An Analysis of Commercialization Pathways for Acoustic Verification of Carbon Sequestration by Seagrass Meadows

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ABSTRACT

Seagrass meadows are among the planet's most efficient natural carbon sinks, capable of sequestering carbon dioxide (CO_2) at rates exceeding many terrestrial ecosystems. Despite their ecological significance and potential role in climate mitigation, their integration into carbon markets remains limited, primarily due to challenges in measurement, reporting, and verification (MRV). This thesis investigates the commercialization pathways for acoustic sensing technologies designed to enhance the verification of seagrass-based carbon sequestration. By synthesizing current scientific literature, cost models, and market projections, the study explores how acoustic methods can detect CO_2 flux and sediment carbon burial at scale, offering a less invasive and more cost-effective alternative to traditional sediment coring and chemical analysis. A ten-year cost comparison reveals that acoustic systems could reduce MRV-related expenses by over 60%, while simultaneously improving data consistency and scalability. The thesis further evaluates how acoustic sensing may resolve key market challenges, such as proving additionality and ensuring permanence, both prerequisites for the issuance of carbon credits. Market opportunity is assessed using Total Addressable Market (TAM), Serviceable Available Market (SAM), and Serviceable Obtainable Market (SOM) frameworks, with projections suggesting that marine carbon dioxide removal (mCDR) could capture up to 5% of the voluntary carbon market by 2030, representing a potential $2.5 billion sector. Regulatory gaps, funding disparities, and ecosystem-specific variables are also examined to understand the broader barriers and enablers of technology adoption. Particular attention is given to how acoustic MRV tools might align with evolving standards in voluntary and compliance carbon markets. This thesis presents a multidisciplinary roadmap for advancing acoustic verification technologies from research environments to commercial deployment. By bridging marine science, environmental policy, and technology commercialization, it demonstrates how these tools could play a critical role in unlocking the climate and economic value of seagrass meadows in global carbon markets.

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