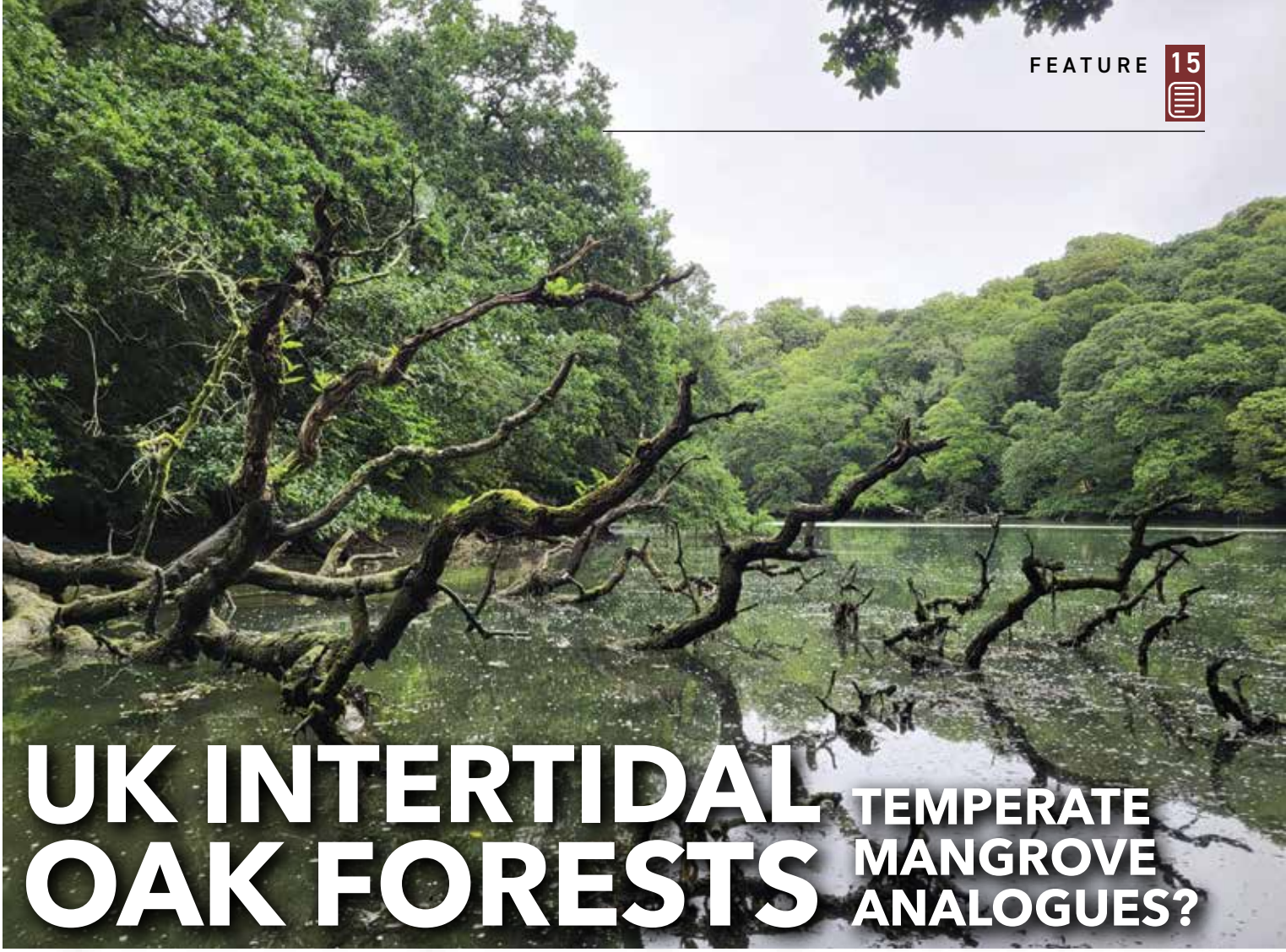

UK INTERTIDAL OAK FORESTS

TEMPERATE MANGROVE ANALOGUES?

Temperate, intertidal oak forests provide marine ecosystem services. By **Ian Hendy, David Jones, Joseph Sargent, Georgia Sharp-Harris, George Leggett, Dillan Barnes, Joshua Howell, Reuben Shipway,** and **Mark Tupper.**

Coastal marine vegetated habitats provide nature-based solutions to the challenge of climate change. Globally, they are worth $190 billion a year in terms of blue carbon sequestration alone, and UK marine ecosystems store more than 200 million tonnes of carbon.[1,2]

Mangroves, saltmarsh, seagrass, and kelp are considered essential fish habitats. Other ecosystem services include coastal protection from erosion and rising sea levels, food production, nursery function for vulnerable and juvenile organisms, bioremediation, and environmental buffering providing stable niches for many vulnerable and juvenile macro-benthic species.[3] Such services drive important trophic and nutrient pathways and help with connectivity, resilience, and robustness of marine ecosystems, all of which help mitigate climate change and improve the global economy.[4]

In the UK, saltmarsh, seagrass, and kelp habitats are disappearing at rates of 1 – 3 per cent per year, with studies reporting total losses of more than 80 per cent of these crucial habitats.[5] No wonder, then, that we see catastrophic declines in biodiversity, fishery biomass, water quality, and environmental health in the UK. The losses of saltmarsh, seagrass, and kelp can be attributed to coastal development, eutrophication, dredging, and coastal squeeze, reducing environmental resilience and impacting local economies.

Figure 1. Partially submerged oak branches, Frenchman's Creek, Helford River, Cornwall, UK. © Mark Tupper

There are coastal marine vegetated areas in the UK that have never been considered as an essential fish habitat, but should be for their ability to enhance coastal protection, significantly enhancing fish biomass and macro-benthic diversity. Picture a coastal forest within shallow, dendritic creeks, where the tree roots, trunks, and branches are immersed in fully marine seawater during high tides (Fig. 1). Hundreds of juvenile fish swim between the branches, with larger predators scouting the perimeter of the trees in search of exposed vulnerable baby fish. Upon the roots grow macroalgae, mussels, anemones, and bryozoans. Beneath the loose bark on the immersed roots and branches, many types of juvenile crustaceans can be found. During low tide, the branches are exposed, revealing the labyrinth of habitat complexity that offers protection to a myriad of species, with large pockets of deep mud trapping substantial amounts of organic matter. You could be forgiven for thinking that this is a tropical mangrove forest; however, these are coastal temperate ancient forests in the UK. Scientists from the Universities of Portsmouth and Cumbria have mapped the distribution of intertidal oak forests throughout England and Scotland and found that only around 141.2 hectares of these forests remain. Strongholds are in Devon and Cornwall, where 87.5 per cent of this habitat occurs (Fig. 2, Table 1). A few small patches also exist in Hampshire, northern England, and Scotland. Historical analysis of coastal oak forests is needed to determine how much has been lost to coastal ►

[1] https://www.nature.com/articles/s41558-021-01089-4
[2] https://www.mcsuk.org/ocean-emergency/climate-change/blue-carbon/
[3] Bioremediation uses microorganisms to degrade organic contaminants in soil, groundwater, sludge, and solids.
[4] https://royalsocietypublishing.org/doi/10.1098/rstb.2019.0104
[5] https://geoengineering.global/blue-carbon/

County	Number of Locations	Area (ha)	% of Total Area
Isle of Wight	6	6.9	4.8%
Hampshire	3	6.0	4.2%
Devon	8	63.1	44.4%
Cornwall	8	61.3	43.1%
Cumbria	1	0.1	0.04%
West Dumbartonshire	1	0.2	0.1%
Aberdeenshire	2	1.0	0.7%
Fife	2	1.1	0.8%
Stirlingshire	1	1.1	0.8%
Northumberland	2	1.4	1.0%

Figure 2. Map of the United Kingdom, showing the locations of intertidal oak forests.

Table 1. List of English and Scottish counties with intertidal oak forests and their respective areas.

development and agriculture. Currently, ecological studies of the functions of this ecosystem are being undertaken at sites on the Isle of Wight, Hampshire and in Falmouth, Cornwall (Fig. 2). The Helford oak forests are the largest such forest in the UK, forming an extensive mangrove-like habitat that spans around 50 km of intertidal coast. coast (see Fig. 3).[6]

The ecology and physiology of these coastal trees have never been studied in detail, but now, coastal and mangrove ecologist Dr Ian Hendy and his team, fisheries ecologist Dr Mark Tupper, and invertebrate specialist Dr Reuben Shipway–along with their team of researchers–have an extensive programme of research planned.

Initial surveys in Cornwall and the Isle of Wight highlight a significant nursery function for many marine species. Hundreds of larval and juvenile mullet (*Chelon* spp.) are found within the immersed tree branches during high tide, along with adult mullet and European sea bass (*Dicentrarchus labrax*). Comparisons of lengths of fish caught in different parts of the habitat show significantly smaller fish amongst branches compared to within channels, indicating that immersed tree branches act as fish nursery areas.

[6] https://www.cornwalls.co.uk/helford/helford_river.htm

Additionally, environmental buffering in the form of reduced temperature is provided by the shade of the branches, algae, and rocks, providing further refugia against heat stress for vulnerable and juvenile animals.

Research projects are planned to determine the ecology of the coastal forests, and the physiology of the coastal trees and their ability to deal with salt. The researchers will: investigate how habitat complexity within the coastal forests drives trophic diversity and community evenness; understand the mechanisms of how adult and juvenile trees deal with saltwater immersion; assess branch epiphytes and epifauna; use BRUVs (baited remote underwater video) to determine fish composition and guild structure; understand fish energetics and growth rates; discover cryptic biodiversity in fallen wood; quantify blue-carbon sequestration rates, and assess coastal forest connectivity.

Data gathering and investigations into the oak trees' physiology are underway; however, results so far suggest that the coastal forests have a similar ecological function to mangrove forests. It is extremely exciting to discover an essential fish habitat, with a suite of ecosystem services that match other marine vegetated habitats.

In a time of impoverished and declining coastal habitats, defining these coastal forests and understanding their marine

Figure 3. Images of Frenchman's Creek, Helford, Cornwall, south-west England. A. Filter-feeding mussels attached to the wood within an oak branch; B. juvenile mullet and silversides caught amongst the oak branches at high tide; C. marine life growing on oak branch exposed during low tide.

ecology and physiology is fundamental for their protection, enhancing coastal resilience, significantly enhancing fish biomass and benthic diversity, and improving sustainable fishery management plans and local economies. The findings from this research may provide a paradigm shift in understanding the contribution of the UK's coastal forests towards climate change mitigation, blue carbon, biodiversity net gain, and fishery management.

These temperate intertidal forests are terrestrial forests thriving in two realms, the land and sea, and compelling us to rethink what we consider as a mangrove forest. Research into these unique ecosystems will reveal exciting and novel ecological information and provide insights towards temperate benthic biodiversity and fishery management. ●

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[2] Just One Ocean https://justoneocean.org/
[3] General Organisation for the Conservation of Coral Reefs and Turtles in the Red Sea
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INTERVIEW
WOMEN IN STEM: SHAPING THE FUTURE OF MARINE SCIENCE AND TECHNOLOGY

The Marine Tech Expert **Sophie Locke**

BLUE MARINE FOUNDATION

***The Marine Biologist* presents influential scientists and professionals from Blue Marine Foundation.**

In this edition we welcome **Sophie Locke.** Senior Research and Projects manager at Blue Marine Foundation (Blue) and leader of the science, impact and innovation team.

What is your area of work?
My job is primarily to support our team and external project partners in delivering our conservation work. That could be anything from focusing on protecting large areas of the ocean to tackling illegal and destructive forms of fishing, or writing policy-makers' briefings based on survey data.

What makes Blue different from other NGOs?
We're reactive, flexible, and I would say we're quite disruptive– we don't have time to wait around anymore. In our roles we wear a multitude of hats and value working in a highly collaborative manner. Blue also has a knack for bringing a network of experts and project partners together to share knowledge and best practice.

How does Blue work with communities and scientists in other countries?
We look to build forums and collaborative advisory teams ▸