Date of Hearing: April 29, 2025

ASSEMBLY COMMITTEE ON WATER, PARKS, AND WILDLIFE
Diane Papan, Chair
AB 1086 (Muratsuchi) – As Amended April 23, 2025

SUBJECT: Marine Carbon Initiative

SUMMARY: Requires the California Air Resources Board (CARB) to establish the Marine Carbon Initiative and sets forth the objectives of the initiative, including advancing the body of research and scientific understanding of marine carbon dioxide removal (CDR) and sequestration. Specifically, **this bill**:

1) Defines the following terms:

    a) "Marine CDR" as an intentional intervention in the marine environment that results in the net removal of carbon dioxide (CO_2) from the upper hydrosphere or atmosphere as measured on a life-cycle basis, taking into account all greenhouse gases (GHG) measured in CO_2 equivalents.

    b) "Marine carbon dioxide sequestration" means an intentional intervention in the marine environment that results in the durable storage of CO_2 in the ocean, excluding any mechanical injection of CO_2 into the seabed.

2) Establishes the Marine Carbon Initiative, which shall consist of both the Marine Carbon Council (Council) and the Marine Carbon Research Program (Program); and,

3) Establishes the objectives of the Marine Carbon Initiative as all of the following:

    a) Advancing the body of research and scientific understanding of marine CDR and sequestration, particularly by enabling in-ocean testing, field trials, and pilot programs;

    b) Evaluating the environmental and ecosystem responses, and social and economic impacts, of marine CDR and sequestration to coastal communities within California;

    c) Understanding the labor, logistics, and supply chain implications of marine CDR and sequestration in California; and

    d) Producing recommendations for the potential commercial deployment of safe and effective marine CDR and sequestration in the state.

4) Requires CARB to establish, on or before July 1, 2027, the Council to advance the science and understanding of marine CDR and sequestration methods and technologies, consistent with the terms and objectives of this bill.

5) Requires the Council's objectives to include evaluating all of the following:

    a) Best practices for measuring, reporting, and verifying marine CDR and sequestration methods and technologies;

b) The sustainability of marine CDR and sequestration projects through life-cycle assessment; and

c) Potential commercialization pathways for marine CDR and sequestration in California.

6) Requires the Council to consist of seven members chosen by CARB on or before August 1, 2027.

7) Requires CARB to issue a public call for nominations for councilmembers and select the councilmembers from among those nominated through this public process. Requires CARB to ensure councilmembers are drawn from various sectors and represent different areas of expertise relevant to marine CDR and sequestration, including representatives from industry, universities, federal laboratories, or nonprofit organizations with specialized knowledge.

8) Requires CARB to consider the following qualifications for Council membership:

a) Expertise in marine carbon removal and sequestration chemistry and biology;

b) Expertise in ocean ecosystem marine ecology;

c) Demonstrated commitment to conservation and restoration of marine ecosystems through background, work experience, community engagement, or other activities CARB deems relevant; and

d) Demonstrated commitment to advancing scientific understanding of nascent technologies through background, work experience, community engagement, or other activities CARB deems relevant.

9) Requires CARB to ensure the Council includes members representing a balance of geographic interests in California by ensuring that no more than any three members reside in the same county. Requires CARB, to the extent practicable, ensure a fair and balanced apportionment of sectors and areas of expertise.

10) Requires, if CARB sees a sufficient cause for removing or replacing a councilmember or if a councilmember sends a formal resignation request to CARB, CARB to issue a public call for nominations within 60 days of the date the member leaves the Council.

11) Requires, by July 1, 2028, the Council to report to CARB with recommendation on all of the following:

a) Identification of gaps in scientific understanding of marine CDR;

b) Identification of gaps in scientific understanding of marine CO_2 sequestration;

c) Identification and coordination with credible efforts underway or planned to establish the necessary knowledge to close the gaps in scientific understanding identified by the Council.

d) Provisions of approaches and recommendations to establish the necessary knowledge to close the gaps in scientific understanding identified by the Council.

e) Provisions of expert advice as requested from state agencies or officials on the topic of marine CDR and sequestration.

f) Identification of opportunities for partnerships among state and federal agencies, academia, industry, and other members of the marine CDR and sequestration community in support of the Program.

g) Evaluation and provision recommendations for the potential establishment of marine carbon research hubs or facilities in California and potential pathways to enable those hubs or facilities to administer certain aspects of marine CDR or sequestration research projects.

h) Provision of support for the Program.

i) Provision of support the advancement of research and demonstration of marine CDR and sequestration methods and technologies as requested by CARB.

12) Authorizes the Council to do any of the following to support the recommendations in #11:

a) Seek input and coordinate with relevant federal, state and local governmental agencies;

b) Seek input from public and private universities; and

c) Identify support from public and private funding to advance and support marine CDR and sequestration field studies and other research methods.

13) Requires CARB, on or before August 1, 2028, to establish the Program and administer the Program in consultation with the Council.

14) Requires the Program to award grants on a competitive basis, and other financial incentives CARB may designate, for eligible marine CDR and sequestration projects.

15) Requires eligible marine CDR and sequestration projects have at least one partner organization based in California, or a contractor or staff member who resides in California.

16) Requires CARB to do all of the following:

a) In addition to any other authorized method of providing moneys to participants, consider and adopt the use of financial incentives;

b) Direct the Council to establish guidelines or other standards for the Program, including guidelines to balance environmental and community impacts and priorities with the needs of eligible projects under the Program;

c) Consult with the State Water Resources Control Board (State Water Board), the Department of Fish and Wildlife (DFW), State Lands Commission (SLC), local air quality management districts and local air pollution control districts, regional water quality control boards (regional water boards), and other relevant local, state, or federal agencies, to ensure program moneys support achieving the state's climate targets, to the extent feasible;

d) Make reasonable efforts to ensure the Program is implemented in a manner consistent with the objectives; and,

e) Ensure that projects that receive funding or financial incentives under the Program provide publicly available annual updates to the council summarizing their research, in accordance with any format or other requirements established by CARB or the Council.

17) Requires CARB to share information relevant to state agencies that would have permitting authority over marine carbon research projects that receive funding pursuant to the program and provide recommendations about what was learned from the research done by the Council.

18) Requires CARB to coordinate with other state departments and agencies to ensure an integrated approach to implementation of the Program, including the California Coastal Commission, DFW, Natural Resources Agency, Ocean Protection Council, SLC, State Water Board, and regional control boards.

19) Requires, on or before January 1, 2029, and biennially thereafter, the Council to submit a report to the Legislature that, at minimum, summarizes the findings and progress of the Council in its work, including the work completed under the Program.

20) Requires, upon appropriation by the Legislature, $2 million to be allocated to CARB annually for no less than seven years to fund the Program.

21) Provides that this bill does not limit or otherwise alter the authority of CARB, including, without limitation, the acceptance or inclusion of marine CDR and sequestration projects under the Carbon Capture, Removal, Utilization, and Storage Program.

EXISTING LAW:

1) Establishes the California Ocean Protection Act [Public Resources Code (PRC) §§ 35500 *et seq.*] and the California Coastal Act of 1976 [PRC §§ 30000 *et seq.*), which find and declare that:

a) The ocean and coastal waters offshore of the state are unique and valuable natural resources that the state holds in trust for the people of California.

b) State decisions affecting coastal waters and the ocean environment should be designed and implemented to conserve the health and diversity of ocean life and ecosystems, allow and encourage those activities and uses that are sustainable, and recognize the importance of aesthetic, educational, and recreational uses.

c) A goal of all state actions shall be to improve monitoring and data gathering, and advance scientific understanding, to continually improve efforts to protect, conserve, restore, and manage coastal waters and ocean ecosystems.

d) Although some development has significant adverse effects on coastal resources or coastal access, it may be necessary to locate such developments in the coastal zone in order to ensure that inland as well as coastal resources are preserved and that orderly economic development proceeds within the state.

2) Makes various agencies responsible for protecting the state's ocean and coastal resources including the California Coastal Commission (PRC §§ 30300 *et seq.*), DFW and the Fish and Game Commission (Fish and Game Code §§ 2050 *et seq.* and §§ 2850 *et seq.*), SLC (PRC §§ 6001 *et seq.)*, and the Ocean Protection Council (PRC §§ 35600 *et seq.*).

3) Authorizes CARB, pursuant to California Global Warming Solutions Act of 2006 [Health & Safety Code (HSC) §§ 38500 *et seq.*] to:

   a) Adopt a statewide GHG emissions limit equivalent to 40% below 1990 levels by 2030 and to 85% below 1990 levels by 2045.

   b) Adopt a regulation that establishes a system of market-based declining annual aggregate emission limits for sources or categories of sources that emit GHG emissions, applicable until December 31, 2030. Under this authority, CARB adopted a cap and trade regulation that applies to large industrial facilities and electricity generators emitting more than 25,000 metric tons of CO_2 equivalent per year, as well as distributors of fuels, including gasoline, diesel, and natural gas.

   c) Require any reduction of GHG emissions used for compliance purposes to be real, permanent, quantifiable, verifiable, enforceable, and additional.

4) Requires CARB to establish a Carbon Capture, Removal, Utilization, and Storage Program to, among other things, evaluate the efficacy, safety, and viability of carbon capture and storage and CDR technologies and facilitate the capture and sequestration of CO_2 from these technologies, where appropriate (HSC § 39741.1).

FISCAL EFFECT: Unknown. This bill is keyed fiscal.

COMMENTS:

1) **Purpose of this bill**. According to the author, "The climate crisis is here and now. As our planet's largest carbon sink, our oceans can play a big part in helping us achieve our climate goals. However, there is a limit to how much CO_2 they can absorb until they reach their breaking point. If we can safely and effectively remove CO_2 from our oceans we can help it absorb more from the atmosphere and give us a fighting chance at keeping our planet below 2 degrees Celsius and avoid the worst effects of climate change. By jumpstarting research and streamlining permitting, [this bill] will catalyze marine CO_2 removal to help California continue its role as a global climate leader."

2) **Background**. The report by the International Panel on Climate Change, Climate Change 2022: Mitigation of Climate Change, states "[t]he deployment of CDR to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or GHG emissions are to be achieved. […] Upscaling the deployment of CDR depends on developing effective approaches to address feasibility and sustainability constraints especially at large scales."

   The marine environment. The ocean, covering 70% of Earth's surface, includes much of the global capacity for natural carbon sequestration, and great potential for uptake and long term sequestration of human produced CO_2 because, per unit volume, seawater holds nearly 150 times more CO_2 than air. According to the University of California, Davis, oceans currently absorb roughly 25% of the CO_2 emitted from anthropogenic activities annually. As

atmospheric CO_2 levels increase, so do the CO_2 levels in the ocean. Scientific observations have measured ocean CO_2, increasing in proportion to the rise in atmospheric CO_2, but there may be a saturation limit. Scientists have observed clear regional deviations from this correlative pattern, suggesting that there is no guarantee that sequestration will remain as robust with time.

Carbon capture and sequestration. Carbon Capture and Storage (CCS, also sometimes referred to as carbon capture and sequestration) is the process of capturing CO_2 that is formed during combustion or industrial processes and putting it into long-term storage so that it is not emitted into the atmosphere. Once the CO_2 is captured, it may be compressed and chilled (depending on the storage situation), and transported to an appropriate storage site, usually by pipelines and/or ships and occasionally by trains or other vehicles. To store the CO_2, it is injected into deep, underground geological formations, such as former oil and gas reservoirs, deep saline formations, and coal beds.

Ocean CDR technology. The types of marine CDR and sequestration included in this bill are: ocean alkalinity enhancement, electrochemical engineering approaches, macroalgae cultivation; nutrient fertilization; artificial upwelling and downwelling; coastal marine ecosystems as a natural climate solution, mineralization, and biomass sinking. Briefly, ocean alkalinity enhancement takes advantage of the natural acid-base buffering system of the ocean by shifting that system to be more basic so that it can absorb more CO_2. It may take months to see results from those efforts as the ocean and air reach new equilibrium, which will be further challenged by the unconfined boundaries of the experimental area.

The University of California, Los Angeles (UCLA) is behind a new technology company that is building a seawater CDR system that could be used off California. The company, Equatic, uses an electrolytic process developed by scientists at UCLA's Institute for Carbon Management. The Equatic process immobilizes new and historic CO_2 by passing seawater through an electrically charged mesh that kicks off a set of chemical reactions that ultimately combines dissolved CO_2 with calcium and magnesium native to seawater, producing limestone and magnesite by a process similar to how seashells form. The seawater that flows out would then be depleted of dissolved CO_2 and ready to take up more. A co-product of the reaction, besides minerals, is hydrogen, which can be used as a clean fuel.

Beyond a stricter chemical approach, some of these technologies would also endeavor to take advantage of natural biological processes. For example, biomass sinking is a process of dumping terrestrial or ocean natural products, which have been incorporating atmospheric CO_2 as they grow, into the deep ocean. Unlike in terrestrial environments, where the CO_2 would be slowly released as the biomass decomposes, the ocean depths are considered to have minimal microbial activity, so the CO_2 would not be released. The cultivation of microalgae could also pull CO_2 out of the atmosphere through natural biological processes, and would provide a foundational food source for the ocean food chain.

The net extent of CO_2 removal accomplished by any of these experimental approaches must be measurable, verifiable, reportable, additional, cost-effective, scalable, and durable. It is critical that these approaches do not add insurmountable additional pressures on the marine environment, which is already under stress due to climate change. The environmental impact of some of these technologies has yet to be understood, and like many technologies, their impact may not be readily understood for years or even decades. Therefore it will also be

critical to determine the scope and scale of this research so that scientific conclusions may still be drawn, while also limiting environmental impact.

Creating recognition for marine CDR. This bill requires CARB to establish the Marine Carbon Initiative to advance the body of research and scientific understanding of marine CDR and sequestration. The initiative would require the Council to advance the science and understanding of marine CDR and sequestration methods and technologies; the Program to award grants and other financial incentives for eligible marine CDR and sequestration projects; and implement an expedited marine carbon research program permitting process.

3) **Policy considerations**. This bill encourages the evaluation of numerous chemical and biological approaches that are in various states of development. Although the ultimate goal of these research is to remove CO_2 from the atmosphere, the medium for these approaches is ocean water and biology. To this end, the author may wish to consider which departments and agencies would be most relevant for overseeing this research. Notably, CARB does not have any permitting authority to oversee these projects or mandate to protect ocean resources, but would have an oversight role in the value these projects have for reducing atmospheric CO_2. *The author may wish to consider if another state agency would have stronger expertise in the research and permitting required through this bill and would give better consideration to protecting the ocean and coastal resources in the pursuit of marine CDR.* Additionally, since economic development is a goal of this bill, the author may wish to consider including the Governor's Office of Business and Economic Development as a collaborative entity.

Sufficient, reliable funding over a consistent stretch of time is needed for scientific research. The Trump Administration's reductions to federal workforces, which includes scientists, and the proposed funding cuts to scientific research will likely imperil much of the science-based policy making coming out of the U.S. This bill implies that $2 million annually over a period of seven years will be available to CARB to implement this bill; however, there is no guarantee these funds will actually be appropriated through the budget process. Without funding, it will not be possible to implement this bill and meet deadlines it sets.

4) **Proposed committee amendments**. *To increase consideration and study of the environmental impacts of marine CDR and carbon sequestration, the author may wish to consider the following amendments:*

Amendment 1 – Give greater weight to environmental impacts in the objectives of the Initiative in subsection (b)(2):

(2) The objectives of the Marine Carbon Initiative shall include all of the following:

(A) Advancing the body of research and scientific understanding of marine carbon dioxide removal and sequestration, particularly by enabling in-ocean testing, field trials, and pilot programs.

(B) Evaluating the environmental and ecosystem responses ***ranging from nutrient changes to wildlife impacts***~~, and social and economic impacts,~~ of marine carbon dioxide removal and sequestration ***and evaluating the extent of the net benefit of implementing each marine carbon dioxide removal and sequestration project.*** ~~to coastal communities within California.~~

(C) Understanding the labor, logistics, and supply chain implications ***as well as the social and economic impacts*** of marine carbon dioxide removal and sequestration in California.

(D) Producing recommendations for the potential commercial deployment of safe and effective marine carbon dioxide removal and sequestration in the state.

Amendment 2 – Explicitly include environmental science in the membership of the Council in subsection (c)(3)(c):

(C) The state board shall ensure council members are drawn from various sectors and represent different areas of expertise relevant to marine carbon dioxide removal and sequestration ***and environmental science***, including representatives from industry, universities, federal laboratories, or nonprofit organizations with specialized knowledge.

Amendment 3 – Require the councils report to include environmental considerations in subsection (d):

(8) Metrics for evaluating impacts to marine ecosystems and resources and recommendations for the limited scale at which the methods and technologies under (d)(1) and (d)(2) could be tested to produce results sufficient to evaluate such metrics.

(9) Evaluation of potential impact to existing ocean uses, including but not limited to, fishing, aquaculture, and recreation.

(10) ~~(8)~~ Provision of support ***and limitations*** for the program.

(11) ~~(9)~~ Provision of support ***and limitations*** the advancement of research and demonstration of marine carbon dioxide removal and sequestration methods and technologies as requested by the state board.

Amendment 4 –Allow CARB to coordinate with other department in all aspects of the Initiative in subsection (h):

(h) The state board shall coordinate with other state departments and agencies to ensure an integrated approach to implementation of the ***initiative*** ~~program~~ […]

5) **Arguments in support**. Supporters encourage the state to employ all available allies and tools to achieve its climate and GHG reduction goals, including carbon capture, removal, and storage—to which they note that marine CDR has largely been excluded from. They note that this bill has the potential to realize both environmental and economic benefits of marine CDR while addressing the climate crisis. Finally, they praise the initiative of the previous federal administration in developing a national marine CDR research strategy and the initial $24 million for research.

6) **Arguments in opposition**. While the Deep Ocean Stewardship Initiative supports efforts to address the climate crisis, they write in opposition indicating that the advancement of marine CDR at large-scales is premature and may pose a risk to California's ocean environment. Specifically, they note that this bill is written under a framework that prioritizes commercial development, which ignores international guidance which has issued a moratorium on

commercial application of these technologies, and they believe that funds would be better spent on working towards emissions reductions instead of offsets.

7) **Double referral**. This bill was referred to the Assembly Natural Resources Committee where it passed 13–0.

8) **Related legislation**. AB 2572 (Muratsuchi) of 2024 would have required CARB to develop criteria to determine whether an ocean CDR project is environmentally safe and sustainable, and to qualify environmentally safe and sustainable projects for inclusion in state carbon credit programs. AB 2572 was held in the Assembly Appropriations Committee.

   SB 905 (Caballero), Chapter 359, Statutes of 2022, requires CARB to establish a Carbon Capture, Removal, Utilization, and Storage Program to evaluate the efficacy, safety, and viability of carbon capture, utilization, or storage technologies and CDR technologies and facilitate the capture and sequestration of CO_2 from those technologies, where appropriate. SB 905 did not recognize marine CDR as a covered technology.

REGISTERED SUPPORT / OPPOSITION:

Support

Altasea (Co-Sponsor)
Ocean Visions (Co-Sponsor)
[C]Worthy
Braid Theory, Inc.
Brineworks
Captura
Capture6
Ephemeral Carbon
Equatic Tech, Inc.
Floofah
Larta Institute
Project 2030
TMA Bluetech
Vesta, PBC

Four individuals

Opposition

Deep Ocean Stewardship Initiative

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