EXECUTIVE SUMMARY

Native Oyster restoration Scotland and the UK

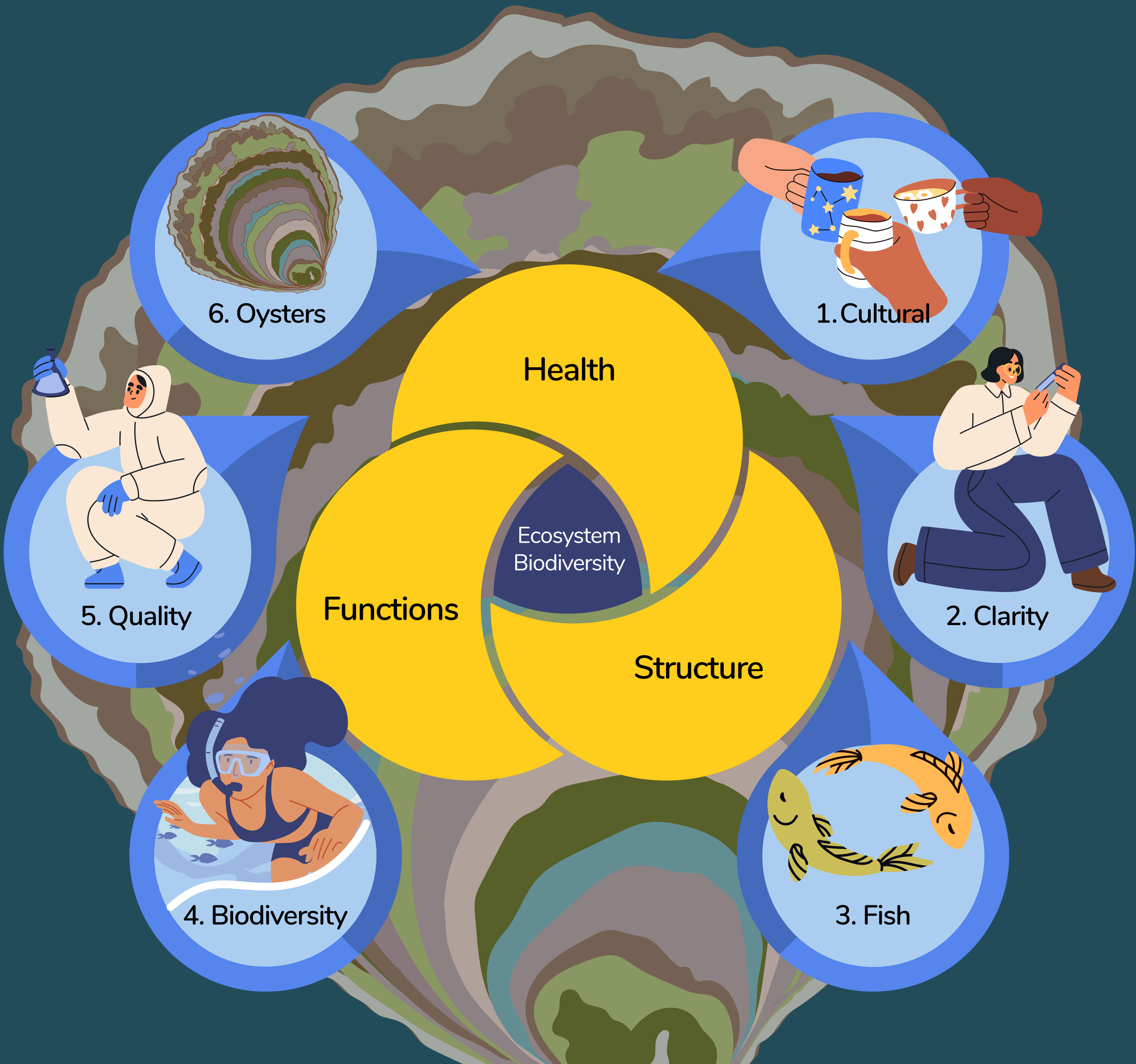
Native Oysters have declined by over 95% in the last 100 years

Historically, Native Oysters were widespread and abundant along the coasts of Europe and the UK, building extensive oyster reefs in shallow subtidal and intertidal areas like estuaries and sea lochs. They were common along significant areas in Scotland such as the Firth of Lorn, the Solway Firth, Firth of Forth and the Tay Coast.

Overfishing, poor water quality, habitat destruction, disease and invasive non-native species, have led to the depletion or disappearance of these large reefs. While Native Oysters are still present along European coastlines and across the UK, their populations are often small, rare, and reproductively isolated.

Scottish & Southern Electricity Networks
TRANSMISSION

SAMS ENTERPRISE

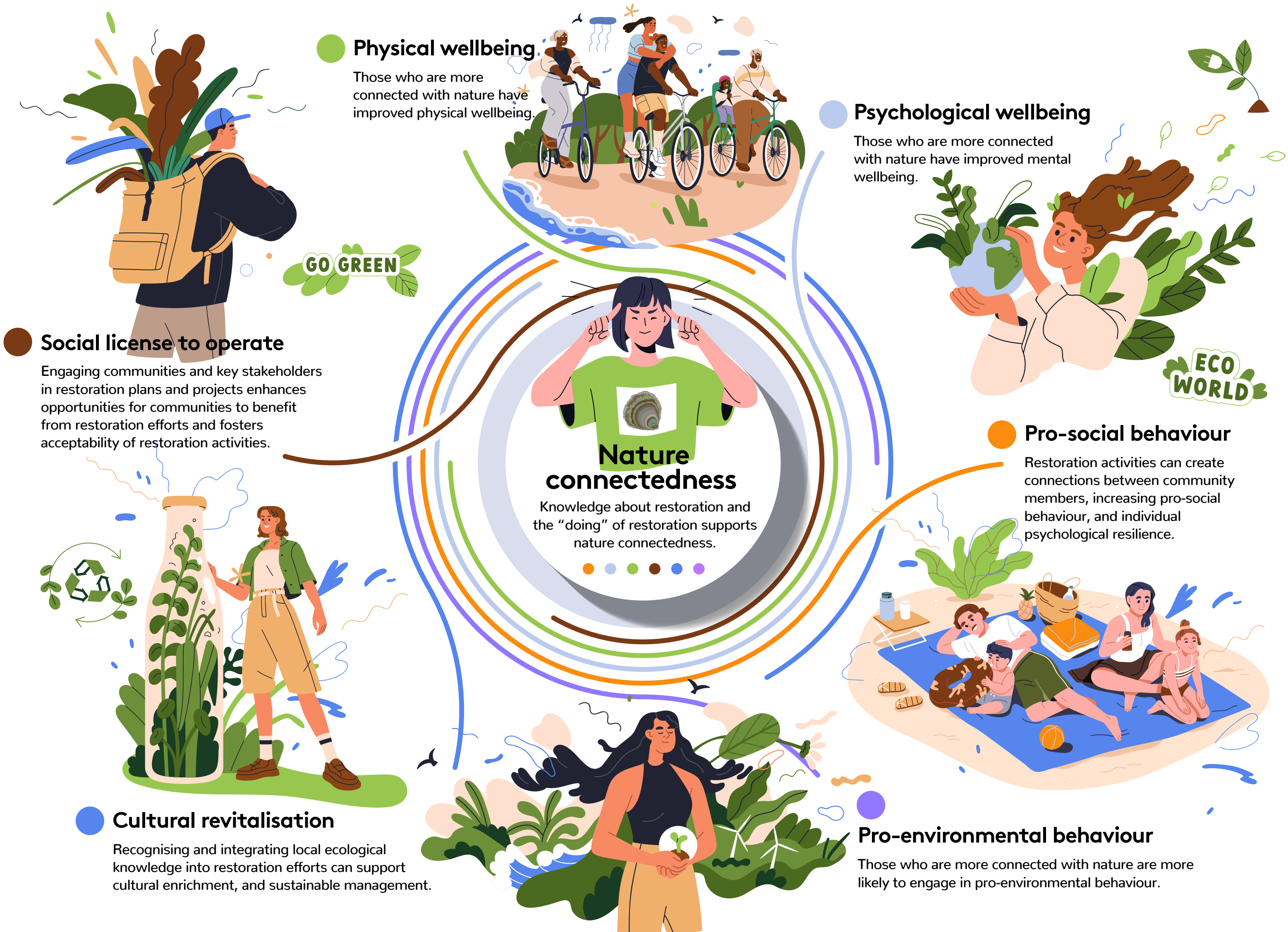


Marine Natural Capital and Ecosystem Services

Native Oyster reefs provide multiple ecological and social benefits:

1. **Cultural** value, connecting people to the marine environment.
2. **Water clarity** increased through filter feeding.
3. **Fish** production increased by providing habitat.
4. **Biodiversity** enhanced due to their complex structure.
5. **Water quality** improved by reducing nutrient content.
6. **Oyster** production increased.

This is done by enhancing the structure, function and health of the oyster reef and its natural capital. These benefits underscore the ecological and societal value of Native Oyster restoration in the UK.



Social sustainability

Community involvement in restoration uniquely connects individuals to local nature, enhancing sense of place, which can improve wellbeing and foster pro-environmental and pro-social behaviours.

How restoration activities are conducted directly contributes to the benefits for society:

- **INCREASED NATURE** connectedness leads to emotional attachment and pro-conservation behaviour.
- **ENHANCED COMMUNITY** wellbeing fosters a sense of belonging and social support.
- **GREATER ACCEPTABILITY** of restoration efforts facilitates ongoing work required for monitoring and expansion.
- **POTENTIAL FOR** cultural revitalisation through integrating local ecological knowledge.

Gaining a social license, the informal acceptance of restoration activities by local communities, is crucial for project viability, expansion and social sustainability.

Actively engaging and empowering communities is beneficial and necessary for the long-term success and sustainability of Native Oyster restoration projects.

Critical Pathways for Native Oyster restoration

Critical success pathways are mutually interconnected streams of activity that are needed for large scale habitat restoration.

Four critical success pathways to enable a step-change to current restoration activities have been identified:

1. Pressure reduction & site protection

Restoration is unlikely to succeed if the original causes of decline are not addressed and sites are not protected from new threats. While fishing pressure has reduced, diseases and other stressors remain significant. Understanding and mitigating complex, interconnected biotic and abiotic stressors impacting all stages of the oyster lifecycle are essential.

KEY CONSIDERATIONS:

- Reliable and cheap real-time disease detection.
- Quick testing for invasive species.
- Understanding critical population density thresholds for self-sustaining oyster reefs.
- Identifying mechanisms to protect restoration sites.

2. Site selection & connectivity

There are three principal aspects that need to be considered when identifying individual restoration sites and creating a network of interconnected sites.

ECOLOGICAL

Assessing regional suitability based on remnant/historical populations along with local suitability based on water quality, suitable substrate, favourable hydrodynamics, and the absence of significant pressures.

SITE CONNECTIVITY

Individual sites must form a coherent ecological network emphasising connectivity to facilitate self-recruitment. Understanding larval dispersal through modelling to identify larval sources and sinks is key to creating resilient reef networks and maximising recruitment in potential restoration hotspots.

POLICY

Marine space has multiple uses and multiple governance layers. Site selection needs to take consideration of these criteria to ensure rapid development and continued success of restoration projects.

3. Social sustainability

Significant gaps exist in understanding the social interactions of marine restoration projects. Lack of clear insights into social dynamics risk missing opportunities for positive social-ecological outcomes and may cause unintended negative impacts, such as resistance to restoration efforts. Unlocking restoration benefits requires monitoring and characterising social interactions across communities and time. This data would enable adaptive management, ensuring the best outcomes for both human and marine communities.

Gaining and Maintaining Social License to Operate considerations:

- **PRIORITISING** community engagement and empowerment by actively involving communities in decision-making processes to ensure projects align with community values and needs.
- **RECOGNISING** the social and cultural context of restoration, considering place attachment, local ecological knowledge and potential for social disruption.
- **BUILDING** nature connectedness by providing opportunities for people to engage with restoration projects, enhancing wellbeing.
- **MAINTAINING** open and transparent communication throughout the restoration process, ensuring regular updates are accessible to the public to build trust and support.
- **ENSURING** restoration plans are goal-oriented and evidence-based, and that they are communicated in ways that resonate with the public.

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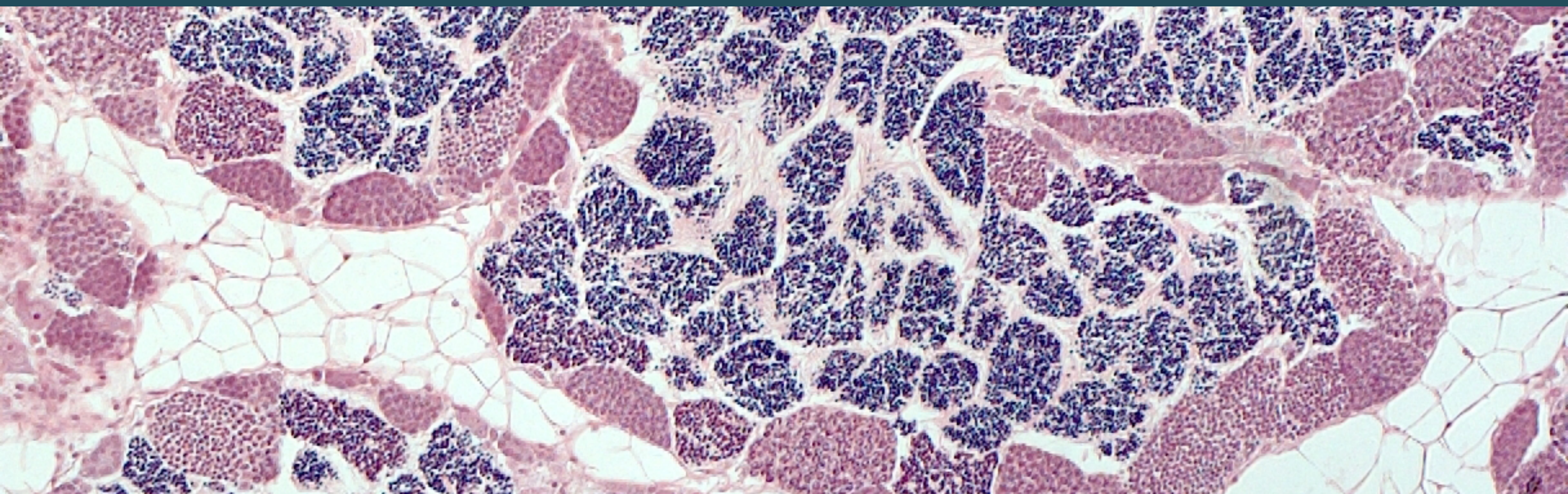
4. Scale

Scaling-up of restoration relies on both the restocking of depleted oyster populations and reef enhancement, to reach a tipping point where oyster reefs become self-sustaining. Strengthening restocking and reef enhancement supply chains provides resilience against future challenges and pressures ensuring long-term sustainability of restoration projects.

Strengthening supply chains and achieving scale

- **Improving** knowledge of Native Oyster biology.
- **Overcoming** oyster seed supply constraints and hatchery production bottlenecks.
- **Improving** substrate availability and knowledge on suitability and reef design.
- **Increasing** knowledge on optimal oyster seed relaying parameters.
- **Reducing** biosecurity risks and gaps in disease diagnostic capabilities.



Enhancing the pace of innovation

Innovation management required for the four critical success pathways, it is proposed to create a research and innovation programme using both:

A. **A TECHNOLOGY READINESS LEVEL** approach to develop and scale the technology, and to manage the risk associated with the innovation pathways.

B. **A QUADRUPLE HELIX** approach combining academic, industry, societal and regulatory stakeholders into innovation. Specifically for each critical success pathway, the following research targets have been identified.

Critical success pathways

1. Pressure reduction & site protection

- Reliable and cheap real-time non-invasive methods of disease detection.
- Quick testing for known and identified invasive species.
- Understanding Native Oyster population density dependent thresholds.

2. Site selection & connectivity

- Site identification tools that integrate ecological, social, and regulatory data with available information on current pressures such as trawling activity, disease presence, diffuse pollution and known point sources.
- Connectivity modelling, based on hi-resolution FV-COM models and known biological characteristics of larval dispersal, ground truthed using a range of techniques, spat collectors, and environmental DNA.

3. Social sustainability

- Integrated transdisciplinary social science research, including social parameters within scientific design and monitoring of restoration schemes.
- Transparent decision-making processes and the demonstration of a commitment to evidence-based practice.

4. Scale

- Year-round reliable larvae and spat production.
- Reef enhancement: substrate suitability, availability and reef design to facilitate deployment and safeguarding of Native Oyster seed.
- Genetic selection for restoration appropriate strains.
- Biosecurity management and disease diagnostics.
- Design of modular rearing units for scalability.

Oyster reef restoration impact

Pressures driving oyster decline

- **Poor water quality** – Anthropogenic pollutants hydrocarbons and PAHs, transitional metals, organometals, pesticides and pharmaceuticals nutrient enrichment.
- **Overfishing and habitat destruction** – Bottom trawling and predation.
- **Disease and parasites** – Bonamiosis, Marteiliosis and shell drillers.
- **Non-native species** – Carpet sea squirts and the pacific oyster *Magallana gigas*.

Potential future scenario after removing pressures

- **Improved water quality** – Reduction in anthropogenic nutrient enrichment sources and clean water from increased nutrient cycling.
- **Improved biodiversity** – From habitat formation. Substrate allowed to build from no trawling and reefs form.
- **Hydrodynamic alteration** – Increased sediment capture.
- **Location** – Suitable site selection to avoid pressures.