Full length article

Analysis and discussion of 28 recent marine protected area governance (MPAG) case studies: Challenges of decentralisation in the shadow of hierarchy

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ABSTRACT

This paper analyses the governance of MPAs through 28 case studies in 17 countries. Limitations of the polycentric governance concept are discussed, particularly its faith in linkages as a means of resolving conflicts and its assumption that the state should only take a passive role. The concept of coevolutionary governance is described and justified, noting that this essentially builds on polycentrism's systematic case study analysis approach, but evolves it to move beyond its limitations. Coevolutionary governance takes a synecology perspective to analyse how incentives coevolve through their functional integration, as well as how social and ecological systems can coevolve through the feedback mechanisms of human impacts and ecological services. Drawing on the wider concept of multi-level governance, coevolutionary governance is considered to provide for synergies between governance approaches, proposing that coordination can be achieved and conflicts addressed through reconfigured roles of the state providing steer through governance in 'the shadow of hierarchy'. The MPAG empirical framework is described and the findings of its application outlined. Drawing on these findings, some key trends within and amongst five categories of incentives are explored. These illustrate that incentives synergistically interact in a way that is analogous to synecology, providing for them to be functionally integrated as a means of combining governance approaches. As such, it is argued that these findings support the validity of the coevolutionary governance concept, as well as supporting the argument that "diversity is the key to resilience, both of species in ecosystems and incentives in governance systems".

1. Introduction

This paper: 1) sets out the underlying theoretical concept for the marine protected area governance (MPAG) analysis framework; 2) details the MPAG framework methodology and rationale; 3) provides an overview of 28 case studies from 15 countries (Fig. 1) that have applied this framework and feature in this special section of *Marine Policy*; and 4) discusses some broad patterns and trends in these case studies (Fig. 1), with implications for marine resource governance in MPAs and beyond. It is accompanied by Supplementary Material, which sets out the theoretical basis of and empirical framework for the MPAG research in more detail, including a glossary of some of the key terms used. This paper and the related case study papers aim to contribute to both wider discussions on different approaches for effectively and equitably governing marine protected areas (MPAs), and inform initiatives to build capacity for the more effective and equitable governance of MPAs. This is part of a wider project to systematically analyse the governance of MPAs around the world, aimed at developing an empirical evidence-base to help inform discussions and initiatives on the governance of MPAs [1].

The Convention on Biological Diversity (CBD) has set a target that,

"At least 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes" [3]. This is incorporated into Sustainable Development Goal (SDG) Target 14.5, which is that at least 10% of coastal and marine areas are conserved by 2020 [4]. This paper focuses on the 'effective and equitable' component of the CBD target. This is because MPAs that are effective and equitable have the capacity, directly or otherwise, to contribute to many of the 17 SDGs and 169 associated targets. It cannot be overemphasised that MPAs must achieve their conservation goals in a manner which is equitable, if they are to support the delivery of other SDGs and targets.

A great deal of attention has been paid to the spatial component (10% of coastal and marine areas) of this target and the degree to which the overall network is an ecologically representative and well-connected system. However, less attention has been focussed on the effectiveness and equity of individual MPAs [5]. It is widely recognised that only a small minority of MPAs are considered to be effective in achieving their

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conservation objectives. For example, in a global analysis of 2688 MPAs covering coral reefs around the world, only 193 (7.2% of designations) were rated as effective and 525 (19.5%) were rated as partially effective, 479 (17.8%) being rated as ineffective 'paper parks' and 1491 (55.5%) being unrated [6]. The authors noted that, "it is highly likely that MPAs for which management ratings were unavailable are not being managed effectively". Reasons identified for protected areas (terrestrial and marine) being ineffective include: (i) a lack of financial resources leading to a lack of boundary demarcation, law enforcement, natural and cultural resource management and infrastructure; (ii) poor governance quality and bureaucratic inefficiency leading to the alienation of stakeholders and the erosion of support for management decisions; (iii) corruption; and (iv) armed conflict [7]. Whilst the number of MPA effectiveness studies is rising, studies to assess the distributional equity and related justice dimensions of MPAs around the world are in their infancy [8]. There are relatively few empirical assessments of MPA equity and related justice issues, e.g. Jones [9], Gurney et al. [10], Dawson et al. [11,12], Hogg et al. [13]. The findings of this limited number of studies indicate that a lack of equity and justice pervades within many MPAs.

This special section presents 28 case studies (#1–28) in 19 papers (excluding this paper), all of which employ the MPAG framework. These are collectively discussed here to identify recurrent themes related to MPA governance. The wider applicability of the MPAG framework and methodology is explored in this special issue through applying the framework to the governance of a fishery [14] and the governance of MPAs in general in areas beyond national jurisdiction (ABNJ) [2]. There are thus 26 specific MPA case studies (#1–26), one fishery area case study (#27) and one high seas MPA governance model case study (#28).

2. Underlying theoretical concept

These case studies utilise the marine protected area governance (MPAG) analysis framework [1]. From its conception, the MPAG framework sought to provide both a framework for critical analysis of

the governance of MPAs and actionable insights for marine resource managers and communities. Any governance analysis is based, explicitly or implicitly, on some conceptual model of how actors within a system should relate and interact. Therefore, for the MPAG framework to be successful in yielding actionable insights, the underlying conceptual model must be able to adequately represent the realities across varied contexts.

The 51 MPAG framework case studies to date, including the 28 in this issue, have helped develop and refine an underlying theoretical concept that we term 'coevolutionary governance' [1]. Before introducing this model and the MPAG framework, it is worth considering other methods used to evaluate the effectiveness of MPA governance around the world and their underlying theoretical approach. These other methods are described and discussed in detail in the Supplementary Material, in particular: 'NEOLI' (no take, enforced, old, large and isolated) features [15]; capacity shortfalls [16]; the IUCN framework for analysing the quality of protected area governance [17]; and the social-ecological systems (SES) framework [18]. It is sufficient to note here that, whilst all these methods have their strengths and useful applications, they were not considered suitable for the MPA governance case studies as part of the MPAG research project due to the theoretical limitations expanded on in the Supplementary Material. Ostrom's SES framework is undoubtedly the most closely related of these to the approach taken in the MPAG project and so it is explored in some detail here and further in the Supplementary Material.

2.1. Limitations of the social-ecological systems (SES) framework

The systematic approach to empirically analysing natural resource governance case studies on a social-ecological systems (SES) basis, inherent in the SES framework [18], was the main inspiration for the MPAG analytical framework. Ostrom's framework is premised on the assumption that local people are best able to collectively manage the resources in a given place. It recognises that there are networks of
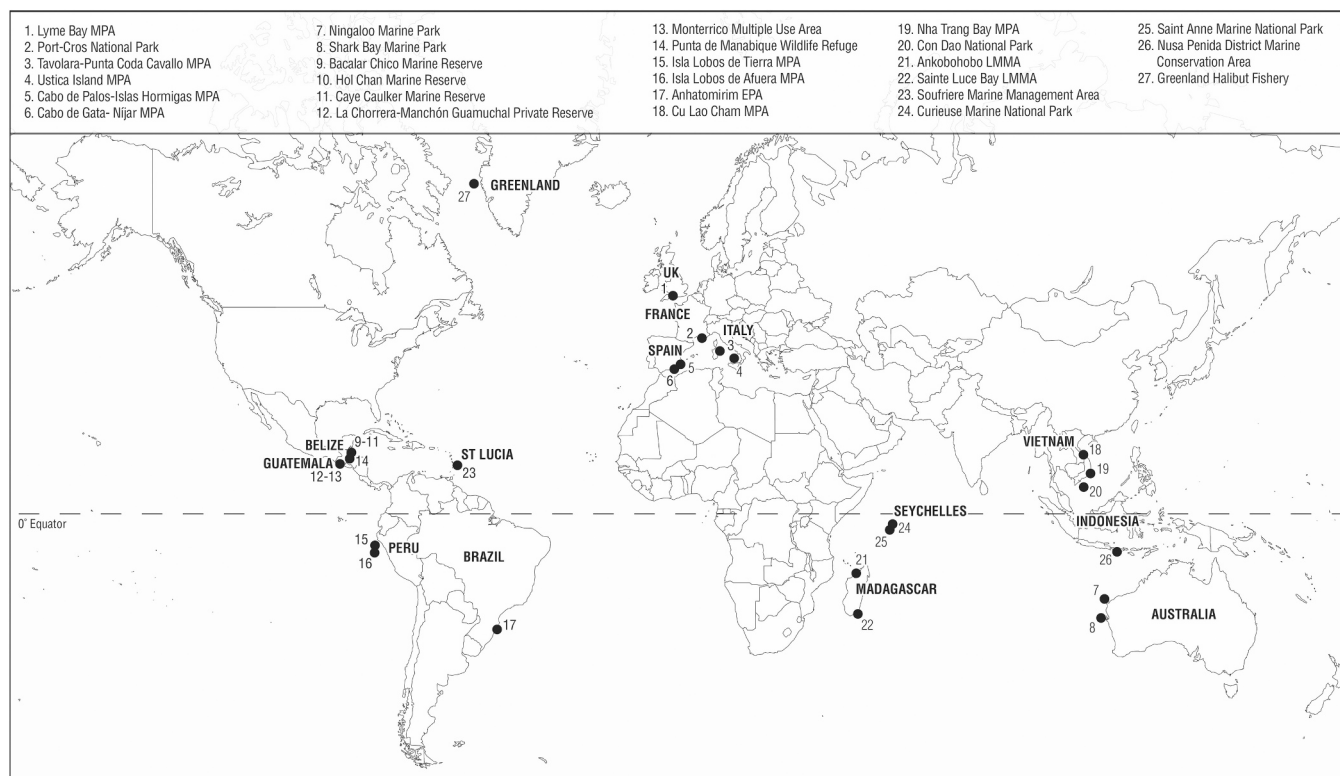

1. Lyme Bay MPA
2. Port-Cros National Park
3. Tavolara-Punta Coda Cavallo MPA
4. Ustica Island MPA
5. Cabo de Palos-Islas Hormigas MPA
6. Cabo de Gata- Nijar MPA
7. Ningaloo Marine Park
8. Shark Bay Marine Park
9. Bacalar Chico Marine Reserve
10. Hol Chan Marine Reserve
11. Caye Caulker Marine Reserve
12. La Chorrera-Manchón Guamuchal Private Reserve
13. Monterrico Multiple Use Area
14. Punta de Manabique Wildlife Refuge
15. Isla Lobos de Tierra MPA
16. Isla Lobos de Afuera MPA
17. Anhatomirim EPA
18. Cu Lao Cham MPA
19. Nha Trang Bay MPA
20. Con Dao National Park
21. Ankobohobo LMMA
22. Sainte Luce Bay LMMA
23. Soufriere Marine Management Area
24. Curieuse Marine National Park
25. Saint Anne Marine National Park
26. Nusa Penida District Marine Conservation Area
27. Greenland Halibut Fishery

Fig. 1. The MPAG case studies in this special issue. Note only 27 (#1–27) are illustrated in this figure, as one of the case studies (#28) [2] focuses on the emerging governance approach to high seas MPAs in general, rather than being focused on a specific geographical area.

linkages amongst many ('poly') different places ('centres'), hence it is often referred to as polycentric governance (Supplementary Material Fig. 1).

The applicability of the SES framework to MPAs has been discussed as feasible and appropriate, e.g. Schlüter, et al. [19] and it has been applied in several MPA and related marine case studies, e.g. Evans et al. [20], Ban et al. [21], Morrison [22], Carlisle et al. [23,24]. However, the theoretical basis of Ostrom's SES framework was not adopted in the MPAG framework. This is because of its reliance on the fulfilment of critical enabling conditions for place-based self-governance in semi-autonomous decision-making centres. This is coupled with tremendous faith in deliberations and negotiations through horizontal and vertical linkages, as a means of achieving coordination and resolving conflicts within and between places. This reliance is stress-tested to failure in MPAs. This is due to MPAs typically operating at smaller spatial scales than marine ecosystems, the connectivity between marine ecosystems [1; p56–57] and their related ecological and human inter-connections [1; p70–71]. Polycentric researchers do recognise that where challenges within and between places cannot be resolved through local deliberations, including through horizontal/vertical linkages, centralised state intervention may be required [25]. However, because the majority of place-based marine self-governance initiatives, including MPAs, raise such intractable conflicts, the exceptions become the norm. This severely undermines the potential of the concept of polycentrism and the related SES empirical framework, as a realist institutional analysis framework that can be routinely applied to case studies of marine places and related MPA governance approaches.

2.2. Introducing the coevolutionary governance model

Given the above limitations (discussed at length in the Supplementary Material), an alternative theoretical basis and methodology was developed and applied. This essentially builds on Ostrom's [15] approach for institutional analyses of natural resource governance, maintaining its systematic case study analysis approach, but evolving it to move beyond its limitations. The coevolutionary governance concept described here is a hypothetical model of how natural resource governance functions in the real world: a hypothesis, which is born out of existing theories, the identified shortcomings of these and observation. This model can be, and is here, tested by empirical evidence from MPAs, see subsequent discussion (Section 4.4). Similarly, recognising that the concept and related empirical framework have evolved through their application to a total of 51 case studies in the last decade, it can and should be further refined and developed by future empirical work. Using the coevolutionary governance concept as a lens through which to consider these case studies also intends to offer MPA managers pragmatic and actionable insights, which are drawn from a concept that reflects reality.

2.2.1. A synecology perspective

The theoretical concept of coevolutionary governance [1] is considered particularly appropriate for analyses of MPAs as social-ecological systems. It adopts the synecology approach that is widely applied to understand trophic relationships in ecosystems, including recognition that a diversity of species from different functional groups tends to make ecosystems more stable and resilient to perturbing forces [26], see further elaboration below. This rationale is extended to the analysis of MPA governance frameworks, focusing on the incentives that constitute a governance framework. Incentives are defined in the MPAG context as being; "*particular types of institution that are instrumentally designed in relation to an MPA to encourage actors (i.e. people involved) to choose to behave in a manner that provides for certain strategic policy outcomes, particularly conservation objectives, to be achieved*". At the core is the recognition that a diversity of incentives tends to make governance frameworks more resilient to driving forces that could

perturb an MPA's social-ecological system and undermine its effectiveness.

The coevolutionary governance concept also builds on early recognition in coevolutionary development studies that reciprocal feedback processes between social and ecological systems can enable them to coevolve [27]. More recently, there has been related recognition amongst complex adaptive systems analysts that the natural resource base, social institutions and the behaviours of individual actors can coevolve through their interactions [28] and that ecological and social dynamics can adapt in response to each other [29]. In a similar sense, coevolutionary governance can also be related to ecological economics [30], as feedback through enhanced flows of ecosystem services are a key element of this social-ecological systems view. In practice, these ecosystem service flows are usually only qualitatively assessed in MPAG analyses through impact and effectiveness evaluations, rather than being routinely quantified. Nonetheless, ecosystem service provision and the impacts of human activities on the flows of these services are important elements of the MPAG framework's coevolutionary conceptual model (Fig. 2).

The coevolutionary governance concept focuses particularly on the synergies between different governance approaches, the strengths of one approach counteracting the weaknesses of the other. It follows that the MPAG framework also particularly focuses on the ways in which different incentives interact and coevolve, in keeping with the synecology approach introduced above. This is analogous to synecology in life sciences, whereby the focus is on the ways in which different species interact to constitute a structurally and functionally integrated, diverse and resilient ecosystem. It is now widely recognised in studies of ecosystems that a diversity of appropriate species from a range of functional/trophic groups tends to confer ecosystem stability and resilience [26]. Similarly, the coevolutionary governance concept recognises that a diversity of incentives from different categories representing different governance approaches tends to confer resilience to the governance framework and related social system, reducing impacts and thereby promoting effectiveness as well as increasing the flow of ecosystem services (Fig. 2).

A key challenge to implementing this coevolutionary rationale is that here is a time lag of at least 2–5 years between impacts being reduced and flows of ecosystem services being increased, related to the time it takes for the species, habitats and ecosystems that constitute an MPA to recover from previous impacts. This time lag can be up to 35 years for the full recovery of overfished populations and the related full flow of spillover and export benefits [32]. Restrictions necessary to reduce impacts in order to promote such recovery may also lead to changes in the distribution of the costs and benefits amongst different social groups. These time lag and distributional factors represent challenges, amongst others, related to equity that must be addressed in any given MPA, recognising that effectiveness and equity are inextricably intertwined.

Through the lens of coevolutionary governance, an increased diversity of incentives for a given MPA should strengthen the governance framework and make it more effective, thereby reducing the impacts of human activities (Fig. 2) on the natural features on which ecosystem services flows depend. This should lead to the recovery of the health of the marine ecosystem, as biodiversity recovers from the impacts of human activities, making the ecosystem more resilient. This should also increase the flow of ecosystem services, e.g. through increased catch-per-unit effort as fish populations become restored through spillover/export, enhanced coastal defence values of recovered habitats such as coral reefs, mangroves, seagrasses and kelps, promotion of tourism through opportunities to dive and snorkel in a restored diverse marine ecosystem. These enhanced ecosystem services provide the feedback from the marine ecosystem that has been subject to protective incentives. This can potentially promote the wellbeing and socio-economic resilience of human communities that rely on the MPA's ecosystem services, which in turn promotes further awareness of the benefits of protection and increases the support and cooperation of
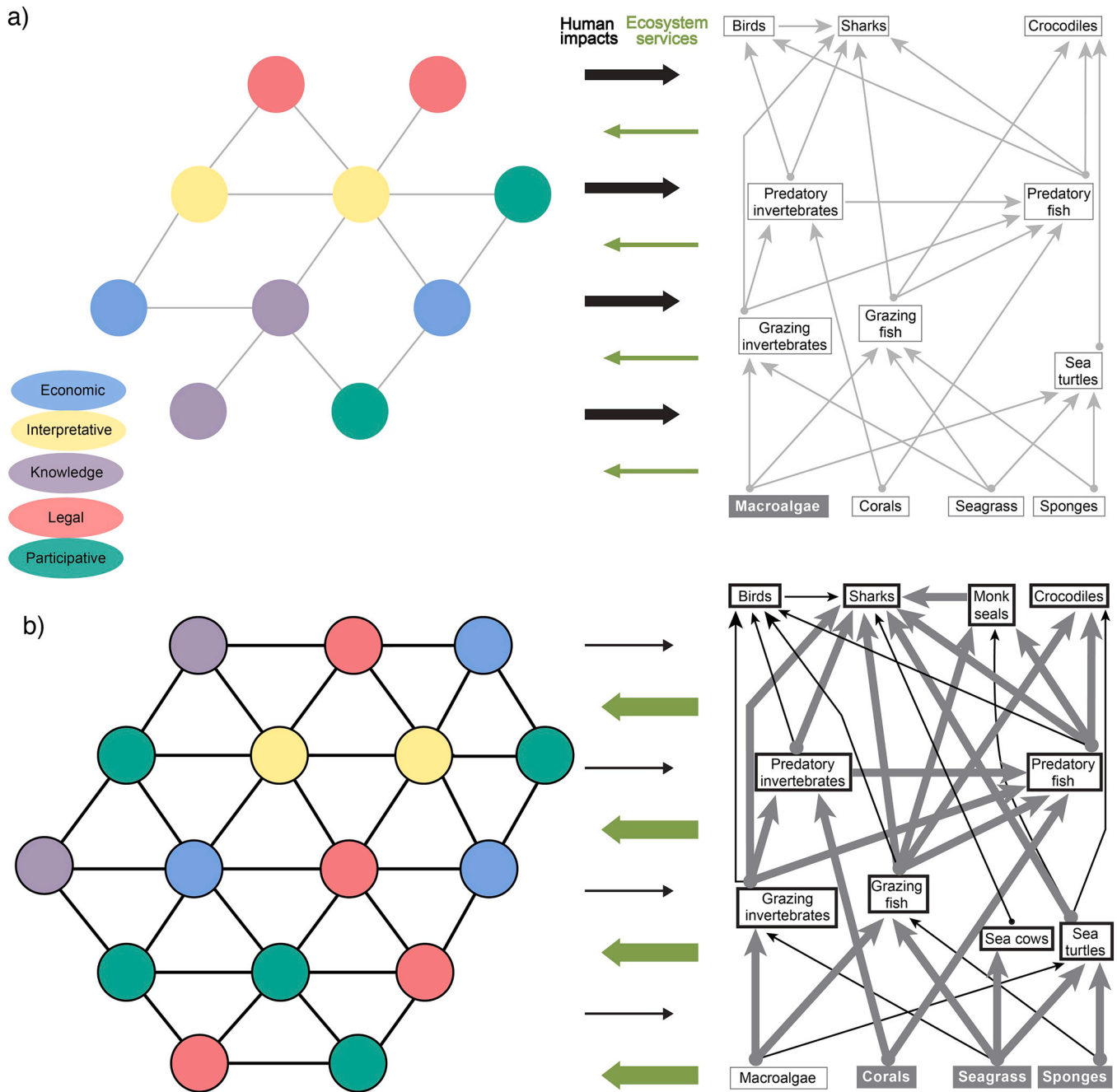
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Fig. 2. Coevolutionary interactions and feedbacks between governance/social systems (left) and ecosystems (right). If the MPA governance framework lacks strong and diverse incentives and is thereby less effective in reducing the impacts of human uses, these impacts will reduce the diversity, health and resilience of the MPA's ecosystem, which in turn reduces the flow of ecosystem services to the MPA's social system, reducing its wellbeing and resilience (a). If the MPA governance framework is augmented by strengthening and introducing incentives and is thereby more effective in reducing the impacts of human uses, the MPA's ecosystem should begin recovering. After several years the diversity, health and resilience of the ecosystem should become sufficiently restored to increase the flow of ecosystem services (e.g. food provisioning, coastal defence and tourism benefits associated with healthy diverse seas) to the MPA's social system, in turn increasing its wellbeing and resilience (b). The social and ecological systems thereby have the potential to coevolve in an upward or downward spiral, as impacts on ecosystems reduce and the flow of ecosystem services increases, or as impacts increase and the flow of services is reduced.
Trophic web adapted from Jackson et al. [31] with permission from AAAS.

actors. This can then lead to users driving the strengthening or introduction of incentives, further increasing effectiveness.

Both social and ecological systems can thus build mutual and complementary resilience through their increased institutional and ecological diversity respectively, as well as through the coevolutionary feedbacks of reduced impacts and increased ecosystem service provision (Fig. 2). The coevolutionary governance concept thereby draws on the inter-related concepts of coevolutionary development [27], complex

adaptive systems [28,29] and ecosystem services [30], whilst building on Ostrom's social-ecological systems concept [18], in its recognition of synecology interactions within and between social and ecological systems.

2.2.2. A multi-level governance context

The coevolutionary governance concept also builds on the political science concept of multi-level governance (MLG) [33]. Two types of

multi-level governance (MLG) are recognised: Type I, in which jurisdictions tend to operate at a limited number of levels, be more rigid in their state-prescribed structure and more general-purpose; and Type II, in which jurisdictions tend to operate at various scales, be more flexible in their emergent structure and be more task-specific. These are not mutually exclusive models, as Type II jurisdictions are often considered to be nested amongst Type I jurisdictions (see further discussion in Supplementary Material). This MLG concept provides a hierarchical structure as wider context for the coevolutionary governance model. MPAs are invariably Type II MLG initiatives embedded within a Type I MLG sectoral hierarchies, being both vertically upwardly connected to the hierarchical structure *and* downwardly contextualised and embedded in local communities (Fig. 3).

This concept is considered as coevolutionary governance in a horizontal sense as different sectoral policies (biodiversity conservation, fisheries management, land-based pollution control, coastal developments, etc.), will need some degree of horizontal integration through cross-jurisdictional coordination. These sectoral policies should coevolve through their interactions with each other and related cross-sectoral adaptations. It is considered as coevolutionary governance in a vertical sense as institutions at all levels interact with each other and adapt accordingly. Higher level institutions are embedded in lower local levels through downward vertical connections – including collaborative platforms, performance standards, targets, obligations and related conditions – through flexible 'negotiated compliance' [34; p93–94] and adaptive and reflexive laws. These serve to sensitively contextualise standards, targets, obligations and/or conditions amongst communities. In turn, bottom-up institutions are embedded in higher levels through upward vertical connections. This includes the capacity for 'institutional learning' [34; p93–94], where experiences of negotiated compliance and the perspectives of local communities are drawn on at higher levels through feedback. This allows the adaption of standards, targets,

obligations and/or conditions on a 'learning by doing' basis, tailored to particular community contexts.

2.2.3. A 'shadow of hierarchy' perspective

The coevolutionary governance model thereby rejects the 'command-and-control' approach inherent in top-down hierarchies, through which a monocentric state attempts to directly control users of natural resources, because of the risks of imposition [1; p80–81] raised by such purely top-down approaches. However, it also recognises that some degree and form of state coordination and even control is often necessary. This oversight, or steer, ensures wider-scale, longer-term strategic societal objectives are achieved, whilst mitigating the risks of localism [1; p82–83]. When the insights yielded from this concept are recognised, the inherent challenge of environmental governance can be addressed, i. e. that problems of any complexity defy centralisation but that decentralisation can undermine the integration required to strategically address wider-scale, interconnected challenges [34; p93–94]. Instead of relying on faith in vertical and horizontal linkages, the coevolutionary governance concept suggests that some top-down steer and coordination, e.g. through standards, targets, obligations and/or conditions, is often necessary to effectively and equitably achieve strategic societal objectives. Accordingly, the state sets the standards, targets, obligations and/or conditions necessary to fulfil strategic societal objectives. Responsibility is then decentralised to achieve these at more local levels through negotiated compliance, with oversight and steer from the state. This is coupled with feedback from the bottom-up, through institutional learning to influence the setting of these standards, targets, etc.

This is consistent with the concept of governance 'in the shadow of hierarchy' [35], whereby the state is still considered to be a key actor that actually continues to play a crucial role in governance. This is contrary to the view amongst many governance analysts that governance by the state has been replaced by networked polycentric
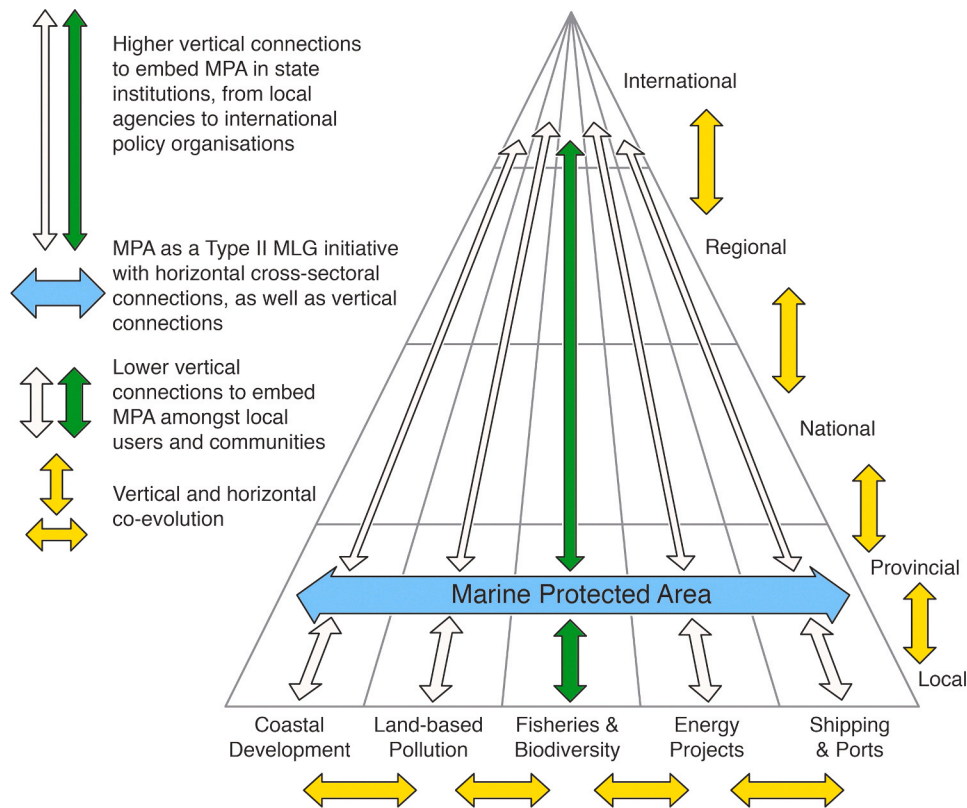

Fig. 3. Coevolutionary perspective on an MPA as a Type II multilevel governance (MLG) initiative embedded within a Type I MLG sectoral hierarchy. The vertical connections related to fisheries and biodiversity governance are more prominent as this sector is particularly important for MPAs, though horizontal coevolutionary connections with other sectoral policies are also important.

governance amongst civil society actors and organisations. Rather than retreating, having been hollowed out, or replaced by networks, states are considered to have been repositioned and/or reconfigured, continuing to provide steer in order to achieve strategic societal objectives [36; p71–114]. Rather than primarily attempting state steer through direct command and control, states have adapted their roles to provide governance steer through persuasion, partnerships, markets, communities and associations, which complement, or replace, direct regulation. Increasingly the state relies primarily on indirect steer by various means such as: setting standards and targets; establishing obligations; and attaching conditions to property rights and decentralisation, which amount to negotiated compliance. The state ultimately retains the right to withdraw such property rights and decentralised authority, and revert to direct state control or other governance approaches if these standards, targets, obligations and/or conditions are not fulfilled.

There has been a resurgence of interest in the argument that the state has adapted its role to providing steer through coalitions with various non-state actors 'in the shadow of hierarchy', e.g. [36; p71–114]. This concept was previously explored by Héritier, et al. [37] and the term was first used by Whitehead [35], based on previous discussions by Scharpf [38]. Interestingly, Ostrom [39; p110, 112, 119, and Note 21] had previously recognised that successful negotiations could be encouraged by the "shadow of court", based on Mnookin, et al. [40] discussions on "Bargaining in the Shadow of Law: the case of divorce". The concept of governance in the shadow of hierarchy has thus clearly long been recognised, including by Elinor Ostrom. Recently, it has been attracting growing interest, consistent with a resurgence of interest in the important and evolving role of the state in governance, including in this context of coevolutionary governance. Relating the shadow of hierarchy concept to MLG (Fig. 3), top-down strategic programmes such as MPA networks and related individual MPAs are contextualised, i.e. negotiated through the local web of relations and embedded in a given place, in order to adapt them to and integrate them into the local context [41]. However, they still also remain embedded in the hierarchical structure from which they derived, i.e. in the shadow of hierarchy, with negotiated compliance being 'encouraged' by the setting of standards, targets, obligations and/or conditions. States retain the option to withdraw property rights and decentralised authority, and revert to centralised control if these are not fulfilled, i.e. recourse to recentralisation.

Coevolutionary governance in the shadow of hierarchy is subject to both the accountability of local initiatives to the state that strategic objectives, conditions, etc. are being fulfilled, and the accountability of the state to locals that institutional learnings from the bottom-up are being taken into account to adapt higher level institutions and decisions. Local people and related initiatives in a given place are thereby not considered as mere subjects of state control, as they can influence higher level decisions through institutional learning, including having a democratic role in establishing strategic societal objectives and related standards, targets, obligations and/or conditions. Nor are local people and related initiatives considered self-governing or semi-autonomous, as decentralisation to them is conditional on specified obligations, conditions, etc. being fulfilled, in order to provide for both effectiveness and equity, but how these are fulfilled is negotiable. Similarly, the state is not considered to need to confine its role solely to either being a passive facilitator of bottom-up approaches or a monocentric controller of top-down approaches. Instead, top-down and bottom-up approaches are combined and integrated through decentralisation in the shadow of hierarchy.

2.2.4. Synergising top-down and bottom-up approaches

The coevolutionary governance concept thereby provides for a more symmetrical understanding of governance frameworks, recognising that both top-down and bottom-up approaches have their respective strengths (Table 1). These strengths are often associated with corresponding weaknesses, which are explored in more detail in the

Table 1

Corresponding strengths of top-down and bottom-up approaches related to nine key dimensions of MPA governance.

Bottom-up		Top-Down
Responsive to local-scale ecological and human complexity	Scale	Coordination allows ecological and human processes to be addressed at the various scales at which they act, including wider scales
Context specific, locally agreed	Objectives	Harmonised at regionally, nationally or internationally agreed wider network scale
Buy-in through local engagement in initiation, design and implementation	Participation	Reduced risk of tyranny of localism, marginalisation of some groups and elite capture. Represents wider societal stakeholders beyond the locality
Local participation promotes understanding and involvement, facilitating transparency and sense of direct accountability	Transparency and accountability	Legal basis to state and local actors' transparency and accountability requirements, provides recourse for disaffected/marginalised people
Draws on local ecological knowledge (LEK), customs and beliefs	Knowledge	Access to data and scientific resources, to inform and monitor. Knowledge can be developed and shared at wider scales
Users directly responsible for equitably managing resource use	Equity	Provides for resources to be managed to the benefit of wider society; reduces risks of capture by local elites and tyranny of localism
Local stewardship, customary practices and peer enforcement can cost-effectively promote cooperation	Enforcement	Legal deterrents applied by agencies with the capability and separation to enforce fairly and consistently, including on incoming users. Not reliant on locally cohesive communities and cooperation amongst them
Values local and traditional resource uses to generate sustainable income and livelihoods	Resource development	State protection against excess development or exploitation by incomers, other state sectors, corporate interests or local elites
Potential for low-cost, sustainable, self-supporting funding, not affected by government policy/strategy	Funding	Substantial, stable, long-term funding able to make capital investments, promote long-term strategic approach and support operating costs

Supplementary Material (Supplementary Material Table 3). These support the argument that top-down and bottom-up approaches need to be combined, this being the essence of the co-management concept, whereby state and local actors work on a partnership basis. It is widely recognised in applied environmental governance in general, and MPA governance more specifically, that governance should combine top-down and bottom-up approaches [42] through co-management partnerships between the state and stakeholders that provide for the participation of people affected by MPA decisions to collaborate in reaching and implementing them [43]. Exploring this principle in more detail, Table 1 and Supplementary Material Table 3 indicate that top-down and bottom-up approaches have strengths and corresponding weaknesses related to different elements of governance. The coevolutionary governance concept recognises that top-down and bottom-up approaches need to be integrated in such a way that they coevolve, along with related market, collective learning and communication approaches, providing for synergies, where the strengths of one approach counters the weaknesses of the other.

Taking a coevolutionary perspective in the context of a multi-level

governance framework provides for a wider analysis of how various governance approaches coevolve. This includes how top-down and bottom-up approaches coevolve through their interactions, including 'hard-wired' legal connections through obligations and conditions associated with decentralisation, as well as informal vertical and horizontal linkages, within which coevolutionary MLG frameworks remain embedded. By contrast, taking a polycentric perspective through the SES framework, from which it is assumed that governance frameworks and related informal vertical and horizontal linkages will evolve from the bottom-up, with top-down state involvement being critically considered to represent inappropriate interference, neglects the importance of these interactions and thus sees only half of the wider coevolutionary picture. The importance of seeing the bigger picture of coevolutionary governance in which the state is involved in various ways, along with local actors and other governance approaches, was the reason the coevolutionary governance concept was developed.

The coevolutionary governance model thereby allows for a combination of top-down and bottom-up approaches. The concept of coevolutionary governance interpreted as a form of multi-level governance addresses the dilemma of whether governance frameworks should be: either, built from the bottom-up through self-governance, as the polycentric concept considers they should be, i.e. nested in higher level institutions but not subject to state interference by them; or, from the top-down through state imposition, as the now rejected monocentric concept considers they should be.

Instead, institutions coevolve through the interaction of top-down and bottom-up processes and influences. As such, it is argued that the coevolutionary governance concept recognises the need to combine top-down and bottom-up governance approaches, and thus provides a more realistic concept for analysing different ways of integrating top-down and bottom-up governance approaches, thereby being more appropriate for *realist* institutional analyses. This recognition that the 'structure' of higher level, wider-scale institutions (including state institutions) and the 'agency' of local people (including private interests) for self-governance can coevolve is consistent with the environmental sociology theory of structuration [44]. It is also consistent with the recognition by McCay [45] that whilst people are influenced by the structures in which they are embedded, they can also influence and alter these structures.

In summary, the coevolutionary governance model provides a conceptual understanding of how within an MPA's governance framework, regulators, users and communities interact to collectively employ incentives. Drawing on multi-level governance theory, it recognises that coordination and control is invariably exerted at multiple nested levels, rejecting binary top-down versus bottom up simplification. It describes how a governance framework, specifically the relationship between actors and the linkages between incentives, is analogous to an ecosystem, where resilience arises from diversity and complexity. This governance system is linked by feedbacks with the marine ecosystem in question. The effectiveness of that governance therefore determines the health of that ecosystem and the flow of ecosystem services. Insight can be gained from considering this model on a purely conceptual basis, but the greatest and most directly applicable insights are gained by using this model as a lens through which to consider real-world case studies of MPA governance, such as those presented in this special issue. In order to assess the effectiveness of governance in a given MPA, one must understand the context, driving forces, actors and the incentives they collectively apply. This is what the MPAG framework and the methodology described below is designed to elucidate.

3. MPAG framework methodology

3.1. MPAG background and rationale

The MPAG framework was originally described by Jones [1,46] and was initially developed through a workshop at the International Marine Protected Area Conference (IMPAC2) in May, 2009. This led to the selection of 20 MPAG case studies to explore and further develop the framework, including a workshop for case study providers in October 2009, funded by the United Nations Environment Programme (UNEP). By design, the framework intends to offer a structured, replicable approach to present and analyse empirical data on the governance of MPAs, allowing a critical assessment of the effectiveness and equity of governance in different MPA contexts. It is proposed that the framework is readily adaptable and can be used to critically analyse the governance of marine resource (or indeed terrestrial resources), beyond MPAs. In this issue, it is worth noting that the Greenland Halibut Fishery case study (#27) employs the MPAG framework to critically analyse the governance of a fishery rather than an MPA. This is premised on the fact that this fishery, as with many others, operates in a discrete area with both environmental and economic objectives, in common with MPAs. It also allows insights to be drawn into the parallels between MPA and fishery governance. It is also worth noting that the case study on MPAs beyond national jurisdiction (#28), focuses on the policy framework that is currently being negotiated through the United Nations, allowing for the adaptation of the MPAG rationale to provide insights into the emerging governance model for high seas MPAs.

3.2. MPAG case study structure

The MPAG framework, the main elements of which are detailed in Supplementary Material Table 4, prescribes six headings, which provide a template for presenting the data and analysis: (i) Context; (ii) Objectives; (iii) Drivers and conflicts; (iv) Governance framework/approach; Incentives; (v) Effectiveness; and (vi) Cross cutting themes. This structure provides clarity in the analysis of each case study but more importantly allows ready comparisons between case studies. Additionally, it is expected that the methods of data collection and analysis will be briefly described, usually preceding these headings. Authors also often elect to include a conclusion, summarising the key findings and drawing comparisons with other MPAs.

3.2.1. Context

This section sets out the geopolitical, socio-economic and ecological context of the study site at national and, if feasible, regional and local scales. In order to establish a consistent approach to describe the national context and facilitate comparison between case studies, the following globally available national indicators are used: per capita GDP, GDP growth rate, proportion of the population below the poverty line, Human Development Index (HDI) [47] and state capacity score. The state capacity indicator is the mean of scores (-2.5 to $+2.5$) for six dimensions of governance (voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; control of corruption), calculated annually using an established methodology [48,49]. It is sometimes useful and informative to report comparative numbers for these metrics, such as the average in the wider geopolitical region. Further, these can and should be supplemented by additional metrics, where available and as the specifics of study site demands. For example, in some contexts the population growth rate would be pertinent, where a high rate of growth is driving pressure on marine resources. In-depth description of the local and regional context provides insights into the challenges and opportunities and introduces factors specific to that site. This is important as it influences where comparisons can and cannot be drawn between MPAG case studies.

3.2.2. Objectives

Here the stated objectives of the MPA are detailed. Usually these are defined by some legal or other formal instrument. Where the objectives are not formally documented or explicitly recognised this is an opportunity to discuss the implicit objectives including how these may vary between actors. It may be important to give due consideration to the

manner in which the objectives were developed, defined and operationalised. These are considered either as conservation objectives, focused on the protection of species, habitats and ecosystems, or operational objectives, focused on the means of achieving such protection.

3.2.3. Drivers and conflicts

An assessment of the current and emerging perturbing forces that may negatively impact the ecosystem through the impacts of human activities. The drivers are factors such as population growth, political prioritisation of rapid tourism development and needs for livelihoods and poverty alleviation. Conflicts are the related specific human activities that can impact conservation features, such as fishing, pollution, coastal development and impacts of tourist activities.

3.2.4. Governance framework/approach

A descriptive assessment of the MPA's governance approach, detailing the institutions and actors involved and the role they play. In most cases the governance approach can be characterised as being in one of four categories accord to the primary actor(s) responsible for governing the resource. These are: i) state governed; ii) decentralised to local institutions with state oversight; iii) governed by local communities; iv) governed by private sector entities and/or NGOs (Supplementary Material Table 5). The coevolutionary governance concept recognises that there is a spectrum, that these are not mutually exclusive and that the governance approach may lie between, or be nested within, one or more of these categories. This should be clearly detailed and discussed in this section.

3.2.5. Incentives

A key component of the MPAG framework is identification of the incentives adopted within the area being governed. The MPAG framework identifies 36 potential incentives from five categories (Table 2; see Supplementary Material, 3.4.1 Incentive Definitions). Each governance analysis not only identifies those incentives employed, but also highlights incentives that represent a particularly important priority for strengthening or introduction. The assessment that incentives require strengthening or introduction is made with reference to the drivers and conflicts, considering whether the incentives currently employed adequately address these by reducing impacts. This is also the underlying logic for the effectiveness score (3.1.5 Effectiveness).

Incentives do not work in isolation. A key consideration is therefore the extent to which one or more incentives are linked or mutually supporting. The diversity and strength of these linkages will determine whether the incentives employed are better than the sum of their parts. Incentives and the linkages between them can be visualised as a web. Fig. 4 is a hypothetical incentive web, where all 36 incentives are employed and each is linked directly to the 35 other incentives. Such a complete web would not be expected, in reality, as not all incentives are appropriate in any given MPA context and some do not necessarily link. However, it serves to demonstrate the complexity that is achieved in a governance framework with multiple incentives working collectively, yielding a resilient web of interacting incentives. Some case studies have included a diagrammatic representation of the linkages between incentives, where that is informative (e.g. case studies #7, #8 and #22, see Table 4 for case study details and citations). Where diagrammatic representation employs the template below (Fig. 4), the standardised web can be readily compared with other case studies. For example,

Table 2
The 36 incentives from five categories in the MPAG framework. From: [1].

| Category	Incentive	Associated governance approach (es)
Economic (10)	i1. Payments for ecosystem services	Market-based
	i2. Assigning property rights	
	i3. Reducing the leakage of benefits	
	i4. Promoting profitable and sustainable fisheries and tourism	
	i5. Promoting green marketing	
	i6. Promoting diversified and supplementary livelihoods	
	i7. Providing compensation	
	i8. Investing MPA income/funding in facilities for local communities	
	i9. Provision of state funding	
	i10. Provision of NGO, private sector and user fee funding	
Communication (3)	i11. Raising awareness	Supporting all three approaches
	i12. Promoting recognition of benefits	
	i13. Promoting recognition of regulations and restrictions	
Knowledge (3)	i14. Promoting collective learning	Supporting all three approaches
	i15. Agreeing approaches for addressing uncertainty	
	i16. Independent advice and arbitration	
Legal (10)	i17. Hierarchical obligations	Top-down (state steer)
	i18. Capacity for enforcement	
	i19. Penalties for deterrence	
	i20. Protection from incoming users	
	i21. Attaching conditions to use, property rights, decentralisation, etc.	
	i22. Cross-jurisdictional coordination	
	i23. Clear and consistent legal definitions	
	i24. Clarity concerning jurisdictional limitations	
	i25. Legal adjudication platforms	
	i26. Transparency, accountability and fairness	
Participation (10)	i27. Rules for participation	Bottom-up (people steer)
	i28. Establishing collaborative platforms	
	i29. Neutral facilitation	
	i30. Independent arbitration panels	
	i31. Decentralising responsibilities	
	i32. Peer enforcement	
	i33. Building trust and the capacity for cooperation	
	i34. Building linkages between relevant authorities and user representatives	
	i35. Building on local customs	
	i36. Potential to influence higher institutional levels	
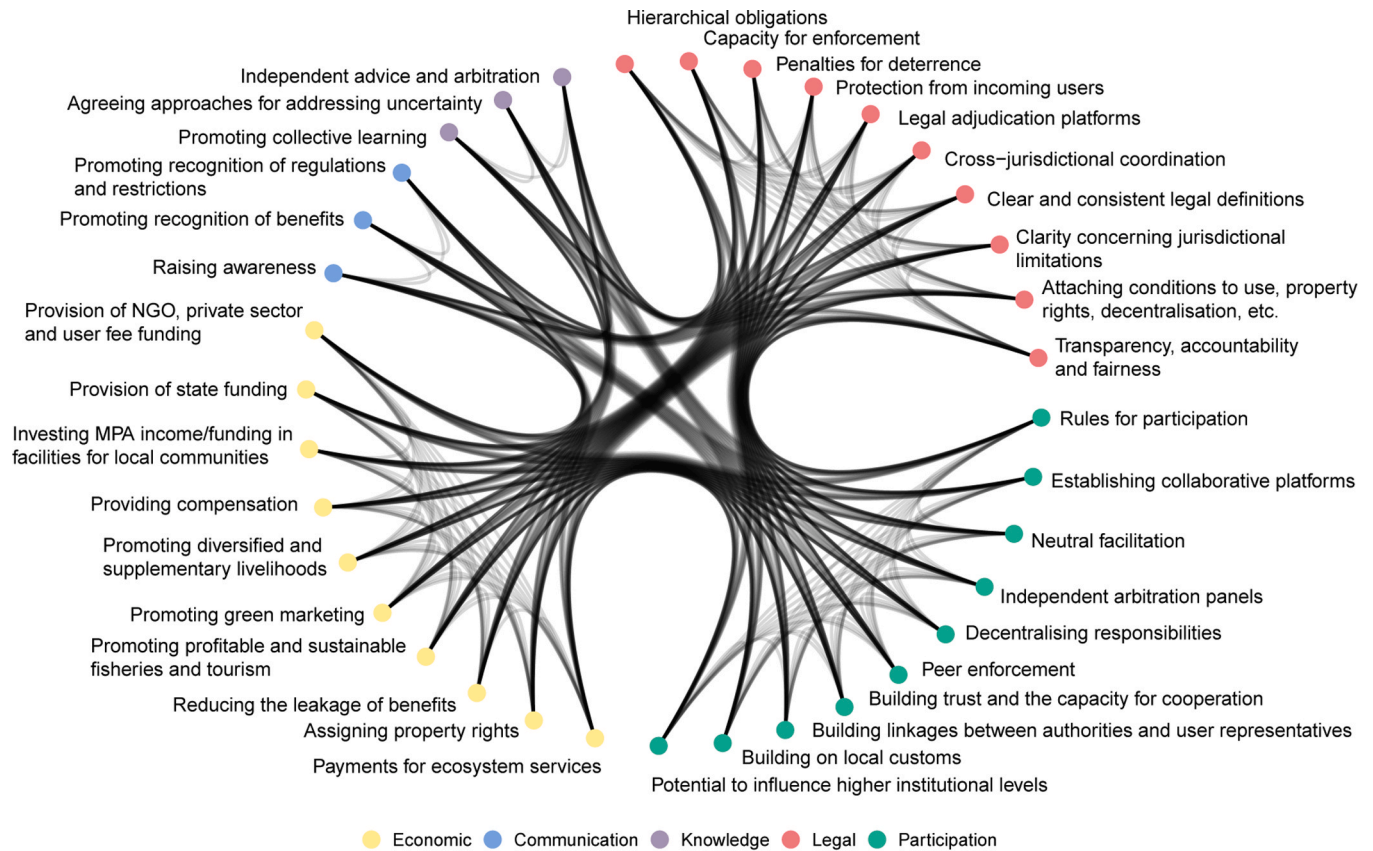
Fig. 4. Hypothetical full incentive web, where all 36 incentives are employed and maximally linked. Each incentive is represented by a coloured dot (according to category), grouped by category, and is detailed by black text. Linkages are shown by a line drawn between individual incentives indicating a functional connection between two incentives that materially impacts the governance. The line representing each linkage is constrained by a bottleneck for each category of incentives to visually differentiate the group of incentives that form each category. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3

MPAG framework effectiveness scores and associated qualitative descriptors (Adapted from: [1, p.104]).

Effectiveness scale (0–5) – assessment of the degree to which the impacts of different sectoral uses, related to basic conflicts that can undermine the fulfilment of objectives, have been effectively reduced/mitigated
0	No use impacts addressed; MPA designation may have increased impacts by undermining previous governance institutions
1	Some impacts beginning to be slightly addressed
2	Some impacts partly addressed but some impacts not yet addressed
3	Some impacts completely addressed, some are still only partly addressed
4	Most impacts addressed but some not completely
5	All impacts from local activities completely addressed

incentive webs for the Ningaloo Marine Park (#7) and Shark Bay Marine Park (#8), demonstrate their similarities in terms of the many (27 and 26 respectively) diverse incentives employed and the linkages between them.

The Incentives section is the primary source of actionable insight for managers. It highlights what is required to improve the effectiveness and equity of the governance framework, in terms of those incentives that particularly need strengthening or introduction and where linkages between incentives particularly need to be established or strengthened.

3.2.6. Effectiveness

The MPAG framework, assesses governance effectiveness on a scale of zero (wholly ineffective) to five (wholly effective) (Table 3). Each score is associated with a qualitative description of the extent to which the incentives applied address the impacts of the drivers and conflicts

identified.

3.2.7. Cross-cutting themes

This section provides an opportunity to highlight themes identified in the data and should be discursive. The sub-headings here should reflect the issues within that specific case study but these are often recurrent, examples include equity issues and the roles of NGOs, political will and leadership (Supplementary Material Table 9).

3.3. Data collection and analysis

The MPAG framework is deliberately not prescriptive about the methods of data collection. This will be determined by a combination of factors including: data availability; existing literature; study site accessibility; the willingness of actors to participate and the appropriateness of their participation given research ethics considerations; resource constraints and importantly the skills and preference of the researcher (s). Fundamentally, researchers should employ a range of complementary methods and sources to ensure that a holistic understanding is developed, over-reliance on one form or source of data risks introducing an unfair bias. Obviously, there are clear advantages to extended data collection in the field but, depending on the availability of existing data and potential to gather data remotely, this may not be essential and/or feasible. It is important that researchers are aware of and recognise the limitations of the data collection approach used. All 28 of the case studies presented in this special issue draw on field data, this being essential for inclusion in the sample of MPAG case studies.

To date, primary data collection ethnographic methods employed include: semi-structured interviews, structured questionnaires, focus

Table 4

The MPAG case studies in this issue. Note only 27 (#1–27) are illustrated here, as one of the case studies (#28) [2] focuses on the emerging governance approach to high seas MPAs in general, rather than being focused on a specific geographical area.

#	Name	Est.	Marine Area (km²)	Country	Governance Type	Equivalent IUCN Category	Incentives Employed (require strengthening)	Needed	Effectiveness score	Ref.
1.	Lyme Bay MPA	2008	275	UK	Government-led	IV	27 (7)	0	3	[54]
2.	Port-Cros National Park	1963	26[a]	France	Decentralised	II	18 (4)	7	[b]	[55]
3.	Tavolara Punta-Coda Cavallo MPA	1997	154	Italy	Government-led	II	16 (3)	6	2	[55]
4.	Ustica Island MPA	1986	159	Italy	Government-led	II	16 (2)	5	2	[55]
5.	Cabo de Palos-Islas Hormigas MPA	1995	19.3	Spain	Decentralised	VI	17 (7)	13	3	[56]
6.	Cabo de de Gata-Níjar MPA	1995	120	Spain	Government-led	V	11 (5)	20	2	[56]
7.	Ningaloo Marine Park	1987	2633	Australia	Government-led	II	27 (10)	0	3	[57]
8.	Shark Bay Marine Park	1990	7487	Australia	Government-led	II	26 (6)	0	3	[57]
9.	Bacalar Chico Marine Reserve	1996	64	Belize	Government-led	IV	8 (5)	11	1	[58]
10.	Hol Chan Marine Reserve	1987	15	Belize	Decentralised	II	16 (6)	8	2	[58]
11.	Caye Caulker Marine Reserve	1998	39	Belize	Government-led	VI	9 (4)	16	1	[58]
12.	La Chorrera-Manchón Guamuchal Private Reserve	1998	12.4	Guatemala	Private sector and/or NGO led	V	14 (5)	6	3	[59]
13.	Monterrico Multiple use Area	1977	28	Guatemala	Decentralised	VI	12 (12)	13	1	[59]
14.	Punta de Manabique Wildlife Refuge	1990	1519	Guatemala	Decentralised[c]	IV	20 (15)	4	2	[60]
15.	Isla Lobos de Tierra Reserve	2009	183	Peru	Decentralised	VI	11 (11)	14	1	[61]
16.	Isla Lobos de Afuera Reserve	2009	83	Peru	Decentralised	VI	12 (12)	13	1	[61]
17.	Anhatomirim Environmental Protected Area	1992	47.3	Brazil	Government-led	V	30 (10)	1	–	[62]
18.	Cu Lao Cham MPA	2005	235	Vietnam	Decentralised	II	26 (23)	3	–	[63]
19.	Nha Trang Bay MPA	2001	160	Vietnam	Decentralised	II	20 (19)	7	0	[63]
20.	Con Dao National Park	1993	150	Vietnam	Decentralised	II	21 (19)	4	1	[64]
21.	Ankobohobo LMMA	2001		Madagascar	Community-based	VI	15 (11)	5	1	[65]
22.	Sainte Luce LMMA	2013	160	Madagascar	Community-based	VI	24 (17)	6	1	[66]
23.	Soufriere Marine Management Area	1994	110	St Lucia	Decentralised	II	25 (13)	3	2	[67]
24.	Curieuse Marine National Park	1979	1370	Seychelles	Government-led	II	11 (8)	10	[d]	[68]
25.	Saint Ann Marine National Park	1973	1073	Seychelles	Government-led	II	13 (13)	9	1	[69]
26.	Nusa Penida District Marine Conservation Area	2014	20	Indonesia	Government-led	VI	21 (11)	2	2	[70]
27.	Greenland Halibut Fishery	[d]	15000	Greenland	Government led	n/a	25 (7)	0	2	[14]

[a] Plus a 123 km² buffer.
[b] The recent extension of Port-Cros National Park makes it inappropriate to assess overall effectiveness.
[c] Up to 2011 management responsibility was held by the Fundación Mario Dary Rivera (Fundary, a domestic NGO). Subsequently under government control with some decentralisation.
[d] No effectiveness score given.

groups, participatory mapping and participant/non-participant observation. Secondary data has been obtained from various sources including: NGO reports, government documents, academic papers, social and other media, existing ecological and/or socio-economic datasets and remote sensing data. All MPAG case studies, including those in this issue, have included semi-structured interviews because this is often the best, and sometimes only, way to capture detailed nuanced knowledge and the perspectives of actors.

Key considerations when planning semi-structured interviews are the sampling methodology, sample size, translation, obtaining informed consent and selecting a suitable venue. Typically, anonymity is guaranteed to interviewees as this ensures they can answer fully and in

confidence, whilst affording them protection. The semi-structure is designed to elicit responses that can be interpreted to populate the MPAG framework structure (2.1 Case study structure) and ensure that the same topics are explored with different interviewees to capture the full range of typical perspectives. The advantage of a semi-structured approach is that it allows the interviewer to delve deeply into complex areas and is sufficiently unrestricted that important subjects can emerge that were not anticipated at the outset of the research [50,51]. Importantly, it avoids a formulaic interaction, where the interviewer asks predetermined questions that the interviewee may not have any relevant knowledge, perspective or interest in. In summary, the approach intends to fit Eyles's [52] characterisation of semi-structured interviews as, "*a*

conversation with a [research] purpose".

The volume and nature of the data collected will determine the analytical approaches required. These studies will always require careful qualitative analysis, for example open-coding of the semi-structured interview data. The aim here is to collate insights into the governance approach, identify emergent themes, recognise where there is a agreement and highlight divergent perspectives. Some studies have used qualitative data analysis (QDA) computer software, such as NVivo [53], to code the data (#27). For example, text can be given an incentive specific code where it provides evidence pertaining to the 36 potential incentives. Additional codes are introduced as key issues or themes emerge. This is particularly helpful where the volume of data is considerable. Quantitative approaches that have been employed include summary statistics, graphical analysis and linear modelling. Spatial data is typically presented and analysed using a geographic information system (GIS) to produce informative maps.

4. Results/Discussion

4.1. Overview of case studies

Whilst the individual details of each MPA case study hold insights applicable locally, it is perhaps in recognising the trends and commonalities across studies that we can observe trends and learn lessons with the widest applications. This section will first overview the case studies, then consider some features related to each category of incentives, before considering the trends across all incentives and then finally considering how the 28 case studies illustrate some interesting themes related to the concept of coevolutionary governance.

An overview of the 28 case studies is provided by Table 4, with Fig. 5 providing a summary of the incentives employed in each case study. There was no systematic selection of the case studies, they arose independently and opportunistically, resulting in a sample that is not purposive, in that only certain sorts of MPA are selected, and thereby

approximates randomness. Reflecting MPAs globally, these case study sites therefore exhibit considerably diversity in terms of age, location, size, governance type and IUCN Category (Table 4).

Notably, there are no IUCN Category I (Strictly protected or Wilderness) areas, perhaps reflecting their relative rarity amongst MPAs, no-take areas in MPAs (if there are any) tending to be zones that may not correspond to the overall categorisation. Consequently, in all case studies the governance framework and management decisions are designed to balance both conservation *and* economic objectives, with inevitable trade-offs. The ubiquity of this challenge may explain why, in terms of effectiveness, many of these case studies perform poorly. This is evident from the relatively low effectiveness scores. Out of a maximum score of 5 for effectiveness, the average score was just 1.7 across the 27 case studies. Further, there was an absence of any high scores (≥ 4) in any of the case studies (See, Effectiveness 3.2.6 and Table 4).

4.2. Trends within categories of incentives

4.2.1. Key trends in economic incentives

To be sustainable, marine governance frameworks must meet the costs associated with management and protect the economic viability of associated communities. It is particularly striking to note that *payments for ecosystem services* (i1) were not employed in any case study and only identified as being particularly needed in one (#24). Despite wide interest in the literature regarding the potential of such market-based approaches to mitigate climate change and fund MPAs (through blue carbon schemes) [71,72], uptake in the marine realm remains in its infancy. Similarly, *providing compensation* (i7) and *assigning property rights* (i2) were employed very infrequently, in just two and four case studies respectively, *assigning property rights* (i2) more frequently being cited as in need of strengthening (three case studies) and introducing (two case studies). Conversely, the *promotion of profitable and sustainable fishing and tourism* (i4) is frequently employed, this perhaps being because it is a more assessable and immediately appropriate incentive in

Fig. 5. Matrix showing the incentives that are employed, employed but requiring strengthening and in need of introduction, in the 27 site specific MPAG framework case studies (#1–27).

many contexts, building on existing infrastructure and established businesses or livelihoods, and crucially providing opportunities. However, whilst frequently employed, this is rarely effectively achieved, this incentive being identified as particularly requiring strengthening in 19 of the 22 case studies that use it (Fig. 5). One exception is the Lyme Bay MPA (#1), where a ban on towed demersal gear (predominantly targeting scallops), has resulted in a switch to lower impact static gears and scallop diving, allowing recovery of benthic habitats along with the promotion of both sustainable static fishing methods and marine wildlife tourism.

4.2.2. Key trends in communication incentives

Encouragingly, the communication category is the most populated category in Fig. 5. This is no surprise given that communication is usually comparatively inexpensive and is essential to ensure that all actors are informed of the need for, and benefits of, conservation. It is therefore not surprising that 7 case studies (#1 #3 #4 #7 #8 #10 #26) employ all three communication incentives (i11–i13). Indeed, the majority of the other case studies identify all three communication incentives as being used or needed (Fig. 5, Supplementary Material Table 4). This indicates the importance of all three of these communication incentives in all MPAs, given their low cost and necessity.

More specifically, the case studies demonstrate that *raising awareness* (i11) is best achieved using a suite of communication approaches, tailored to different audiences – a simple and widely applicable lesson. For example, in the Greenland Halibut Fishery (#27), researchers produced an online game – 'Tricky Trawling' – to teach children about sustainable fishing and benthic habitats in Greenland, drawing on ongoing research [73]. In the Nusa Penida District Marine Conservation Area (#26), interviewees recalled a comprehensive programme of multi-actor village meetings, providing an opportunity for *awareness-raising on the importance of effective conservation* (i11) alongside *promoting awareness of the benefits of such conservation* (i12) and *of the regulations and restrictions* (i13) that should be followed to achieve these benefits.

4.2.3. Key trends in knowledge incentives

Managing uncertainty is inherently challenging, so it is not surprising that *agreeing approaches for addressing uncertainty* (i15) stands out in this category, in that it is rarely employed and usually with only limited success. This may be because it represents the sort of 'fine tuning' of the incentives framework that most case studies have not yet progressed to. Perhaps more surprisingly though, is that it was not identified as needed in the majority of case studies in which it was not used. On consideration, it may be that this represents an oversight on the part of both managers and MPAG researchers, whose attention is focussed on more immediate and important governance challenges. However, uncertainty is inevitable, not least associated with the impacts of anthropogenic climate change. The long-term sustainability of any governance framework will depend on the ability to respond to changes and this should arguably be considered at the design and implementation phase. Whilst more immediately important governance priorities often prevail, in some cases foresight has been used to address uncertainty through this incentive. For example, in the Anhatomirim Environmental Protected Area (#17), uncertainty around bycatch and mitigation was addressed through collective research undertaken on the understanding that this would inform future regulation. Shark Bay Marine Park (#8) is particularly notable in being the only case study to explicitly require a precautionary approach where evidence of impacts of ecotourism activities on whale sharks is difficult to obtain and interpret.

4.2.4. Key trends in legal incentives

The most striking column in Fig. 5, is that for capacity for enforcement (i18), where without exception this is found to require strengthening or introduction. The ability to adequately enforce regulations, be they legal or collectively agreed, is a basic requirement for managing

resources and yet it is consistently not met. Where governance is decentralised or community-based, this capacity is often sought (e.g. #2, #21 and #22) from the related incentive of peer enforcement (i32). Whilst seemingly attractive, the reality is complex, with issues around social capital, intra-community relationships and power structures, often in contexts where poverty makes infraction a necessity for some. In many cases, if peers are to have the capacity for enforcement, this requires the endorsement and potential for back-up intervention by the state, which can be hampered by a lack of resources (#21) and/or political will (#11, #18–20 and #23). The need for support with peer enforcement from a state with limited capacity is a lesson learnt and being tentatively applied in the Sainte Luce locally managed marine area (LMMA, #21), where capacity-building efforts include promoting state enforcement capacity (i18) by the fisheries authority to support and back-up peer enforcement (i32).

Meanwhile, elsewhere in MPAs governed by the state (e.g. #24), the large spatial scales and limited resources account for the weakness in *enforcement capacity* (i18). Potential solutions include cross-jurisdictional coordination (i22) between different authorities operating in an MPA to maximise enforcement, as seen in Lyme Bay (#1). Additionally, technology is increasingly offering a pathway to a 'virtual' presence on the water, with remote sensing, satellite vessel monitoring systems (VMS) and smartphone 'iVMS' allowing fleets to be tracked. The challenges and emerging solution around capacity for enforcement all reinforce a recurrent lesson from MPAG studies: resilient governance is achieved through a diversity of interacting incentives [1,74].

Cross-jurisdictional co-ordination (i22) is another incentive that requires strengthening or introduction in every case study bar one. This speaks to the fundamental ecological properties of marine ecosystems and their wide-scale connectivity and associated threats, which defy place-based or sectorally-focussed management. This is compounded by complex and increasingly globalised socio-economic systems, which influence MPAs but fall outside of their jurisdiction. The case studies repeatedly demonstrate the need for cross-jurisdictional co-ordination at multiple spatial scales, whether that is between community groups (#21), regions (#2–4), bi-laterally, or internationally as in the case of the governance of areas beyond national jurisdiction (ABNJ) (#28).

4.2.5. Key trends in participation incentives

The nature and opportunities for participation vary considerably between MPAs according to the governance type, from state-led to community-based approaches. The use of *collaborative platforms* (i28) is broadly applicable and was either employed or needed in all case studies. Where used, collaborative platforms ranged from multi-stakeholder working groups (#1–3, #17) to advisory groups representing different user sectors (#8). For example, the Fisheries Council is widely seen as an effective collaborative platform in Greenland (#27). Established by law, the Fisheries Council must be consulted on all matter of fisheries policy (e.g. setting quotas, spatial management); the voting members represent the industry and individual fishers, whilst non-voting attendees include Ministries, NGOs and scientific institutions. Such platforms are a simple and visible incentive, promoting participation and engendering a sense of representation. Providing that, as in the Greenland example, these platforms have adequate influence on outcomes, they are a valuable and replicable tool.

4.3. Trends across all incentives

Looking across all 36 incentives for all 27 case studies (excluding #28 as not a specific case study), Table 5 indicates some particularly interesting trends, this data being reported in more detail in Supplementary Material Table 10.

The case studies collectively used 491 incentives, with an average of 18.2 incentives used in each case study, a slim majority (Y* 265–54%) of which needed strengthening across all 27 case studies, with an average of 9.8 incentives in need of strengthening in each case study. The case

Table 5

Summary of incentive usage in the 27 case studies (#1–27) from a potential 36 incentives in 5 categories (cat.): Economic (Eco.), Communication (Com.), Knowledge (Kno.), Legal (Leg.) and Participation (Par.). The total numbers of incentives used, needed and used or needed in each category are detailed, along with the mean per case study and a rate. The rates are a measure of the rate at which the incentives in each category are used, needed or used + needed. For example, a zero for used rate would indicate that no incentives in that category were used in any case study, whilst a rate of one would indicate that all incentives in that category were used in all case studies.

Usage		Calculation	Incentives					
			Eco.	Com.	Kno.	Leg.	Par.	All
Used								
	Employed	Y	41	36	21	68	60	226
	Employed needs strengthening	Y*	79	34	15	79	58	265
	Used	=Y+Y*	120	70	36	147	118	491
	Mean used	=(Y+Y*)/27	4.4	2.6	1.3	5.4	4.4	18.2
	Used rate	=mean/no in cat.	0.44	0.86	0.44	0.54	0.44	0.51
Needed								
	Needed	N*	45	7	18	66	50	186
	Mean needed	=N*/27	1.7	0.3	0.7	2.4	1.9	6.9
	Needed rate	=mean/no in cat.	0.17	0.09	0.22	0.24	0.19	0.19
Used + Needed								
	Used or Needed	=Y+Y*+N*	165	77	54	213	168	677
	Mean used or needed	=(Y+Y*+*N)/27	6.1	2.9	2.0	7.9	6.2	25.1
	Rate used or needed	=mean/no in cat.	0.61	0.95	0.67	0.79	0.62	0.70

studies collectively needed 186 incentives introducing, with an average of 6.9 incentives in need of introducing in each case study. These figures indicate that most case studies lack both a sufficient diversity of incentives and that the majority of incentives used need strengthening, which explains the fairly low average effectiveness score of 1.7 out of a potential 5 (Table 3).

A common question when presenting or discussing the MPAG research findings is 'how many incentives does a typical MPA need?' The findings of these 27 case studies indicate that most MPAs use ~18 incentives but need an additional ~7 incentives, indicating that a given MPA should probably aim to have ~25 incentives in its governance framework, with the related proviso that even if these sorts of figures are achieved, it will still need to be ensured that the incentives are appropriate for the specific context of the MPA, have sufficient 'strength' and that they are integrated in a mutually supportive manner. Four incentives are cited as used or needed in all of the 27 case studies – *raising awareness* (i11: communication), *capacity for enforcement* (i18: legal), *cross-jurisdictional coordination* (i22: legal) and *establishing collaborative platforms* (i28: participation), so these could be considered as essential starting points for an MPA governance framework, representing three of the five categories of incentives and thereby a range of governance approaches. This makes practical sense, as for any MPA to be effective, there is a need for people to know why the marine area is of particular conservation importance, for the restrictions needed to protect it to be adequately enforced, for restrictions and related policies to be 'joined-up' across different sectors, and for people to be involved in decisions on what is protected and how. These could thereby be considered as basic building blocks that are common to all MPAs, around which an appropriate combination of another ~21 incentives should aim to be built.

Table 5 also reports the average use rate for each category of incentives, zero showing that no incentives in that category were used in any case study, one showing that all the incentives in that category were used in every case study. These rates show that communication incentives were most frequently utilised (0.86), whilst legal incentives were most frequently identified as being needed (0.24). This is consistent with the findings of a previous analysis of 20 MPAG case studies [74], which also found that communication incentives were most frequently cited as used whilst legal incentives were most frequently considered as needed. Again, this makes practical sense as the three communication incentives are almost universally required in all MPAs, as people need to understand why an area needs protecting (*Raising awareness* i11), what benefits are likely to flow from its protection (*Promoting recognition of benefits* i12) and what restrictions are in place to protect it (*Promoting recognition of regulations and restrictions* i13),

awareness being an essential prerequisite to participation, cooperation and compliance. Communication incentives also tend to be relatively inexpensive and easy to put in place, as well as being fundamentally important for participation and cooperation, hence it follows that they will be most frequently recognised as the most utilised category of incentives.

Legal incentives, on the other hand, can be challenging to put in place as they require state capacity and state support (i.e. political will), as well as support amongst users and other civil society actors. However, the need for them is widely appreciated, hence it follows that they will be most frequently recognised as the most needed category of incentives. For example, both the Ankobohobo (#21) and Sainte Luce (#22) LMMAs are community-based, with the participation incentive of *peer enforcement* (i32) playing a key role, but given the social challenges of relying solely on peer enforcement in these isolated subsistence communities, *state enforcement capacity* (i18) is identified as particularly in need of introducing (#21) and strengthening (#22), along with the strengthening of legal *penalties for deterrence* (i19). This demonstrates that even bottom-up MPAs identify such legal incentives as being particularly needed to ensure compliance, a lack of which can erode the capacity for cooperation, especially if persistent freeriders [39] who gain from non-cooperation are not caught (i18) and deterred (i19). Otherwise this can lead to a loss of trust and of confidence amongst actors that cooperation will be mutually reciprocated, i.e. a downward spiral of loss of trust, confidence, cooperation and compliance. Legal incentives are therefore always needed. No MPA, including 'bottom-up' LMMAs, can be effectively governed without the provision of some legal incentives by the state to address wide-scale driving forces such as increasing market demand, population growth and increasing effort from internal migration of fishers into the area.

Whilst communication incentives are *most* used and legal incentives are *most* needed, Table 5 also indicates that all categories of incentives are both used and needed to varying degrees, with a much more even spread of used and needed rates across the five categories of incentives. Whilst communication incentives have the highest used/needed rate (0.95), followed by legal incentives (0.79), Table 5 shows that knowledge (0.67), participation (0.62) and economic (0.61) incentives are also frequently identified as used or needed. This illustrates the importance of focusing on how a diversity of incentives from different categories can be functionally integrated to combine different governance approaches.

4.4. Themes related to the concept of coevolutionary governance

4.4.1. MPAs as synergistic top-down and bottom up approaches

As was discussed above (2.2.4), the coevolutionary governance concept recognises that both top-down and bottom-up approaches have their respective strengths and weaknesses (Table 1, Supplementary Material Table 3), therefore they should be functionally integrated in such a way that they coevolve. The case studies show that both legal incentives as top-down approaches and participation incentives as bottom-up approaches are combined in all the case studies, with a used rate of 0.65 for legal incentives and 0.44 for participation incentives. They also show that both approaches are recognised as in need of strengthening and that additional legal and participation incentives need to be introduced, with a needed rate of 0.24 for legal incentives and 0.19 for participation incentives (Table 5).

These combinations of top-down and bottom-up incentives are functionally integrated in that they are mutually supportive. Several case studies (#18–20, #26) show, for example, that *decentralising responsibilities* (i31) to local MPA actors need to be accompanied by the *attachment of conditions to use and property rights, decentralisation, etc.* (i21) and an obligation for *transparency, accountability and fairness* (i26) in the exercise of decentralised responsibilities. This is to ensure that the risks of localism, particularly a focus on economic development opportunities related to tourism, will not undermine both effectiveness through the impacts of rapid mass tourism growth and equity through the displacement and marginalisation of traditional user communities. There are many other examples of the myriad ways in which top-down and bottom-up incentives are combined and functionally integrated amongst these 28 case studies that are detailed in the 19 papers (Fig. 5). These indicate that rather than considering this as a balance between the opposing forces of top-down and bottom-up approaches, this is better considered as a functional integration between the synergistic roles of legal and participation incentives in a mutually supportive manner, the strengths of one approach serving to counteract the weaknesses of the other.

From a multi-level governance perspective (2.2.2), the various synergies between legal and participation incentives illustrated by the case studies can also be seen to (a) provide the lower and upper vertical connections between MPAs as Type II MLG initiatives that serve to embed and integrate the MPAs into the wider Type I MLG framework; and (b) provide for negotiated compliance coupled with institutional learning that together enable top-down and bottom-up approaches to be combined and functionally integrated.

4.4.2. Decentralising MPAs in the shadow of hierarchy

This functional integration between the synergistic roles of legal and participation incentives can also be considered as an illustration of 'decentralisation in the shadow of hierarchy'. Amongst the 27 site-specific case studies, Table 5 (and the related figures in Supplementary Material Table 10) shows that 21 of the case studies employed the incentive *decentralising responsibilities* (i31) whilst one case study identified it as particularly needed, illustrating that decentralisation to varying degrees and in varying ways is feasible in many contexts but would not appear to be a universally applicable panacea. All 21 case studies that *decentralised responsibilities* (i31) also employed various legal incentives, in some cases including *attaching conditions to use and property rights, decentralisation, etc* (i21) and/or an obligation for *transparency, accountability and fairness* (i26), both representing the coordinating and steering role of the state on an indirect oversight basis to ensure that such decentralisation does not undermine effectiveness and equity. Other legal incentives, such as *hierarchical obligations* (i17) and *legal adjudication platforms* (i25) help provide a degree of state steer, whilst a diversity of economic, communication, knowledge and participation incentives help provide for decentralisation.

It could be argued, from a polycentric SES perspective (2.1) that the need for legal incentives is incorporated into the polycentric SES concept, in that they represent sanctions that local actors can request from the state. Hence their importance is recognised and provision provided for in the polycentric SES concept, therefore an alternative concept such as coevolutionary governance is not necessary. However, a recurring theme in polycentric governance is that the state should passively facilitate self-governance in a given place and provide legal sanctions only when requested by local actors, rather than imposing such sanctions and thereby interfering in self-governance and reverting to a controlling role [39]. It is argued here that this assumption that the state should be a passive provider of legal incentives is neither realistic nor appropriate, as the state has a responsibility to ensure the fulfilment of wider-scale and longer-term societal priorities and related obligations. Therefore, the state has crucial roles to play in ensuring that effectiveness in achieving conservation objectives and equity in promoting fairness is not undermined by the risks of localism. This highlights the need to recognise that the state is more than a passive actor and must sometimes provide indirect steer, in a manner that minimises the risks of imposition, in order to provide for effective and equitable governance 'in the shadow of hierarchy'.

Having critiqued the validity of the polycentrism concept, it must again be stressed that the coevolutionary governance concept is argued to represent an evolutionary progression of the polycentric concept that inspired it. Both concepts are essentially focused on how governance can be decentralised to lower institutional levels in given places, i.e. MPAs, but where the polycentric concept places tremendous faith in deliberations and negotiations through horizontal and vertical linkages, as a means of achieving coordination and resolving conflicts within and between places through place-based self-governance, the coevolutionary concept focuses on the coordinating role of the state, along with other linkages, through decentralisation in the shadow of hierarchy.

4.4.3. MPAs as coevolution in practice

All the case studies employ a diversity of incentives representing a combination of governance approaches (Fig. 5), as is indicated by the spread of used rates across the five categories of incentives. A similar diversity of incentives is also cited as needed, as is indicated by the spread of needed rates across the five categories of incentives. The 28 case studies analysed in the papers in this special section reveal many examples of the importance of adopting a coevolutionary synecology focus (2.2.1), in order to understand how incentives mutually support each other, the adaptation of incentives being strongly influenced by their inter-dependence and functional integration.

A good example of this is provided by the particular combination of incentives employed in Ningaloo Marine Park (#7), where a whale shark watching programme has been developed that aims to protect marine wildlife, whilst also providing a recreational activity for tourism, supporting the local economy. A limited number of licences are issued to operate tourism boats for snorkelling with whale sharks, and this minimises the disturbance to whale sharks. Cooperation amongst operators limits the number of whale shark encounters as they restrict interaction through creating a broader whole day tour package priced above a certain agreed level, including other activities that do not involve encounters with whale sharks. This serves to *promote profitable and sustainable tourism* (i4), but many other combinations of incentives are also involved. There are strict and *clearly defined regulations* (i23) in place on how the activities are undertaken, including *legal conditions attached* (i21) to the whale shark watching vessel licences, and license holding boat operators eagerly watch each other with the potential to support *peer enforcement* (i32) actions through competition for licences, *building trust and the capacity for cooperation* (i33) amongst the operators, authorities and the surrounding communities. It is the responsibility of each operator to *raise the awareness* (i11) of tourists on the boats of the conservation importance of the whale sharks, to *promote recognition of the regulations and restrictions* (i13) and of the *benefits for conservation* (i12) of cooperating with them, in particular regarding behaviour and activities that should be followed or avoided when swimming with the

whale sharks.

This also serves to promotes *green marketing* (i5) as whale shark watching is publicised as a marine conservation-friendly ecotourism activity to help attract visitors. As this area is popular with whale shark aggregations they are considered as a feature of Outstanding Universal Value under the Ningaloo Coast World Heritage Site listing, placing *hierarchical obligations* (i17) to ensure whale shark watching does not undermine these values. This also encourages *state funding* (i9), effective *enforcement capacity* (i18) and *sufficient penalties for deterrence* (i19), including the potential for licences to be withdrawn from operators that breach restrictions, whilst a *fee on each user* (i10) helps support research, monitoring and surveillance. There is also a requirement under the World Heritage Convention for this programme to report annually on the status of the whale shark aggregations, and also to include relevant research, compliance and operations information in order to support adaptive management, which encourages *collective learning* (i14) amongst tour operators, management authorities and scientists, financially supported by the *user fees* (i10). Such collective learning approaches have significantly advanced scientific knowledge of whale shark aggregations and the risks to them of ship strikes in the open ocean during their wider migrations [75]. The hierarchical obligations to the World Heritage Convention (WHC) means that the World Heritage Committee, amongst other commonwealth bodies, provides for *independent arbitration & advice* (i16) in the face of uncertainty in knowledge and has helped promote a *precautionary approach to address uncertainty* (i15). Meanwhile, the Ningaloo World Heritage Advisory Committee, representing local actors, can influence WHC related decisions taken at state, commonwealth and even international levels, providing for *institutional learning from the bottom-up* (i36).

This combination of incentives has evolved over many years, arguably representing global best practice. This example also illustrates the importance of adopting a synecology focus, i.e. in order to understand why an individual incentive has been formulated, implemented and adapted in a particular way, you have to look at its synergistic and supportive connections with other incentives. This also illustrates that in being functionally integrated, the diversity of incentives from different categories also have the potential to coevolve. Through this functionally integrated combination of incentives, the institutional or social system both helps protect the ecological system and benefits from it through sustained and enhanced flows of ecosystem services, particularly the provision of sustainable whale shark watching opportunities. This illustrates how social and ecological systems can coevolve through their interactions of impacts and ecosystem service flows. As the diversity of incentives in the social system minimises the impacts of whale-watching, this reduces the impacts on the ecosystem, thereby increasing the health and diversity of the ecosystem. This in turn maintains or enhances the flow of ecosystem services back to the social system (Fig. 2).

This coevolutionary social-ecological systems perspective is reflected in the closing sentence of the book on MPAG [1, p. 197], i.e. that "diversity is the key to resilience, both of species in ecosystems and incentives in governance systems". This is the essence of the MPAG rationale from a social-ecological systems perspective, recognising the potential for the coevolution not only of incentives within social systems, but also of coevolution between social and ecological systems, through feedbacks between the magnitude of human impacts on ecosystems and of flows of ecosystem services to social systems. Positive feedbacks allow both social and ecological systems to become more resilient with increased incentive and species diversity respectively. This provides for the social and ecological systems to coevolve through their respective diversity (Fig. 2). Recognising this, the distinction between governance approaches becomes blurred and arguments about which governance approach is 'best' or 'right' become irrelevant, as the focus of coevolutionary governance is on how a diversity of governance approaches develop in such a way that they are functionally integrated and coevolve, so that the weaknesses of one approach are balanced by the strengths of other approaches in a synergistic manner.

The findings of applying the concept of coevolutionary governance to MPA case studies around the world not only provide for such theoretical discussions. They can also be distilled to guidance for practitioners, e.g. UNEP Guidance on combining governance approaches to enable effective and equitable MPAs [76]. Such applications provide for the identification, adaptation and transfer of examples of combinations of incentives that appear to represent good practice in promoting effectiveness and equity. This realist institutional analysis approach through the MPAG framework based on the coevolutionary governance concept thereby provides for both theoretical and applied contributions to the field of MPA governance, with the potential for contributions to wider natural resource governance debates and practices.

5. Conclusions

This paper analyses the governance of MPAs through 28 case studies in 17 countries (Fig. 1). Some limitations of the polycentric governance concept and related SES framework are discussed, particularly its faith in linkages as a means of resolving conflicts and its assumption that the state should only take a passive role. The concept of coevolutionary governance is described and justified, noting that this essentially builds on polycentrism's systematic case study analysis approach, but evolves it to move beyond its limitations. Coevolutionary governance takes a synecology perspective to analyse how incentives coevolve through their functional integration, as well as how social and ecological systems can coevolve through the feedback mechanisms of human impacts and ecological services (Fig. 2). Drawing on the wider concept of multi-level governance, coevolutionary governance is considered to provide for synergies between governance approaches, proposing that coordination can be achieved and conflicts addressed through the reconfigured role of the state, providing steer through governance in 'the shadow of hierarchy'.

The MPAG empirical framework, which is premised on the coevolutionary governance concept, is then described and the findings of its application to 28 case studies are outlined (Table 4, Fig. 5). Trends within and between economic, communication, knowledge, legal and participation incentives are drawn from these case studies. These highlight that the incentives synergistically interact in a way that is analogous to synecology, providing for them to be functionally integrated as a means of combining governance approaches. As such, it is argued that these findings support the validity of the coevolutionary governance concept. They also further explore and support the argument that "diversity is the key to resilience, both of species in ecosystems and incentives in governance systems" [1, p.197], a key insight for the effective and equitable governance of MPAs round the world.

CRediT authorship contribution statement

Peter J.S. Jones: Conceptualization, Methodology, Investigation, Writing - original draft, Visualization, Supervision, Project administration. **Stephen D. Long:** Software, Formal analysis, Investigation, Writing - review & editing, Visualization.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2020.104362.

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