Advancing IMBeR Innovation Challenge 5 through the IOC-R Report under the Leadership of Dr. Nina Bednaršek

Prepared for: IMBeR Science Steering Committee

Summary

This document highlights how the 2025 IOC-R report ("Integrated Ocean Carbon Research: A Vision Primed for Implementation") has contributed to advancing IMBeR's Innovation Challenge 5 (IC5), under the leadership of Dr. Nina Bednaršek. IC5 focuses on evaluating and guiding responsible interventions to mitigate climate-related impacts on marine ecosystems. Dr. Bednaršek co-led the IOC-R chapter on the "Marine Carbon Dioxide Removal (mCDR) ", contributed to the chapter on "The Changing Role of Biology in the Ocean Carbon Cycle" (Section 3.b), and led the chapter "New Needs for Ocean Carbon Research" (Section 4). Her work ensured that IC5 goals were reflected across scientific, ethical, and governance dimensions of the report, especially in aligning biological and ecosystem processes with climate intervention frameworks.

I. Innovation Challenge 5: Interventions to Change Climate Impacts

Objective: Evaluate and guide responsible interventions to reduce climate-related risks to ocean ecosystems and dependent societies.

1. Advancements from IOC-R

- **Evaluation of Marine CDR**: Section 3.e of the IOC-R report assesses multiple mCDR techniques (e.g., biological and chemical mCDR approaches), examining their biogeochemical and ecological implications.
    - Supports IC5's goal of improving modeling capacity to simulate intervention outcomes.
- **Ecosystem Dynamics and Feedbacks (Section 3.b)**: This section outlines how biological processes regulate carbon cycling, including export pathways and remineralization.
    - This section highlights the importance of understanding how interventions might alter biological carbon pumps, microbial dynamics, and community composition.
    - It provides a scientific foundation for assessing unintended consequences and long-term efficacy of mCDR approaches.
- **Governance and Risk Frameworks**: The IOC-R outlines the necessity of developing transdisciplinary and governance frameworks, including policy-relevant best practices.
    - Directly informs IC5's call for decision thresholds and ethical governance of ocean interventions.
- **Feasibility and Scaling**: The report identifies key uncertainties and data gaps preventing mCDR scalability, a central concern of IC5.
    - Emphasizes the need for interdisciplinary frameworks to manage and evaluate interventions at various stages and scales.

- **Future Directions ("New Needs for Ocean Carbon Research" - Section 4)**: This chapter identifies forward-looking research needs that directly support IC5, including:
    - Coordinated monitoring frameworks for interventions
    - Integration of biological thresholds into risk assessment
    - Ethical considerations and co-development with stakeholders Section 4 lays the foundation for IC5's innovation agenda by emphasizing responsible scaling, ecosystem integrity, and policy-relevant science.

2. Role of Dr. Nina Bednaršek

As IC5 chair and contributor to multiple IOC-R chapters, Dr. Bednaršek:

- Integrated biological and ecological knowledge to assess the consequences and effectiveness of mCDR approaches.
- Ensured environmental safeguards and social-ecological feedbacks were represented in intervention modeling and design.
- Facilitated alignment of IOC-R content with relevant international frameworks (e.g., London Protocol, BBNJ Agreement).
- Provided scientific leadership across Section 3.e (mCDR), Section 3.b (biological processes), and Section 4 (New Needs for Ocean Carbon Research).
- Strengthened the scientific foundations of IC5 by linking mechanistic ecosystem knowledge to intervention design, risk management, and scalability analysis.

II. Future Directions

This work has advanced IC5 by grounding intervention strategies in science, ethics, and systems thinking. The IOC-R report provides a blueprint for:

- Expanding interdisciplinary networks to develop, test, and monitor mCDR solutions.
- Supporting decision-making on marine interventions by establishing ecological thresholds and risk assessments.
- Guiding responsible innovation in ocean-based climate mitigation.
- Leveraging the insights from Section 3.b and Section 4 to frame implementation science and inclusive governance models.
- Leverage the insights from the Innovation Challenge 5 with the goals of the Ocean action Plan that is proposed as a next

Next Steps:

- Translate the IOC-R mCDR chapter into implementation guidelines within IMBeR's IC5 roadmap.
- Strategically co-align Innovation challenge 5, future steps (as identified by IOC-R) and Ocean Action Plan.
- Position IMBeR and IOC-R outputs in key policy dialogues on ocean-based climate solutions.