REST~COAST

LARGE SCALE RESTORATION OF COASTAL ECOSYSTEMS THROUGH RIVERS TO SEA CONNECTIVITY

ARCACHON BAY

RESULTS & ACHIEVEMENTS REPORT

After deployment, photo: ©SEABOOST

SUMMARY

The Arcachon Bay pilot site tackled the long-term decline of seagrass meadows through a novel nature-based engineering approach. The core innovation was the deployment of Roselière® ® hydrodynamic attenuation structures at the Gaillard site (>1 ha equipped, October 2023), designed to reduce near-bed flow velocities and create conditions suitable for seagrass settlement and survival. Transplantation and seeding complemented the physical intervention. Implementation levels ranged from 25% to 100% across the seven challenge categories, with hydrodynamic control and sediment management measures were fully delivered. Seagrass survival rates in equipped areas reached up to 70%, compared with 0% in unequipped reference areas. Model projections indicate potential restoration of more than 300 ha by approximately 2045 under baseline sea-level conditions.

Funded by the European Union

This project receives funding from the European Union's Horizon 2020 Innovation Action under grant agreement No 101037097.

THREATS AND PRESSURES TACKLED

- Long-term decline and fragmentation of *Zostera noltei* and *Zostera marina* seagrass meadows
- Increased water turbidity following seagrass fragmentation
- Mechanical damage to seagrass beds from navigation, aquaculture, and recreation (e.g. mooring)
- Reduced sediment deposition and increased bottom shear stress => both of these result in a positive feedback loop accelerating seagrass loss
- Alteration of local hydrodynamics and sediment behaviour
- Rising water temperatures and pollution contributing to seagrass regression

BASELINE CONDITION

Arcachon Bay has experienced severe long-term seagrass loss. Dwarf eelgrass (*Zostera noltei*) cover decreased by 45% over three decades from 6,846 ha in 1989 to 3,994 ha in 2019. *Zostera marina* declined even more dramatically, by approximately 89% over the same period. This degradation was driven by a self-reinforcing cycle: seagrass loss increases near-bed flow velocities and turbidity, which in turn prevents seagrass recovery. Physical pressures from boating, aquaculture, and recreation, combined with rising temperatures and altered hydrodynamics, compounded the decline.

RESTORATION STRATEGY SELECTED AND WHY

The project selected a nature-based engineering strategy centred on breaking the self-reinforcing degradation cycle rather than attempting direct replanting into hostile conditions. The Roselière® tidal and current attenuation system was deployed to reduce near-bed flow velocities and create sheltered settlement zones where seagrass can establish. Transplantation and seeding provided biological input, supported by instrumented monitoring and hydro-biological modelling to identify and target priority areas.

The approach followed a staged process: small-scale instrumented trials first, followed by numerical optimisation of structure layout (triangular and fractal patterns with line spacing of approximately 15-25 m), then medium-scale field deployment and monitoring to validate predictions and refine upscaling design.

This integrated and staged approach was selected because passive restoration alone was insufficient given the strength of the degradation feedback cycle. The Roseliere® system proved as an innovative solution capable of modifying near-bed conditions at ecologically meaningful scales. A staged deployment methodology allowed for design optimisation before commitment to full-scale intervention.

Restoration in progres, photo: ©SEABOOST

HOW THE CHALLENGES WERE ADDRESSED AND KEY RESULTS ACHIEVED

100% Implemented

Seagrass Recovery initiated

The hydrodynamic-control demonstration was launched at the Gaillard site with more than 1 ha equipped in October 2023. Seagrass settlement and survival reached up to 70% in equipped areas, compared with 0% in unequipped reference areas. Model projections indicate potential recovery of more than 300 ha by approximately 2045 under baseline sea-level conditions if restoration conditions are maintained.

25% Implemented

Protection of Seagrass Beds from mechanical damage

Mechanical pressures were addressed primarily through spatial planning: zones with navigation channels and high-use constraints were excluded from initial intervention areas. Engagement with oyster farmers enabled safe deployment using standard aquaculture vessels. No dedicated mechanical-damage mitigation (e.g. mooring replacement) was implemented within the reported on-the-ground actions.

100% Implemented

Attenuation of Local Hydrodynamics and Sediment Behaviour

The Roselière® solution was designed, modelled, instrumented, and deployed. The current shelter zone extends 4-7 m downstream of structures; double and triple configurations increased the drag coefficient (Cd) by approximately 20-42% (up to approximately 45% in triple setups). For peak flow velocities of approximately 66 cm/s, Cd values reached approximately 30% of standard-condition values.

75% Implemented

Measures to reduce Water Turbidity

Hydrodynamic attenuation is expected to reduce turbidity by lowering near-bed velocities. Instrumented monitoring (October-November 2023) and planned multi-campaign surveys provide the dataset to quantify outcomes. Vegetated areas show substantially higher carbon burial rates (81 vs 33 g CO2-eq per square metre per year in bare sediments), consistent with enhanced fine-particle retention.

100% Implemented

Increased Wave Disturbance from Boats and Maritime Traffic

The Roselière® structures create protected wakes and low-velocity fields near the bed, promoting fine sediment settlement and lowering shear stress. An exposure-time metric indicates approximately 20% reduction in high near-bed stress exposure inside the system relative to outside conditions.

75% Implemented

Positive Feedback Loop Accelerating Seagrass Loss

The loss-flow-turbidity-shear-further loss feedback cycle was translated into a concrete intervention: hydrodynamic attenuation combined with transplantation. Monitoring and modelling infrastructure has been established to quantify loop-breaking effects. Model projections suggest potential large-scale recovery trajectories (>300 ha by approximately 2045) if conditions are maintained.

25% Implemented

Rising Water Temperatures and Climate Pressures

Temperature stress was identified as a key driver. REST-COAST incorporated climate considerations through modelling and scenario analysis including sea-level rise impacts and light limitation. The project recommended accounting for greenhouse-gas dynamics: carbon emissions from disturbed sediments can offset approximately 29% of the carbon burial benefit. Actions focus on increasing overall meadow resilience through improved physical habitat conditions rather than direct temperature mitigation.

PERCENTAGE OF TARGET ACHIEVED

100% Hydrodynamic attenuation structures deployed and sediment management measures implemented (Roselière® system, Gaillard site, >1 ha).

75% Turbidity reduction and positive feedback loop reversal -- monitoring infrastructure established, quantification ongoing.

25% Mechanical damage mitigation and climate temperature adaptation -- addressed through spatial planning and scenario modelling; no dedicated on-the-ground measures yet implemented.

SPECIFIC SOLUTIONS IMPLEMENTED

Roselière® hydrodynamic attenuation system

Tide and current attenuation structures deployed at the Gaillard site (>1 ha, October 2023) to reduce near-bed flow and create seagrass settlement conditions, with layouts optimised using triangular and fractal patterns.

Seagrass transplantation

Biological input provided through transplantation to complement hydrodynamic improvement; seeding also explored..

Instrumented monitoring campaign

Full hydrodynamic, sediment, and biological monitoring at the Gaillard site (October-November 2023) to validate model predictions and refine upscaling design.

Hydro-biological modelling

Numerical modelling used to optimise structure layout, target priority restoration areas, and project long-term recovery trajectories.

Spatial planning

High-conflict use zones excluded from initial intervention areas to minimise mechanical disturbance.

CORE-PLAT stakeholder engagementt

Ongoing dialogue with oyster farmers, park managers, and authorities to co-design operations and build governance foundations for scaling.

Restoration in progress, photo: ©SEABOOST

Restoration in progress (end of winter), photo: ©SEABOOST

KEY STAKEHOLDERS INVOLVED AND HOW

Arcachon Bay Marine Natural Park (PNMBA) served as the local manager and coordinator. IFREMER and Seaboost/Egis developed and refined the technical solution. Oyster farmers provided critical logistics support using aquaculture vessels during deployment and monitoring. Local and regional authorities engaged included SIBA, the Water Agency, DREAL/DDTM, the Region Nouvelle-Aquitaine, and the Department of Gironde. The Banc d'Arguin marine reserve was also consulted. Scientific partners and PNMBA jointly integrated climate-risk considerations into monitoring and long-term planning.

INFLUENCE ON DECISION-MAKING

Policy influence has been primarily indirect, through evidence generation and governance support. Quantified results on hydrodynamics and ecosystem service benefits are feeding into future regional planning and seagrass management strategy development. A regulatory pathway is under development to enable the use of donor seagrass material (transplants and seedlings) and to facilitate scaling beyond the pilot; formal adoption is still pending. Alignment with broader EU and national restoration and climate-adaptation agendas has been noted, though no specific policy change attributable to the pilot has been confirmed yet.

After deployment, photo: ©SEABOOST

RECOMMENDATIONS FOR FUTURE DEVELOPMENT

Seagrass recovery

Maintain multi-year monitoring to confirm recovery trajectories; integrate results into a basin-wide seagrass management strategy; expand deployment to additional suitable intertidal zones; combine hydrodynamic control with targeted transplantation and seeding; operationalise a cost-per-hectare metric to guide scaling.

Turbidity

Establish a clear turbidity KPI set (SSC/NTU time series inside vs outside equipped zones) with seasonal replication; connect turbidity outcomes to ecosystem-service valuation to strengthen the case for funding.

Mechanical damage

Implement eco-moorings and anchoring exclusion zones over sensitive beds; improve signage and enforcement; co-design boating and aquaculture operational guidelines; integrate mechanical-pressure mapping into restoration prioritisation.

Hydrodynamics and sediment

Continue validating responses across seasons and storm conditions; refine anchoring and structure layout for stability; expand to additional priority zones identified by modelling; standardise design rules per linear metre deployed and per hectare influenced.

Sediment deposition

Quantify deposition directly (sediment traps, cores, elevation change from orthophotos) across seasons; use results to refine design thresholds for safe shear stress and to support permitting for larger deployments.

Feedback loop

Demonstrate loop-breaking outcomes with paired-control monitoring covering seagrass cover change, turbidity, shear stress, and biodiversity metrics; embed the approach in a basin-wide restoration strategy.

FINANCIAL MECHANISMS USED AND PROPOSED

Primary funding was provided through EU Horizon 2020 REST-COAST project resources, with co-financing and in-kind support from PNMBA for studies and field operations. The PROSPERE project contributed almost 400,000 EUR for deployment. Future mechanisms under exploration include public funds from the French Biodiversity Agency and the Water Agency, and potential carbon-finance pathways, though no dedicated long-term framework is yet secured.

The seagrass restoration activities are expected to generate a wide range of economic benefits, including carbon credits on the voluntary market, payments reflecting anticipated reductions in dredging costs, visitor fees or earmarked tourism taxes, and potential revenue from oyster-farming activities. Future scaling will likely require dedicated public funding and cost-efficiency assessment across all funding streams.