

How To Do Things With Objects: Boundary Objects in Inter- and Transdisciplinary Marine Research

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Abstract

Marine research increasingly requires early career researchers to translate knowledge across disciplinary, institutional, and societal boundaries, often under conditions of asymmetrical power and limited training. In response, many early career researchers intuitively employ objects such as maps, models, concepts, diagrams, or tools to support participation and shared understanding, while opportunities to reflect collectively on how and why these practices work remain limited. Drawing on boundary object theory and insights from cognitive science, this article conceptualizes such objects as cognitive and social mediators that enable shared sense-making without requiring consensus. It further argues that such objects are not neutral, and that their effectiveness depends on attention to power relations, framing, and positionality within inter- and transdisciplinary marine contexts. By articulating how and why boundary objects function, this article invites early career researchers to recognize and use boundary objects intentionally, offering practical, reflexive guidance for their use in inter- and transdisciplinary marine research. In doing so, it contributes to ongoing discussions on inter- and transdisciplinary marine training by foregrounding boundary objects as a legitimate practice and inviting more intentional and reflexive engagement with it in translating marine research across science, policy, and society.

Keywords

boundary objects; interdisciplinarity; knowledge translation; ocean–society translation; reflexivity; science communication; transdisciplinarity

1. Introduction

Inter- and transdisciplinary marine research—research that draws on multiple disciplines and, in its transdisciplinary form, actively engages non-academic actors—is, in many ways, an inherently translational practice. Researchers working across diverse disciplinary and societal perspectives must continually interpret and translate concepts, methods, and assumptions across boundaries. For early career researchers (ECRs), navigating such environments is both intellectually exciting and practically demanding: It involves constant movement between different languages, expectations, and forms of expertise.

These dynamics resonate with broader developments in science communication, where the notion of knowledge as being passed from experts to non-experts is increasingly challenged and replaced by understandings of knowledge as co-created and exchanged through more dialogic, interactive, and participatory processes (Cortassa, 2016; Hetland, 2016; Irwin & Wynne, 1996; Stocklmayer, 2018). This shift is accompanied by the emergence of the *interdependency* model of knowledge exchange, which emphasizes that different forms of knowledge are interdependent in such processes (Contandriopoulos et al., 2010; see also Cvitanovic et al., 2015). Taken together, these developments are of particular importance in inter- and transdisciplinary marine science, where science translation often is constitutive of the research process itself.

At the same time, science communication has gained structural prominence specifically as a funding and evaluation strategy, with communication strategies now often embedded in project proposals and impact pathways (see, for example, European Commission, 2021). Reasons for this are both increasing expectations to engage with societal actors, and the growing recognition that translation is also required within and across scientific domains.

While this recognition of communicative work is both necessary and important—particularly in inter- and transdisciplinary marine contexts, where science translation is so central—it also tends to channel institutional attention toward visible and quantifiable outputs, such as policy briefs, workshops, or reports. These outputs are institutionally legible and therefore become key reference points for evaluating effective science communication.

Yet, for ECRs working in inter- and transdisciplinary marine research contexts, science communication rarely begins or ends with these finalized products. ECRs' own accounts of this work emphasize that translating research into action requires sustained engagement throughout the research process (Shellock et al., 2023), rather than through discrete communication products alone. For them, what precedes these products and shapes what they ultimately become is rooted in the inter- and transdisciplinary research process itself; in the ongoing work of rendering concepts, data, and uncertainties intelligible across disciplinary and epistemic boundaries. Here, “translation” is used to capture this broader, ongoing interpretive work—distinct from, though closely related to, the more visible, product-oriented sense of science communication described above.

In practice, much of this work occurs through the objects that sit at the boundaries of different experiences and perspectives: It takes place in diagrams sketched and resketched during meetings; in maps used to negotiate spatial meanings; in models adjusted to accommodate competing knowledge claims; or in the

careful calibration of terminology across disciplinary assumptions. Science translation through the use of objects as shared reference points is therefore a central part of science communication in the inter- and transdisciplinary marine research realm.

Echoing J. L. Austin's insight in *How To Do Things With Words* (Austin, 1962), stating that language does not merely describe the world but helps to constitute it, this article argues that objects, too, mediate how shared understanding emerges. This argument is conceptual in nature: It draws on boundary object theory to articulate a practice that many ECRs—the author included—already engage in, a practice that often goes unnamed, and therefore unrecognized. Recognizing work with “boundary objects” as translational mediators invites a more attentive and intentional engagement with the seemingly ordinary objects through which inter- and transdisciplinary marine research is conducted.

2. Conceptual Framework and Theory: Boundary Objects as Cognitive and Social Mediators

Boundary object theory offers a lens for tracing how such objects mediate shared understanding, particularly in contexts characterized by epistemic diversity and complex problem framings.

The concept of boundary objects describes how actors from different social worlds collaborate through shared objects while maintaining distinct perspectives (Star & Griesemer, 1989). Crucially, although boundary objects can sustain different meanings across different social worlds, “their structure is common enough to more than one world to make them recognizable, as a means of translation” (Star & Griesemer, 1989, p. 393). While the discussion here is grounded in inter- and transdisciplinary marine research, boundary objects are not specific to this context, but can be observed across a wide range of collaborative settings and knowledge practices (Carlile, 2002, 2004; Star, 2010; Star & Griesemer, 1989). Accordingly, these objects are not limited to specific object categories, and they can take both conceptual and material forms.

Rather than treating translation as something that happens only once knowledge is finalized, this perspective foregrounds the objects, processes, and interactions through which understanding is negotiated in the first place. In doing so, it invites us to see everyday collaborative practices as central, rather than peripheral, to how inter- and transdisciplinary marine research becomes intelligible and actionable across diverse actors and knowledge systems. Such translatory practices are iterative, in that they evolve through repeated cycles of discussion, adjustment, and reinterpretation, as well as relational, in that they thrive through these interactions among participating actors (cf. Carlile, 2004).

Marine research has documented the value of boundary organizations (Cvitanovic et al., 2024) and boundary-spanning roles (Karcher et al., 2024) for knowledge exchange between science, management, and policy actors. Beyond such organizations and roles, inter- and transdisciplinary marine research involves a wide range of objects that ECRs themselves work with directly and that can potentially function as boundary objects, including maps, models, concepts, diagrams, and tools. These objects can be interpreted differently by ecologists, social scientists, policymakers, or community actors, allowing each group to engage with the object in ways that align with their own expertise and priorities.

A habitat map, for instance, may serve as a biodiversity assessment tool for ecologists, a planning instrument for managers, and a reference point for local stakeholders concerned with access and livelihoods. This flexibility allows actors to attach distinct meanings to the same object without destabilizing collaboration. Its recognizable structure anchors discussion to a shared reference point, enabling coordination and communication.

2.1. Boundary Objects as Social Mediators

In inter- and transdisciplinary marine research, such objects can therefore function as a shared reference point around which discussion unfolds, and frequently mediate interaction among researchers trained in different disciplines, as well as between scientific and non-academic actors. Boundary objects thus operate as social mediators: They create a common focus of attention, structure interaction, and allow partial alignments to emerge without requiring complete agreement (Carlile, 2002; Harvey, 2024). As emphasized both in the original formulation of boundary object theory (Star & Griesemer, 1989) and in Star's later reflections on the concept (Star, 2010), boundary objects do not depend on fully shared interpretations. Instead, they maintain a sufficiently shared identity while remaining adaptable to different—and at times conflicting—local practices and work processes. They therefore remain only loosely structured in shared use while becoming more strongly structured within specific individual contexts of application (Star & Griesemer, 1989).

In doing so, they can shift interaction from abstract disagreement to engagement with a shared object. Disciplinary differences become attached to particular elements of the object rather than to abstract positions, reducing polarization and making negotiation more concrete. The object becomes a site where difference is articulated, negotiated, and temporarily coordinated (Akkerman & Bakker, 2011). In fact, enabling what might be described as “good enough” alignment across differences might be the greatest strength of boundary objects: Rather than eliminating difference, they render it workable.

Seen from this perspective, the intuitive tendency of many ECRs to reach for a boundary object in moments of uncertainty is not incidental. These objects help to make abstract, contested, or discipline-specific knowledge collectively negotiable. They provide temporary contextual stability in complex collaborative settings, making difference discussable rather than paralyzing.

2.2. Boundary Objects as Cognitive Mediators

Beyond their social mediating function, boundary objects can also be understood as cognitive mediators. Drawing on insights from research on distributed cognition, external representations, cognitive load, and working memory (Cowan, 2010; Hutchins, 1995; Kirsh, 2010; Sweller, 1988), boundary objects may be understood as helping to reduce cognitive load while simultaneously providing anchoring and framing in the development of shared understandings.

Engaging with the unfamiliar concepts, methods, and problem framings that inter- and transdisciplinary marine research entails can place substantial demands on working memory, as complex, multi-dimensional problems—such as those typical of coastal and marine systems—easily exceed the processing limits of individual cognition (Cowan, 2010; Sweller, 1988). External representations, particularly visual or material objects, help offload some of this burden (e.g., Kirsh, 2010).

Rather than relying solely on internal and potentially divergent mental representations, boundary objects allow participants to interact with a shared representation of the issue at hand (cf. Hutchins, 1995). By making relationships physically tangible, spatially or schematically, or simply visible at all, boundary objects reduce the effort required to hold multiple variables in mind simultaneously. They allow participants to point at, annotate, and rearrange elements, returning to them as needed, thereby stabilizing interpretations that might otherwise remain fleeting or misaligned.

Boundary objects also shape how understanding is anchored and framed. An initial representation—whether a map, model, or diagram—can serve as a cognitive anchor by making some problem definitions and solution pathways more salient than others, guiding subsequent interpretation. Because these cognitive framings are externalized in a shared object, they may also become visible and contestable, allowing participants to question, negotiate, and potentially reconfigure the assumptions embedded within them.

2.3. Cognitive and Social Mediation in Practice

In practice, the cognitive and social dimensions of boundary objects are often closely intertwined. Through shared engagement with boundary objects, participants may develop sufficiently overlapping mental models to coordinate attention and action. Marine spatial planning offers one such setting, where participatory mapping has been used to integrate diverse forms of knowledge across sectors (Littaye et al., 2016; Slater et al., 2020). Here, a map that delineates fixed ecological zones may foreground biodiversity hotspots and habitat boundaries as primary units of concern, while backgrounding seasonal fishing patterns or cultural use areas that do not align neatly with more rigid spatial delineations. As discussion unfolds around this representation, shared attention may initially become anchored to zoning-based solutions rather than alternative governance or livelihood-oriented approaches. At the same time, the map may also provide a shared site through which these omissions become visible and contestable, allowing participants to articulate concerns, negotiate priorities, and potentially revise the representation itself.

This example illustrates how a map, when employed as a boundary object, neither merely facilitates communication nor merely depicts marine systems; it shapes how problems are perceived and interpreted, both collectively and individually, thereby influencing which interventions can be considered (see also Harvey, 2024, for a general discussion of maps as boundary objects). Through these intertwined cognitive and social processes, boundary objects can actively structure how shared understandings emerge in inter- and transdisciplinary marine research.

2.4. Forms of Boundary Objects and Functional Tendencies

The cognitive and social functions discussed so far are shaped both by how boundary objects are used and by the forms they take. Different forms of boundary objects may lend themselves to different functions in inter- and transdisciplinary marine collaboration: More material or visual objects (such as maps or models) can provide clearer constraints and a more concrete point of reference, which may be particularly valuable in the early stages of collaboration, when collaborating actors have not yet established a shared understanding of the problem space or of each other's knowledge and assumptions. Materially grounded objects can thus help stabilize discussion and create an initial point of anchoring. They might also be better at addressing specific information needs, which can be especially helpful in gauging knowledge gaps. Their grounding in

specific dimensions (spatial, material, or data-related) can support shared orientation and reduce the cognitive demands associated with holding multiple elements in mind.

As collaboration progresses and shared reference points become more established, conceptual boundary objects, such as frameworks or metaphorically charged concepts (for example, the “blue economy”), may offer greater flexibility and open up new lines of inquiry; they often support abstraction, reframing, and the exploration of alternative problem definitions. Conceptual boundaries can be easily crossed, yet also readily re-established. In this sense, different forms of boundary objects may not only serve different functions, but also become more or less useful at different stages of a given collaborative process.

At the same time, the distinction between conceptual and material boundary objects is not always rigid. Many objects combine both dimensions: An organizational chart, for instance, represents abstract relationships such as roles and hierarchies while also functioning as a shared visual object that can be collectively examined and modified. Such hybrid boundary objects can simultaneously support cognitive processes—by externalizing complex structures and anchoring attention—as well as social processes—by enabling participants to articulate, question, and reshape otherwise implicit assumptions. This suggests that the functions of boundary objects are less determined by their form alone than by how they are introduced and used in practice. The distinctions drawn here are intended for reflection rather than as a strict typology, in line with cautions against treating the concept as a fixed classificatory scheme (Star, 2010), and their real-world relevance will depend on how ECRs find them applicable in their own work.

As suggested by the anchoring functions of boundary objects discussed earlier, specific material objects can acquire shared conceptual meaning through social practice and remain stably associated with these meanings over time. This can be illustrated by considering money as a “material anchor” (Fauconnier & Turner, 2002, p. 202). A banknote, in itself, has little intrinsic value; it only functions as money because it is embedded in a shared system of meanings and supported by social agreement. Detached from these structures—as in the often-cited example of a deserted island—it quickly loses its function.

This suggests that the effectiveness of boundary objects does not reside in the objects themselves, but emerges through how they are taken up and engaged with in interaction. Their role is therefore not fixed, but co-constructed in practice—an idea that resonates with broader work on how material objects acquire meaning and function within social worlds (Harré, 2002). When objects are institutionally and culturally supported, they can profoundly shape social practice, as is the case with money. In a similar way, boundary objects do not work simply because of their material form; their effectiveness depends on how they are conceptually framed and socially sustained within collaborative settings. This, in turn, raises important questions about when and how boundary objects support collaboration effectively—and when they may instead reinforce existing asymmetries or exclusions.

3. When Boundary Objects Work—and When They Don't

Having established how boundary objects can function as social and cognitive mediators in inter- and transdisciplinary marine research, it is important to acknowledge that these effects are neither automatic nor inherently beneficial (Star, 2010). Rather, recognizing the mediating power of boundary objects also means recognizing that they are never neutral (Kimble et al., 2010; Oswick & Robertson, 2009).

Precisely because boundary objects anchor attention and structure interpretation, they inevitably foreground certain elements while backgrounding others. What is included, excluded, simplified, or emphasized influences how problems are defined and which solutions appear feasible or legitimate. In complex coastal and marine contexts, where ecological processes, economic interests, governance arrangements, and cultural values intersect, no single object can represent all perspectives symmetrically—which is also not their purpose. Boundary objects are not neutral mirrors of reality; they are structured representations that make some dimensions more visible than others. For ECRs, this implies that working with boundary objects is not a self-evident practice, but one that requires attentiveness to context, framing, and power.

Classic boundary object theory emphasizes interpretive flexibility, robustness across contexts, and coordination without consensus as defining features of effective boundary objects (Star & Griesemer, 1989). However, these characteristics alone do not fully account for how boundary objects can support collaboration in practice and in relation to the specifics of inter- and transdisciplinary marine collaboration.

Thus, informed by later, more process-oriented interpretations of boundary objects (Carlile, 2002, 2004; Oswick & Robertson, 2009; Star, 2010), but without directly deriving from any single framework, this section proposes three “conditions of effectiveness” that seem to be of particular relevance in relation to the context of inter- and transdisciplinary coastal and marine settings: (a) negotiability, (b) participatory accessibility, and (c) institutional embedding. Together, they provide an analytical lens for examining how boundary objects can function in practice in these settings.

In the following, these three conditions of effectiveness are discussed using ecological indicators—a type of boundary object that has already been discussed in the context of environmental policy research (Turnhout, 2009)—as a running example to illustrate how boundary object use operates across these three dimensions (see Figure 1).

3.1. *Negotiability as a Condition of Effectiveness*

First, the negotiability of a boundary object matters: the extent to which it remains open to revision and reinterpretation by those engaging with it. Boundary objects are most generative when they function as working artifacts (cf. Section 2). The practice of shared, iterative adjustment and, at times, even contestation is what enables their effectiveness. Collective revision can itself become a meaningful site of participation. When actors are able to question assumptions and reshape representations, the object becomes a space of negotiation rather than a static reference point. Negotiability is therefore closely linked to participatory potential.

Ecological indicators provide a particularly illustrative example here. Biodiversity indices, water quality scores, or Sustainable Development Goal metrics encode what counts as relevant and what “good” or “bad” means. As boundary objects, ecological indicators can support the negotiation of these embedded, otherwise hidden assumptions because they have to be discussed in the very process of indicator development. However, when this discussion of assumptions surfaces differences that prove irreconcilable, this can lead actors to reject the developed indicators altogether (Turnhout, 2009).

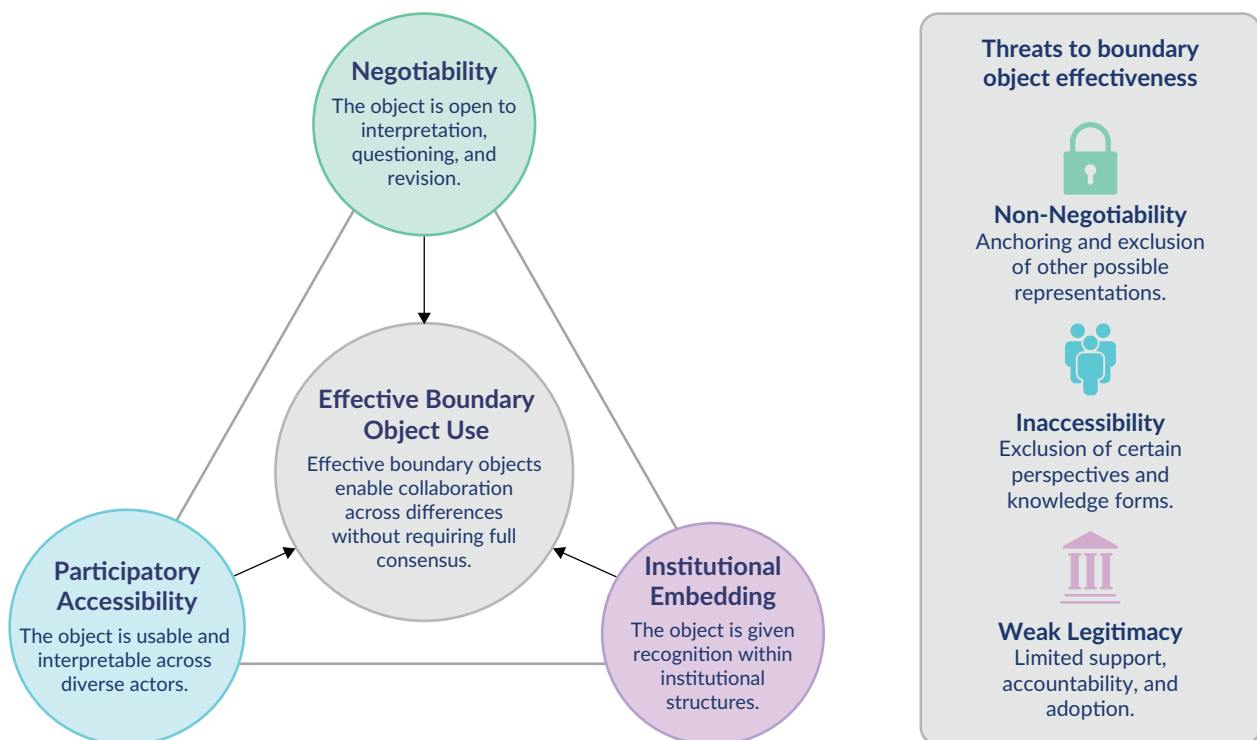


Figure 1. Conditions for boundary object effectiveness: Balancing negotiability, participatory accessibility, and institutional embedding.

Likewise, threats to negotiability arise when a boundary object becomes fixed too early—due to time pressure, institutional constraints, or asymmetries of authority—leaving participants with a “finished” object rather than an evolving and negotiable one. In the case of indicators, this may occur when pre-defined indices are introduced without room for collective reflection or adaptation. When revision is foreclosed, the object may still coordinate action (for example, by triggering decisions once predefined indicator thresholds are exceeded), but it no longer supports shared sense-making.

Endless modification, however, can undermine the stability that makes a boundary object useful. For indicators, stability is essential if they are to serve as benchmarks, track progress, and inform decisions based on agreed-upon thresholds. Effective boundary objects therefore maintain a productive tension between stability and revisability: stable enough to facilitate discussion, yet open enough to accommodate different perspectives.

3.2. Participatory Accessibility as a Condition of Effectiveness

Second, the participatory accessibility of a boundary object matters: the degree to which different actors are able to engage with and influence it, cognitively, practically, and socially. An object may be open to revision in principle, yet remain effectively closed if only a subset of collaborating actors can understand the language it is presented in, navigate its format, or feel authorized to intervene.

Participatory accessibility therefore extends beyond clarity of representation. It also concerns the social conditions under which engagement occurs. Highly technical models, discipline-specific visualizations, or

jargon-laden diagrams may privilege certain forms of expertise while marginalizing others. Similarly, hierarchies of seniority or disciplinary authority can shape who feels entitled to question or modify a shared object.

Returning to the example of ecological indicators: They can enhance participatory accessibility by condensing complex information into more manageable forms—such as a number, score, or category. In this sense, they function as cognitive mediators by reducing complexity, allowing participants to engage with shared representations without needing to fully understand the underlying technical details.

However, what makes indicators easy to use is also what can make them difficult to question. Accessibility is achieved through simplification, and simplification can reduce the visibility of underlying assumptions and complexity. In this sense, indicators illustrate how different conditions of effectiveness can come into tension: The very features that make them accessible can simultaneously limit their negotiability. Participatory accessibility that does not come at the cost of negotiability therefore depends not only on whether actors can interpret the indicator, but also on whether they can question how it was constructed and what it represents.

When the ability to interpret, question, or modify a boundary object is unevenly distributed among actors, boundary objects may coordinate action without enabling meaningful inclusion. They can align outcomes while leaving certain perspectives underrepresented or unarticulated. Conversely, when diverse actors are able to engage—by questioning assumptions, suggesting alternatives, or reshaping representations—the object becomes something participants can actively work with. In practice, participatory accessibility often hinges on whether actors experience the boundary object as something they can legitimately influence, rather than merely interpret.

3.3. Institutional Embedding as a Condition of Effectiveness

Third, the institutional embedding of a boundary object matters: the ways in which it is positioned within organizational structures, authority relations, and decision-making processes. The effectiveness of boundary objects depends on where they circulate, who endorses them, and how they are taken up in formal and informal arenas of decision-making.

Beyond questions of circulation and uptake, institutional embedding also shapes the accountability structures surrounding boundary objects. Accountability to both scientific and political actors has been shown to be critical for the perceived legitimacy of boundary objects (Latour & van Laerhoven, 2024), just as trust shapes the effectiveness of boundary organizations through which such objects often circulate (Cvitanovic et al., 2024).

An object that enables productive exchange in a workshop setting may carry different weight once it enters institutional processes. Some boundary objects become stabilized as official representations—informing planning decisions, policy frameworks, or funding priorities—while others remain informal and provisional. Ecological indicators provide a clear example of this dynamic: Once embedded in institutional frameworks, they can become formal benchmarks that guide decision-making, define targets, and trigger action. In doing so, they often derive their authority from institutional accountability structures while simultaneously stabilizing specific ways of measuring and valuing complex phenomena.

For ECRs, the institutional positioning of boundary objects is often beyond their direct control. Decisions about which representations are formalized, circulated, or acted upon are frequently shaped by senior actors, organizational mandates, or broader governance structures. As a result, boundary objects may reproduce existing hierarchies even when they were initially introduced as tools for more inclusive collaboration.

Despite these constraints, awareness of how boundary objects become embedded in institutional structures can still support a reflective research practice for ECRs. This may involve anticipating how representations might travel beyond initial collaborative settings, making assumptions and limitations explicit, or documenting where certain perspectives are not captured. While ECRs may not control how boundary objects are ultimately taken up, they can shape how these objects are introduced, framed, and critically reflected upon.

In practice, this means that the effectiveness of a boundary object cannot be assessed solely at the level of interaction. It also depends on how the object travels beyond immediate collaborative settings and becomes embedded in structures that shape what ultimately counts as legitimate knowledge and action.

Institutional embedding of the object can thus facilitate a boundary object's negotiability and participatory accessibility by creating time, space, and stability for shared interaction with the object among collaborating actors.

More broadly, these three conditions of effectiveness—(a) negotiability, (b) participatory accessibility, and (c) institutional embedding—are analytically distinct but practically intertwined: Whether a boundary object can be revised (a) is often shaped by who is able to engage with it (b), and by the institutional contexts in which it circulates (c).

4. Working With Boundary Objects: Reflective Considerations for Practice

If boundary objects are mediators that shape how understanding and coordination emerge, rather than neutral tools, then working with them requires more than intuition alone. For ECRs in inter- and transdisciplinary marine research contexts, developing an intentional and reflexive approach to working with boundary objects can help navigate the complexities outlined above.

Building on the discussion of boundary object effectiveness, this section proposes a set of reflective questions intended to support ECRs in deliberately designing, evaluating, and critically engaging with boundary objects. These questions are intended to support different stages of working with boundary objects—from their selection or production to reflection on, and discussion of, their use in practice. Developing this sensitivity also involves learning from observation—paying attention to how objects are used in collaborative settings, and reflecting on what works, what does not, and why. The following considerations are not intended as prescriptive guidelines, but as prompts to support ongoing reflection.

As a starting point, a few orienting questions may help clarify the role an object is intended to play:

- What is the object intended to do within the collaboration?
- What form does it take, and why (e.g., conceptual, material, or hybrid)?
- What does the object represent, and which aspects does it leave out?

The following questions are organized along the conditions of effectiveness discussed above.

4.1. Negotiability

Given the importance of negotiability, key questions concern whether a boundary object remains open to revision throughout the collaborative process:

- At what stage is the object introduced, and does it remain open to modification over time (e.g., relatively fixed formats such as reports, versus more adaptable formats such as collaborative platforms or websites)?
- Who is able to suggest changes, and how are these taken up?
- Does the object function as a working artifact? Are there parts of it that can be built and developed together?
- At what point does it need to stabilize to support cooperation?
- Is it sufficiently stable to remain recognizable as the same object across different contexts of use?

4.2. Participatory Accessibility

Participatory accessibility raises questions about who is able to meaningfully engage with a boundary object:

- Who is able to understand and meaningfully engage with the object, and who might find it difficult to engage with it?
- What knowledge does the object assume and whose knowledge does it reflect?
- Who feels authorized to question or modify it?
- What forms of expertise are privileged by the object's format or representation, and how might this both enable and constrain participation (e.g., through the use of technical models, discipline-specific visualizations, or specialized language)?
- To what extent can the object be modified to different contexts, local needs, or forms of knowledge without undermining its function as a shared reference?

4.3. Institutional Embedding

Institutional embedding highlights that boundary objects gain significance through the contexts in which they circulate, prompting the following questions:

- Where does the object travel beyond the immediate collaboration?
- Who can formalize, endorse, or act upon it?
- How is the object taken up in decision-making processes in a given context (e.g., when spatial plans, conservation maps, or management frameworks are formalized within marine governance)?
- Which interpretations become formalized, and which remain informal or invisible?
- How might institutional dynamics shape the object's influence over time?

These questions are not intended to produce a single "correct" answer. Rather, they are designed to help ECRs identify where a boundary object or the way it is used in collaboration may require changes to support

its negotiability, broaden its participatory accessibility, or better account for its institutional embedding. The resulting reflections can help identify opportunities to adapt the boundary object itself, (re-)consider how it is introduced or used in collaborative settings, or recognize where additional actors or perspectives should be included. They may also provide a basis for discussion with peers, collaborators, supervisors, or other actors about how the boundary object can better support communication and collaboration throughout the research process.

The questions can also be used prospectively when considering whether a particular object is likely to function effectively as a boundary object. ECRs can use these prompts to consider whether it is likely to support communication across different actors, remain open to negotiation, enable broad participation, and how it may become embedded in institutional processes.

5. Conclusion

Producing knowledge is only part of the work of inter- and transdisciplinary marine science; for this knowledge to be of impact, it must be made intelligible across disciplinary and societal boundaries. Much of this translational work unfolds through work with shared objects, and ECRs especially engage in it routinely, working with and through maps, models, and diagrams—often without these effects being reflected upon explicitly. The contribution of this article is to name and conceptualize this practice: Understood as cognitive and social mediators, boundary objects reduce cognitive load, anchor attention, and provide shared reference points, while creating spaces in which differences can be articulated, negotiated, and temporarily aligned.

However, the effectiveness of boundary objects does not reside in the objects themselves. Boundary objects are not neutral or self-executing tools; their capacity to enable coordination, inclusion, or shared understanding in collaborations depends on how they are introduced, framed, and engaged with in specific collaborative contexts.

Recognizing this has practical implications. It enables ECRs to better understand their own role in inter- and transdisciplinary research settings, and to articulate forms of work that often remain invisible as they can be difficult to isolate, measure, or quantify. Naming and articulating boundary-object work highlights these contributions, justifying the time and effort invested in collaborative processes, and supporting more strategic engagement with the design and use of shared representations.

Finally, a shared vocabulary around boundary objects can support training, mentoring, and evaluation practices that better recognize the cognitive and social dimensions of inter- and transdisciplinary collaboration, while also inviting a reconsideration of what counts as science communication work within marine research. Attending to how boundary objects are designed, negotiated, and embedded may therefore not only improve collaboration, but also contribute to more reflexive and inclusive forms of marine science translation.

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