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Social Synergies, Tradeoffs, and Equity in Marine Conservation Impacts

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Abstract

Biodiversity conservation interventions often aim to benefit both nature and people; however, the social impacts of these interventions remain poorly understood. We reviewed recent literature on the social impacts of four marine conservation interventions to understand the synergies, tradeoffs, and equity (STE) of these impacts, focusing on the direction, magnitude, and distribution of impacts across domains of human wellbeing and across spatial, temporal, and social scales. STE literature has increased dramatically since 2000, particularly for marine protected areas (MPAs), but remains limited. Few studies use rigorous counterfactual study designs, and significant research gaps remain regarding specific wellbeing domains (culture, education), social groups (gender, age, ethnic groups), and impacts over time. Practitioners and researchers should recognize the role of shifting property rights, power asymmetries, individual capabilities, and resource dependency in shaping STE in conservation outcomes, and utilize multi-consequential frameworks to support the wellbeing of vulnerable and marginalized groups.

Contents

1. INTRODUCTION

Governments, corporations, and private citizens are increasingly using conservation interventions to meet biodiversity and sustainable development goals [e.g., Goal 14 and 15 of the UN Sustainable Development Goals (1)]. Four prominent families of interventions have rapidly expanded in scale, extent, and scope: payment for ecosystem service (PES) schemes, eco-certification programs, community-based management (CBM), and protected areas (2–5). Protected areas currently cover 15% of the world's land and 7.3% of the ocean surface. Furthermore, two environmental certification schemes (Rainforest Alliance and Marine Stewardship Council) alone account for 10%, 20%, and 14% of the world's cocoa, tea, and wild marine catch production, respectively (6–8).

Tradeoffs: occurrence of both positive (gains) and negative (losses) outcomes across social groups, scales, or wellbeing domains attributed to an intervention

As conservation interventions continue to increase in size and number around the world to meet global targets (9–11), so too will the number of people affected by their implementation (12). There is considerable debate on whether conservation and environmental interventions result in social and environmental benefits (13–15) or instead produce tradeoffs (12, 16–21). Many proponents of the win-win discourse see conservation as a way to create synergistic benefits for biodiversity and human wellbeing (e.g., 22–25), highlighting the many potential social benefits from improved environmental conditions, such as increased ecosystem services (26). Skeptics argue, however, that the restrictions necessary to improve environmental conditions inevitably incur some form of social loss (including opportunity costs) to some individual or group, even with associated development activities (12, 27). Although there are many examples of environmental interventions resulting in social benefits (e.g., 23, 28–30) or social harm (e.g., 31–35), both sides of the debate present simplified narratives that do not consider the complexities of conservation impacts on human wellbeing—particularly the synergies, tradeoffs, and (in)equity among impacts (36, 37).

Synergies: multiple positive (gains) or multiple negative (losses) outcomes across social groups, scales, or wellbeing domains attributed to an intervention

Equity: when processes and outcomes associated with an intervention are fair and just

1.1. Knowledge Gaps on Social Synergies and Tradeoffs

There has been an increased effort to develop frameworks and monitoring protocols for assessing social impacts from conservation (e.g., 38–43), as well as numerous case studies, meta-analyses, and reviews (e.g., 24, 44–49). However, many evidence gaps remain (49), particularly regarding marine conservation interventions and the diversity of their social impacts on coastal communities (13, 36).

Despite growing recognition of the need to account for the heterogeneity within and among affected populations (19, 50), and the multidimensional nature of human wellbeing (37, 51), limited research has examined synergies and tradeoffs among social benefits and costs from conservation (13, 52). A lack of evidence on the heterogeneity of marine conservation impacts on human wellbeing can impede effective and equitable policy and practice. Without an understanding of how people are affected, the synergies and tradeoffs that occur between social groups, and the spatiotemporal distribution of impacts, policy makers are "shooting in the dark" when designing, managing, and implementing conservation interventions (37, 53). Unawareness of the diversity of social consequences of conservation could result in negative impacts on coastal communities, including the inequitable distribution of costs and benefits (36, 54, 55) and increased vulnerability to shocks such as climate change (31). Policy makers need greater insights on the range of social impacts stemming from various conservation interventions, particularly regarding the distribution of these impacts across various aspects of human wellbeing, social groups, and scales (56, 57). Furthermore, in a systematic map of conservation social impacts, McKinnon et al. (58) noted relatively few studies on marine conservation intervention outcomes compared to their terrestrial counterparts. Thus, many questions remain: How are different domains of human wellbeing impacted by marine conservation interventions? Do we only observe social losses in marine conservation? Are certain groups systematic "winners" or "losers" (59)? How do impacts vary across space and time?

1.2. Study Objectives

In this review, we examine synergies, tradeoffs, and equity (STE) of social impacts in marine conservation interventions. We approach STE through the examination of the heterogeneity of conservation impacts on human wellbeing and the distribution of these impacts across wellbeing domains, social groups, and scales. More specifically, this review seeks to

1. provide a conceptual and analytic lens for describing social STE in the impacts of conservation interventions,
2. characterize the growth and evolution of the scientific literature on STE of social impacts associated with marine conservation interventions,
3. synthesize the literature on the STE of social impacts from marine conservation interventions,
4. discuss emergent themes and highlight gaps in current evidence on STE for future research.

To place our findings into context, we first review existing conceptual frameworks relevant to heterogeneity in social impacts from conservation—particularly those related to STE (Section 2).

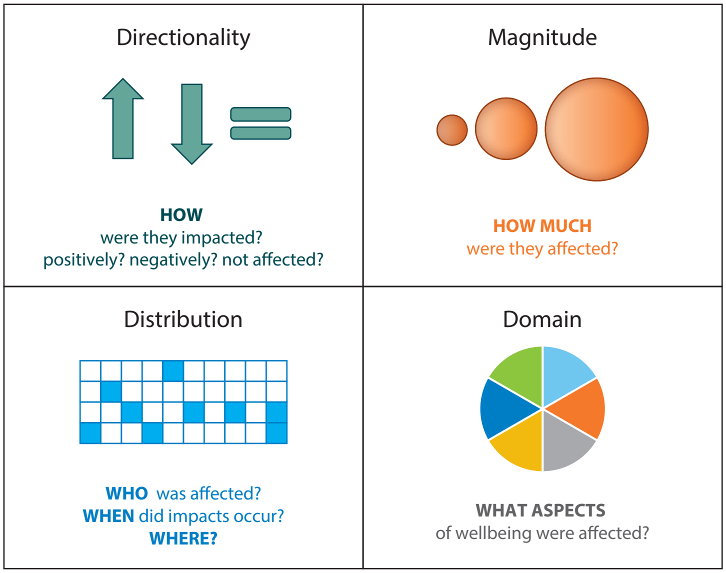

Figure 1

Framework for assessing heterogeneity in social impacts, focusing on four major dimensions of heterogeneity: directionality, magnitude, distribution, and domain.

In Section 3, we characterize the growth, evolution, and state of the scientific literature on marine conservation synergies (both positive and negative) and tradeoffs as it relates to the direction, magnitude and distribution of social impacts among wellbeing domains, social groups, space, time, and levels of organization [here termed the STE framework (**Figure 1**)]. For each type of conservation intervention, and across each of the above dimensions of heterogeneity, we map the distribution of marine STE studies, highlighting the gaps in the literature. We also assess the types and quality of data used to draw inference on STE (**Supplemental Appendix 2**). Finally, we conclude in Sections 4 and 5 with a discussion of emergent themes, research frontiers, and conclusions.

Supplemental Material >

2. CONCEPTUALIZING SYNERGIES, TRADEOFFS, AND EQUITY IN SOCIAL IMPACTS

2.1. From Mono-Consequentialism to Distributional Equity

Conservation scholars are giving increasing attention to how conservation affects local communities; however, many fail to recognize the heterogeneity in social outcomes. Earlier research focused on how conservation influences individual outcomes, such as levels of overall economic wealth or poverty (53, 60, 61). However, such mono-consequential assessments ignore the potential, and often substantial, variations in the social impacts of conservation (52), which are not often examined in the literature (13, 37).

Conservation interventions can result in equitable or inequitable outcomes given the variation in the direction, magnitude, and distribution of impacts (**Figure 1**). Although many types of social equity exist [e.g., recognition, contextual equity, procedural equity (50, 62, 63)], distributional equity speaks to the distribution ("Who was affected? When did impacts occur? Where?"), direction ("How were they impacted? positively? negatively? not affected?"), and magnitude ("How much were they affected?") of costs, risks, and benefits from a specific event or intervention (50).

This variation results in synergies (both positive and negative), tradeoffs, and inequitable impacts among social groups, space, time, and levels of social organization (27, 37, 64) (**Figure 1**).

2.2. Identifying Winners and Losers

Within the conservation literature, pairs of outcomes are commonly conceptualized as so-called win-lose tradeoffs or synergistic win-win or lose-lose scenarios in comparative studies (e.g., 30, 65, 66) and in many conceptual frameworks (e.g., 57, 67). Although most of this previous work focuses on social versus biodiversity impacts, understanding whether conservation results in gains for one social group (the so-called winners) at the expense of another (the losers) has considerable implications for achieving equitable and just conservation (50). Who wins and who loses may vary substantially across space, time, and other scales (13, 57), highlighting the importance of simultaneously examining heterogeneity along these multiple dimensions. Additionally, the perceived direction, magnitude, and distribution of impacts may also differ substantially from objective measurements (68, 69), creating disparities between researcher observations and what is experienced and reported by respondents. Although disparities may never be fully resolved, understanding the experiences and perceptions of affected individuals is necessary for a more complete view of the relational and subjective aspects of wellbeing (41).

2.3. Beyond Winners and Losers: Domains of Human Wellbeing

Identifying conservation winners and losers is important but insufficient for advancing beyond mono-consequential frameworks of social impacts. Although the winners-losers framework is useful for assessing distribution of impacts across contexts ranging from local area-based marine management (e.g., 70, 71) to global change processes [e.g., climate change and globalization (59)], the idea of discrete winners and losers is inadequate to fully capture the diversity and equity of impacts from change (59). Human wellbeing comprises multiple domains [e.g. economic wellbeing, culture, health (40, 42, 72, 73)], and individuals can simultaneously experience gains from one domain and losses in another (e.g., 74). Thus, given the myriad ways in which conservation can impact these various domains (52, 75), it is likely that a single social group or individual can experience both synergies and tradeoffs at the same time.

Recent advancements in the literature describe the diversity of ways environmental policies and practices impact human wellbeing (e.g., 38, 40, 42, 51, 72, 73, 76, 77), extending beyond a traditional focus on income and other material indicators (37). Human wellbeing refers to having a positive physical, social, and mental state (78), and includes subjective and relational aspects of life (40, 77). Therefore, for a more comprehensive evaluation of the diversity of impacts from marine conservation interventions, we need to not only consider the direction, magnitude, and distribution of impacts across groups/individuals and scales, but also the synergies and tradeoffs that may occur between various domains of wellbeing (37, 40, 52).

3. GROWTH AND STATE OF SYNERGIES, TRADEOFFS, AND EQUITY LITERATURE IN MARINE CONSERVATION

3.1. Conservation Interventions

From the 2,619 articles that we screened, we identified and extracted information from 75 studies that reported heterogeneous social impacts from marine conservation interventions (see the **Supplementary Materials** for the review methodology). Here we define a conservation

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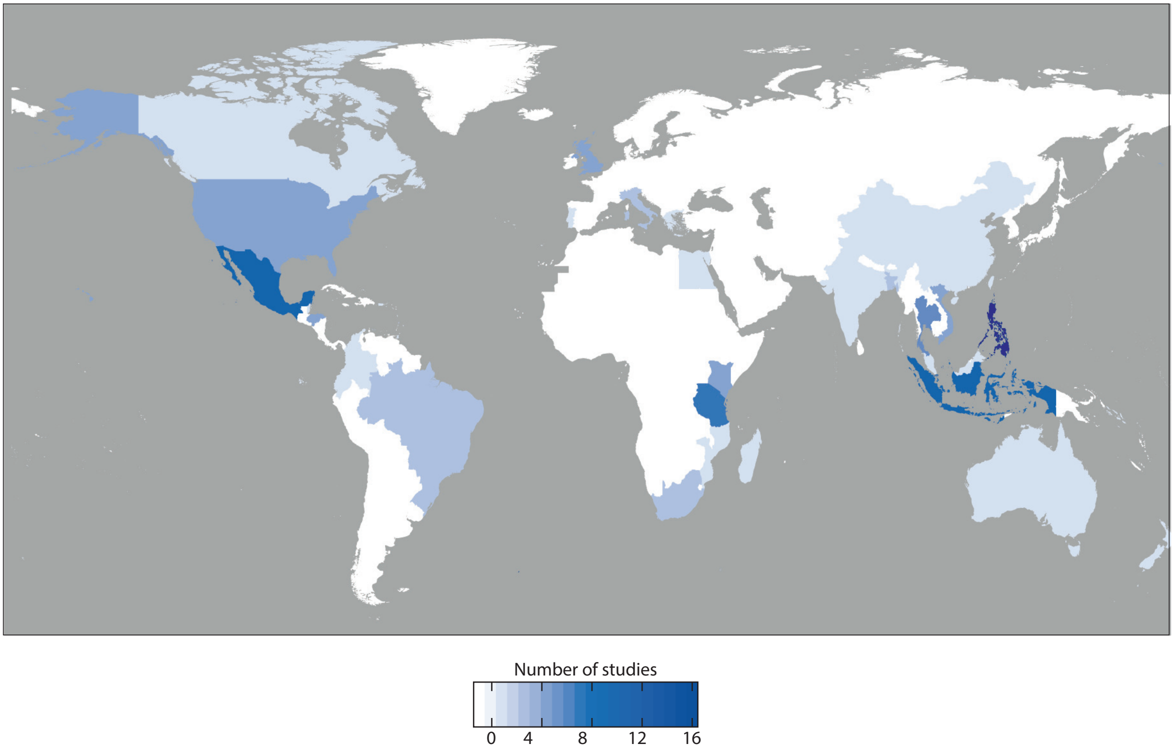

Figure 2

Number of articles by country based on study site location ($n = 75$ studies). Country border map provided by Sandvik 2019 (**https://thematicmapping.org/downloads/world_borders.php**).

intervention as a specific action (project, program, or initiative) where the primary objective is the preservation of biodiversity and associated habitats (79). We focused on four prominent families of conservation interventions: marine protected areas (MPAs), PES, environmental certification, and community-based management (CBM). These represent the most prominent types of interventions examined within the conservation literature on social impacts (58). The 75 studies in our sample assessed interventions in 44 countries/territories (**Figure 2**) and focused heavily on interventions in Southeast Asia (36% of studies), Eastern Africa (13%), and Central America (12%). Almost all studies focused on local-scale interventions (93%), and were predominantly located in or near tropical nearshore environments such as coral reefs and their associated ecosystems (e.g., sea grass, mangroves) (53%).

Research on MPAs was the major driver of growth of studies in our sample (**Figure 3**), potentially reflecting the rapid increase in the number and extent of these interventions in the past few decades (7) and their prominence in the global conservation and development agenda [e.g., 10% MPA coverage target in UN Sustainable Development Goal 14.5 (1, 80)]. MPA literature represented 85% of the sample ($n = 64$ of 75 studies), with nine of these studies (12%) assessing MPAs that were part of a CBM intervention (**Figure 4**). Given their hybrid nature, we assigned this subset of research on community-based MPAs into its own category (CBMPAs). Studies on other interventions were comparatively rare, with only 8 (11%) and 3 studies (4%) assessing CBM and certification interventions, respectively. None of the PES studies met the inclusion criteria. Intervention sizes (MPAs, CBMPAs) ranged from approximately 1 km^2 to $>$10,000 km^2.

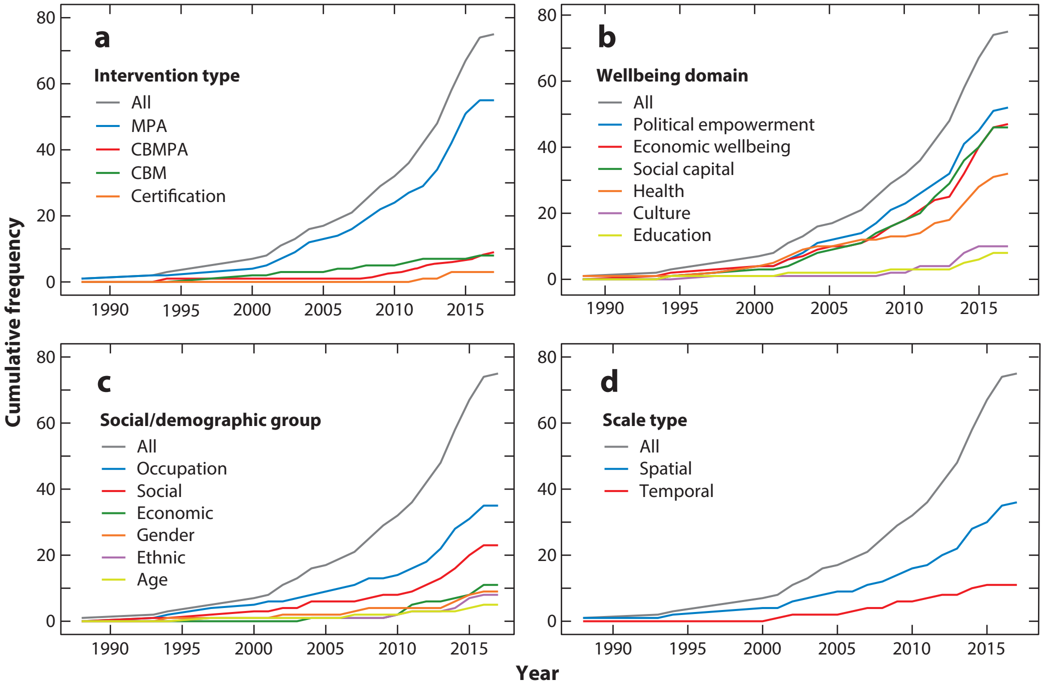

Figure 3

Cumulative number of studies over time by (*a*) intervention type, (*b*) wellbeing domain, (*c*) social/demographic group, and (*d*) scale type ($n = 195$ outcomes in 75 studies). The total number of studies (labeled as "All") is less than the sum of individual categories, as a single study can include more than one category. Abbreviations: CBM, community-based management; CBMPA, community-based marine protected area; MPA, marine protected area.

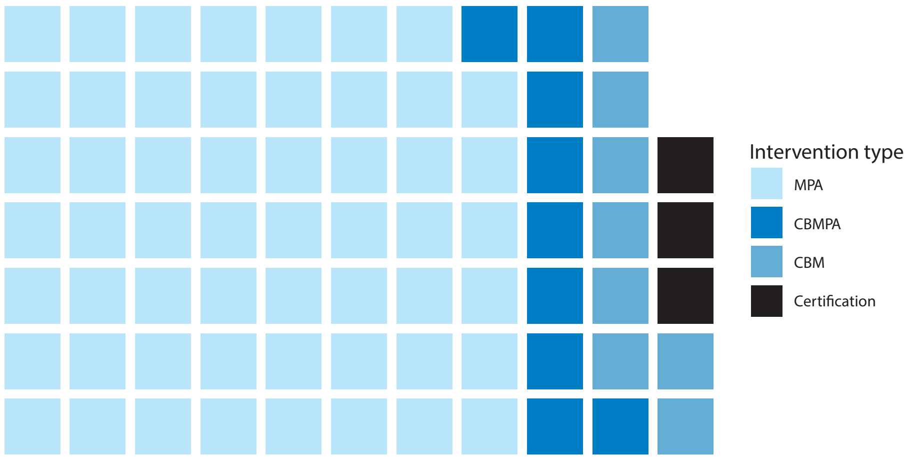

Figure 4

Number and types of marine conservation interventions where authors assess heterogeneous social outcomes ($n = 75$ studies). MPAs ($n = 55$; 73%) and CBMPAs ($n = 9$; 12%) made up the majority of the sample, with few studies assessing outcomes in CBM ($n = 8$; 11%) and certification ($n = 3$; 4%) interventions. Abbreviations: CBM, community-based management; CBMPA, community-based marine protected area; MPA, marine protected area.

3.2. Conservation Outcomes

From the 75 studies included in our review, we identified 195 combinations of outcomes that acted synergistically, antagonistically (i.e., tradeoff), or had unequal impacts across various domains of wellbeing, social/demographic groups, or scale.

Supplemental Material >

3.2.1. Human wellbeing domains. Drawing on recent reviews of wellbeing frameworks (40, 72, 73), we classify wellbeing outcomes into economic, health, political, education, social capital, and cultural domains (see **Supplementary Table 1** for typology). For every impacted wellbeing domain reported in the literature, we recorded observed synergies (positive or negative), tradeoffs, or cases where both synergies and tradeoffs occurred across multiple wellbeing domains.

Literature reporting social STE associated with marine conservation interventions has increased considerably over the past two decades, increasing at an average rate of 2.5 studies/year (**Figure 3*a***). Across intervention types, researchers most commonly reported outcomes related to political empowerment ($n = 52$ of 75 studies; 69%), economic wellbeing ($n = 47$; 63%), and social capital ($n = 46$; 61%), with notably few studies assessing cultural or education outcomes (**Figures 5*a*** and **6**). Within these domains, resource use rights, social capital/cohesion, and income were the most commonly reported subdomains or attributes [64%, 61%, and 47% of the 75 studies, respectively (**Figure 7**)]. Resource use rights mostly referred to changes in access, use/withdrawal, or management rights for resource extraction (e.g., mangrove harvesting, fishing), and social capital/cohesion commonly referred to changes in levels of conflict. Some social outcomes were inferred from study results, even though these outcomes were not a principal focus of the study. For example, in their study assessing spillover of fish biomass from the Mombasa Marine Park, McClanahan & Mangi (81) also reported on changes in conflict levels and access rights attributable to the Park.

Within the literature, synergies and tradeoffs between wellbeing domains were pervasive, particularly among political empowerment, economic wellbeing, and social capital domains. Authors

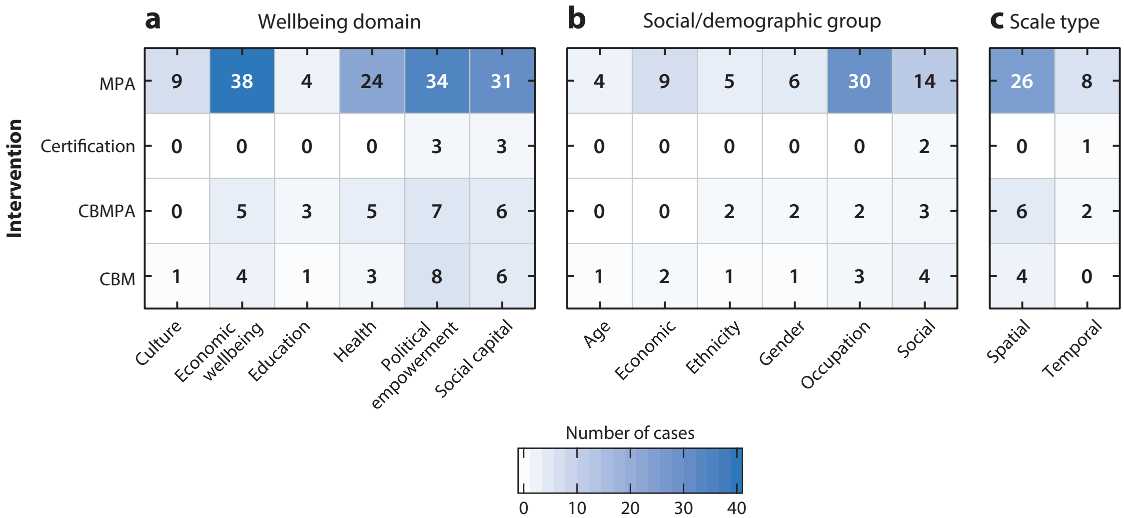

Figure 5

Distribution of outcomes (cases) by intervention for each (*a*) wellbeing domain, (*b*) social/demographic group, and (*c*) scale type ($n =$ 195 outcomes in 75 studies). The color and numbers within the cells represent the frequency of occurrences. Abbreviations: CBM, community-based management; CBMPA, community-based marine protected area; MPA, marine protected area.

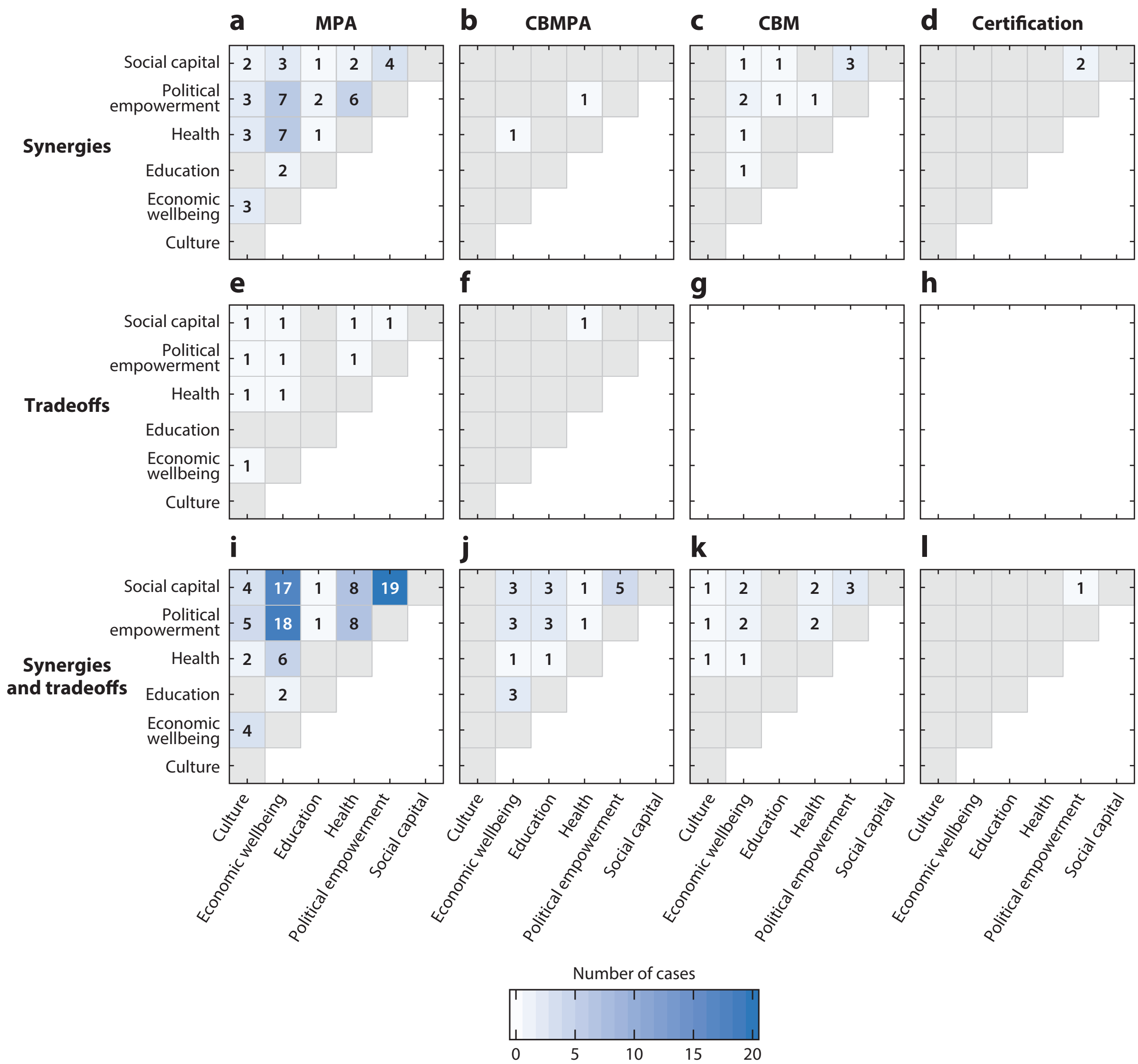

Figure 6

Distribution of reported synergies (*a–d*), tradeoffs (*e–h*), and both synergies and tradeoffs (*i–l*) between human wellbeing domains in MPAs (*a*,*e*,*i*), CBMPAs (*b*,*f*,*j*), CBM (*c*,*g*,*k*), and certification (*d*,*h*,*l*) interventions ($n = 195$ outcomes in 75 studies). The color and numbers within the cells represent the frequency of occurrences. Abbreviations: CBM, community-based management; CBMPA, community-based marine protected area; MPA, marine protected area.

commonly reported synergies between income (economic wellbeing) and food security (mostly catch rates) (**Figure 6*a–c*,*i***). For example, Weigel et al. (82) reported positive synergies between fisher income (economic wellbeing) and catch per unit effort [food security (health domain)] from the Chumphon Archipelago Marine National Park, Thailand. Kamat (83) noted multiple negative synergies, where the loss of access to fishing grounds (resource use rights) and gear confiscations (material wealth) reduced fishing activity and subsequently led to hunger and malnourishment in

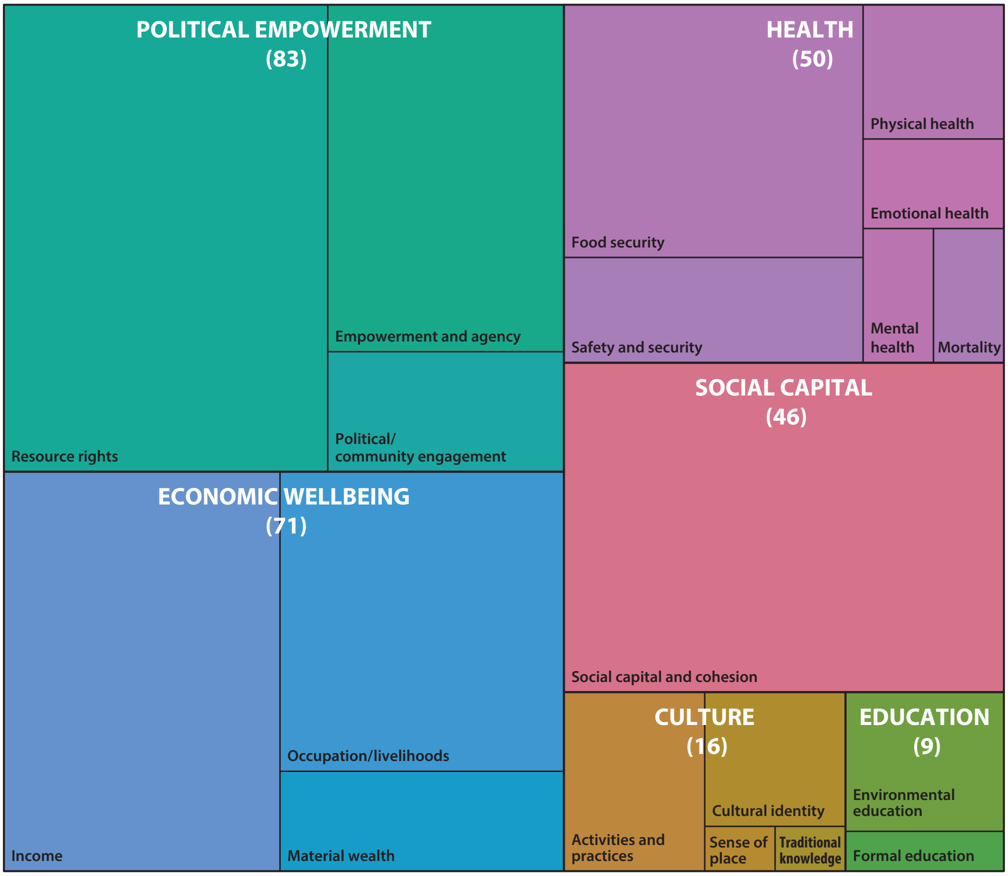

Figure 7

Distribution of domains ($n = 195$) and subdomains/attributes ($n = 275$) reported in the 75 studies. Total number of subdomains reported in each domain shown in parentheses.

the affected communities (food security). When comparing the number of synergies and tradeoffs reported, across interventions, we observed more synergies than tradeoffs between wellbeing domains (**Figure 6**). This is not surprising, as human wellbeing is interconnected (40), and a positive or negative impact on one domain is likely to result in synergistic impacts across others. Nonetheless, a common tradeoff (particularly in community-based interventions) was when decision makers such as community leaders changed who had access to marine resources (political empowerment), which then resulted in conflict with other users or communities [social capital (e.g., 66, 84)].

When one considers the broad suite of impacts across multiple wellbeing domains concurrently, and the multi-way interactions between them, it is not surprising that most studies reported both synergies and tradeoffs occurring at the same time (**Figure 6**). These mixed outcomes commonly occurred between the political empowerment, economic wellbeing, and social capital domains (**Figure 6*i***). Similar to the example above, there were cases where increased management rights led to greater income from fishing and/or tourism, but also to increased conflict with groups with restricted access (83, 85). Multiple synergies and tradeoffs also occurred among other domains. Users of the traditionally managed areas in the Diani-Kinondo area in Kenya reported that the community-managed areas supported their cultural fishing practices (culture) as well as good catch rates [health (synergy)] (86). However, the perpetuation of the traditional management systems also contributed to conflict (social capital/cohesion) between the elders who practice traditional spiritual practices and younger Muslim fishers (tradeoff).

3.2.2. Social and demographic groups. The current literature highlights the disparity in conservation impacts among various demographic and social groups (particularly on those involved in fisheries), and the impacts of altering use, withdrawal and access rights. Authors most frequently described differential impacts by occupational groups such as tourism operators, net fishers, etc. ($n = 35$ of 75 studies; 47%) (**Figures 2*c*** and **5*b***). Overall, fishing was the most studied occupational group, where authors considered fishers as either a distinct group of interest or as a key stakeholder within a broader group of actors. These studies reported changes in catch, income, or access rights of different types of fishers (81, 87), fisheries sectors (82), or fisher economic classes (88) following an intervention or a regulatory change. Other studies reported changes in resource use rights for fishers relative to other sectors such as tourism (e.g., 66, 89, 90). Studies that assessed impacts on other types of social groups ($n = 23$ of 75 studies; 31%) often compared impacts on "insiders" versus "outsiders" [e.g., co-op members versus non-members (91)] in the fishing community.

When assessing distribution of impacts across social groups, authors reported more synergies than tradeoffs (**Supplemental Figure S5**). For example, Foucat (92) described the economic benefits that both co-op members and nonmembers derived from a community-based ecotourism project. The authors also reported synergistic benefits to both women and men, although most of the ecotourism activities were carried out by male cooperative members. Although less commonly reported, tradeoffs did occur in some cases, particularly around access and use rights. Of the eight studies that report impacts on different ethnic, cultural, or religious groups (11%), five reported tradeoffs between members of different castes (93), clans (84, 94), or other people groups (85, 95). Here one or more groups gained additional resource rights and others experienced partial or whole losses in their rights. These changes in resource rights often resulted in synergistically negative experiences of conflict between the groups. For example, fishers in Mabini, Philippines, stated that tourism operators were given greater control over MPA policy at the expense of the fishers, resulting in conflict between fishers and tourism operators (66). Other studies either reported positive (74) or negative (96) synergies between religious groups (e.g., education, conflict), or synergistic losses of traditional and cultural uses across multiple ethnic groups (33). Most studies that assessed impacts by age reported synergistic impacts between older and younger individuals ($n = 5$; 7%). In the two studies that reported tradeoffs between age groups, authors stated that older and/or younger individuals did not benefit from the intervention because they either (*a*) were not part of a major stakeholder group and thus unaware of how to access program benefits (95), or (*b*) felt dispossessed by new regulations limiting their use and access to marine resources (97). In seven of the nine studies that reported gendered impacts, we observed synergistic positive [e.g., increased income, greater energy and protein intake (82, 98)] or negative [e.g., loss of income, food security, and access to fishing grounds (83, 99)] impacts for both women and men. These impacts were not always equivalent, and we observed cases where women were uniquely negatively affected or benefited less from conservation than men (e.g., 86, 100). For example, in Cogtong Bay, Philippines, women "were significantly more negative in their perceptions of household income," changes stemming from a community-based mangrove project (99, p. 419). In two CBMPAs in Kenya, Mahajan & Daw (86) explained that although both women and men perceived increased conflict, female fish traders reported receiving less or no benefits from the *tengefus* (CBMPAs) compared to male traders.

Supplemental Material >

When considering a wide array of impacts across economic and ethnic groups, gender, or age, attempts to identify discrete winners and losers are obscured by the fact that synergistic gains, losses, and tradeoffs can stem from the same intervention. In the studies reporting impacts by economic class ($n = 11$ of 75 studies; 15%), many authors reported tradeoffs and inequalities where disproportionate negative impacts fell on poorer individuals (e.g., 15, 31, 88, 93, 101–103), but not always, as some individuals simultaneously experienced both synergistic benefits and tradeoffs (e.g., 71, 104). For example, poor Kenyan fishers were more likely to perceive bearing the costs of displacement, but were also more likely to report having catch benefits from a nearby MPA (71).

3.2.3. Scales. Few studies examined heterogeneity in social impacts across temporal or social scales. Between 2000 and 2015, most studies assessing variation across scales focused on spatial heterogeneity ($n = 36$ of 75 studies; 48%). These spatial comparisons varied from comparing two discrete communities (e.g., 98) to assessing how impact magnitude changes with increasing distance from the intervention (e.g., 81, 105). McClanahan & Mangi (81) noted more discernable spillover effects on the southern edge of the reserve boundary than the northern end where management was much weaker, and Abesamis et al. (106) reported higher mean catch rates (and estimated income per unit effort) near the Apo Island Reserve boundary relative to further away (although potentially attributable to variations in fishing activity). In Brazil, catch rates near to the Tamoios MPA were lower than those from the comparison site further away, indicating that at the time of study, the MPA did not have a discernable effect on catch (107).

Supplemental Material >

Similar to impacts across social groups, we observed more synergies than tradeoffs between spatial units (**Supplemental Figure S5**). Although many of these synergies related to conflict stemming from the reallocation of access or use rights, we also observed cases where authors attributed positive synergies in social capital (108), empowerment (109), economic (110), and health (98, 111) outcomes between sites to an intervention. For example, Harris et al. (111) stated that an integrated population, health, and environment program in Velondriake, Madagascar, provided both synergistic economic and health benefits from family planning in multiple villages where the project was implemented. In many cases, tradeoffs between sites appeared to be linked to differences in how communities (namely fishers) use and depend on the marine environment. Fishers in communities whose historical use was most affected by restrictions (e.g., gear type, fishing area) often had more negative perceptions of the impacts than communities using different gears or spaces (e.g., 32, 84, 112, 113), particularly if the rules were created by one of the communities with more tenure rights or influence in decision making (e.g., 84, 112). In the Mafia Island MPA, Kincaid et al. (112) suggested that unequal fishing restrictions and different fishing histories likely contributed to fishers from the Utende community (who were more involved in decision making) perceiving greater benefits from the MPA and associated livelihoods programs than fishers from the Chole community who were also more affected by the fishing restrictions. Clarke & Jupiter (84) found that some CBMPAs in the Kubulau District in Fiji resulted in conflict between fishers in different clans and villages due to uncertainties with regard to property rights over various marine areas. Although these villages all synergistically experienced conflict, the change in property rights meant that villages exercising management rights benefited to the exclusion of others (i.e., tradeoff).

Within the modest literature on temporal variation ($n = 11$ of 75 studies; 15%), authors described the variability in the direction and magnitude of impacts over the lifetime of an intervention. Temporal comparison includes studies that assessed impacts across multiple discrete temporal units (e.g., time period 1 versus 2; $n = 4$; 5.3%) or variation in short- versus longer-term impacts ($n = 7$; 9.3%). Within the early stages of the implementation of the Madison–Swanson and Steamboat Lumps Marine Reserves in the Gulf of Mexico, Smith et al. (114) reported differences between the instantaneous (−4%) and the subsequent short-term (−14%) effects of the MPA on fish catch for select commercial fisheries. Although Aswani & Furusawa (98) observed potential synergistic (but unequal) food security benefits among MPA villages in Roviana, Solomon Islands, they cite one of their previous studies that reported negative impacts during the early stages of implementation. Similarly, Gurney et al. (115) reported that an Indonesian conservation and development project was effective at reducing some aspects of poverty during the project's implementation (e.g., livelihood insecurity); however, many of these improvements did not continue to accrue after the project's external support was withdrawn.

We also observed synergies and tradeoffs within the literature that discussed social impacts across various levels of social organization (e.g., household versus community). Some authors reported cases where impacts were scale-independent and thus synergistic across different levels of social organization. For example, Kamat (83, p. 295) noted that the Mnazi Bay-Ruvuma Estuary Marine Park in southern Tanzania had "not brought any noticeable economic benefits to the local residents, individually or at the household level…" and called for additional research to examine differences in impacts at the village level. Although there was considerable variation in perceived impacts at the study site, some respondents in Mahajan & Daw's (86) study described both personal and community-scale benefits from the CBMPA. Other authors presented cases of tradeoffs, where, for example, an organization financially benefited from an intervention, such as the marine management agency in the Cayos Cochinos Natural Monument (85), while community members felt that they either benefited less or were disadvantaged as a result of management-related activities.

4. DISCUSSION

Examining the direction and magnitude of social impacts across social groups, scales, and domains reveals the complex and diverse ways that marine conservation interventions affect human wellbeing. The ubiquity of diverse impacts suggests that heterogeneity—and, thus, synergies, tradeoffs, and unequal impacts—should be expected from conservation interventions. While highlighting the insufficiency of simple conservation versus development narratives, this complexity also shows that winners, losers, equity, and overall "success" can be difficult to define, as both (positive and negative) synergies and tradeoffs can be experienced by the same individual.

Although this review highlights the importance of considering heterogeneity of social impacts, it also reveals that the state of the current literature is insufficient to robustly demonstrate cause and effect relationships. Few studies were intentionally designed to empirically measure casual impacts (**Supplemental Appendix 2**), and even fewer were designed to empirically describe why outcomes occur. Furthermore, current research effort shows potential bias toward specific fields (**Figure 5**) and geographies of study (**Figure 2**). As such, we do not collectively quantify magnitude nor direction of impact across the literature given the potentially low number of rigorous study designs. Although this obscures causality and attribution of impacts to specific drivers, the literature base does allow us to characterize emergent themes regarding drivers of heterogeneity and thus STE of social impacts that should be considered in conservation research and design. In particular, disparities in access, power, capabilities, and resource dependency within a particular context appear to affect how vulnerable (per se) individuals are to conservation impacts (both positive and negative), as social impacts manifest themselves among domains and across groups.

Supplemental Material >

4.1. Vulnerability and Conservation Impacts

Marine conservation interventions can have disproportionate effects on select populations (36, 71, 75); thus it is important to identify which groups are most sensitive to impacts and have limited capacity to adapt to avoid losses or accrue benefits (116). Within the climate literature, vulnerable populations are those that are exposed to climate threats (e.g., sea-level rise), sensitive to changes in the environment (e.g., high dependency on coral reefs), and limited in their adaptive capacity to change (e.g., sufficient social and financial capital) (117–119). Similarly, conservation interventions can be seen as a shock to marine social-environmental systems (120), where disparities in vulnerability are functions of the differences in the level of exposure to the intervention in the water [e.g., closed fishing grounds in MPAs (112)] or in the market [e.g., certification programs (91)], sensitivity to change in marine resource health and access [e.g., high resource dependency (83)] and the capacity to benefit (or avoid losses) from an intervention [e.g., power over rights allocation, education level, occupational mobility (100, 103, 121, 122)]. Although vulnerable groups can be more sensitive to improvements in resource condition (e.g., 71), they are also most sensitive to negative synergistic impacts on their wellbeing (123). These negative impacts (e.g., decreased income and food security, conflict, disempowerment, etc.) could, in turn, produce feedbacks that further compromise the ability of individuals to adapt to future shocks such as climate change (31). Here we discuss how aspects of adaptive capacity (access, power, capabilities) and sensitivity (resource dependency) contribute to variations in conservation impacts among "exposed" populations, and ultimately, synergies, tradeoffs, and inequity.

4.1.1. Access rights and wellbeing. A common theme within our sample of 75 studies is how changes in political empowerment, particularly resource rights, result in cascading synergies (both positive and negative) and tradeoffs across other domains of wellbeing, particularly economic wellbeing and social capital (**Figure 6*i–l***). Across intervention types, conservation regimes alter human access to and control over natural resources, and the consequences of these alterations affect wellbeing through a variety of mechanisms (72, 124). In many cases, the reallocation of property rights had positive or negative cascading effects on other aspects of wellbeing, including access to income-generating activities (e.g., 93, 109, 122, 125), food security (83, 103), education (e.g., 83), cultural uses (e.g., 33, 126), and social connections (e.g., 94).

Conservation can provide considerable benefits to individuals with access (or who gain access) to marine resources (23, 127). Within the literature, we observed instances of positive synergies that the authors attribute to improved ecosystem condition, namely income and food security (**Figure 6*a–d***). By improving ecosystem health, marine conservation can result in increased ecosystem services and positive impacts on human wellbeing (128). Leisher et al. (23) present various cases where improved ecosystem health led to increased catch rates and tourism livelihoods, which in turn led to improved economic wellbeing and food security. Russ et al. (28) describes how fishers within the community saw increased catch rates and revenues from tourism following the establishment of the Apo Island Reserve in the Philippines.

Empowerment through gains in management and exclusion rights (particularly in CBM) represents another pathway in which conservation can lead to multiple wellbeing impacts. Both Steenbergen (94) and Webster et al. (129) reported cases where select members of the community received additional ownership and/or management rights (political empowerment) to regulate outsider access and fishing activity, and as a result, saw increased collective income and living standards (economic wellbeing). Excluding outsiders from a defined area (e.g., CBMPA) or market (e.g., certification) can lead to increased benefits by reducing competition for resources (79, 91). In their examination of fisheries certification programs in Canada and Mexico, Foley & McCay (91, p. 9) noted that each program "confers access, exclusion, and conversely, privileges resembling property rights" to members of recipient groups (e.g., fishing cooperatives) to the disadvantage of nonmembers. Fabinyi (29) reported that the development of CBMPAs in the Calamianes Islands, Philippines, "produced an artificial form of marine tenure among coastal communities," by allowing a subset of users to determine what fishing practices were allowed and fees imposed at the expense of other fishers and dive operators (respectively). For those individuals who lost access or use rights as a result of state or nonstate conservation initiatives, we observed negative synergistic impacts on their wellbeing (127). For example, Kamat (83) reported that loss of access to ancestral fishing waters (political empowerment) as a result of the Mnazi Bay-Ruvuma Estuary Marine Park (Tanzania) and associated enforcement led to synergistic losses of livelihoods and assets (economic wellbeing) and, subsequently, food insecurity, malnourishment (health), and lower school attendance (education) among community members. In the Natural Marine Monument Archipiélago Cayos Cochinos, indigenous community members stated that the MPA regulations and enforcement resulted in the "criminalization of the Garifuna fishing activity" (culture) and increased risk at sea (health) (85).

There were many cases where the reallocation of property rights also led to increased conflict between user groups. For example, we observed multiple cases where individuals or groups who gained property rights would experience synergistic increases in economic wealth, but tradeoffs in terms of conflict with groups who synergistically lost access rights, economic opportunities, and/or fish catch (e.g., 66, 88, 97, 130; see also Section 3.2.1). Causes of conflict included perceptions of unfair rules or inequitable outcomes (e.g., 66, 122, 131) as well as increased competition due to displacement (e.g., 33, 97). There were even cases where conflict surrounding conserved areas or resources led to violence or fatalities (e.g., 102, 126).

Not all cases of lost access, however, result in negative synergies, particularly if there are other mechanisms or pathways to impacts. Despite the multiple negative impacts the Garifuna fishing community felt from the Cayos Cochinos MPA, local residents stated that the MPA also provided employment and income to the community (economic wellbeing) through a private tourism enterprise (85). In Salisu Barau & Stringer (132), local communities lost access to spiritual sites as a result of the Pulau Kukup Ramsar site, yet spoke of increased land tenure and economic growth over time as a result of the protected area and associated programs.

Given the strong connection between resource access and wellbeing impacts (51), decision makers should pay careful attention to how resource rights are allocated and provide accessible conflict resolution mechanisms where conflict is prevalent or expected (15, 32, 133). In addition to identifying winners and losers, examining the synergies and tradeoffs on the various domains of wellbeing (particularly of vulnerable or marginalized groups) will give a better understanding of the range of expected social impacts and facilitate designing more equitable interventions (51, 134).

4.1.2. Context and distributional equity. Access, capabilities, power, and relationship to the environment can vary greatly among individuals or groups in any affected population (50). These disparities appear to be significant explanatory factors of STE between groups, influencing who benefits or bears the costs from conservation interventions.

4.1.2.1. Contextual equity and adaptive capacity. Differences in access, power, and capabilities (contextual equity) play a key role in conservation outcomes, both in terms of who is involved in decision making (procedural equity) and who is most vulnerable to being disproportionately affected (distributional equity) (50). According to McDermott et al. (50, p. 420), contextual equity "takes into account the uneven playing field…created by the pre-existing political, economic and social conditions under which people engage in and benefit from resource distributions—and which limit or enable their capacity to do both." Within the literature, authors described how factors such as an individual's education or language (100), occupation (135), ability to change occupations (104), financial capital (103, 121), and social group (86, 95) affected the distribution, magnitude, and directionality of conservation impacts. Such factors are important in determining whether an individual can benefit from, adapt to, or shape changes such as intervention outcomes (51, 100, 116). For example, authors described how inadequate resources can limit fishers' ability to adapt to displacement or fishing restrictions (103, 121, 122). Also, although development programs such as alternative livelihood projects can provide considerable benefits to communities (e.g., 86), the ability to accrue benefits from these programs can be limited by one's occupational mobility, existing resources, education, or language skills (85, 100).

In many cases, pre-existing power imbalances meant that select individuals or groups with power (or access to power) influenced intervention design and, subsequently, influenced who benefited or bore the costs from the intervention. Within the literature, authors describe how distributional equity was affected by pre-existing social hierarchies (95), power, social connections (94, 103), and influence over management design and rules (15, 66, 88, 95, 135). The outcomes of these interventions can reinforce and exacerbate existing inequalities, further marginalizing groups who were not part of the decision-making process (66, 91, 100, 136). For example, in the Karbonkelberg Sanctuary, South Africa, authorities did not consult poor fishers with historical fishing rights about the new MPA fishing restrictions, and these fishers stated that they had to watch as commercial vessels with lobster permits "take out tons in our backyard and we have to stay out" of no-take areas where the poor fishers were no longer allowed access (122, p. 577).

The importance of contextual and procedural equity in the distribution of impacts highlights the need to identify marginalized groups whose limited access, capabilities, and power traditionally prevent them from accessing decision-making fora or benefiting from interventions (31, 50). These individuals have limited capacity to adapt to change in resource governance, benefit from development programs, and could be disproportionately affected by limited access rights to the resource base.

4.1.2.2. Sensitivity to conservation impacts. The expected magnitude of impacts on specific social groups from conservation is strongly linked to their relationship to the marine environment. In the review, all else equal, individuals who were more dependent on marine resources were more sensitive to changes in resource condition and governance (e.g., access or use rights). Of all the user groups assessed by authors, fishers were most affected by conservation. Although this is expected, as all the intervention types in this study generally seek to regulate extractive uses in some way, we observed that fishers with high resource dependency, low occupational diversity, and low mobility were most sensitive to conservation impacts (e.g., 31, 71, 83, 126, 137). In Tanzania, Kamat (83, p. 293) noted that those who were "solely reliant on fishing and marine extraction activities for their livelihood saw a direct connection between the implementation of the Marine Park and their deteriorating food security." In other cases, strong cultural ties to marine resources also increased sensitivity to change in access and use rights (e.g., 33, 126). Nonetheless, there were examples where these groups were also more sensitive to improvements in marine resource condition or related conservation program benefits. In Cinner et al. (71), poorer Kenyan fishers appeared to be more sensitive to both negative (displacement) and positive (catch benefits) effects from MPAs. Similarly, Gurney et al. (74) found that Muslim community members appeared to receive more environmental education benefits from an integrated marine conservation and development program than Christians. This is likely because the education programs were more relevant to Muslims who generally live closer to shore and rely more heavily on marine resources.

4.1.3. Addressing inequalities in vulnerability. Although conservation creates unequal impacts, practitioners can design interventions that support equitable outcomes by including vulnerable groups in decision making. By applying a vulnerability framework to identify exposed and sensitive individuals or groups who have limited adaptive capacity, decision makers can focus efforts on improving (or not compromising) the wellbeing and resilience of these vulnerable groups, especially those that might otherwise be excluded from the decision-making process (138).

Working with stakeholders, implementing entities can identify what type of outcomes and equity outcomes are important for the social-ecological context (e.g., reduced economic inequality), and integrate them in intervention design, implementation, and evaluation (37, 64). Furthermore, with careful assessment of the preexisting social context with its diverse array of resource use histories, and capabilities, practitioners and stakeholders can design interventions that seek to, for example, increase positive synergies within marginalized and vulnerable groups or create tradeoffs that reduce power inequalities between groups (50). Such inclusive and context-relevant approaches are resource and time intensive (138), and may require building capacity for some groups to effectively participate (50). Nonetheless, these approaches help to tailor the intervention to better align with the values, beliefs, and aspirations of affected stakeholders, and help to improve the overall fit of the intervention to its social-ecological context (139, 140). Outcomes from these processes can then inform the design of equitable rules and regulations regarding resource use, as well as compensatory mechanisms in cases where considerable losses are expected for particular groups (141, 142; but see 37). Furthermore, given the limited information on the distribution of impacts across age, gender, and ethnic groups, policy makers should pay special attention to potentially marginalized segments of these groups, especially when it involves significant changes in their resource rights.

4.2. Knowledge Gaps and Research Frontiers

To advance both conservation science and policy, researchers will need to address major knowledge gaps regarding STE within marine conservation, and apply rigorous research designs to improve our understanding of causal impacts and mechanisms.

4.2.1. Filling knowledge gaps. Despite a considerable increase in literature on STE of marine conservation impacts, many knowledge gaps remain. Of the 2,619 articles we screened in this review, less than 3% reported multiple social impacts from marine conservation, and only a subset of these intentionally assessed heterogeneity as part of the study objectives. Although this highlights the need for more research on STE in general, the review also revealed areas where specific knowledge gaps exist. First, our review highlights the need for research on the social impacts of marine conservation interventions other than MPAs (**Figure 4**). The Marine Stewardship Council certification program, for example, accounts for 14% of the world's wild marine catch production (8); however, this review and others (e.g., 2) suggest that very little research has been done on the social impacts of such certification schemes. Second, few studies assessed synergies or tradeoffs regarding (*a*) cultural and educational outcomes (**Figure 5*a***); (*b*) variation in outcomes by age, gender, ethnic, and economic groups (**Figure 5*b***); and (*c*) impacts over time (**Figure 5*c***). The variability observed in these categories (Section 3.2) suggests a need for long-term monitoring on these and other aspects of heterogeneity. Third, additional research on STE across spatial, temporal, and organizational scales as well as understudied regions (e.g., West Africa, Middle East; **Figure 2**), ecosystems (e.g., offshore and temperate ecosystems), and user groups (nonfishing actors) would strengthen the scientific literature.

4.2.2. Rigorous, holistic study designs. Counterfactual study designs can contribute to a more robust understanding of STE. Quantitative wellbeing indicators provide insight as to whether the magnitude of impacts are statistically different between groups (e.g., 137) or compared to a counterfactual (115). Counterfactual approaches are integral to effective impact evaluation; they add considerable rigor to the results by allowing the researcher to identify and control for alternative explanations and separate trends from impact. Such studies were rare within the literature (e.g., 114, 115), but can provide robust insights that are both locally relevant and generalizable across contexts for cross-case comparisons (e.g., systematic reviews, meta-analyses). Well-designed counterfactual studies can simulate randomized control trials [which are not feasible to implement within most conservation contexts (120, 143)] when they are able to account for factors affecting site selection and those that affect outcomes (120, 144). These studies can be costly to implement, and should therefore be applied strategically where the return-on-investment from study insights is expected to be high (e.g., emerging or contested interventions) (79).

Mixed-method approaches can facilitate more holistic assessments of wellbeing impacts. Combining qualitative and quantitative observations can provide valuable insight into how people are objectively and subjectively affected by an intervention [e.g., perceived versus absolute equity (68)]. However, most studies in this review reported impacts based solely on respondent subjective perceptions and recall. Although subjective and objective observations can agree (e.g., 145), they can also disagree significantly (e.g., 74, 129), and both observation types are necessary to fully understand changes in various aspects of wellbeing (41). Thus, we recommend combining quantitative and qualitative approaches within quasi-experimental (counterfactual) frameworks, as such study designs can capture insights on heterogeneous changes and impacts between different groups beyond what quantitative indicators can ascertain alone (72, 146). Mixed methods can help researchers develop plausible theories of change, identify indicators that are locally relevant, use recall methods to construct baselines, and provide context for understanding underlying mechanisms driving impacts [see Woodhouse et al. (41) for additional methods and guidance on mixed method approaches in impact evaluation].

5. CONCLUSION

This review highlights the heterogeneous nature of social outcomes stemming from marine conservation interventions. This study demonstrates that conservation impacts extend far beyond social-ecological win-wins where everyone gains, or tradeoffs where nature always wins and people always lose. Furthermore, conservation does not create systematic winners or losers of any particular group. Instead, people experience a diverse array of synergies and tradeoffs in impacts that vary in distribution and magnitude across domains, individuals, locations, as well as over time. Conservation alters how people interact with resources and each other (36, 147), and the literature demonstrates the importance of property rights in shaping social outcomes, as well as how the preexisting context and power asymmetries in decision making contribute to varying vulnerabilities to change in resource governance and ultimately, variation in impacts.

Given the complex diversity of wellbeing impacts on different groups of individuals, which vary over time, space, and social scales, tradeoffs are inevitable in marine conservation interventions. To achieve more equitable conservation, policies should attempt to foster positive synergies, minimize negative synergies, and carefully consider tradeoffs for those most vulnerable to negative conservation impacts. To effectively inform such policies, it is critical to understand the enabling conditions and mechanisms that contribute to maximizing positive synergies as well as those that produce tradeoffs or negative synergies. On the basis of our review, it appears that the allocation of resource rights, power to shape these resource rights, relationship to the environment (e.g., resource dependence), and capacity to benefit from intervention (particularly development programs) are key determinants to what type of synergies or tradeoffs accrue across groups, domains, space, and time. These hypotheses have not been robustly tested, as few studies in our sample empirically tested relationships between context and outcomes, and many other determinants may exist [e.g., cross-scale interactions (139), cultural dynamics (86)]. Nonetheless, assessing the relative vulnerability to conservation impacts can provide valuable insight into who will likely be most affected by conservation and how.

Although there has been a significant increase in the number of studies assessing STE in marine conservation interventions, the absolute number of studies remains limited, and significant knowledge gaps remain. To advance science and inform policy, there is a critical need to improve our understanding of how impacts are distributed across understudied domains, groups, interventions, and geographies as highlighted in this review. Rigorous study designs that (*a*) capture STE using context-appropriate indicators, (*b*) allow for holistic assessments of wellbeing, and (*c*) facilitate cross-site inference are necessary to build a strong evidence base for both local management and the conservation sector as a whole (36). These evidence-based insights, applied within good governance frameworks, can help guide practitioners toward more equitable and sustainable policy and practice.

As coastal communities face increasing risks from climate change, biodiversity loss, and other changes, marine conservation interventions are likely to expand both in coverage and scope to address these imminent threats (148, 149). Conservation has the ability to build resilience in coastal systems (150); however, decision makers must ensure that conservation activities support, and not undermine, people's ability to adapt to change (116). The multi-consequential approach we use in this review can shed light on who is likely to be impacted by conservation and how, providing insights for designing conservation strategies that provide synergistic benefits to (or minimize negative synergies on) coastal communities, particularly vulnerable and marginalized groups. Extending this approach to terrestrial and freshwater systems will help to advance efforts to building a more just and sustainable future for people and the planet.

SUMMARY POINTS

1. Four main dimensions of heterogeneity appear useful for assessing STE of social conservation impacts on human wellbeing: domains, distribution, magnitude, and directionality.
2. Although there is an increasing body of literature on STE of social impacts of marine conservation, significant knowledge gaps remain for particular wellbeing domains, social and demographic groups, scales, interventions, and geographies.
3. Many conservation interventions reallocate property rights over marine resources, propagating a diversity of synergies and tradeoffs among other aspects of human wellbeing, particularly economic wellbeing and social conflict.
4. In addition to property rights, contextual factors—such as local power asymmetries, individual capabilities, and resource dependency—affect how vulnerable individuals are to conservation benefits and costs, leading to inequitable outcomes.

FUTURE ISSUES

1. What are the major drivers, mechanisms, and feedbacks contributing to heterogeneous social outcomes?
2. How are marine conservation impacts distributed across different levels of social organization and other scales?

3. Are marine conservation interventions exacerbating or reducing existing inequality within coastal communities?
4. What types of governance approaches lead to synergistic positive impacts on different domains of wellbeing?
5. What is the role of procedural and contextual equity in shaping distributional equity in marine conservation?
6. Are marine conservation interventions supporting or compromising people's resilience to climate change?
7. How does the relative vulnerability (exposure, sensitivity, adaptive capacity) of individuals to changes in resource governance affect conservation outcomes?
8. How can counterfactual designs and mixed-method approaches be integrated to assess objective and subjective aspects of wellbeing impacts?

DISCLOSURE STATEMENT

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