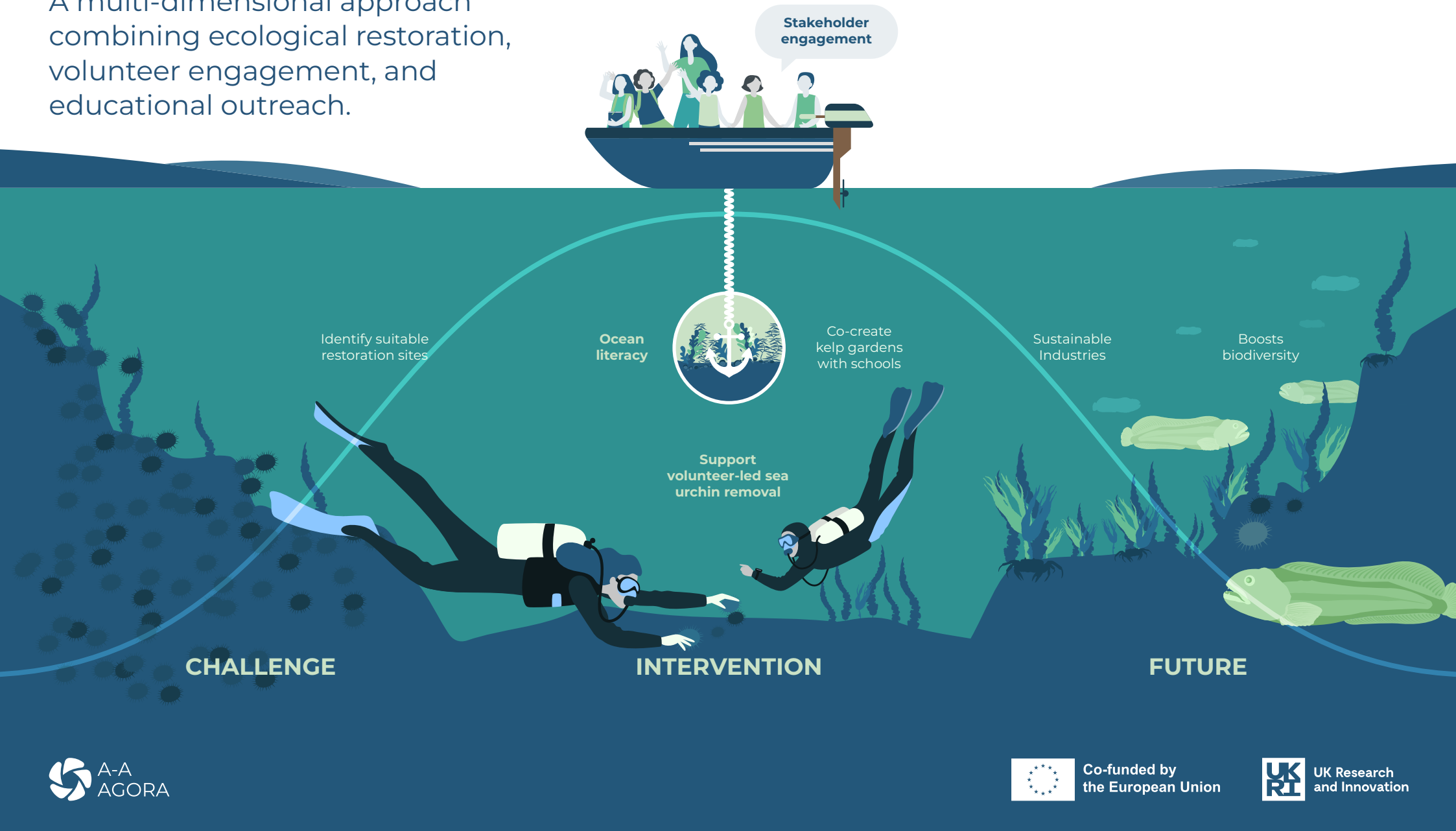
Restoration of kelp forests through sea urchin removal

A multi-dimensional approach combining ecological restoration, volunteer engagement, and educational outreach.



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Key Message

- Active sea urchin removal accelerates kelp forest recovery, boosting biodiversity and strengthening climate resilience in coastal ecosystems
- Community-driven restoration builds ocean literacy and long-term stewardship


Foto: Max Emanuelson

Policy Relevance

International policies

- EU Mission Ocean & Waters – This blueprint supports EU goals for marine ecosystem restoration and biodiversity recovery
- UN Decade on Ecosystem Restoration – The project contributes to global efforts to reverse ecosystem degradation through active restoration
- Convention on Biological Diversity (CBD) – Aligns with commitments to conserve biodiversity and restore degraded habitats

National policy

- White Paper No. 21 (2023–2024) – Integrated Management Plans for Norwegian Sea Areas – This solution directly supports Norway's mandate to develop a plan for systematic kelp forest restoration

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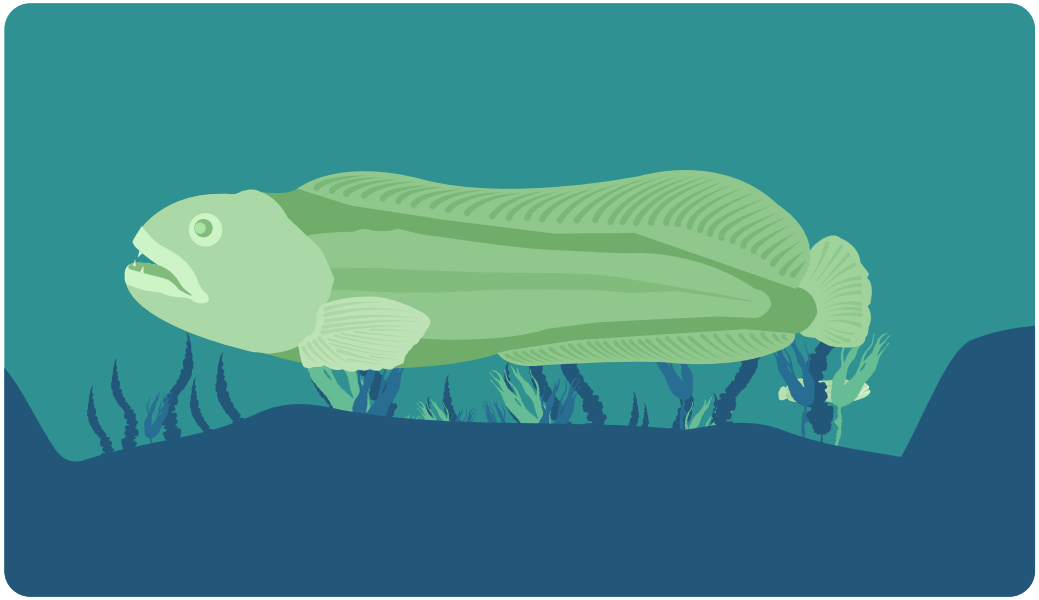
What is the Challenge

Kelp and macroalgal forests are declining in many coastal areas, primarily due to intense grazing by sea urchins. This overgrazing creates extensive urchin barrens, which represent a severe loss of habitat complexity, biodiversity, and ecosystem services such as blue carbon storage. These changes reduce the resilience of coastal ecosystems and limit their ability to support fisheries, protect shorelines, and contribute to climate mitigation. The challenge lies in reversing these degraded states, which persist even after initial drivers such as overfishing have been addressed. Without active intervention, natural recovery is often slow or absent, leaving ecosystems locked in a low-diversity state dominated by sea urchins.



An Innovative Solution

Sea urchin removal combines ecosystem restoration with citizen engagement, education, and policy dialogue to address kelp forest degradation caused by overgrazing from sea urchins.

Implementation involves:

- **identifying suitable restoration sites based on ecological criteria and accessibility**
- **facilitating volunteer-based sea urchin removal efforts**
- **collaborating with schools through co-creation of kelp gardens and an outdoor learning space**
- **engaging stakeholders through workshops and data-driven planning**

The approach is supported by monitoring, modelling, and valuation of ecosystem services, and contributes to national and international restoration goals.

The Benefits the solution produces

- **Ecological:** Restores kelp forests, boosts marine biodiversity, and rebuilds vital coastal habitats
- **Socioeconomic:** Creates opportunities for sustainable industries, regenerative tourism, and local jobs
- **Social & educational:** Engages schools and communities, builds ocean literacy, and inspires stewardship
- **Climate:** Supports blue carbon, climate resilience, and aligns with EU Mission Ocean goals
- **Policy:** Supports national restoration strategies and coastal management plans

How developed is the solution

The solution has been tested and validated in real-life environments (Societal Readiness Level 8: SRL-8), through Living Labs in the Atlantic and Arctic involving schools, municipalities, the tourism actors, NGOs, and researchers. Ocean literacy activities, including educational materials, art workshops, and digital mini-games, and ecotourism-based citizen science, demonstrated strong engagement and measurable improvements in awareness and pro-environmental behaviour. With proven tools, partnerships and frameworks in place, the solution is ready for wider adoption and replication in other coastal communities.

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Where could also be applied to?

This solution is applicable to other coastal regions experiencing blue forest degradation due to sea urchin overgrazing. It can be adapted to coastal areas in Northern Europe, North America, and parts of Asia with similar ecological conditions. The model is transferable to other marine restoration contexts involving community engagement and multi-sector collaboration.

Area characteristics	Intention for applying this solution
Coastal areas with documented sea urchin overgrazing and kelp loss due to grazing	Restore degraded kelp ecosystems and enhance marine biodiversity
Sites with suitable substrate, physical conditions, and historical kelp forest presence	Re-establish kelp habitats in areas where they previously thrived
Locations accessible to volunteers, schools, or local communities	Engage local actors in marine restoration and build long-term stewardship
Regions with infrastructure or interest in marine restoration (e.g. diving clubs, NGOs)	Facilitate community involvement and support knowledge-sharing across sectors
Areas aligned with international restoration and climate commitments	Contribute to global goals such as EU Mission Ocean and the UN Decade on Ecosystem Restoration
Regions with potential for sustainable sea urchin harvesting	Explore commercial opportunities linked to restoration and circular blue economy

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Who is this relevant to?

- Local dive clubs and volunteers for urchin removal.
- Schools and educators for kelp garden co-creation.
- NGOs and community groups for outreach.
- Researchers for monitoring and modelling
- Government agencies (at both local and national levels) and industry partners for policy alignment and scaling.

What do you need to have in place:

- Absence of kelp must be primarly due to high grazing pressure from sea urchins, not other limiting factors such as pollution, poor light conditions, or unsuitable substrate.
- The site must have appropiate physical conditions and substrate to support kelp regrowth after urchin removal.
- The site should be easily accessible for volunteers (e.g., near urban centres or dive clubs) to ensure high participation and continuity.
- All restoration activities must comply with relevant environmental regulations and permitting requirements.
- Collaboration with local diving clubs or others willing to contribute, voluntary effort is essential.
- Communication platforms should be in place to share knowledge and raise awareness about the issue.
- Partnerships with industry, Non-Governmental Organisations, schools, and research institutions are needed to support up-scaling, innovation, and outreach.
- School-based underwater kelp gardens require proximity to coastal areas, regulatory permission for outplanting kelp, and resources for educational follow-up and maintenance.

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Key components of implementation:

Pilot the change: Engage, train, and monitor

To implement volunteer-based kelp restoration, begin with a small-scale pilot that demonstrates feasibility. Engage and build partnerships with local dive clubs, Universities or ecotourism operators to recruit and train volunteers. Develop simple monitoring protocols to track kelp recovery and urchin density. Engage communities to organize manual sea urchin removal. Make the experience educational by sharing restoration goals and ocean literacy content with participants. Plan for funding early – e.g. grants, sponsorships or community fundraising.

Facilitate collaboration – from policy to practice (Conference report)

Organize and run multi-sector workshops that bring together representatives from government, industry, NGOs, and academia to identify actionable steps for kelp forest restoration in your area. Make sure you keep things interesting, mixing presentations, group discussions, and plenary sessions. Ensure that the meeting has a defined outcome, for example a workshop report that records perspectives, and informs regional and national collaboration, and policy development.

Teach through nature – connect students to the sea

Work with local schools to co-create underwater kelp-gardens. These serve as living classrooms to raise ocean literacy and awareness of marine ecology and negative human impact. The gardens allow younger students to explore biodiversity recovery firsthand, integrate marine ecological issues into school curricula, and foster a stronger connection to the ocean.

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Make kelp restoration investable – combine ecology and economy

Begin by estimating restoration costs for different techniques to understand what is required for high success rates. Use these insights to design a business canvas that positions sea urchin removal as a viable kelp restoration measure. Map potential markets and outline revenue streams to inform future business plans, highlighting both ecological and economic benefits.

Map the future – combine local knowledge with spatial intelligence

Engage stakeholders early - SMEs, local authorities, and community representatives can be consulted to identify social, technological, and financing needs. At the same time, prepare for industrial scaling by combining economic planning with spatial intelligence. Conduct mapping of sea urchin barrens and kelp habitats using underwater cameras and aerial drones. Use these data to identify suitable sites for restoration and harvesting, and develop classification models based on drone and satellite imagery to support site selection at scale. Mapping sea urchin barrens and kelp habitats using underwater cameras and aerial drones provides a practical tool for planning and decision-making, ensuring that industrial upscaling is guided by accurate ecological and spatial information.

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Monitoring your success

To track restoration progress effectively, combine ecological, social, educational, and operational indicators. Start by setting clear goals for kelp regrowth and biodiversity recovery. Use systematic biological surveys and photo documentation - underwater photos can help capture habitat changes over time.

Engage volunteers and communities by collecting feedback through short surveys or interviews to understand motivation, sense of hope, and continued participation. Monitor school-based activities by gathering teacher and student feedback.

Operational success depends on collaboration and knowledge use. Record the number and diversity of stakeholders involved in workshops, and ensure collected data informs site selection and policy input. Finally, test and refine tools and models for scaling restoration, so monitoring becomes a foundation for long-term planning.

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Costs and Timeframes

	Cost categories	Cost range*	Approximate timeframe
Piloting the change	Direct expenses for materials, equipment, and logistics, and indirect costs related to planning, coordination, volunteer engagement, monitoring, and reporting throughout the pilot implementation.	Low-Medium	One to two years
Facilitating collaboration	Direct and indirect expenses for planning and facilitating multi-sector workshops, stakeholder mapping, logistics, materials, reporting, and follow-up to ensure actionable outcomes and policy alignment	Low-Medium	Half a year – one year
Teaching through nature	Direct and indirect expenses for co-creating underwater kelp gardens with schools, integrating ocean literacy into curricula, providing materials and equipment, coordinating activities, and monitoring educational outcomes	Low-Medium	One-two years
Making restoration investible	Direct and indirect expenses for analysing restoration techniques, developing a business model for sea urchin removal, conducting market mapping, and outlining revenue streams to link ecological benefits with economic viability	Low-Medium	One-two years
Mapping the future	Direct and indirect expenses for habitat mapping using underwater cameras and drones, and developing classification models to support large-scale site selection	Medium - High	Half a year-one year

**Cost ranges are relative to each other within this blueprint document, and have been developed by looking at the demonstration sites the activities were undertaken in. Please contact the authors for more information on how they could translate in your region.*

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The challenges you may encounter

Activity	Challenge 1	Challenge 2
Piloting the change	**Consistency of effort** - Maintaining volunteer engagement over time is difficult, especially outside peak seasons.	**Handling and disposal of urchins** – Managing large quantities of removed urchins can be logistically challenging.
Facilitating collaboration	**Stakeholder alignment** - Different priorities among government, industry, and NGOs can slow decision-making.	**Funding and follow-up** – Workshops risk becoming "one-off" events without resources for implementation.
Teaching through nature	**Teacher engagement** - Teachers need time and motivation to participate actively.	**Funding for equipment** - Costs for snorkel gear, cameras, and materials can be a barrier.
Making restoration investible	**Action implementation** - Moving from discussion to concrete actions can be slow.	**Investor interest** - absence of established carbon or biodiversity credit schemes for kelp forest is a barrier.
Mapping the future	**Technological and Financial Constraints** - Collecting high-quality underwater mapping data is expensive, and the technology for using drone and satellite imagery to classify underwater habitats is still emerging. Limited availability of cost-effective tools and reliable algorithms can slow down implementation and scaling..	**Stakeholder Engagement and Coordination** - differing priorities and interests, varying levels of technical understanding, and different financial expectations among stakeholders can cause conflict.

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Key Contact
who to talk to about your application

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Further information

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- Guardians of the kelp.
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Blueprint

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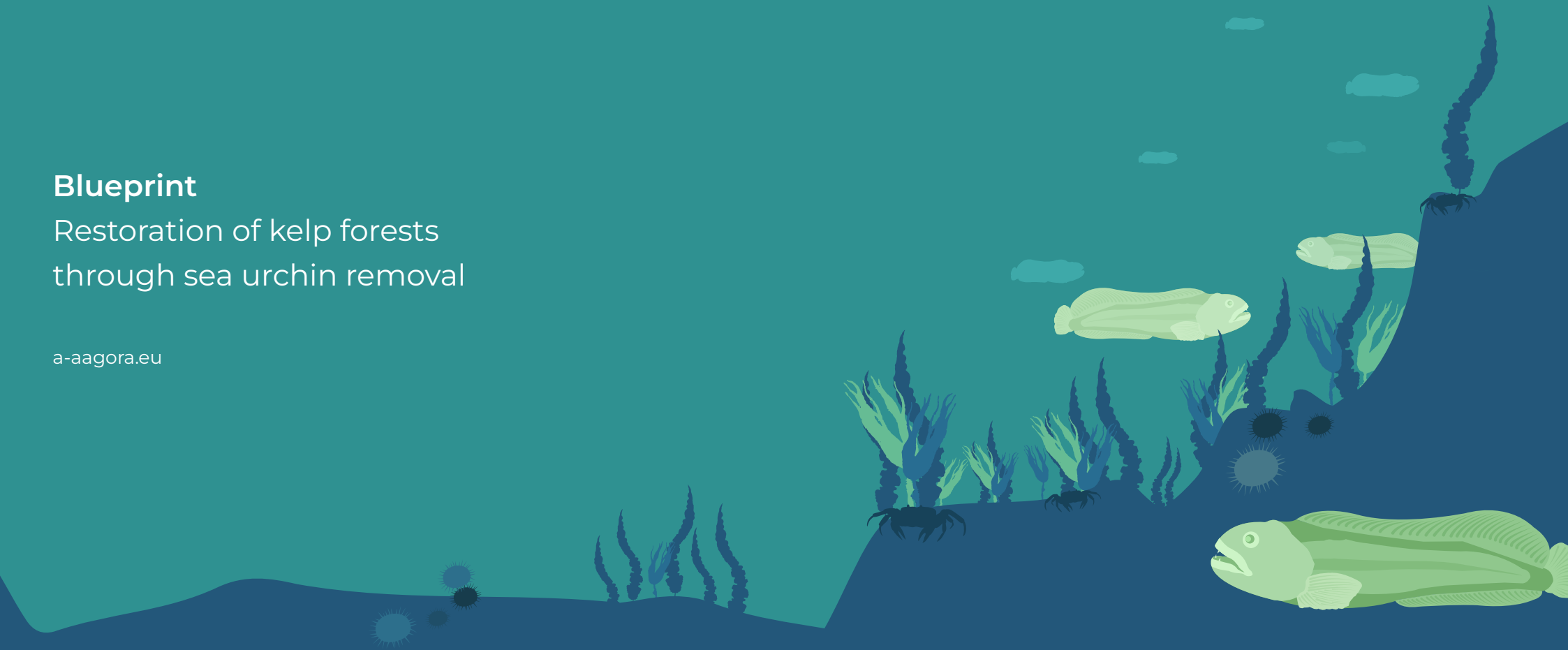

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