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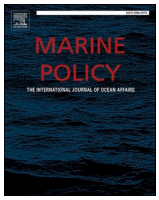

Untangling theories of transformation: Reflections for ocean governance

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ABSTRACT

Transformation as a concept has gained prominence in environmental governance as a proposed solution to the plethora of major global crises facing ocean spaces. Recent analysis has begun exploring the concept within the context of ocean governance. However, the question of how transformation is achieved is hindered by a perceived lack of clarity, multiple interpretations of the concept, and its growing buzzword status. This comprehensive review untangles theories of transformation in the context of ocean governance by proposing a conceptual 'Taxonomy of Transformation' and synthesises key attributes of definitions of transformation. Conceptualisations of transformation converge around depth of change, but have different interpretations of speed and scale, which highlight potential risks to implementing transformation. In light of this, this review proposes an interpretation of transformation in ocean governance that synthesises multiple theoretical perspectives, and moves towards a more contextually nuanced and less prescriptive approach to transformation.

1. Introduction

Arguably, ocean management is not fit for purpose [19,34]. Despite the awareness of humanity's dependence on the ocean for everything from climate regulation to sustenance, the increasing extent, diversity and negative impacts of human activity in ocean spaces is unprecedented [41]. Globally, the 'Blue Acceleration' into ocean environments has led to increased commercialisation, resulting in the dominance of 100 corporations over the ocean economy [41,75]. The triple threat of climate change, biodiversity loss, and pollution are direct consequences of human activities on nature and are 'self-inflicted' crises [74]. Efforts to address these challenges have had mixed results. The Aichi Biodiversity Targets have not been met [66]. The Sustainable Development Goals (SDGs) are failing to catalyse the action needed to achieve sustainable development [8,12]. Progress to achieving SDG 14 in particular has been limited [3]. Fragmented ocean management has not prevented these crises and lacks capacity to provide the multiple simultaneous solutions needed [20]. The failure to agree upon the Biodiversity Beyond National Jurisdiction (BBNJ) Treaty earlier in 2022 is evidence of this inability to manage ocean spaces.

In light of these failures, increasing demands are being made for a change in the relationship between humanity and oceans [63]. Given the recognition of the interconnectivity and compounding nature of these crises, there is a strong call for transformative change as a solution [64,73,74].

Transformation is not a new concept to global governance, particularly in the context of sustainability and climate change. It is seen to evoke an ambitious and innovative context for change [9]. However, it is an amorphous term, used often without definition leading to its perception as a buzzword [9,71]. If it is condemned to such status, its power to catalyse change will diminish rapidly.

Transformation is invoked as a concept in multiple ways, ranging from prescriptive and normative within policy, to descriptive and analytical with academia [9,13]. Beyond its invocation in global policy, there is limited understanding of what this term entails. Narratives surrounding the objective of transformation in ocean spaces are expansive, including "what we do, how we do it, and who influences" ([27], p. 2). Beyond broad agreement that change is needed in ocean spaces, there is no consensus as to what this looks like or how it is achieved. Therefore, there is a practical question around what the concept means and how this influences its operationalisation.

In 2012, O'Brien wrote a seminal paper that outlined the "surprising and disconcerting" lack of literature and knowledge surrounding the concept of transformation as a response to global crises. It has been continually reinforced that transformation lacks cohesive theoretical understanding (as outlined by Shove [67] and re-asserted by Blythe

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et al., [9]) and does not have an established set of practices or norms. This review adopts these hypotheses, along with [53] observation that transformation means "different things to different people or groups" as a baseline for a literature review. Since [53] publication, the concept of transformation has experienced swift growth within literature and policy circles, with debate spanning potential avenues and pathways of transformation, and what the term means in practice. Therefore, a practical definition of transformation is required to ensure that the various initiatives implemented under these calls for transformation follow the similar guiding attributes.

This paper provides a timely review of the landscape of transformation in academic literature and begins to untangle the characteristics of transformation specifically in ocean governance. Mapping the landscape of existing theorisations of transformation through the proposition of a heuristic Taxonomy of Transformation in Section 2 allows for exploration of the attributes of transformation from a multi-disciplinary perspective. The major attributes of transformation are discussed, including conceptual advances, debates, and gaps in the field of transformation. Finally, a definition of transformation in ocean governance is synthesised.

In framing and identifying transformation as a solution to the multiple crises facing oceans, this review focuses on deliberate transformations (which are a result of human agency) and excludes emergent transformations which do not result from human agency [26]. The limitation of adopting agency as an intrinsic element of transformation is the presumption that transformation must have a determined end point. This is not true, transformations can start with no clear consensus as to what the end goal of change is. At some scales, this may be preferable as it allows for reflexive learning to guide transformation.

1.1. Research design

This review adopts the position that transformation as a concept does not and should not belong to a single academic discipline. Despite this review targeting scientific literature and interpretations of transformation, it is recognised that diverse knowledge forms, such as art, historical knowledge, and ingenious knowledge, are vital in exploring the societal connotations and understandings of transformation. However, it is recognised that the exclusion of these forms of knowledge in this review is a critical barrier to a full and holistic interpretation of transformation. The primary purpose of this review is to situate and contextualise transformation in scientific literature, incorporating insights from different perspectives, such as climate, sustainable development, and biodiversity governance where relevant and does not limit scope of literature included.

A Boolean Search was used to identify key literature, using search terms "transformation" AND "transformative governance" AND "transformative ocean governance" in literature databases such as Google Scholar, Web of Science and Scopus. From this initial sample of papers, a snowball methodology was used to identify further relevant literature, whereby papers that were not initially included in the review were identified from citations in identified papers. Prior to analysis, titles and abstracts were reviewed for relevance; Literature was excluded based on breadth of perspective, for example, if titles and abstracts focused too narrowly on technical elements of transition management (such as Geels and Schot's [29] typology of transitions). Literature was also rejected if it outlined reasons for transformation, or incited a call for change, rather than discussing transformation as a concept.

Given that this review seeks to reassert if a "surprising and disconcerting" lack of literature and knowledge surrounding transformation [53] still exits, papers published prior to 2012 were not included unless needed to add detail or context to an earlier paper. The initial literature search was conducted in May, 2022 and considering the rapid growth of transformative literature, papers published between May and the submission date of September 2022 were also included where possible. 62 initial articles were reviewed in total, spanning various perspectives, such as general systems change literature, climate change adaptation, and transition literature. Following the snowball technique, a further 106 articles were reviewed that were not immediately identified through the Boolean Search. It is also noted that through the search methods employed, 'blue' was not included as a search term, meaning that literature such as blue justice, blue governance or other process-oriented approaches to transformation have not been included as part of this review.

2. Taxonomy of transformation

Transformation means different things to different people [53], resulting in an urgent need for transparency in its use. This review identified 43 distinct definitions of transformation, which were reviewed for content and construction with the aim of identifying the characteristics of and theoretical implications within different conceptualisations of transformation. First, the major theoretical approaches to transformation are identified.

It is well identified that transformation can be loosely separated into different theoretical backgrounds [6,10], allowing for it to be mapped in a pseudo-taxonomical fashion (Fig. 1). These include socio-ecological systems (SES), socio-technical systems (STS), and general systems thinking approaches to transformation. Additional non-systemic approaches to transformation were identified, including social and political theories of transformation, theories of change and organisational change management. These are discussed further in Section 2.4.

From these high-level system framings, further approaches to transformation can be identified, differing in characteristics, processes and type of transformation analysed. Significant conceptual differences and debate exist within these theories, resulting in a messy and sporadic theoretical landscape with both divergence and synergy. From a practical perspective, the challenge is therefore not a lack of understanding of transformation, but rather that there are many different theoretical directions in which transformation can be understood. This is simultaneously a virtue and limitation, with the plurality of interpretation arguably necessary when considering the magnitude of change evoked through 'transformation.' However, from a practical perspective, it seems as if almost anything can be defined as transformative with there being little unifying characteristics, processes or conceptualisations identified. It is daunting to translate this complexity into a practical context, which heightens the risk of greenwashing and adopting business-as-usual practices under the banner of transformation.

Thus, a rounded definition in the context of ocean governance is required, which synthesises and evaluates the different theoretical approaches. As a field, it lacks cohesive direction, as explored in Section 3.

Many uses of transformation do not have an explicitly identified theoretical background. Instead, many adopt a holistic disciplinary perspective, using elements of SES, STS and general systems thinking principles in their conceptualisations of transformation. Papers often discussed theories such as adaptation or transition, which were commonly associated with either a SES or STS framing but did not explicitly incorporate the broader theories of such a framing. This move to a theoretically blended understanding of transformation is reflected in literature, as evidenced in the framing of socio-ecological-technical systems, and a growth in literature exploring the synergies and potential lessons of SES, STS and transition approaches to change. There is significant opportunity for learning from these different perspectives and adopting a more blended and holistic approach to conceptualisations of transformation.

This review and the existing variety of classifications (such as Nalau and Handmer [52] and Feola [23]) shows that existing attempts to understand transformation do not exist in neatly defined silos, and significant conceptual overlaps exist between these categories. Imposing strict delineations onto these resultant theories is a complex and a futile endeavour, and a multi-disciplinary approach to transformation should be adopted. The remainder of the section details the major similarities

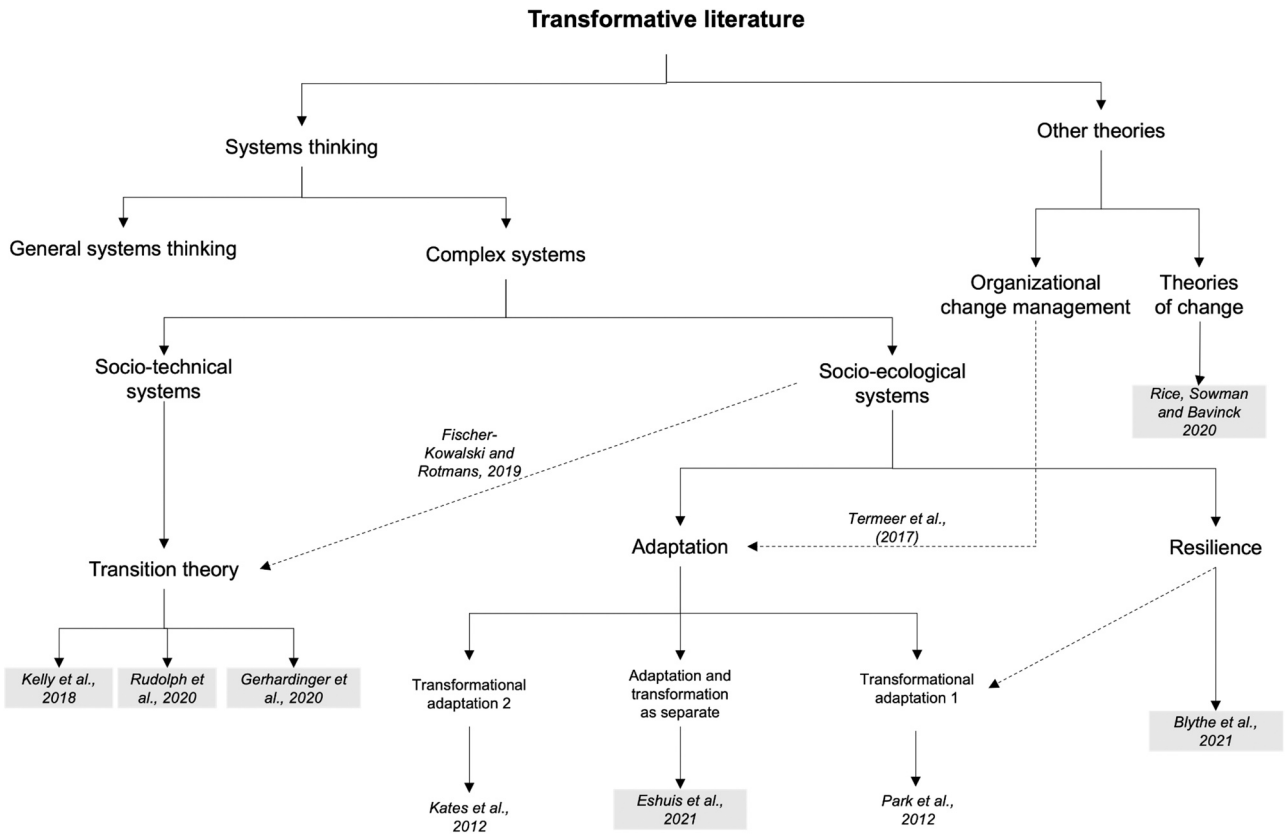

Fig. 1. Taxonomy of transformation literature identified. Where relevant, key papers have been identified, and key ocean papers are highlighted in grey. Conceptual overlaps are indicated by dotted lines. This Taxonomy builds on previous categorization efforts by Feola [23] and Nalau and Handmer [52].

and differences between these different understandings of transformation in order to propose a nuanced interpretation of transformation in ocean governance in the context of scientific literature.

2.1. Systems thinking

Most of the theories and conceptualisations of transformation are based on systems thinking, and the understanding of the world as a dynamic, complex and multi-level system [23]. Systems thinking is a well-established concept that is used in many disciplines and contexts, from policy to organisational change. Concepts such as tipping points, leverage points and feedback loops are used across differing approaches to transformation, and are present in multiple narratives of change. Using a systems perspective challenges a different way of understanding and visualising the relationship between different elements of governance systems [50].

From this general systems perspective, transformation can be viewed through the lens of SES or STS. Other framings exist, such as the socio-institutional perspective, but these are less common in literature. In general, these systemic framings can be divided by how the problem is framed: if a problem is regarded as narrow or broad [14]. A narrow problem can be solved by "applying greater expertise, more innovation, and better management" and adopting a technocratic perspective ([54], p. 154). In contrast, if a problem is viewed as broad, adaptive and emergent approaches are used which can be framed as requiring "a new way of viewing both problems and solutions" ([54], p. 154). While it is tempting to frame transformation in ocean governance as a technical problem, in reality the multilevel nature of the triple ocean crises can be viewed as an "opportunity to radically rethink and rebuild" ([32], p. 256).

2.2. Socio-ecological systems

SES framing was the most common theoretical perspective identified, which is cognizant with Blythe et al.'s (2021) observation that SES is the prevailing theory of transformation of ocean governance in both policy and academia. Although many definitions of SES exist, it generally regards human and natural systems as interdependent and of equal value [17,26]. Such a conceptualisation of the relationship between society and ecology requires different "ontological and epistemological commitments" resulting in different forms of governance ([32], p. 255; [25]).

Conceptualisations of change within SES are difficult to untangle but can be loosely separated into adaptation and resilience, with significant synergy between the two. Both conceptualisations can be viewed as a desired end state or desired inherent system characteristics. Adaptive governance can simultaneously be regarded as a continuous process or desired end state through which resilience thinking is employed.

Transformation is defined and deployed subtly differently within these frames of thinking [59]. Adaptive governance adopts multiple conceptualisations of transformation, as outlined in the proposed Taxonomy (Fig. 1). Adaptation conceptualises transformation either as part of an adaptive response [57,60] or as an entirely separate and new process [16,26,51,80]. Alternatively, transformational adaptation is a specific and unique process [42]. Kates, Travis and Wilbanks [42] outline three types of transformational adaptation: adaptation which occurs at a larger scale, adaptations that are 'truly new' to a location or resource system, adaptations that transform places. As such, transformation in the context of adaptation can mean different things depending on the specific theory ascribed to, necessitating clarity in specifically what characteristics of change are ascribed to a transformative process.

Resilience is defined as "the ability of a system to anticipate, adapt or

transform in the face of change" and is regarded as an important governance approach in times of crises ([10,26], p. 242). In SES, the distinction between transformation and resilience is contested. For some, transformability is a fundamental characteristic of a resilient system [23,26,79].

Transformation in the perspective of resilience has been explored in an ocean governance context by Blythe et al., [11] and in a national fisheries setting by Gelcich et al., [30], using the Olsson framework of transformation [55]. This framework conceptualises transformation as a deliberate and planned process, having three phases: (i) preparing for transformation, (ii) navigating a transition, and (iii) building resilience [55]. Both case studies identify the need for a 'window of opportunity' or tipping point to catalyse action to build resilience. It is not clear how such tipping points or catalysts for change fit with the identified need for deliberate transformation in ocean governance.

2.3. Socio-technical systems

The socio-technical systems (STS) perspective encompasses interrelated social and technological processes [32] which particularly focus on the roles of niche innovation to drive change [28]. Transition theory is the dominant perspective applied within a STS framing, which is being explored to facilitate change within SES [25]. Despite being most often applied to constrained sub systems, such as energy, the concept of transitions has been explored in the remit of ocean governance transformations [43,63,70]. Transitions to a sustainable blue economy in Brazil have also been explored [31].

Confusingly, transition and transformation are often used synonymously in literature [23,37,59] leading to the perception that they are interchangeable. Emphasising the distinction between these terms is imperative, as not only do they mean different things, but ascribe different processes to achieve change. Temper et al., [71] distinguishes between the two by virtue management, and notes that in contrast to transformation, transition implies a controlled and manageable change process. In this conceptualisation, transformation is a diverse and emergent change which challenges existing structures [68,71].

Whether the terms exist synonymously, exclusively, or as a nested pair depends largely on context. Multiple distinctions between the terms exist. As identified by Stirling [68], a heuristic distinction can be made between the two, with transition invoking processes that are controlled and managed towards an identified end point of change. In an ocean context, transition and transformation have been used interchangeably, notably by Armitage, Marschke and van Tuyen [4] and Kelly et al., [44].

Transition and transformation can also be regarded as a duality [37]. Kok et al., [45] highlight the need to consider transition and transformation in the context of biodiversity governance as part of an overarching process to achieve transformational change, using specific transitions alongside generic social transformations. In other words, using the practical insight of transition theory to facilitate transformative change.

2.4. Organisational change management and theories of change

Two additional and non-systemic types of change were identified throughout the review with different conceptualisations of how to achieve transformation. Valuable lessons can be obtained by the analysis of these less explored ways of approaching change. Organisational change management has been explored from a climate perspective by Termeer et al., [72], but no further exploration in the context of environmental or ocean governance transformations could be identified.

Theories of change are usually an organisation's vision statement of the change they wish to achieve and are growing in popularity throughout biodiversity and conservation science. The Convention on Biological Diversity (2020) has proposed a Theory of Change which is "expected to embody transformative change" ([56], p. 3). However, it is not clear what transformation means in this context. Similar to transition theories, theories of change are simultaneously a way of conceptualising change, a process and a product [62]. No examples of theories of change for ocean governance could be identified. While theories of change have promise for facilitating change at an organisational level, it must be questioned how useful they are at delivering change at a governance level, especially given the lack of critical analyses.

3. Characteristics of transformative blue governance

Following an overview of the major theoretical silos and their approaches to transformation, it is necessary to distil the principal attributes of transformation and discuss how these could inform an interpretation of ocean governance transformation. This review included analysis of the definitions used when discussing transformation, and the broader characterisations of transformation. Echoing the sentiments of Ziervogel, Cowen and Ziniades, [83] the pursuit of defining transformation is undertaken with "trepidation." In practice, it is difficult to separate what transformation means, the proposed values or principles of the end state of transformation, and how transformation should be achieved. Often, these features are amalgamated into a singular definition. However, this review specifically focuses on the characteristics of a transformative process and does not include analysis of the principles or values of such a process as these are likely to be context and scale dependent.

The following section is organised around three principal attributes of transformation, which have been identified from the literature and are outlined in Table 1. Fazey et al., [22] identify depth, breadth and speed as indicative characteristics of transformation, and are also consistent with the approach adopted by Linnér and Wibeck [46] in their analysis of governance of transformations, and the assertion that transformations must be deep, wide and enduring [21]. These indicative attributes are similar to those identified by Termeer et al., [72] who posit depth, scope and speed as defining traits from the perspective of organisational change management.

3.1. Breadth, scale and scope

The breadth of transformation is defined as the distribution of change across a system and can be limited to single or multiple elements of a system. Definitions of transformation differ in their degree of prescriptiveness of breadth. Often, definitions will include dimensions (such as societal, economic, and legal) that must be changed to achieve transformation. The inclusion of such dimensions of change can give a valuable insight into how transformation in a specific context can be achieved. Some conceptualisations of transformation, such as Visseren-Hanmakers and Kok (2022), include the need for both societal and personal levels of transformation. From a practical and policy

Table 1
Attributes of transformation, as identified by [22] and identified through the literature review.

Identifying characteristics of transformation		*Attributes identified in literature*
Breadth or scope	The distribution of change	• System wide • Specific elements of society or governance
Depth	The intensity of change	• Non-linearity • Dramatic, profound and fundamental • Radical • Addressing root causes • Reorganisation • Creating new • Irreversible or flexible
Speed	The timeframe in which change occurs	• Deliberate vs emergent • Rapid • Incremental

perspective, such prescriptiveness is also of benefit, as it facilitates a deliverable and quantifiable interpretation of transformation.

In an oceans context, Blythe et al., [11], who adopts a resilience perspective of transformation, include 'structures, processes, rules and norms' as dimensions of change in transformative ocean governance. In contrast, Kelly et al., [44] adopts a transitions perspective of transformation of marine governance in Ireland that requires addressing 'institutional, legislative, social, and economic' factors. Both interpretations of transformation are different by virtue of scale, context and theoretical framing. The resilience underpinning of the first definition squarely focuses transformation at targeting intangible and underpinning elements of a system, and implicitly advocates for a societal approach to change. The technocratic underpinning of the second definition regards the changes needed as being fairly prescriptive.

It is acknowledged here that there is no minimum prescribed breadth or scope of change required for change to be transformative [21] as such a description would be dependent on context and depth of change. For example, it would be impossible to generically state that transformation must target an entire system, or that it could be achieved by targeting one single element of the system as change depends on the existing system dynamics and distribution of power. In the context of urban transformation, Eshuis and Gerrits [21] state that transformation must be widely felt, and not limited to a specific system element. In the context of ocean governance, a notoriously complex and fragmented system, transitions to achieve transformation are often invoked in a systemic context, recognising the need for multi-level and bottom-up initiatives to catalyse change [43].

In the context of a transformation towards sustainability, governance systems are a widely accepted, if often overlooked, avenue of delivering transformative change across multiple system elements and scales [2,61,70,73]. A further rationale for targeting governance in pursuit of ocean transformation is the recognition that fundamentally inadequate governance has allowed current crises to proliferate. The crises faced by ocean environments are not novel or unique and are also observed across biodiversity and climate governance. [38] observation that "the climate crisis is more like a crisis of governance than a crisis of the environment," is true in the context of any governance system. Governance is therefore central to any form of change [2,59].

Governance is an often-nebulous term that encapsulates different elements dependent on who is using it and in what context. Simply, governance is "how power is directed to enable or constrain human action" ([69], p. 3). [11] adopts a broader perspective of governance in an ocean context, and identifies the role of structures, processes, rules and norms in shaping decision-making, including how actors "share power, assign responsibility, and ensure accountability in the use and management of the marine environment." From this perspective, ocean governance has the capacity to set "the vision and conditions that enable others to take action" ([45], p. 348). In adopting Blythe et al.'s (2021) conceptualisation of governance, framings of transformation of, in, and for governance are "focused on the role of current institutions, modes of governance or characteristics" ([76], p. 86).

Situating transformation of governance requires precision about what exactly is being discussed. There is often not a clear distinction in literature [76]. [77] segregate between transformative change and transformative governance, with "change referring to the actual shift and governance to "steering" the shift." Therefore, transformative governance must result from deliberate human agency. The concept of agency, particularly in transitions [81] and adaptive governance [82], is well discussed. In acknowledging the role of agency in deliberate transformation, transformation becomes "an inherently political act" [39,59]. A rich literature examines the political nature of transformation, and stresses the need for awareness around who is calling for transformation, and who bears the costs and consequences of such change through an evaluation of power [5,11,59,65]. As part of governance transformations, issues of power in ocean governance are often discussed [6,9]. Redistributing or changing existing power structures within a governance framework are regarded as critical to ensuring that transformative efforts do not result in the same unequitable system that preceded it [10].

Patterson et al., [59] outline three avenues of transformative governance in literature: governance for transformations, governance of transformations, and transformations in governance. Despite being presented as separate avenues, these pathways are highly interdependent and have significant overlap. As such, these avenues of transformation can be visualised as a cycle (Fig. 2).

In acknowledging the 'environmental glass ceiling' of transformations, it is clear that governance systems themselves must be transformed to achieve the radical change needed [35,36]. Therefore, governance for transformations involves creating the governance conditions necessary for transformation which in turn facilitates effective governance of transformative processes. The creation of such enabling conditions are likely to be transformative of the governance system and of itself [72]. Therefore, situating governance as the scene of transformation in ocean governance should result in broadscale change that results in a system that is fundamentally new.

3.2. Depth

Depth of change refers to the distance of change from surface level, i.e, the changing of deep elements of a system such as underlying logic, values and assumptions rather than superficial surface level change. As referenced in Section 3.1, this can be operationalised as the 'intangible' elements of a system. Again, it is critical to reflect on who is calling for transformation, and how depth of change could be interpreted by them. For example, in biodiversity governance it is recognised that transformation does not stem from ambitious goals, and instead is galvanised in transformation of "working arrangements, mechanisms and institutions" ([14,45], p. 348), or the hidden and underpinning parts of a system.

Within the reviewed definitions of transformation, multiple ways of describing the depth of transformation were employed. Descriptors included fundamental, dramatic, profound, and radical, which while subtly different, have largely synonymous connotations of the magnitude and depth required. These descriptors existed across theoretical backgrounds, leading to the conclusion that regardless of theoretical 'siloing', the depth of change perceived as being needed for transformation remains similar. This is congruent with the findings of Nalau and Handmer [52], who found that a majority definitions of transformation include 'fundamental' change. It often is agreed that more than 'small tweaks' is needed to facilitate change [48]. Some definitions of transformation explicitly reject the idea of small-scale (or incremental) change [9,47,58], and advocate that transformation must comprise of change that is greater in magnitude [40].

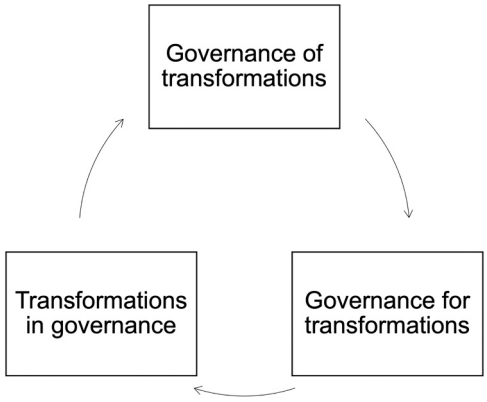

Fig. 2. Interdependence of governance transformations, based on initial theory by Patterson et al., (2016). Types of transformation in governance exist as an interdependent cycle.

Often, it is not clear specifically what is meant by fundamental, dramatic, radical or profound, but it invokes the perception of the need to tackle deep rooted and systemic issues [71]. From an etymological perspective, radical comes from 'root' [71], and as such invites a closer re-evaluation of what values, assumptions, and power structures the governance system is built upon [21]. This emphasis and awareness of the need to address roots is not universal across interpretations of transformation. In the context of ocean governance, it is difficult to identify what the roots to be changed are. This is a major challenge to transformation; the multiple and multiscalar interpretations of root causes of crises make a consensus driven approach to change difficult, and could risk delaying action. In addition, such divergence of interpretation stresses the deeply political nature of transformations, which cannot be ignored. Furthermore, whether a change is fundamental, dramatic or profound is inherently subjective [22] which increases the risk of being used to greenwash change [24].

The inclusion of such fundamental depth of change is not standard in STS definitions of transformation. While some (notably Kelly et al. [44]) include the radical nature of change needed, many included the characteristics of reorganisation and reconfiguring. This more practical interpretation of transformation has gained some traction in global policy, and has been explored in the context of global ocean governance. Rudolph et al., [63] argue that a "purposeful transition" in oceans governance can lead to transformation through incremental change.

An area of significant conceptual divergence is the dichotomy of incremental versus radical change [13,72]. Incremental changes can be characterised in different ways. In a general SES framing, incremental can mean a reliance on current and normative "ways of thinking and governance structures" to change the existing system [6]. In contrast, from an adaptive perspective, incremental change can also be interpreted as small scale, slow, stepwise change in the short-term which directly contrasts with a notion of large scale, system wide and rapid change [72]. Incremental change is also strongly associated with adaptation [53]. This plurality of meaning masks whether radical change relates to depth, speed or scale or a combination of all three. In this section, the former framing is adopted, and the discussion of radical change relating to speed is continued in Section 3.3.

From a transition perspective, incremental change is observed through the development of niche level changes which aggregate to change at a landscape or regime level. Exploratory work by Rudolph et al., [63] identifies several niche level changes that have capacity to aggregate to transformative change in ocean governance. These incremental changes often exist in specific sectoral responses to existing drivers of change, such as efforts to decarbonise the shipping sector [63]. Significant risks are identified with adopting an incremental approach however, such as the disconnect between the emphasis on radical change by the global scientific community and the incremental policies proposed by implementing institutions [7,58]. Confining policy and actions to those "accommodated by the existing system" to such incremental change risks wasting valuable time [58]. Incremental change is often susceptible to path dependency, and is a well-documented barrier to incremental change [81]. Radical change could have the potential to overcome such a barrier.

However, there is also significant criticism of a radical approach. Radical change presumes that there is total knowledge and confidence that the direction of change is correct, the eventual and unequivocal success of interventions, and does not reflect the fact that there is still an "incremental understanding of transformation processes themselves" ([13], p. 24). Brand [13] also outlines the tension between radical problem diagnoses and 'docile' solutions proposed, and the inherent flaw in assuming that transformation can be achieved with current structures and systems. This is cognizant with the differentiation of stages of governance of transformation identified by Patterson et al., [59], and the recognition that to facilitate transformation in governance, governance systems themselves must transform to create enabling conditions for change (outlined previously in Section 3.2). Therefore, it can be summarised that any transformative effort within ocean governance can only be achieved through a transformative change in governance. Additionally, "too rapid and drastic change can easily lead to losses, instability and confusion" ([52], p. 355), and lead to inequitable outcomes and processes. Adopting an incremental approach can allow for 'small wins' in this regard, and in theory could support an inclusive and equitable process. However, there is little evidence to support this logic in practice. Furthermore, incremental change, if limited by path dependency, could risk further entrenching existing interests and inequality.

[23] suggests that the "general idea of transformation as a major, fundamental change, as opposed to minor, marginal, or incremental change, appears to be widely agreed upon in both research and policy." However, based on the findings of this review so far, we reject this hypothesis and instead argue that such a binary perspective of change is not constructive. In ocean governance, both forms of change are needed. A recent development in literature is the exploration and reconceptualization of the incremental versus radical debate towards a process that sees both processes as interdependent [15,72]. Such a reconceptualization would lie between radical and incremental processes, and potentially sees transformation as a continuous process that includes incremental and radical shifts. The concept of continuous transformational change as a compromise between the incremental and the radical [72] has some merit in this regard. As advocated by Fazey et al., [22], a move beyond over-simplified distinctions of incremental and radical, and the adoption of a more context specific approach that addresses the depth, breadth and speed of change is required.

Leverage points from an STS perspective are useful tools for understanding depths of changes towards transformative change, and represent areas of influence which can result in system wide change [49]. Depth of change in this context can range from shallow interventions, such as financial incentives, to deeper interventions, such as changing power structures, goals and visions of a system [1].

3.3. Speed

Speed of change is often not explicitly addressed in definitions of transformation [72], and represents an avenue of exploration. Depending on theoretical background, transformation could be an incremental, adaptive process facilitated by reflexive learning and course correction, or it could be a rapid and spontaneous event driven by the passing of an external shock event [53]. Regardless, when discussing speed of transformation, it is clear understanding the perceived drivers of change are imperative in identifying the process and characteristics of change [23].

It has been suggested that transformation implies the need for rapid change [22], particularly given the urgency of response to multiple nested crises [80]. Beyond the interpretation of incremental change as slower and more step-wise change, there is little contrasting opinion in literature. In the context of ocean governance, Rudolph et al., [63] characterises transformation as needing to be rapid and nimble.

[59] sees the interdependency of incremental and radical change temporally driven a focus on long-term transformation with "an honest recognition of the realities of near-term incrementalism at the same time." Such short term incrementalism can also create momentum for long term and larger scale change by advocating for 'small wins' [14,33,59]. This also creates space for multiple pathways of transformation that "intersect, overlap and conflict in unpredictable ways" ([65], p. 21). The resulting cross-scale confluence of processes can also be transformational [51], resulting in the need for a coevolutionary and multidisciplinary approach [59]. While urgent change is clearly advocated for, it must not undermine reflexivity and reflection necessary to create any depth or permanence of meaningful of change. The trade-offs between rapid and slow (or radical and incremental according to some interpretations) warrants further critical attention.

4. Synthesis and conclusions

4.1. An interpretation of transformation

This review began with the baseline of a "surprising and disconcerting" lack of literature and knowledge surrounding transformation [53]. Based on the findings of this review, this statement is rejected. In the decade of scholarship since this assertion, transformation has undergone a deep growth and maturation as field resulting in a largely uniform understanding that transformation is radical, profound, and fundamental change regardless of the process by which this is achieved. The various theoretical framings of STS and SES have led to different understandings of scale and breadth, but depth remains constant. What is unacknowledged in these discussions of depth of transformation is how these are dependent on internal values of those evaluating change. Simply, what is radical to one may be superficial to another. Therefore, it is critical to reflect on who is calling for transformation, and how this shapes the resultant trajectory and narrative of change [11].

From these findings, it can therefore be summarised that to achieve such deep systemic change as is common to most definitions, transformation cannot be relegated to the surface, and must result in a system that is unrecognisably different to what preceded it. However, there are significant practical challenges associated with such change, and limited empirical evidence of such transformations having been achieved particularly in the context of ocean governance. Future research could identify and analyse historic examples of such change, and what driving and enabling factors facilitated such deep change.

Beyond the inclusion of specific focuses of change, Nalau and Handmer [52] found that many definitions of transformation do not include consideration of the scale and endurability of transformation. This was also observed in this review, with definitions often stating the need for generic 'system-change.' Without a solid appreciation of which system is the target of change, systems change is a concept that promises much but delivers little tangible direction as to where transformative efforts should be focused. It is proposed through this review that transformation, particularly for ocean sustainability, should be targeted at governance systems. This position agrees with the perspective of Blythe et al., [11], who advocate for an ocean governance transformation. While the importance of multi-scale transformation cannot be understated, this review advocates that a focus on governance can facilitate transformation across multiple scales.

4.2. Moving beyond granularity

It is suggested here that transformative literature is often viewed in too granular and siloed a fashion to see the broader understandings of change. Moving beyond this granularity, and beyond dichotomies of incremental and radical and SES and STS, into a broader and more integrated understanding of change would majorly benefit operationalisation of transformation in ocean governance. For example, exploring how niche innovation in transition theories, as described by Rudolph et al., [63], could be applied in the context of the Olsson Framework of transformations in SES in an ocean governance context [10]. Additional research could review organisational change management-centric approaches to social dynamics of transformation, and how these could be translated to larger and more complex governance systems. Observations of the practical implementation of such theoretical framings of transformations of governance transformations in reality would test whether such an integration is observed in practice.

It is recognised that transformation has plurality of meaning across different domains of knowledge [18]. The subjectivity and fuzziness of this term is in equal parts its strength and weakness. On the one hand, it inspires creative, rapid and unlimited capacity for change, and on the other can be used to describe minor 'greenwashed' changes that do not facilitate the depth required of transformative change [22]. The 'fuzziness' of transformation often stems from the existing system complexity and vision-oriented outcomes rather than a reliance and use of goals and objectives [22].

When proposing a definition of transformation, there is an inherent tension between the need for a clear definition to avoid greenwashing, simply repeating what has been defined previously, and the limitations that are necessarily imposed through such a definition. As such, through the evaluation of different interpretations of transformation, it must be questioned if proposing an interpretation of transformation at the scale of ocean governance is desirable. As identified above, the diversity of interpretations of transformation has facilitated a plurality of meaning, whereby very different attributes of change can fall under the umbrella of transformation.

Similar to the findings of Voyer et al., [78] in the analysis of interpretations of the blue economy, this review suggests that any uniform definition may "result in particular lens being privileged, and undermine the ability of states or regions to develop a more contextualized Blue Economy which is sensitive to the aspirations and objectives of their communities." Therefore, transformation should adopt a conceptually 'elastic' perspective that is heavily contextually dependent [23] but grounded in the need for deep and radical change. Furthermore, consistent with the assertion that definitions of transformation reflect contextual and situational nuance, it is important that through empirical exploration and grounding any plan, model or definition generated in the context of transformative scholarship is not a "blueprint" for transformation ([46], p. 188). Blueprints in this context imply static narrative of change which is at odds with these findings. Reconciling this elastic approach with the need to generate a definition of transformation that is specific enough to be clearly identified and measured against is challenging, and needs to result in a definition that can be applicable to diverse contexts.

From this review, the following definition of transformation in ocean governance is proposed: systemic change that addresses the roots of persistent problems and results in a fundamentally different system. This definition does not seek to prescribe what must change, and instead advocates for an entire system change that is facilitated by the radical reassessment of underlying values and assumptions, as facilitated by an evaluation of the roots of change. While the utility of addressing roots of persistent problems is contemplated above, it is ultimately concluded that while the reflection and debate required to identify such roots would facilitate a deeper and more robust level of change across a breadth of system dynamics. In addition, addressing persistent problems inspires a more practical approach to problem solving, and is understood across a variety of contexts. In this regard, space is allowed for multiple transformations to grow and shape transformative processes. This definition is similar to that proposed by Blythe et al., [11], but instead targets transformation at the hidden elements of governance rather than "structures, processes, rules and norms."

4.3. Conclusions

In conclusion, it is clear that well established theories of transformation exist, with significant differences relating to what constitutes a transformation in relation to speed, and scale. Depth of change remains relatively constant across definitions. A largely consistent understanding that transformation is radical, profound, and fundamental change highlights further questions as to what exactly these concepts look like in practice. It is still not clear how these different characteristics of transformation can be applied to transformative change in ocean governance, representing an area of future research that seeks to operationalise these terms, or ground them in reality.

These differences in characterisation are simultaneously a virtue and challenge to implementation of the concept, with plurality of interpretations necessary when navigating complex issues, yet also potentially shelter a business-as-usual status-quo. This conceptual malleability represents a significant challenge for policy and implementation in pursuit of transformation to meet global challenges

identified in the introduction. As such, caution is advised when using transformation as a policy objective, with clarity in what exactly is meant being paramount.

In light of this plurality and the practical challenges associated with such malleability, this review has generated a holistic and multi-disciplinary interpretation of transformation in the context of ocean governance, which aims to begin to bridge these theoretical silos towards a unified understanding of transformation. This now needs to be refined through practical application and reflection. From this definition, and its focus on persistent problems, the question of how transformation is undertaken is more contextually driven and nuanced than prescriptive.

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Data availability

No data was used for the research described in the article.

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