greenminds

greenminds insight paper

Developing a Blue Carbon Methodology to Support Seagrass Restoration and Protection: Plymouth Insights

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Green Minds Model summary

The Green Minds Model aims to summarise the structure of the GM approach, to aid its transfer and replication to other urban areas and authorities.

Green Minds piloted new ways of implementing nature-based solutions within an urban environment. The project's central aim was to collaborate with stakeholders to recognise how humans, as part of nature, interact with nature in a complex system and to identify ways in which *systemic* change is brought about.

The model is presented as an integrated approach, where various nested elements are shown working together as a system. It reflects the particular challenges and scales of focus in urban areas - from individuals, to communities and neighbourhoods and at a citywide level. It focuses on particular leverage points for change (best practices) with regard to nature in cities, and is guided at its core by a set of underlying principles to inform practice.

At the centre of the model sits the system goal - *Urban Wilding. A set of guiding Principles have been created to inform the practice of Urban Wilding. These principles have emerged from our experiences designing and implementing Urban Wilding in Plymouth.

The eight Principles that have emerged from our programme of testing and development represent key leverage points to effect system change and to successfully integrate nature within urban place shaping. This includes exploring deeply held beliefs and values around our relationship to nature and to others, the creation of new organisational and digital infrastructures which empower citizens, and the development of new policy, planning and financial frameworks to support this.

Complex systems can behave differently at differing scales and so these are reflected too in the model to recognise the importance of understanding *who* needs to be engaged and *how*. This takes into account the need for multiple perspectives and the importance of equity (who participates), through an inclusive process of engagement from individuals to groups and organisations, and at neighbourhood and citywide scales.

Finally, the model acknowledges the importance of an ongoing and iterative co-design process. This process recognises that resilience requires the ability to adapt as solutions emerge within a complex and constantly changing environment. It is delivered through a cyclical, action learning approach in which lessons learned influence the next cycle of implementation to ensure a progressive approach.

The model is brought to life through our suite of Insight Papers, Guides and Case Studies which aim to illustrate how the model was implemented and what we learnt.

Green Minds Urban Wilding Principles

The quality and quantity of nature has declined significantly in recent decades. Across the UK and Europe, nature recovery and restoration, rather than just preserving or conserving what remains, has become a high priority, as we have become more aware of society's dependence on nature[1].

We know that spaces that are more biodiverse can deliver multiple health and wellbeing benefits as well as other nature-based solutions such as improvements in water drainage, increased carbon sequestration, removal of air pollutants and increased pollination for food security[2]. 'Rewilding' has gained prominence as one approach to achieving such improvements in biodiversity, with a growing research body assessing its impact.

Urban (re)wilding, however, is still a new concept. We define Urban Wilding as 'any initiative, both human-aided and natural colonization, that aims to encourage biodiversity, ecosystem function and native species in urban settings'[3].

Urban Wilding is fundamentally different from wilding/rewilding/renaturing elsewhere. Cities and towns are dominated by human infrastructure and activity. Consequently, many natural ecosystem processes are significantly modified or constrained in urban areas. We rely upon ecosystem services for our health and wellbeing. Urban ecologies, which deliver these ecosystem services, are complex and poorly understood. However, we know that more biodiverse systems deliver more or better ecosystem services. We also know that we can mimic, or engineer, some specific ecosystem services such as storm water management. Whilst we don't know enough to design urban ecosystems to deliver all the services we need, we do know that more nature is good for people and urban living and that arranging it in certain ways can deliver certain specific benefits. We can't achieve this by doing nothing – positive interventions are required, which in turn demand enabling policy, community action and practical delivery mechanisms.

The Green Minds understanding of Urban Wilding recognises the need to shift from nature conservation to nature recovery - to focus on restoring much of what is rare or has gone and a recognition that we need to bring high quality Nature into places where people live.[4]

The Urban Wilding Principles below are designed as a set of prompts to help guide initiatives for nature to thrive in cities: to survive and reproduce, to expand, and to function as a system and so deliver more and better services to support urban environmental health, our economy, and human wellbeing.

*We have chosen to use the term 'wilding' instead of 'rewilding', as it better reflects the reality of nature in urban areas - to rewild implies a return to nature before urbanisation, which is not possible.

[1] Nature Recovery for Our Survival, Prosperity and Wellbeing: A Joint Statement by the Statutory Nature Conservation Bodies of the UK. jncc.gov.uk/our-role/the-uk/nature-recovery-joint-statement

[2] Dasgupta, P. (2021). The Economics of Biodiversity: the Dasgupta Review. London (HM Treasury); Maller, C. (2018) Healthy Urban Environments. Routledge

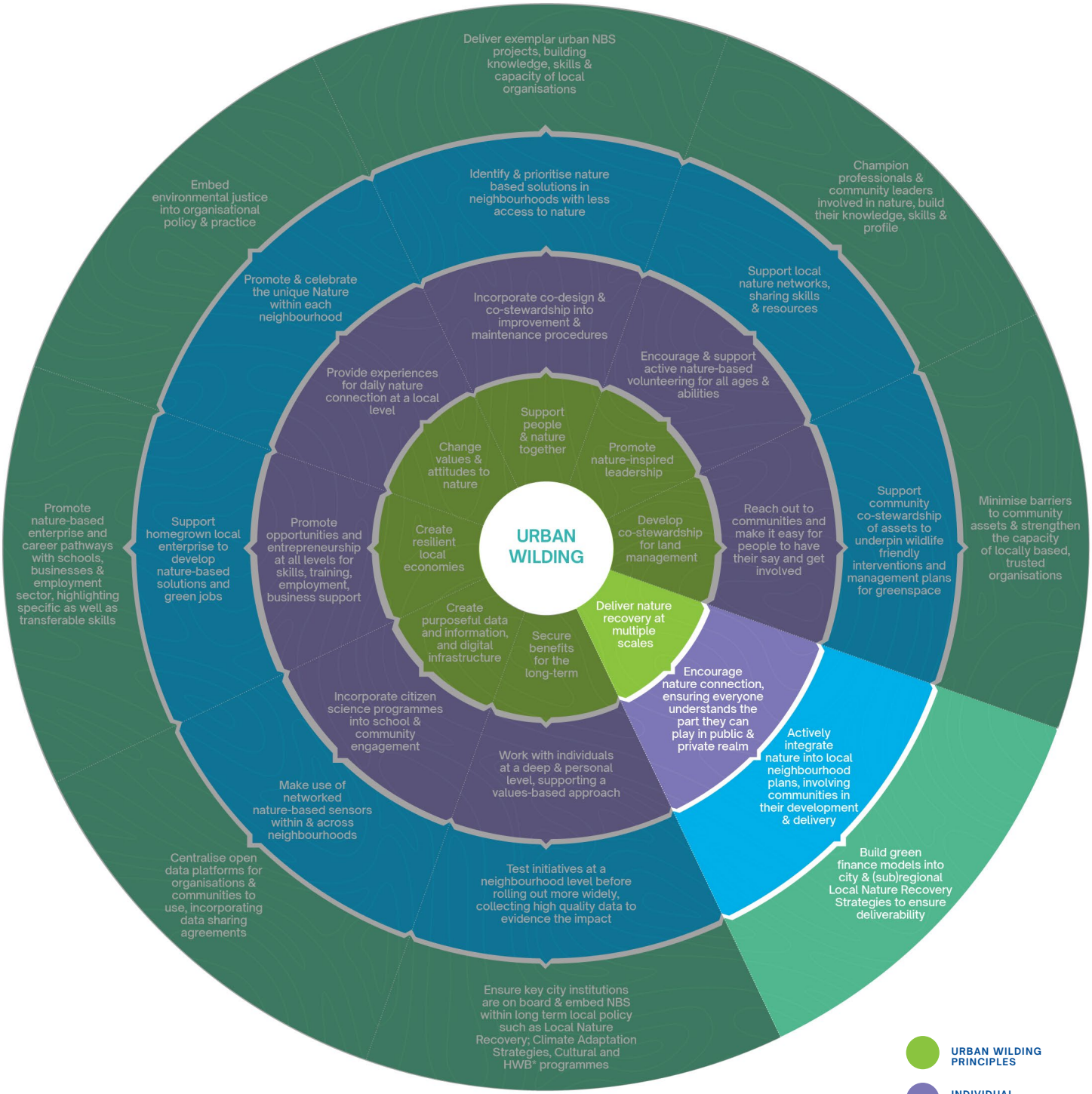
[3] Maller, C., Mumaw, L., & Cooke, B. (2019). Health and social benefits of living with 'wild' nature. Ch 9 in Rewilding. Pettorelli, N., Durant, S., and du Toit, J. (eds). Cambridge University Press

[4] Juniper, T. (2022) Tony Juniper: Green Paper – an opportunity for an integrated approach to Nature recovery - Natural England

greenminds model

The model illustrates the three system levels at which the Urban Wilding principles are applied to drive action: the individual, with neighbourhoods, and within organisations.

Permeability, both within and between segments, reflects the need for adaptability through local learning gained through an action learning approach, in which lessons learned influence the next cycle of implementation.



EUROPEAN UNION
European Regional Development Fund

*Health and wellbeing

Urban Wilding Principles

Support people and nature together

Promote a just transition to wilder cities through equitable access to nature, socially just policy and involvement in the co-creation and co-stewardship of nature-based solutions that are adapted to climate change, biodiverse and support nature connection.

Promote nature-inspired leadership

At all levels of management (individual, community/neighbourhood, city administration, business, etc) enable nature positive actions to enhance urban liveability through education, training, and policy.

Develop co-stewardship for land management

Democratise land management and ownership through the development of co-stewardship solutions with user communities, introducing inclusive and empowering processes for engagement, creating community assets, and utilising diverse governance structures.

Deliver nature recovery at multiple scales

Make the most of the local built environment and its scale, acknowledging that no space is too small to be valuable whilst at the same time recognizing that larger green spaces and high degrees of connectivity are key for nature recovery.

Secure benefits for the long-term

Develop integrated policy instruments that embed urban wilding in development practice, led by communities and advised and supported by public administrations to create resilient cities and a population connected to nature.

Create purposeful data and information supported by digital infrastructure

Develop new digital infrastructures to generate community-owned and insightful knowledge of urban nature to support nature connection, and nature-positive policy and practice.

Create resilient local economies

Promote and empower nature-related careers, cooperatives and social enterprise across all sectors, to create new jobs and new value in green and blue infrastructure.

Change values and attitudes to nature

Promote nature connection amongst citizens, to enhance individual and community wellbeing and to foster nature-positive choices.

Introduction

Globally, seagrass ecosystems are known for generating a wide range of ecosystem services including: the provision of food through fisheries,[1] improvement of water quality,[2,3] and carbon sequestration and storage.[4 5]

The Plymouth Sound National Marine Park is home to two species of seagrass. In 2005, Plymouth Sound and Tamar Estuaries Special Area of Conservation (SAC), was designated to protect a number of conservation features including subtidal and intertidal seagrass features Zostera marina and Zostera noltei. Management of the MPAs in Plymouth is coordinated by the Tamar Estuaries Management Plan (TEMP) developed by the Tamar Estuaries Consultative Forum (TECF), hosted by Plymouth City Council (PCC), and chaired by the Kings Harbour Master (KHM) for the Dockyard of Plymouth.

Currently, most projects seeking to achieve the creation, restoration or recovery of seagrass habitat rely on grant funding and donations. Through the Green Minds project we began the process of exploring the potential to sustainably finance seagrass habitat enhancement projects though the sale of a seagrass product or service linked to carbon sequestration and storage.

Very few studies have investigated carbon storage of seagrass beds in temperate regions and only one has been carried out in the UK[6]. **Therefore, Green Minds funding facilitated the sampling and analysis of sediment cores required to quantify carbon values linked to seagrass in Plymouth Sound.**

1 Bertelli, C. M. & Unsworth, R. K. F. (2014) 'Protecting the hand that feeds us: Seagrass (Zostera marina) serves as commercial juvenile fish habitat'. Marine Pollution Bulletin, 83 (2), pp. 425-429.

2 de los Santos, C. B., Olivé, I., Moreira, M., Silva, A., Freitas, C., Araújo Luna, R., Quental-Ferreira, H., Martins, M., Costa, M. M., Silva, J., Cunha, M. E., Soares, F., Pousão-Ferreira, P. & Santos, R. (2020) 'Seagrass meadows improve inflowing water quality in aquaculture ponds'. Aquaculture, 528 pp. 735502.

3 Moore, K. A. (2004) 'Influence of seagrasses on water quality in shallow regions of the lower Chesapeake Bay'. Journal of Coastal Research, (10045), pp. 162-178.

4 van Katwijk, M. M., van Tussenbroek, B. I., Hanssen, S. V., Hendriks, A. J. & Hanssen, L. (2021) 'Rewilding the Sea with Domesticated Seagrass'. Bioscience, 71 (11), pp. 1171-1178.

5 Sousa, A. I., da Silva, J. F., Azevedo, A. & Lillebo, A. I. (2019) 'Blue Carbon stock in Zostera noltei meadows at Ria de Aveiro coastal lagoon (Portugal) over a decade'. Scientific Reports, 9

6 Green, A., Chadwick, M. A. & Jones, P. J. S. (2018) 'Variability of UK seagrass sediment carbon: Implications for blue carbon estimates and marine conservation management'. Plos One, 13 (9), pp. 18

LEFT: Spider Crabs amongst Seagrass in Cawsand Bay

Developing a blue carbon methodology

Sediment cores were analysed at high resolution to gain a better understanding of the variability of carbon stock and accumulation rates with depth, providing insight into the carbon storage capabilities of Plymouth's seagrass beds over time.

Sampling method and location

9 sediment cores were collected from 3 seagrass sites across Plymouth Sound (Drakes Island, Cawsand and Jennycliff), each using a vibracorer that penetrated 3m deep.

Sampling processing[1]

Cores were prepared and analysed every 1cm for the top 50cm.

1. Cores were logged for grain size, colour, biota, patterns etc.
2. Sliced at 1cm intervals
3. Freeze-dried
4. Observed under the microscope
5. Sieved (Jennycliff cores only)
6. Ground and homogenised
7. Weighed (wet, dry)

Analyses

% Organic Carbon:

Analysed using an Elemental Analyser (EA) to directly measure Carbon, Hydrogen and Nitrogen content. Prior to analysis, all inorganic carbon in the form of Calcium Carbonate (CaCO3) was removed from samples. A subset of samples from Drakes Island were also analysed using the method of Loss on Ignition to test the feasibility of this method compared to an EA.

Lead-210 (210Pb) Dating:

This is one of the only feasible methods that can be used to age sediments and calculate sediment accumulation rates.[2]

1. Howard, J. , Hoyt, S., Isensee, K., Pidgeon, E. & Telszewski, M. (2014) 'Coastal Blue Carbon: Methods for Assessing Carbon Stocks and Emissions Factors in Mangroves, Tidal Salt Marshes, and Seagrass Meadows'. Conserv Int Intergov Oceanogr Comm UNESCO, Int Union Conserv Nature Arlington, Virginia, USA. Available from: thebluecarboninitiative.org.

2. Appleby, P. G., (2001): 'Chronostratigraphic Techniques in Recent Sediments, in: Tracking Environmental Change Using Lake Sediments'. Springer, the Netherlands, 1, pp. 171–203.

RIGHT: Sediment core sampling

What we have found so far

Results from Drakes Island (top 50cm)

Organic Carbon (OC) content at Drakes Island appears to be relatively high compared to other seagrass beds in the UK8 and observed peaks in OC content have been attributed to a large presence of coal, as a result of intense industrial activity around the period of WW1. OC content is highly variable among the cores and with depth, with the Core 3 showing much higher OC content and highest variability with depth.

210Pb dating results indicate that the top ~25cm of sediment is equivalent to the last ~100yrs. These initial results suggest that cores required to assess carbon stock and accumulation rates likely do not need to exceed the top 50cm, even 30cm of sediment.

Developing investment models

Our results so far show how variable carbon storage can be among seagrass sediments, both spatially across the seagrass bed and with depth. This is very important to consider when developing investment models for sustainable seagrass conservation.

Results have also highlighted the importance of determining sources of carbon within seagrass sediments and how this influences carbon stocks. It is difficult to determine how much coal contributes to the whole carbon stock of this seagrass bed at Drakes Island, however, it does reveal the anthropogenic influence in these types of coastal habitats and that this needs to be considered when evaluating carbon storage of seagrass sediments.

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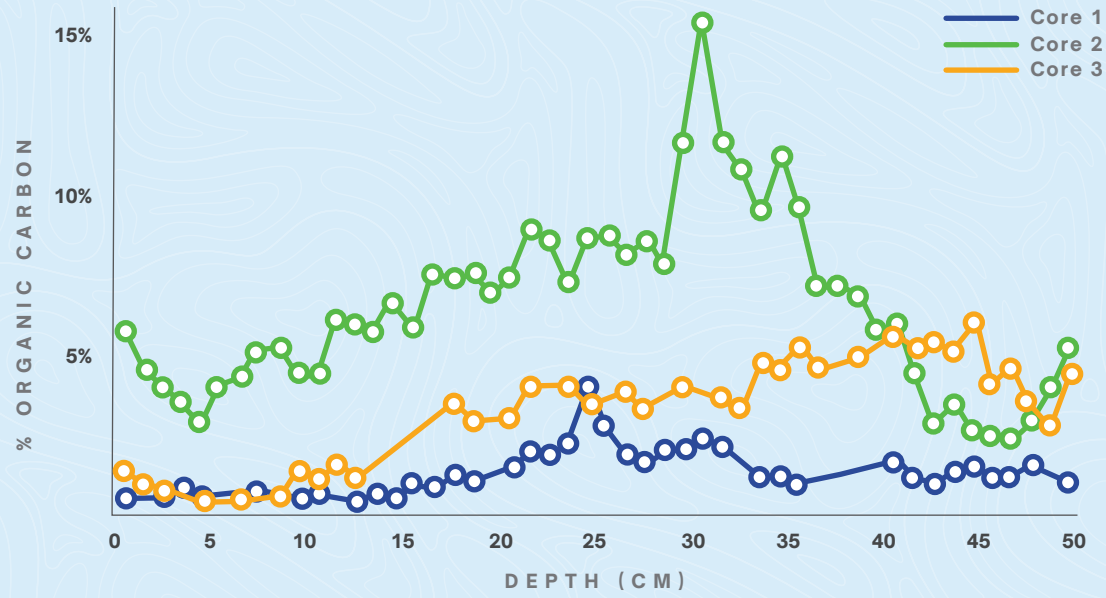
Organic carbon content percentages at Drakes Island



Graph showing % Organic Carbon content with depth, from 3 cores sampled at Drakes Island.

8 Green, A., Chadwick, M. A. & Jones, P. J. S. (2018) 'Variability of UK seagrass sediment carbon: Implications for blue carbon estimates and marine conservation management'. Plos One, 13 (9), pp. 18

Moving forward

Next steps

We have demonstrated that the seagrass beds in Plymouth Sound hold stocks of carbon which could potentially financially support wilding though the generation and sale of carbon credits. This would enable both protection and restoration actions.

For wilding to be successful under a sustainable finance model, there is a need for Plymouth City Council and TECF to implement governance that limits or removes certain activities and operations that could impact seagrass beds. This type of governance provides an increased opportunity for Plymouth City Council to foster an ecosystem management approach that blends blue and green spaces, as well as incorporates nature based solutions.

Further research is required to fully understand how the 'condition' (or health) of the habitat influences the amount of carbon stored; where the carbon originates from (from the seagrass or other sources), and the optimum environmental and physical requirements for rewilding at scale.

Protection and active restoration of seagrass beds will provide so many more benefits than carbon sequestration. It may then be possible to develop a blended sustainable finance tool that combines both the biodiversity and carbon benefits.

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Cramp, J., Attrill, M. & Fisher, J., 2023. Progress Report for Methodology of Sediment Carbon Stock Sampling, Sample Preparation and Analyses. A report by research staff at the University of Plymouth.