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Australasian Mangrove & Saltmarsh Network Conference '26
WOLLONGONG, 24 – 27 Nov

Day 1 – Tuesday November 24th



Looking south over Wollongong from Brokers Nose on the Illawarra Escarpment. The Wollongong CBD and Port Kembla line the coast, with the Five Islands offshore. Mt Keira rises on the right, and Lake Illawarra is visible in the distance.



Keynote – Nathan Thomas

A Golden Age of Earth Observation: Is this long overdue promise about to become true?

N. Thomas[1]

[1]Edge Hill University, Ormskirk, UK

We have repeatedly been told that we are in a "Golden Age of Earth Observation" that will overcome long-standing challenges, improve our understanding of the natural world and do away with the need for expensive and time-consuming field visits. So why do we have more questions than we started with and how have we come to realise that field specialists are more important than ever? This keynote will present the origins of Earth Observation for coastal ecosystems, including the technologies that pioneered the science, the established workhorses that delivered invaluable datasets and the unfortunate accidents and mishaps that happened along the way. We will see how a succession of consistent missions has allowed us to gain decadal knowledge on ecosystem extent and change and how these have reenforced, rather than diminished, our reliance on critical field measurements. Today, data captured at a rate that almost exceeds our demand brings both opportunities and challenges, particularly as 2026 delivered a series of exciting but long-awaited and overdue missions. New abilities to directly measure sub-canopy changes in water level, understory volume and canopy height from over 500 km from Earth unveil new insights, but bring with them new technical difficulties. We demonstrate the power of collaboration to overcome this and provide a sneak peek at brand new trends in regional mangrove biomass estimates derived from spaceborne measurements. Importantly, we will also look to the future where we are building cloud infrastructure capable of meeting our appetite for data and eagerly look forward to the next generation of futuristic technologies. More so than ever, Earth Observation is positioned to help us assess and build wetland resilience, empower a global community of connected team players and look forward to an exciting and hopeful future as we ask ourselves if we have finally reached our golden age of Earth Observation.

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Session 1 · Blue carbon — coastal wetland processes

Session Chair: Madeline Goddard

Blue Carbon Stocks in Aotearoa New Zealand's Coastal Wetlands and Prospects under Rising Sea Levels

A. Swales[1], I. Zabarte-Maeztu[1], P.J. Stewart-Sinclair[2], K.J. Buffington[3], J. Carr[4], G.R. Guntenspergen[4], K.W. Krauss[5], G. Reeve[1], I. Hamling[6], C.E. Lovelock[7]

[1]Earth Sciences New Zealand, Hamilton Campus, Waikato, NZ
[2]Earth and Environmental Sciences, James Cook University, Townsville, QLD, Australia
[3]Western Ecological Research Centre, U.S. Geological Survey, Davis, CA, USA
[4]Eastern Ecological Research Centre, U.S. Geological Survey, Laurel, MD USA
[5]Louisiana Universities Marine Consortium (LUMCON), Chauvin, LA, USA
[6]Earth Sciences New Zealand, Avalon Campus, Wellington, NZ
[7]School of Biological Sciences, The University of Queensland, Brisbane, QLD, Australia

Interest in coastal wetland's capacity to sequester atmospheric carbon (i.e., coastal blue carbon), for climate-warming mitigation and habitat restoration has grown in recent decades. Blue-carbon ecosystems in New Zealand include seagrass, mangrove, saltmarsh and supratidal-forests. NZ blue-carbon research has been initiated in just the last decade. Coastal wetlands are constrained to the intertidal zone, due to their physiological tolerances to hydroperiod. In many estuaries, coastal squeeze or narrowing (e.g., infrastructure, topography) impedes upslope migration with sea level rise (SLR). Consequently, coastal wetlands, and their ecosystem functions, are vulnerable because they must keep pace with SLR, by building substrate elevation via mineral and organic sedimentation. Lowland salinisation and wetland migration are already apparent. Measurements and modelling of coastal wetlands are being conducted in the Future Coasts Aotearoa programme, across a range of environmental conditions (i.e., sediment supply, SLR, climate) in intertidal–supratidal habitats.

We seek to determine how these coastal wetlands will evolve with SLR over coming decades, inform adaption and restoration, and quantify carbon stocks. Findings to date highlight the relative youth of blue carbon stocks and large differences between habitats. Sediment C stock (top 1-m) in supratidal forests (80–245 MgC ha^{-1}) are

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substantially higher than for saltmarsh and mangrove (40–100 MgC ha^{-1}). Geochronology indicates that 20–80% of this C stock has accumulated in just the last century, representing < 2% of the sedimentary record sampled. Mean accumulation rates varied with ^{210}Pb-record length, largely driven by sedimentation rate, ranging from 2–5 MgC ha^{-1} yr^{-1} (20–70-yr mangrove), 1–1.5 MgC ha^{-1} yr^{-1} (supratidal forest) to ≤ 0.5 MgC ha^{-1} yr^{-1} (saltmarsh, mangrove) over 100+ yr. These results suggest that these wetlands largely sequestered carbon in their youth. Longer timescales also integrate a wider range of conditions that influence accumulation and preservation of blue-carbon stocks.



Balancing Carbon Storage and Biodiversity in Developing Restoration Scenarios for a Degraded Coastal Wetland in Adelaide

B.M. Conroy[1], K. Beaumont[2], S.K. Russell[3], E. Judge[1], B. Thomas[4], A. Sforza[4], A.R. Jones[1]

[1]School of Biological Sciences and Environment Institute, Adelaide University, Adelaide, Australia
[2]College of Science and Engineering, Flinders University, Adelaide, Australia
[3]Department for Environment and Water, Government of South Australia, Adelaide, Australia
[4]School of Biological Sciences and Acid Sulfate Soil Centre, Adelaide University, Adelaide, Australia

Many coastal wetlands have been degraded by historical modifications to tidal regimes to reclaim and develop low-lying coastal landscapes, including bund wall and tide gate construction. With growing recognition of the carbon storage and biodiversity benefits of healthy blue carbon ecosystems, and threat of sea-level rise, coastal managers are considering restoration options for wetlands (e.g., tidal reintroduction). Effective restoration requires an understanding of both baseline conditions in degraded/restorable wetlands and the relationships between carbon storage and biodiversity across natural tidal gradients. This study aimed to: (1) quantify baseline carbon stocks and biodiversity (vegetation and invertebrates) at the degraded Magazine Basin wetland, Port Adelaide (SA); (2) compare these values with those along a natural mangrove-saltmarsh gradient at nearby Torrens Island; and (3) develop management scenarios for Magazine Basin using information gained in objectives 1 and 2, airborne LiDAR-derived digital elevation models, and water-level data, and stakeholder input from natural resource managers, landowners and community groups. Above- and below-ground carbon stocks (to 50cm depth) were lower across ecosystem types (e.g., saltmarsh, invasive grassland) at the degraded wetland than at Torrens Island where variation was driven by vegetation composition and structure and tidal position. While tidal reintroduction could increase carbon storage at Magazine Basin, recent subsidence associated with mangrove loss, conversion to saltmarsh and grassland, loss of below-ground organic matter and acid sulfate soils, has lowered surface elevations to positions unsuitable for supporting intertidal wetlands (i.e., below mean sea level) under full tidal reintroduction. Future management must consider a modified, reduced tidal regime informed by ecosystem tidal positions at a nearby reference site (Torrens Island), sea-level rise predictions, and community and landowner priorities; including maintaining shorebird habitat and the site's function as a stormwater retention basin. This study provides a framework for restoring urban wetlands while balancing carbon storage, biodiversity, and stakeholder priorities.

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Vegetation Cover Reduces Coastal Wetland Carbon Greenhouse Gas Fluxes from Heatwave-Driven Sediment Warming

S.D. Sasmito[1], A. Barkley[1], L. Montagna[1], B. O'Breza[1], M.A. Linnas[2], A.K. Mishra[1], C. Duvert[3], R. Mulloy[1], P. Cartwright[1], E. Douglas[4], C.E. Lovelock[5], N.J. Waltham[2]

[1]Centre for Tropical Water and Aquatic Ecosystems Research (TropWATER), James Cook University, Townsville, Australia
[2]College of Science and Engineering, James Cook University, Townsville, Australia
[3]Research Institute for the Environment and Livelihoods (RIEL), Charles Darwin University, Darwin, Australia
[4]NIWA, New Zealand
[5]School of the Environment, The University of Queensland, Brisbane, Australia

Atmospheric heatwaves are increasing in frequency, intensity and duration under anthropogenic climate change, yet their effects on greenhouse gas (GHG) fluxes from coastal wetland ecosystems remain poorly understood. Coastal wetlands, including saltmarshes and salt flats (also called sabkha or saltpans), are globally significant carbon stores, but their vulnerability to extreme heat events has rarely been tested experimentally. Here we report CO_2 and CH_4 fluxes from a seven-day simulated heatwave experiment conducted across three coastal wetland habitat types in the tropical dry climate region of Australia — unvegetated salt flat, and saltmarsh dominated by *Sarcocornia quinqueflora* and *Sporobolus virginicus*. Heatwave simulation significantly elevated CO_2 efflux in the unvegetated salt flat ($p < 0.05$), accompanied by a significant increase in sediment temperature ($p < 0.05$), while neither vegetated saltmarsh habitat showed a significant heatwave response ($p > 0.05$). CH_4 efflux did not respond significantly to heatwave simulation in any habitats ($p > 0.05$); however, CH_4 efflux in simulated heatwave plots was significantly higher in *S. quinqueflora* than in salt flat and *S. virginicus* habitats ($p < 0.05$), suggesting a habitat or plant species-mediated response to warming. These findings suggest that vegetated coastal wetlands possess an intrinsic thermal resilience that buffers their carbon cycling functions during heatwave events, whereas unvegetated salt flats represent a disproportionate vulnerability hotspot under future climate extremes. Our results have important implications for blue carbon conservation strategies and the management of coastal wetland carbon stocks in a warming world.

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Does Structural Complexity in the Oyster-Pneumatophore Zone of Intertidal Wetlands Enhance Sediment Deposition and Retention?

G. Bendall-Pease[1], T.J. Mason[1]

[1]NSW Department of Climate Change, Energy, the Environment and Water, Sydney, Australia

Both oyster reefs and mangrove roots or trunks are foundational habitat-forming structures that promote biodiversity. In the intertidal mangrove zone, oysters (*Saccostrea glomerata*) and mangrove (*Avicennia marina*) pneumatophore roots provide hard substrates in an otherwise soft-sediment environment. These intertidal environments are vulnerable to accelerated sea-level rise and strategies that increase sedimentation and vertical accretion may enhance their resilience to open water conversion or landward migration. We are investigating, and monitoring, whether oyster-pneumatophore associations increase potential sediment deposition in the seaward mangrove zone at Towra Point Nature Reserve, Gamay (Botany Bay, Australia). Initial terrestrial laser scans of this zone indicated that oysters and pneumatophores were associated with increases in microtopography. We then established a manipulative study to measure potential sedimentation along the foreshore using 1 m x 0.5 m quadrats at approximately 5 m intervals, 2 m landward of the mudflat zone. Pneumatophore density (0 m^{-2}, 300 m^{-2}, 600 m^{-2}) and oyster coverage (0%, 35%, 70%) were manipulated factorially across nine treatment levels. Short-term sedimentation was calculated using sediment traps deployed for ten tidal cycles. Longer-term sedimentation was measured seasonally using sediment pins installed within the quadrats. Preliminary results provided strong evidence that moderate (35%) and high (70%) oyster cover retained more sediment than quadrats without oysters. There was no evidence that pneumatophore density affected sediment deposition, nor an interaction between the independent variables. Sediment trap results indicated that short-term mean sediment deposition rates did not differ significantly across the treatments, although quadrats with increased structural complexity (pneumatophore density and oyster cover) displayed greater variability than expected under a constant variance model. The preliminary findings suggest that higher complexity or rugosity within the oyster-pneumatophore zone facilitates increased sediment trapping and deposition. While further monitoring and trials are required, oyster-pneumatophore associations may enhance elevation gain and mangrove resilience to accelerating sea-level rise.

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Application of Rock-Eval Pyrolysis to Investigate Organic Matter Dynamics in Mangrove Soils

S.L. Robin[1], C. Marchand[1], F. Baudin[2]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

[2]Institut des Sciences de la Terre de Paris (ISTeP, UMR 7193), Sorbonne Université, CNRS, CY Cergy Paris Université, Paris, France

Rock-Eval pyrolysis is an analytical technique initially developed for petroleum exploration that has been adapted for the study of recent sediments. It provides information on the quantity, origin, and transformation of organic matter (OM) by progressively increasing the temperature of a sample and analyzing the gases released during thermal degradation. Although Rock-Eval pyrolysis has been successfully applied to various sedimentary environments, its potential for studying OM dynamics in mangrove soils remains largely unexplored, despite the increasing importance of understanding blue carbon stocks and processes. This study aims to evaluate the ability of Rock-Eval pyrolysis to discriminate OM sources in mangrove soils and to provide information into OM transformation processes, degradation and preservation. The Rock-Eval analyzer used in this study also measures total and organic sulfur contents, providing additional information on soil biogeochemical processes. We investigated mangrove forests in New Caledonia characterized by the same vegetation zonation, with Avicennia marina on the landward side and Rhizophora stylosa on the seaward side. Samples including leaves, roots, surface soils, and soil cores down to 40 cm depth were analyzed from sites with different environmental conditions, including impacted and non-impacted areas, and during two contrasting seasons. Plant tissues displayed distinct Rock-Eval signatures, with clear differences between mangrove species. In soils, environmental conditions strongly influenced OM transformation, with deeper layers containing more refractory OM characterized by higher thermal stability. Rock-Eval indices indicate that OM degradation involves dehydrogenation followed by OM oxygenation processes beneath A. marina, whereas OM oxygenation was not detected beneath R. stylosa, likely due to more reducing conditions. The results suggest that mangrove species may exert a stronger control on OM transformation pathways than site-specific environmental conditions. This study shows the potential of Rock-Eval pyrolysis as a complementary tool for investigating OM dynamics and improving our understanding of mangrove blue carbon processes.

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CO_2 and $\delta^{13}C$-CO_2 Emissions from Carbonated Mangrove Soils: Evidence of Substrate Dissolution

C. Marchand[1], O. Hoane[1], N. Mouras[1], S.L. Robin[1], M. Mathian[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

In mangrove ecosystems, soil CO_2 fluxes are usually low but highly variable depending on many drivers, including soil characteristics, temperature, mangrove tree species, presence of microphytobenthos, length of tidal immersion, etc. If there is an increasing number of studies exploring this topic, very few focus on mangrove forests developing on carbonate substrates. The dissolution of the latter under the influence of organic acids produced during the decomposition of mangrove-derived organic matter may increase CO_2 emissions. In New Caledonia, the atoll of Ouvéa consists of an uplifted paleoreef fringing system from the Quaternary period. Its inherited rocks consist mainly of non-dolomitic and partly aragonitic bioconstructed limestones. In the north of the atoll, a bay hosts mangrove forests mainly composed of *R. apiculata* and *B. gymnorhiza*, which develops directly on the limestone or on carbonate soils. The main objectives of this study were to characterize soil properties beneath the two mangrove species at different development stages and to quantify soil CO_2 and $\delta^{13}C$-CO_2 fluxes at low tide, in order to identify if part of the CO_2 emitted is related to carbonate dissolution rather than mangrove-derived organic matter decomposition. To reach our goals, we collected 50 cm soil cores and measured pH, Eh, salinity, water content, grain size, mineralogical composition and TOC. Soil CO_2 and $\delta^{13}C$-CO_2 emissions were measured using closed incubation chambers connected to a G2131-i CRDS analyzer. A keeling plot approach was used to identify the sources of the CO_2 released from the soils, mangrove-derived organic matter or limestone. Our results show that soil properties and CO_2 emissions differed between mangrove tree species and their development stages. CO_2 fluxes at the air-atmosphere interface ranged from 1.54 to 4.89 mmol m^{-2} h^{-1}, and the keeling plot approach revealed that 20 to 33% of these fluxes derived from carbonate dissolution, confirming our hypothesis.

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Navigating Restoration Objectives: Insights from Malabar Creek

T.A. Tucker[1], A.J. Harrison[1], M. Osborne[2]

[1]Water Research Laboratory, School of Civil and Environmental Engineering, UNSW Sydney, Sydney, Australia
[2]NSW Department of Primary Industries and Regional Development (Fisheries and Forestry), Kempsey, Australia

Coastal floodplains across NSW have undergone extensive modification over the past 200 years. In many instances, coastal wetland habitats have been drained to support dryland agriculture. Restoration of degraded landscapes is more important than ever, especially as impacts such as sea level rise reduces agricultural productivity and society becomes more aware of the natural values of coastal wetlands. Malabar Creek, located on the Moruya River estuary, is an example of a former wetland that has undergone extensive change. The construction of Malabar Weir in the 1930s significantly changed the system's tidal hydrology resulting in impacts to wetland vegetation including saltmarsh, mangroves and seagrass. A detailed assessment of the hydrology at Malabar Creek was completed to identify opportunities to improve its natural values. Acknowledging that the majority of land surrounding Malabar Creek is privately owned, landholder engagement activities were also conducted. The study identified that Malabar Creek already provides significant natural values. The system has adapted to the tidal changes imposed by Malabar Weir resulting in the establishment of important seagrass habitat now protected as a Sanctuary Zone within Batemans Marine Park. On the floodplain, however, progress continues. While activities such as fencing have helped protect wetland habitats, acidic scalds highlight opportunities to modify floodplain infrastructure and further improve natural values. Malabar Creek illustrates the complexities of tidal wetland restoration. Key challenges include balancing agricultural productivity with environmental outcomes, determining the most appropriate habitat to restore, and adapting to climate change and sea level rise. Addressing these challenges needs to occur whilst protecting the existing natural environment. This study identified clear opportunities to restore degraded wetland habitat. Emerging opportunities within natural capital markets or other offset schemes may also incentivise landholders for change. Further, development of site-specific values would enable the adaptive management of Malabar Creek into the future.

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Using Biodegradable Structures for Early Saltmarsh and Mangrove Establishment

S.M. Trevathan-Tackett[1], S. Olsson[1], P. Fidge[1], A. Rendall[2]

[1]Centre for Nature Positive Solutions, Department of Biology, School of Science, RMIT University, Melbourne, Australia

[2]School of Life and Environmental Sciences, Deakin University, VIC, Australia

Active restoration techniques can re-establish coastal wetland vegetation where biogeographic or hydrodynamic barriers prevent natural recruitment. We hypothesised that combining direct seeding and plantings with biodegradable structures would enhance early survival and establishment in saltmarsh and mangrove habitats. We present four years of research from the Regenerating Our Coasts programme in Victoria, testing potato starch-based BESE-Elements and bamboo "Mangrove Mates", which are designed to reduce wave and tidal energy and stabilise near-surface sediments. We compared direct seeding and planting with and without BESE-Elements, while also monitoring natural recruitment.

Transplanting adult *Salicornia quinqueflora* (plants with intact soil core) and planting nursery-grown, 9- to 18-month-old *Avicennia marina* seedlings produced the highest survival and expansion over the first two years, compared to direct-seeding approaches. Saltmarsh and mangrove transplants within BESE-Elements had highly variable survival compared with transplants without the structures, driven by site characteristics and seasonal timing of plantings. Direct seeding in saltmarsh (single-species *Salicornia* and a seven-species mix) showed limited germination in the first 12 months, with evidence that *Salicornia* spp. germinated only after two growing seasons, suggesting seed dormancy or other cues needed for germination. In both habitats, BESE-Elements supported substantially greater cover from natural recruitment than bare plots, indicating microhabitat benefits. Finally, we present very preliminary sedimentation and natural recruitment results of the taller Mangrove Mates structures. In this talk, we will discuss the benefits, limitations and outlooks of biodegradable structures to enhance coastal revegetation.

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Rehabilitating the Blue Heart Wetlands on the Sunshine Coast, Queensland, Australia, to Mitigate the Effects of Climate Change

I.G. Cooray[1], G. Chalmers[1], D. Chittleborough[1,2]

[1]School of Science, Technology and Engineering, University of the Sunshine Coast, Sunshine Coast, Australia
[2]School of Physics, Chemistry and Earth Sciences, University of Adelaide, Adelaide, Australia

Coastal wetland restoration offers a nature-based solution for mitigating the effects of climate change. The Blue Heart project, covering an area of more than 5,000 ha, was initiated by the Sunshine Coast Council, Queensland, Australia with the objective to rehabilitate degraded agricultural lands on the low-lying (<1 m Australian Height Datum) Maroochy River floodplains to coastal wetlands. We deployed a highly precise (1 mm accuracy) network of 24 Rod Surface Elevation Table and Marker Horizon (RSET-MH) stations across coastal wetlands under different stages of development and rehabilitation to measure changes in their surface (sedimentation rates) and subsurface (shallow subsidence, compaction or subsurface expansion). Results showed that sediment accretion supports surface elevation in Coastal Wetlands Under Rehabilitation (CWUR). Radiocarbon dating of sediments from CWUR revealed that converting coastal forested areas such as Melaleuca forests to agriculture in the past caused an elevation deficit of ~0.9 m which now provides accommodation space for incoming sediment. Bayesian stable isotope mixing models determined that suspended particulate matter in tidal water dominates the sources of soil organic carbon (SOC) in CWUR, whereas mature mangroves in the Blue Heart source their SOC mainly from in-situ mangrove vegetation. CWUR had lower SOC stocks than those for mature mangrove wetlands and higher SOC stocks compared to SOC stocks for Australian pasturelands. In addition, SOC fractionation revealed the dominance of organo-mineral associations in soils from Blue Heart wetlands. In conclusion, preliminary findings suggest that CWUR in the Blue Heart can keep pace with current local sea-level rise (2.3 mm $year^{-1}$) by elevating the land surface (4-15 mm $year^{-1}$), except for open-water unvegetated areas (<1 mm $year^{-1}$). Contemporary sediment accumulation in CWUR provide opportunities for carbon farming and generating carbon credits. Organo–mineral associations may help protect SOC from the impacts of climate change, thereby promoting its long-term storage.

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Session 2 · Fire, extreme events and ecosystem responses

Session Chair: Vishnu Prahalad

Mangrove Resilience to a Changing Climate Hindered by Bushfire Impact

A. Green[1], J. Kelleway[1], K. Rogers[1], O. Price[1], C.D. Woodroffe[1], S. Eichmann[2], N. Lenehan[2]

[1]University of Wollongong, Wollongong, Australia
[2]Batemans Marine Park, NSW Department of Primary Industries and Regional Development, Narooma, Australia

The resilience of mangroves to the effects of sea-level rise is heavily reliant on their ability to build and maintain surface elevation. Previous research has shown the importance of root productivity and sediment deposition in driving elevation patterns in mangrove forests. The influence of disturbances on surface elevation adjustment in these ecosystems is still a significant research gap. The 'Black Summer' bushfires of 2019/2020 devastated the east coast of Australia. This included the intertidal zone, where an estimated total of 23ha of mangroves were burnt. No historical records of fire impact have indicated such extensive mangrove disturbance prior to this event. Vegetation, sediment characterisation and surface elevation monitoring approaches have been used to assess post-fire responses of mangrove species *Avicennia marina* on the Clyde River. Post-fire regeneration of trees occurred in the form of epicormic growth and was typically first observed >12 months following fire impact. Of regenerating trees, 58% were producing propagules 5-years post-fire disturbance. Recruitment of new individuals via mangrove propagules showed strong elevation patterns with 80% establishing in the upper half of the mangrove tidal range, but only 3% of propagules establishing in the lower quartile. Hydrodynamic data collected using mini buoys showed a longer 'window of opportunity' for seedling development in the upper portion of the tidal range. Root biomass and volume, 2-years post-fire disturbance, was significantly lower at fire-impacted sites than closely located unburnt sites. Changes in surface elevation and accretion rates were measured using Rod Surface Elevation Table-Marker Horizons with results indicating net subsidence at fire-impacted sites compared with elevation gains at unburnt sites. These findings indicate that fire can negatively impact mangrove vegetation distribution and elevation maintenance processes. Mitigation of fire risks and/or interventions to restore elevation-building processes may be required to combat the compounding effects of climate change on these mangroves.

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A New Deep Learning Framework for Mapping Burnt and Unburnt Coastal Wetlands across New South Wales, Australia

Z. Wang[1], J. Kelleway[1], E. Asbridge[1], O. Price[1], K. Rogers[1,2]

[1]School of Earth, Atmospheric and Life Sciences, University of Wollongong, Wollongong, Australia
[2]School of Geosciences, University of Sydney, Sydney, Australia

The 2019–2020 Black Summer bushfires affected extensive coastal wetlands across New South Wales, challenging the assumption that these tidally inundated ecosystems are relatively resistant to severe fire impacts. A limited number of datasets are available for assessing fire impacts in coastal wetlands: the NSW Government dataset provides mapped burnt and unburnt mangrove and saltmarsh areas, while the Fire Extent and Severity Mapping product (FESM) and the Google Earth Engine Burnt Area Map (GEEBAM) are fire products developed primarily for terrestrial ecosystems. The suitability of FESM and GEEBAM for coastal wetlands remains uncertain. This study evaluates the effectiveness of existing fire products in differentiating bushfire impact and severity, develops an improved approach for classifying burnt and unburnt coastal wetlands, and establishes a framework for mapping future coastal wetland fire risk across New South Wales. Evaluations of the burnt and unburnt mangrove and saltmarsh areas showed considerable agreement between FESM and NSW Government. However, severity thresholds were highly sensitive and produced false-positive classifications. GEEBAM had minor overlap with NSW Government mapping, limiting its suitability for statewide assessment. To improve statewide burnt–unburnt classification, Random Forest, Support Vector Machine, Backpropagation Neural Network and Convolutional Neural Network models were developed using pre- and post-fire Sentinel-2 imagery, spectral change indices and topographic variables. The Backpropagation Neural Network performed best for mangrove wetlands, whereas Random Forest performed best for saltmarsh. Overall, wetland-specific model selection improves classification reliability. The evaluation undertaken in this study is being extended to develop a coastal wetland fire-risk map using variables representing such as fuel conditions, hydrology, topography, historical fire and exposure to adjacent flammable vegetation. This integrated framework is important for understanding coastal wetland vulnerability under interacting pressures from climate change, drought, fire and sea-level rise.

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Mangrove Dynamics in the Gulf of Carpentaria: A Cycle of Dieback, Recovery and Expansion

R.V.S. Gonçalves[1], E. Asbridge[1], J. Kelleway[1], K. Rogers[2]

[1]Environmental Futures, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia

[2]School of Geosciences, Faculty of Science, University of Sydney, Sydney, Australia

Global climate and tidal oscillations act as hydrological modulators of mangrove ecosystems by altering sea level, rainfall, and tidal amplitude. Yet their combined effects on mangrove dieback, recovery, and expansion remain poorly understood. The Gulf of Carpentaria provides an ideal setting to examine these relationships due to its geomorphologically complex coastline with minimal direct anthropogenic disturbance. Here, we used annual Earth-observation records from 1990–2025 and field data to quantify canopy-state transitions among live mangrove, dieback, recovery, and expansion states and test their relationships with the El Niño–Southern Oscillation, Indian Ocean Dipole, and lunar nodal cycle across annual and multi-year periods. Despite recurring episodes of canopy decline, subsequent recovery, and expansion, live mangrove extent increased by 9.4% over the study period. New dieback was associated with reduced tidal range linked to the lunar nodal cycle over three-year periods and with lower sea level and rainfall associated with El Niño conditions. These relationships strengthened when climate and tidal indicators were combined across multi-year windows, indicating that dieback was most strongly associated with compound and persistent low-water conditions. Recovery was associated with increasing tidal amplitude, whereas expansion showed a weaker association with negative Indian Ocean Dipole conditions over three-year periods. These responses indicate that the environmental conditions promoting dieback and recovery are likely different from those supporting mangrove expansion. Overall, this study shows that long-term mangrove persistence depends on resistance to low water, post-disturbance recovery, and suitable intertidal surface available for expansion. On modified coastlines, anthropogenic pressures may increase risk by reducing recovery capacity and restricting landward or seaward expansion as sea level and sediment conditions change. Reframing mangrove vulnerability assessments to include canopy-state transitions and the compound effects of climate and tidal oscillations is critical for supporting global mangrove sustainability.

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Extreme Cyclones Can Leave Lasting Ecological Legacies: Divergent Mangrove Recovery following Tropical Cyclone Yasi

E. Asbridge[1], R.V.S. Gonçalves[1], K. Rogers[2]

[1]Environmental Futures, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia

[2]School of Geosciences, Faculty of Science, University of Sydney, Sydney, Australia

Extreme climatic events are expected to become more intense under climate change, posing increasing risks to coastal ecosystems. Mangrove forests are particularly vulnerable to severe tropical cyclones, with Category 3 or greater storms capable of causing extensive canopy defoliation, tree mortality, sediment redistribution and long-term alterations to ecosystem structure and function. Despite the ecological importance of mangroves and their role in coastal protection and blue carbon storage, the long-term recovery of mangrove ecosystems following extreme cyclone disturbance remains poorly understood. Most studies have focused on immediate impacts or short-term recovery, with few examining ecosystem trajectories over decadal timescales or the environmental controls governing resilience. Tropical Cyclone Yasi (2011), one of the most intense cyclones to impact the Queensland coast, caused widespread damage to the extensive mangrove forests of Hinchinbrook Island. Fifteen years later, this study characterises mangrove recovery using dense Earth observation time series integrated with high-resolution drone imagery. Annual Landsat imagery (2010–2025) is used to quantify long-term changes in mangrove extent and canopy condition before and after disturbance, while drone-derived products provide detailed assessments of forest structure and zonation. Recovery trajectories are examined in relation to environmental controls, including elevation, inundation regime, cyclone exposure and geomorphic setting, to identify the drivers of recovery success and persistent degradation. Analyses indicate that mangrove recovery is highly heterogeneous across the landscape, with contrasting trajectories ranging from rapid canopy regeneration to prolonged degradation and incomplete recovery in some areas. These findings suggest that geomorphic and hydrological setting strongly influence ecosystem resilience and may determine whether mangrove forests recover to their pre-disturbance condition or transition towards altered ecological states. By integrating dense satellite archives with drone-based observations, this study provides new insights into the long-term ecological legacy of extreme cyclone disturbance and demonstrates the value of multi-scale Earth observation for quantifying ecosystem resilience. The findings will improve understanding of mangrove responses to increasingly intense climatic disturbances and inform the conservation and management of tropical coastal wetlands under a changing climate.

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Burning Down the House: Fire Impact Leads to Elevation Loss in Bhundoo/Clyde River Mangrove Forests

J. Kelleway[1], A. Green[1], Z. Wang[1], K. Prior[2], S. Eichmann[3], N. Lenehan[3], K. Rogers[1,4]

[1]School of Science and Environmental Futures Research Centre, University of Wollongong, Wollongong, Australia

[2]School of Natural Sciences, Macquarie University, Sydney, Australia

[3]Batemans Marine Park, NSW Department of Primary Industries and Regional Development, Narooma, Australia

[4]School of Geosciences, University of Sydney, Sydney, Australia

The maintenance of surface elevation is critical for tidal wetlands exposed to sea-level rise and is underpinned by processes that add mineral and organic material to substrate volumes. Past research has demonstrated the important roles of plant root growth and mineral sediment delivery, and their interactions, in driving elevation patterns in tidal wetlands. The influence of climate-driven disturbances on these biogeomorphic processes, however, remains a significant knowledge gap. The 2019/20 'black summer' fires ravaged the east coast of Australia, impacting mangrove, saltmarsh and supratidal forest ecosystems. Post-fire responses of mangroves have been assessed using a combination of vegetation and surface elevation monitoring approaches in Bhundoo/Clyde River of southern New South Wales. Fire impacts and subsequent mangrove response have been spatially variable. Vegetation impacts ranged from partial defoliation of landward-fringing individuals through to dieback of entire forests in some reaches of the estuary. Recovery via epicormic regrowth has been spatially variable and slow relative to adjacent terrestrial forests. Limited regrowth, combined with spatially-variable post-fire recruitment has left some mangrove zones devoid of live vegetation. Measurement of surface elevation change and sediment accretion rates via the rod surface elevation table-marker horizon (rSET-MH) technique have shown net autocompaction of fire-impacted mangroves, despite evidence of continuing sedimentation associated with tidal inundation. This elevation loss contrasts the net elevation gain observed in the nearby reference mangroves in an adjacent embayment. Loss of surface elevation has implications for ecosystem structure and function, including carbon sequestration processes, nursery functions for aquatic biodiversity and fisheries, and limiting the prospects of natural recruitment in lower mangrove zones experiencing the greatest elevation loss. In the longer term, declining organic matter addition and ongoing autocompaction of substrates will jeopardise the capacity of mangrove forests to maintain their tidal position under conditions of accelerating sea-level rise.

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Impacts of Fire on Germination and Growth of Saltmarsh Vegetation

P. Ross[1]

[1]School of Life and Environmental Sciences, University of Sydney, Sydney, Australia

Extreme climate events such as fire in saltmarsh and mangrove habitats are an increasing feature of a climate-changing world. Although fire is predicted to become more frequent and intensive in these habitats, we still know comparatively little about how it will shape flora. Given the associations between flora and fauna in saltmarsh and mangrove habitats, such changes are likely to impact estuarine ecosystem structure and function. Despite the growing fire threat, the impacts of fire remain poorly understood. This study measured after a bushfire burnt through 7.7 hectares of saltmarsh habitat on Ash Island, Shortland (32°50' 23.97", 151°43' 07.30") in the summer of 2012. A fully orthogonal four factor experimental design tidal elevation (low and high marsh), burnt and unburnt soil, with and without ash, and salinity was used to compare the rate of germination and growth of native saltmarsh plants, *Juncus kraussii, Suaeda australis, Salicornia quinqueflora* and the invasive *J. acutus*. Overall, the percentage of germination of *J. kraussii* and *S. australis* was reduced in burnt soil, with some differences between high and low marsh elevation. In contrast while the percentage germination of *J. acutus* was greatest in unburnt soil there was still significant germination in burnt soils. Mean stem length of *S. quinqueflora* was greatest in unburnt soil, with no effect of ash or salinity. In summary, more research is needed to determine the impact of fire on flora and fauna interactions to extreme climate events in these endangered ecological habitats.

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Marinisation of Lake Illawarra following Construction of a Permanent Entrance

R.J. Williams[1], D. Wiecek[2], A.F. Nielsen[3], M. Fraser[4], T. Costa[4]

[1]NSW Department of Primary Industries (Fisheries), Sydney, Australia (retired)
[2]Biodiversity and Conservation, NSW Department of Planning, Industry and Environment, Wollongong, Australia
[3]Worley Consulting, Sydney, Australia
[4]Wollongong City Council, Wollongong, Australia

In 2007, the construction of entrance breakwaters created a permanent tidal inlet at Lake Illawarra, previously an intermittently opening barrier estuary in southeast Australia. A legacy of nutrient enrichment had led to water quality degradation including extensive algal mats and offensive odors.
The works were intended to reduce water quality problems by enhancing tidal ventilation. On those occasions when the entrance opened either due to rainfall or excavation, littoral drift rapidly refilled the channel. A series of major hydraulic changes followed breakwater construction including an immediate lowering of mean water level and ongoing divergence of tidal planes. In turn there was a progressive increase of the tidal prism causing continuous scour of the entrance channel. Within a decade, the lower leg of the thalweg had migrated to the east; channel depth had eroded to -14 m in some places, and there was loss of foreshore infrastructure. Sediment scoured from the channel caused subsidence of the Windang Bridge requiring rock placement to arrest erosion under its piers. Tidal exchange enhanced water quality.

Seagrass beds in the channel were eroded, and other loss occurred due to smothering as the flood tide delta expanded. From several mangrove Avicennia marina trees identified in aerial photos before construction of the breakwaters, there are now many thousands. Saltmarsh has been lost through increased inundation, particularly within the entrance channel, well above that of sea level rise and the ability of these plants to survive. Expansion of mangroves into saltmarsh areas is also an increasing management concern. A substantive change in the composition of the commercial fish catch has been noted. In effect, a marinisation process has been initiated.

Multiple solutions have been proffered to control the unpredicted consequences of the works designed to ventilate the lake. The changes seen at Lake Illawarra should provide salient insight where entrance works are proposed at similar estuaries, and could suggest a "fast-forward proxy" for a rise of sea level by which to guide management and research elsewhere.

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The Critically Endangered Mangrove Finch Depends on Unique Mangrove Habitats on Isabela Island, Galápagos, Ecuador

H.F. Cunninghame[1,2], C. Feller[3], B. Fessl[2], M.I. Beltrán[2], C. Sevilla[4], Y. van Heezik[1], P. Seddon[1]

[1]Department of Zoology, Ōtākou Whakaihu Waka University of Otago, Dunedin, New Zealand
[2]Charles Darwin Foundation for the Galápagos Islands, Puerto Ayora, Ecuador
[3]Smithsonian Environmental Research Center, Edgewater, USA
[4]Galápagos National Park Directorate, Puerto Ayora, Ecuador

Mangroves are rich ecosystems providing critical habitat for threatened species. The Galapagos Islands, Ecuador, contain limited areas of mangrove forest supporting significant biodiversity. The island endemic Critically Endangered mangrove finch (*Camarhynchus heliobates*), with an estimated population of 100 individuals, is a mangrove specialist dependent on this habitat for its survival. Historically distributed on two western islands, their range is now restricted to just 30ha of mangrove forest at two sites where three species of mangrove *(Avicennia germinans, Rhizophora mangle, Lacungularia racemosa*) reach canopy heights of 20m. While mangrove finches have been the focus of conservation research and management since 2006 with multiple techniques used to try and halt the species' decline and results used to inform future conservation, the structure and health of the mangroves has been less understood although potential impacts from climate change may already be altering the habitat the birds rely on. Here, in the context of the endangered bird that depends on these mangroves, we present plot data collected from occupied mangrove finch habitat. These forests, containing some of the tallest mangrove trees found in Galapagos are now the only sites where the birds are still found with our plot data posing hypotheses as to why: Low salinity water feeds the trees from a subterranean source from rainfall at higher elevation up adjacent volcanos. The sites are at the receiving end of nutrient rich upwelling of the Equatorial Under Current. High nutrient and low salinity meet at a few depressions along the west side of Isabela Island such as the subterranean estuary sites where the mangrove finches persist. Alongside, we present results from 15 years of intensive mangrove finch management including population trends, Population Viability Analysis, and we provide recommendations to inform the future conservation of the rarest of Darwin's finches within a unique mangrove ecosystem.

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Mangrove Forests and Extreme Events

K. Rogers[1,2]*, E. Asbridge[2], J. Kelleway[2], R.V.S. Gonçalves[2], S.K. Chapman[3], A. Armitage[4], K.W. Krauss[5], C.D. Woodroffe[2]

[1]School of Geosciences, Faculty of Science, University of Sydney, Sydney, Australia
[2]Environmental Futures, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia
[3]Center for Biodiversity and Ecosystem Stewardship and Department of Biology, Villanova University, Villanova, USA
[4]Department of Marine Biology, Texas A&M University, Galveston, USA
[5]Louisiana Universities Marine Consortium, Chauvin, USA

Mangroves occupy dynamic intertidal environments where structure, extent and condition are shaped by interactions between episodic disturbance and longer-term environmental change. Although broad-scale drivers such as climate change and sea-level rise influence mangrove distribution over regional to global scales, severe impacts are often triggered by discrete extreme events. We synthesise the global literature on mangrove responses to extreme events, defined by impact on forest condition rather than solely by driver magnitude. Such impacts may arise from cyclones, freezes, fire, tsunamis, earthquakes and anthropogenic disturbance. While typically infrequent and spatially constrained relative to large-scale drivers, these events can cause mortality, canopy loss, altered substrate elevation, disrupted hydroperiods and structural change. Impacts may be immediate, as occurs with cyclones and freezes, or gradual with prolonged stress, which may occur due to tidal impoundment, sediment smothering of roots or salinisation. Recovery trajectories are diverse; rapid where hydroperiods and hydrodynamics are restored; slow when inundation is modified and often characterised by forest restructuring where substrate elevation, drainage or sediment chemistry are altered. Severe impacts may result from multiple drivers rather than isolated events. Modes of climate variability, such as ENSO, can increase forest vulnerability, while tidal modulation, including changes arising from the lunar nodal cycle, may amplify hydrological stress. These interactions are examined using a case study drawing upon mangrove dieback along the Gulf of Carpentaria, Australia, where climate and tidal variability converged in 2015-16. We conclude monitoring should contextualise mangrove dynamics beyond discrete events to broader spatio-and temporal scales, while management should restore hydrological connectivity, sedimentation, and substrate tidal positions.

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Session 3 · Flash research forum — carbon, habitats and rehabilitation

Session Chair: Patrick Dwyer

Seasonal Variability of Carbon Outwelling from a Semi-Enclosed Mangrove Bay in a Carbonated Low-Lying Island (Ouvéa, New Caledonia)

O. Hoane[1], N. Mouras[1], S.L. Robin[1], M. Mathian[1], C. Marchand[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

Mangroves' primary productivity and the products of its decomposition, notably dissolved inorganic carbon (DIC) and CO_2, are subject to tidal pumping, enriching adjacent ecosystems and participating in the trophic chain. However, the amount of the different forms of carbon exported through this process depends on multiple factors, including geomorphological settings, mangrove soil characteristics, seasons, tides, etc. In order to better constrain carbon budget in blue carbon ecosystems, all these driving factors must be understood. The objective of this study was to characterize the seasonal variability of the carbon exchanges between a pristine, semi-enclosed carbonate mangrove bay to the adjacent lagoon in a low-lying island of the Pacific (Ouvéa, New Caledonia). To reach our goal, we acquired 24-h measurement time series in the single narrow channel that connects the mangrove bay to the lagoon both during the cool and the warm season. Water and suspended matter samples were collected every two hours to determine POC, DOC and DIC concentrations. High frequency measurements of pCO_2, $\delta^{13}C\text{-}CO_2$ and pCH_4 using a G2131-i CRDS analyzer were also performed. At the same time, water physicochemical parameters (pH, temperature, salinity, O_{2d}) were measured as well as ^{222}Rn. In this specific system, the exchanges of the different forms of carbon depend on tides, seasons and on the day-night alternation. During the warm season, the elevated temperature, by enhancing microbial activity, resulted in a strong increase in DIC concentrations. pCO_2 varied strongly between night and day; the lower concentrations measured during the day (<400 ppm) may reflect its use by the seagrass beds developing in the tidal creek within the mangrove bay. Eventually, at the lowest tide levels, peaks of CH_4 concentration were measured, associated with salinity decreases. This result may reflect a potential input of fresh groundwater stored within the karst aquifer developing beneath mangrove soils.

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Variability of Above-Ground Carbon Stocks along a Gradient of Tidal Immersion in an Urban Mangrove (New Caledonia)

N. Lanos[1], C. Marchand[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

Mangrove forests can store significant amounts of carbon in their biomass. However, their storage ability depends on numerous factors, including tree species, climate, position within the intertidal zone, and anthropogenic pressure. In semi-arid climates, limited freshwater inputs constrain mangrove growth, resulting in lower above-ground biomass than in humid tropical climate. In addition, mangrove zonation is highly structured and the main factor controlling the distribution of mangrove species is soil salinity, itself controlled by the duration of tidal immersion. In New Caledonia, *Rhizophora* spp. dominate the lower intertidal zone, while *Avicennia marina* develops behind them, being less frequently immerged. However, in urban zone, freshwater runoff may influence these environmental gradients and influence mangrove forest development. This study aimed to quantify the above-ground carbon stocks of these two species in an urban mangrove and to assess the influence of tidal immersion on their biomass. Six sampling zones representing gradient of tidal immersion duration were selected: five within the *Rhizophora* spp. forest and one in an *Avicennia marina* stand. In each zone, tree height and trunk circumference were measured within triplicate quadrats of known area. Above-ground biomass was estimated using the common allometric equations developed by Komiyama et al., and carbon stocks were calculated using a carbon conversion factor. Above-ground biomass showed clear spatial variability and differed between species with significant decrease as tidal immersion decreased. Above-ground carbon stocks in *Rhizophora* spp. stands decreased from 125,86 ± 59,68 MgC/ha to 25,87 ± 10,45 MgC/ha at the highest elevation of their development zone, while AGB was of 50,7 ± 12,7 MgC/ha in the *A. marina* stand. These values are higher than the mean above-ground carbon stocks usually reported for mangroves developing under semi-arid climate suggesting that urban freshwater runoff may enhance mangrove productivity and promote biomass accumulation to levels comparable to those observed in tropical mangrove forests.

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Total Carbon Stocks of Reforested Mangrove in Clungup, Indonesia: A Preliminary Study

S.S. Rijal[1,2], N. Saintilan[1], J.A.L. Raja[2], K. Daylaela[2], Z. Muawana[2], T. Baruna[2], J.O.J. Ello[2], A. Siburian[2], Saptoyo[3]

[1]School of Natural Sciences, Faculty of Science and Engineering, Macquarie University, Sydney, Australia
[2]Marine Science Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia
[3]Clungup Mangrove Conservation, Malang, Indonesia

Mangrove reforestation is widely promoted as a nature-based climate solution, yet carbon stock data from restored Indonesian mangroves remain scarce, limiting confidence in blue carbon accounting for such sites. This preliminary study quantifies total ecosystem carbon stocks in a reforested mangrove stand at Clungup Mangrove Conservation (CMC), East Java, Indonesia. Above-Ground Carbon (AGC), Below-Ground Carbon (BGC), and Soil Organic Carbon (SOC, to 1 m depth) were estimated across four transects (n = 12 plots). AGC and BGC were calculated from diameter-at-breast-height (DBH) measurements, species-specific wood density values, and allometric equations, while SOC was determined using the Loss-on-Ignition (LOI) method. Mean carbon stocks were 66.7 Mg C ha^{-1} (AGC), 31.9 Mg C ha^{-1} (BGC), and 743.7 Mg C ha^{-1} (SOC), yielding a mean total ecosystem carbon stock of approximately 842 Mg C ha^{-1}. Soil carbon dominated the total stock (~88%), consistent with the recognized role of mangrove soils as the primary long-term carbon reservoir, while biomass carbon (AGC + BGC) showed considerable variability among plots, likely reflecting differences in stand age and structural development since reforestation. These preliminary results, while based on a limited sample, suggest that reforested mangroves at Clungup are already accumulating substantial soil carbon stocks comparable to mature mangrove systems reported elsewhere in Indonesia. Expanded sampling and depth-resolved SOC profiling are underway to strengthen these estimates and better characterize the trajectory of carbon accumulation in this restoration context.

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Coarse Fragments, Coarse Roots, and Bulk Density Calculation Method as a Source of Systematic Error in Blue Carbon Accounting

E. Leyden[1], A. Sforza[1], B.M. Conroy[2]

[1]School of Agriculture, Food and Wine, Adelaide University, Adelaide, Australia
[2]School of Biological Sciences, Adelaide University, Adelaide, Australia

Soil bulk density (BD) is the conversion factor linking organic carbon concentration to areal carbon stock, and even small methodological inconsistencies in its determination propagate directly into stock and accumulation rate estimates. A substantial proportion of the carbon stored in coastal blue carbon ecosystems resides in the soil, meaning methodological uncertainty in BD determination can influence carbon accounting outcomes, including overestimation of stocks. A recent continental-scale analysis of nearly 2,900 US Forest Inventory plots demonstrated that mean soil organic carbon stock estimates varied by up to 32% depending solely on how coarse rock and root material (>2 mm) was treated in the BD calculation. This methodological artefact remains largely unexamined in coastal blue carbon systems.

Terrestrial soil science has begun to develop and validate fine and coarse fraction separation methods for BD and organic carbon stock calculation, yet these approaches have not been incorporated into blue carbon field or laboratory protocols. Current guidance for coastal systems diverges from established terrestrial practice in its treatment of carbonate and shell material, and coarse root content is repeatedly identified as a source of sampling artefact across the wetland carbon methods literature, with no equivalent correction framework to account for it.

We examine the scale and implications of this gap for coastal blue carbon systems, and consider why existing methodologies may warrant reassessment if reliable accounting is to underpin formal crediting frameworks. We outline the reasoning behind a potential fine/coarse correction approach for coastal systems, and present preliminary evidence from existing sample data pointing to its significance as this work develops.

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Carbon and Biodiversity in Tasmanian Paperbark Swamp Forests

I. Flett[1], V. Prahalad[1], L. Mackenzie[1], J. Kelleway[2]

[1]School of Geography, Planning and Spatial Sciences, University of Tasmania, Hobart, Australia
[2]School of Science, University of Wollongong, Wollongong, Australia

In Australia, coastal wetland and blue carbon research has largely focused on mangroves, saltmarshes and seagrass meadows, yet there is growing evidence that supratidal forested wetlands can hold similar quantities of carbon. In Tasmania, where there are no mangroves, *Melaleuca ericifolia* (swamp paperbark) forests are a key component of coastal wetland complexes in the north of the state, as well as occurring further inland, in riparian and freshwater swamp settings.

This PhD project is the first state-wide investigation of the plant diversity and carbon stocks in remnant patches of Tasmanian paperbark swamp forest, a State-listed threatened vegetation community under pressure from agriculture, coastal development and rising sea levels.

In the coming years, around 60 paperbark swamp forest sites will be sampled across northern Tasmania and the Bass Strait islands. Site selection is designed to capture the range of settings where these forests occur, including estuarine, coastal, riparian and freshwater swamp environments, while also spanning differences in underlying geology, bioregion and land tenure. Sampling will include floristic surveys, vegetation condition assessments, plus measurements of biomass and carbon above and below ground. Data analysis will test relationships between environmental context, plant assemblages and carbon stores.

Preliminary data supports earlier work in the Tamar Estuary, indicating that "paperbark swamp forest" is not a single, uniform vegetation community across its range. Instead, distinct plant assemblages are likely associated with differences in salinity, hydrology and landscape position, and initial results indicate that these differences also drive variation in carbon storage.

Our findings will improve scientific understanding of temperate blue carbon ecosystems, and help coastal landholders and managers to appreciate the value of the paperbark swamp forests' complex carbon and biodiversity patterns. We aim to contribute to discussions about how forested wetlands fit within Australia's blue carbon management framework including opportunities for restoration.

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Ground-Truthing for Mangrove Carbon Stock Assessment in Selected Sites of Samoa

S. Virly[1], N.C. Duke[2], G. Thompson Saud[2], A. Canning[2]

[1]Sabrina Virly Consultant, Nouméa, New Caledonia
[2]Centre for Tropical Water and Aquatic Ecosystems Research (TropWATER), James Cook University, Townsville, Australia

Through the Regional Pacific NDC Hub established in 2018, the Government of Samoa via the Ministry of Natural Resources and Environment (MNRE), has launched a project aiming to conduct ground truthing of selected mangrove areas for carbon stock assessment, that will directly support the implementation of Samoa's NDC 3.0 mangrove target. Existing datasets rely heavily on remote sensing, with limited ground-truth validation, reducing accuracy for national greenhouse gas (GHG) inventories and carbon accounting. Accurate site-specific data is required to move beyond global estimates and establish a robust Monitoring, Reporting, and Verification (MRV) system.

This project seeks 1) to validate mangrove extent and condition, 2) to generate site-specific biomass and carbon stock data and 3) to enhance national capacity for mangrove carbon stock management and reporting as well as other future blue carbon initiatives.

The IPCC-compliant methodologies applied to quantify biomass and carbon stocks ensure consistency with national inventory practices and international guidelines.

Field surveys are carried out in the different types of mangrove forests on the two main islands of Samoa during July 2026. The field program collects data on the structure, biomass, biodiversity, and condition of mangrove stands at a selection of 6 sites—4 in Upolu and 2 in Savai'i. Data on the aboveground biomass of mangrove vegetation is collected using the Rapid Long Plot method. Additionally, peat depth and total organic carbon content in the sediments are measured.

The final phase involves carrying out capacity building and on-site knowledge transfer, as well as workshop training for the MNRE technical staff in September 2026, during which field manuals and data collection templates suitable for the long-term MRV use by the Ministry, are provided.

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Assessing Sediment Carbon Exchange in Tropical Coastal Saltmarshes and Salt Flats

M.A. Linnas[1], S.D. Sasmito[2], A. Barkley[1], L. Montagna[1], B. O'Breza[2], A.K. Mishra[2], C. Duvert[3], R. Mulloy[3], N.J. Waltham[1]

[1]College of Science and Engineering, James Cook University, Townsville, Australia
[2]Centre for Tropical Water and Aquatic Ecosystems Research (TropWATER), James Cook University, Townsville, Australia
[3]Research Institute for the Environment and Livelihoods (RIEL), Charles Darwin University, Darwin, Australia

Coastal wetlands such as mangroves, seagrasses, salt marshes, and tidal flats are important blue carbon ecosystems because they store large amounts of organic carbon in their sediments for centuries. Understanding sediment carbon exchange, together with decomposition processes, offers unique opportunities to improve carbon accounting frameworks and to support climate change mitigation strategies for coastal wetland restoration. Here we report plot-scale CO_2 and CH_4 flux measurements using paired semi-transparent (light) chambers for net CO_2 and CH_4 exchange and opaque (dark) chambers for sediment total CO_2 and CH_4 effluxes across three coastal wetland habitat types in the tropical dry climate region of Australia — unvegetated salt flat and saltmarsh dominated by *Sarcocornia quinqueflora* and *Sporobolus virginicus*. Across five sampling days, chamber-based LI-COR measurements revealed significant differences in net CO_2 and CH_4 fluxes and their total effluxes among *Sarcocornia*, *Sporobolus*, and salt flat habitats ($p < 0.001$). These preliminary findings have important implications for whether tropical saltmarsh ecosystems act as net carbon sinks or sources, thereby providing important data to inform coastal climate mitigation strategies.

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Conserving and Restoring Migrating Coastal Wetlands

N. Perera[1], M. Wartman[1], P. Macreadie[1], M. Costa[1]

[1]Centre for Nature Positive Solutions, Department of Biology, School of Science, RMIT University, Melbourne, Australia

Coastal wetlands are increasingly at risk from climate change, with impacts expected to intensify through sea level rise, coastal squeeze, and compounding anthropogenic pressures. While many studies focus on projected ecosystem losses, these landscapes may also experience gains through landward migration, with the balance between loss and gain varying across regions depending on local conditions. Anticipating these dynamics is critical for guiding conservation and restoration under future climate scenarios.

We applied a scenario-based analysis to assess future risks and adaptation potential of coastal wetlands under alternative climate and socio-economic pathways. Our study focused on Victoria, Australia, using present conditions and two future shared socio-economic pathways (SSP2 and SSP5) for the year 2100. We integrated elevation data, sea level rise projections, multiple environmental stressors, and tenure data to understand how coastal wetlands may respond to environmental change.

We found that these ecosystems will be affected differently, with saltmarshes experiencing higher cumulative stress, highlighting their greater sensitivity to environmental change. Sea level rise emerges as the dominant driver of net change, with potential area gains from landward migration exceeding losses from seaward inundation. However, the capacity to realise these gains depends strongly on land tenure and use. For saltmarshes, losses are primarily driven by mangrove encroachment rather than inundation. Future accommodation space for mangroves occurs mostly under public land within protected areas, whereas most of saltmarsh migration space lies on private land, highlighting the importance of early engagement with landholders in adaptation plans.

These findings demonstrate the value of scenario-based approaches for identifying spatial patterns of vulnerability, supporting adaptive conservation and restoration planning for coastal wetlands under future climate conditions.

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From Germination to Field Delivery: Developing Seed-Based Approaches for Saltmarsh Restoration

M. Wartman[1], N. Tropeano[1], S.M. Trevathan-Tackett[1]

[1]Centre for Nature Positive Solutions, Department of Biology, School of Science, STEM College, RMIT University, Melbourne, Australia

Saltmarsh restoration commonly relies on natural regeneration or the planting of nursery-grown plants. Although these approaches can be effective, their application across large or difficult-to-access areas may be constrained by plant availability, propagation requirements and the logistics of transplanting. Seed-based restoration offers a complementary approach with potential for broader-scale deployment, but its application is limited by gaps in knowledge about species-specific germination requirements and effective methods for delivering and retaining seeds in the field. This research investigates multiple stages of the saltmarsh restoration pathway, from germination under controlled greenhouse conditions to seed delivery, capture and retention at restoration sites. Greenhouse trials are assessing germination success, emergence timing and early establishment across a range of native Australian saltmarsh species. These experiments aim to identify species suitable for seed-based restoration and improve understanding of the environmental conditions required for successful germination. Building on this work, field trials are evaluating biodegradable materials designed to address different barriers to seed-based restoration. Biodegradable seed pods are being developed as a method for targeted drone delivery, allowing seeds to be deployed across large, inaccessible or difficult-to-traverse restoration areas. Biodegradable seed mats are being trialled for their capacity to capture naturally dispersed seeds, retain them within suitable establishment zones and reduce their redistribution by wind, water or tidal movement. Field assessments examine material performance, seed capture and retention, local environmental conditions and subsequent germination and seedling establishment. Together, these studies connect knowledge of saltmarsh seed biology with the development of practical tools for seed delivery and retention. The research will identify species and approaches suitable for future field application and support the development of scalable, biodegradable methods for restoring degraded saltmarsh ecosystems.

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What Is a Mangrove?

N.C. Duke[1]*, S.Y. Lee[2,3], IUCN SSC Mangrove Specialist Group

[1]Centre for Tropical Water and Aquatic Ecosystems Research (TropWATER), James Cook University, Townsville, Australia
[2]The Chinese University of Hong Kong, Hong Kong SAR, China
[3]Australian Rivers Institute, Griffith University, Gold Coast, Australia

The IUCN Mangrove Specialist Group (MSG) has recently made a determination about which plants are to be officially recognised as mangroves. Until now, the list of plants known as mangroves has varied almost author by author, and jurisdiction by jurisdiction. While most accounts contain a core group of commonly-recognised plant species, there are a few other plants whose mangrove status has been subjective and globally inconsistent. The MSG determination, based on world-recognised expert advice, provides the currently considered list of plants recognised as mangroves.

Inconsistences have stemmed from mangroves being an ecological grouping rather than a single genetic entity with common physiological and morphological traits. While key functional traits are essential for these highly specialised plants to live in intertidal settings, regularly flooded and drained with seawater, the numbers of plants involved is relatively small. In fact, mangroves while small in number with ~ 80 plant species have evolved independently within 18 or more diverse plant families – a real wonder of convergent evolution!

Since a core responsibility of the MSG is the determination of Red List risk and threat status for each mangrove species, for that purpose, an agreed list of plants is needed. The newly authorised list further gives certainty about mangrove plants for environmental managers, policy makers, researchers and communities worldwide.

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Saltmarsh Projects in the Sydney Region over 25 Years

G. Dalby-Ball[1]

[1]Dragonfly Environmental, Sydney, Australia

An overview of Saltmarsh projects in the Sydney Region over 25yrs.

Covering a range of types: regeneration, rehabilitation, re-creation and translocation we present what has been learnt and what can be applied on other projects.

How is success measured?

The importance of strategic planning in coastal Australia and importance of Community appreciation and care for long-term outcomes.

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Variation in Supratidal Forest Productivity over an Annual Monitoring Period

V. Bennion[1], V. Kwan[1], **J.W. Hill**[1], C.E. Lovelock[1]

[1]School of the Environment, The University of Queensland, Brisbane, Australia

Supratidal forests are important but understudied coastal vegetated ecosystems. Despite their significant woody biomass and blue carbon stocks, little is known about their growth and productivity on long-term scales. We followed supratidal forest productivity for one year at a densely instrumented site in south-east Queensland, with distinct *Melaleuca* and *Casuarina* zones. We captured forest dynamics using litterfall traps, electric dendrometers, radial plots, root in-growth bags, soil cores, sediment pins, marker horizons and groundwater wells. We will present results from this monitoring, including contrasts with adjacent mangrove and terrestrial ecosystems. Across our sampling year, supratidal forest productivity varied seasonally both above- and belowground. There were observable phenological patterns that aligned with observations from national floristic databases. We also observed relationships between groundwater dynamics and stem size and growth. Our site provides valuable fundamental data about supratidal forest growth and productivity, and we suggest that future studies should expand the diversity of supratidal forests to be monitored in a detailed fashion.

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Recovery of Coastal Ecosystem Habitats in Morari Bay (New Caledonia) Using Nature-Based Solutions

S. Virly[1], C. Haverkamp[2], J. Winterwerp[3]

[1]Sabrina Virly Consultant, Nouméa, New Caledonia
[2]Conservation International, Nouméa, New Caledonia
[3]I-Mud and Delft University of Technology, Delft, Netherlands

New Caledonia is home to the world's largest coral reef lagoon, covering 24,000 km^2, which was listed as a UNESCO World Heritage site in 2008. Clearing land, abandoned mines, the increasing intensity and frequency of bushfires, invasive species, and unsustainable development all harm the watersheds' ability to retain water. This in turn worsens terrestrial erosion, carrying large amounts of sediments to the coast, affecting the health of the coral reef.

This is also the case for Morari Bay

, which receives large amounts of sediment from its watershed carried by the La Coulée River, in particular during cyclones. This bay lies in the southern Province of New Caledonia.

A pilot project based on a «ridge-to-reef" approach has been developed by Conservation International in collaboration with local environmental organizations to recover coral-favourable conditions in the bay. This approach aimed at limiting the impacts of the human and natural pressures on the coastal ecosystem and strengthening their resilience (coral reefs, seagrass beds, and mangroves). Setting up sediment traps downstream of the existing mangrove fringes is an effective way to both 1) reduce suspended sediments inputs into the bay and limit their spread, 2) stabilize existing mudflats and reduce coastal erosion, and 3) support the natural expansion of mangroves by promoting mangrove habitat formation.

The project's intervention area covers 400 linear meters of sediment traps, aiming at a gain in mangrove area of about 2.5 hectares. These traps were made of bamboo fascines.

Since their installation breaking the effect of waves and wind, there has been significant sediment buildup upstream of the traps, and young *Rhizophora* seedlings have taken root in this area favourable for their growth.

We will discuss the design philosophy and criteria and present the details of the construction of the traps, together with our monitoring program and results.

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Mānawa in Aotearoa (New Zealand Mangroves)

S.B. De Luca[1]

[1]Boffa Miskell, Tauranga, New Zealand

There is a single species of mangrove in New Zealand (*Avicennia marina* subsp. *australasica*), which is native to New Zealand. *A. marina* is present only in the upper North Island across four regions (Northland, Auckland, Waikato and Bay of Plenty).

There has been and continues to be (to a lesser extent in the past few years) polarising public opinion of value of mangroves.

In previous decades, the common public view was that mangroves are ugly, smelly, invasive, and serve no purpose. Many people were concerned about the expansion of mangroves into areas where they have historically not been present, their lack of open water view from their private properties and perceived degradation to private property values. Pressure has been put on Regional Councils by the public to remove mangrove forests, with large areas destroyed (using mechanical and hand-held tools) during this period. Significant ecological damage has occurred during this period.

In more recent years, the perception of mangroves is more balanced, with a greater understanding of mangrove ecological and biodiversity values, coastal edge protection and ecosystem services they provided. There is now a recognition that the discharge of sediment from the land to the Coastal Marine Area has provided silty soft sediment habitat for mangroves to colonise. Many Regional Councils currently only allow juvenile mangroves (single stem, less than 0.6m) to be removed using hand-held tools but require independent ecological assessments and catchment management plans to be prepared in order to inform decisions about whether Regional Councils give consent to remove mangrove stands or not.

I have had a role in many Environment Court hearings in New Zealand as a marine ecology expert witness supporting the protection of mangroves, making some progress towards the understanding of the ecological value of mangroves in our coastal environment.

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Australasian Mangrove & Saltmarsh Network Conference '26
WOLLONGONG, 24 – 27 Nov

Day 2 – Wednesday November 25th



Towra Point Nature Reserve, Sydney, NSW. Grey mangroves (Avicennia marina) and tidally inundated saltmarsh vegetation, including Sarcocornia spp., Sporobolus virginicus and Juncus kraussii, during a summer high tide. Towra Point supports the largest remaining natural wetland complex in the Sydney region, providing critical habitat and important coastal ecosystem functions.



Keynote – Colin Woodroffe

Mangroves and Sea Level

C.D. Woodroffe[1]

[1]Environmental Futures, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia

Radiometric dating of fossil coral has provided important evidence for past sea level, resulting in the identification of several modes of reef response to post-glacial sea-level rise, including keep up, catch up and give up. A similar concept, informed by paleoenvironmental studies, can be applied to mangrove wetlands which are constrained within an accommodation space in the upper tidal frame. Intertidal mangrove sediments represent a more precise indicator of sea-level position than subtidal corals. The stratigraphic record of intertidal sedimentation provides a time-averaged record of wetland continuity with respect to sea level at a longer timescale than ecological studies of processes by which inorganic sediments and organic matter accrete and substrate elevation changes. When considering whether mangroves can keep pace with sea-level rise, it is necessary to consider appropriate temporal and spatial scales. At millennial scales, geomorphological setting and paleo-topography appear to have been constraints on the extent of mangrove habitats. Short-term observations from surface elevation table/marker horizon installations show that adjustments of surface elevation vary in complex ways in wetlands unrelated to changes in mean sea level. Sedimentary evidence should not be misinterpreted to presume an equilibrium response at observational scales, and to extrapolate this into mangrove response to future sea-level rise. It is not feasible to observe whether a wetland is 'keeping up' with sea-level rise, only retrospectively to see if it 'kept-up'.

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Session 4 · Biodiversity and ecological responses

Session Chair: Brooke Conroy

A Multi-Trophic Biodiversity Assessment of Human Impacts in a Temperate Saltmarsh Ecosystem

P.I. Fidge[1,2], S.M. Trevathan-Tackett[1,2], K. Bell[1], R. Crofts[2], M. Wartman[1,2]

[1]Centre for Nature Positive Solutions, Department of Biology, School of Science, RMIT University, Melbourne, Australia

[2]School of Life and Environmental Sciences, Deakin University, Melbourne, Australia

Coastal wetlands play a pivotal role in supporting biodiversity and providing essential ecological services. However, the effects of land use, such as tidal restriction and ungulate grazing, on wetland biodiversity across multiple trophic levels remain understudied. To address this gap, we assessed vegetation, macroinvertebrates, soil microbiomes and birds across natural, grazed, tidally restricted and pre-restriction saltmarshes. Natural saltmarsh was characterised by a higher diversity of benthic macroinvertebrates and bacterial communities, whereas disturbed sites were characterised by greater richness of weeds, disturbance-tolerant bacteria groups and generalist bird species. Weeds occurred exclusively in grazed habitats, highlighting their applicability as a simple and cost-effective indicator of ungulate disturbance. These patterns show that species richness alone misrepresents ecological condition, as disturbed sites often appeared 'diverse' while lacking specialist and functionally important groups. Disturbance also compressed beta diversity and homogenised communities across vegetation, invertebrates and soil bacteria. Multivariate analyses of vegetation and bacterial communities revealed reduced compositional turnover in grazed and tidally restricted sites, indicating the loss of microhabitat-driven heterogeneity that underpins saltmarsh functioning. Strong transect-level patterns demonstrated that fine-scale gradients in elevation and inundation exert greater influence on soil bacterial and vegetation assemblages than site-level disturbance categories. Overall, our findings show that multi-trophic, composition-based indicators offer more reliable assessments of ecological condition than richness alone and provide stronger baselines and monitoring for coastal wetland restoration.

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Poleward Tropical Fish Range Extensions under Climate Change Are Limited by Minimum Thermal Thresholds, Not Mangrove Habitat Expansion

J. Shukla[1], C. Mellin[2], A. Mitchell[1,3], A. Duval[1], M. Hart[1], T. Hall[4], D. Booth[3], I. Nagelkerken[1]

[1]Southern Seas Ecology Laboratories, School of Biological Sciences, Adelaide University, Adelaide, Australia
[2]The Environment Institute and School of Biological Sciences, Adelaide University, Adelaide, Australia
[3]School of Life Sciences, University of Technology Sydney, Sydney, Australia
[4]School of Physical Sciences and the Sprigg Geobiology Centre, Adelaide University, Adelaide, Australia

Climate change is reshaping marine community compositions and biodiversity distributions as species track shifting thermal niches. While the climate-driven range expansion of tropical estuarine fishes and mangroves has been studied in isolation, the interplay between these parallel shifts and their influence on seascapes historically dominated by temperate saltmarsh remains unclear. Here we tested whether mangrove range expansion or species-specific minimum thermal tolerance (CTmin) better predicts the distribution of range-extending tropical fishes at their temperate range edge, and whether resident temperate fish alter their trophic reliance as mangroves expand polewards. We quantified estuarine fish assemblages across a ~2000 km latitudinal gradient along Australia's east coast, a global warming hotspot, compared poleward range-edge trajectories of abundant taxa against historical baselines, and used stable isotope mixing models to assess trophic assimilation across mangrove and saltmarsh habitats. Latitude at median fish abundance was negatively correlated with species' CTmin in mangrove habitat, with each 1°C decrease in CTmin corresponding to an ~80 km poleward shift in population centers. Tropical fish exceeded their CTmin limits in both habitats, with leading-edge detections extending into cold-temperate latitudes. However, median fish abundance remained concentrated near their trailing edge in subtropical to warm-temperate waters, consistent with seasonal recruitment pulses rather than established populations. The fastest poleward advances matched documented isotherm velocities, indicating that tropical fishes are tracking warming waters despite CTmin-constrained overwinter survival. Stable-isotope analysis revealed mixed resource use by tropical vagrants and local temperate fishes, implying dietary flexibility rather than a systematic shift towards mangrove-derived production. We suggest that species-specific thermal tolerance, not habitat availability, dictates the poleward limits of tropical fish distribution, and that trophic flexibility underpins resource assimilation across the temperate estuarine mosaic. Mangrove expansion may continue largely decoupled from tropical fish distributions, making habitat gain a poor proxy for realized range shifts under continued warming.

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Session 5 · Surface elevation, sediment and groundwater

Session Chair: Cath Lovelock

Generating and Evaluating Rates of Surface Elevation Change from Multi-Temporal Vegetation Boundaries

L. Mogensen[1], K. Rogers[2]

[1]School of Science, University of Wollongong, Wollongong, Australia
[2]School of Geosciences, University of Sydney, Sydney, Australia

Understanding surface-elevation change is essential for assessing the response and resilience of coastal wetlands to rising sea levels. However, direct measurements of surface-elevation change are often spatially sparse, temporally uneven, and impractical to extend across broad wetland systems. Alternative approaches are therefore needed to estimate surface-elevation change where observational data are limited or incomplete. Building on the accommodation-space approach, this study developed and evaluated a reduced-complexity, mapping-based approach for estimating surface-elevation change across Western Port Bay, Victoria. Multi-temporal vegetation boundary mapping from 1973/74, 1985/89, 2009 and 2019/20 at four focus locations around the bay was used in combination with elevation data and tidal information to estimate boundary elevation trajectories and derive standardised rates of surface-elevation gain per metre of inundation depth below a high-water datum. A multi-method evaluation compared the derived factors with independent centennial-scale ^{210}Pb estimates and approximately 20 years of surface elevation table- marker horizon (SET-MH) observations. Derived factors differed strongly among wetland settings, from 4.22 mm m^{-1} yr^{-1} at a sediment-rich, prograding site to 1.32 mm m^{-1} yr^{-1} at a hydrodynamically constrained setting. Evaluation against independent ^{210}Pb-derived estimates showed close agreement across the four focus locations, and modelled rates were broadly comparable with SET-MH-derived rates of surface-elevation change. The performance of the mapping-based approach against other methods of establishing surface-elevation change suggests that the method of this study using historical vegetation change can provide meaningful estimates of wetland vertical adjustment capacity, despite the uncertainties associated with mapping-derived data. This approach therefore provides a transparent, data-efficient method for comparing wetland vulnerability, resilience and adaptation pressure where long-term field observations are limited, incomplete or impractical to extend across broad areas, supporting planning-scale assessment of future wetland change under sea-level rise.

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Beneath the Tide: Sediment-Controlled Groundwater and Salinity Stratification across an Estuarine Wetland Transect

C. Owers[1], R. McGivern[1], W. Brown[2], G. Rau[1]

[1]Earth Sciences, School of Science, The University of Newcastle, Newcastle, Australia
[2]Central Coast Council, Wyong, Australia

Coastal vegetated wetlands occur at the interface between marine and terrestrial hydrological processes, yet the subsurface controls governing salinity persistence and vegetation zonation remain poorly constrained, particularly in settings where wave energy is suppressed, such as barrier estuaries. We investigate seawater–groundwater interactions along a transect spanning mangrove, saltmarsh, supratidal, and terrestrial vegetation zones using electrical resistivity tomography (ERT), water-level and salinity monitoring, and sediment analysis. Results reveal a pronounced lateral and vertical salinity structure characterised by a shallow saline wedge extending inland within fine-grained intertidal sediments, while deeper groundwater remains comparatively fresh. Vegetation zonation closely mirrors this subsurface composition: mangrove and saltmarsh communities are associated with persistent shallow salinity in low-permeability silt–clay substrates, whereas supratidal and terrestrial vegetation occurs where sandier sediments and less saline water dominate. Although rainfall and tidal forcing dynamically influence shallow groundwater, salinity variability attenuates rapidly with depth, indicating limited vertical connectivity and sediment-controlled hydraulic anisotropy. The persistence of fresh groundwater beneath saline shallow sediments departs from the classical homogeneous, density-driven coastal aquifer model. Instead, the system reflects a hydraulically stratified composition in which fine-sediment accretion promotes vertical permeability contrasts and shallow saline retention, while deeper freshwater-dominated zones (indicated by low bulk electrical conductivity, potentially reflecting terrestrially recharged groundwater) extend towards the estuary. This vertically differentiated configuration influences vegetation distribution and contributes to carbon-rich intertidal sediment accumulation. We propose a refined conceptual model for microtidal, wave-dominated barrier estuaries with similar settings, emphasising sediment-controlled hydraulic anisotropy over density-driven stratification. This framework advances process understanding of groundwater–vegetation interactions and provides a basis for assessing ecosystem resilience under accelerating sea-level rise.

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Mangrove Establishment in Fringing Coral Reef Settings

S. Wells[1], B. Henderson[1], A. Dansie[2], W. Glamore[1]

[1]Water Research Laboratory, School of Civil and Environmental Engineering, UNSW Sydney, Sydney, Australia
[2]Water Research Centre, UNSW Sydney, Sydney, Australia

Mangrove forests provide critical ecosystem services throughout the Pacific Islands, including shoreline stabilisation and wave attenuation during storm events. Predicting where mangroves can establish on reef-fringed coastlines is therefore important for assessing the future resilience of these shorelines under changing sea levels and wave climates. Mangrove establishment depends on windows of opportunity during which hydrodynamic conditions are suitable for seedling survival. In reef-protected environments, however, nearshore hydrodynamic conditions are controlled not only by offshore forcing but also by reef morphology, making long-term reconstruction challenging.

This research presents a framework for reconstructing long-term nearshore hydrodynamic conditions using offshore wave hindcast data and satellite-derived bathymetry. One-dimensional reef transects are simulated in XBeach (Surfbeat mode) across a range of offshore wave heights, wave periods, and water levels spanning the expected range of offshore forcing conditions. Twenty years of offshore wave hindcast data are then interpolated across the model simulations to reconstruct continuous nearshore wave conditions at each transect. The resulting time series are analysed to identify windows of opportunity suitable for mangrove seedling establishment. Results demonstrate that wave transmission and wave setup are governed by reef crest depth and offshore water levels, suggesting that sea-level rise may alter the frequency and duration of hydrodynamically suitable windows for mangrove establishment.

The framework is demonstrated at two reef-fringed coastlines: Viti Levu, Fiji, and Molokaʻi, Hawaiʻi. Multiple reef transects are extracted from locations both supporting and lacking mangroves to investigate differences in reconstructed hydrodynamic windows of opportunity. By linking offshore wave climate, reef morphology, and nearshore hydrodynamics, this approach improves understanding of the physical controls on mangrove establishment and provides a basis for projecting future habitat suitability under sea-level rise and changing wave climates.

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Tidal Restoration Produces Genetically Diverse, Resilient Wetlands

D. Lanceman[1,2], J. Bragg[3], M. Coleman[4,5], W. Glamore[2], M. Mayer-Pinto[1]

[1]Centre for Marine Science and Innovation, School of Biological, Earth and Environmental Sciences, UNSW Sydney, Sydney, Australia
[2]Water Research Laboratory, School of Civil and Environmental Engineering, UNSW Sydney, Sydney, Australia
[3]Research Centre for Ecosystem Resilience, Botanic Gardens of Sydney, Sydney, Australia
[4]NSW Department of Primary Industries and Regional Development (Fisheries), Coffs Harbour, Australia
[5]School of Biological Sciences and Oceans Institute, University of Western Australia, Perth, Australia

With widespread global intertidal wetland loss, large-scale habitat restoration is essential. Numerous studies have shown that tidal restoration can effectively restore mangrove and saltmarsh populations. However, of high relevance to land managers is understanding the long-term functionality and resilience of these restored habitats. Our research sought to answer these questions by inspecting a range of natural and tidally restored wetland sites of different ages in eastern Australia. Given genetics strongly influences population survival, we undertook widespread genetic sampling of dominant saltmarsh and mangrove species (*Sporobolus virginicus* and *Avicennia marina*) across eastern Australia. This allowed us to unpack genetic diversity and connectivity patterns at multiple spatial scales (metres to 100s of kilometres). We simultaneously measured physical traits of sampled plants to link genetics with morphological responses, which impact wetland functionality. We also tested for correlations between gene flow and hydrological patterns, to predict genetic responses in water-dispersed wetland species. We found that restored wetlands had equivalent genetic diversity to remnant wetlands, with high phenotypic plasticity, indicative of strong adaptive capacity. Gene flow was associated with hydrological patterns, allowing identification of gene flow directionality and thus important sites for future conservation and restoration. Overall, our research demonstrates that tidal restoration can effectively produce functional, resilient wetlands. Our novel multidisciplinary approach translated genetic patterns into management-relevant findings, which can help predict wetland restoration success and therefore improve stakeholder confidence in restoration.

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Surface Elevation Trends in a Macrotidal Mangrove Setting

M. Goddard[1], L. Hutley[1], C.E. Lovelock[2]

[1]Research Institute for the Environment and Livelihoods (RIEL), Charles Darwin University, Darwin, Australia
[2]School of the Environment, The University of Queensland, Brisbane, Australia

Darwin Harbour, a macro-tidal estuary that supports a significant and intact mangrove ecosystem in the wet-dry tropics. Mangrove vegetation surveys suggest the forests are relatively stable in terms of area occupied and floristic composition, yet these mangroves occur in the intertidal zone from below mean-sea level through to the highest astronomic tide and are experiencing rates of sea-level rise of 10.8 mm y-1 over the last decade, four-fold higher than the global average. To assess potential vulnerability of the ecosystem to this rapid sea-level rise, surface elevation change was monitored biannually between 2014 and 2026 via 42 surface elevation tables (RSET-MHs) distributed across the 20,440 ha Darwin Harbour mangrove estate. Elevation trends varied with tidal position and geomorphic setting: seaward zones showed higher surface elevation gains driven by sediment accretion, while landward zones gained elevation primarily through below-ground processes. Position within the Harbour had an influence on surface elevation with riverine settings accumulating more sediment than harbour mangroves. This long-term surface record captures the influences of recent disturbance events, including a category 2 tropical cyclone, severe convective storms resulting in localised dieback, as well as interannual variations in mean sea level. These results suggest that despite limited sediment inputs, Darwin Harbour's mangroves gain some stability from the large tidal range to which they are exposed and elevation capital they possess. However, the seaward fringes remain most at risk, as recovery below mean sea level approaches a critical threshold presenting empirical data on thresholds and resilience to disturbance.

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Keynote – Havalend Steinmuller

Where Wetlands Collide: Carbon, Nitrogen, and Coastal Change

H.E. Steinmuller[1]

[1]Louisiana Universities Marine Consortium (LUMCON), Chauvin, USA

Along the Atlantic and Gulf coasts of the United States, black mangroves (*Avicennia germinans*) are expanding poleward into salt marshes at their freeze-limited range limits. Range-limit ecotones at different stages of encroachment provide a natural laboratory for testing how well habitat type predicts wetland biogeochemical function. In east-central Florida, where mangroves are longer established, transition zone soils were functionally equivalent to mangrove soils in total C, N, and P stores, and enzyme activities and N mineralization rates shifted before vegetation conversion was complete. In a global synthesis of mangrove organic carbon burial, sedimentary and geomorphic setting resolved differences obscured by a single habitat-wide estimate, with the highest burial rates in deltaic settings. Applying the same framework to soil nitrogen, carbonate-setting mangroves stored twice as much N as terrigenous settings, whereas carbon burial is greatest in terrigenous settings, indicating that the controls on C and N storage are not interchangeable. In marshes and mangroves occupying 'restored' wetlands within coastal Louisiana, emerging data indicate that substrate legacy, rather than plant functional type, governs belowground biogeochemical function. Despite these findings, blue carbon assessments continue to classify and upscale by habitat type. I present evidence that sedimentary setting, geomorphology, and land-use history are stronger predictors of C and N storage and processing than vegetation alone, and consider the implications for "blue nitrogen," where catchment-specific N loading and removal pathways make context even more decisive.

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Session 6 · Management, policy and engagement

Session Chair: Jack Hill

From Hidden Landscapes to Future Coasts: Engaging People with Wetlands

V. Prahalad[1], K. Pratt[1], X. Wang[1], J. Kirkpatrick[1]

[1]School of Geography, Planning and Spatial Sciences, University of Tasmania, Hobart, Australia

Coastal wetlands are increasingly recognised as critical not only for biodiversity conservation and climate resilience, but also for supporting meaningful connections between people and nature. Yet, conservation of these wetlands continues to be constrained by low public awareness, limited ecological understanding and community engagement. Framed around the conference themes of resilient wetlands, connected communities, and future coasts, this presentation synthesises findings from three Tasmanian studies examining how people experience, perceive, and connect with wetlands, and how these experiences can inform wetland conservation. Drawing on surveys, semi-structured interviews, and field-based auditing across a range of wetlands, the research reveals that many visitors remain unfamiliar with wetlands as ecological systems, despite regularly encountering them in everyday landscapes. Even at an internationally significant Ramsar wetland, public awareness of the site and its conservation status was low. At the same time, participants consistently expressed strong preferences for non-extractive, immersive and contemplative experiences including walking, wildlife observation and photography, alongside demand for accessible infrastructure such as trails, viewing platforms and online information. Using a human–nature connection framework, the studies further demonstrate that coastal wetlands can evoke powerful emotional, sensory and reflective experiences, while also revealing tensions around solitude, development, accessibility and ecological understanding. To support integration of these insights into planning and management, the presentation introduces the Wetland Wanderer Tool (WWT), a new systematic framework developed and tested across 21 diverse wetlands to assess opportunities for human–nature connection. Application of the tool identified widespread gaps in orientation, interpretation and visitor engagement, alongside examples of best practice. Collectively, the findings highlight the importance of designing wetland experiences that are accessible, immersive and ecologically meaningful. Strengthening human–nature connections in wetlands may play an important role in building public awareness, community stewardship, and long-term support for conservation and restoration to support resilient future coasts.

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From Strategy to Scale: Advancing Blue Carbon Delivery in New South Wales

S. Fawcett[1], C. Latella[1], S. Paul[1], J. Morris[1]

[1]NSW Department of Climate Change, Energy, the Environment and Water, Sydney, Australia

The NSW Blue Carbon Strategy represents a coordinated, cross-agency effort to protect, restore and enhance blue carbon landscapes across NSW to deliver climate mitigation, biodiversity, and coastal floodplain resilience outcomes. Since its release in 2022, significant progress has been made in advancing the enabling policy, science, and delivery frameworks required to scale blue carbon outcomes across New South Wales.

This presentation provides an update on the implementation of the Strategy, highlighting key achievements across five priority areas: Conserving blue carbon ecosystems and supporting their adaptation and migration; Delivering blue carbon projects on public, private and First Nations-owned and managed land; Embedding blue carbon in coastal and marine policy, planning and management; Progressing blue carbon research; and, Promoting blue carbon investment.

Early outcomes have highlighted the complexity of restoring blue carbon landscapes. Working through the full range of technical, regulatory and delivery challenges at the demonstration scale has been essential to building the foundations for broader landscape-scale implementation across NSW.

Emerging challenges and opportunities in scaling blue carbon delivery across NSW will be discussed, particularly where projects must navigate the need for coordinated delivery mechanisms across multiple landholdings, dynamic risks such as sea-level rise, and competing land use priorities across coastal floodplains.

This work underscores the role of blue carbon as a practical, nature-based solution within NSW's climate change and coastal management agenda, and identifies the next steps required to transition from pilot projects to landscape-scale delivery.

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Management Priorities for Saltmarsh and Mangroves in NSW: Insights from the Intertidal Marine Vegetation Strategies

K.A. Buckley[1], P.G. Dwyer[1]

[1]NSW Department of Primary Industries and Regional Development (Fisheries and Forestry), NSW, Australia

The Intertidal Marine Vegetation Strategies (IMVS) are funded by the NSW Marine Estate Management Strategy to address priority threats and risks to saltmarsh and mangroves. GIS modelling is used to identify priority sites where these habitats are likely to persist into the long-term and, at these sites, recommend management strategies to improve their resilience, recovery or protection.

To date, three IMVS have been completed, encompassing five estuaries: the Tweed River, Richmond River, Minnamurra River, Crooked River and Werri Lagoon. In total, 476 actions were recommended in 46 priority sites (hotspots). Twelve different action types were recommended within the key approaches of 'Hydrology', 'Sediments', 'Vegetation' and 'People and Planning'.

The number of actions recommended per hotspot ranged from 2 to 26, with a similar average number for each estuary. Most recommendations were to "provide sea level rise migration pathways for intertidal vegetation" (20 %) and "reinstate and maintain more natural tidal hydrology and catchment connectivity" (15 %), indicating that these are management priorities for intertidal vegetation in NSW. The next three most common recommendations related to the conservation of existing saltmarsh and mangrove vegetation, comprising an additional 30 % of all recommendations.

Most recommendations for the Tweed, Richmond and Minnamurra Rivers related to 'People and Planning' and 'Vegetation'. Recommendations for Werri Lagoon and Crooked River mostly related to 'People and Planning' and 'Hydrology'. This highlights the importance and challenges of stakeholder engagement when managing intertidal habitats. The Sediments approach was least frequently recommended, indicating that localised issues occur but are less common than other recorded threats.

Insights from the IMVS demonstrate that resilient wetlands in NSW rely on a combination of actions, dependent on local conditions. However, broadscale action to provide SLR migration pathways, restore more natural hydrology and conserve existing wetlands is needed to ensure future delivery of ecosystem services.

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Documenting Mangrove Dieback in NSW with a New Reporting Tool

P.G. Dwyer[1], K.A. Buckley[1], A. Wray-Barnes[1], G. West[1], T.M. Glasby[1], D. Britton[2]

[1]NSW Department of Primary Industries and Regional Development (Fisheries and Forestry), NSW, Australia
[2]NSW Department of Primary Industries and Regional Development (Agriculture and Biosecurity), NSW, Australia

Mangrove dieback can be a natural part of system development and renewal as a response to disturbance such as hail, lightning, defoliation from insect grazing or physical impact from roosting bats and birds.

Mangrove dieback can also be initiated by anthropogenic impacts including filling or draining intertidal areas or changing catchment or tidal flows. Sometimes it can take years before the dieback linked to anthropogenic change becomes evident. Also, when dieback is linked to hydrologic change there can be kilometers between the change and the consequential mangrove dieback.

Accelerating sea level rise is an additional stress on saltmarsh and mangrove systems. Individually mangroves display a range of adaptations to accommodate low rates of sea level rise in situ. As a community they can demonstrate an ecogeomorphic capacity to build ground surface and retain a suitable position within the intertidal. This capacity has a limit that may be impeded by stressors reducing resilience, initiating dieback or increasing its extent or frequency.

This presentation highlights a recently developed Mangrove Dieback Reporting Tool and the opportunity it provides to create connected communities of citizen scientists with greater awareness of shifting intertidal systems and future coasts. Improving documentation of mangrove dieback occurrence and scale may also complement lines of evidence showing stressors, such as changing hydroperiod, accelerating or impeding the repositioning of intertidal systems with sea level rise.

The Mangrove Dieback Reporting Tool is part of the Intertidal Marine Vegetation Strategies evidence-based approach to identify prioriy sites for protection, management and restoration of saltmarsh and mangrove habitats to safeguard their widely appreciated ecosystem services, now and into the future.

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Session 7 · Coastal change, resilience and flash insights

Session Chair: Chris Owers

Flood Events and Their Effects on Surface Elevation Change in a Tropical Mangrove Landscape

C.E. Lovelock[1], V. Bennion[1], N. Brothers[1], A. Pearse[1]

[1]School of the Environment, The University of Queensland, Brisbane, Australia

Increased pulses of heavy rainfall, which are a consequence of climate change, lead to enhanced flooding in many catchments. Flooding can lead to increased sediment delivery to mangroves, which can contribute to resilience to sea level rise but may also lead to declines in mangrove condition due to extended periods of inundation. In the Daintree River, extreme floods in 2019 and 2025 led to increased surface elevation across multiple habitats of the mangrove landscape, even in those habitats that are infrequently inundated by the tide. These increases in surface elevation associated with floods were often not maintained in years after the flood and shallow subsidence was evident. While compaction of delivered riverine sediments may be partially responsible for shallow subsidence in the years following floods, shallow subsidence was associated with declines in canopy condition in some sites indicating biotic belowground processes may also be responsible. Across the different mangrove habitats in the Daintree estuary, floods generally enhanced surface elevation at ~3 mm year^{-1} despite shallow subsidence, suggesting the mangroves of the estuary are resilient to current rates of sea level rise, at least over the time series of this experiment. However, the heterogeneous patterns in surface elevation change observed among mangrove habitats and sites suggests floods can have both negative and beneficial interactions that influence the resilience of mangroves to sea level rise. Differences in flood effects on mangroves resilience depend on the mangrove setting and the magnitude of the flood event, with the potential for threshold responses.

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Catastrophic Flooding: Council-Led Response to Mangrove Loss in the Hawkesbury River

A. Hughes[1]

[1]Hornsby Shire Council, Sydney, Australia

Between 2021 and 2022, the Hawkesbury River experienced repeated catastrophic flood events that severely impacted the region. These events caused widespread sediment movement, bank erosion and waterlogging, impacting approximately 50 ha of mangrove habitat, resulting in one of the largest recorded mangrove diebacks in New South Wales. Observations by Hornsby Shire Council between 2022 and 2023 identified Grey Mangroves (*Avicennia marina*) as the most affected species. These diebacks frequently occurred in areas where sediment deposition had smothered the mangroves' aerial root systems (pneumatophores), which are essential for gas exchange and survival. However, other significantly impacted areas did not show evidence of sediment deposition, suggesting multiple contributing factors. In response, Council's Catchment Team initiated a structured monitoring program in 2023, in close collaboration with researchers from Macquarie University and NSW Department of Primary Industries - Fisheries. The program aimed to quantify the impacts of the flood events by comparing post-flood canopy health with pre-flood conditions, establishing long-term monitoring sites to track recovery, and developing key health indicators such as seedling density, crab activity and pneumatophore condition. In April 2025, Hornsby Council, Central Coast Council, and Macquarie University re-surveyed the long-term monitoring sites and conducted a 33 km shoreline assessment. The results revealed 14 km of shoreline with no mangrove mortality, 9 km with 25% mortality, 5 km with 50% mortality, 4 km with 75% mortality, and 1 km with 100% mortality. Recent findings indicate that while some previously affected areas are showing promising signs of recovery, others remain severely impacted with no evidence of natural regeneration. Council continues to monitor the condition of the Hawkesbury mangrove habitats in collaboration with researchers, other councils, and landowners. Rehabilitation options currently under evaluation include targeted replanting and riverbank erosion control measures.

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Trends in Surface Elevation Change in Tidal Saltmarsh Wetlands of South-West Western Australia

A. Pearse[1], P. Lavery[2], C.E. Lovelock[1]

[1]School of the Environment, The University of Queensland, Brisbane, Australia
[2]School of Science, Edith Cowan University, Perth, Australia

Tidal wetlands including mangroves, saltmarsh and supratidal forests are some of the most important ecosystems to help mitigate the effects of climate change and sea level rise (SLR). Tidal wetlands are also vulnerable to increased loss with increasing rates of SLR. While much research has been done globally on mangrove forests vulnerability to SLR, much less research has been done on tidal saltmarsh wetlands, especially in mediterranean climates with microtidal tidal ranges. Understanding the rates and patterns of tidal saltmarsh wetland elevation change relative to SLR is essential to provide proper management and protection of these ecosystems. Tidal saltmarsh wetlands in Western Australia are highly vulnerable to loss due to decreasing annual precipitation, a microtidal tidal range (~0.3m) and high relative rates of SLR. Yet to date, very little research has been done on the vulnerability of tidal saltmarsh wetlands to SLR in Western Australia. The Rod Surface Elevation Table Marker Horizon (RSET-MH) method has been used globally to assess wetland surface elevation trends relative to SLR in tidal wetlands. In this current study, we installed 24 RSET-MH stations across a range of geomorphic settings to provide the first trends of surface elevation change and sediment accretion in tidal saltmarsh wetlands relative to SLR in Western Australia. Trends in surface elevation ranged from -3.56 mm yr^{-1} in a tidally disconnected paddock to + 3.1 mm yr^{-1} in a riverine saltmarsh wetland in Perth. While all sites have shown positive trends in surface elevation change and sediment accretion, all sites also show elevation deficits relative to local SLR trends. This research is a first step in filling an important gap in our knowledge of tidal saltmarsh wetlands vulnerability to SLR in Western Australia and can be used to help prioritise their conservation and management.

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Saltmarsh Storm Tide Flood Frequency in Western Port Bay

J. O'Grady[1], H. Bloustein[2]

[1]CSIRO, Melbourne, Australia
[2]Department of Energy, Environment and Climate Action (DEECA), Melbourne, Australia

Western Port Bay is a Ramsar-listed wetland of international importance. Saltmarsh terraces surround the bay and occur within a narrow elevation band and are commonly interpreted as part of the broader intertidal landscape. Here, we use hourly water-level observations from the west and north of the bay, together with extreme sea-level analysis, to examine whether these terrace surfaces are inundated by regular astronomical tides or by less frequent storm-assisted high-water-level events.

Our analysis suggests that some saltmarsh terrace surfaces sit above the normal tidal range and may be better described as supratidal landforms, similar to saltmarsh systems in the South Australian gulfs. Rather than being regularly inundated by astronomical tides, these surfaces appear to be flooded during storm-assisted high-water events, when elevated astronomical tides combine with meteorological surge.

This places the terraces within a probabilistic sea-level framework, where inundation is episodic and may not be flooded in all years. Their formation and maintenance may therefore be linked to occasional storm-tide events rather than regular astronomical tidal inundation. Understanding these terraces as storm-tide-influenced supratidal landforms has implications for interpreting Western Port's coastal evolution and for assessing future saltmarsh vulnerability, migration and displacement under sea-level rise.

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Expanding Mangrove Forests on the Great Barrier Reef: Drivers and Implications

S. Hamylton[1], J. Kelleway[1], K. Rogers[2], E. Asbridge[3], C.D. Woodroffe[3], B.M. Conroy[4], H. Muecke[1]

[1]School of Science, University of Wollongong, Wollongong, Australia
[2]School of Geosciences, Faculty of Science, University of Sydney, Sydney, Australia
[3]Environmental Futures, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, Australia
[4]School of Biological Sciences, Adelaide University, Adelaide, Australia

The northern Great Barrier Reef have 47 low wooded islands. These sandy islands have formed on top of coral reefs and are accompanied by forests of *Rhizophora stylosa*. Observations across many of these low wooded islands suggest that these mangrove forests are undergoing expansion. What are the causes and implications of this good news story for the Great Barrier Reef?

We report initial findings of a monitoring program established at Low Isles, the island with the longest cartographic record of historic forest extent. Drivers of forest expansion including measurements of surface elevation changes and the composition of associated muds (inorganic content, bulk density) are investigated across a range of local reef top environments. Implications of forest expansion are explored, including estimates of above ground biomass and associated wetland ecological diversity.

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Biodiversity Trends in Tidal Freshwater Wetlands Revealed by Environmental DNA in Subtropical Australia

A. Acero Suarez[1]

[1]Australian Rivers Institute and Coastal and Marine Research Centre, Griffith University, Brisbane, Australia

Tidal freshwater wetlands (TFWs) are coastal ecosystems that provide important ecological functions at the interface between freshwater and marine environments, such as carbon sequestration and nitrogen removal. In subtropical Australia, some TFWs are characterised by Melaleuca-dominated swamps and sedge swamps. However, despite growing recognition of their ecological importance, their faunal biodiversity remains poorly documented. This knowledge gap is particularly concerning given the ongoing loss and fragmentation of Melaleuca ecosystems. Biodiversity baselines are also necessary to support ecosystem environmental accounting and restoration initiatives through biodiversity markets. This study provides the first comprehensive assessment of biodiversity in Australian TFWs using environmental DNA (eDNA) in the Noosa Everglades in Southeast Queensland. Water and sediment samples were collected from five sites spanning a freshwater-to-marine gradient of TFWs in southeast Queensland. We evaluated differences between eDNA substrates and used a habitat-association framework that integrated ecological literature and eDNA evidence to identify taxa most strongly associated with TFWs. Water and sediment eDNA recovered significantly different but complementary components of biodiversity. Species richness and community composition varied along the salinity gradient, with both freshwater and marine-associated taxa detected, including what may represent one of the first records of marine fauna within subtropical Australian TFWs. The results show that TFWs support a broader range of vertebrate and invertebrate fauna than currently recognised, comprising both widespread species and a smaller assemblage of habitat specialists. Our findings demonstrate the value of combining water and sediment eDNA for characterising TFW biodiversity and provide the first biodiversity benchmark for relatively intact Australian TFWs. These results improve understanding of a poorly studied ecosystem and establish a critical reference for future conservation, restoration, and biodiversity accounting initiatives.

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Streamlining Marine Plant Rehabilitation for Resilient Coastal Wetlands into the Future

G. MacKenzie[1], L. Bekker[1], S. Georgeson[2], B. Mackenzie[1]

[1]Fisheries Queensland, Department of Primary Industries, Nambour, Australia
[2]Fisheries Queensland, Department of Primary Industries, Cairns, Australia

The value of coastal ecosystems is widely recognised; however, efforts to restore these critical habitats often encounter unintended governance barriers. Government agencies play an important role in reducing these constraints to support wetland recovery, including restoring tidal flows, shellfish reefs, and mangrove and saltmarsh wetlands.

In Queensland, planning legislation provides a pathway for certain works to proceed as self-assessable development under accepted development requirements. This approach avoids the time and costs associated with formal development assessment processes, enabling more efficient project delivery. In June 2026, Fisheries Queensland released an updated Accepted Development Requirements for Operational Work that is the Removal, Destruction or Damage of Marine Plants (ADR). This update introduces new work types to facilitate rehabilitation works involving impacts to marine plants. This update enhances regulatory certainty and streamlines authorisation pathways for the rehabilitation of coastal wetlands and fish habitats.

This presentation will outline the regulatory framework for rehabilitation works involving impacts to marine plants, with a focus on the new rehabilitation work types within the ADR. The accepted development requirements align with the operational works development trigger under the Planning Act 2016 and establishes a structured, risk-based framework to enable restoration, remediation and rehabilitation activities while maintaining environmental safeguards and promoting net ecological benefits.

By expanding the scope of accepted development requirements to include rehabilitation-focused activities, the revised ADR provides greater certainty for proponents, reducing approval risks and administrative burden. These new work types allow for the aligning of restoration efforts with existing regulatory frameworks, minimising the need for further assessment and the associated costs. For proponents, it focuses resources on delivering ecological outcomes rather than navigating bespoke approvals, ultimately supporting more efficient, predictable, and cost-effective marine and coastal rehabilitation.

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Establishment Thresholds for Guiding Hybrid Mangrove Living Shoreline Design: Seedling Anchoring Force

R.O. Bodycomb[1], B.S. Lanham[1], S.E. Swearer[2], A.W. Pomeroy[1], R.L. Morris[1]

[1]School of Biosciences, The University of Melbourne, Melbourne, Australia
[2]Oceans Institute, The University of Western Australia, Perth, Australia

Living shorelines recover coastal ecosystems and provide resilience against coastal hazards. There is increasing interest in the uptake of these solutions as an alternative to conventional hard engineered structures (e.g. seawalls, breakwaters), with benefits including adaptability in response to sea level rise, lower maintenance costs and habitat provision. Because mangroves are vulnerable in their early life stages, establishment success is often observed to be enhanced when small structures are implemented at a restoration site. These hybrid approaches support mangrove establishment and persistence by mimicking the emergent traits of mature mangrove forests (e.g. wave attenuation, sediment stabilisation). In New South Wales, rock fillets have been widely used to manage erosion and facilitate mangrove establishment. Other techniques include timber fillets, oyster shells, and biodegradable logs. To identify mangrove establishment thresholds that inform restoration site selection and appropriate hybrid approach, we measured the anchoring force and the influence of seedling morphology on 161 *Avicennia marina* and *Aegiceras corniculatum* seedlings located in fringing mangroves across two estuaries on the mid-north coast of NSW. Some seedlings were located on eroding shorelines whilst others were in the lee of rock fillets. We found that anchoring force increased significantly with seedling height, belowground biomass, and proximity to adult mangroves (all $p < 0.001$). Furthermore, the anchoring force of *A. marina* was significantly higher behind rock fillets compared to those without (35.5 N vs 26.6 N; $p = 0.024$). Removal mechanism differed significantly between species ($p < 0.001$; *A. marina* exhibited root breakages in 37.4% of removals; *A. corniculatum* pulled intact 91.9% of removals). The results show that hybrid structures not only protect mangrove seedlings from hydrodynamic and erosive forces but also facilitate greater anchoring over time, improving establishment resilience. By embedding ecological knowledge into hybrid living shoreline design, mangrove establishment can be improved and over-engineering avoided.

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Fast Response Eco-Geomorphological Models for Rapid Assessment of Wetland Resilience and Adaptation to Sea-Level Rise

J.F. Rodriguez[1], P.M. Saco[2], E. Sandi[2], A. Breda[3], S. Sandi[4]

[1]Centre for Water Security and Environmental Sustainability and School of Engineering, The University of Newcastle, Newcastle, Australia
[2]School of Civil and Environmental Engineering, University of Technology Sydney, Sydney, Australia
[3]WaterNSW, NSW, Australia
[4]School of Civil and Environmental Engineering, Deakin University, Melbourne, Australia

Traditional eco-geomorphological wetland evolution models require detailed information for setup and validation, and they typically demand long simulation times. We present the latest advances in the development of fast response eco-geomorphological models, which retain the representation of the most important processes for wetland evolution (hydrodynamic, sediment transport, vegetation dynamics and soil accretion) and simplify the domain description by using characteristic values that can be easily obtained. These models have been developed to assess long-term response and resilience to sea-level rise and are able to accommodate adaptation measures to help wetlands cope with sea-level rise. The adaptation measures that can be incorporated in the models include drainage improvements, sediment nourishment, inlet control, and vegetation planting. The models have been designed to run on supercomputers, which reduces the simulation times and allows for the exploration of scenarios required for decision making.

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Poster session · Viewing and presenter discussions

Integrating Remote Sensing, Field-Measured Tree Heights, and Machine Learning to Enhance Mangrove Above-Ground Carbon Estimation in Baluran National Park, Indonesia

S.S. Rijal[1,2], N. Saintilan[1]

[1]School of Natural Sciences, Faculty of Science and Engineering, Macquarie University, Sydney, Australia
[2]Marine Science Study Program, Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

Mangroves play a critical role in coastal ecosystem services, particularly through their capacity to sequester large amounts of atmospheric carbon, contributing to climate change mitigation. Developing accurate mangrove carbon models is therefore essential for monitoring ecosystem condition and carbon stocks at relevant scales. This study aimed to estimate mangrove Above-Ground Carbon (AGC) in Baluran National Park by integrating field measurements and remote sensing data within a Machine Learning (ML) framework. The study utilised an extensive field data collection programme of 60 sampling plots of girth at breast height, canopy cover, tree height, and tree density. Mangrove AGC was estimated using allometric equations. AGC was also modelled by processing satellite images, conducting statistical analyses, developing models with five ML algorithms (Random Forest (RF), Support Vector Machine (SVM), Decision Tree (DT), k-Nearest Neighbour (k-NN), and Gradient Boost (GB)), and checking accuracy using 5-fold cross-validation (CV) of Root Mean Square Error (RMSE). The RF model, using field-measured tree height, Ratio Vegetation Index (RVI), and Transformed Soil-Adjusted Vegetation Index (TSAVI), achieved the best performance (R^2 training = 0.93, R^2 testing = 0.84, 5-fold CV RMSE = 12.20 Mg C ha^{-1}). Predicted AGC ranged from 5.39 to 57.18 Mg C ha^{-1} (mean ± Standard Deviation (SD) = 30.43 ± 16.09 Mg C ha^{-1}) and showed improved accuracy compared to the global mangrove biomass dataset of (Simard et al., 2019). A key contribution of this study is the integration of field-measured tree height within a satellite-based ML framework, which enhances the accuracy and ecological relevance of AGC estimation compared to approaches relying solely on spectral predictors or remotely sensed canopy height products, offering a practical and cost-effective alternative for sites where UAV or LiDAR data are unavailable. This approach provides a practical method for regional mangrove carbon monitoring, national carbon accounting and supports climate change mitigation efforts.

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Coastal Wetland Resilience under Sea-Level Rise Using a Simplified Process-Based Framework

E. Sandi[1], P.M. Saco[1], J.F. Rodriguez[2], A. Breda[3]

[1]School of Civil and Environmental Engineering, University of Technology Sydney, Sydney, Australia
[2]Centre for Integrated Resilience: Coastal, Water and Climate (CIR) and School of Engineering, The University of Newcastle, Newcastle, Australia
[3]WaterNSW, NSW, Australia

Mangrove and saltmarsh wetlands are extremely sensitive to changes in hydrological, climatic, and anthropogenic conditions and are threatened by sea-level rise. Surface elevation gain and landward migration are the most common mechanisms by which wetlands can cope with sea-level rise. However, current global predictions indicate that a large proportion of mangrove and saltmarsh wetlands will disappear before the end of the century due to accelerated sea-level rise. These projections are subject to considerable uncertainty because most models simplify the dynamics and feedbacks between tidal flow, vegetation, and accretion.

Process-based eco-geomorphological (flow/vegetation/accretion) models have the potential to provide robust predictions of wetland evolution, but their use has been historically limited to local scale studies due to computational limitations. In this contribution, we present a process-based geomorphological model with simplifications that retain the essential dynamics but reduce computational requirements, allowing it to be applied to many sites around the world. Upscaling from local scale wetland dynamics to a global scale, using the same model, allows for cross-site comparison of wetland evolution and the study of various wetland resilience metrics in different parts of the world. Initial results show that wetland resilience in the model is heavily tied to the mean intertidal elevation, sediment supply, and tidal range. Additionally, similar patterns of wetland evolution are observed in sites that share common characteristics, regardless of geographical location.

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Assessing Sediment Carbon Exchange in Tropical Coastal Saltmarshes and Salt Flats

M.A. Linnas[1], S.D. Sasmito[2], A. Barkley[1], L. Montagna[1], B. O'Breza[2], A.K. Mishra[2], C. Duvert[3], R. Mulloy[3], N.J. Waltham[1]

[1]College of Science and Engineering, James Cook University, Townsville, Australia
[2]Centre for Tropical Water and Aquatic Ecosystems Research (TropWATER), James Cook University, Townsville, Australia
[3]Research Institute for the Environment and Livelihoods (RIEL), Charles Darwin University, Darwin, Australia

Coastal wetlands such as mangroves, seagrasses, salt marshes, and tidal flats are important blue carbon ecosystems because they store large amounts of organic carbon in their sediments for centuries. Understanding sediment carbon exchange, together with decomposition processes, offers unique opportunities to improve carbon accounting frameworks and to support climate change mitigation strategies for coastal wetland restoration. Here we report plot-scale CO_2 and CH_4 flux measurements using paired semi-transparent (light) chambers for net CO_2 and CH_4 exchange and opaque (dark) chambers for sediment total CO_2 and CH_4 effluxes across three coastal wetland habitat types in the tropical dry climate region of Australia — unvegetated salt flat and saltmarsh dominated by *Sarcocornia quinqueflora* and *Sporobolus virginicus*. Across five sampling days, chamber-based LI-COR measurements revealed significant differences in net CO_2 and CH_4 fluxes and their total effluxes among *Sarcocornia*, *Sporobolus*, and salt flat habitats ($p < 0.001$). These preliminary findings have important implications for whether tropical saltmarsh ecosystems act as net carbon sinks or sources, thereby providing important data to inform coastal climate mitigation strategies.

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Saltmarsh Projects in the Sydney Region over 25 Years

G. Dalby-Ball[1]

[1]Dragonfly Environmental, Sydney, Australia

An overview of Saltmarsh projects in the Sydney Region over 25yrs.

Covering a range of types: regeneration, rehabilitation, re-creation and translocation we present what has been learnt and what can be applied on other projects.

How is success measured?

The importance of strategic planning in coastal Australia and importance of Community appreciation and care for long-term outcomes.

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Seasonal Variability of Carbon Outwelling from a Semi-Enclosed Mangrove Bay in a Carbonated Low-Lying Island (Ouvéa, New Caledonia)

O. Hoane[1], N. Mouras[1], S.L. Robin[1], M. Mathian[1], C. Marchand[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

Mangroves' primary productivity and the products of its decomposition, notably dissolved inorganic carbon (DIC) and CO_2, are subject to tidal pumping, enriching adjacent ecosystems and participating in the trophic chain. However, the amount of the different forms of carbon exported through this process depends on multiple factors, including geomorphological settings, mangrove soil characteristics, seasons, tides, etc. In order to better constrain carbon budget in blue carbon ecosystems, all these driving factors must be understood. The objective of this study was to characterize the seasonal variability of the carbon exchanges between a pristine, semi-enclosed carbonate mangrove bay to the adjacent lagoon in a low-lying island of the Pacific (Ouvéa, New Caledonia). To reach our goal, we acquired 24-h measurement time series in the single narrow channel that connects the mangrove bay to the lagoon both during the cool and the warm season. Water and suspended matter samples were collected every two hours to determine POC, DOC and DIC concentrations. High frequency measurements of pCO_2, $\delta^{13}C\text{-}CO_2$ and pCH_4 using a G2131-i CRDS analyzer were also performed. At the same time, water physicochemical parameters (pH, temperature, salinity, O_{2d}) were measured as well as ^{222}Rn. In this specific system, the exchanges of the different forms of carbon depend on tides, seasons and on the day-night alternation. During the warm season, the elevated temperature, by enhancing microbial activity, resulted in a strong increase in DIC concentrations. pCO_2 varied strongly between night and day; the lower concentrations measured during the day (<400 ppm) may reflect its use by the seagrass beds developing in the tidal creek within the mangrove bay. Eventually, at the lowest tide levels, peaks of CH_4 concentration were measured, associated with salinity decreases. This result may reflect a potential input of fresh groundwater stored within the karst aquifer developing beneath mangrove soils.

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The Critically Endangered Mangrove Finch Depends on Unique Mangrove Habitats on Isabela Island, Galápagos, Ecuador

H.F. Cunninghame[1,2], C. Feller[3], B. Fessl[2], M.I. Beltrán[2], C. Sevilla[4], Y. van Heezik[1], P. Seddon[1]

[1]Department of Zoology, Ōtākou Whakaihu Waka University of Otago, Dunedin, New Zealand
[2]Charles Darwin Foundation for the Galápagos Islands, Puerto Ayora, Ecuador
[3]Smithsonian Environmental Research Center, Edgewater, USA
[4]Galápagos National Park Directorate, Puerto Ayora, Ecuador

Mangroves are rich ecosystems providing critical habitat for threatened species. The Galapagos Islands, Ecuador, contain limited areas of mangrove forest supporting significant biodiversity. The island endemic Critically Endangered mangrove finch (*Camarhynchus heliobates*), with an estimated population of 100 individuals, is a mangrove specialist dependent on this habitat for its survival. Historically distributed on two western islands, their range is now restricted to just 30ha of mangrove forest at two sites where three species of mangrove *(Avicennia germinans, Rhizophora mangle, Lacungularia racemosa*) reach canopy heights of 20m. While mangrove finches have been the focus of conservation research and management since 2006 with multiple techniques used to try and halt the species' decline and results used to inform future conservation, the structure and health of the mangroves has been less understood although potential impacts from climate change may already be altering the habitat the birds rely on. Here, in the context of the endangered bird that depends on these mangroves, we present plot data collected from occupied mangrove finch habitat. These forests, containing some of the tallest mangrove trees found in Galapagos are now the only sites where the birds are still found with our plot data posing hypotheses as to why: Low salinity water feeds the trees from a subterranean source from rainfall at higher elevation up adjacent volcanos. The sites are at the receiving end of nutrient rich upwelling of the Equatorial Under Current. High nutrient and low salinity meet at a few depressions along the west side of Isabela Island such as the subterranean estuary sites where the mangrove finches persist. Alongside, we present results from 15 years of intensive mangrove finch management including population trends, Population Viability Analysis, and we provide recommendations to inform the future conservation of the rarest of Darwin's finches within a unique mangrove ecosystem.

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Variability of Above-Ground Carbon Stocks along a Gradient of Tidal Immersion in an Urban Mangrove (New Caledonia)

N. Lanos[1], C. Marchand[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia

Mangrove forests can store significant amounts of carbon in their biomass. However, their storage ability depends on numerous factors, including tree species, climate, position within the intertidal zone, and anthropogenic pressure. In semi-arid climates, limited freshwater inputs constrain mangrove growth, resulting in lower above-ground biomass than in humid tropical climate. In addition, mangrove zonation is highly structured and the main factor controlling the distribution of mangrove species is soil salinity, itself controlled by the duration of tidal immersion. In New Caledonia, *Rhizophora* spp. dominate the lower intertidal zone, while *Avicennia marina* develops behind them, being less frequently immerged. However, in urban zone, freshwater runoff may influence these environmental gradients and influence mangrove forest development. This study aimed to quantify the above-ground carbon stocks of these two species in an urban mangrove and to assess the influence of tidal immersion on their biomass. Six sampling zones representing gradient of tidal immersion duration were selected: five within the *Rhizophora* spp. forest and one in an *Avicennia marina* stand. In each zone, tree height and trunk circumference were measured within triplicate quadrats of known area. Above-ground biomass was estimated using the common allometric equations developed by Komiyama et al., and carbon stocks were calculated using a carbon conversion factor. Above-ground biomass showed clear spatial variability and differed between species with significant decrease as tidal immersion decreased. Above-ground carbon stocks in *Rhizophora* spp. stands decreased from 125,86 ± 59,68 MgC/ha to 25,87 ± 10,45 MgC/ha at the highest elevation of their development zone, while AGB was of 50,7 ± 12,7 MgC/ha in the *A. marina* stand. These values are higher than the mean above-ground carbon stocks usually reported for mangroves developing under semi-arid climate suggesting that urban freshwater runoff may enhance mangrove productivity and promote biomass accumulation to levels comparable to those observed in tropical mangrove forests.

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Trends in Surface Elevation Change in Tidal Saltmarsh Wetlands of South-West Western Australia

A. Pearse[1], P. Lavery[2], C.E. Lovelock[1]

[1]School of the Environment, The University of Queensland, Brisbane, Australia
[2]School of Science, Edith Cowan University, Perth, Australia

Tidal wetlands including mangroves, saltmarsh and supratidal forests are some of the most important ecosystems to help mitigate the effects of climate change and sea level rise (SLR). Tidal wetlands are also vulnerable to increased loss with increasing rates of SLR. While much research has been done globally on mangrove forests vulnerability to SLR, much less research has been done on tidal saltmarsh wetlands, especially in mediterranean climates with microtidal tidal ranges. Understanding the rates and patterns of tidal saltmarsh wetland elevation change relative to SLR is essential to provide proper management and protection of these ecosystems. Tidal saltmarsh wetlands in Western Australia are highly vulnerable to loss due to decreasing annual precipitation, a microtidal tidal range (~0.3m) and high relative rates of SLR. Yet to date, very little research has been done on the vulnerability of tidal saltmarsh wetlands to SLR in Western Australia. The Rod Surface Elevation Table Marker Horizon (RSET-MH) method has been used globally to assess wetland surface elevation trends relative to SLR in tidal wetlands. In this current study, we installed 24 RSET-MH stations across a range of geomorphic settings to provide the first trends of surface elevation change and sediment accretion in tidal saltmarsh wetlands relative to SLR in Western Australia. Trends in surface elevation ranged from -3.56 mm yr^{-1} in a tidally disconnected paddock to + 3.1 mm yr^{-1} in a riverine saltmarsh wetland in Perth. While all sites have shown positive trends in surface elevation change and sediment accretion, all sites also show elevation deficits relative to local SLR trends. This research is a first step in filling an important gap in our knowledge of tidal saltmarsh wetlands vulnerability to SLR in Western Australia and can be used to help prioritise their conservation and management.

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Saltmarsh Storm Tide Flood Frequency in Western Port Bay

J. O'Grady[1], H. Bloustein[2]

[1]CSIRO, Melbourne, Australia
[2]Department of Energy, Environment and Climate Action (DEECA), Melbourne, Australia

Western Port Bay is a Ramsar-listed wetland of international importance. Saltmarsh terraces surround the bay and occur within a narrow elevation band and are commonly interpreted as part of the broader intertidal landscape. Here, we use hourly water-level observations from the west and north of the bay, together with extreme sea-level analysis, to examine whether these terrace surfaces are inundated by regular astronomical tides or by less frequent storm-assisted high-water-level events.

Our analysis suggests that some saltmarsh terrace surfaces sit above the normal tidal range and may be better described as supratidal landforms, similar to saltmarsh systems in the South Australian gulfs. Rather than being regularly inundated by astronomical tides, these surfaces appear to be flooded during storm-assisted high-water events, when elevated astronomical tides combine with meteorological surge.

This places the terraces within a probabilistic sea-level framework, where inundation is episodic and may not be flooded in all years. Their formation and maintenance may therefore be linked to occasional storm-tide events rather than regular astronomical tidal inundation. Understanding these terraces as storm-tide-influenced supratidal landforms has implications for interpreting Western Port's coastal evolution and for assessing future saltmarsh vulnerability, migration and displacement under sea-level rise.

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Impacts of Fire on Germination and Growth of Saltmarsh Vegetation

P. Ross[1]

[1]School of Life and Environmental Sciences, University of Sydney, Sydney, Australia

Extreme climate events such as fire in saltmarsh and mangrove habitats are an increasing feature of a climate-changing world. Although fire is predicted to become more frequent and intensive in these habitats, we still know comparatively little about how it will shape flora. Given the associations between flora and fauna in saltmarsh and mangrove habitats, such changes are likely to impact estuarine ecosystem structure and function. Despite the growing fire threat, the impacts of fire remain poorly understood. This study measured after a bushfire burnt through 7.7 hectares of saltmarsh habitat on Ash Island, Shortland (32°50' 23.97", 151°43' 07.30") in the summer of 2012. A fully orthogonal four factor experimental design tidal elevation (low and high marsh), burnt and unburnt soil, with and without ash, and salinity was used to compare the rate of germination and growth of native saltmarsh plants, *Juncus kraussii, Suaeda australis, Salicornia quinqueflora* and the invasive *J. acutus*. Overall, the percentage of germination of *J. kraussii* and *S. australis* was reduced in burnt soil, with some differences between high and low marsh elevation. In contrast while the percentage germination of *J. acutus* was greatest in unburnt soil there was still significant germination in burnt soils. Mean stem length of *S. quinqueflora* was greatest in unburnt soil, with no effect of ash or salinity. In summary, more research is needed to determine the impact of fire on flora and fauna interactions to extreme climate events in these endangered ecological habitats.

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Carbon and Biodiversity in Tasmanian Paperbark Swamp Forests

I. Flett[1], V. Prahalad[1], L. Mackenzie[1], J. Kelleway[2]

[1]School of Geography, Planning and Spatial Sciences, University of Tasmania, Hobart, Australia
[2]School of Science, University of Wollongong, Wollongong, Australia

In Australia, coastal wetland and blue carbon research has largely focused on mangroves, saltmarshes and seagrass meadows, yet there is growing evidence that supratidal forested wetlands can hold similar quantities of carbon. In Tasmania, where there are no mangroves, *Melaleuca ericifolia* (swamp paperbark) forests are a key component of coastal wetland complexes in the north of the state, as well as occurring further inland, in riparian and freshwater swamp settings.

This PhD project is the first state-wide investigation of the plant diversity and carbon stocks in remnant patches of Tasmanian paperbark swamp forest, a State-listed threatened vegetation community under pressure from agriculture, coastal development and rising sea levels.

In the coming years, around 60 paperbark swamp forest sites will be sampled across northern Tasmania and the Bass Strait islands. Site selection is designed to capture the range of settings where these forests occur, including estuarine, coastal, riparian and freshwater swamp environments, while also spanning differences in underlying geology, bioregion and land tenure. Sampling will include floristic surveys, vegetation condition assessments, plus measurements of biomass and carbon above and below ground. Data analysis will test relationships between environmental context, plant assemblages and carbon stores.

Preliminary data supports earlier work in the Tamar Estuary, indicating that "paperbark swamp forest" is not a single, uniform vegetation community across its range. Instead, distinct plant assemblages are likely associated with differences in salinity, hydrology and landscape position, and initial results indicate that these differences also drive variation in carbon storage.

Our findings will improve scientific understanding of temperate blue carbon ecosystems, and help coastal landholders and managers to appreciate the value of the paperbark swamp forests' complex carbon and biodiversity patterns. We aim to contribute to discussions about how forested wetlands fit within Australia's blue carbon management framework including opportunities for restoration.

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Mangrove Carbon Outwelling: Tidal and Seasonal Controls on Dissolved Organic Carbon Export

N. Mouras[1,2], S.L. Robin[1], O. Hoane[1], H. Lemonnier[2,3], C. Marchand[1]

[1]Institut de Sciences Exactes et Appliquées (ISEA, EA 7484), Université de la Nouvelle-Calédonie, Nouméa, New Caledonia
[2]Ifremer, UMR 9220 ENTROPIE, Nouméa, New Caledonia
[3]MARBEC, Université de Montpellier, CNRS, Ifremer, IRD, Montpellier, France

Mangrove ecosystems are ecotones that play a major role in coastal carbon cycling, acting both as carbon sinks and sources. Outwelling processes contribute to the export of dissolved organic carbon and matter (DOC, DOM) to adjacent ecosystems. However, global DOC export budgets remain poorly constrained across contrasting geomorphic settings. Carbonate mangroves without riverine input are particularly underrepresented, limiting our ability to distinguish between autochthonous mangrove-derived DOC and externally supplied carbon. In this study, we quantified and characterized DOM export from a pristine, semi-enclosed carbonate mangrove bay in New Caledonia, connected to a lagoon by a single tidal outlet. Porewaters and surface waters were collected and analyzed for DOC concentrations, optical properties (UV-visible absorbance and fluorescence using EEM-PARAFAC) as well as in situ physicochemical parameters, and high-frequency current measurements for the tidal channel, over complete tidal cycles during cool and warm seasons. Our results reveal a net DOC export during both seasons, with fluxes approximately 2.3 times higher during the warm season than during the cool season (8.09 ± 5.72 and 3.47 ± 1.25 mmol C m^{-2} d^{-1}, respectively), likely reflecting higher DOM productivity at higher temperatures. Incoming lagoon waters were rich in protein-like fluorescence compounds, while outgoing waters were dominated by humic-like fluorescence compounds, similar to those observed in mangrove porewaters, confirming a mangrove soil origin of the DOM exported. Our findings highlight that carbonate, riverine-input-free mangroves export DOC at some of the lowest rates reported in the literature. This study emphasizes the need for geomorphic-setting-specific approaches in global mangrove carbon budgets.

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