NORRI

Native Oyster Reef Restoration Ireland

ONLINE WORKSHOP, 31.3.2020

(30 participants)

- Anamarija Frankic, NORRI
- Stephen Kavanagh, NORRI
- Ana Yael Prelog, PlasmaSaal

www.NORRI.ie

WICKLOW
ENDLESS OPPORTUNITIES

BIM Ireland's Seafood Development Agency

Agenda

A) Introduction to the first oyster restoration project in County Wicklow; (presentation by A. Frankic)

B) Industry participation and stakeholder collaboration (circular funding opportunities);

(BREAK 11:30 AM)

C) Oyster sourcing for this project and disease detection (Introducing quantum technology to detect *Bonamia ostreae*); (presentation by A. Prelog)

- NORRI oyster documentary by E. Corcoran
  https://youtu.be/trRkAzOL1G0
- Presentations will be available at www.norri.ie

Key discussion questions

1. Addressing the need for integrated coastal habitat restoration, e.g. restoring kelp and oysters in NORRI project;
2. Oyster source/seed for NORRI project and how can we make sure the oysters are healthy when moving them to the project restoration site?
3. Funding opportunities - collaborating and learning from each other's efforts through NORA, and Native Oyster Network UK & Ireland.
4. Q&A

Restoration of *Ostrea edulis* L. along the east coast of Ireland

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NORA – 2019 Meeting in Edinburgh, 21-23 May

Abstract

Globally, oyster habitats (reefs) are the most degraded habitats among costal systems, with the **loss of 99%** in the last 150 years. These 350 million years old keystone species and their natural keystone habitats are at the brink of a total collapse due to intensive human industrial harvesting and pollution. *Ostrea edulis* (native flat oyster) historically embraced and provided numerous ecological functions along the east and southeast coastline of Ireland, establishing 80 km extensive reefs from Wicklow Head to Ravens Point. Where **Arklow** was the main port for oyster fisheries in the 1800s, with a harvest of **40 million oysters in 1863**, while today the whole of Ireland lands about 2.1 million native oysters per year. The local community started the initiative to restore their historic beds and established the **Native Oyster Reef Restoration Ireland** (NORRI), now supported by **Wicklow County Council.** The first restoration goal is to provide a detailed, comprehensive site suitability analysis of Wicklow's coastal marine area, to identify the pilot project sites for oyster reef restoration, as a no-take Biomimicry LivingLabs® that can be replicated throughout Europe. Our presentation includes successful examples of the oyster restoration biomimicry design in the USA, based on the historic and existing environmental, social and economic GIS data sets necessary for the site suitability modelling, feasibility and feedback loop analysis. Our solution for oyster habitat restoration uses **six biomimicry principles**: evolve to survive, adapt to changing conditions, be locally attuned and responsive, resource efficient, use life-friendly chemistry, and integrate development with growth. The environment sets the limits for sustainable and resilient development and restoration, so our premise is to work with nature to establish conditions conducive to life and help restore native oyster reef habitats and, therefore, improve water quality, marine biodiversity and health.

Ireland Oyster Facts

Arklow, Wicklow County, in 1863, native oyster fisheries landed 40 million oysters per season; while today, Ireland's harvest is about 2.1 million native oysters per year.

Area along the Irish coastline where historic oyster reef used to stretch 80 km long between Wicklow Head and Ravens Point. Image source: K. Janke

Biomimetic Restoration Solution

Oyster reef restoration projects have been focused more on reversing the trend of inhibited areas than on rebuilding self-sustaining reefs to promote ecosystem health and services. Oyster population dynamic, carrying capacity and ecological services in any given location depends on that location's environmental conditions. In the restoration work we have provided natural hard benthic substrates (cultch) to support oyster settlement (Wellfleet Harbor, Chesapeake Bay); however, in the areas where there is a limited or no oyster population, propagation was supported by the 'spat on shell' approach (Boston Harbor, Nantucket Island, Orleans Harbor). We also used floating structures in the areas where benthic substrate was not suitable, made from various materials (recyclable plastic, green cement and concrete). Type of environmentally friendly materials (based on Green Chemistry) that we identified to be the most suitable to support oyster reef restoration include various green cements manufactured by BluePlanet Ltd, ECOncrete, and Growoysterreefs.

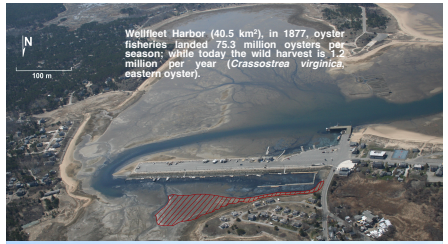
How many oysters are necessary to support healthy population and reef habitat? Based on the paper by Luntz in 1960, native reefs consisted of **5,895 oysters per square yard**. We based our calculations on this historic benchmark in order to address status and trends of oysters in a certain area, their population structure, density and biomass, as well as carrying capacity to sustainably support natural oyster population. **How would nature restore oyster reefs?** Oysters have been an essential part of global coastal ecosystems and natural source of flux and nexus of food, water and energy between land and ocean. Biomimicking natural solutions is the most environmentally, economically and socially justified approach. The biomimetic restoration is based on the six life principles that are nonnegotiable and involve creating and supporting conditions conducive to life, which are essential not only for life itself, but for any ethical, moral, and environmentally sound activity, design or decision.

A biomimicry-based approach to oyster habitat restoration will seek to ensure that infrastructures and activities are based on the six core principles: **1) Does the new structure have the capacity to evolve and survive?** The goal is for the restored or new communities to become self-sustaining in situ, evolving naturally, providing ecosystem services. **2) Is it resource efficient?** The multifunctional design in oyster reef restoration uses a water-energy-food nexus process, established between the building structure, surrounding water and benthic communities. **3) How does it adapt to changing conditions and model resilience?** Resiliency of habitats and ecosystems attributes to their interconnectedness and interdependence, as living things adapt and evolve locally without waste of energy or materials.**4) Are development and growth integrated?** Structural designs of oyster habitats are modular and nested within the water column, over time they integrate development and growth to self-organize to develop complex food webs and trophic interactions. **5) How is it locally attuned and responsive?** The complex ecological functions provided by an oyster reef at the restoration site will need to be determined and incorporated in designing the built structures. **6) Does it use life-friendly materials, water based chemistry and self-assembly?** This principle requires that structures are built by local, natural, untreated materials, sustainable, recycled, not harmful to water and support conditions conducive to life. Adequate water quality is the most important factor supporting coastal habitats' health, function and biodiversity. There is a potential ecosystem function and service for oyster reefs to provide bioremediation in polluted marine ecosystems, specifically when addressing the impact and exposure to microplastic contamination.

Background

Historically, oyster reefs were capable of spanning several hectares in area and could reach 4-7 meters in height. Presently, global oyster reefs have been reduced by approximately 85% in many coastal ecoregions and by 99% in many bay areas. These declines in oyster reef population are mainly due to anthropogenic activities leading to overharvesting, habitat destruction, coastal water pollution, and diseases. Oyster reefs are formed through the gregarious settlement of oysters, preferably on their own shells or any other calcium carbonate substrate, which creates three-dimensional structures promoting many important ecological services. As ecosystem engineers oyster reefs help facilitate ecosystem-wide biodiversity; enhance benthic and pelagic coupling by harbouring of juvenile and smaller fish species; they create natural coastal buffer zones absorbing wave energy and protecting from erosion. Oysters provide excellent water filtration removing nitrogen bound in phytoplankton and organic particulates, as well as promoting bio-deposition, bioremediation, while their shells have pH buffering capacity. An adult oyster can filter between 100 and 240 l of water per day and have been observed to remove as much as 0.52 g of N and 0.16 g P at harvest. Similarly, oyster filtration can help reduce the turbidity and improve photosynthesis in deeper waters, promoting the growth of submerged aquatic vegetation (SAV). This very important symbiotic relationship between oyster habitats and SAV has been supporting synergistic ecosystem benefits such as sediment stabilization, habitat creation, and improved water quality. Oyster reefs along intertidal coastal areas have this symbiotic relationship with not just eel grass beds but also with salt marshes. Together these three keystone coastal systems act in unison creating some of the most biologically productive areas promoting the overall ecosystem health and function in coastal systems and estuaries. Therefore, the presence of three keystone coastal habitats is vital to the overall success of each habitat and the coastal ecosystems as a whole.

Example - Biomimetic Oyster Habitat Restoration in Wellfleet Harbor, MA, USA
Low tide Images: A. Frankic



Wellfleet Harbor, MA, USA, 7.8.2011.

On 2 acres, in 2 years, restored oyster population of ~ 6 mill oysters
16.10.2013.

Key References

Farinas-Franco, J.M. et al (2018). Missing native oyster (*Ostrea edulis* L.) beds in a European Marine Protected Area: Should there be a widespread restorative management? *Biol Conserv.* Vol. 221, pp. 293-311

Frankic, A. (2015). Oyster Reef Restoration Project 2011-2014.Town of Wellfleet. USDA Report. https://www.umb.edu/ghp/green_harbors/wellfleet_harbor

Frankic, A. et al (2011). Teaching and learning with nature using a biomimicry based approach to restore three keystone habitats: salt marsh, eelgrass, and oyster beds. *Biomimicry Institute*, Editor. Proceedings of the first biomimicry in higher education webinar. January 29, 2011: TBI.

Senga, D.G. (2016). Effects of microplastics on European flat oysters, *Ostrea edulis* and their associated benthic communities. *Env. Pollution*, Vol 216, pp 95-103

Hargis, W. J., & D.S. Haven. (1999). Chesapeake Oyster Reefs, Their Importance, Destruction and Guidelines for Restoring them. In: Oyster Reef Habitat Restoration: A synopsis and synthesis of approaches. Edited by M.W. Luckenbach, R. Mann and J.A. Wesson. 1999. VIMS Press, Gloucester Pt. VA, USA.

NORA (2017). Native oyster restoration in Europe – current activities and future perspectives. Kick-off Workshop Berlin, Nov. 1-3, 2017.

Rees, J. (2008). The fisheries of Arklow 1800-1950. Four Courts Press Ltd.

Funding and Support

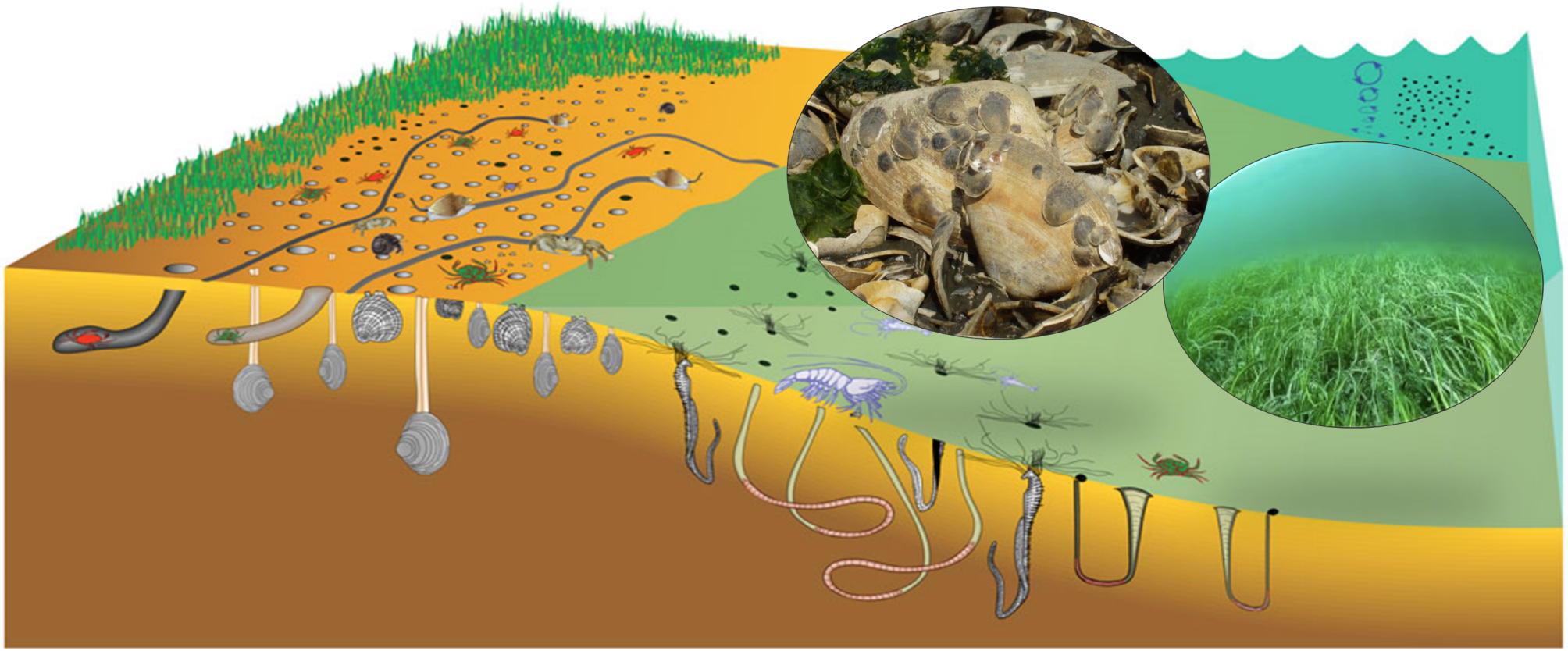
NORRI pilot project site selection is based on the site suitability assessment, and currently available data:

- Benthic & sediment analysis (integrated GIS data)
- High Resolution 3D Modeling
- Hydrodynamic survey
- Historic suitability indices (HIS)

HOW WOULD NATURE RESTORE NATIVE OYSTER REEFS?

Restoration Guidelines for Shellfish Reefs, TNC, (2019).
The status and management of oyster (*Ostrea edulis*) in Ireland. Tully, O. & S. Clarke (2012).

FEEDBACK LOOPS

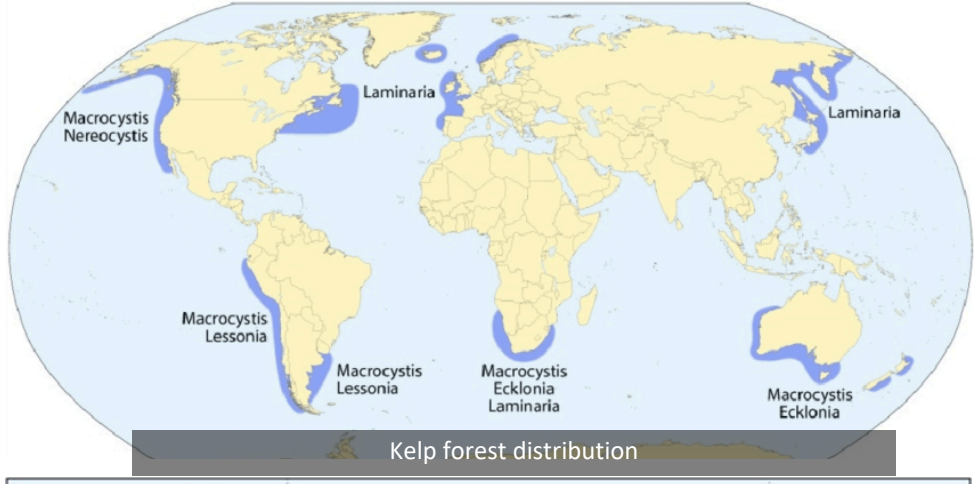


Water – energy –food nexus in coastal ecosystems design and engineering is based on system's collaboration not a competition: sediment transport, bioturbation, hydrodynamic processes (nature of water), biodiversity (image source: Bouman et al, 2005)

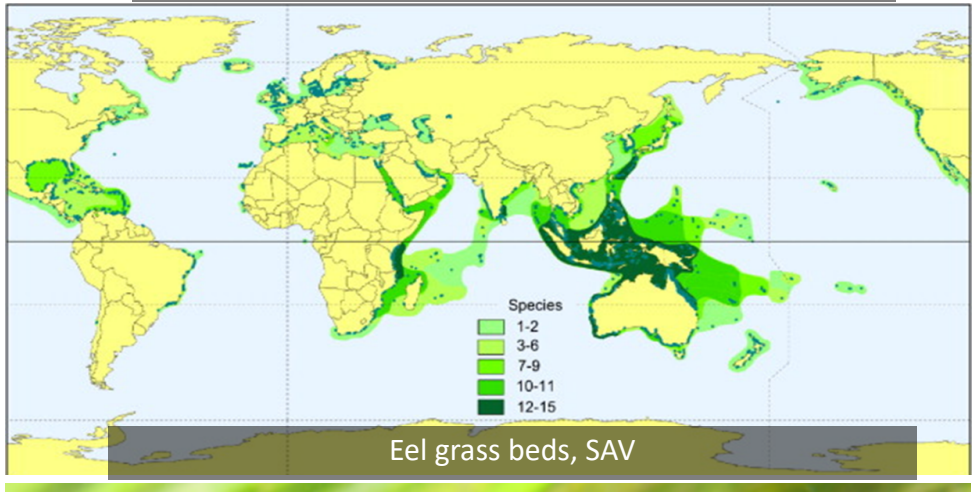
The goal is to emulate coastal systems' processes, strategies, designs and functions in restoration efforts of oyster reefs, salt marshes, SAV. (Frankic et al, 2011)

Oyster reefs

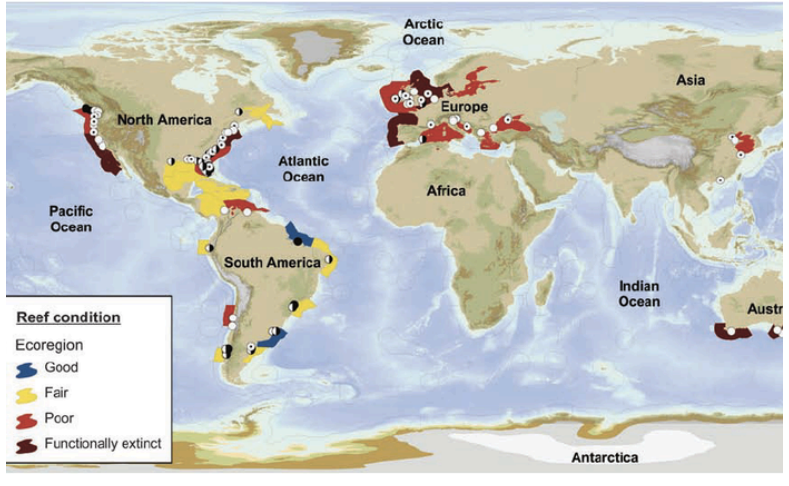
Salt marshes

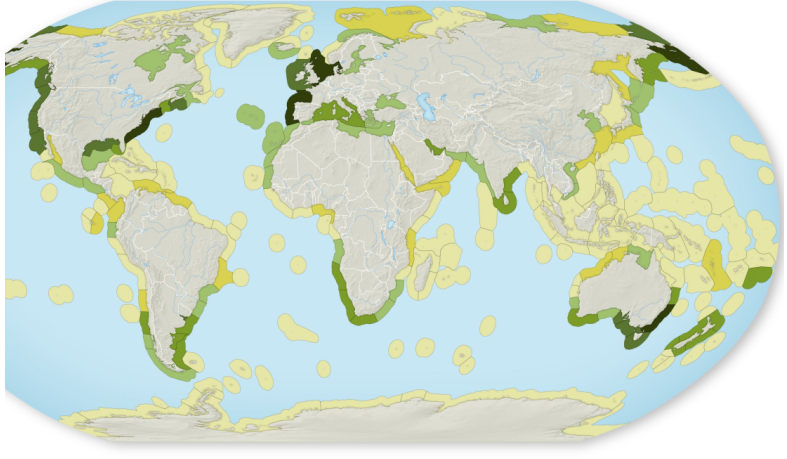


Kelp forest distribution

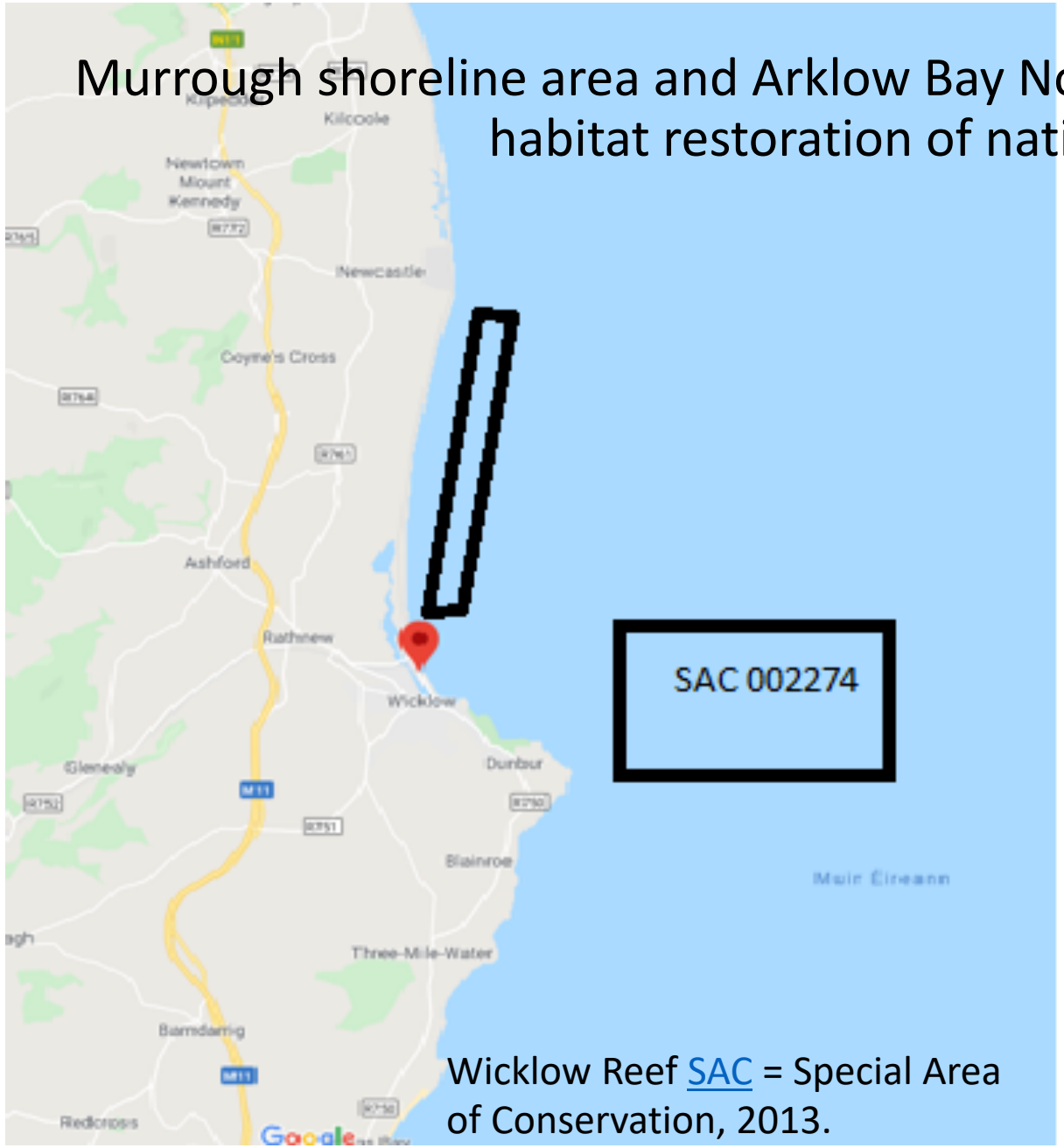


Eel grass beds, SAV

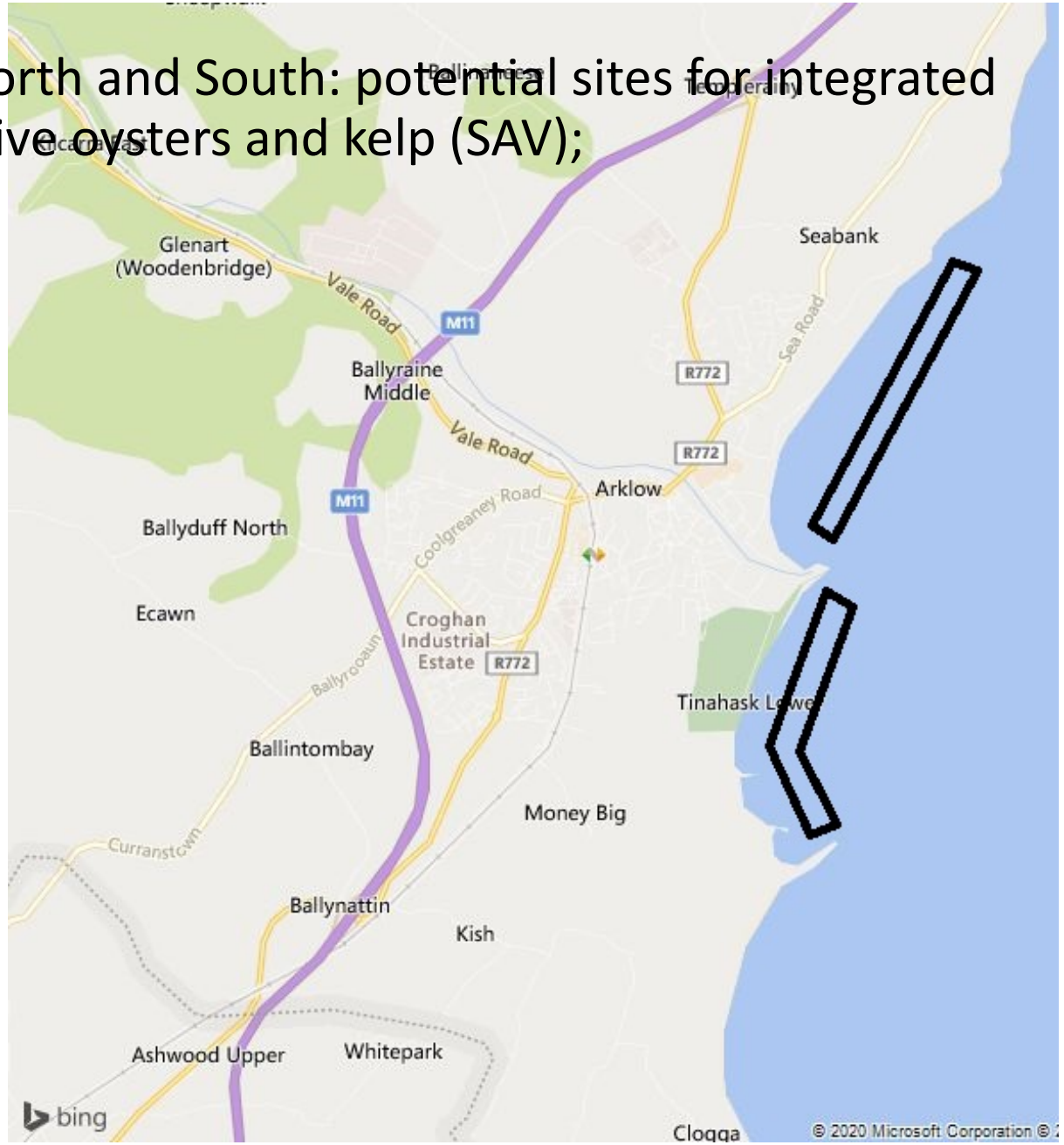




Murrough shoreline area and Arklow Bay North and South: potential sites for integrated habitat restoration of native oysters and kelp (SAV);



Wicklow Reef SAC = Special Area of Conservation, 2013.



Integrating coastal, marine habitat restoration: kelp and oyster reef; (Shelamoff et al, 2019.)

Bringing back ecosystem functions, biodiversity, water quality, shoreline protection; (e.g. Sussex UK, Yorkshire Wildlife Trust)

Kelp forest by Andy Jackson

Collaborative activities through NORA and Native Oyster Network:

- Research paper with 22 scientist identifying: “Forty questions of importance to the policy and practice of oyster restoration in Europe”, *Aquatic Conservation*.
- European Guidelines on Biosecurity in Native Oyster Restoration.
- Native Oyster Restoration Handbook, UK & Ireland Annex.

- **Next Steps? Q&A**

THANK YOU!

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