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A Hegelian Ecocentric Framework for Evaluating Deep-Seabed Mining Moratoria

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The governance of deep-seabed mining (DSM) in the international seabed area has become one of the defining environmental controversies of the present decade. As the International Seabed Authority (ISA) struggles to finalise its exploitation regulations, and as unilateral action by the United States threatens to fracture the multilateral order established under the United Nations Convention on the Law of the Sea, a coalition of states has called for a moratorium or precautionary pause on commercial extraction. This article develops a Hegelian ecocentric framework for evaluating such moratoria. It argues that the dominant framing of the debate—a zero-sum trade-off between economic development and environmental protection—rests on a static and ultimately impoverished ontology of ecological equilibrium. Drawing on G.W.F. Hegel's dialectical categories of becoming, contradiction, sublation (Aufhebung), and ethical life (Sittlichkeit), and integrating them with the ecocentric traditions of Arne Næss, Aldo Leopold, Val Plumwood, and Hans Jonas, the article reconceives ecological equilibrium as a dynamic, self-mediating process rather than a fixed state. On this reading, the contradiction between extraction and preservation is not an external collision of interests but an internal tension whose rational resolution, under conditions of deep scientific uncertainty, is a moratorium understood as dialectical sublation: a determinate negation that preserves the developmental impulse while suspending its most irreversible expression. Employing qualitative normative policy analysis, the article advances a framework of ecocentric marine governance grounded in precaution, ecological stewardship, and adaptive management, and addresses the strongest objections from both orthodox developmental economics and the internal critics of ecocentrism. The contribution is a philosophically rigorous reframing of precautionary governance that resists both the technocratic optimism of the extractive lobby and the static preservationism of its opponents.

Introduction

In the abyssal plains of the Clarion–Clipperton Zone (CCZ), a swathe of Pacific seabed roughly the size of the contiguous United States, lie trillions of potato-sized concretions known as polymetallic nodules. Rich in nickel, cobalt, copper, and manganese, these nodules have become the focus of a contest that compresses, within a single policy arena, the central antagonisms of twenty-first-century political economy: the imperative of decarbonisation, the geopolitics of critical-mineral supply chains, the fragility of the multilateral legal order, and the moral status of ecosystems about which we know almost nothing. The deep seabed beyond national jurisdiction was designated by the United Nations Convention on the Law of the Sea (UNCLOS) as the "common heritage of mankind," to be administered for the benefit of humanity as a whole (United Nations, 1982). The International Seabed Authority (ISA), established under that Convention, is charged with the dual and increasingly strained mandate of organising the exploitation of the Area's mineral resources while ensuring effective protection of the marine environment (Jaeckel, 2017).

That mandate has now reached a point of acute tension. As of late 2025, the ISA Council had still not adopted the "Mining Code"—the body of exploitation regulations that would govern commercial extraction—despite years of negotiation and a self-imposed timeline that envisaged adoption during the Authority's thirtieth session in 2025 (International Seabed Authority, 2025). By the Authority's own account, forty states have formally called for a moratorium, a precautionary pause, or an outright ban on deep-seabed mining (International Seabed Authority, 2025). Simultaneously, the multilateral framework has been challenged from without: in April 2025, the United States, which is not a party to UNCLOS, issued Executive Order 14285, "Unleashing America's Offshore Critical Minerals and Resources," directing its domestic agencies to expedite the licensing of seabed mining in areas beyond national jurisdiction under the Deep Seabed Hard Mineral Resources Act of 1980 (Baskaran & Schwartz, 2025). Within days, a subsidiary of The Metals Company submitted the first-ever applications for commercial recovery of nodules in the CCZ to the United States National Oceanic and Atmospheric Administration, prompting the ISA to warn that any exploitation conducted outside its authorisation would violate international law (Singh et al., 2025).

The debate, as conventionally framed, presents a stark dichotomy. On one side stands the developmental case: critical minerals are indispensable to the energy transition and to national security, terrestrial mining carries its own grave social and ecological costs, and prudent extraction of the seabed can be conducted under a robust regulatory regime. On the other stands the preservationist case: the deep sea is the planet's largest and least-understood biome, its ecosystems recover over geological rather than human timescales, and the precautionary principle counsels against irreversible interference with systems we cannot model. This article contends that the antithetical structure of the debate, while not false, is philosophically underdetermined. Both camps tend to presuppose that ecological equilibrium is a state—a stable baseline either to be exploited within

tolerable limits or to be conserved intact—and it is precisely this shared ontological assumption that a Hegelian analysis is positioned to disrupt.

The central research question of this article is therefore the following: how can Hegelian dialectics provide an ecocentric framework for evaluating deep-seabed mining moratoria under conditions of ecological uncertainty and competing developmental demands? The central argument proceeds in three moves. First, ecological equilibrium should be understood not as a static condition but as a dynamic dialectical process—a becoming in Hegel's technical sense, the restless unity of being and nothing, of persistence and perpetual self-transformation. Second, the conflict between extraction and preservation is best grasped not as an external clash of incompatible goods but as an internal contradiction immanent to a single developmental totality: the relation between human metabolic activity and the living systems on which it depends. Third, given the depth of scientific uncertainty regarding deep-sea ecosystems, a moratorium constitutes a rational dialectical sublation (*Aufhebung*)—a determinate negation that simultaneously cancels, preserves, and elevates the opposing moments, rather than a mere prohibition or a deferral of the inevitable.

In advancing this argument the article makes three contributions. To environmental ethics, it offers a processual reconstruction of ecocentrism that escapes the charge of static preservationism without collapsing into anthropocentric instrumentalism. To marine governance scholarship, it supplies a normative grammar—grounded in precaution, stewardship, and adaptive management—for evaluating the legitimacy of moratoria beyond the language of cost–benefit calculation. To Hegel scholarship and political ecology, it demonstrates that the dialectic, so often read as a philosophy of human mastery over nature, can be turned against that very mastery once its concept of contradiction is taken seriously. The remainder of the article is organised as follows. Section 2 reviews the relevant literature. Sections 3 and 4 elaborate the Hegelian and ecocentric components of the framework respectively. Section 5 sets out the methodology. Sections 6 and 7 apply the framework to deep-seabed mining as a dialectical contradiction and to moratoria as dialectical synthesis. Section 8 develops the resulting governance framework, Section 9 engages the principal objections, and Section 10 concludes.

Literature Review

2.1 Deep-seabed mining and its governance

The scholarly literature on deep-seabed mining has expanded rapidly in tandem with the prospect of commercial exploitation. A substantial strand examines the institutional architecture of the ISA and the legal status of the Area under Part XI of UNCLOS (Jaeckel, 2017; Ardron et al., 2018). These works document a recurring structural problem: the ISA is simultaneously the promoter and the regulator of seabed mining, an arrangement that critics argue compromises its capacity to discharge its environmental mandate impartially (Ardron et al., 2018). The so-called "two-year rule," triggered by Nauru in 2021, sharpened this tension by obliging the Council to consider exploitation applications even in the

absence of agreed regulations, thereby converting a deliberative process into a race against a procedural deadline (Singh et al., 2025).

A second strand assesses the legal basis and pathways for a precautionary pause or moratorium. Singh, Jaeckel, and Ardron (2025) provide the most systematic treatment, demonstrating that a pause is legally available to ISA members through several mechanisms and that, far from being a derogation from the Authority's mandate, it may be the course most consistent with the precautionary obligations embedded in UNCLOS Article 145 and in the 2011 Advisory Opinion of the Seabed Disputes Chamber. The unilateral turn represented by the 2025 United States executive order has generated a third and growing body of analysis concerned with the geopolitical fragmentation of seabed governance and the risk that a regulatory vacuum invites a "race to the bottom" in both senses of the phrase (Baskaran & Schwartz, 2025).

2.2 The science of deep-sea ecosystems and mining impacts

The ecological literature is marked by a striking and consequential asymmetry between the scale of proposed intervention and the depth of available knowledge. The CCZ harbours a fauna of extraordinary and largely undescribed diversity; a landmark synthesis estimated that the overwhelming majority of species in the region are new to science (Rabone et al., 2023). Polymetallic nodules are not merely a substrate but a habitat: they form over millions of years and provide the only hard surface for sessile organisms across vast tracts of soft sediment, such that their removal is, for the organisms concerned, the destruction of the habitat itself (Van Dover et al., 2017). Modelling and in situ studies of sediment plumes—the clouds of resuspended material generated by collection and by dewatering discharge—indicate potential impacts extending well beyond the immediate mining track, though the magnitude remains contested (Spearman et al., 2020).

The empirical picture is genuinely mixed, and intellectual honesty requires acknowledging this. A 2025 study in Nature revisiting a 1979 test-mining site in the CCZ found that biological impacts persisted four decades later, with seafloor furrows still visible, yet also documented the early stages of recolonisation by several faunal groups and detected only limited residual sedimentation impact from the test plume (Jones et al., 2025). A separate study of a 2022 collector trial found a marked reduction in biodiversity and animal abundance at the mined site, while noting that impacts appeared concentrated near the disturbance rather than dispersed over thousands of kilometres (Smith et al., 2025). This evidentiary ambiguity is itself analytically central: it neither vindicates the catastrophist nor licenses the optimist, and it is precisely the condition under which the precautionary principle is designed to operate. Emerging work on under-studied stressors such as anthropogenic noise further underscores how much of the impact pathway remains uncharacterised (de Sousa et al., 2025).

2.3 Ecocentrism, precaution, and environmental ethics

The environmental-ethics literature furnishes the normative resources the governance debate often lacks. Ecocentrism, in the lineage running from Leopold's (1949) land ethic through Næss's (1973) deep ecology to Plumwood's (1993, 2002) critique of the dualisms underpinning ecological domination, locates moral considerability in ecological wholes and relations rather than in human interests alone. The precautionary principle, articulated in Principle 15 of the Rio Declaration and theorised philosophically by Jonas (1984) as an "imperative of responsibility," supplies the action-guiding correlation of ecocentric value under uncertainty. Yet a recurrent objection—pressed by critics within environmental philosophy as much as by its opponents—is that strong ecocentrism rests on a static "balance of nature" that contemporary ecology has abandoned in favour of models of flux, disturbance, and non-equilibrium dynamics (Botkin, 1990). It is this objection that the Hegelian reconstruction is designed to absorb rather than evade, and it marks the principal gap this article addresses: the absence of a processual ontology adequate to an ecocentrism that can survive the ecology of disequilibrium.

2.4 Hegel, dialectics, and ecological thought

That a Hegelian framework should be brought to bear on ecological governance may appear counterintuitive, given Hegel's reputation as a philosopher of Spirit's mastery over a merely external nature. Two bodies of work make the move defensible. First, the ecological Marxist tradition has recovered, via Marx's appropriation of Hegel, the concept of a metabolic rift—a rupture in the metabolic interaction between humanity and the rest of nature induced by capitalist production (Foster, 2000; Saito, 2017). Second, a revisionary current in Hegel scholarship has argued that Hegel's philosophy of nature and his concept of Sittlichkeit contain resources for an ecological ethics that recognises nature as having its own forms of organisation and even its own "interests" that the ethical community must mediate rather than simply override (Lumsden, 2021; Stone, 2005). Building on these openings, the present article treats the dialectic not as a metaphysical guarantee of progress but as a logic of mediation under contradiction—precisely the situation of seabed governance.

Hegelian Dialectics and Environmental Governance

To deploy Hegel responsibly in an applied context requires first dispelling the caricature that has long circulated under his name. The textbook formula of "thesis – antithesis – synthesis," though convenient, is not Hegel's; it derives from Fichte and Schelling by way of later popularisers, and Hegel himself never employs it as a description of his method (Mueller, 1958). Treating the dialectic as a mechanical recipe in which two propositions are averaged into a third both trivialises the logic and invites precisely the "simplistic" reading this article is at pains to avoid. What follows is therefore an attempt to reconstruct the relevant categories with sufficient fidelity that their application to seabed governance is illuminating rather than ornamental.

3.1 Becoming: equilibrium as process

Hegel's Science of Logic opens with the most austere of beginnings. Pure being, taken in complete indeterminacy, proves indistinguishable from nothing; each immediately passes over into the other. Their truth is neither being nor nothing in isolation but becoming (Werden)—the unity of the two in which each is preserved as a vanishing moment (Hegel, 1812/2010). Becoming is not a third term standing beside the first two but the movement that was implicit in them all along. The significance of this opening for environmental thought is considerable. It supplies an ontology in which stability and change are not opposites to be traded off but co-constitutive moments of a single process. An ecosystem, in this view, is not a thing that either persists or is destroyed; it is a becoming, a continuous self-maintenance through the very metabolic exchange that also continuously transforms it.

This reframing matters because the deep-sea governance debate is haunted by an equivocation on "equilibrium." Preservationists are frequently accused of defending a "balance of nature" that ecology has discredited; developmentalists exploit this to suggest that since ecosystems are always changing anyway, mining is merely one more perturbation among many. The Hegelian response dissolves the dilemma. Equilibrium is real, but it is the equilibrium of a process—a dynamic steady state maintained far from thermodynamic rest by continuous flows of matter and energy, what the deep-sea literature describes when it notes that nodule fields persist as habitats over millions of years precisely through slow, ordered accretion (Van Dover et al., 2017). To remove the nodules is not to nudge a static balance but to sever the process that constitutes the system as what it is. The distinction between perturbation-within-becoming and the destruction of the conditions of becoming is exactly what a processual ontology makes available and a static one obscures.

3.2 Contradiction as the motor of the real

For Hegel, contradiction is not a logical defect to be eliminated but the very principle of movement and life. "Something is therefore alive," he writes, "only insofar as it contains contradiction within it" (Hegel, 1812/2010, p. 382). A living thing sustains itself by being internally divided—assimilating an environment that is both other than it and necessary to it, persisting only by continuously negating and renewing itself. Contradiction so understood is immanent: it inheres within a totality rather than obtaining between two externally related things. This is the decisive conceptual point for the present analysis. The conflict between human extractive activity and the integrity of marine ecosystems is ordinarily represented as an external opposition between two parties with incompatible preferences. Read dialectically, it is an internal contradiction within a single metabolic totality—the planetary system of which human economy and ocean biology are differentiated but inseparable moments.

This is where Hegel's legacy connects with the ecological-Marxist concept of the metabolic rift. Marx, transforming Hegel's dialectic, characterised capitalist production as opening an "irreparable rift in the interdependent process of social metabolism" between humanity and the earth (Foster, 2000; Saito, 2017). The deep seabed represents this rift at

its frontier: an attempt to resolve the contradictions of terrestrial accumulation—resource depletion, the mineral demands of decarbonisation—by externalising them onto the one biome that has so far escaped industrial metabolism. To grasp seabed mining as the displacement of an internal contradiction rather than the discovery of a new external resource is to see why a purely technical "mitigation" framing misses the structural character of the problem.

3.3 Sublation: the logic of determinate negation

The category that does the principal normative work in this article is Aufhebung, conventionally rendered as sublation. Hegel exploits the term's ordinary German ambivalence: aufheben means at once to cancel, to preserve, and to lift up (Hegel, 1812/2010). A sublation is therefore not an abolition that leaves nothing behind, nor a compromise that splits the difference, but a determinate negation—a negation with a specific content, which negates one configuration of the opposing moments while preserving their rational kernel at a higher level of mediation. This is the precise sense in which, in Section 7, a moratorium will be characterised as sublation rather than as prohibition or postponement. Crucially, determinate negation is the opposite of the "abstract" negation that merely says no; it carries forward what is rational in what it negates.

3.4 Sittlichkeit: ethical life and institutional mediation

Finally, Hegel's concept of Sittlichkeit—ethical life—supplies the institutional dimension the framework requires. Against the abstract moralism that locates ethics in the isolated conscience of the individual agent, Hegel insists that genuine ethical life is realised in and through shared institutions, customs, and communities that give concrete content to freedom (Hegel, 1821/1991). Recent scholarship has read Sittlichkeit as an essentially ecological concept: a community understood as an evolving system of mutual constraint and enablement, in which the actions of each continuously reshape the whole that conditions them (Lumsden, 2021). Extended beyond human polity, this suggests that the appropriate locus of ecological ethics is neither individual virtue nor abstract rule but institutions of mediation—of which the ISA, for all its present deficiencies, is a nascent and imperfect example. The governance framework developed in Section 8 is, in Hegelian terms, a proposal for the ethical life adequate to humanity's metabolic relation with the deep ocean.

Ecocentrism and Marine Ethics

If Hegel supplies the form of the framework—a processual ontology and a logic of mediated contradiction—ecocentrism supplies its content: an account of what is at stake and why it matters. The two traditions are not obvious bedfellows, and part of this article's task is to show that their integration is more than a marriage of convenience.

4.1 From the land ethic to deep ecology

Leopold's (1949) land ethic enlarged the boundaries of the moral community to include "soils, waters, plants, and animals, or collectively: the land," and proposed as its summary maxim that a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. As Callicott (1989) has argued in systematising the land ethic, this holism does not abolish concern for individuals but situates it within an obligation to the community as such—a structure of nested duties rather than a simple subordination of parts to wholes. Næss (1973) radicalised this insight into deep ecology, distinguishing a "shallow" environmentalism concerned with human welfare from a "deep" ecology that affirms the intrinsic value of the flourishing of human and non-human life alike and the relational, field-like character of organisms-in-environments. Both thinkers shift moral attention from individual entities to ecological wholes and relations—a holism that maps naturally onto the deep-sea case, where what is threatened is less a charismatic individual organism than an entire system of relations of which science has so far catalogued only a fraction (Rabone et al., 2023).

4.2 Plumwood and the critique of dualism

Val Plumwood's (1993, 2002) contribution is indispensable precisely because it guards the framework against a danger internal to both Hegel and deep ecology. Plumwood diagnosed the ecological crisis as rooted in a structure of dualism—the hierarchical splitting of reason from nature, human from non-human, mind from body—in which the subordinated term is defined as a mere resource for the master term. Her critique cuts two ways here. It warns against the anthropocentric Hegel for whom nature is only the externalisation of Spirit, to be reclaimed and superseded; and it warns equally against a romantic deep ecology that would simply invert the hierarchy and dissolve the human into an undifferentiated nature. Plumwood's alternative—a relational self that recognises the other as both continuous with and genuinely different from itself—is structurally Hegelian in its refusal of both fusion and separation, and it is the key to reading the human–ocean relation as a mediated identity-in-difference rather than as either domination or merger.

4.3 Jonas and the imperative of responsibility under uncertainty

Hans Jonas (1984) provides the temporal and epistemic dimension. Confronted with a technological power whose effects are cumulative, irreversible, and planetary, Jonas argued that traditional ethics—oriented to the near and the certain—was inadequate, and he formulated a new imperative: act so that the effects of your action are compatible with the permanence of genuine human (and, by extension, ecological) life. Where consequences are uncertain but potentially catastrophic and irreversible, Jonas enjoined a "heuristics of fear" that gives priority to the worst prognosis. This is the philosophical foundation of the precautionary principle, and it is tailored to the deep-sea case, where the relevant timescales of recovery are measured in decades to millennia (Jones et al., 2025) and where the loss of undescribed species is, by definition, a loss we cannot fully assess in advance. Jonas thus converts ecocentric value into an action-guiding asymmetry under uncertainty—the normative engine of the synthesis developed below.

Methodology

This article employs qualitative normative policy analysis, an approach appropriate to questions that are irreducibly evaluative and cannot be settled by empirical measurement alone. Rather than predicting outcomes or estimating costs, normative policy analysis clarifies the values, concepts, and principles at stake in a policy controversy and assesses competing options against defensible standards of justification. The method here is composed of four integrated procedures.

Philosophical analysis reconstructs the conceptual frameworks—Hegelian and ecocentric—with fidelity to their primary sources, establishing the categories (becoming, contradiction, sublation, Sittlichkeit; intrinsic value, relationality, precaution) that structure the evaluation. Conceptual analysis then interrogates the key terms of the policy debate—"equilibrium," "sustainability," "moratorium," "risk"—to expose the often-unexamined ontological commitments they carry. Critical policy evaluation applies the resulting framework to the deep-seabed case, assessing the moratorium option not merely for its instrumental efficacy but for its coherence with the values and ontology defended. Comparative literature review situates the argument within, and tests it against, the existing scholarship in marine governance, deep-sea ecology, and environmental ethics surveyed in Section 2.

Three methodological caveats are warranted. First, the approach is interpretive rather than predictive: its claims are claims about justification, not forecasts. Second, the empirical inputs—particularly the state of ecological knowledge—are drawn from the peer-reviewed scientific literature and treated as provisional, in keeping with the article's own thesis about uncertainty; where that literature is genuinely divided, as on recovery dynamics, the division is reported rather than resolved. Third, the framework is offered as a contribution to public reason about a contested matter, not as a deduction from premises that all parties must accept; its ambition is to reframe the debate more cogently, and to withstand the strongest objections, rather than to compel assent.

Deep-Seabed Mining as a Dialectical Contradiction

We may now bring the framework to bear on the case. The argument of this section is that deep-seabed mining instantiates a genuine dialectical contradiction—and that recognising its contradictory structure is the precondition of evaluating it rationally.

6.1 The thesis: development through extraction

The developmental moment—the thesis, in the loose sense the structure permits—is not a straw position and must be stated at its strongest. The transition away from fossil fuels requires vast quantities of nickel, cobalt, copper, and manganese for batteries, grids, and electrified transport. Terrestrial sources of these metals are concentrated in a handful of jurisdictions, are frequently associated with severe environmental degradation and labour abuses, and are increasingly subject to geopolitical leverage; cobalt supply, in particular, is dominated by extraction in conditions that few defenders of the seabed status quo would wish to endorse. Proponents argue that polymetallic nodules offer comparatively high ore

grades, require no drilling or blasting, and lie in a biome of low biomass per unit area, such that, on a per-tonne basis, seabed extraction may impose a smaller footprint than its terrestrial alternatives (Baskaran & Schwartz, 2025). On this view, a blanket refusal to mine the seabed is not the avoidance of harm but the displacement of harm onto terrestrial communities and ecosystems, and onto the climate itself through delayed decarbonisation.

6.2 The antithesis: the integrity of marine systems

The preservationist moment opposes this as an equally serious case. The deep sea is the largest habitat on Earth and among the least understood; the CCZ alone may host thousands of species unknown to science, the great majority still undescribed (Rabone et al., 2023). Polymetallic nodules are non-renewable habitat structures formed over millions of years; their removal eliminates the substrate on which a distinctive sessile fauna depends, and the cleared seabed shows impaired recovery over decadal scales (Jones et al., 2025; Van Dover et al., 2017). Sediment plumes may smother filter-feeders and alter midwater ecosystems at distances and depths that remain poorly constrained (Spearman et al., 2020), and mining noise introduces a chronic stressor into an environment evolved under near-silence (de Sousa et al., 2025). Because abyssal processes operate over geological time, the relevant impacts are effectively irreversible on any human horizon. The antithesis, in short, is that extraction would destroy, before it is even known, a domain of intrinsic ecological value.

6.3 The contradiction is internal, not external

The crucial dialectical observation is that these two moments are not the preferences of two separate constituencies that happen to collide; they are two expressions of a single underlying relation. The demand for seabed minerals arises from the attempt to resolve the ecological contradictions of terrestrial industrial metabolism—to decarbonise, to secure supply, to sustain accumulation—by opening a new frontier. The seabed is thus drawn into the human metabolic process not as an external resource but as the latest site at which an internal contradiction is displaced. This is the metabolic rift extended to the abyss (Foster, 2000; Saito, 2017). Recognising the contradiction as internal has a direct analytical payoff: it explains why the debate cannot be settled by the technical question “can mining be done with acceptable impacts?” The deeper question is whether the displacement resolves the contradiction or merely relocates and deepens it—whether, that is, the seabed frontier represents a genuine sublation of the metabolic rift or only its geographical extension. It is to that question that the next section turns.

Moratoria as Dialectical Synthesis

The temptation, having posed a contradiction, is to seek a “synthesis” that splits the difference: mine, but carefully; extract, but with safeguards. This is the logic of the Mining Code as currently conceived, and it is, in Hegelian terms, not a synthesis at all but an external compromise that leaves the contradiction intact. A genuine dialectical resolution must be a determinate negation—an *Aufhebung* that cancels the immediate form of the opposition while preserving and elevating what is rational in each moment. This section

argues that, under present conditions of uncertainty, a moratorium is precisely such a sublation.

7.1 Why "regulated mining now" is not a synthesis

The proposal to proceed with regulated extraction presupposes that the regulator possesses the knowledge required to set meaningful environmental thresholds, monitor compliance, and manage adaptively. But the scientific literature establishes that this presupposition does not yet hold: baselines are incomplete, recovery dynamics are imperfectly understood and contested even after four decades of observation (Jones et al., 2025; Smith et al., 2025), and key impact pathways such as plume dispersal and noise remain poorly constrained (Spearman et al., 2020; de Sousa et al., 2025). To regulate under these conditions is to perform the form of mediation without its substance—to issue thresholds whose ecological meaning is unknown. The "Friends of the President" negotiations and the still heavily bracketed draft regulations attest to the depth of unresolved disagreement (International Seabed Authority, 2025). "Regulated mining now" therefore does not preserve the rational kernel of the preservationist moment; it overrides it under cover of procedure. It is abstract mediation, not concrete.

7.2 The moratorium as determinate negation

A moratorium, properly understood, is not the abstract negation of development—not a simple "no" that would freeze the human–ocean relation and revert to a static preservationism. It is a determinate negation with a specific content. It cancels the immediate form of the contradiction (the rush to extract under conditions of ignorance) while preserving both moments at a higher level. It preserves the developmental impulse, because a moratorium is not a permanent ban but a suspension conditional on the generation of knowledge—indeed, exploration and independent science continue, and the developmental option is held open rather than foreclosed (Singh et al., 2025). And it preserves the preservationist moment, because it gives effect to the intrinsic value and irreplaceability of deep-sea systems by refusing their irreversible destruction in advance of understanding. The moratorium thus lifts up the contradiction: it transforms a zero-sum collision into a temporal and epistemic process in which the conditions for a rational future decision can be created. This is sublation in the strict sense—cancellation, preservation, elevation.

7.3 Becoming, precaution, and the asymmetry of the irreversible

The processual ontology of Section 3 explains why this sublation is rationally compelled rather than merely permitted. If ecological equilibrium were a static state, the choice would be symmetric: mine and perhaps degrade, or refrain and forgo benefit, with the balance struck by expected-value calculation. But because the deep-sea system is a becoming whose constitutive processes operate over geological time, the two errors are radically asymmetric. To mine wrongly is to sever an irreplaceable process and foreclose options permanently; to pause wrongly is to defer benefits that remain recoverable. Jonas's

heuristics of fear and the precautionary principle formalise exactly this asymmetry: where harm is potentially irreversible and its probability uncertain, priority goes to averting the worse outcome (Jonas, 1984). The moratorium is the institutional expression of the precautionary asymmetry generated by a processual ecocentric ontology. It is not timidity; it is the rational response to the structure of the risk.

7.4 The unilateral challenge and the threat to ethical life

The 2025 United States executive order and the ensuing applications to NOAA illustrate, by contrast, what the abandonment of dialectical mediation looks like in practice (Baskaran & Schwartz, 2025; Singh et al., 2025). To proceed unilaterally, outside the multilateral institution charged with administering the common heritage of humankind, is to dissolve the very locus of Sittlichkeit in which a rational resolution could be achieved. It substitutes the abstract will of a single actor for the concrete mediation of a community of states, and it converts a shared developmental contradiction into a competitive scramble that can only deepen the rift. Whatever one's view of mining on the merits, the unilateral path is, in Hegelian terms, a regression from ethical life to the state of nature—and it strengthens, rather than weakens, the case for a moratorium adopted multilaterally as an act of collective ethical self-determination.

Toward an Ecocentric Marine Governance Framework

A moratorium is a moment in a process, not its terminus. The dialectical analysis would be incomplete—and would collapse into the static preservationism it rejects—if it did not specify the ethical life within which the suspension is to be held and eventually resolved. This section sketches the institutional form of an ecocentric marine governance grounded in precaution, stewardship, and adaptive management.

Precaution as a constitutive principle. Precaution should function not as an occasional exception but as the constitutional default of seabed governance, with the burden of proof resting on those who propose irreversible intervention to demonstrate the absence of significant harm, rather than on the public to demonstrate its presence. This reading is already latent in UNCLOS Article 145 and in the 2011 Advisory Opinion of the Seabed Disputes Chamber, and a moratorium operationalises it (Singh et al., 2025).

Stewardship and the common heritage. The designation of the Area as the common heritage of humankind should be read ecocentrically as well as distributively: humanity holds the seabed in trust not only across present and future generations of people but on behalf of the biotic community itself. The principle has always carried a latent conservationist charge—a recognition that some domains are held in common precisely so that they not be appropriated and consumed by the powerful—and recent scholarship has argued that the common heritage functions as a genuine limit on exploitation rather than merely a formula for sharing its proceeds (Mickelson, 2019). Stewardship in this sense reframes the ISA's mandate so that environmental protection is not one objective to be balanced against exploitation but the precondition of any legitimate use

whatever—resolving, at the level of principle, the structural conflict of interest that critics have identified in the Authority's dual role (Ardron et al., 2018).

Adaptive management as institutionalised becoming. Adaptive management—iterative, evidence-driven, and reversible by design—is the governance analogue of the processual ontology defended here. First developed as a response to precisely the kind of irreducible ecological uncertainty at issue in the deep sea, it treats policy as a hypothesis to be tested and revised rather than a decision to be implemented once and for all (Holling, 1978). Crucially, genuine adaptive management requires reversibility, and it is the irreversibility of seabed mining that makes adaptive management of extraction largely illusory while making adaptive management of the moratorium itself—its conditions, triggers, and review—both possible and appropriate. A moratorium can be tightened or relaxed as knowledge accumulates; a mined-out nodule field cannot be restored within any horizon relevant to the decision. The asymmetry of reversibility therefore dictates which object adaptive management can coherently take. The moratorium becomes a living institution that metabolises new knowledge, the very embodiment of Sittlichkeit as an evolving ecological community (Lumsden, 2021).

Together these principles describe a governance regime in which the moratorium is neither a permanent prohibition nor a holding pattern but a determinate, knowledge-generating phase of a mediated relation between human economy and ocean ecology. The conditions under which a moratorium might rationally be lifted—robust baselines, validated recovery models, demonstrable reversibility or genuine no-net-loss, and independent verification—are specifiable in principle, and their specification is itself the work of the ethical life the framework prescribes.

Discussion

A framework of this kind earns its keep only by surviving the strongest objections from both directions. This section engages four.

9.1 The orthodox-economic objection: opportunity cost and displaced harm

The most serious developmental objection holds that a moratorium is not the avoidance of harm but its displacement: refusing seabed minerals intensifies terrestrial mining, with its documented human and ecological costs, and slows decarbonisation, with its own catastrophic and irreversible risks. The objection has real force and the framework must meet it head-on rather than wish it away. Three replies are available. First, the asymmetry argument is not refuted but specified: terrestrial harms, however grave, are generally better understood, more localisable, more remediable, and subject to existing (if imperfect) governance, whereas deep-sea harms are uncharacterised and irreversible—precisely the profile precaution targets (Jonas, 1984). Second, the premise that seabed minerals are indispensable is increasingly contested by trends in battery chemistry, recycling, and material efficiency, such that a pause may forgo less than the objection assumes. Third, and dialectically, the displacement objection actually concedes the central thesis: it acknowledges that seabed mining resolves no contradiction but merely relocates it. The

rational response to a contradiction one cannot yet resolve is not to displace it into the least-known and least-reversible domain available.

9.2 The realist objection: unilateralism makes moratoria futile

A realist might argue that, with the United States proceeding outside UNCLOS and other actors potentially following, a multilateral moratorium is a unilateral disarmament that simply cedes the seabed to the least scrupulous (Baskaran & Schwartz, 2025). The reply is that the legitimacy and the durability of governance are not independent. A moratorium adopted by a growing coalition—now numbering forty states by the ISA's own count (International Seabed Authority, 2025)—constructs the normative baseline against which unilateral action is judged unlawful, raises its political and commercial costs, and preserves the institution within which a stable settlement can later be reached. Futility is not a property of the moratorium but a prediction about others' behaviour that the moratorium itself helps to shape.

9.3 The internal-ecological objection: ecocentrism rests on a discredited "balance of nature"

From within environmental thought, critics charge that ecocentrism presupposes a static balance of nature that ecology has replaced with models of flux and non-equilibrium (Botkin, 1990); if nature is always already in disequilibrium, the appeal to "integrity" loses its footing. This is the objection the Hegelian reconstruction is built to absorb. The processual ontology of becoming concedes the premise—ecosystems are indeed dynamic, disturbance-driven, far-from-equilibrium systems—while denying the conclusion. What matters ethically is not a frozen baseline but the persistence of the processes of self-maintenance, and it is exactly those processes, operating over geological time, that nodule removal severs. Disequilibrium ecology does not dissolve ecocentric value; it requires that ecocentric value be formulated processually, which is what this framework does.

9.4 The objection from Hegel: is this not an anthropocentric philosophy of mastery?

Finally, the Hegel scholar may object that the dialectic is the wrong tool, since Hegel subordinates nature to Spirit and narrates history as the progressive humanisation of an external world—the very metaphysics of mastery that Plumwood (1993) indicates. The reply, developed throughout, is twofold. The framework does not import Hegel's metaphysics of Spirit wholesale; it appropriates specific logical categories—becoming, contradiction, sublation, Sittlichkeit—whose value does not depend on the teleology of Geist. And the revisionary scholarship marshalled here shows that even Hegel's own texts contain resources, in the philosophy of nature and the concept of ethical life, for recognising nature as self-organising and as a partner in mediation rather than mere raw material (Lumsden, 2021; Stone, 2005). Read through Plumwood's relational lens, the human–ocean relation becomes an identity-in-difference: neither domination nor fusion, but mediation. The dialectic, turned against the mastery it has so often served, becomes a logic of ecological responsibility.

Conclusions

This article set out to ask how Hegelian dialectics might provide an ecocentric framework for evaluating deep-seabed mining moratoria under conditions of ecological uncertainty and competing developmental demands. Its answer has been that the dialectic, properly reconstructed, transforms the terms of the debate. Where the conventional framing offers a static trade-off between development and preservation, the Hegelian framework reconceives ecological equilibrium as a becoming—a dynamic, self-mediating process—and reconceives the conflict between extraction and preservation as an internal contradiction within a single human–ocean metabolic totality rather than an external clash of preferences. On this basis, a moratorium emerges not as a prohibition, a compromise, or a mere postponement, but as a determinate negation: an Aufhebung that cancels the immediate, knowledge-blind rush to extract while preserving the rational kernel of both the developmental and the preservationist moments and lifting the contradiction onto the higher plane of a knowledge-generating, institutionally mediated process.

The novelty of the contribution lies in this synthesis. To environmental ethics, it offers an ecocentrism reformulated processually, able to absorb the ecology of disequilibrium that has embarrassed static preservationism. To marine governance, it supplies a principled grammar—precaution as constitutional default, stewardship of the common heritage extended to the biotic community, and adaptive management understood as institutionalised becoming—that evaluates moratoria by their coherence with ecological reality rather than by the false precision of cost–benefit calculation under radical uncertainty. To political ecology and Hegel scholarship, it demonstrates that the dialectic can be turned against the metaphysics of mastery to which it has so often lent itself, becoming instead a logic of ecological responsibility under conditions of irreversibility.

None of this settles the question of whether humanity should ever mine the deep seabed. The framework is, in keeping with its own dialectical commitments, not a final verdict but a specification of the conditions under which a rational verdict could one day be reached—robust baselines, validated and reversible impact pathways, independent verification, and an institutional ethical life equal to the task. What the framework does establish is that, here and now, under the conditions of uncertainty and ecological risk that actually obtain, a moratorium is not a failure of governance but its highest expression: the moment at which a community of states, confronting a contradiction it cannot yet resolve, refuses to displace that contradiction irreversibly onto the last unindustrialised biome on Earth, and chooses instead the patient, mediated work of becoming. In an age tempted by the false resolution of the frontier, that refusal is itself a form of wisdom.

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