE LOCATION

Darling West Lecture Theatre, University of Adelaide, Adelaide, South Australia.
Limited meter street parking is available on Victoria Drive and Kintore Avenue.

CONFERENCE FIELD TRIPS

Adelaide International Bird Sanctuary Field Trip – Tuesday, 20 February 2018

This field trip will visit the newly created Adelaide International Bird Sanctuary, nearby salt field wetlands and then get on board a dolphin river cruise down the historic industrial Port Adelaide region. Kaurna indigenous elders will share their interpretation of the area and hear from experts about the significance of the sanctuaries, environmental management issues facing the northern Adelaide region and conservation opportunities for the decommissioning of Australia's oldest salt mine. (approx. 30 min drive from Adelaide).

The tour will depart at 9.00am SHARP and if you miss the bus it will not be possible to re-join the tour after departure. For urgent help on the day of the tour contact the tour leader.

Tour Leader: Chris Gillies, Mobile 0412 663 506

TOUR REQUIREMENTS

Participants are encouraged to wear comfortable walking shoes, a hat and sunscreen.Please bring with you your conference name tag and lanyard.

TOUR INCLUDES:

- Transport
- Site Visits
- Light morning tea
- Lunch
- Bottle of water

Any dietary requirements provided to the Conference Organisers have been passed on to the lunch caterers. Please make yourself known to your tour leader or the catering staff.

ATTENDEE & TOUR LEADER CONTACT DETAILS

We would like each participant to provide us with a mobile phone contact number that can be passed on to the tour leaders. Your details will be kept private and not circulated to any other contacts. This will allow the tour leaders to contact you on the day should there be any changes or emergencies. We would appreciate you providing these details no later than Monday 12 February 2018.

WEATHER

Visit the Bureau of Metrology for the latest weather forecasts at **bom.gov.au/sa/forecasts/adelaide.shtml**

TERMS & CONDITIONS

The Conference Organisers, bus company and tour leaders take no responsibility for any lost, damaged or stolen items you take on the tour. Your belongings are your responsibility.

ITINERARY

Time	Location
9.00am	Depart University of Adelaide
10.00am	Salt fields / Morning Tea
12.00pm	Leave Salt fields
12.30pm	Largs Bay Pier Hotel
2.00pm	Leave Semaphore
2.15pm	Arrive in Port Adelaide
2.30pm	Port Adelaide Dolphin Cruise
5.00pm	Arrive at University of Adelaide

Gulf St Vincent Shellfish Restoration Field Trip – Tuesday, 20 February 2018

This field trip to Yorke Peninsula includes visits to the rural towns of Ardrossan, where just offshore Australia's largest shellfish restoration project is located, and to Oyster Bay at Stansbury, the primary oyster growing town on the Peninsula. You will hear from local managers of the shellfish restoration site, learn about local oyster aquaculture from the farmers, and enjoy the freshest oysters in South Australia shucked right on the beach (approx. 4 hours return from Adelaide).

The tour will depart at 8.00am SHARP and if you miss the bus it will not be possible to re-join the tour after departure. For urgent help on the day of the tour contact the tour leader.

Tour Leader: Anita Nedosyko, Mobile 0400 779 279

TOUR REQUIREMENTS

Participants are encouraged to wear comfortable walking shoes, a hat and sunscreen.

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ITINERARY

Time	Location
8.00am	Depart University of Adelaide
10.00am	Ardrossan coffee stop (at guests own cost)
10.30am	Ardrossan lookout (morning Tea items on bus)
11.00am	Leave Ardrossan look out
11.40am	Arrive Stansbury
12.00pm	Steve and Paul talk oysters
1.00pm	Dalrymple Hotel for lunch
2.30pm	Leave Dalrymple hotel and head back to Adelaide
5.15pm	Arrive at University of Adelaide

SPEAKERS

TOM LOONEY loved catching clams when he was a young kid living on Long Island. That's why seafood is now part of his DNA. Later in life, he sold typewriters – that experience taught him to be open to trying new things so that his professional career would not run aground. He learned that lesson well; Tom recently retired as the General Manager of Lenovo North America. Tom is devoted to making North Carolina a better place. He is active on prestigious boards, including those of the North Carolina Economic Development Partnership, North Carolina School of Science and Mathematics and Wake Technical Community College. Tom is also a member of the federation's board of directors, President's Council and Coastal Society. He spends a huge amount of his time and resources helping to restore oysters and the coast. He realizes oysters are key to providing expanded economic opportunities for many coastal residents. He also believes that having more people invested financially in clean coastal waters will result in better, long-term protection of coastal resources. Tom's business savvy leadership is helping to chart out a path forward so North Carolina is the Napa Valley of Oysters in the United States. Over the past several years, he's become a leader in our state for restoring the coast's natural environment as a way to improve economic opportunity as well.

TODD MILLER is the founder and executive director of the North Carolina Coastal Federation, a nonprofit with over 15,000 supporters working for a healthier North Carolina coast. With 30+ staffers and a multi-million dollar budget targeted for educating the public, advocating for a clean coast and restoring water quality and shorelines, the federation takes on projects, and partners with others in hundreds of endeavors that influence these priorities. Miller is a founding board member of Restore America Estuaries and currently serves on the Board of Visitors for the UNC Institute for the Environment and as a board member on the Policy Committee for the Albemarle-Pamlico Estuary Partnership.

BOZE HANCOCK is the Marine Restoration Scientist for TNC's Global Marine Team. Boze assists in developing marine habitat restoration in new geographies and provides technical support for numerous restoration projects throughout TNC's global portfolio. He also works to provide the science support for marine habitat restoration, particularly through quantifying the ecosystem services these habitats provide human communities, such as coastal protection, fish production and improved water quality, and making the results available to the marine policy community and restoration practitioners.

BO LUSK grew up playing and working in the waters of the Eastern Shore. He leads The Nature Conservancy's Virginia Coastal Reserve's marine restoration work, including ongoing projects to restore oyster and eelgrass habitats, as well as working with partners to re-introduce the bay scallop to Virginia waters.

ANDY LACATELL is the Virginia Chesapeake Bay Director for The Nature Conservancy in Virginia. Over the last 17 years with TNC, Andy has been working on large-scale land protection and oyster restoration projects along the western shores of the Chesapeake Bay. Prior to joining The Nature Conservancy, Andy was the Assistant Director of the Center for Environmental Studies at Virginia Commonwealth University. Andy holds a BA in Sociology from the University of Richmond, a Master of Interdisciplinary Studies (Environmental Studies) degree and a Master of Public Health degree from Virginia Commonwealth University and the Medical College of Virginia, respectively.

COLIN CREIGHTON has a BSc in metallurgical engineering and postgrads in natural resources and in management. Colin practices what he preaches on a dairy – horticulture – plantation forestry – rainforest nature refuge farm on the Eungella Tablelands, undertakes volunteer assignments in the Pacific and South East Asia, is a member of Greening Australia's executive and mentors the World Academy of Science's program for women in science from developing countries (OWSD). Colin was the inaugural Australian President of the Global Water Partnership and has contributed at an international policy level to the Millennium Assessment, Convention for Sustainable Development, WMO Floodplain Management Guidelines and Global Climate Services. Colin was recently awarded the Order of Australia for significant service, leadership and innovation in environmental science and natural resource management, especially marine biodiversity, coastal ecology, fisheries and sustainable agriculture.

PAPER ABSTRACTS

Monday, 19 February – Opening plenaries

9:30am

Developing an Oyster Mariculture Business Case that Delivers Sustained Economic Development

Tom Looney (Board Member, Economic Development Partnership of North Carolina (USA), North Carolina Coastal Federation)

The Economic Development Partnership of North Carolina (EDPNC) is a private-public partnership that was created in 2012 by the state lawmakers. Its mission is the pursuit of sustainable job-creation and investment. The EDPNC works closely with public and private sector partners at the state, regional and local levels. As a nonprofit private-public partnership, the EDPNC operates under contract with the state's Department of Commerce, while receiving financial support from private companies throughout the state. The North Carolina Coastal Federation is a private non-profit organization with approximately 15,000 supporters that is working to enhance the environmental and economic future of the coast.

Historically, the coastal counties of North Carolina have relied heavily on the farming and fishing industries. These industries have been in a significant decline due to reduced fishing stocks and the changing hydrology of our coastal counties. Today, the largest non-government industries along our coast are dependent on tourism, which is primarily seasonal employment. In addition, increased water run-off from coastal development has impacted the water quality in the more populated areas along our coast.

The objective of this initiative, which was originally advocated by the federation, is to drive sustained economic development, jobs and clean water by building $100 million shellfish industry along our cost over the next 10 years. The state legislature wants a strategic plan for growing the state's shellfish mariculture industry by late 2018. It will be an end-to-end business case that includes recommendations on research, regulations, education, investment, routes to market and distribution. The key focus is eliminating barriers to entry and to build a broad coalition of support that includes local, state & federal government, environmental organizations, industry associations, universities, community colleges and business. A further outcome is the desire to maintain the unique culture and character of our coastal communities.

To learn more about the Economic DPNCNC go to:
edpnc.com

To learn more about the presenter go to:
linkedin.com/in/thomaslooney

10:10am

Restoring Oysters in North Carolina (USA): A Blueprint for Action

Todd Miller (Executive Director, North Carolina Coastal Federation, Inc.)

Since 2003, the North Carolina Coastal Federation (a private nonprofit conservation organization) has convened and provided leadership to a diverse group of stakeholders involved in growing, harvesting, studying, and educating, managing and eating oysters have worked together to protect and restore North Carolina's oyster habitats and fisheries. Their combined efforts present a holistic approach to advancing the vision of North Carolina becoming "the Napa Valley of oysters." The strategy involves seven tangible goals: (1) Link restoration of oysters and water quality to an economic development strategy for the coast; (2) Establish at least 500 acres of new oyster sanctuaries to ensure an abundant supply of spat; (3) Plant cultch in good oyster growing waters to provide ample substrate to provide a sustainable wild oyster harvest; (4) Build a sizable shellfish mariculture industry; (5) Sustainably manage oysters on public bottoms for wild harvest; (6) Protect and improve water quality to ensure that oyster are not polluted and remain healthy; and (7) Document status and trends resulting from successful implementation of the Blueprint. The Blueprint includes specific actions that include adoption of new laws, policies, revised regulations, federal and state appropriations, government grants, and the development of a strategic plan for shellfish mariculture. For more information about the blueprint what is being done to carrying it out go to: **ncoysters.org** and to learn more about the North Carolina Coastal Federation go to: **nccoast.org**

Monday, 19 February – Enabling restoration and case studies: South Australia

11:00am

Loss, optimism and restoration of oyster reefs in South Australia

Sean Connell (University of Adelaide), Heidi Alleway (Primary Industries and Regions South Australia), Alan Noble (AusOceans), Steve Bowley (Pacific Oysters), Dominic McAfee (University of Adelaide)

There is a surprising story behind the discovery of loss oyster reefs that once ringed the gulfs of South Australia. I will trace this story from a chance discovery in the bowels of a government transport department through to seizing the restoration idea in government and non-government sectors. It's a story of hope. This hope has galvanised the most unlikely of people (both glass half-full and half-empty types) and departments (conservation, exploitation and transportation). To enable this hope, we desperately need to learn from future surprises of evitable failures and succusses of restoration. Those providing their expertise are not just interested in biology, but they also involve people with an interest in the psychology of hope, enablement through business and policy and even industry leaders of information technology.

11:15am

Laying the foundations of South Australia's Blue Infrastructure Initiative:

Windara Reef Stage 1

Sarah-Lena Reinhold (PIRSA Fisheries and Aquaculture)

Phase one of Windara Reef marks the first step to trialling methods to restore shellfish reef habitats that were historically prolific in South Australia's coastal waters. Developed under the broader scope of the Blue Infrastructure Initiative, the transition from concept development, stakeholder and community engagement through to reef construction has provided a foundation for shellfish restoration in South Australia.

Guided by a Habitat Enhancement Working Group made up of eleven stakeholder representatives across three levels of Government, commercial and recreational fisheries, non-for-profit organisations and community, Windara Reef is now the largest shellfish reef development in Australia. This project highlights the importance of co-management and community stewardship in raising both public and political awareness of the forgotten shellfish reef habitat, its ecosystem functions, traditional owners and relevance to supporting fisheries productivity.

The first development phase in the construction of Windara Reef, led by State Government, demonstrates a 'hands on' approach to site management, policy, biosecurity and construction in partnership with The Nature Conservancy, University of Adelaide, the Yorke Peninsula Council and RecFish SA. This project highlights the importance of collaboration in delivering shellfish reef restoration projects and provides examples of site management considerations into the future at both a State and National level.

11:25am

Strengthening South Australia's blue economy: Windara Reef expands in Stage 2 and beyond

Anita Nedosyko (The Nature Conservancy Australia)

In 2014, the South Australian Minister for Environment made an election commitment to build an artificial reef for recreational fishers. The vision has since expanded from an initial proposal to build concrete reef structures to ambitiously restoring the first shellfish reefs in the state. The Nature Conservancy in partnership with the South Australian Government, Yorke Peninsula Council and the University of Adelaide helped grow the initial $600,000 investment for a trial reef into a $4 million -20 hectare- full scale project. This has projected South Australia rapidly into the forefront of large-scale marine habitat restoration. Our successful bid for funding under the National Stronger Regions program provides a model project to demonstrate how restoration activities can support the Government's infrastructure investments namely by creating jobs, driving economic growth and supporting strong regional communities. Moving beyond Windara, we seek to establish a new blue economy industry through the restoration of native oyster reefs at priority locations. By doing so, we will build capacity in South Australia's natural resource management agencies, community groups and the shellfish aquaculture industry to continue to undertake large-scale marine habitat restoration.

11:35am

Oyster optimism bridges cultural barriers to restoration

Dominic McAfee (University of Adelaide), Zoe Doubleday (University of Adelaide), Sean Connell (University of Adelaide)

Although global conservation efforts are steadily increasing, media saturation of environmental doom and gloom stories have fatigued the public. For many, marine conservation has become synonymous with habitat degradation. The history of shellfish reef exploitation is a familiar tale

of human habitat destruction and ecosystem collapse. However, few people are aware of this historic habitat loss, and as such, shellfish restoration carries great positivity. In South Australia, we have witnessed a snowballing effect of optimism surrounding the Ardrossan shellfish reef restoration, with community, government, and industry keen to be involved. Cultural barriers that frequently hinder cross-sector collaboration were surrounded in the "spirit of collaboration", fuelled by the stakeholder's enthusiasm to be associated with a positive environmental story. The capacity of environmental optimism to help disparate stakeholders find common ground for collaboration cannot be denied, and where used responsibly can help generate community support, industry funding, and government backing for future restoration projects.

11:45am

Port River Shellfish Restoration Project

Catherine McMahon (Estuary Care Foundation SA Inc.)

This project arose from community concern about the impacts of rising sea levels along the Port River and community interest in Living Shorelines to enhance the resilience of the River shoreline and the community. The possibility of shellfish reef restoration surprised many, as did the presence of thousands of Pacific oysters and blue mussels. The restoration of the native oyster, *Ostrea angasi*, became a goal together with the restoration of multi species reefs.

A group of interested people began this project in January 2016, aided by some key advisers, and later that year the project came under the auspices of the newly formed Estuary Care Foundation SA, with its focus on the restoration of the Port River and Barker Inlet Estuary.

Trials in oyster baskets across multiple sites, testing the survival of *Ostrea angasi*, have become trials assessing survival and growth with encouraging results to date. The oyster baskets, though a tiny habitat, are also attracting diverse marine organisms. Approval is being sought for trials with bagged shell for reef restoration and seagrass restoration.

While community development was a goal, it was unclear from where support might come and to date it includes our site owners (business and government), local community members and environmental advocates, malacological and marine society members, high schools, government agencies.

Some of the complexities have included the embryonic state of estuary restoration in our State, the involvement of multiple agencies along the River including industrial operations, introduced species especially Ciona intestinalis, lack of information specific to our Australian context.

Since the concept of estuary restoration was very unfamiliar here, we have initially engaged in community education through targeted groups and events rather than mass audiences. Local community members are heartened by the progress to date and the hope it provides.

12:00pm

Technical talk: Peopling WaterPlaces

Mary Gardner (WaterPlaces, Byron Bay)

My doctoral research into the historical ecology of key marine animals in subtropic East Australia involved an assessment of resilience (using the Resilience Alliance workbook version 2). What with Aboriginal dispossession and the commercialism of colonial and early Federation eras, our aquatic places were left in the dissipative stage, degraded, unable to support foundation species. As significantly, our communities were lacking the socio-ecological knowledge and actions to improve conditions. In response, our small team organised WaterPlaces, a not for profit group offering a long term whole-of- catchment programme to strengthen deep resilience and revive aquatic populations. We train and support community members to survey and monitor aquatic places. We help build ecological knowledge and the design of action plans supported by both community and local government. We designed two levels of training, one for participants (approx 15 hours) and another for community-based coordinators (hopefully leading to paid positions). The courses draw on both Aboriginal nature knowledge and science. Successful completion of courses gives members access to lending libraries of equipment including digital water quality multi-meters and gear to assess aquatic macro-invertebrates. For 2018, almost a dozen level I training sessions are planned, supported by councils, Landcare groups and the local water management authority. With informed people in waterplaces on the Brunswick, Belongil and Richmond, we hope to avert further dissipation. We hope to usher in the next stage of socio-ecological resilience: re-assembly of habitats, re-organisation of knowledge and the revival of shellfish and other aquatic species.

12:15pm

Compensation then collapse: How *Ostrea angasi* responds to a warming and acidifying ocean

Ben Freeling (The University of Adelaide), Dominic Mcafee (The University of Adelaide), Sean D. Connell (The University of Adelaide)

This poster describes a laboratory study investigating how the native oyster *Ostrea angasi* responds to warming and acidification.

Oysters were exposed to temperatures (20°C, 25°C and 30°C) and pH (current = 8.1 and future = 7.8) that simulate the current and end-of-century ocean. Filtration rate was measured as a proxy for metabolism, and survival as an indication of whether oysters can cope with extreme stress. Filtration rate was highest under moderate stress (future pH at 20°C; or current pH at 25°C) but declined under extreme stress (future pH at 25°C). Survival remained stable until suddenly declining at 26°C (for future pH) or 28°C (for current pH). The results demonstrate that *O. angasi* can compensate for moderate environmental stress, but collapses under extreme stress.

These findings are immediately relevant for the management of Windara Reef, a restoration project that depends on *O. angasi*. By the end of the century, Windara Reef is likely to experience the same conditions that caused oysters to die. Reef managers must research ways to avert reef-wide mortality. At a broader scale, these findings contribute to models describing how calcifying organisms respond to environmental stress.

12:17pm

Marine Sensor Networks for Greater Restoration Information

Catherine Larkin (University of Adelaide)

Commercial dredging, overfishing and pollution have contributed to the loss of 85% of oyster reefs globally. Large scale restoration of shellfish reefs has the capacity to restore the lost ecosystem services and biodiversity that shellfish reefs previously provided. However, the success of such restoration efforts rely on efficient, regular monitoring of the restored population, and the surrounding environmental conditions. Recent advances in underwater sensor technology provide the ability for continuous, real time, in situ monitoring of species and collection of environmental data. In order to monitor and observe the implementation and on-going restoration of the largest oyster reef restoration project in the Southern hemisphere, an underwater, multifaceted sensor network is currently being developed and deployed in the Spencer Gulf of South Australia. This state-of-the-art technology is a promising alternative for future ocean-observational systems and marine sensor networks that will change the future of marine conservation monitoring.

12:20pm

Technical talk: How to shoot videos from the field on your mobile phone

Ian McLeod (James Cook University)

All of us carry a powerful video production tool in our pocket, our smart phones. In this 15- minute workshop, Ian will guide you through the process of planning, shooting and editing and share tips and tricks about how to use your smart phone to shoot great videos and tell your story. We will also discuss workflow, uploading and the best ways to maximise the impact of your videos without detracting from your busy scientist workload. The workshop will be hands-on and interactive, so bring your phones. To get the best out of this workshop, download the free App 'Adobe Clip' and shoot a few video clips with your phone so you have some footage ready to edit.

Monday, 19 February – Research and Development

1:30pm

The timing and type of substrate deployment influences recruitment of Sydney rock oysters, *Saccostrea glomerata*, and associated communities

Maria L. Vozzo (Macquarie University) and Melanie J. Bishop (Macquarie University)

The recruitment and succession of fouling invertebrates is dependent on the timing and identity of substrate deployed. Shellfish reef restoration typically involves the deployment of substrate, and/or live oysters that provide spawning stock biomass and recruitment cues for conspecifics. Substrate deployed just prior to oyster recruitment may favour oyster community development, while substrate deployed too early or late may favour alternative community development. This project assessed how the type of substrate deployed and the timing of deployment influences recruitment of Sydney rock oysters, and associated invertebrates, in south eastern Australia. At five estuarine sites in Sydney, New South Wales live oysters, dead oyster shells, or a mix of the two were deployed in each of four seasons, in each of two successive years, with oyster shells loose or attached. Recruitment of oysters and barnacles was greatest during the summer months wherein barnacle recruitment peaked just prior to oyster recruitment. Additionally, recruitment of the two was greater when at least some dead oyster shell was present in the substrate, than when live oysters were deployed alone. Further, oyster and barnacle recruitment was not influenced by whether shell was loose or attached. We found that although sessile invertebrate recruitment peaked during warm summer months, the diversity of mobile invertebrates was greatest in the winter. Our results suggest that the Sydney region is substrate- rather than larvae-limited and thus there is great potential for oyster reef restoration. However, the substrate composition and structure should be considered in order to maximise native oyster species over potential competitors for space, in order to encourage development of native shellfish reefs. Generally, mid-summer deployment of substrate should allow oyster larvae to settle and grow into complex reef habitat that supports biodiverse communities.

1:45pm

The mechanisms by which oysters facilitate invertebrates vary across environmental gradients

Melanie Bishop (Macquarie University), Dominic McAfee (University of Adelaide)

The mechanisms by which ecosystem engineers facilitate biodiversity will vary with the abiotic and biotic environmental context. Therefore, effective use of ecosystem engineers to conserve biodiversity requires an understanding of the types of resources an engineer modifies, how these modifications vary spatially, and how difference taxa respond to these modifications. In the physically and biologically extreme intertidal, oysters are important ecosystem engineers that can modify the abiotic and biotic pressure experienced by associated fauna. Using a manipulative field experiment we investigated how the mechanisms by which intertidal oysters facilitate invertebrates varies among four estuaries distributed over 900km of east Australian coastline. To partition the direct vs indirect mechanisms of invertebrate facilitation we used shading and caging structures that mimicked the environmental amelioration provided by oysters, with a combination of live and dead oyster habitat, and oyster-free bare habitat. We found that as maximum temperatures increased, the amelioration of abiotic pressure was the primary mechanism of facilitation by oysters, whereas in cooler estuaries, the provision of a predation refuge played a more important role. Irrespective of the background abiotic environment, the direct effect of habitat provision by oysters had the greatest effect on species abundance and richness, in particular epibionts (barnacles and oyster spat) and grazing gastropods. Mobile arthropods utilised the habitat provided by disarticulated dead oysters more than live oyster habitat, whereas the abundance of polychaetes and bivalves were much greater in live oysters, suggesting the oyster filter-feeding activity is important for these groups. Such knowledge of how ecosystem engineering effects vary across environmental gradients can help inform management strategies targeting ecosystem resilience via the amelioration of specific environmental stressors, or conservation of specific community assemblages.

2:00pm

Complementary technologies and shared concerns of oyster farming and reef restoration

Wayne Hutchinson (Oysters Australia)

TBC

2:15pm

Oyster reef restoration on soft sediments benefits from substrate addition and prolonged grow out in South-East Australia

Ben Cleveland (The University of Melbourne), John Ford (The University of Melbourne), Paul Hamer (Victoria Fisheries Authority), Steve Swearer (University of Melbourne), Simon Branigan (The Nature Conservancy Australia)

Native flat oysters (*Ostrea angasi*) reefs were once an ecologically important feature of the benthic structure of Port Phillip Bay, Victoria. Today, oyster populations in the Bay have been severely depleted and in most areas eliminated through overfishing and compounded by pollution, disease and exotic species. However, the presence of flat oysters on isolated structures in areas consistent with historical shellfish reefs, suggest they can still persist if they have suitable elevated attachment substrate. A small-scale pilot trial was therefore conducted to evaluate potential restoration approaches, with an aim to guide future large-scale restoration efforts. The influence of substrate addition and extended mid-water grow-out on survival and growth was assessed over a 30-month period. This experiment indicated that improved survival and growth could be obtained by deploying small hatchery reared oyster spat (< 30 mm) settled on scallop shell cultch medium onto raised (ca. 10 cm) rubble beds, as opposed to directly onto the natural sediments. However, survival rates were overall very low, mostly due to physical disturbance and sedimentation of the experimental units, including loss/burial of cultch. Strong differences in performance between sites within Port Phillip Bay suggest that a multi-faceted approach will be necessary to facilitate restoration due to the strong gradient of environmental conditions. Greater elevation, complexity and stability of base material is likely required to achieve higher survival rates for ongoing restoration. We discuss the lessons learnt, issues faced and how they are guiding current restoration efforts in the region, including research areas requiring further investigation.

2:30pm

Faunal communities associated with *Ostrea angasi* oyster reefs in Tasmania

Christine Crawford and Gideon Heller-Wagner (IMAS, University of Tasmania)

The last known remaining naturally occurring reef (beds) of the native oyster *Ostrea angasi* occurs in Georges Bay, northeastern Tasmania and remains an active fishery. Very little is known about the ecosystem services provided by *O. angasi* oyster reefs in Australia, including associated biological communities. This was the focus of a recent Honours research project to determine the diversity and abundance of faunal communities on the last remaining naturally occurring reef. Four sites were sampled in the oyster reef and were compared to the surrounding soft sediment regions. Assemblages were correlated against environmental variables to determine if any patterns were present. Oyster reef sites contained three times the faunal abundance than the surrounding soft sediment regions. Abundance among echinoderms, arthropods, molluscs and fish were much higher, whilst annelids showed similar levels of abundance but differed in diversity. These results show that oyster reefs do support abundant and diverse assemblages, emphasizing the probable loss associated with the historical decline around Tasmania.

2:45pm

Exploitation and supply of European flat oyster (*Ostrea edulis* Linnaeus, 1758) seeds

Bérenger Colsoul (Alfred Wegener Institute), Verena Merk (AWI), Bernadette Pogoda (AWI)

The European flat oyster is a sessile, filter-feeding bivalve. It is considered a keystone species with special ecological functions in its typical species community and habitat. Due to the fishing pressure as well as due to continuing bottom trawling, responsible for the loss of settlement substrate, the functional extinction of European oyster stocks was recorded in the 20th century for the German Bight.

Today, the restoration of oyster beds by reintroduction is necessary for the re-establishment not only of the species but also its characteristic biocoenosis and essential ecosystem services.

The production of seed of flat oysters in Europe being erratic, to compensate for a new application that is marine conservation, it appeared necessary to conduct a review on all the technologies of production and collection of seeds of the species.

This presentation will address the history of the exploitation (fishing, mariculture, conservation) and supply (wild collection, breeding-ponds, oyster-polls, hatcheries) of the resource in flat oyster spat in Europe, it will establish the state-of-the-art and it will attempt to assess the future challenges facing to traditional and new.

3:15pm

Reintroducing Native Oysters in the German North Sea: An offshore field study

Verena Merk (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), Bérenger Colsoul (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research) and Bernadette Pogoda (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research)

Within the last century, the oyster grounds of the German North Sea vanished entirely and the native European flat oyster *Ostrea edulis* is nowadays considered functionally extinct in this area. Due to its ecological significance in terms of biodiversity and other ecosystem services, the species is listed as threatened and the habitat they provide defined as endangered by the Oslo-Paris Commission (OSPAR). Taking actions in restoration and reinforcement is compulsory for all OSPAR member states. Since *Ostrea edulis* has to be reintroduced in the German Bight, conclusive recommendations on a large-scale restoration program are necessary. Project RESTORE, funded by the German Federal Agency for Nature Conservation (BfN) and conducted by Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), aims at evaluating the performance of Ostrea edulis under present-day environmental conditions of the German North Sea.

Target areas of potential reintroduction efforts are the vast oyster grounds formerly located far off the coasts in the German Bight. In May 2017, an offshore study-site was established in 25 m water depth to collect applicable data. Sampling of seed oysters has been conducted regularly throughout the year by a scientific diving team. Changes and development of condition and growth give insight into the general performance of the species under this deep, subtidal conditions. Additionally, biochemical data and health monitoring determine the animals nutritional status and possible infections by macroparasites and disease like Bonamiosis. First analysis of growth and condition show a promising trend for the course of the project.

3:30pm

Assessment of conservation metrics for oyster reef restoration at Hab River Delta, Balochistan, Pakistan

Sadar Aslam, Ghazala Siddiqui, Syed Jamil Hassan Kazmi (University of Karachi, Pakistan)

The decline of oyster reefs due to water quality degradation, overfishing, boat traffic, harmful harvesting practices and diseases have great impact on oyster fisheries and ecosystem services provided by them. The oyster reefs in Pakistan are deteriorating and are on the verge of extinction. A field survey and Geographical Information System (GIS) based approach was used for planning future oyster reef restoration efforts. The field surveys were based on reef categorization, universal metrics, universal environmental variables, restoration goal-based metrics, habitat suitability analysis, sounding, condition indices, grain size composition and oyster spat-fall. The reefs were categorized into three main categories on the basis of fragmented spatial geometry. Dispersed reefs were more in number then continuous, and patch categories. The difference between morphometric measurements and density of oysters amongst oyster reefs types was insignificant. The environmental and restoration goal-based metrics were favorable for oyster growth and survival. Habitat suitability analysis was done by 'Benthic Terrain Modeler' using ArcGIS software. The moderate positive values of Bathymetric Position Index (BPI) of the oyster reef indicates an area of high or open slope (low depth) with sea bottom (6.00 to 15). The area of reef location showed high to moderate values of rugosity (0.8 to 0.9), indicate good to intermediate condition. Aspect analysis revealed slope orientation of the reefs in southeast direction. The dispersed reefs have lowest bathymetry points compared to patch and continuous reefs. The values of condition indices reveal insignificant difference among reef types. Fine sand has the highest percentage (71%) followed by silt and clay fraction (18%). The mean density of oyster spat was 60.67 ± 9.09 (mean ± SE) while the spat size was 23 ± 0.68 mm. Current study suggests that the present reefs are viable and have potential for successful restoration.

3:45pm

Developing a consistent approach to monitoring shellfish reefs in Australia

Simon Reeves (The Nature Conservancy), Simon Branigan (The Nature Conservancy), Anita Nedosyko (The Nature Conservancy), Chris Gillies (The Nature Conservancy)

Shellfish reef restoration is currently in its infancy in Australia and has recently been receiving a lot of positive recognition with rapid growth in projects, lots of media attention and strong support from multiple-levels of government and recreational fishers. With this burgeoning interest in shellfish reef restoration, we lie at an exciting time that presents many opportunities and challenges. One of the challenges is to develop a consistent approach to monitoring restoration projects and reference sites across different shellfish species, geographies and stages of project development.

The role of monitoring alongside restoration is essential for acomplishing the goals and objectives of a restoration project. A considered monitoring approach allows for:

(1) comparison among restoration projects; (2) adaptive management; and (3) determination of whether reef restoration projects are a success. Here we outline a method that is adaptable for Australian projects and species and which also enables comparison amongst more established projects in the US and globally. We have used the universal metrics (UMs) outlined in the Oyster Restoration Handbook as a basis for our approach. We build on the UMs by using the Reef Life Survey methodology and BRUVs for monitoring fish and invertebrate, biomass and diversity on our reefs. The BRUVs, as well as additional settlement plates (for monitoring shellfish recruitment), have also enabled us to develop a citizen science aspect to our monitoring program. This presentation aims to encourage discussion around the benefits and costs of monitoring, and how to develop consistant approaches to shellfish reef monitoring across a wide range of ecosystems, project stages and objectives.

4:00pm

The efficacy of eco-engineering interventions in enhancing native shellfish communities on seawalls across the globe

Melanie Bishop (Macquarie University), Beth Strain (Sydney Institute of Marine Sciences), World Harbour Project Partners

Along many urbanised shorelines of the world, seawalls are now the dominant habitat-type. As compared to the natural habitats they displace, seawalls typically support small populations of shellfish because their flat, vertical surface compresses the intertidal zone, limits the amount of space available for colonisation and growth, and lacks microhabitat refuges from predators and environmental stressors. In 15 harbours around the world, we assessed (1) how retrofitting seawalls with complex tiles that add surface area and microhabitats (ridges/crevices) influences recruitment, growth and survival of shellfish and (2) how establishment of shellfish on seawalls influences development of associated invertebrate communities. Complex tiles were most effective in enhancing recruitment and survivorship of shellfish at sites where the dominant predators were larger than the diameter of the ridges (e.g. fish and seastars), but were ineffectual at sites with smaller predators or where other stressors limited bivalve establishment. Complex tiles with abundant shellfish generally supported greater biodiversity than complex tiles without shellfish, or flat habitat. Knowledge of site-specific factors that limit shellfish establishment will be critical to developing eco-engineering interventions that seek to reinstate their biogenic habitat on artificial structures, such as seawalls.

4:15pm

Technical talk: A prototype mobile application for documenting remnant shellfish reefs

Elisa Bone (Ashore Consulting) Adela Sobotkova (Field Acquired Information Management Systems (FAIMS) at Macquarie University), Petra Janouchová (FAIMS)

Successful widespread restoration of biogenic shellfish reefs first requires identifying locations that might be suitable for restoration and determining the success of existing remnant reefs within these locations. Although these data may not be technically difficult to obtain, it can be time-consuming and costly to cover the broad areas required for useful mapping.

As a potential means to collect such data, and to engage the public with their coastal environment, we have designed a prototype mobile application that allows non-specialist users to record basic information about the types of habitat, and any existing oyster or mussel aggregations, found at local shoreline sites. The application enables offline data collection, online data storage and easy data synchronisation across multiple users.

In developing the parameters, we considered both applicability to potential restoration work and ease of use for non-specialists. Our prototype thus allows users to record broad general observations, such as habitat type, and simple categorical descriptions of shellfish aggregations. Users are guided by descriptive images and text, and directed to upload photographs to support their observations at several points in the application. These checkpoints allow off-site validation of most records, but species identification would require further on-site field validation by trained researchers.

Following field testing and further refinements, we anticipate that the app may provide an additional tool for both managers, to prioritise assessments of the restoration potential of shoreline sites, and educators, who wish to engage their communities in local shoreline ecology.

4:30pm

Oyster reefs in NSW – a new opportunity

Kylie Russell (NSW Department of Primary Industries, Port Stephens Fisheries Institute, NSW)

Prior to the 19th century, oyster reefs were common features of NSW estuarine and coastal systems providing substantial environmental benefits. From early European settlement, vast quantities of oysters and mussels were harvested in an unsustainable manner for food and as a source of lime used in construction. By the late 1800's,

exacerbated by increasing catchment sources of sediment, acidic events and disease, oyster reefs had all but disappeared in NSW. Today, only a fraction of natural oyster reefs survive.

Recognition of historical loss and current rehabilitation of natural oyster reefs is a rapidly emerging issue across Australia, including in NSW. Research continues to demonstrate the value of oyster reefs as habitat structures for biodiversity, for water filtration, shoreline and seagrass protection, nitrogen fixation and related environmental benefits. International experience has demonstrated the considerable social and economic benefits of restoration projects to local communities, including increased employment opportunities. Strong support for rehabilitation has been demonstrated across the community.

The NSW Government is reforming its management of coastal and marine areas through the Marine Estate Management process and Coastal Management Act 2017. These reforms provide significant opportunities to increase the investment in and opportunity for oyster reef restoration. In addition, recent analysis on the cost-benefit ratio of these projects to the NSW community has also been completed. Oyster reef restoration provides a practical and effective means of rebuilding lost habitats and regaining environmental services while creating new job and community involvement opportunities in NSW. Recently, a site in Port Stephens has been identified as suitable for the first large scale oyster reef restoration project in NSW.

This paper will describe the history of oyster reefs in NSW, key opportunities for new investment and describe a proposal for a large scale oyster reef restoration in Port Stephens.

4:45pm

Technical talk: Making modern middens at Ningi Ningi (Place of many oysters)

Ben Diggles (DigsFish Services)

In Moreton Bay, Southeast Queensland, Australia, shellfish resources were sustainably utilized as food for thousands of years by indigenous groups. This was evidenced by the existence of large "middens" which were described in many coastal areas by early European settlers. The word 'midden' is derived from a Scandinavian word meaning 'kitchen refuse' or 'rubbish'. In Australia archaeologists use the term midden to describe piles of shell deposited after the collecting and eating of shellfish such as oysters, eugaries, cockles, mussels and mud whelks.

However, since European settlement in the late 18th Century, these middens were mined and the shells were used as roadbase or burnt to make lime to build the colony's first roads and buildings. With the rapid pace of colonization and urbanization of Southeast Queensland, today only remnant middens remain as a reminder of the former abundance of these shells. Similarly, in Pumicestone Passage historical records show abundant subtidal shellfish (Sydney rock oyster, *Saccostrea glomerata*) reefs occurred in the mid to late 1800's, but today around 96% of zonation suitable for natural *S. glomerata* recruitment has been lost, and subtidal shellfish reefs are functionally extinct.

The town of Ningi on the shoreline of Pumicestone Passage was named after the Aboriginal phrase Ningi-Ningi meaning "place of plenty of oysters". With community efforts to begin restoration of shellfish reefs in Pumicestone Passage now underway to try to return the many missing environmental, social, cultural and economic benefits historically provided by these valuable ecosystem engineers, Ningi appears an entirely appropriate place to conduct Queensland's first shell recycling program. The concept of establishing a shell recycling station at Ningi Transfer Station was first raised in May 2016, but it was soon discovered that the process of recycling oyster shells had been made illegal in QLD under the Waste Reduction and Recycling Act (2011). Thus a disentangling of red tape was required and it took over 13 months before the original concept was seen through to fruition with the opening of the Ningi Transfer Station Shell Recycling Centre on 9 July 2017. This presentation will detail the various processes and obstacles that needed to be overcome by the local community in order to re-establish "modern middens" at Ningi. The various biosecurity processes and sanitary protocols that need to be applied to the recycled shells prior to them being approved for use to supply local shellfish reef restoration efforts with clean shell cultch substrate will also be discussed.

Wednesday, 21 February – Opening Plenaries

9:00am

The development of oyster habitat restoration in Chesapeake Bay leading to the world's biggest oyster restoration project to date- Harris Ck. Sanctuary.

Boze Hancock (TNC), Stephanie Westby (NOAA) and Andrew Lacatell (TNC)

Chesapeake Bay, on the east coast of the US, has a long history of oyster restoration. Initial restoration focused on boosting the failing oyster fishery. This objective had changed by the early 2000's with the growing recognition of the importance of the ecosystem services provided by oyster habitat in addition to the fishery product. For over 15 years the primary objective has been the restoration of oyster habitat for enhanced ecosystem services such as water clarity, denitrification and fish production to support non-oyster fisheries.

The focus on oyster habitat restoration has been accelerated by strong and complimentary political support and leadership. In 2009 the Obama administration issued an Executive Order calling for restoration of the bay. As part of the response to the recession of 2008, the American Resource Recovery Act, or stimulus package, included support for oyster habitat restoration as a job creation mechanism. Subsequently the Governors of the states directly connected to the Chesapeake Bay, along with the Federal Government, signed the Chesapeake Bay Agreement with the common goal of restoring 10 tributaries by the year 2025. Scientific Teams were convened to provide guidelines on large scale restoration, including definitions and success metrics to be used.

The result has been a coalition of partners and a network of restoration projects in multiple tributaries of Chesapeake Bay. The first of these projects to be completed was Harris Ck. in Maryland. Between 2011 and 2015, 141 ha of oyster habitat was restored to Harris Ck. and seeded with 2 billion juvenile oysters. The development and preliminary results from the Harris Ck. project will be discussed.

9:15am

Large-Scale Oyster Restoration in the Piankatank River, Chesapeake Bay (USA)

Andy Lacatell (The Nature Conservancy)

Chesapeake Bay, North America's second largest estuary, is home to more than 3,700 species of plant and animal life and more than 18 million people. The healthy management of the Bay has been a challenging issue since the 1970's. No species better defines the Chesapeake Bay, and no species offers a more direct link to the future health of the Bay than the eastern oyster (*Crassostrea virginica*). In the early 1900's more than 9 million bushels of oysters were harvested in Virginia. In the 1997-1998 season, the Virginia landings were just 14,295 bushels. Today, the population of the Eastern oyster in the Chesapeake Bay is around 1% of mid-19th century levels.

The Piankatank River is a 45,000-acre tributary of the Bay. In the late 1800's, the Piankatank had more than 7,000 acres of oyster beds. By the mid-1980's there were less than 200 acres. Since the late 1980's efforts to restore oyster populations in the Chesapeake Bay have been underway. Starting with small-scale pilot projects, scientists, fisheries managers and non-profit organizations have been developing more effective and larger scale restoration projects.

Over the last decade, in a collaboration of state, federal and non-profit partners large-scale oyster reefs have been restored and managed as sanctuary reefs in a complex and complementary network of commercially harvested reefs. In the last three years, The Nature Conservancy, the Virginia Marine Resources Commission and the US Army Corps of Engineers have built 50 acres of new oyster reefs in the Piankatank toward a goal of 600 acres by 2025.

This presentation will discuss the history and lessons learned from over a decade of oyster restoration in the Piankatank River, and specifically the use of alternate substrate, the measurement of fish production and the cultivation of enabling conditions for success.

9:30am

Seventeen Years of Restoring the Eastern Oyster in Virginia's Atlantic Coastal Bays

Bowdoin Lusk, Jr. (The Nature Conservancy), Andrew Button (Virginia Marine Resources Commission)

Reefs of Eastern Oysters (*Crassostrea virginica*) were once abundant in the shallow coastal bays on the Atlantic coast of Virginia's Eastern Shore, and these reefs supported the region with myriad ecosystem services including the provision of local communities with thriving seafood economies. Disease and overfishing throughout the twentieth century depleted these oyster reefs to near commercial extinction by the mid-1990's. In 2001, The Nature Conservancy (TNC) and the Virginia Marine Resources Commission (VMRC) partnered to attempt to restore this once plentiful resource through the planting of shell cultch in strategically chosen areas, relying on small populations of surviving wild oysters for larval supply. These first projects proved successful in developing into ecologically functional reefs, and they justified continued investment in oyster restoration by TNC and VMRC. Over

the course of the following seventeen years the partnership has built nearly 50 acres of shell cultch reefs, established five co-managed shellfish sanctuaries, and experimented with methods of employing an alternative substrate, Oyster Castles.

Today, oysters in Virginia's coastal bays remain substrate limited, but the existing population is thriving and shows evidence of tolerance to disease which once significantly contributed to its decline. Rather than focusing solely on scale or increasing total acreage of reefs in the system, recent projects have focused on building reefs for shoreline protection, reviving dead remnant reefs through elevation of substrate in the water column, and even building small reefs with the goal of maximizing sustainable harvest by commercial watermen.

9:45am

Restoring the Bay Scallop (*Argopecten irradians*) to Virginia After Restoring Its Eelgrass (Zostera marina) Habitat

Bowdoin Lusk, Jr. (The Nature Conservancy)

In the 1920's and first two years of the 1930's Virginia was a leading producer of bay scallops (*Argopecten irradians*) on the east coast of the United States. However, during the same period eelgrass (*Zostera marina*) meadows were declining due, at least in part, to "the wasting disease" brought on by a pathogenic slime mold, *Labyrinthula zosterae* sp. By late 1933, all the bay scallop's eelgrass meadow habitat was gone from the coastal bays on Virginia's Atlantic coast and with it the last of Virginia's bay scallops.

Over the course of the last twenty years, efforts by the Virginia Institute of Marine Science (VIMS) assisted with support from The Nature Conservancy (TNC) have restored eelgrass in the coastal bays from zero acres in 1997 to over 7,000 acres today. With the establishment of this essential bay scallop habitat, VIMS and TNC began attempting to reintroduce the bay scallop to Virginia waters in 2009. A Virginia broodstock has been established and maintained in local hatcheries and work is still in progress to discover how to create the area's first self-sustaining bay scallop population in 85 years.

Wednesday, 21 February – Enabling restoration and case studies

9:50am

Half Moon Reef – A Socio-Economic Analysis of Recreational Fishing Benefits of a Restored Reef in Texas

Mark Dumesnil (The Nature Conservancy); Bryan DeAngelis (The Nature Conservancy); Christine Shepard (The Nature Conservancy); Boze Hancock (The Nature Conservancy); Jeff DeQuattro (The Nature Conservancy); Bill Balboa (Texas Sea Grant); Andrew Ropicki (Texas Sea Grant); and Stuart Carlton (Texas Sea Grant)

This presentation highlights the results of a socio-economic evaluation of a large-scale, sub-tidal, 20 ha. oyster reef restoration project in Texas. Both recreational fishers and professional guides were queried using a combination of techniques that included in-person intercept and online surveys. Key findings indicated that fishers found the restored reef to be an excellent recreational fishing area, believed that similar future projects were critical to the health of the Texas coast, and demonstrated that economic impacts due to the restoration of the reef from increased fishing activity were substantial.

10:05am

From little things, big things can grow back again: Pumicestone Shellfish Habitat Restoration Project

Susie Chapman (Healthy Land and Water), Dr Ben Diggles (Digsfish Pty Ltd), Rob King (Sunfish), Karin Didderen (Bureau Waardenburg)

Prior to the 20th century, shellfish reefs were common features of estuarine systems, however they are currently considered functionally extinct ecosystems in Australia (Beck et al, 2011) and most particularly in Pumicestone Passage (Diggles, 2013).

Local organisations and individuals including Traditional Owners, fishing groups, local government, utilities, research institutions and the regional NRM group have been working together for more than two years to develop a monitored shellfish habitat restoration trial in the Southern Pumicestone Passage. This trial using live and dead shell will feature a variety of reef structures including patch reefs of shell confined by reef balls, steel cages with shell,

and a biodegradable potato starch matrix (BESE-elements) developed by Bureau Waardenburg and Radboud University Nijmegen, used here for the first time in Australia. This trial is supported by two innovative community projects of shell recycling and oyster gardening.

The intent is to restore previous shellfish habitat for environmental remediation and as fish habitat, and to acknowledge and protect Aboriginal cultural heritage values. If the concept can be proven on a small scale by establishment of self-sustaining subtidal oyster reefs in key parts of Pumicestone Passage which are accompanied by improvements in fisheries production, these data can be used to justify and inform estuary restoration efforts in other areas of Moreton Bay and/or on larger scales.

Pumicestone Passage is a shallow passage-type estuary located just north of Brisbane. The proposed 2.5 hectare sub-tidal trial area is within the Moreton Bay Marine Park, and outside the Mooring Zones, Fish Habitat Area, Navigation Channel, located in an area with depth range of -5.2 to -2.5 metres AHD. All of the Pumicestone Passage is within the high risk maritime development zone. Achieving state government approval has been a long sequential process with many agencies working together to ensure the outcome for this small project is legislatively and ecologically sound.

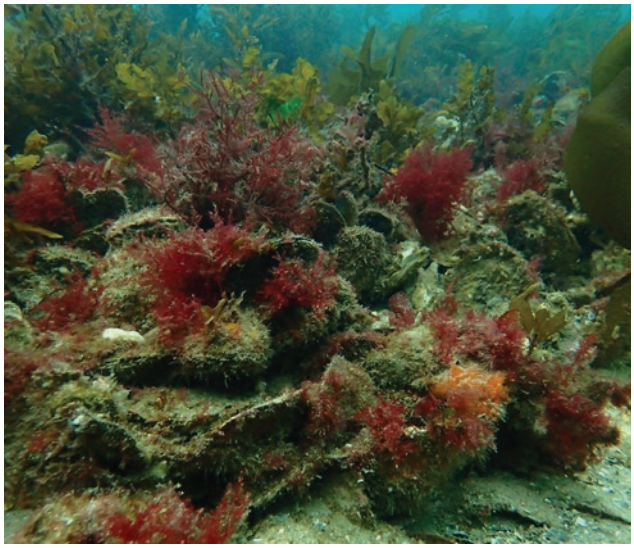
10:20am

Pioneering shellfish reef restoration in Australia: from ground zero to reality

Simon Branigan (The Nature Conservancy), Chris Gillies (The Nature Conservancy), Simon Reeves (The Nature Conservancy), Paul Hamer (Victorian Fisheries Authority), Ben Cleveland (University of Melbourne)

Restoration of Australia's shellfish reefs has been a key component of The Nature Conservancy's Great Southern Seascapes program since its inception. Starting in 2014, the Port Phillip Bay Shellfish Reef Restoration Project has been in the process of restoring over 1200 m^2 of reefs. Nevertheless, pioneering restoration of shellfish reefs in an Australian context has required many elements to align. The driving force for early action came from a partnership between a recreational fishing club, scientists, and a NGO. This early impetus has led to success in securing funding and permits, finalisation of a pilot study, ongoing promotion and now the scale up phase. There are many other facets that have evolved to become essential in ensuring reconstructed shellfish reefs become a reality. These include a PhD study that is informing the development of restoration approaches, fostering strong project partnerships such as a shell recycling initiative, a volunteer and citizen science network, and building experience with *Ostrea angasi* husbandry, marine construction and ongoing monitoring for our developing reefs.

Whilst the restoration method applied is based on the US approach, the science has been tailored to local conditions and further experimentation is being built into future works. The Port Phillip Bay Shellfish Reef Restoration Project is now moving towards a 20-hectare proposal based on the results of earlier stages. The experience gained and lessons learnt from implementing this project continues to unfold, and will be valuable information to other practitioners embarking on a similar undertaking.



11:00am

Bringing Oyster Reefs Back to Oyster Harbour

Peter Cook (University of Western Australia) Bryn Warnock (University of Western Australia) and Chris Gillies (The Nature Conservancy)

The benthic habitat of Oyster Harbor once supported extensive beds of the native flat oyster (*Ostrea angasi*), abundant enough for the first European explorer, Captain George Vancouver in 1791 to give it its name. The oysters became a precious commodity during the mid to late 1800s, supporting a vibrant commercial fishing industry for over 20 years. Unfortunately, the oyster reefs were unsustainably harvested, causing a collapse in the oyster fishing industry and loss of shellfish reef habitat. Catchment modifications, increased sedimentation and disease are likely to have further exacerbated the loss of habitat.

In 2015 The Nature Conservancy (TNC) approached UWA with a plan to bring native flat oysters back to Oyster Harbour. While oyster reef restoration projects have been undertaken overseas, and in other parts of Australia, they are new to Western Australia. Funding for the project was provided both by TNC and by Recfishwest. The restoration of Oyster Harbour's oyster reefs will compliment current catchment management activities which are helping to alleviate sedimentation and pollution issues for the harbour. It is hoped that this dual approach, of improving water quality and bringing back habitat, will increase oyster population numbers and, by proving new productive reefs, will improve recreational fishing opportunities.

The first year of the restoration project focused on trialling different methods to spawn and settle oysters onto different types of substrate, and on investigating different methods to deploy settled oysters onto experimental artificial reefs in the harbour. Approximately 40,000 juvenile oysters were spawned in the Ocean Foods International (OFI) hatchery in Albany during December 2015 from brood stock collected from Oyster Harbour. These oysters were seeded onto a variety of cultch types, with various mean densities per cultch. After 4 weeks in the hatchery, the average density per clutch shell was estimated, and abalone shells were found to be the best substrate, supporting an average of over 70 settled oysters per shell. From February 2016, these oysters were moved out onto long lines in Oyster Harbour and then, subsequently, deployed onto the rock reefs.

Overall, the initial trials were very successful and will now become the basis of the method that will be used moving forward to produce more oysters and bigger reefs. Recent monitoring of oysters settled onto clutch and placed on the reefs has demonstrated a good survival rate and, by about a year after deployment, the largest oysters had reached about 7cm shell length. The hatchery also produced single seed juvenile oysters that have been deployed onto aquaculture leases until they are large enough to be placed onto the reefs.

Because of potential problems caused by oyster diseases, the project will also attempt to identify any diseases (particularly Bonamia) that occur in the small, existing populations of oysters in the harbour (and in nearby locations), in the hatchery-produced stock, and in the oysters that have been deployed onto the reefs after specified periods of time.

11:15am

Oyster restoration in urbanised estuaries

Victoria Cole (University of Sydney), Jason Ruszcyzk (Northern Beaches Council), Peter Scanes (NSW OEH), Alistair Becker (NSW DPI Fisheries), Wayne O'Connor (NSW DPI Fisheries), Matthew Taylor (NSW DPI Fisheries), Laura Parker (University of Sydney), Alyce Stiff (Western Sydney University) and Pauline Ross (University of Sydney)

Oyster reef restoration has been proposed as a solution for improving water quality and enhancing biodiversity in degraded coastal waterways. Although restoration has been successful in many parts of the world, ecological patterns and processes are contingent on their location such that the outcome in Australian systems is unclear. In two separate experiments we tested the plausibility of oyster reef restoration using native oysters in heavily modified intermittently open and closed lakes and lagoons (ICOLLs) in NSW. In the first experiment, Sydney rock oysters, *Saccostrea glomerata*, were deployed at six randomly chosen sites within three urbanised estuaries of similar size. The survival, growth, filtration rates, and nutrient flux of *S. glomerata* were determined soon after deployment and three months later. There was clear enhancement of sessile epibiota and infauna, but larger scale reefs may be needed to detect impacts on fish. In the second experiment, we are testing the effectiveness of using "oyster castles" in enhancing biodiversity, and determining the best type of oysters (i.e. climate proof *S. glomerata*, laboratory reared *S. glomerata*, wild-type *S. glomerata*, and the flat oyster *Ostrea angasi*) for restoration in systems of poor water-quality. Early results indicate survival of all types of oysters and attraction of fishes.

11:30am

Historical baselines for shellfish reefs, from 100 million years ago to present

Dr Heidi Alleway (Primary Industries and Regions South Australia), Prof Sean Connell (University of Adelaide)

Efforts to rebuild shellfish reefs are gaining pace worldwide, based on the knowledge that these habitats make an important contribution to ecosystem services and have been widely impacted by human activities. Historical baselines can provide evidence of human impacts, and contribute to a picture of a 'reference' or target for restoration by illustrating the likely past distribution, density and function of shellfish reefs at local or regional scales. Historical baselines that focus only on human history can, however, overlook other important drivers of change, such as climate change or natural variation in bottom-up processes, and incomplete baselines can lead to the significance of any change being under or overestimated. To extend the available baseline for shellfish reefs further into the past we traced the history of key reef building shellfish genera (*Ostrea* spp., *Saccostrea spp*., *Crassostrea* spp., *Pinctada* spp., *Mytilus* spp., and *Pinna* spp.) back to the Triassic, Permian and Carboniferous, finding a geological history that rivals if not surpasses that of coral reefs. Geological expressions of shellfish reefs from 50 to 100 mya showed clear similarities to our current expectations for shellfish reefs, e.g. complex multi-dimensional structure, generation of biodiversity, and environmental settings. These expressions could be an important and as yet unused source of reference for restoration, particularly in areas where shellfish reefs have been lost and little knowledge of their ecological characteristics remain. For restoration, as well as conservation, accurate historical baselines are needed to guide management and investment. We demonstrate how palaeoecological data could be key in building better baselines, and assist us to resolve questions around extinction risk, conservation priorities, and the setting of local and global targets for restoration.

11:45am

Past Aboriginal exploitation of Tasmanian's marine fisheries: using historical baseline data to track and explain change in shellfish/crustacean distribution over the last 8,000 years.

Richard Cosgrove (La Trobe University) and Jillian Garvey (La Trobe University)

Archaeology and, in particular zooarchaeology (the study of animals remains from archaeological sites), is a valuable tool in conservation biology. It is especially relevant in predicting how animals respond to environmental and anthropogenic impacts since the recovered data can cover tens of thousands of years, intersecting at significant points in global climate and/or past human exploitation patterns. This temporal reach has significant predictive value for estimating the influence of climate changes and human exploitation on fauna in the context of modern marine fisheries. Although it is recognized that the zooarchaeological record is a product of anthropogenic filtering, it also reflects the natural productivity of the environment at the time of accumulation. Thus, it provides a temporal framework within which to analyze the underlying causes of fluctuations in marine species. Tasmania has a wealth of evidence of human exploitation of marine resources over the past 8,000 years found in shell middens and an excellent palaeoecological record with which to compare. Archaeological research has shown dramatic changes in the frequency and species exploited over this time frame. Social, economic and environmental forces have been used to explain these differences in both freshwater and marine ecosystems. The main species that dominate the archaeological record and, are of interest to contemporary fisheries conservation are the abalone, native and introduced oyster, and the southern rock lobster. Other marine species that were also exploited by Tasmanian Aborigines include the limpet, turbo, mussel and seal species. This presentation will outline the current state of knowledge of midden distribution, their composition and explanations for shifts in species distributions.

12:00pm

Restoring a lost ecosystem: citizen scientists helping restore what they did not know existed!

Kade Mills (Victorian National Parks Association) and Simon Branigan (The Nature Conservancy)

Research has shown that Port Phillip Bay has lost an estimated 90% of its shellfish reefs and globally shellfish reefs are the most threatened marine habitat on earth. In Port Phillip Bay shellfish restoration work is being undertaken by multiple organisations to reverse this trend. Yet, the people who live in Melbourne and dive in Port Phillip Bay have no idea of the role shellfish reefs have played in the city's history and the positive outcomes of restoring this "lost" habitat.

It was recognised early in the shellfish restoration project's creation that to be successful in the long term, the community needed to be involved. To achieve this Victorian National Parks Association's long running ReefWatch program in collaboration with The Nature Conservancy brought together community groups around Port Phillip Bay to develop a long-term citizen science monitoring program to collect data on the recruitment dynamics of oysters and

mussels around Port Phillip Bay. Not only does this engage the community it provides them with a way to make an authentic scientific contribution to the restoration program.

This presentation will outline the way citizen scientists have been engaged to understand what has been lost and then, how they were empowered to build a body of knowledge on the recruitment dynamics of native oysters and mussels in Port Phillip Bay. It will also outline the ongoing scientific review process for the project.

12:15pm

Maximising the benefits of oyster reef restoration for finfish and their fisheries

Ben L. Gilby, Andrew D. Olds, Charles H. Peterson, Rod M. Connolly, Christine M. Voss, Melanie J. Bishop, Michael Elliott, Jonathan H. Grabowski, Nicholas L. Ortodossi, and Thomas A. Schlacher

Global declines in oyster reefs have resulted in decreased habitat heterogeneity, extent, and quality for some coastal finfish, potentially reducing fish populations and catches. It is well established that habitat restoration results in higher finfish biomass and diversity where oyster reefs replace bare substrates. In this presentation, we offer an approach for projects seeking to restore both oyster reef habitat and finfish communities. Structurally and biologically complex oyster-reefs, comprised of both oysters and other invertebrates, are required to provide shelter, food and nursery services to fish. By carefully considering site selection at seascape scales (kilometres to 10s of kilometres), restoration can enhance the network of habitat available to fish, and potentially increase the overall carrying capacity of the estuary. We support this by demonstrating that landscape context is poorly considered for all kinds of restoration globally across marine, freshwater and terrestrial realms. Managers of estuaries that now include restored oyster reefs should implement fisheries management plans and consider the effects of management actions broadly throughout catchments; failing to do so may jeopardise gains in fish biomass from previous habitat restoration. Importantly, management decisions must be adaptable, responding to key criteria in thorough monitoring programs. We conclude by presenting some preliminary data on fish assemblages around restored reefs in Noosa, Australia, that use some of these concepts.

Wednesday, 21 February – Research and Development

1:30pm

Oyster reefs as fish habitat in NSW

Francisco Martinez-Baena (Department of Biological Sciences – Macquarie University); Ian McLeod (TropWATER – James Cook University); Matthew Taylor (NSW Department of Primary Industries – Fisheries | Port Stephens Fisheries Institute); Melanie Bishop (Department of Biological Sciences – Macquarie University)

Estuarine systems are characterized by their spatial heterogeneity. They comprise a mosaic of biogenic and abiogenic habitat patches, that provide food and habitat to fish and invertebrates, many of which display tidal, diurnal, seasonal and/or ontogenetic migrations among habitats. Oyster reefs were once an important component of temperate estuarine seascapes, but historic overharvest for food and lime has rendered them functionally extinct across much of their former range. In southeastern Australia, little is known about the role oyster reefs played in underpinning fisheries productivity. As interest in oyster reef restoration grows, there is need to understand the communities of fish associated with oyster habitats across a range of habitat contexts, and how these communities compare to those of other estuarine habitats or oyster farms, which provide filter-feeder biomass and habitat structure. Remote underwater video sampling in two New South Wales estuaries compared fish communities between remnant oyster reefs and: (1) oyster habitat fringing mangroves or attached to rocky shores; (2) adjacent mangroves, seagrass beds and bare sediment; and (3) oyster farms. In ascertaining the role of remnant oyster reef in supporting fish habitat, and how this varies with habitat context, this research will assist in building a business case for oyster reef restoration and identify scenarios in which oyster reef restoration will yield greatest benefit.

1:45pm

Would ocean acidification affect the defence strategy of *Saccostrea cucullata*?

Camilla Campanati, Gray A. Williams, Vengatesen Thiyagarajan (The Swire Institute of Marine Science and School of Biological Sciences, The University of Hong Kong, Hong Kong SAR, China)

Projected future ocean acidification (OA) has proved to threaten shellfish persistence in costal waters. Impaired calcification and increased mineral dissolution could cause benthic calcifiers to become more vulnerable preys under future scenarios. The rock oyster *Saccostrea cucullata*, which is a foundation species in the intertidal rocky shores of the Indo-pacific, bears shells with hyote spines. These structures, besides creating suitable microhabitats to several intertidal organisms, were suggested to be deterrent traits against boring predators. Spines production among different oyster size classes, tidal heights and predator abundance were first investigated in the field. Results suggest that smaller individuals, with greater proportion of growth squamae, bear more spines. Though independently of size, the highest percentages of spiny oysters occurred in the mid-shore, possibly related to oyster density and/or predation pressures. Acidified intertidal microcosms were then used to assess whether *S. cucullata* juveniles develop any defence strategy inducible by the presence/absence of predators (i.e. the oyster drill, *Reishia clavigera*) and whether this plasticity could be affected by low pH/OA. Juvenile oysters were exposed for two months to one of three different seawater pH (control 8.1 vs. 7.7 and 7.3), in experimental tanks with or without the predatory snails. Oysters' survival, growth rate and overall metabolism were monitored during the acclimation period and at the end of the experiment spines calcification density was assessed. In order to investigate stress on the predators, whelks physiology and drilling behaviour were inspected throughout the experimental period. Snail radulae samples were also observed at the scanning electron microscope (SEM) to inspect malformations. In this study, a natural environmental component, such as the tidal cycle, often neglected in experimental studies, was included. By exploring the indirect effect of a predator-prey association, the results aim at highlighting potential alteration in this interaction under future acidification conditions.

2:00pm

Assessing the biological feasibilities of oyster restoration in Hong Kong

Sally C.Y. Lau (Swire Institute of Marine Science, The University of Hong Kong), Marine Thomas (The Nature Conservancy), Boze Hancock (The Nature Conservancy), Jun Cheng (The Nature Conservancy), Bayden D. Russell (Swire Institute of Marine Science, The University of Hong Kong)

One of the greatest challenges in restoring oyster reefs is a lack of knowledge about the biological viability of historically over-exploited populations. Therefore, assessing baseline oyster ecology in Asia is fundamental for understanding the challenges and potential when setting regional restoration goals. Hong Kong (HK) is home to 10 Ostreidae species which naturally form reef habitat, all of which are currently threatened by over-exploitation and/or habitat degradation. By investigating the ecology of reef-building Ostreidae species in HK, this study aims to understand the feasibilities of local oyster restoration. To achieve this aim, oyster habitat mapping, population structure and larval recruitment surveys were conducted at 10 intertidal areas spanning HK's waters during spring – autumn 2017. We found that *Crassostrea* sp. are the key reef-building oysters in HK, with the average shell length below landing size (mean $\pm$ SD: 39.6 $\pm$ 11.5 mm) and overall abundance between 1.1 and 82.3 ind. m^{-2} across sites. Larval recruitment peaked in May with maximum settlement density varying from 24.7 to 163,355.0 ind. m^{-2} among sites. The average filtration rate of the two major species, *C. hongkongensis* and *C. bilineata* at landing size (60 – 70 mm) was 24.29 and 17.49 l h^{-1}, respectively, at summer temperatures (30 °C). While oysters in HK are subjected to over-exploitation, our results suggest that populations appear to have recruitment levels with apparent restoration potential. Given the high filtration rates, HK oysters could be useful in servicing local ecosystem restoration and remediation.

2:15pm

Quantifying the Water Quality, Benthic Macrofaunal Community, Nitrogen and Phosphorus Assimilation, and Fisheries Benefits of Oyster Aquaculture in the Chesapeake Bay (USA): Implications for Restoration and Science Communication

Andy Lacatell (The Nature Conservancy), Lisa Kellogg (Virginia Institute of Marine Science)

This presentation will describe a two-year research project focused on measuring the ecosystem services provided by four oyster aquaculture growers in the Virginia portion of the Chesapeake Bay. The Nature Conservancy, in partnership with the Virginia Institute of Marine Science (VIMS) and four oyster aquaculture growers, is conducting research into the assimilative, habitat and fisheries benefits of on-bottom and floating cages. For each gear type, we will: 1) quantify both the degree and spatial extent of the benefits and impacts of oyster aquaculture on water quality parameters including chlorophyll concentrations, total suspended solid

concentrations, dissolved nitrogen concentrations, light penetration and hydrodynamic patterns; 2) quantify both the degree and spatial extent of the benefits and impacts of oyster aquaculture on sediment quality parameters including organic content, grain size and percent moisture; 3) quantify benefits and impacts of aquaculture on benthic macrofaunal community structure in relation to an adjacent reference site; 4) quantify the amount nitrogen and phosphorus removed by the harvest of aquacultured oysters; and 5) compare utilization of aquaculture gear by mobile organisms to nearby unstructured habitats. Preliminary results will be presented. Additionally, there will be a discussion of efforts to communicate the science around this project to the public and important stakeholders. An accompanying video can be viewed at: **youtube.com/watch?v=CUWePUvBGBE**.

2:30pm

Valuing Australia's oyster reefs

Ian McLeod (James Cook University), Chris Gillies (The Nature Conservancy)

Estimates of the value of habitats can provide an objective basis for the prioritisation of conservation and restoration actions. Bivalve habitats, three-dimensional structures made of high-densities of bivales (most often oysters or mussels), their shells and other organisms, used to be a dominant habitat found in temperate and subtropical coastal waters. These habitats provide a suite of ecosystem services such as habitat provision and food supply for many species, substrate stabilisation and shoreline protection, and water quality improvements through their filter feeding. Bivalve habitat restoration is increasingly seen as an opportunity to return lost ecosystem services. In Australia, there is growing interest in bivalve habitat restoration, but there is a knowledge gap in regards to the services they provide. Here, we estimated the habitat value and the amount of seston and nutrients removed from the water column by a historically dominant oyster species in Australia, *Saccostrea glomerata*. At remnant soft-sediment oyster reefs at four locations we estimated density, biomass, productivity and composition of mobile macroinvertebrate communities and compared these with adjacent 'bare' soft sediments, which typically replace ecologically extinct oyster reefs. The oyster reefs had a distinct assemblage of macroinvertebrates, with 30% higher densities, 5 times the biomass and almost 5 times the productivity of adjacent bare sediments. Infauna macroinvertebrate productivity was more than twice as high below oyster reefs, suggesting these reefs facilitate infaunal productivity. Crustaceans, an important food source for small fishes, were 13 times more productive on oyster reefs compared to adjacent bare sediments. Oysters removed large amounts of seston and nutrients from the water column. These results demonstrate that oyster reefs provide an important habitat for macroinvertebrates and that restoration efforts are likely to provide significant returns in enhanced productivity and water quality.

2:45pm

The efficacy of suspended broodstock cages as a restoration strategy for the European flat oyster *Ostrea edulis* Linnaeus, 1758: A case study in the Solent, UK

Luke Helmer (University of Portsmouth), Ian Hendy (University of Portsmouth), Paul Farrell (University of Portsmouth) and Joanne Preston (University of Portsmouth)

As with population declines of most oyster species, that of the European flat oyster, *Ostrea edulis*, has occurred due to a continued and combined attrition of multiple detrimental influences. For this reason a multifaceted approach to restoration projects is required to address and counteract these causes. This study, as part of a larger restoration project, aims to address issues surrounding larval supply and recruitment by trialling a novel system of broodstock cages suspended beneath existing pontoon structures. By using and modifying marina environments the limitations surrounding the access to, and funding of, vessel hire and dive time are removed. High and low density cages containing broodstock oysters from the same source location were deployed at six locations across the Solent (Hampshire, UK). Populations were monitored on a monthly basis with mean mortality across all sites remaining extremely low (< 6 %) during May and June 2017. During this period a peak in spawning activity was recorded, following which an increase in mortality to 21.2 % in July was observed. Subsequent months saw progressive reductions in mortality suggesting that this peak in mortality was associated with post-spawning stress which would occur naturally. Microgeographic variations in mortality between all locations are likely to be attributed to the environmental conditions. Mean survival for this six month study was extremely high, 87.3 %, demonstrating that suspended broodstock cages are a viable means of larval output in recruitment or spat limited areas. In addition to this, the cage structures function as artificial reefs, increasing fish abundance and species diversity. The finding of protected, critically endangered and commercially important species further highlights the need for oyster restoration on a global scale.

3:15pm

Oysters of Hong Kong – ecology, distribution and cultural aspects

Marine Thomas (The Nature Conservancy), Sally CY Lau (Swire Institute of Marine Science, The University of Hong Kong), Jun Cheng (The Nature Conservancy), Bayden D. Russell (Swire Institute of Marine Science, The University of Hong Kong) Boze Hancock (The Nature Conservancy)

Located in subtropical southeast China, Hong Kong is home to diverse marine habitats with high biodiversity. However, population growth and over a century of rapid coastal development have led to the destruction of Hong Kong's natural shorelines with severe impacts on its marine environment. Amongst the declining coastal habitats, oyster reefs are largely overlooked as being a habitat of conservation importance. Even with the deep cultural significance of oysters in Hong Kong, with a continuous aquaculture industry for over 700 years, little information is available on their past and present abundance or distribution. Therefore, we reviewed historical charts, existing literature, and conducted site verification to build baseline knowledge on oyster habitats in Hong Kong, potential implementation of restoration, and reformation of the local oyster aquaculture industry. Although a preliminary study building up towards in-depth research on oyster habitats in Hong Kong, we have now developed a baseline from which to understand current ecological, economic and cultural values for oysters in Hong Kong, as well as estimate ecosystem service benefits that could be gained from potential restoration.

3:30pm

Australian shellfish ecosystems: past distribution, current status and future direction

Chris L Gillies (The Nature Conservancy), Ian M McLeod (TropWATER), Heidi K Alleway (Primary Industries and Regions, South Australia), Peter Cook (University of Western Australia), Christine Crawford (University of Tasmania), Colin Creighton (TropWATER), Ben Diggles (DigsFish), John Ford (University of Melbourne), Paul Hamer (Victorian Fisheries Authority), Gideon Heller-Wagner (TropWater), Emma Lebrault (Fisheries NSW) Agnès Le Port (TropWATER) Kylie Russell (Fisheries NSW), Marcus Sheaves (TropWATER) and Bryn Warnock (University of Western Australia)

We review the status of marine shellfish ecosystems formed primarily by bivalves in Australia, including: identifying ecosystem-forming species, assessing their historical and current extent, causes for decline and past and present management. Fourteen species of bivalves were identified as developing complex, three-dimensional reef or bed ecosystems in intertidal and subtidal areas across tropical, subtropical and temperate Australia. A dramatic decline in the extent and condition of Australia's two most common shellfish ecosystems, developed by *Saccostrea glomerata* and *Ostrea angasi* oysters, occurred during the mid-1800s to early 1900s in concurrence with extensive harvesting for food and lime production, ecosystem modification, disease outbreaks and a decline in water quality. Out of 118 historical locations containing *O. angasi*-developed ecosystems, only one location still contains the ecosystem whilst only six locations are known to still contain *S. glomerata*-developed ecosystems out of 60 historical locations. Ecosystems developed by the introduced oyster *Crasostrea gigas* are likely to be increasing in extent, whilst data on the remaining 11 ecosystem-forming species are limited, preventing a detailed assessment of their current ecosystem-forming status. Our analysis identifies that current knowledge on extent, physical characteristics, biodiversity and ecosystem services of Australian shellfish ecosystems is extremely limited. Despite the limited information on shellfish ecosystems, a number of restoration projects have recently been initiated across Australia and we propose a number of existing government policies and conservation mechanisms, if enacted, would readily serve to support the future conservation and recovery of Australia's shellfish ecosystems.

3:45pm

The expanding network of native oyster habitat restoration in Europe

Philine zu Ermgassen (University of Edinburgh/ENORI), Karel van den Wijngaard (ARK), Bill Sanderson (Heriot-Watt University) Boze Hancock (The Nature Conservancy)

The habitat formed by the European oyster, *Ostrea edulis*, has been identified as a conservation priority across many jurisdictions in Europe. There are now concerted efforts to actively restore this threatened habitat throughout its European range. In this presentation we provide an overview of the restoration activities taking place in the Dutch Waddensea, the Essex coast (England), Milford Haven (Wales), and Dornoch Firth (Scotland). These projects include efforts which are driven solely by biodiversity conservation (ARK WWF in the Netherlands), by conservation-fishery partnerships (Essex Native Oyster Restoration Initiative [ENORI], Milford Haven), and by industry-conservation partnerships (Dornoch Environmental Enhancement Project [DEEP], a partnership between the Glenmorangie Whiskey Company, Heriot-Watt University and the Marine Conservation Society). The motivation to restore, the restoration activities undertaken and the future restation plans are outlined in each case. We will also introduce briefly the important and growing roles of the European Native

Oyster Restoration Alliance (NORA) and the UK Native Oyster Restoration Network in exchanging knowledge to promote successful O. edulis restoration.

4:00pm

Historical distribution and current conditions of oyster habitats in China

Qing Liu (The Nature Conservancy), Boze Hancock (The Nature Conservancy), Jun Cheng (The Nature Conservancy), Yue Wang (The Nature Conservancy)

While China has more than 1000-year history of oyster aquaculture, and is the largest oyster aquaculture region in the world in present time, there has been little attention focused on oyster reefs. To understand the historic and current extent of natural oyster reefs in China, we compiled historical distribution and current conditions of China oyster habitats by reviewing published literature.

Historically, oyster reefs in China predominantly distributed in five regions: Dashentang in Tianjin (Bohai Bay), Xiaomiaohong in Jiangsu province, Laizhou Bay in Shandong province, Jinmen in Fujian province and Maoweihai in Guangxi province. There are five main oyster species and the dominant oyster species varies depending on the location. North of the Yangtze River estuary, *Crassostrea gigas* and *C. ariakensis* dominate the oyster habitats; whereas in areas south of the Yangtze River estuary, the dominant species are *C. hongkongensis*, *C. angulata* and *C. sikamea*. For areas near the Yangtze River estuary, *C. sikamea* and *C. ariakensis* are the dominant species.

Our search found a few literatures on oyster reef conditions in China. Two oyster reefs, Dashentang (subtidal) and Xiaomiaohong (intertidal) are the most studied. Evidence indicates that they are the only known naturally occurring oyster reefs in China that are currently existing, with a total area of 0.8km2. Studies showed that both oyster reefs have undergone severe declines, with a loss of 80% in both locations in the past decade. The major factors leading to these declines included overfishing, water pollution and sedimentation caused by coastal development (e.g. land reclamation and dredging).

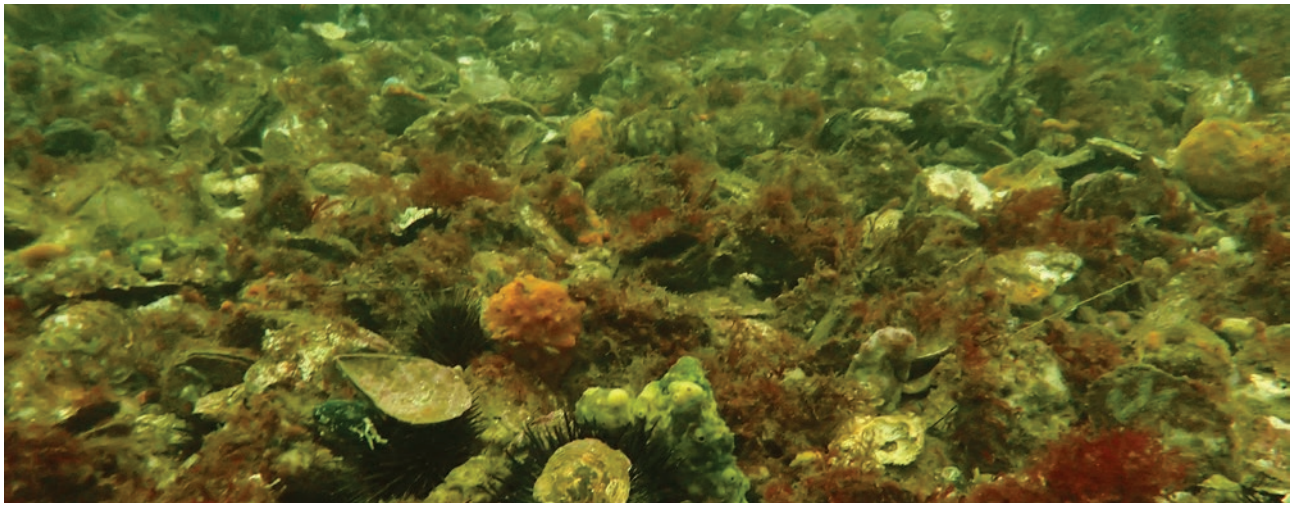
This literature review reveals the critical conditions of oyster reefs in China and identifies knowledge gaps. More importantly, this is the first step in effort to plan oyster reef restoration in this region.4:15 PM

4:15pm

Shellfish restoration NZ

Peter van Kampen (Revive our Gulf)

This presentation provides an overview of shellfish restoration activities throughout Aotearoa – New Zealand focusing on the mussel restoration efforts in the Hauraki Gulf. The seafloor of the Hauraki Gulf was once abundant with green-lipped mussels Perna canaliculus, these mussels supported a dredge fishery from early 1900's through to the 1960's when the fishery collapsed. Since 2011 there have been five restoration projects which have a greater goal of restoring subtidal mussel reefs to the seafloor of the Hauraki Gulf. What have we learned from these projects? What works? What doesn't? What are the constraints? Where to from here?



Wednesday, 21 February – Closing Keynote

4:30pm

Is my receiving an Order of Australia for services to coastal Australia enough?

Colin Creighton (TropWATER)

The short answers and key words are:

- NO, its not enough!
- Productivity
- Profitability
- Teams
- Smart Strategic Investment
- Win-win and more wins

This paper outlines briefly how we have probably reached the null point in estuary and nearshore productivity. Our goal is to seek a new and much elevated baseline for ecological productivity and with it enhanced profitability for all sectors of coastal Australia.

Building on the proceedings of the Conference this paper concludes by summarising some of the key elements of "what's next".

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