WestLand Publishers

Volume 3 Issue 2
www.westlandpublishers.com

ISSN: 3066-3822

Digital Journal of Science (DJS)

Short Communication

Bivalve Farming Is Not a Solution for Marine Carbon Dioxide Removal

Chen-Tung Arthur Chen*
Department of Oceanography, National Sun Yat-sen University, Kaohsiung 804, Taiwan.

***Corresponding author:** Chen-Tung Arthur Chen, Department of Oceanography, National Sun Yat-sen University, Kaohsiung 804, Taiwan.

Received Date: **27 January, 2026** ; **Published Date:** **10 February, 2026**

Keywords:
marine carbon dioxide removal, shellfish farming, carbon credit

Citation:
CTA Chen* (2026) Bivalve Farming Is Not a Solution for Marine Carbon Dioxide Removal. Digital J Sci 3(2): 152.

DOI: 10.63592/DJS/152

Marine carbon dioxide removal (mCDR) refers to a suite of approaches that artificially enhance the ocean's capacity to remove carbon dioxide from the atmosphere and store it for long periods. Interest in mCDR has grown because most climate pathways consistent with limiting global warming to 1.5–2 °C require not only rapid emissions reductions but also substantial "negative emissions" during this century. The ocean is considered a potentially large CO_2 sink and has already absorbed roughly one quarter of excess atmospheric CO_2 [1,2]. mCDR approaches can be broadly grouped into five categories: ocean alkalinity enhancement, direct ocean capture via chemical or electrochemical processes, seaweed or phytoplankton cultivation, artificial upwelling/downwelling, and the protection and restoration of blue-carbon ecosystems such as mangroves, seagrasses, and salt marshes. Recently, bivalve farming has been proposed as a potential mCDR strategy. In 2022, 18.7 million tons of marine mollusks, predominantly bivalves, were produced worldwide [3]. Because a substantial amount of carbon is sequestered in their shells, bivalve farming has been suggested as a potential mCDR hotspot for climate change mitigation, and the possibility of claiming carbon credits has also been investigated [3–7]. It is important, however, to emphasize that the objective of mCDR is to remove CO_2, not merely carbon.

The seawater CO_2 system and the formation of bivalve shells are governed by thermodynamics:

$$CO_2 + H_2O = H_2CO_3 \quad (1)$$
$$H_2CO_3 = H^+ + HCO_3^- \quad (2)$$
$$HCO_3^- = H^+ + CO_3^{2-} \quad (3)$$
$$Ca^{2+} + 2HCO_3^- = CaCO_3 + H_2O + CO_2 \quad (4)$$

Equation (1) is governed by the solubility of CO_2. Equation (2) has a pK of about 6, and Equation (3) has a pK of about 9 in seawater, which has a pH of approximately 8. Equations (2) and (3) indicate that, in seawater, HCO_3^- is about 100 times more abundant than H_2CO_3 or dissolved CO_2 and about ten times more abundant than CO_3^{2-}. Shell formation draws carbon from the most abundant carbon species, HCO_3^-, and converts it into the least abundant form, CO_2. Indeed, Equation (4) shows that for every carbon atom sequestered in shells, one molecule of CO_2 is released into surface seawater and eventually into the atmosphere. In summary, shell formation stores one carbon atom but releases one CO_2 molecule, which contributes to global warming and is precisely the focus of mCDR.

Shellfish farming is, of course, more complex than simple thermodynamics. One additional process is the formation of soft tissue, which is traditionally the primary objective of farming. The flesh, or organic carbon, does take up carbon and thereby reduces CO_2 concentrations in seawater. However, it is well established that shells contain more carbon than the soft tissue; thus, mollusk growth results in a net release of CO_2. The controversy over whether shellfish farming absorbs or releases CO_2 arises from the claim that, when considering the ecosystem as a whole, it may nevertheless absorb CO_2. This argument is based on the growth of phytoplankton within shellfish farms, where photosynthesis consumes CO_2. If phytoplankton production is sufficiently high, photosynthetic CO_2 uptake could exceed CO_2 release from shell formation. Under such conditions, assuming adequate nutrient supply, shellfish farms could function as carbon sinks. However, this scenario effectively represents phytoplankton farming rather than shellfish farming. A recent mesocosm study [7] further suggests that oyster farming produces dissolved and particulate organic carbon and promotes organic carbon deposition in sediments. As a result, oyster-driven organic carbon production was reported to sequester more carbon than is released during shell formation, thereby enhancing atmospheric CO_2 uptake. Nevertheless, this study cannot be regarded as conclusive because it was conducted in a mesocosm and over a relatively short duration.

Most freshly produced dissolved organic carbon is labile and decomposes rapidly. For example, in the East China Sea, approximately 85% of primary production is regenerated within the seawater residence time of less than two years [8]. Consequently, only about 15% of biologically produced organic carbon, dissolved or particulate, survives and is exported to the Pacific Ocean. In the open ocean, organic carbon is rapidly remineralized within the euphotic zone, and only recalcitrant dissolved organic carbon enters the deep-water circulation, where it is isolated from the atmosphere for millennia [9]. Returning to the mesocosm study [7], even if oyster-driven organic carbon production temporarily exceeds carbon release from shell formation, most of the organic carbon would likely be remineralized to CO_2 after the short experimental period. Likewise, organic carbon deposited in mesocosm sediments would probably be regenerated into CO_2, or even more potent greenhouse gases such as CH_4 and N_2O, had the experiment been extended. Because mesocosm experiments are inherently limited in duration, the ultimate test of whether shellfish farming represents a credible mCDR strategy must rely on field observations. A recent synthesis [10] examined 48 studies on bivalve farming, of which only eight were based on observational data. Seven of these eight studies reported net CO_2 release from the system. Notably, the most recent publication [11], which included the corresponding author of the mesocosm study [7], also documented intense CO_2 outgassing in an intensive mariculture bay, results that stand in direct contrast to those of the mesocosm experiment. In conclusion, shellfish farming is not a solution for marine carbon dioxide removal.

Financial Support and Sponsorship

Financial support from the ROC National Science and Technology Council (NSTC 113-2611-M-110-010) and the Ministry of Education, Higher Education SPROUT Project 13C14 is gratefully acknowledged.

Conflict of Interest

The author declares no conflict of interest.

References

1. Chen CTA (1993) The oceanic anthropogenic CO_2 sink. Chemosphere 27 (6): 1041-1064.
2. Friedlingstein PM, O'Sullivan M, Jones MW, Andrew RM, Bakker DCE, et al (2025) Global Carbon Budget 2025. Earth Syst Sci Data Discuss. [preprint], https://doi.org/10.5194/essd-2025-659 (in review).
3. Food and Agriculture Organization of the United Nations (FAO) (2022) The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. Pp, 266.
4. Tang QS, Zhang JH, Fang JG (2011) Shellfish and seaweed mariculture increase atmospheric CO_2 absorption by coastal ecosystems. Mar Ecol Prog Ser 424: 97-104.
5. Alonso AA, Álvarez-Salgado XA, Antelo LT (2021) Assessing the impact of bivalve aquaculture on the carbon circular economy. J Clean Prod. 279: 123873.
6. ABC South East NSW (2022) Researchers, farmers investigate carbon neutral accreditation for Australian oysters.
7. Chen XW, Zhang Z, Pan MJ, Liu Y, Chang-Lin L, et al. (2025) Oyster farming acts as a marine carbon dioxide removal (mCDR) hotspot for climate change mitigation. Proc Natl Acad Sci USA. 122 (36): e2504004122.
8. Chen CTA, Wang SL (1999) Carbon, alkalinity and nutrient budgets on the East China Sea continental shelf. J Geophys Res 104(C9): 20675-20686.
9. Chen CTA (2011) Microbial carbon pump: additional considerations. Nat Rev Microbiol 9: 555.

10. Pernet F, Dupont S, Gattuso JP, Metian M, Gazeau F (2025) Cracking the myth: Bivalve farming is not a CO_2 sink. Rev Aquac 17(1): e12954.

11. Han AQ, Wang B, Su JZ, Chen ML, Li HL, et al. (2026) Riverine-coastal carbon dynamics, acidification, and CO_2 outgassing in an intensive mariculture bay. Agriculture, Ecosystems & Environment 396: 109972.