Restoration of seagrass in Guadeloupe: Experiments with eco-moorings and outplanting of *Thalassia testudinum*

Restauración de los pastos marinos en Guadalupe: Experimentos con anclajes ecológicos y trasplantes de *Thalassia testudinum*

Restauration des herbiers marins en Guadeloupe: Expérimentations avec des mouillages écologiques et des transplantations de *Thalassia testudinum*

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EXTENDED ABSTRACT

INTRODUCTION

The Guadeloupe Port Authority is actively committed to preserving and restoring marine and coastal ecosystems. Through the LIFE Adapt'Island project, it implements nature-based solutions to address the impacts of climate change, particularly on coral reefs, seagrass beds, and mangroves. These essential ecosystems, rich in biodiversity and providing critical ecosystem services, are increasingly under pressure from pollution, urbanization, and deforestation.

In this context, innovative efforts such as experiments in seagrass restoration (*Thalassia testudinum*) and the installation of eco-moorings are being undertaken to enhance the resilience and sustainability of these natural environments. This approach demonstrates Guadeloupe's commitment to balancing economic development with environmental conservation.

METHODOLOGIES

The seagrass restoration study for *Thalassia testudinum* combined three key steps: seed collection, in vitro cultivation, and outplanting at pilot sites.

Seed collection was conducted at four sites (Petit Havre, Bois Jolan, Folle-Anse, and Banc Rose). An operator systematically surveyed each seagrass bed over 350 to 400 meters for 30 to 45 minutes, recording the number of male and female flowers as well as fruits. Additional parameters such as the health status of the seagrass beds and average leaf length were also measured. Mature fruits were manually harvested and stored in plastic containers filled with seawater to maintain viability.

The collected seeds were grown in vitro under controlled conditions (temperature, salinity, and light) to promote germination. Plant growth was monitored regularly to assess survival rates and identify challenges such as algal proliferation.

Finally, the plants were transplanted at two sites: Folle-Anse (favorable conditions but prone to erosion) and Banc Rose (exposed to climatic disturbances). Periodic monitoring was carried out to measure survival and analyze limiting factors. Eco-moorings were also installed to reduce anthropogenic impacts on existing seagrass beds.

RESULTS & DISCUSSION

The seed collection phase was successful, with 162 fruits (yielding 236 seeds) collected, mainly from Petit Havre and Bois Jolan. This confirmed that the health of the seagrass beds directly influences fruit productivity.

During in vitro cultivation, the seeds exhibited a high initial survival rate (95% at 2 months) due to controlled conditions. However, algal proliferation reduced this rate to 59% before outplanting, highlighting the limitations of the in vitro method over the long term, due to the ecological imbalance caused by the absence of fauna typically associated with seagrass beds in their natural environment.The outplanting results were mixed:

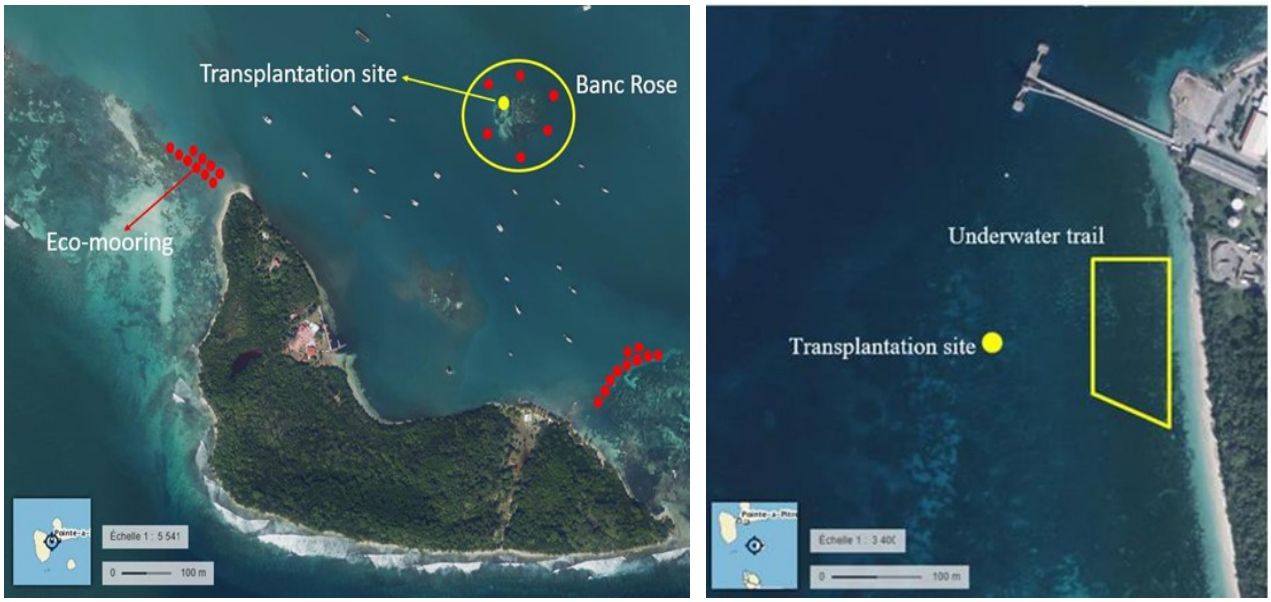

Figure 1: Outplanting and eco-mooring sites of *Thalassia testudinum*

At Folle-Anse, survival was high initially (87% at 1 week), but erosion and epiphyte colonization reduced survival to 4% after 5 months. Nevertheless, natural vegetative reproduction was observed, indicating the potential resilience of the seagrass bed installed nearby.

At Banc Rose, while initial survival was also 87%, all plants were lost due to a tropical storm, highlighting the vulnerability of restoration efforts to climatic events. This loss was largely attributed to the fact that the young plantlets had shallow root systems that were not yet deeply anchored in the substrate. While seagrass beds are generally resilient to climatic disturbances, the lack of established root systems made these transplants particularly susceptible to uprooting.

The installation of eco-moorings showed promise as a method for protecting existing seagrass beds. Two designs were employed: one cylindrical, mimicking mangrove roots, and the other featuring various structural shapes, including round holes and 3D protruding triangles. These designs aimed to simulate natural habitats and create complex surfaces suitable for colonization. Over 12-18 months, the eco-moorings were extensively colonized, not only by juvenile marine species but also by sub-adults, creating a refuge effect.

This colonization reduces anthropogenic pressure on seagrass beds by providing an ecological anchoring alternative, which simultaneously enhances biodiversity and promotes sustainable boating practices. Although preliminary results are promising, long-term evaluations are necessary to fully measure their ecological benefits and durability.

CONCLUSIONS

The restoration of Thalassia testudinum seagrass beds underscores the opportunities and challenges of ecological rehabilitation. While in vitro cultivation demonstrated strong initial success, long-term viability was hindered by algal proliferation. Outplanting outcomes highlighted the influence of environmental factors, such as erosion and climatic disturbances, on plant survival.

The failure at Banc Rose, caused by a tropical storm, emphasizes the vulnerability of restoration projects to unpredictable natural events. Conversely, the natural vegetative reproduction observed at Folle-Anse confirms leveraging existing seagrass resilience as a more effective strategy.

The installation of eco-moorings represents a valuable complementary measure, reducing anthropogenic impacts and supporting the conservation of both restored and existing seagrass beds.

Future restoration efforts should focus on:

- Prioritizing natural vegetative reproduction,
- Enhancing protection of restoration sites against environmental pressures,
- Promoting eco-friendly anchoring practices and public education through initiatives like underwater trails.

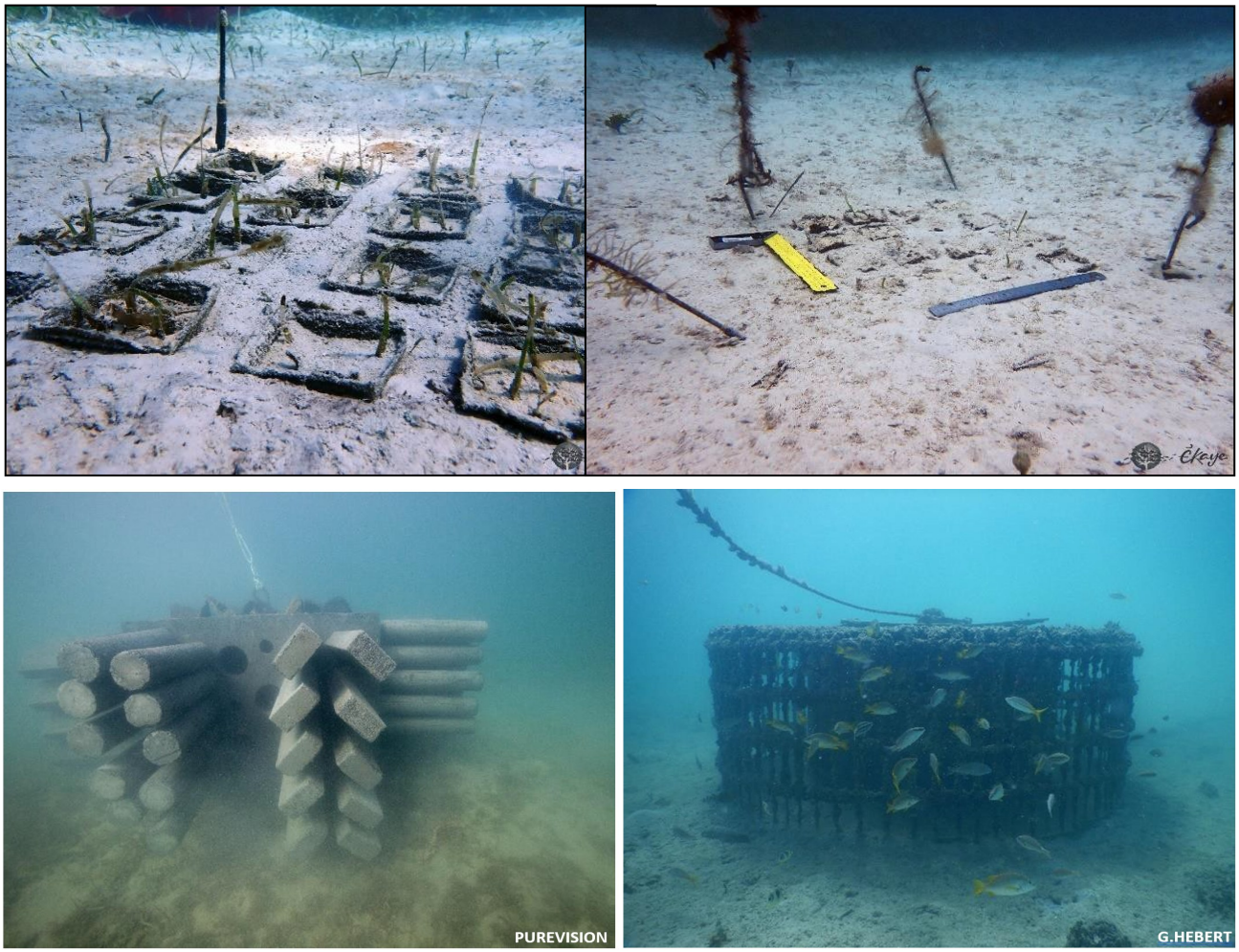

Figure 2. Growth of outplanted *Thalassia testudinum* plants at the Folle Anse site (T+1 week, T+3 months) and two types of eco-moorings included one observed before biological colonization and the other examined 12 months after its installation

Balancing restoration techniques with ecosystem resilience will be key to safeguarding the vital role of seagrass beds in marine biodiversity and coastal stability.

KEYWORDS: ecological restoration, seagrass beds, *Thalassia testudinum,* outplanting, eco-moorings Effective Communication