

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

Prepared for: IMBeR Science Steering Committee

Executive Summary

This document outlines how the 2025 IOC-R report ("Integrated Ocean Carbon Research: A Vision Primed for Implementation") has significantly contributed to the advancement of IMBeR's Grand Challenge I (GC I), chaired by Dr. Nina Bednaršek. The report provides foundational research, implementation strategies, and a forward-looking vision for understanding the role of marine ecosystems in the ocean carbon cycle under the pressures of climate change and human activities. Dr. Bednaršek led the IOC-R chapter "**New Needs for Ocean Carbon Research**" (**Section 4**), contributed to the chapter on "The Changing Role of Biology in the Ocean Carbon Cycle (3.b)," and played a central role in ensuring the integration of ecosystem science across the report.

I. Grand Challenge I: Understanding and Quantifying Marine Ecosystem Function

Objective: Develop a comprehensive understanding of how marine ecosystems function, respond to multiple stressors, and contribute to carbon cycling across scales.

1. Advancements from IOC-R

- **Biological Carbon Pump Research:** The IOC-R report (Section 3.b) provides a deep analysis of biologically-mediated carbon fluxes, identifying key uncertainties in carbon transformation, remineralization, and export efficiency.
 - Supports IMBeR's call for mechanistic understanding of plankton, microbial and metazoan contributions to carbon cycling.
- **Multi-Stressor Ecosystem Response:** The report offers insight into synergistic impacts of warming, deoxygenation, and acidification on marine carbon processes and ecosystem dynamics.
 - This aligns with GC I's goals of quantifying ecosystem vulnerabilities and feedbacks.
- **Process-Oriented Modeling and Observations:** Emphasis is placed on integrating modeling with long-term observations and experimental studies, addressing a major GC I priority.
- **Emerging Priorities ("New Needs for Ocean Carbon Research" - Section 4):** This chapter identifies cross-cutting gaps in current research, including the need for:
 - Multi-driver ecosystem experiments
 - Integrative monitoring of biological and carbon system feedbacks
 - Interdisciplinary collaboration frameworks across scales and disciplines Section 4 of the IOC-R report feeds directly into GC I's mandate by establishing a forward-

looking research agenda that highlights ecosystem complexity, resilience under compound stressors, and methodological innovation.

2. Role of Dr. Nina Bednaršek

As GC I chair and author of key IOC-R chapters, Dr. Bednaršek played a role in:

- Advancing the biological carbon pump science, especially regarding acidification impacts on calcifiers and ecosystem structure.
- Promoting mesocosm/macrocsm experimentation and omics approaches to assess organismal adaptation and physiological thresholds.
- Bridging disciplinary silos by aligning ecosystem biology with geochemistry and modeling in IOC-R.
- Driving the identification of "New Needs for Ocean Carbon Research" (Section 4) to shape IMBeR's evolving priorities for GC I.
- Contributing scientific expertise to Section 3.b on biological processes in the ocean carbon cycle.

II. Future Directions

Based on the IOC-R report, a clear scientific and collaborative pathway for GC I can be established. The IOC-R report stands as a foundational reference for IMBeR's future activities by:

- Strengthening the scientific basis for carbon-climate-ecosystem feedbacks.
- Encouraging transdisciplinary approaches and capacity development aligned with IMBeR's Vision 2030 goals.
- Providing future research directions through the "New Needs for Ocean Carbon Research" (Section 4) that anticipates emerging challenges and innovation opportunities in ocean carbon science.

Next Steps:

- Integrate findings into GC I working group agendas and regional pilot studies.
- Build links between IOC-R ecosystem studies and IMBeR-led observing and modeling initiatives.
- Leverage IOC-R recommendations to enhance grant applications and policy engagement strategies.