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Scalar capital as ingredient of success in conservation governance: evidence from Melanesia

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ABSTRACT

Problems of scale abound in the governance of complex social-ecological systems. Conservation governance, for example, typically occurs at a single scale, but needs to inform governance and action at other scales to be truly effective at achieving social and ecological outcomes. This process is conventionally conceived as unidirectional – either scaling down or scaling up – in the way it both exploits and creates the natural, social, human, institutional, and financial resources and benefits that are collectively known as conservation 'capital'. Here we analyse multiscale conservation governance and the different types of capital that impede or facilitate its effectiveness. Comparative analysis of conservation planning in Papua New Guinea and the Solomon Islands, through in-depth document review, key informant interview, and participant observation, reveals limited evidence of unidirectional processes. Instead, we observe multidirectional scaling pathways, cultivated by the following six scale-explicit characteristics of effective conservation governance: 1) multiscale understanding, 2) scale jumping, 3) scaled leadership characteristics, 4) scaled stakeholder engagement, 5) scaled policy frameworks, and 6) scaled institutional settings. While the latter four are familiar concepts, though not always recognised as explicitly scalar, we know little about the first two attributes of conservation governance. Based on this novelty and relevance, we propose a new form of capital – 'scalar capital' – to complement natural, social, human, institutional, and financial capitals as both input and outcome of effective conservation governance. We find that scalar capital facilitates flows of different resources (data, conservation objectives, practitioner experience, institutional support, and funding) in multiple directions. Critically, we present empirical evidence that conservation governance can foster scalar capital to improve outcomes across multiple scales.

1. Introduction

Difficulties in understanding scale have pervaded the fields of environmental governance, management, and planning since their inception (Cumming et al., 2015; Margules and Pressey, 2000; Morrison, 2017; Termeer et al., 2010), and have been a central concern in ecology for nearly a century (Wiens, 1989). Here, we define scale as the spatial, temporal, quantitative, or analytical spectra that measure and understand social or ecological phenomena, and the relational comparisons between different points along these spectra. Difficulties with scale are manifest in a multitude of ways, though all are in some way a reflection of our limited understanding of social and ecological processes that operate and interact differently between scales. We use the term 'social processes' to refer to the ways in which individuals and groups act and interact to construct and adapt relationships and behaviour. These ways are continually modified and refined through, for example, social learning and memory, institutional and organisation inertia and change, social networks, and adaptive capacity and governance (Folke, 2006). We use the term 'ecological processes' to refer to the biological, chemical, and physical actions and interactions that occur between organisms and their environment. Examples are dispersal and movement of species across landscapes or seascapes through habitat connectivity (Maciejewski and Cumming, 2016), environmental degradation and impacts on species community composition, and competition-colonisation dynamics (Driscoll et al., 2013).

The problem of scale is particularly pronounced in the sub-field of systematic conservation planning. Systematic conservation planning is the process of allocating conservation interventions in space and time (Pressey and Bottrill, 2009). We define the term 'planning process' as a series of analyses, consultations, decisions, and actions directed at identifying, and sometimes also implementing, conservation actions in specific areas. Planning processes across local extents generally identify conservation areas at the spatial resolution at which practical actions are applied. Planning processes across larger, such as national, extents

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identify potential conservation areas at much coarser resolutions. These differences influence the degree to which very extensive and very localised planning processes can inform one another. Problems with scale in conservation planning differ according to planning stage (see Supporting Information for detailed explanation of conservation planning processes). In the design phase of planning (e.g., delineating the planning region, collecting data, setting objectives, identifying priorities), difficulties with scale largely pertain to the inappropriate resolution of ecological or socioeconomic data used to identify conservation priorities (Cheok et al., 2016). Priority areas identified for actions are guided by conservation objectives, which are formulated in the design phase of planning to represent broad ecological or socioeconomic goals (Pressey and Bottrill, 2009). In the implementation phase (e.g., applying prioritised actions, monitoring outcomes, reviewing current achievement of objectives), problems with scale become more intractable because they necessitate unmediated and often unpredictable interactions with further forms of human-related scales (Cash et al., 2006), as plans transition to applied actions (Mills et al., 2015; Pressey et al., 2013). Problems with scale encountered during the transition from design to implementation contribute to a widespread 'implementation gap' (Knight et al., 2008) in which effort is wasted when plans do not inform actions, and limited resources for conservation are used inefficiently when actions are not strategic.

Though we focus here on conservation planning as a case study, the concepts we explore ultimately concern the multiscale governance of complex social-ecological systems and the resources and benefits that are used or generated during this process. Collectively, these resources and benefits are conservation 'capital', which can be natural, social, human, institutional, and financial (Bottrill and Pressey, 2012). Problems of scale essentially relate to the 'problem of fit' in these complex systems (Bodin et al., 2014; Folke et al., 2007), which has historically yielded adverse outcomes for environmental governance (Crowder et al., 2006). A better understanding is crucial for the successful management of these systems (Epstein et al., 2015) and, because any ecological or social system operates over or within a range of spatial, temporal, and organisational scales (Cumming et al., 2017), this need has broad-reaching relevance across many research areas. For example, theories of collaborative and polycentric governance (Ansell and Gash, 2007; Morrison et al., 2019), policy and social networks (Sandström and Carlsson, 2008), and advocacy coalition (Weible et al., 2009) all consider interactions and connections between public and private stakeholders or policies that inevitably exist at multiple jurisdictional and institutional scales. Despite these considerations, explicit treatment of scale in these theoretical frameworks is a relatively recent development (Bodin, 2017; Weible et al., 2011). Of particular relevance is the scale-explicit idea in social network theory of scale-crossing brokers, described as a social network position that bridges specifically across ecological scales (Ernstson et al., 2010). There is now empirical evidence of the value of scale-crossing brokers (Cohen et al., 2012; Guerrero et al., 2015; Reid et al., 2016) in facilitating links between jurisdictional levels (e.g., local and national levels), along with disparate sectors of society (e.g., policymakers, communities, and researchers). Similarly, related fields of social-ecological systems and ecosystem services have also begun to more appropriately, and explicitly, conduct analyses at multiple scales of assessment (Scholes et al., 2013) or against a multiscale framework (Cumming et al., 2015).

2. Multiscale conservation governance

There is now much evidence to suggest that conservation governance needs to explicitly consider and integrate across multiple scales as a response to scale mismatches (Cumming et al., 2015; Morrison, 2007; Scholes et al., 2013). However, despite frequent calls for integration across scales, conservation scientists, policymakers, and practitioners have yet to define explicitly what this means or demonstrate how they should approach it. To assess the extent to which multiscale conservation governance is occurring, and whether it does, in fact, lead to improved outcomes, we first need to define it. We understand multiscale conservation governance to occur when conservation planning processes undertaken at different scales effectively inform one another and consequently result in improved outcomes, compared to processes undertaken at a single scale or at multiple scales without informing one another. Informing requires some level of coordination between processes and policies at multiple scales, and cooperation between actors and institutions that span different processes across scales (Lubell, 2013). Given that hundreds of conservation plans are developed every year (Álvarez-Romero et al., 2018), more effective and deliberate planning across multiple scales could improve conservation outcomes and achieve greater impact with the limited resources available for conservation. In our assessment of conservation planning, we refer to spatial extent, measured in km^2, and to jurisdictional levels, defined as, 'the units of analysis that are located at different positions on a scale' (Cash et al., 2006). References to 'lower' or 'higher' jurisdictional levels here specifically refer to parts of a spectrum between international (high) and local (low).

The conservation planning literature largely conceives multiscale governance as a dichotomy. 'Scaling down' (Fig. 1A) assumes modification of designs generated at higher jurisdictional levels to incorporate local objectives and preferences as planning is done at progressively lower jurisdictional levels (Mills et al., 2010). In contrast, 'scaling up' (Fig. 1B) refers to attempts to coordinate and place separate locally driven initiatives in a higher jurisdictional context (Horigue et al., 2015). These opposing trajectories are associated with two main approaches through which conservation planning has occurred: 'top-down' centralised management or 'bottom-up' decentralised management (Ban et al., 2011). The literature has advocated for both scaling down and scaling up based on their respective benefits. Top-down planning is advantageous because it can incorporate wider perspectives, such as consideration of connectivity and complementarity between biodiversity features, possible only at higher jurisdictional levels and correspondingly larger extents. This perspective leads to planning initiated at high levels, with progressive refinement through scaling down (Ban et al., 2011). An alternative perspective is that the advantages of bottom-up planning, including local stakeholder engagement, buy-in, and compliance (Gaymer et al., 2014), call for planning to be initiated at local levels, and scaled up to incorporate higher-level perspectives. Other attempts to integrate planning across scales have involved the amalgamation of different scales into a singular static assessment (Bombi et al., 2013). This is problematic, however, because the assessment still occurs at a single scale of analysis, maintaining the limitations associated with such assessments (Lemos and Agrawal, 2006).

We use the term 'scalar pathway' to describe the movement of different directional flows across multiple jurisdictional levels over time (Fig. 1). Scaling-up or scaling-down pathways imply that planning processes inform one another unidirectionally through time (Fig. 1A, B). It remains unclear, at least in the field of conservation planning, whether this perceived dichotomy actually exists in the real world, or whether other modes of scalar pathways (e.g., Fig. 1C) occur. Public policy scholars resolved a similar argument in the 1980s by merging the best attributes of the bottom-up and top-down approaches, with the explicit distinction of applying this combination of approaches to a longer timeframe than was the case in most research on policy implementation (Sabatier, 1986). While conservation practitioners recognise the complementary advantages of scaling up and scaling down (Gaymer et al., 2014), no study has offered ways to operationalise cycling between multiple scales of planning. We argue here that multiscale conservation planning likely requires more flexible scalar pathways, beyond unidirectional scaling up or scaling down.

Understanding of the factors that influence successful outcomes in conservation planning has typically been limited (Ferraro and

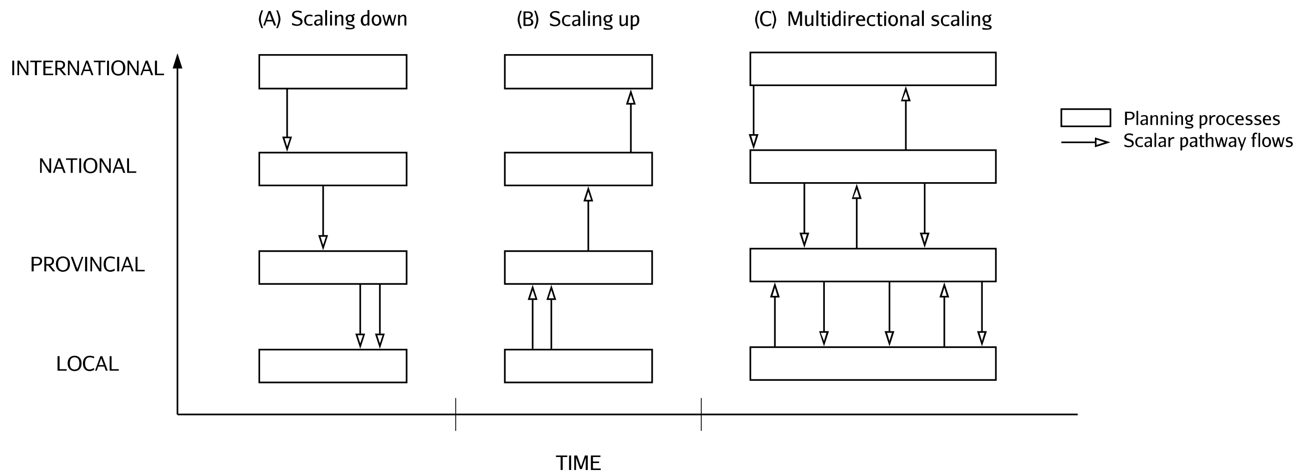

Fig. 1. Conceptual representations of directional movement (e.g., of planning resources, such as data, expertise, or funding) across multiple jurisdictional levels over time. Scaling down (A) and scaling up (B) represent the dichotomy prevalent in the conservation planning literature. Scaling down begins at higher jurisdictional levels, sometimes informed by international agreements, and involves modification of national- or provincial-level designs to include additional objectives and preferences as planning is subsequently adapted to lower levels. Scaling up moves in the reverse direction, whereby higher levels of planning inform and contextualise separate initiatives initiated at lower levels. National governments frequently co-opt these lower-level initiatives to calculate country-level progress towards achieving spatial targets set by international agreements. We propose a more realistic archetype of planning across multiple scales, named here multidirectional scaling (C). In this mode, movement between processes can occur in both directions, and planning processes can occur simultaneously at different levels and inform subsequent planning at higher or lower levels, occasionally bypassing the adjacent level. Tick marks on time axis denote separate timelines for each archetype.

Pattanayak, 2006). To address this, Bottrill and Pressey (2012) proposed an evaluation framework adapted from Scoones' (1998) sustainable livelihoods framework, which defines different types of capital (natural, financial, social, human, and institutional) as an input for and product of investment, ultimately accruing flows of planning resources and benefits over time (Table 1). We drew from Bottrill and Pressey's (2012) framework (hereafter, evaluation framework) to assess the relative success of each scalar pathway. Relative success was evaluated with respect to reported and perceived gains in the different types of capital in each planning process that comprised the scalar pathways, and how these gains related to factors that specifically facilitated multiscale planning (e.g., where planning processes effectively informed those at other levels across each pathway).

3. Methods

Any efforts to foster multiscale planning will require better understanding of three central elements: 1) how planning efforts at different levels can and do inform one another, 2) scalar pathways through which multiscale planning occurs in practice, and 3) factors that can impede or facilitate multiscale planning in particular contexts. Analysing these elements will elucidate how specific socio-political conditions can influence the effectiveness of multiscale planning. To understand these three central elements, we evaluated conservation planning developed at different levels in Papua New Guinea (PNG) and the Solomon Islands (SI) (Fig. 2; 14 conservation plans in total, 10 from PNG and 4 from SI). Vertical integration and coordination of conservation planning across jurisdictional levels is paramount in the region in which these countries are located, due to the presence of customary governance regimes that necessitate local-level involvement in environmental planning. Nevertheless, although conservation planning has occurred at multiple scales in these countries (e.g., Green et al., 2007; Kool et al., 2010; Smith et al., 2002) (often with the same single organisation leading multiple planning processes: The Nature Conservancy [TNC]), planning has not been deliberately multiscale.

3.1. Identifying scalar pathway case studies

We identified planning processes ($n = 14$) that comprised each scalar pathway ($n = 3$) per country by searching available peer-reviewed and grey literature (details provided in Table A.1, Appendix A of Supplementary data). Each scalar pathway was first constructed through process-tracing (*sensu* George and Bennett, 2005; also see Morrison, 2017), based on a comprehensive review of all collated planning documentation, which reported specific events, dates, places, and any connections between planning processes. Through discussion with key informants during interviews these initial pathways were subsequently refined, then completed and corroborated based on all information collected from the interviews.

3.2. Document review

We reviewed all reports, management plans, and other relevant scientific or governmental publications ($n = 38$; Table A.1, Appendix A of Supplementary data) on each planning process included in our case studies. We identified documentation through searches of peer-reviewed and grey literature, as well as receiving additional documents from key informants. Documents were analysed for information such as spatial extent, timeline, planners and stakeholders, specific planning context involved, general planning process undertaken, known planning outcomes, and any reported connections, including the nature of these connections, to other planning processes.

3.3. Key-informant interviews and participant observation

To triangulate collated and collected data, we undertook in-depth and confidential interviews ($n = 12$) with key informants who were involved in planning processes across different jurisdictional levels. Since it was not possible to conduct interviews with all planners involved across all processes, sampling of key informants was stratified to ensure that planners operating at different levels (i.e., local, provincial, and national) were represented. Twelve in-depth interviews were deemed sufficient for reaching adequate code and meaning saturation on the basis of our study purposes, which were to identify broad thematic topics related to factors influencing multiscale planning, discussion with a relatively homogeneous population of conservation practitioners, and extraction of the richer insights that in-depth interview data provide (see Hennink et al., 2017). The key informants included

Table 1
Summary of definitions, example outcomes, and indicators for the five forms of capital relevant to conservation planning processes (natural, financial, human, social, and institutional) from Bottrill and Pressey (2012), with the addition of scalar capital as a proposed new form.

Capital	Definition	Example outcome	Indicator with example	Reference
Natural	Stock and flow of goods and services provided by ecosystems, including the diversity of species, regulating processes, and supporting services	Reduction in loss or degradation of natural values	Extent and intensity of threatening processes (e.g., deforestation; exploitation)	(Costanza and Daly, 1992)
Financial	Gains or savings of cash, property or goods that represent the wealth or economic value of an individual or organisation	Leverage of additional funds or in-kind support	Proportion of additional funds received (e.g., % change in annual budget of implementing agency attributable to new donors)	(Bottrill and Pressey, 2012)
Human	Knowledge or skills that enable people to develop strategies to achieve their objectives, which provide the foundation for the other four types of capital	Learning applied in future plans	Use of new knowledge or skills applied in subsequent plans (e.g., application of new decision tool by members of planning team)	(Scoones, 1998)
Social	The relationships and interactions between individuals and groups with productive benefits	Trust in planning processes	Perceptions of planning process and outputs by stakeholders (e.g., % of stakeholders with positive view of plan)	(Pretty and Ward, 2001)
Institutional	The capacity, structure, or functioning of institutions through formal means (e.g., laws and regulations) or informal arrangements (e.g., cultural norms applied in governing natural resource uses)	Influence on resource-use planning	Avoidance by developers of priority conservation areas (e.g., occurrence of development applications in priority areas)	(Ostrom, 1990)
Scalar	**The explicit consideration and application of understanding of the important dimensions of scale, as they pertain to the governance of complex systems**	**Planning processes informing other processes at different scales**	**Scale-constrained actors gaining access to resources from levels of planning otherwise inaccessible (e.g., individuals from planning processes put into contact with processes at other levels to share knowledge)**	

planners from local and international environmental NGOs and national government representatives. We also undertook participant observation at in-country planning workshops ($n = 2$), where participants included governmental and non-governmental conservation practitioners, representatives from local communities and different levels of government, as well as different industry sectors.

Face-to-face interviews were conducted over a two-month period (August – September 2017) and lasted 1-2.5 hours each. The lead author audio-recorded and subsequently transcribed all interviews. Interview questions were semi-structured and focused on individual planning processes, outcomes from these processes, how individual plans related to other plans, and perceptions of planning successes. To avoid biased recollection of responses, results were corroborated with those of other interview respondents and through review of associated documentation on these processes. We treated discrepancies between respondents as results, evaluated against the specific context of the planners, and discussed accordingly in the paper.

3.4. Data analysis

We analysed the content of interview transcripts supplemented with document-review and participant-observation data to elicit factors related to the successes and failures of individual planning processes, as well as connections between different planning processes and how these explicitly related to successes or failures across scales and jurisdictional levels. This analysis involved determining common themes and patterns from the collected and collated qualitative data and occurred in two main parts: identifying *a priori* themes gleaned from literature on conservation planning across multiple scales and the document review, and then analysing the data for *emergent* themes and patterns. All themes that were repeatedly identified (defined as three or more times) during content analysis across the majority of respondents were considered important. Success of individual processes and scalar pathways was assessed according to an evaluation framework comprised of the five established forms of capital (i.e., natural, human, social, institutional, and financial; Bottrill and Pressey, 2012). For example, a local-level planning process in PNG (Keppel et al., 2012) resulted in new legislation that enabled the formal recognition and management of conservation areas, an outcome of gaining institutional capital (Bottrill and Pressey, 2012). One respondent reported: “The first step was to address the issue that [people] did not have consent [over] their land. We engaged an environmental law firm […] to develop a law […] so that local-level governments could directly have a say in how the forest resources were being used”. We then associated the successful outcomes of planning processes with factors that facilitated or impeded multiscale planning, through thematic analysis of key-informant interviews. Document and participant-observation data also were used to confirm and supplement the analysis.

4. Multidirectional scaling: multiscale planning in practice

We identified 14 conservation plans in total, resulting in three scalar pathways for analysis (two pathways elicited for PNG and one for SI; Figs. B.1-3, Appendix B of Supplementary data). This analysis demonstrated that conservation planning processes inform one another through flows of data, conservation objectives, practitioner experience, institutional support, and funding (Fig. 3). These resource flows between planning processes undertaken at different levels allowed multiscale planning to occur. Conservation practitioners involved in planning at higher levels often reused large datasets collated or collected for these plans; interviewees regarded these datasets as relatively constant through time. Objectives were frequently associated with these data flows and often originated from international-level commitments. Where flows between multiple processes involved the same personnel at different levels, they contributed flows of planning experience from other contexts, as well as providing broader perspectives for individual

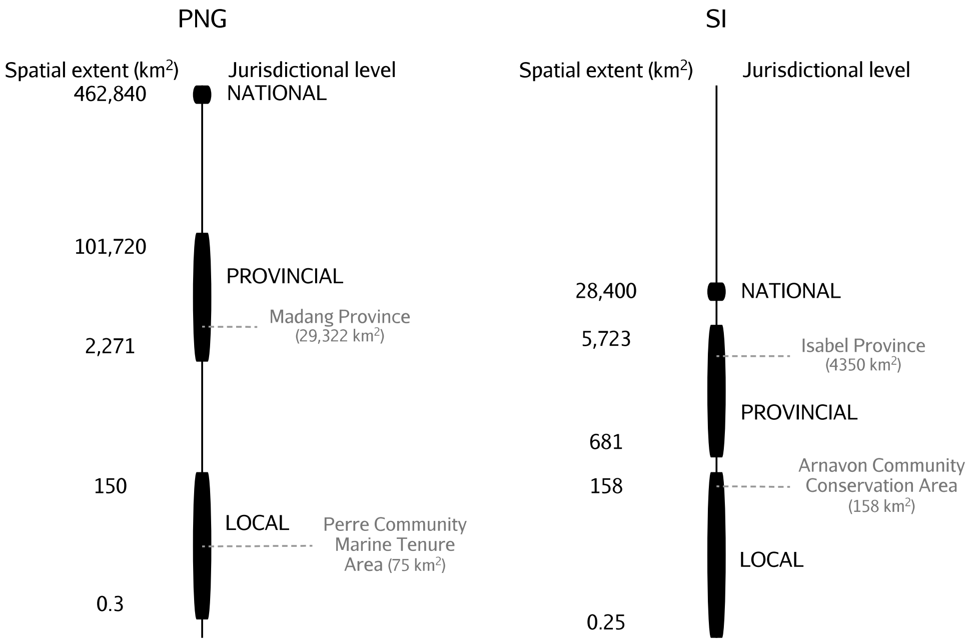

Fig. 2. Relationships between spatial extents and jurisdictional levels in our two study regions: Papua New Guinea (PNG) and Solomon Islands (SI). Jurisdictional levels are points on the jurisdictional scale (Cash et al., 2006). Note additional jurisdictional levels exist in PNG; however, for the purposes of consistent comparison between case studies, we focused only on levels common to both countries.

planning processes. Key informants frequently considered these flows of shared experience to result in increased efficiency in planning processes. Institutional support (i.e., policy- or governance-related support from existing formal institutions such as national ministries, or international conventions) was often associated with flows of funding from higher levels to lower levels of planning.

We did not find empirical support for either exclusively scaling-down or exclusively scaling-up pathways (Fig. 3; see Figs. B.1-3, Appendix B of Supplementary data for empirical pathways). Instead, we found that scalar pathways demonstrated iterative, bidirectional flows between multiple levels of planning. Our finding of multidirectional scalar pathways demonstrates that multiscale planning is occurring in PNG and SI, although this has been opportunistic rather than the result of deliberate high-level coordination over long timeframes.

Planning processes at all levels contributed some flow of planning resources to other processes, at either the same or different levels (Fig. 3). Pathways cycled between provincial and national levels in PNG, and mostly within provincial levels in SI, with consistent flows of data or objectives and practitioner experience involved. International-level processes (e.g., Convention on Biological Diversity) supplied flows of planning objectives to conservation practitioners operating at higher levels (i.e., provincial and national), with these objectives informing which datasets to obtain. However, adjustments of objectives from higher levels to consider local preferences occurred as planning progressed to lower levels, a characteristic of scaling-down pathways. Similarly, while multiple higher-level processes often shared datasets,

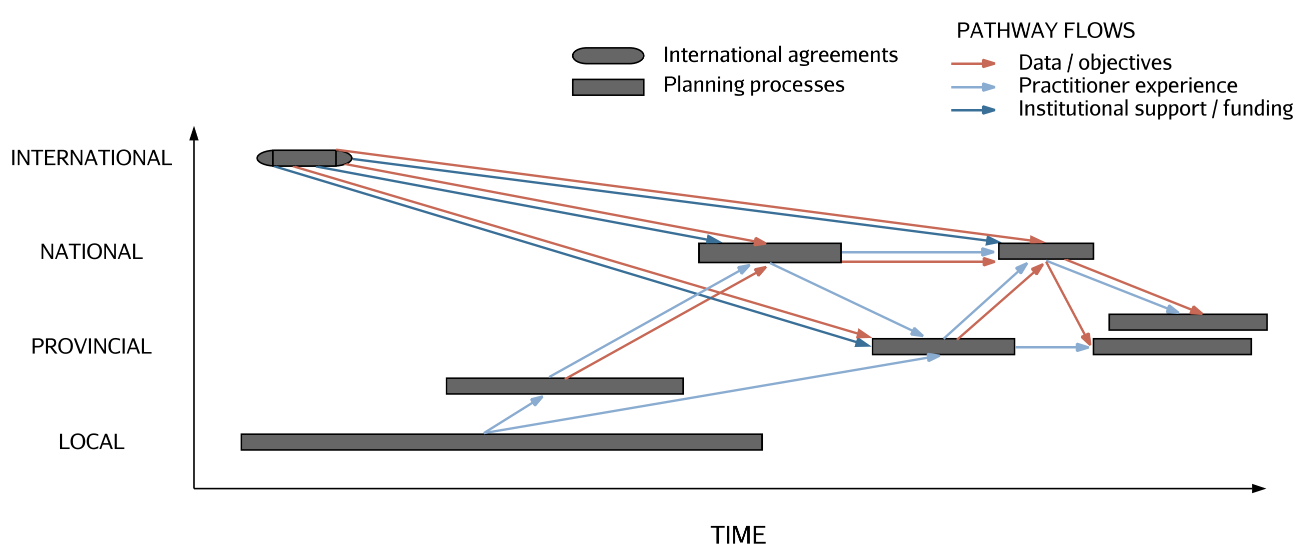

Fig. 3. Simplified depiction of scalar pathways among published conservation planning processes in Papua New Guinea and Solomon Islands between 1995 and 2017. Pathways consist of different types of flows between levels, which are not unidirectional but vary idiosyncratically over time (see archetype in Fig. 1C). Planning occurs infrequently at international levels; agreements and conventions between nations are a focal process at this level (e.g., Convention on Biological Diversity targets, the Coral Triangle Initiative). These agreements can provide institutional support and funding for planning at lower levels. Pathways frequently began at the local level, likely a by-product of customary tenure over resources and the strength of local governance in this region, and a lack of institutional capacity at higher levels in the early years of conservation planning. Flows of resources identified between levels of planning were composed of data, conservation objectives, practitioner experience, institutional support, or funding. Practitioner experience was the main resource flow between planning at local and provincial levels, while common datasets and related objectives as well as practitioner experience flowed between planning at higher levels (provincial and national).

practitioners updated data to finer resolutions as planning proceeded to local levels. Evidence of this is significant, because practitioners have typically assumed that new and finer-resolution data will either be collected or become available as planning is undertaken at lower levels (Pressey et al., 2013).

Less iterative cycling occurred between the local-provincial and local-national levels than between higher levels (Fig. 3). Nevertheless, local-level planning played a pivotal role in learning that practitioners subsequently applied at higher levels, with flows from local to provincial (and occasionally national) levels consisting primarily of practitioner experience and occasionally data. Interview respondents repeatedly stated that the flows of information and learning between planning processes, particularly from local levels, were highly beneficial; this is supported by the well-established understanding that learning and adaptation are critical to effective conservation planning (Grantham et al., 2010). The reduced iterative cycling observed between lower levels of planning is potentially a result of the available timeline for study (i.e., the timeline of all planning processes evaluated might not be long enough to capture more local-level planning processes, which might occur after the documented provincial- and national-level processes).

Flows of planning resources occurred primarily between processes at adjacent levels (Fig. 3). The only exception was where particular local-level planning processes achieved a high profile (e.g., in terms of importance or perceived success), leading to recognition at, and interactions with, national or international levels. For example, the Kimbe Bay (PNG) planning process emerged from international-level assessments of regional priorities for conservation action, instigating flows of institutional support and funding to this local level (Green et al., 2009). Similarly, the significance and success of the Arnavon Islands community-based conservation area (SI) influenced national-level planning through contribution of data and spatial targets towards national biodiversity commitments (Kool et al., 2010). In turn, these flows of data from local to national levels have generated further flows of institutional support from the national government down to the local-level Arnavon Islands planning process (Foale and Wini, 2017).

In all case studies, scalar pathways were initiated at the local level by a range of governmental, NGO, and community stakeholder groups involved in planning. This likely reflects two contextual features: customary governance of resources in Melanesia, and the strategy of TNC to trial and learn from conservation planning at smaller extents (i.e., local levels) in order to apply the knowledge gained to subsequent processes at higher levels. However, a unidirectional scaling-up pathway, commonly associated with customary resource ownership and bottom-up conservation planning, was not evident in SI or PNG. Elsewhere, it is possible that scalar pathways could begin at higher jurisdictional levels in contexts with more centralised resource governance and stronger institutional capacity (e.g., Yellowstone National Park, USA, in 1872; Day and Dobbs, 2013, Great Barrier Reef Marine Park, Australia, in 1975; Oakerson and Parks, 2011), but similarly not result in a unidirectional (scaling-down) pathway.

Other external economic and socio-political conditions also influenced the direction of scalar pathways. Interview respondents indicated that planning moved away from a local-level focus to higher levels of planning following the global financial crisis in 2009. This was a deliberate strategy by planners to implement actions more cost-effectively, since higher-level planning processes involve less on-the-ground engagement, requiring less time and funds to complete than intensive local-level planning exercises. A significant institutional driver was national conservation legislation, which helped to provide institutional support to planning at lower levels. The creation of such legislation also provided incentives for further planning across all levels and increased time-efficiency in gaining institutional support and endorsement from national governments.

5. Scalar capital as input and outcome of multiscale planning success

A number of themes emerged repeatedly when analysing factors that facilitated or impeded multiscale planning, all of which were notably scale-explicit. When attempting to evaluate these scale-explicit factors against the evaluation framework, it was apparent that the five forms of capital (Bottrill and Pressey, 2012) did not explicitly consider scalar dimensions. Because explicit consideration of scale appears to be fundamental to multiscale planning and scale can in fact be viewed as a resource (Bebbington and Batterbury, 2001), we propose a new form of capital – 'scalar capital'.

We define scalar capital as the explicit consideration and application of understanding of the important dimensions of scale, as it pertains to the governance of complex systems (Table 1). We term these scale-explicit factors that influence multiscale planning, the 'dimensions' of scalar capital. In line with the framework to evaluate conservation planning outcomes (Bottrill and Pressey, 2012), we propose scalar capital as a form of capital that may be used in planning processes as either a resource or product of investment. If conservation problems are inherently multiscale, then solutions must also be, making scalar capital essential to evaluations of conservation planning. We identify six principal dimensions of scalar capital: 1) multiscale understanding, 2) scale jumping, 3) scaled leadership characteristics, 4) scaled stakeholder engagement, 5) scaled policy frameworks, and 6) scaled institutional settings. The first two dimensions are concepts unfamiliar in the conservation planning literature; we describe these in detail in the following sections and discuss potential implications for future multiscale conservation planning. The literature has long recognised the remaining four dimensions, which we corroborated with the findings across our case studies. Critically, while these dimensions are recognised, we emphasise the need to ensure that they are multiscale (i.e., present across all levels of planning) to contribute to scalar capital. Scalar capital exhibited equal or greater importance when evaluating successful outcomes of planning processes perceived by key informants, compared to natural, social, and financial capital (Fig. 4A). The majority of in-depth interviews consistently mentioned all dimensions of scalar capital we identified (Fig. 4B).

We acknowledge that there should be considerable overlap between scalar capital and other types of capital, because problems of scale relate to entire social-ecological systems. For example, though initially conceived in the context of governance and policy (Cash and Moser, 2000), literature on social capital concerning the role of boundary spanners bridging the gap between disconnected networks has been increasing (Bodin and Crona, 2008; Brondizio et al., 2009; Pahl-Wostl, 2009). Viewing scalar capital as its own form of capital gives the concept of scale more agency in evaluations of conservation planning processes and governance. This notion is recognised as a cross-cutting issue for future research directions (Newig and Moss, 2017) and has been long proposed by researchers in the field of environmental planning. In that field, the term 'scalecraft' has been coined to refer to skills and experiences that enable cross-scale analyses, and the idea of 'scalar practices' concerns scale as a product of social and political construction to use strategically in environmental governance (Fraser, 2010). Furthermore, human capital provides the foundation for the other four types of capital (natural, financial, social, institutional; Table 1); similarly, scalar capital should emerge from other types of capital. We note that our case studies are of similar governance contexts (i.e., highly decentralised systems) with developing economies and similarly complex socio-political and cultural structures (Govan et al., 2009). Thus, our proposed framework is nascent, and research is necessary to further develop and substantiate our findings in different socio-political and governance contexts (e.g., centralised systems). Nevertheless, the concepts proposed here can contribute to overcoming

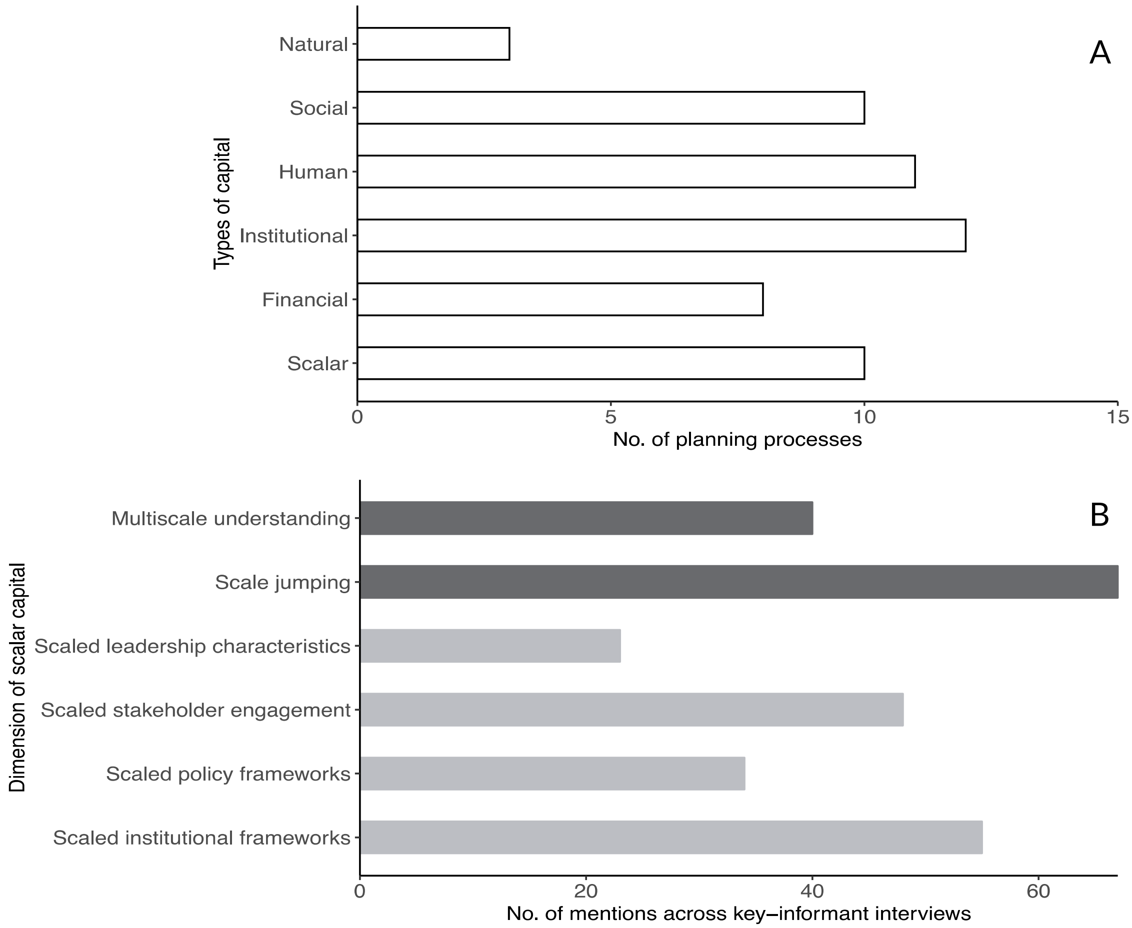

Fig. 4. Relative importance of types of capital and dimensions of scalar capital identified from key-informant interviews. (A) Frequency of capital type associated with perceived outcomes of planning processes, and (B) frequency of mentions across key-informant interviews that involved references to any of the six principal dimensions of scalar capital identified (dark grey, unfamiliar concepts in the conservation planning literature; light grey, familiar concepts in the literature). Note that the potential for perceiving outcomes differs between planning processes initiated at different times.

the challenges associated with scale mismatches in conservation planning (e.g., linking across multiple levels of planning; Beever et al., 2014).

Regarding the more familiar dimensions of scalar capital, much evidence supports the vital importance of leadership characteristics in successful conservation planning (e.g., sharing a clear, long-term vision, “hands-on” management, ability to switch between the big picture and finer details, and stimulating learning, improvement, and receptiveness to alternative solutions; Black et al., 2011). Many argue that a leadership approach (e.g., conflict management and partnership building) can be intentionally managed to maximise impact (Bruyere, 2015). Similarly, there is now a very clear understanding of the necessity of genuine stakeholder engagement in any conservation planning process (see Pomeroy and Douvere, 2008 for examinations of various engagement approaches, and Reed, 2008 for a comprehensive review). While there are no silver-bullet policy frameworks and institutional settings that can be applied to ensure success in any given planning context, the importance of frameworks operating effectively in the context of natural resource management is obvious (Ferse et al., 2010; Kingsford et al., 2009).

In PNG and SI, we found that, where certain policies and institutions existed at the relevant levels, practitioners were able to expedite planning processes and achieve greater implementation success compared to other instances where these policies or institutions were absent. This concept is referred to in the literature as vertical policy integration (Adger and Jordan, 2009; Roux et al., 2008) or cross-scale linkages (Wyborn, 2014) and, while typically discussed with reference to policies, applies equally to institutions (Schout and Jordan, 2008). Though there is no established solution to achieving vertical integration in an uncoordinated or fragmented decision-making system (Lane and Robinson, 2009), it is clear that successful integration requires policies and institutions that are consistent, coherent, and mutually supportive across jurisdictional levels, and that mechanisms are in place that facilitate regular exchange of information, consultation, and arbitration between all levels (Jordan and Lenschow, 2008).

6. Novel dimensions of scalar capital

6.1. Multiscale understanding

To successfully plan across multiple scales, practitioners first need to understand the purpose, strengths, and weaknesses of planning at different jurisdictional levels. We looked at realised (c.f. anticipated) outcomes from individual planning processes in PNG and SI to identify the purposes of planning at different levels. Key informants linked the absence of explicit understanding of the functions and limitations of what planning can realistically achieved at each level, to less effective planning outcomes at these levels and, therefore, across scales. For example, where planning teams expected that protected area implementation would be a direct outcome from national planning exercises and this did not transpire, it led to disappointment, decreased morale, and perceptions of wasted effort. At local levels, we found socially motivated objectives gained the most importance compared to other levels. Planning processes that involved expectations and

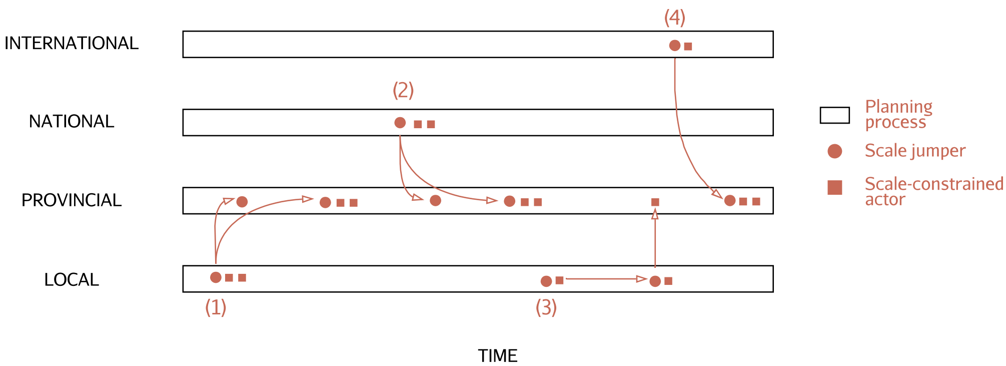

Fig. 5. Schematic depiction of four outcomes of scale jumping, across jurisdictional levels: 1) contextualising, 2) grounding, 3) forecasting, and 4) accessing exogenous and cross-level resources. Jurisdictional levels chosen to demonstrate each type are notional and outcomes directional, although, all types of scale jumping can occur from and to any level and might or might not cross over intermediate levels.

objectives related to social factors were more successful in implementing actions than those that did not. It is important to consider here that outcomes observed at higher levels can be idiosyncratic due to a lower number of system units than at lower levels. However, potentially idiosyncratic higher-level outcomes have been demonstrated to exert significant forces in influencing community assembly in ecosystems (Terborgh et al., 2001).

A factor that inhibited understanding the purpose of planning at different scales was the misconception, held by many involved in the planning processes, that leveraging planning into broader scales can decrease the costs incurred to implement plans at the local level (through 'economies of scale'). This was inhibiting because it encouraged conservation planning to move away from local levels to maximise cost-effectiveness. Although economies of scale are applicable in certain planning contexts (see Armsworth et al., 2011), our case studies demonstrated that actions are implemented at the local level and, therefore, associated costs of doing so cannot be leveraged upwards (i.e., implementing actions at higher levels while achieving the same intended outcomes at the local level for the same cost).

Related to multiscale understanding is the explicit consideration of how the intrinsic geography of a location relates to the different jurisdictional levels of planning, and how this can influence planning success. Aspects of geographical context that we found influential were the potential physical restriction of actors across landscapes and consequent social networks that arise from levels of connectivity; access to available resources; and the spatial fit between jurisdictional, geographical, and pragmatic concerns. The spatial fit between governing institutions and ecological processes or problems is an established concern in the social-ecological systems literature ('ecological fit', Bodin et al., 2014; Epstein et al., 2015). However, the connection between institutions and the intrinsic geography in the ecological fit literature is often implicit; here we refer to the fit between these explicitly. For example, some key informants perceived planning processes as less complex and more successful in SI than PNG due to geographical differences: SI comprises small, discrete island units separated by tracts of ocean, compared to the larger contiguous landmasses of PNG. The physical separation and comparatively smaller extents of provincial jurisdictions, and consequent greater fit between provinces and spatial extents to be planned for and managed by communities in SI (Fig. 2), contributed to more effective planning outcomes. The ability of geographical context to influence successful planning highlights the importance of understanding this dimension of scalar capital.

Explicit consideration of temporal scales is another essential component of multiscale understanding. Appropriate temporal scales appear to reflect the varying purposes of design and implementation that are relevant across different spatial extents. If we consider that spatial extent motivates the way conservation practitioners think about different objectives, and planning at different levels serves different purposes, then the expected temporal scales upon which different planning processes operate should also differ between levels and purposes. Consistent across our case studies (Figs. B.1-3, Appendix B of Supplementary data), all gazetted local protected areas have required extensive periods from conception to implementation (15–25 years; also see Morrison, 2009). Conversely, at higher levels (e.g., national and provincial) where planning more appropriately revolves around the design stages of conservation planning but lacks implementation, processes occurred over much shorter timeframes (2–3 years).

6.2. Scale jumping

Placed within the context of conservation planning, scale jumping (Smith, 1993) refers to the ability of actors or organisations to interact and operate vertically across multiple scales (here, across multiple jurisdictional levels), thereby enhancing the capacity of one scale from another (Morrison, 2007). This is integral to multiscale planning because it creates social or institutional links between the different levels of planning, facilitating planning processes at particular levels to inform those at other levels. For example, an individual capable of scale jumping is involved in processes at multiple levels (e.g., local and national) and, as a result, is capable of connecting otherwise constrained individuals or organisations at either of these levels. Considerable overlap exists here with problem of fit and governance literature, which views bridging and boundary organisations as important for enhancing the fit between governance and biophysical systems (Galaz et al., 2008). Our case studies build on this discourse in the context of conservation planning, demonstrating that successful occurrences of scale jumping had the potential to produce positive feedback flows through the generation of resource flows to other levels, or through the positive attitudes accumulated through cross-level activities.

We identified four outcomes of scale jumping pertinent to multiscale planning from our case studies: 1) contextualising, 2) grounding, 3) forecasting, and 4) accessing exogenous and cross-level resources (Fig. 5 and Table 2). These outcomes are not mutually exclusive; rather, we found that they were associated with other successful outcomes from planning processes. For example, accessing exogenous and cross-level resources often preceded contextualising, grounding, or forecasting outcomes. We describe below each of these outcomes, highlighting a mechanism that commonly enabled them, and their implications for multiscale planning. Delineating different types of scale jumping outcomes contributes to the broader governance discourse by highlighting ways in which engagement and collaborations between diverse groups (Pittman and Armitage, 2017) can be improved, and governance can be harmonised across scales and between ecosystems and management (Dallimer and Strange, 2015; de Oliveira Faria and Magrini, 2016).

Contextualising and grounding (Fig. 5) involve scale-constrained actors or organisations making decisions in the contexts of higher or lower levels, respectively. For contextualising, whereby decisions at lower levels are placed into the context of higher levels, scale jumpers motivate decisions by local stakeholders with a broader context (e.g., understanding the full extent of the degradation of timber resources

Table 2
Outcomes of scale jumping identified from interviews with key informants involved in conservation planning in Papua New Guinea and Solomon Islands, with observed examples described.

Outcomes of scale jumping	Observed examples identified from interviews
Contextualising (decisions made at lower levels placed into the social and/or ecological context of higher levels)	In participatory workshops, local community members were able to physically see themselves within the bigger context of their province, and make governance decisions on this basis
	Conservation practitioners (scale jumpers) applied lessons learned at lower, local levels to provincial and national processes, increasing efficiencies and effectiveness
Grounding (decisions made at higher levels placed into the social and/or ecological context of lower levels)	Provincial-level decision makers learned about the planning process and successful conservation outcomes of a local community conservation area
	Identified conservation priorities of local communities were placed into the context of an international mining company, with respect to tenement sites
Forecasting (extension of temporal perspectives)	In visiting successful conservation sites, local decision makers were able to imagine a potential future for their province if conservation initiatives were implemented
	Participatory planning workshops helped local actors to understand long-term consequences of development actions (e.g., mining)
Accessing exogenous and cross-level resources (external social, human, institutional, or financial resources from other levels)	Linking small local NGOs with higher-level funding opportunities (e.g., from provincial or national organisations), providing technical and financial assistance
	Training workshops held for local organisations involving the direct provision of exogenous resources (e.g., mapping tools, awareness products) to extend the impact of local organisations across the province

that has occurred across the whole province). Grounding places decisions at higher levels into a lower-level context, whereby scale jumpers mediate an international organisation to broaden their decision-making context to consider local circumstances, around which the international organisation has stakes (e.g., identification of conflict between an allocated mining tenement site with the highest conservation priorities established by local communities).

We found that contextualising and grounding also applied to scale jumpers themselves. Interview respondents reported that conservation practitioners who were involved in planning processes at multiple levels were able to draw from a richer knowledge base, informed by social, human, and institutional conditions experienced in varying contexts at each level of planning. These outcomes of scale jumping are important contributors to successful adaptive planning, which necessarily requires ongoing and explicit learning, as well as engagement with organisations and stakeholders at multiple levels (Mills et al., 2015). Moreover, the retention of individuals across different processes that these outcomes of scale jumping entail has been shown to promote retention of institutional knowledge (Fox et al., 2013).

Forecasting (Fig. 5) similarly involves a broadening of scalar contexts, but along temporal dimensions. In this outcome of scale jumping, actors or organisations constrained to thinking within short timeframes broaden these to consider processes over a wider range of temporal scales, relevant at higher social or ecological scales (e.g., Cumming et al., 2015). In this way, the jumping of spatial scales that occurs in forecasting is coincidental, arising from the expansion of temporal perspectives. This scale-jumping outcome can be used to address time-scale mismatches in addressing conservation problems (Wilson et al., 2016).

Interviewees also repeatedly highlighted accessing exogenous and cross-level resources (Fig. 5) as a factor contributing to the success of conservation planning across levels, emerging in our analysis as a significant outcome of scale jumping. Our reference to resources here is not exclusively monetary but includes several forms of capital (social, human, and institutional; Table 1). We found that, across all levels of planning, required resources consistently existed at other levels (both above and below, from external organisations or individuals), which were not accessible without scale jumpers liaising between levels.

A notable enabling mechanism identified for many of these scale-jumping outcomes was maintaining the continuity of individuals' involvement in planning processes across multiple levels and geographies. This concept is alluded to in descriptions and examples of human and institutional capital (Bottrill and Pressey, 2012); however, neither the role of this concept nor its pertinence to scale has been made explicit. While we refer to individuals remaining constant between processes, individuals can be substituted with organisational memory (Walsh and Ungson, 1991) but with the strong caveat of needing accurate, comprehensive, and timely recording systems within the organisation. Continuity of individuals across different levels contributes to increasing the wealth of planning experiences and knowledge gained from different institutional and geographical contexts by conservation practitioners (Fox et al., 2013), while also strengthening the capacity of these individuals to jump between different levels of planning. The significance of this role has been outlined previously with respect to successful adaptive conservation planning (Mills et al., 2015). Understanding different enabling mechanisms that facilitate scale-jumping outcomes, particularly given the conceptual overlap with broader environmental management and governance theory, is clearly needed.

Crucially, we found that consequences of scale jumping can effect a positive feedback loop whereby enabling mechanisms are facilitated, thus allowing more scale jumping outcomes to be produced. For example, a pivotal consequence of scale jumping is the development of broad social networks, which in turn contribute to the abilities of a scale jumper in connecting previously unconnected actors or organisations at different levels (Fig. 5). Bridging ties (within and across scales, as per social network theory; Schneider et al., 2003) spur collective action through connecting a diversity of actors, experiences, knowledge systems, and trust relations (Bodin and Crona, 2009; Cohen et al., 2012; Ernstson et al., 2010; Guerrero et al., 2015).

We observed one instance of scale jumping hindering the progression of a planning process (and thus, potentially, of multiscale planning). This occurred where a provincial planning process that experienced many of the beneficial outcomes of scale jumping also experienced an overload of attention as a result. Too many individuals and organisations sought to be involved, inadvertently overwhelming the province and rendering planning processes less effective and efficient (i.e., coordination between projects became challenging and local practitioners were overworked). This consequence could be attributable to the fact that scale jumpers and their activities were unequally distributed across the region. Were scale jumping enacted more uniformly across the region and beyond the one province, outcomes might have remained productive. For example, if grounding (Fig. 5; Table 2) were occurring in local-level sites across multiple provinces, attention from higher levels would be more evenly distributed. A similar conclusion has been drawn in the context of multilevel governance for large marine commons, where less distributed decision making in a nested system can constrain innovation and diversity (Gruby and Basurto, 2014). This has potentially important implications for 'hotspots' approaches to conservation (Myers et al., 2000) because these encourage concentrations of funds and actors into a few regions (e.g., Allen, 2008).

7. Scope to foster dimensions of scalar capital

Given that multiscale governance is critical to maximising conservation outcomes (Cumming et al., 2015; Lemos and Agrawal, 2006) and that scalar capital enables multiscale conservation planning, fostering scalar capital should be a prime consideration of conservation scientists, policymakers, and practitioners. The matching of management scales with ecosystem scales is a key mechanism purported to overcome problems of fit in social-ecological systems (Dallimer and Strange, 2015). Investing and accruing scalar capital could play an important role in facilitating such scale-matching. For example, increased coordination and collaboration across institutional levels is an often-cited strategy to increase fit (Bergsten et al., 2014; Pittman and Armitage, 2017; Sayles and Baggio, 2017) and was frequently achieved with scale jumping. However, further research is necessary to understand the extent to which scalar capital applies in a variety of different environmental governance systems than those examined here. Importantly, our case studies provide empirical evidence that the different dimensions of scalar capital can be fostered in planning processes (see Table B.1, Appendix B of Supplementary data). Based on our findings, we make other recommendations on ways scalar capital might be fostered.

In the dimension of multiscale understanding, we highlight the significance of understanding the purpose(s) of planning at different scales. Despite social objectives gaining the most importance at local levels and the difficulties in operationalising social objectives at high levels (Cheok et al., 2019), we propose that conservation practitioners consider social objectives at all levels. What requires change is the way that these objectives are conceptualised at different levels, being formulated to consider actors and features of the governance system that are relevant to each level. Local-level planning processes are likely essential in any multiscale planning context and we contend that the associated high costs, along with concomitant advantages, should be explicitly acknowledged to avoid failed expectations, particularly in discourses with funding donors who favour projects that appear more cost-effective (AbouAssi, 2013). To overcome the inherent variation in temporal scales relevant at different levels of planning, we suggest that conservation practitioners build a 'planning system identity' (as complex systems; Cumming and Collier, 2005; Folke, 2006), with iterative flows and feedbacks that need to occur between each of the levels over time. We argue that conceiving multiscale conservation planning as a complex system will facilitate more effective outcomes across scales, especially through promoting multiple-loop learning between different levels or ecological scales to inform decision making (e.g., Argyris, 1976; Pahl-Wostl, 2009). For planning at particular jurisdictional levels to inform and align with planning at other levels, practitioners and, importantly, funding institutions, must expand the temporal scales considered to include as much of the planning system as possible (e.g., long-term institutional commitment, recording and revision of organisational memory, and continuity of personnel, Pressey et al., 2013; Pressey and Bottrill, 2009). Otherwise, these organisations will waste brief but valuable efforts when institutional responses are not synchronised with ecological or social processes (Epstein et al., 2015; Levin et al., 2013).

Across a number of research areas, significant overlap is evident in the concepts we have identified and discussed, related to governance, geography, and interactions within and between actors and organisations at different levels. This suggests that the ability to foster scalar capital is of broader relevance and interest across the fields of collaborative governance, policy and social network theory, political geography, social-ecological systems theory, and institutional fit. In understanding policy and social networks in environmental governance, certain networks have been identified as less effective for multi-actor collaboration (e.g., Mills et al., 2014; Sayles and Baggio, 2017). The specific outcomes of scale jumping we have identified can be targeted in such cases, to influence the social or policy networks and improve the capacity for collaborative governance. This is further impetus for future research to investigate specific enabling mechanisms in scale jumping. Moreover, empirical studies of social networks that analyse explicit cross-scale relations have identified only the relative positions of scale-crossing brokers within the network that provide integral links between levels, or areas within the network where cross-scale links are lacking (Cohen et al., 2012; Guerrero et al., 2015). In these analyses of social networks and the related fields of social-ecological systems theory and problems of fit (Epstein et al., 2015), fostering the dimensions of scalar capital can contribute by identifying where and how beneficial cross-scale links can be created, aligning the planning and institutional systems, and temporal scales considered, closer to ecological systems.

An important consideration in evaluating and fostering scalar capital is our ability to measure it in planning processes. Given the overlap in concepts between scalar and the other existing forms of capital (e.g., connections between actors in social capital and these occurring at different scales for scalar capital), evaluations need to go beyond quantitative reporting of the total number of indicators for each capital alone. Evaluating scalar capital should include understanding the extent to which planning processes invest or accrue the different dimensions of scalar capital, in addition to descriptions of beneficial outcomes and the mechanisms adopted to achieve these. In particular, we note that there were distinct enabling mechanisms that facilitated the scale-jumping outcomes identified here. Future research should investigate methods to best measure and understand these mechanisms in detail, as well as potential causal and interacting relationships between them.

8. Conclusions

The intrinsic role of scale in any social-ecological system means that scientists, policymakers, and planners must explicitly consider multiple scales in the successful understanding or management of these systems. For the first time, we demonstrate empirically how multiscale conservation planning occurs in practice and that the perceived dichotomy of scaling down and scaling up in conservation planning might not, in fact, be representative of real-world multiscale governance. Despite highly decentralised governance systems in Melanesia, evidence of multiscale planning was not strictly unidirectional and involved multidirectional flows of planning resources between different levels.

We propose the novel concept of scalar capital, and provide empirical evidence that supports and highlights its necessity for effective multiscale governance. Two novel dimensions of scalar capital – multiscale understanding and scale jumping – appear equally critical in successfully integrating and coordinating conservation governance across multiple scales. We propose that scientists, policymakers, and planners integrate scalar capital into existing evaluation frameworks for conservation planning and governance to improve explicit considerations of scale in these processes and, ultimately, multiscale outcomes. Much scope remains to explore these concepts further and understand the extent of their applications in more detail. While inputs of scalar capital into multiscale conservation planning have thus far been inadvertent, we suggest that conservation scientists, policymakers, and planners should invest in generating scalar capital within and across processes, and intentionally design multiscale planning as a way to improve conservation outcomes across multiple scales. We also stress the necessity to examine other multiscale conservation governance systems in contrasting socio-political contexts to those investigated here, to further substantiate and explore these new ideas.

CRediT authorship contribution statement

Jessica Cheok: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Visualization. **Rebecca Weeks:** Conceptualization, Methodology, Formal analysis, Writing - review & editing. **Tiffany H. Morrison:** Conceptualization, Methodology, Formal analysis, Writing - review & editing. **Robert L. Pressey:** Conceptualization, Methodology, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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