An alternative pathway to restore a wetland - the restoration story of Long Swamp (within the Glenelg River and Discovery Bay Ramsar Site), Victoria, Australia.

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Building a consensus for action to restore wetlands can be a tricky business, especially when the history of a site is shrouded in confusion as a result of conflicting early accounts and fading memories, as well as a wide range of modern subsequent assumptions and interpretations which, as a result of ecological shifts, have sometimes taken on a life of their own.

This is the story of how Nature Glenelg Trust (NGT) was able to build a consensus for action, through a blended approach that used a thorough investigation of a range of historic materials (such as early maps, journals, government files and newspaper articles), in combination with the use of modern scientific tools (e.g. GIS tools and modelling), to provide a sound platform to inform restoration planning and works.

This was not simply a theoretical exercise however, with restoration trials implemented to help answer our final technical questions. This allowed NGT to propose a permanent solution with a level of confidence sufficient to gain support from the local community and government agencies with an interest in the site.

The result today, several years since NGT became involved, is that Long Swamp in Discovery Bay Coastal Park has now successfully had its hydrology permanently restored, and, thanks to local community advocacy and State Government support, is also part of Victoria's newest Ramsar site (Glenelg Estuary and Discovery Bay Wetlands).

This approach to both science communication and wetland restoration is likely to be of great value at other complex sites.

China’s Coastal Wetlands in Thirty Years: Degradation Trend, Restoration Practices and Strategies for Function Improvement

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Healthy coastal wetland ecosystems play an important role in guaranteeing territory ecological security and sustainable development of China, yet their changing status is largely unknown. In this paper, the current status of China’s coastal wetlands and its change during the past 30 years were analyzed based on spatially constrained manual interpretation of nationwide high-resolution images in 2017. The results showed that China’s coastal wetlands have decreased significantly as a result of continuing population growth, large-scale infrastructural developments, extensive land reclamation projects, and the ineffective control of various types of pollution. Coastal human activities in China are found to change shoreline evolution and wetland hydrology, to deteriorate soil and water quality, to alter vegetation succession, benthic animal and microbial communities, and fisheries, and to impair ecosystem functioning and services. In order to alleviate the degradation of its costal wetland, China has made grate efforts in coastal wetland conservation by implementing coastal wetland restoration projects, establishing coastal protected areas, and launching sustainable development schemes. Our interpretation demonstrates an urgent need to arrest the decline of China’s coastal ecosystem, which could be achieved by developing a multi-objective, multi-scenario, and multi-scale framework that integrate research institutes, production sectors, policy makers and users of coastal wetland resource.

Greater Wellington Regional Council's Healthy Waterways programme: Expanding our wetland management toolbox

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Greater Wellington Regional Council's Healthy Waterways programme supports landowners throughout the Wellington Region to restore and manage natural wetlands and waterways on their land. The programme has been in place since 2016. As part of this programme, Greater Wellington provides advice, assistance, and incentives to landowners for key wetland management activities including fencing to exclude stock, pest plant control, pest animal control and planting. We have recently been exploring the opportunity to add further wetland management tools to our toolbox. Over the past year we have embarked on a project to restore the hydrology of an existing natural wetland and construct a wetland for biodiversity and water quality enhancement. This presentation will introduce the programme and delve into the learnings so far from this project.

Hyperspectral Estimation of the Chlorophyll Content in Short-Term and Long-Term Restorations of Mangrove in Quanzhou Bay Estuary, China

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The chlorophyll content can indicate the general health of vegetation, and can be estimated from hyperspectral data. The aim of this study is to estimate the chlorophyll content of mangroves at different stages of restoration in a coastal wetland in Quanzhou, China, using proximal hyperspectral remote sensing techniques. We determine the hyperspectral reflectance of leaves from two mangrove species, Kandelia candel and Aegiceras corniculatum, from short-term and long-term restoration areas with a portable spectroradiometer. We also measure the leaf chlorophyll content (SPAD value). We use partial-least-squares stepwise regression to determine the relationships between the spectral reflectance and the chlorophyll content of the leaves, and establish two models, a full-wave-band spectrum model and a red-edge position regression model, to estimate the chlorophyll content of the mangroves. The coefficients of determination for the red-edge position model and the full-wave-band model exceed 0.72 and 0.82, respectively. The inverted chlorophyll contents are estimated more accurately for the long-term restoration mangroves than for the short-term restoration mangroves. Our results indicate that hyperspectral data can be used to estimate the chlorophyll content of mangroves at different stages of restoration, and could possibly be adapted to estimate biochemical constituents in mangrove leaves.

Restoring ephemeral wetlands through community participation - a dry wetland is part of the outcome not a sign of degradation

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Ephemeral wetlands have been subject to degradation and conversion to alternative land uses, and at times unrecognised as wetlands when they are dry. Or if they have been recognised the dry phase has been seen as an unhealthy state. In Australia these perceptions have gradually been changing as communities have been engaged in restoration efforts and ongoing management. However, the issue of dry still remains a public and managerial problem - how do we convince the wider community that a wetland can be dry? And that it should be valued as such, and not seen as unhealthy? With this in mind two examples from inland Australia are examined. One is a large ephemeral lake, Lake Cowal, that sits alongside a gold mine and farming properties and has an innovative foundation in place to encourage conservation and education efforts. The other is a decommissioned irrigation reservoir that is guided by an expert scientific panel that advises the community-based management committee and holds an annual science forum. Are they successful? The answer is yes, but still the perception that dry is bad persists. What else can be done to change this ridiculous attitude? Education yes, but of whom? The wider community, the politicians and our fellow scientists and managers all need to come in from the wet and embrace the dry.

Role of governance in sustaining wetlands restoration: Learnings from experiences of Indian National Wetlands Programme

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Wetlands restoration is as much about enabling ecological conditions that sustain diverse ecosystem services and biodiversity, as well as mainstreaming wetlands within societal development agendas. Achieving a fit between institutions and governance regimes and ecosystem dynamics operating at multiple spatial and temporal scale is crucial for achieving wetlands conservation and wise use outcomes. With India becoming a party to the Ramsar Convention in 1982, a national programmatic framework aligned with wise use approach has been shaped by the Ministry of Environment, Forest and Climate Change, enabling a shift from erstwhile protected area based management approaches. Despite an increase in coverage of sites under the national programme, loss of natural wetlands has continued, outpacing the conservation and management efforts. Patch-centric management of wetlands, especially for those located within protected areas, have turned out to be of limited influence on basin-scale land and water use related drivers of degradation. Wetlands Authorities, envisaged as special purpose institutions to ensure cross-sectoral engagement in planning and decision-making for wetlands, have been successful wherein leadership and political ownership distinct and clear. Creating separate financing arrangements for wetlands restoration from central government has created an inverted incentive structure, with the uptake in state's developmental planning processes being very limited. Local community driven wetlands restoration initiatives, on the other hand, have been relatively successful in addressing degradation and mobilizing citizen action. There is an urgent need to scale up wetlands restoration from a handful of sites to a pan-India coverage, taking into account the differences in governance settings.

Constructed wetlands with subsurface flow for nitrogen removal from tile drainage

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In 2018, three experimental constructed wetlands with horizontal subsurface flow were built to treat tile drainage from 15.73 ha watershed. The wetlands have a surface area of 79, 90 and 98 m2 and were planted with Phalaris arundinacea and Glyceria maxima in parallel bands. The substrate in the first two wetlands is gravel (4-8 mm) mixed with birch woodchips (10:1 volume ratio). In one of those wetlands, the water level is kept 10 cm above the surface, in the second one the water is kept below the surface. The third wetland has 20 cm layer of birch woodchips on top of gravel. The monitoring started in August 2018 and in this abstracts results are reported until February 2020. The mean inflow total nitrogen concentration of 13.6 mg/l was reduced to average concentrations of 4.9, 4.6 and 3.8 mg/l, in wetlands 1, 2 and 3, respectively and the respective average removal efficiencies amounted to 64%, 66% and 72%. The average load removals amounted to 0.47, 0.33 and 0.37 g N m-2 d-1 or 1715, 1193 and 1362 kg ha-1 yr-1 in wetlands 1, 2 and 3 respectively. The plant uptake and nitrogen sequestration in aboveground biomass contributed only marginally to the overall nitrogen removal. Among the three variants, the one with shallow water on the surface has exhibited the highest removal of nitrogen from tile drainage so far.

Doubling the extent of wetlands on dairy farms – what will it take?

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More than 90% of New Zealand's wetlands have been drained to increase land available for primary production over the last 150 years. Between the early 2000's and approximately 2015 the number of dairy cows increased from around 3.5 to 5 million and with the increase in production, associated contaminant losses have been observed in many locations. Under the Dairy Tomorrow Strategy, the dairy sector has committed to leading efforts to improve the health of our rivers and streams and protecting and enhancing biodiversity. Given that much of the loss of wetlands occurred on land that is now under dairy production, dairy farmers have the opportunity to play a significant role in reversing wetland loss, and with that improve water quality outcomes. We will outline the dairy industry's approach to increasing the extent of wetlands. We will outline our efforts to date to see wetlands effectively recognised by regulatory processes so that farmers are incentivised to increase their spatial extent. We will also discuss perspectives on 'pollution swapping' associated with the interception and denitrification of nitrate in wetlands, which can generate a small amount of nitrous oxide. Considering the potential 'contraindications' of a water-based mitigation action on greenhouse gas emissions is critical to facilitate increasing the spatial extent of wetland in dairy landscapes.

Faecal indicator removal and generation (?) in agricultural wetlands

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A constructed wetland treating episodic (rain event driven) dairy pasture subsurface drainage was found to be a net exporter of the faecal indicator bacterium, Escherichia coli. Monthly monitoring of farm drainage to the wetland during the wetter months of the year indicated a relatively low median inflow concentration of 23 E. coli/100mL increasing to 98 E. coli per 100mL in the outflow. This is a surprising finding given that constructed wetlands treating steady-flow wastewaters usually achieve net removal of E. coli. Investigating if the increase in E. coli was an artefact of sampling biased towards flow recession after rain events entailed considerable flood-chasing work using time-based and flow-proportional sampling to calculate inflow and outflow fluxes (cfu/s) and loads (cfu/event and cfu/yr). Testing this "hypothesis" concluded that the wetland was indeed a net exporter of E. coli with increases in E. coli export ranging from 2 to 34-fold. Subsequent work has sought to understand if the export of E. coli is due to environmental "naturalized" populations of this bacterium that may survive and grow in the wetland. Further investigation into the diversity of E. coli isolates collected from water, sediment, soil and faecal material from the constructed wetland and adjacent pasture, found evidence of naturalised cryptic clades of Escherichia species phenotypically indistinguishable from faecally-derived E.coli but divergent at the genetic level. This raises interesting questions regarding the microbial ecology of E. coli and interpretation of E. coli-based water quality in relation to waterborne disease and health risk downstream from wetland environments.

Mitigating the potential for constructed wetlands to release dissolved reactive phosphorus

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Constructed wetlands (CWs) are one of the tools being utilised to mitigate agricultural diffuse pollution losses to waterways. However, in some situations they may be sources rather than sinks of dissolved reactive phosphorus (DRP). This is likely due to their creation on drained, fertilized areas where local, carbon rich top-soils have been added to the wetland to increase rates of denitrification and increase initial macrophyte growth rates. Draining of swampy soils for agriculture increases the rate of organic matter mineralisation and the conversion of organic phosphorus into DRP. This DRP can bind to soils in forms that are unavailable to pasture grasses and crops in aerated soils but can be mobilised if these soils become inundated and anoxic, through Fe and Mn reduction. Here we investigate the risk of DRP release following inundation for gley soils, an often-drained soil type that is common to lowland agricultural regions of New Zealand. To assess DRP release risk we have; 1) measured degrees of phosphorus saturation (DPS) in a range of gley soil types with different total P concentrations and chemical characteristics indicative of DRP binding potential, and 2) conducted assays to measure DRP release after inundation and subsequent de-oxygenation 3) tested a range of potential mitigation measures. We have identified a critical DPS threshold for DRP release from gley soil and identified some potentially effective mitigation measures.

Multi-ecosystemic services provided by artificial wetland receiving agricultural subsurface drained water

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Agricultural watershed suffers from a misbalance between crop activities and environmental protection. Exceed fertilizers or synthetic products ended in surface water bodies, especially in context of subsurface drainage degrading dramatically water quality for aquatic life. Additionally to best management practices at farm scale, buffer zones help by intercepting drained water to reduce non point source pollution. Those mitigation zones nevertheless provide other ecosystemic services.

We present ecosystemic services assessment of an artificial wetland receiving the drained water from a 400ha watershed in conventional agriculture in Paris suburb at Rampillon (CW; 5600m²; 2600m3), built in 2010, France, corresponding to a surface ratio of 0.15% with upstream connected watershed.

Flood mitigation is strongly limited due to the weak storage volume. Pollutant mitigation due to mainly microbial activities led to reduce 12% of annual nitrogen by denitrification, and 30% of total pesticide annual fluxes. Regulation services strongly depends on seasonal and pesticides properties. GHG and carbon balances were calculated to be less than 0.03% for N2O emitted from denitrification, and emit 1005 kg/ha of CO2eq. Based on biodiversity surveys (8 taxonomic groups), the 0.5ha of artificial wetland supports about 60% of local species compared to regional survey. These field results were transferred to local stakeholders by implementing an educational path supporting the recreation services. In parallel to the upscaling approach, involvement of stakeholders was stimulated by testing participatory approach based on perception of biodiversity, prospective scenario, and roleplay in order to manage better a socioeconomical territory coupling agricultural production and environmental protection.

Saturated and integrated buffer zones as novel drainage mitigation measures in Denmark

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Vegetated buffer strips (VBSs) along watercourses have been introduced in many European countries to mitigate impacts on water quality and ecological quality of watercourses by reducing inputs of sediment and nutrients from surface runoff on intensively managed agricultural land. However, the effectiveness of VBSs was proven to be low for the retention of dissolved nutrients (NOx, PO43-), especially when agricultural drainage water was directly discharging to streams via tile drainage pipes. Therefore, two new drainage mitigation measures namely saturated and integrated buffer zones (SBZs and IBZs) have been implemented at test sites and studied during the last five years in Denmark for their retention efficiency for nitrogen and phosphorus. Tile drain pipes were disconnected at the sloping field margin to the riparian zone by diverting drainage water either to a buried, lateral distribution pipe running parallel to the stream (SBZ) or charging a pond combined with a sub-surface flow infiltration zone planted with vegetation (IBZ). Altogether, six sites were intensively monitored over a period of 2-5 years to evaluate the nutrient removal efficiency of SBZs and IBZs. Depending on the water inflow, physical soil characteristics, water saturation of soils and dominant vegetation type, a substantial fraction of the water can infiltrate the soil before reaching the watercourse. While the results on total nitrogen removal were promising for both systems with mean removal efficiencies between 31% and 76 % of the load, a risk of phosphorus release occurred at higher summer temperatures or if the buffer zone had organic soils.

Surface flow treatment wetlands support native biodiversity in intensified agricultural landscapes

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Wetland drainage to convert land for agriculture has contributed to declines in water quality, biodiversity, and ecosystem services globally. Remediation options include constructing surface flow treatment wetlands (CTW) to intercept and treat agricultural runoff to improve water quality and biodiversity. To inform biodiversity management in surface flow CTW, we surveyed the vegetation and fauna assemblages in five established CTW in a lowland, pastoral landscape in the central North Island, New Zealand. The CTW had been established for between 3-19 years, planted with a restricted variety of native plant species, and fenced to exclude livestock access. Larger wetlands hosted significantly more plant and mammal species. However, other than wetland size, we found few other significant relationships between wetland habitat, landscape characteristics, and measures of biodiversity (total species, proportion of native species, and number of specialist or rare/threatened species). We recorded 113 plant, 20 bird, 5 mammal, 85 terrestrial invertebrate, 47 aquatic invertebrate, 6 fish, and 2 amphibian species inhabiting CTW. Native species comprised 96% of the total aquatic invertebrate fauna identified. Otherwise, native flora and fauna accounted for half or less than half of all species identified: 53% terrestrial invertebrate, 50% fish, 45% bird, 32% plant, 0% amphibian and mammal species. Few wetland specialists (aquatic or wetland-adapted) and rare or threatened native species were detected. CTW supported native biodiversity, but further enhancement may require active management of exotic and pest species, followed by native species re-introductions to overcome limiting biotic factors such as competition and predation.

Effects of temperature on swimming capabilities of native New Zealand fish

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In recent years, the importance of fish passage has become increasingly recognized across the world. Special emphasis has been placed on the ability of fishes to migrate upstream to their spawning or rearing grounds through man-made barriers, such as instream culverts and dams. In New Zealand, swimming capabilities of native fish are not well studied and their ability to migrate past these barriers is only partially understood. Due to the large latitudinal and altitudinal variation within New Zealand, freshwater average daily temperatures range from 4°C to 28°C. It is important to understand how fish swimming performance may be impacted by temperature as fish populations are found across this range. In this study, the effects of temperature on the swimming capabilities of native fishes was assessed. The swimming capabilities of the juvenile life stages of inanga, koaro, banded kokopu, and redfin bullies were tested at 8°C, 15°C, and 26°C. To measure swimming ability, individual fish were placed in a swim tunnel where the water velocity increased in a stepwise fashion until the fish fatigued. Results show that at higher temperatures, the swimming abilities of all fish species decreases. It was also observed that across all temperatures, inanga are the weakest swimmers and koaro are the strongest. This has implications for fish passage designs to ensure that even weak swimming species can migrate upstream in warm waterways to their natural rearing habitats. As the climate continues to warm, it is important to understand how these fish may be negatively impacted.

Freshwater Mussel Monitoring in Auckland Lakes – Program Design and Initial Results.

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Concurrent 7C, October 13, 2021, 2:30 PM - 5:00 PM

Freshwater mussels are threatened keystone species and provide a myriad of ecosystem functions in lakes. To date there has been no quantitative assessment of these species in the Auckland region. Very little is known about their regional distribution and population dynamics. We wanted to create a monitoring program that would establish a regional distribution, baseline population assessment, identify key impacts/extent limiting factors as well as inform predictive models that will aid in future species management. Currently used survey methods were not able to satisfy these outcomes and a new approach was needed. We developed a stratified survey method that was rapid, repeatable, applicable to all lake environments and able to provide high resolution data and habitat mapping. The initial surveys have provided critical insights into the freshwater mussel population in Auckland lakes. The mortality rates are as high as 85% with no evidence of successful recruitment occurring, there is limited representation of size classes with majority of individual being 51 mm or larger. These results emphasis the urgent need for targeted monitoring and management before these species are completely lost from the regions lakes. Key extent limiting attributes have been consistent and habitat preferences have been established. Preliminary lake scale distribution prediction models have been successful and show promise for increased accuracy as data is obtained. This pilot project has provided the platform on which to launch a region wide monitoring program and establish targeted management plans focused on managing threatened species and improving in-lake biodiversity.

IDENTIFYING THE IMPACT OF NON-NATIVE BROWN TREE FROG, LITORIA EWINGII, ON NEW ZEALAND POND SYSTEMS.

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Concurrent 7C, October 13, 2021, 2:30 PM - 5:00 PM

Australian brown tree frogs (Litoria ewingii) have spread across New Zealand for decades. Their tadpoles have been widely observed, but their effects on New Zealand pond ecology are unknown. New Zealand has few anurans and none with fully aquatic tadpoles, so the presence of a large generalist herbivore, often at high densities, could potentially have strong effects. Moreover, the faunas of temporary ponds likely occupied by L. ewingii tadpoles are also vulnerable because of increased magnitude drying events associated with climate warming. We surveyed ponds ranging from temporary to permanent in the Cass Basin, Canterbury, to identify the types of ponds used by L. ewingii tadpoles, and to assess breeding frequency and natural densities. They seem to be opportunistic colonizers, because they were found in high densities in fishless temporary ponds. To determine the functional role of tadpoles at different densities, we also carried out a mesocosm experiment with 4 different tadpole densities, shading half of them to simulate more permanent ponds. Shaded mesocosms were cooler, and tadpole growth was consequently slower. Tadpoles significantly grazed down macrophytes and altered macroinvertebrate community composition. Therefore, tadpoles are likely to have large influences on ecosystem processes like nutrient cycling in small lentic habitats, and due to their grazing of aquatic plants, could fill a functional role not currently occupied. Therefore, the spread of these frogs in New Zealand may need to be more carefully considered, especially in light of other influences on temporary pond ecosystems due to climate warming.

Quantifying spatial and temporal patterns in whitebait research: a semiquantitative review

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Concurrent 7C, October 13, 2021, 2:30 PM - 5:00 PM

Aotearoa's whitebait fishery is made up of five species of amphidromous fish, three of which are endemic. Four of the five species are declining and there is an urgent need to improve our understanding of the threats they face, along with a more general understanding of their population dynamics. To this end, and more generally there is a growing body of literature examining aspects of the ecology of whitebait here in Aotearoa and more widely across the southern hemisphere. While there have been reviews conducted on aspects of whitebait's ecology, these have been achieved using a narrative approach, there has not been a quantitative review of whitebait research. Here, we conducted a semiquantitative literature review of research focusing on whitebait across the southern hemisphere. Specifically, we analysed the spatial patterns of whitebait research, produced collaborator networks, and used topic modelling to understand how research trends have changed through time. Our research highlights major trends in whitebait research over the past 70 years, and more importantly highlights under researched areas suitable for future focus.

Surface sediment bacteria as indicators of lake health in New Zealand.

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Concurrent 7C, October 13, 2021, 2:30 PM - 5:00 PM

Lakes provide key ecosystem services and are culturally significant. However, lake environments are vulnerable to perturbations and this is being exacerbated by increasing anthropogenic pressures. Surface sediments act as a natural archive accumulating chemicals and nutrients, often derived from the lake catchment. Microbial taxa are numerically dominant in surface sediments and play critical roles in biogeochemical cycling. Their rapid responses to changes in environmental conditions means that they have a potential to act as indicators of lake health. Here we utilise high throughput sequencing of the 16S rRNA gene to investigate the spatial patterns of surface sediment microbial communities from ~280 lakes spread along the latitudinal gradient of New Zealand. We attempt to ascertain the drivers, including land use pressures and nutrient dynamics, of changes in microbial communities on a national scale. Furthermore, using a subset of data consisting of lakes which are regularly monitored, we identify bacterial taxa which are indicative of different levels within the trophic lake index. Investigating the correlations between these indicative taxa and a variety of environmental variables may provide an improved understanding of what pressures are driving changes in lake health in New Zealand. These data will provide a better understanding of how microbial communities can be incorporated into the monitoring of lake health and demonstrate the potential of using microbial changes to inform lake management.

Community based planning to ensure Ecosystem based solutions: A case study of Jagdishpurreservoir Ramsar site in Nepal

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Ecosystem based solutions are widely discussed to manage common property resources globally. With changing climate and socio-economies, these solutions are instrumental in adapting such negative changes, and making ecosystem resilient. Wetlands, with less than 0.1% of global land use, are highly diverse ecosystem and instrumental in maintaining ecosystem health, and water recharge. Nepal, a signatory to the conference of Parties to Ramsar convention, declared ten wetlands of global importance under Ramsar sites. Jagadishpur reservoir is one among ten declared Ramsar sites in Nepal Fisheries, ecotourism and additional source of local income that the wetland has been contributing to local livelihoods.
While considering the number of challenges to manage this important wetland, a participatory comprehensive management plan has been developed applying participatory tools, focus group discussions, key informant survey, and stakeholders' consultations. An Institutional analysis is done, with particular focus on Nepal's new federal governance regime. The management plans adopted DFID sustainable livelihoods framework (SLF), and Ostrom's framework on institutional development for common property regimes. The management plan suggests a participatory management committee representing local communities, and representing all tiers of government entities, identified critical ecosystem based solutions such as vegetative spur, discourage cement based infrastructure, and plantation of water friendly tree species around the reservoir. Management decisions are also suggested in a coherent way with ecosystem based solutions, considering ecosystem landscape of the reservoir. This plan further suggests, ensuring habitat of migratory birds, eco clubs and community based anti-poaching squad for proper implementation of activities envisioned in the plan.

Developing a database of land use actions to improve river health

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The health of our aquatic ecosystems is under pressure, but many farmers, community groups, iwi/hapū/whānau, forest managers and others are doing things to improve the situation. Unfortunately, it is unclear what is being done, where it's being done or how much is being done, because little of this information is recorded. Therefore, we are missing the opportunity to learn what actions are most effective at improving outcomes at a catchment scale. Similarly, the efforts that people have made are not visible and therefore not acknowledged by the wider community. A 3-year project funded by the Our Land & Water NSC is aiming to build and populate a register of information on land management actions. Our initial work focused on understanding the range of purposes that people see for the register, so it can be designed to meet their needs. Subsequent work on indicators of land use actions from Te Ao Māori and scientific perspectives is further influencing register design. Initial testing of the register is underway with data providers and within four focus areas, including two Māori-led pilot catchments where we are working with Māori entities and iwi/hapū/whānau. We are addressing challenges related to reporting information at a meaningful scale while protecting confidential information, and trying to balance the tension between recording enough detail to be useful without making data provision too demanding. We are also building a business case to help ensure that the register will have a life beyond the term of this project.

Nitrogen signatures and transformations in a constructed wetland system

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Nitrogen compound concentrations in modified urban streams can be very high, often exceeding toxic concentrations, which can have a significant effect on downstream ecological health. To better understand and assess nitrogen compounds and transformations along heavily modified urban streams and the benefits of treatment with a receiving wetland system, water quality monitoring was conducted in the Haytons Stream/Wigram basin system of Christchurch, New Zealand, during different seasons and under different flow conditions over a recent two-year period.
Nitrogen compounds were analysed in terms of ammoniacal and oxidised nitrogen (inorganic nitrogen) and particulate and dissolved organic nitrogen. Results showed that average total nitrogen (TN) concentrations were the highest in the middle of the stream (10.2 mg/L) and the lowest concentrations were at the outlet of the wetland (1.8 mg/L).
TN concentrations were greater under stormflow conditions (SF) compared to baseflow conditions (BF). Under BF, nitrogen was mostly in its inorganic form in the upper and middle part of the stream and in its organic form in the wetland; under SF, the majority of the nitrogen was in its organic form indicating contribution from catchment runoff and resuspension of bed sediment under turbulent conditions. In the wet season TN concentrations were lower than in the dry season.
The constructed wetland acted as a buffer, maintaining TN concentrations stable under different flow and weather conditions. Furthermore, it converted inorganic to organic nitrogen, mainly in the form of algae and/or other microoganisms, which can be removed through physical processes such as filtration and sedimentation.

Social-ecological mismatches in wetland ecosystem management: Diverse mechanisms can achieve equity across interest groups

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Concurrent 7D, October 13, 2021, 2:30 PM - 5:00 PM

The diverse range of interest groups and their activities within catchments can challenge wetland management. To better inform decision-making, we investigated the desired social and ecological states that multiple groups associate with wetlands, and mechanisms/constraints to achieve those states. Specifically, we investigated whether the desired states were conducive to the application of kaitiakitanga (Māori environmental guardianship) by tangata tiaki (Māori environmental guardians).
Interviews were conducted with 44 participants: 13 landowners, 14 tangata tiaki, 14 Crown (government) representatives, and 6 recreational hunters.
Findings show that all groups shared a similar desired state of biologically healthy wetlands. However, tangata tiaki desired state was centred on 'biocultural' wetland health, which embeds culture within a holistic (catchment-wide) perspective of the environment and elevates Māori self-determination. Despite landowner commitment to biological wetland health, the desire for economic outcomes, from what was largely intensive farming, was a major constraint to achieving biological or biocultural wetland health. Different groups agreed about what mechanisms (e.g. funding, policy, collaboration) could improve biological health, which can help groups to collaborate on common goals. Social-ecological scale mismatches in wetland management were uncovered, including lack of power-sharing and spatially fragmented management, which most impacted tangata tiaki, showing a non-Indigenous view of wetland catchments being essentially privileged in current wetland governance and management. We advocate for a biocultural approach that enables kaitiakitanga to foster both biological and cultural diversity by addressing social-ecological mismatches at individual, community and policy levels.

Developing stream temperature models for an urbanizing catchment: an approach using spatially balanced sampling and biologically relevant metrics

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Concurrent 7E, October 13, 2021, 2:30 PM - 5:00 PM

The thermal regime is a critical regulator of ecosystem structure, function and habitat suitability for aquatic taxa. Climate change impacts on thermal regimes are predicted to be severe for aquatic ecosystems, but how these impacts manifest in urbanizing watersheds remains unknown. Here we (1) investigate the primary environmental drivers of several biologically relevant summary metrics of stream-water thermal regimes in an urbanizing catchment and (2) develop robust statistical models that describe spatio-temporal variation in these water temperature summary metrics. To do this, we collected water temperature data continuously at 15 minute intervals from temperature loggers deployed across 82 streams around the city of Melbourne (using a spatially balanced sampling framework), in south-eastern Australia, over a 3 year period. Model environmental predictor variables were informed by mechanistic and process-based understanding of stream thermal energy budgets and a review of stream-temperature modelling studies, and included climatic, topographic, hydrologic and land cover attributes. Preliminary modelling indicates that metrics describing important aspects of the summer water regime (i.e. mean annual and 99th percentile summer stream-water temperature) are positively influenced by catchment area, attenuated imperviousness (weighted measure of urban stormwater runoff), and mean air temperature records but negatively influenced by forest cover. Our current models will allow us to map predictions of water temperature regimes across the greater Melbourne region under different land-use and climate-change scenarios. These maps will be invaluable in identifying potential thermal habitat shifts of aquatic biota and for the development of successful long-term strategies to protect aquatic biota within the region.

Organic matter pulses influence ecosystem productivity and food web structure in experimental mesocosms

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Concurrent 7E, October 13, 2021, 2:30 PM - 5:00 PM

Understanding the pathways of energy transfer through the food web is fundamental to understanding ecosystem function. In Australian lowland river systems this is often a difficult task as the basal resources supporting river food webs substantially change during hydrological fluctuations such as flood events that result in large inputs of organic matter from upstream and floodplain environments into river channels. To help understand how resource pulses of organic matter during flood events influence food web production and energetic pathways we conducted a five-week mesocosm experiment testing how additions of an organic matter solution influenced ecosystem productivity, biomass and assemblage structure. The experiment was conducted in a new mesocosm facility consisting of ten 2000 L circular flume mesocosms, each fitted with paddles to maintain flow rates equivalent to lowland systems, with a natural planktonic assemblages of micro and macroinvertebrates and the addition of larval fish. Productivity varied between treatment (organic matter addition) and control (no addition) with significantly higher production and respiration occurring the treatment during the first two weeks of the experiment. Algal and zooplankton assemblages and biomass varied between treatments and time with significantly higher biomasses occurring in the initial weeks of the experiment. The results reveal how resources pulses of organic matter lead to a trophic upsurge through aquatic food webs and the importance of protecting flood events in lowland rivers to maintain and improve ecosystem productivity.

Seasonality in the trophic base of intermittent Alpine streams

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Concurrent 7E, October 13, 2021, 2:30 PM - 5:00 PM

Flow intermittency in Alpine headwater streams drives variation in ecological function. For example, the trophic base of benthic macroinvertebrate assemblages may shift from terrestrial sources to an increasing reliance on periphyton in more highly intermittent streams. Yet Alpine streams are highly seasonal, with pronounced periods of both increased and decreased flow throughout the year. Benthic macroinvertebrates in Alpine streams can also exhibit high plasticity in feeding behaviours. While variation in the trophic base of Alpine streams can be affected by flow intermittency, the seasonality of this effect has not been previously examined. Here, we used stable isotope (δ13C and δ15N) analysis to compare the trophic base of macroinvertebrate assemblages across three seasons (Alpine spring, summer and autumn) and across a gradient of flow intermittency in headwater streams of Val Roseg, a glacierized catchment in the Swiss Alps. Our hypotheses were that: i) the effect of flow intermittency would be greatest in summer, corresponding with the greatest extent and frequency of drying events; and ii) the effect would be greatest in specialised primary consumers (e.g., grazers). Initial results suggest that the effects of flow intermittency on benthic macroinvertebrates were strongest in summer and for primary consumers, although variation in periphyton isotope signatures across seasons complicates source discrimination. We compare these results to those of related field experiments and in the context of future climate-driven changes to Alpine stream flow regimes.

The conservation challenge of protecting recently discovered subterranean wetlands and stygofauna in northern Australia

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Concurrent 7E, October 13, 2021, 2:30 PM - 5:00 PM

Karst and other subterranean hydrological systems are recognised worldwide for the uniqueness of their hydrological and ecological processes and the endemism of their species. The importance of protecting and conserving subterranean karst wetlands was recognised by the 1996 Ramsar meeting (CoP6) and guidelines for identifying karst and other subterranean aquatic systems were provided at the 1999 meeting (CoP7). The recent discovery of stygofaunal assemblages in the subterranean environments of the karstic Tindall Limestone aquifer in the Northern Territory, Australia, revealed the presence of multiple new species, predominantly Crustacea, all endemic to this system. This system likely constitutes an evolutionary refugium - a permanent groundwater-dependent habitat that supports rare and endemic species that have persisted over millennia. Molecular analysis of a predatory species at the top of the subterranean foodchain, a blind and colourless shrimp, Parisia unguis, previously described from caves within the region, revealed low genetic divergence across a geographic distance of ~300km. This range is likely to be extended with further sampling. This finding supported previous studies, undertaken with environmental tracers, that this karstic system is a highly connected aquifer. The connectedness of the aquifer indicates a significant risk from contamination by pollutants. Historically, groundwater use within the region has been low, mainly supporting remote settlements and cattle stations. However, an emerging shale gas industry (involving fracking) and proposed intensive agricultural and horticultural developments, indicate that maintaining the quantity and quality of the groundwater resource that supports these subterranean systems and their stygofauna will be both important and challenging.

The impact of storm pulses on DOM concentration and composition in Australian Alps peatlands

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Concurrent 7E, October 13, 2021, 2:30 PM - 5:00 PM

Peatlands are important sources of dissolved organic matter (DOM) for freshwater ecosystems. Extreme events (e.g. storms, fires) can alter the composition of DOM derived from peatlands, which is likely to impact the downstream aquatic ecosystems. The impact of heavy storms on the composition of peatland-derived DOM is largely unknown in the Australian Alps. This study aims to assess the impact of storm pulses on the quality (composition) and quantity of DOM in peatland streams on the Bogong High Plains, near Falls Creek, Victoria, Australia. Water samples were collected during two storm events over 10 time periods encompassing pre, during and post storm event, at the beginning (November-December 2019) and end (February-March 2020) of the productive season. Preliminary results show that the storm-driven dissolved organic carbon (DOC) concentrations increase up to four-fold in stream water while carbon loads increase ten-fold. DOM characterization via fluorescence excitation emission scans followed by parallel factor analysis (PARAFAC) revealed the presence of humic-like (C1; 40 -55%), fulvic-like (C2; 35-40%) and protein-like (C3; 5-10%) components in the catchment, with no significant difference in relative abundance of these components over the storm pulse. Moreover, the increased values of spectral slope and fluorescence index indicate the presence of higher amount of more labile autochthonous DOM during the storm pulse. This research provides important insights into how DOM may change in response to expected extreme hydrological events and has implication for peatland management in the context of a changing climate.