Marine Policy 93 (2018) 223–231

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

A rapid assessment of co-benefits and trade-offs among Sustainable Development Goals

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ARTICLE INFO

Keywords:
Sustainable Development Goals
Ocean sustainability
Policy prioritization
Sustainability framework
Sustainability relationships

ABSTRACT

Achieving the United Nations' 17 Sustainable Development Goals (SDGs) results in many ecological, social, and economic consequences that are inter-related. Understanding relationships between sustainability goals and determining their interactions can help prioritize effective and efficient policy options. This paper presents a framework that integrates existing knowledge from literature and expert opinions to rapidly assess the relationships between one SDG goal and another. Specifically, given the important role of the oceans in the world's social-ecological systems, this study focuses on how SDG 14 (Life Below Water), and the targets within that goal, contributes to other SDG goals. This framework differentiates relationships based on compatibility (co-benefit, trade-off, neutral), the optional nature of achieving one goal in attaining another, and whether these relationships are context dependent. The results from applying this framework indicate that oceans SDG targets are related to all other SDG goals, with two ocean targets (of seven in total) most related across all other SDG goals. Firstly, the ocean SDG target to increase economic benefits to Small Island Developing States (SIDS) and least developed countries for sustainable marine uses has positive relationships across all SDGs. Secondly, the ocean SDG target to eliminate overfishing, illegal and destructive fishing practices is a necessary pre-condition for achieving the largest number of other SDG targets. This study highlights the importance of the oceans in achieving sustainable development. The rapid assessment framework can be applied to other SDGs to comprehensively map out the subset of targets that are also pivotal in achieving sustainable development.

1. Introduction

Achieving sustainable development faces many ecological and social challenges, such as single sector resource management, resource scarcity, environmental contamination, and the persistence of forced labour [1,2]. These challenges are interlinked and to address them will require a concerted international effort beyond independent or specialized programs [2]. In 2015, The United Nations formalized 169 targets to gauge progress towards sustainability under 17 Sustainable Development Goals (SDGs), including for example eradicating poverty

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http://dx.doi.org/10.1016/j.marpol.2017.05.030
Received 30 March 2017; Received in revised form 23 May 2017; Accepted 24 May 2017
Available online 05 June 2017

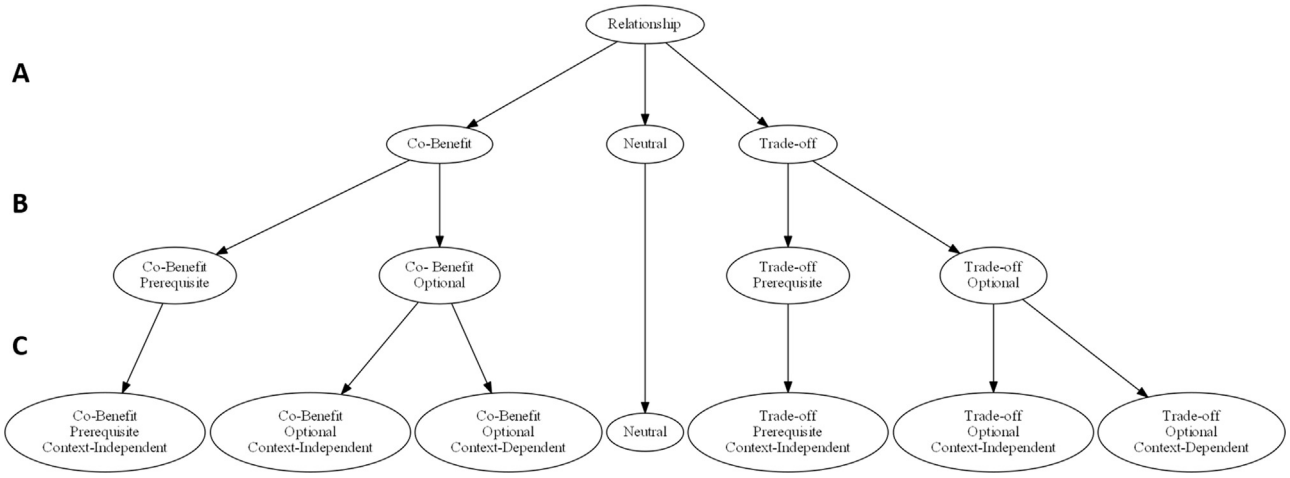

Fig. 1. Hierarchical framework to characterize relationships among SDG targets. A) Compatibility of the relationship is determined (co-benefit, neutral, or trade-off). B) Relationships are considered "prerequisite" or "optional" if progress on the first target is needed to fulfill the second target, or not, respectively. C) The degree of confidence in relationships is determined. For relationships categorized as "context independent" there is high confidence that achieving a specific SDG target contributes to a co-benefit (or trade-off) with another; "context-dependent" indicates that the compatibility of the relationship is likely to be context-dependent.

and hunger, and promoting innovation and economic growth [3]. These goals resulted from international and interdisciplinary collaboration, and explicitly allow countries to determine their own context-appropriate strategies [3].

Among those goals, goal 14: Life Below Water (the "Oceans goal") aims to "*conserve and sustainably use the oceans, seas and marine resources for sustainable development*". Ocean targets comprise ecological and socioeconomic concerns, including reducing marine pollution (SDG 14.1); restoring marine habitat (SDG 14.2); reducing impacts of ocean acidification (SDG 14.3); eliminate overfishing as well as illegal, unreported and unregulated fishing (SDG 14.4); conserve marine areas (SDG 14.5); eliminate harmful fishing subsidies (SDG 14.6); and increase economic benefits to Small Island Developing States and least developed countries (SIDS, SDG 14.7). The current state of global oceans limits the potential to achieve far reaching sustainability objectives [4,5]. Realizing sustainable oceans has the potential to contribute to other sustainable development goals, though currently this SDG has the least identified progress [6], and has received the third lowest philanthropic funding [7].

The goals are presented independently. While their diversity and scale may seem prohibitive, these goals are in practice often interrelated and interdependent in social-ecological systems, meaning that progress on one can advance or impact a suite of others [8]. Relationships among goals can often be path-dependent, where achieving a certain SDG may contribute to another, but that relationship may not be true in reverse [8]. Relationships can also be characterized differently depending on the nature of the contribution [9]. In some cases, achieving an SDG target may be required to attain another SDG target [8]. For example, achieving sustainability of food production systems (SDG 2.4) requires the elimination of harmful fishing practices and overfishing (Target 14.4) [10]. In other cases, achieving a specific SDG target can contribute to but not be a prerequisite in realising a different target. For example, establishing effective marine protected areas (Target 14.5) may contribute to ecosystem restoration (Targets 14.2 and 15.5), but there are other ways that ecosystem restoration can be achieved [11]. Understanding the nature of such relationships, and their interdependencies, is required to show the interconnections between ocean and society and to indicate where SDG targets work in concert and co-benefit. This understanding potentially allows for greater return on management investment, or can indicate where SDG targets conflict, which can inform important decisions regarding trade-offs [8].

This paper introduces and operationalizes a framework for identifying the dependencies (co-benefits) and hindrances (trade-offs) among directional relationships. This framework does not assume that a functioning biophysical environment is a necessary pre-requisite to support social and economic goals, as is central to some conceptual treatments of the relationships between economy, society, and environment [12], rather the framework allows for the possibility that ecological goals can be supported by social and economic concerns. Most importantly, this framework allows for an understanding of the prevalence of co-benefits versus trade-off relationships between ocean sustainability and other SDGs in particular settings. This framework was used to characterize the contribution of SDG 14 to other SDG targets globally. Additionally, we suggest that the framework can also be used to explore relationships between other SDG targets or similar multi-goal policies (e.g. the Convention on Biological Diversity's Aichi Targets [13]), and could be modified to increase its relevance in specific contexts (such as national or regional scales).

2. Material and methods

There are 17 SDGs, with most including between 3 and 10 targets. Goals focus on environment (ocean and terrestrial), social justice (ending poverty, hunger, etc.), economy (creating meaningful jobs, sustainable economies), and infrastructure (cities and urban planning). The final goal (SDG 17, with 19 targets) focuses on creating international partnerships with the capacity to support the achievement of the other goals. Relationships between SDG targets (i.e. does one contribute or detract from another, and under what context) were mapped following a formal framework during a series of workshop sessions with subject experts (see Section 2.2 below).

2.1. SDG relationship evaluation framework

To assess the relationships between SDG targets, the framework presented here addresses three hierarchical considerations: the compatibility of the relationship (co-benefit, trade-off, neutral); the requirement of the first SDG target for the fulfillment of the second SDG target or not (prerequisite versus optional); and whether or not the compatibility of the relationship is confidently understood as independent of social-ecological context and implementation (context-independent versus context dependent, Fig. 1).

Below are some example relationships to illustrate the framework:

- *Co-benefit-prerequisite-context-independent:* Effectively regulating overfishing and destructive fishing practices (SDG 14.4) is required to achieve global resource efficiency (SDG 8.4);

- *Co-benefit-optional-context-dependent:* Eliminating marine pollution (SDG 14.1) can contribute to eliminating malnutrition (SDG 2.2) by increasing the availability of marine resources for food, though ending malnutrition can be achieved without reducing marine pollution and reducing marine pollution may not have any effects on malnutrition;
- *Co-benefit-optional-context-independent:* Increasing marine resources availability through marine restoration (SDG 14.2) can invariably help end malnutrition (SDG 2.2), but there are other strategies to can end malnutrition without relying on marine restoration.
- *Trade-off-optional-context-dependent:* Establishing marine protected areas (SDG 14.5) can work against improving rights and access to resources (SDG 1.4) if they are established and enforced without engaging local stakeholders. However, protected area planning may mitigate against these conflicts through proper consultation.
- *Neutral:* Reducing impacts from ocean acidification (SDG 14.3) has no influence on reducing mortality from road traffic accidents (SDG 3.6).

2.2. Evaluation workshop

The workshop was divided into 16 sessions, with each session focussed on one of the SDG goals. All sessions were held in a conference room with no more than two sessions per day. Participants were from diverse fields including marine ecology, natural resource and fisheries economics, ocean governance and social anthropology, all of whom have a publication record in marine research. The focus of each session was the population of a matrix representing the seven targets of SDG 14 versus the targets of the other SDG goal of the session. Each cell in the matrix required three pieces of information (A: co-benefit vs. trade-off, B: prerequisite vs. optional, and C: context-independent vs. context-dependent in Fig. 1). The meaning of each SDG target was taken verbatim from the wording of the target text and was not considered more broadly. For example, considering how ocean sustainability can relate to gender equity in terms of increased economic equity was only considered in specific targets where economic equity concerns were explicitly mentioned. Attention was paid to the timelines for each target, so that relationships noted in each cell of the matrix also consider the implications of any intended target achievement dates. For example, ending overfishing (SDG 14.4) is intended to be achieved by 2020, and halving the number of people in poverty (SDG 1.2) by 2030. Most Oceans targets have target achievement dates of 2020, and most targets of other SDGs (other than SDG 15: Life on Land) have achievement dates of 2030. Therefore, most relationships considered a ten-year lag, but some targets such as reducing the number of youth not in employment or training (SDG 8.6) which has an achievement date of 2020 are considered without this ten-year lag. Some targets do not have explicit achievement dates and these targets were treated without the ten-year achievement period.

Three participants initially debated characterizations for each cell, for each stage in the hierarchical framework (Fig. 1). One participant had a background in marine ecology and management, one had a background in fisheries economics and management and one had a background in marine anthropology. Having participants from mixed fields can combat overconfidence bias that can occur when participants have similar backgrounds [14], though even when all participants agreed on a characteristic, they were asked to explicitly consider alternative characteristics. Explicit consideration of alternatives was designed to challenge preconceptions in participants and stimulate discussion and feedback that can lead to better participant contribution [15–17]. A dedicated facilitator and note-taker was present, who recorded the rationale for assigning relationship categories. The relationship of SDG 14 to SDG 17 (Partnerships for the Goals) was not considered because SDG 17 relates to the international policy cooperation and capacity-building necessary to achieve other goals, and so is meant to support other goals, but not be supported by them. Secondary targets within each SDG goal were also not considered, as these targets (delineated with letters instead of numbers, e.g. 1.a; [3]) do not include goal achievement dates or specific actions, requiring extra interpretation for what achievement means.

2.3. Expert confirmation

Once the matrix was compiled, the responses for each Oceans target against all other SDG targets were vetted by experts (n = 10) associated with specific Oceans targets. All experts were academics with training and publication histories associated with the corresponding ocean target they were asked to review (e.g. marine pollution, ocean acidification, fisheries subsidies, etc.). One to three experts provided comments and suggestions for each Oceans target. One expert vetted results for marine pollution, two experts vetted for environmental restoration, one expert vetted for ocean acidification, one expert vetted overfishing, three experts vetted for marine protected areas, one expert vetted for subsidies, and one expert vetted for economic benefits to SIDS. Experts were provided with the framework used to characterize the relationships, the matrix summarizing the assigned relationships, and a summary text document describing the mechanistic relationships between the Oceans target and other SDG targets. These steps were taken to reduce linguistic uncertainty arising from the communication between the workshop participants and the experts [18]. Experts were asked not only to reflect on the relationships as identified by the workshop, but also provide literature (where possible) to support (or challenge) resulting relationships. In cases where experts disagreed, favour was given to relationships with literature support. If there was no literature support and expert disagreement, experts were contacted to settle the disagreement. Experts' comments were then incorporated into the final matrix describing relationships between ocean targets and other SDG targets. The matrix with supporting comments and literature is provided in Supplementary File A.

3. Results

All 16 SDGs evaluated (excluding SDG 17 as noted above) were associated with SDG 14: Life Below Water (Fig. 2), though to different degrees and with different relationships. This included a cross-comparison of each target of SDG 14, with each other target within SDG 14. Increasing economic benefits to Small Island Developing States (SIDS) and least developed countries (SDG 14.7) was the only target associated with all 16 SDG goals considered. Ending overfishing (SDG 14.4), environmental restoration (SDG 14.2), and marine protection (SDG 14.5) were associated with 14, 14, and 13 SDGs respectively. Ending harmful subsidies (SDG 14.6), reducing marine pollution (SDG 14.1), and reducing impacts from ocean acidification (SDG 14.3) were associated with 11, 11, and 8 SDGs respectively. Ending overfishing was positively related to the largest number of other SDG targets, including the largest number of obligate relationships. Ending overfishing had approximately twice the number of obligate relationships as increasing economic benefits to SIDS - the ocean target with the second-most obligate relationships (Table 1).

All SDGs are associated with progress on achieving the Oceans goal (SDG 14). Six SDGs are positively related to every Oceans target: ending poverty (SDG 1), ending hunger (SDG 2), creating sustainable cities and communities (SDG 11), climate action (SDG 13), life on land (SDG 15), and peace, justice, and strong institutions (SDG 16). In contrast, only four SDGs are positively associated with three or fewer Oceans targets: good health and wellbeing (SDG 3), gender equality (SDG 5), clean water and sanitation (SDG 6), and affordable and clean energy (SDG 7). Ending poverty (SDG 1) has co-benefit-prerequisite-context independent relationships with six of the seven Oceans targets, and ending Hunger (SDG 2) has co-benefit-prerequisite-context independent relationships with five out of seven Oceans targets. These findings indicate that achieving six of the seven and five of the seven Oceans

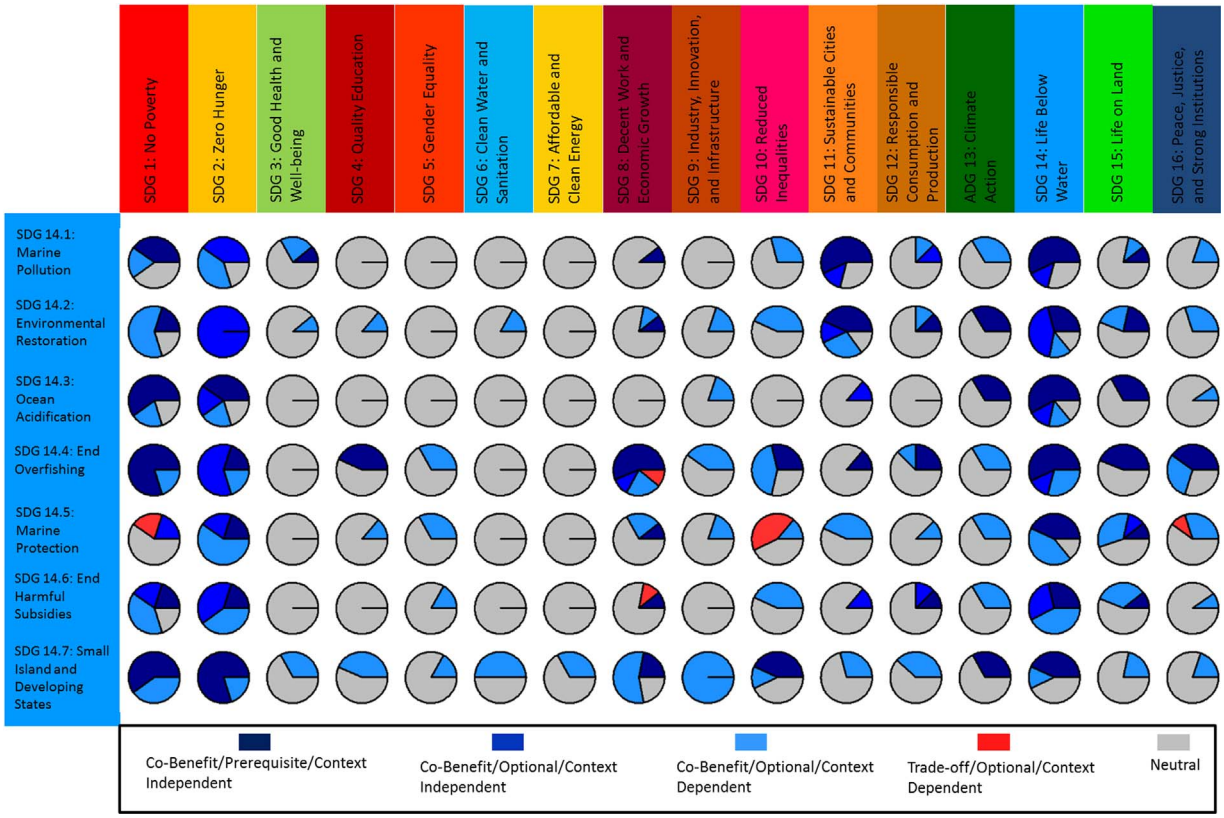

Fig. 2. Characterized relationships between Oceans targets and other SDGs. Pie charts represent the proportion of targets within SDGs to which a given Oceans target contributes, according to the framework presented in this paper. The pie charts do not indicate how much achieving Oceans targets contributes to other SDGs.

targets are necessary in order to achieve the SDG goals of ending poverty and hunger, respectively.

Most relationships between Oceans targets and other SDG targets are co-benefits – indicating compatibilities between the Oceans and other SDG targets (Figs. 3 and 4). Of the 267 non-neutral relationships between ocean SDG targets and other SDGs (35% of all relationships), 260 are co-benefits and 7 are trade-offs – indicating that there may be an incompatibility between certain Oceans targets and other SDG targets (Table 1). Ending overfishing (SDG 14.4), creating marine protected areas (SDG 14.5), and ending harmful fishing subsidies (SDG 14.6) can lead to trade-offs with other SDGs. Both ending overfishing (SDG 14.4) and ending harmful subsidies (SDG 14.5) have trade-off relationships with Decent Work and Economic Growth (SDG 8). The specific target that has trade-off relationships (the number of youth in employment or training) only considers a short term relationship as the achievement date for this target is the same year as the achievement of the Oceans targets, and does not represent long term relationships. Marine protection (SDG 14.5) has negative relationships with the largest number of other SDGs, including Ending Poverty (SDG 1), Reducing Inequalities (SDG 10), and Peace, Justice, and Strong Institutions (SDG 16) (Fig. 2). These trade-offs are all associated with targets focussed on inequalities (and associated conflict) and resource access concerns. Experts indicated that these trade-offs may be avoided through protected area consultation and implementation, and in the long term the protected areas may increase marine productivity that spill over protected area boundaries and increase resources for people. All trade-off relationships are classified as “optional-context dependent”, indicating that the trade-off relationships may not be guaranteed and may be mitigated through policy implementation.

Approximately half of the non-neutral relationships between Oceans targets are prerequisite-context independent or optional-context independent (128 of 267 relationships, Table 1). Contributing to these

Table 1
Number of relationships between SDG 14: Life Below Water targets and other SDGs, categorised by their compatibility, necessity and context dependence.

Ocean target	Co-Benefit			Trade-off			Neutral
	Prerequisite Context Independent	Optional Context Independent	Optional Context Dependent	Prerequisite Context Independent	Optional Context Independent	Optional Context Dependent	
1: Reduce Marine Pollution	13	5	12	0	0	0	76
2: Ecosystem Restoration	11	9	20	0	0	0	66
3: Reduce Impact of Ocean Acidification	13	3	5	0	0	0	85
4: End Overfishing	30	5	20	0	0	1	50
5: Marine Protection	6	3	24	0	0	5	68
6: End Harmful Fishing Subsidies	7	7	16	0	0	1	75
7: Increase Economic Benefits to Small Island Developing States and Least Developed Countries	16	0	35	0	0	0	55
Total	96	32	132	0	0	7	475

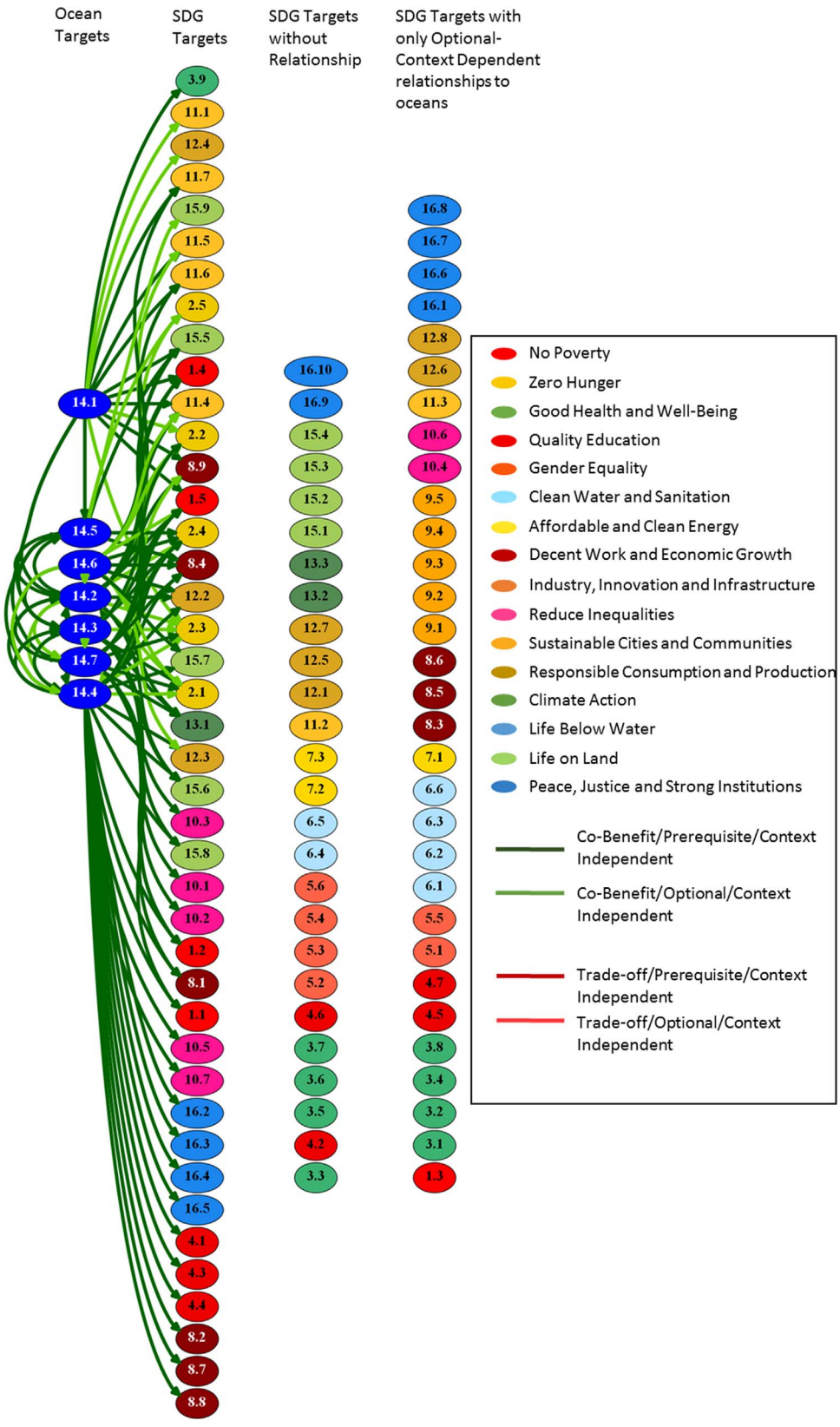

Fig. 3. The prerequisite and optional-context-independent relationships between ocean SDG targets and other SDG targets. SDG targets are labeled according to their numeric codes (e.g., 14.1 is reducing marine pollution). The Oceans targets with the most connections to other SDG targets are found centrally relative to the other SDG targets.

128 relationships, Oceans targets are related to 42 other SDG targets through prerequisite-context independent and optional-context independent linkages (Fig. 3). Of these 44 SDG targets, 14 SDG targets are related to Oceans targets solely through prerequisite-context independent and optional-context independent relationships. The remaining 139 of 267 relationships are characterized as optional-context dependent between Oceans targets and other SDG targets. Contributing to these 139 relationships, Oceans targets are related to 62 other SDG targets through optional-context dependent relationships (Fig. 4). Of these 63 SDG targets, 31 SDG targets are solely related to Oceans targets through optional-context dependent relationships.

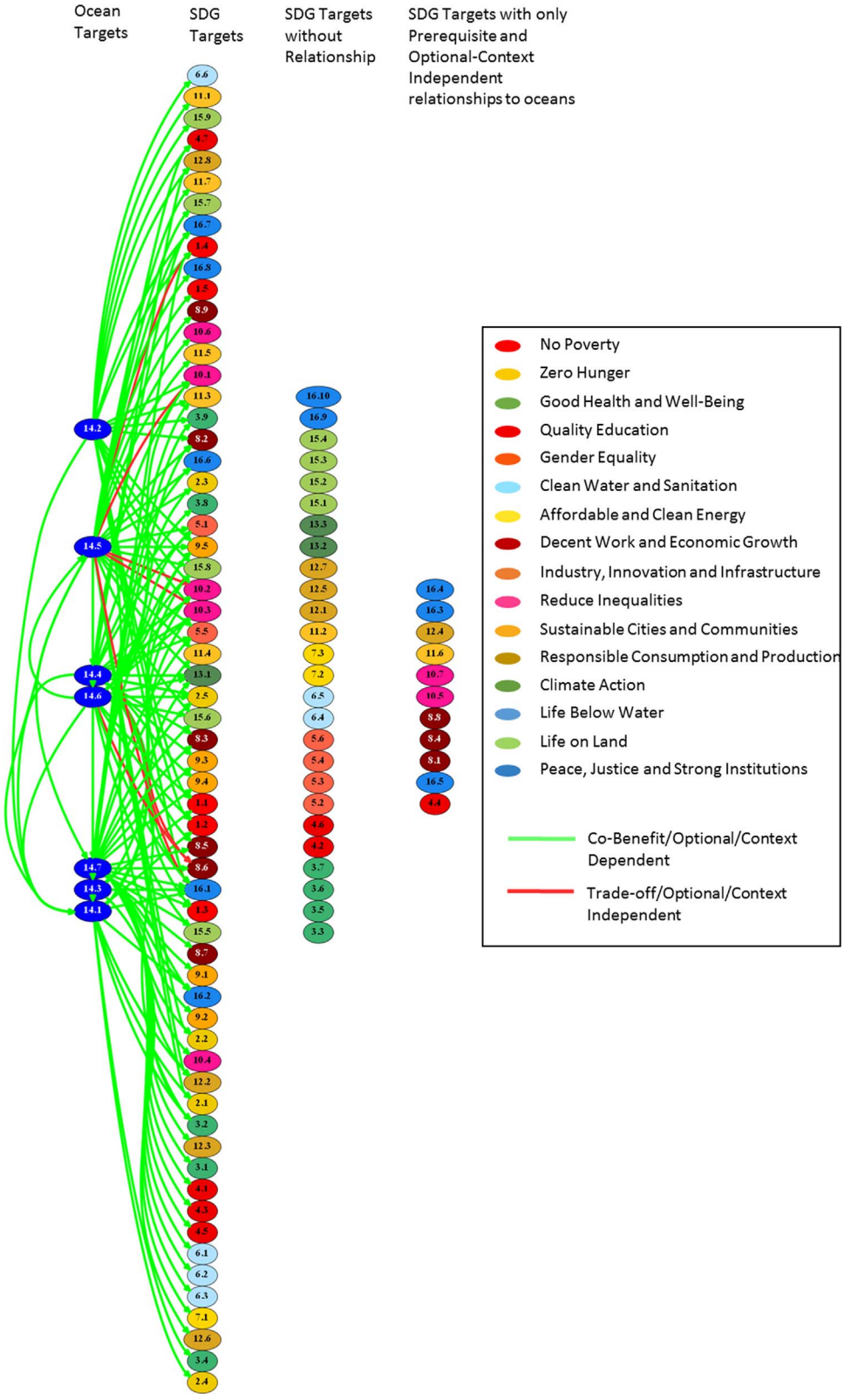

Fig. 4. The optional-context-dependent relationships between ocean SDG targets and other SDG targets. SDG targets are labeled according to their numeric codes (e.g., 14.1 is reducing marine pollution). The Oceans targets with the most connections to other SDG targets are found centrally relative to the other SDG targets.

4. Discussion

The results of this study highlight the importance of the ocean for achieving the Sustainable Development Goals, and suggest that achieving Oceans targets has important co-benefits through supporting diverse aspects of sustainable development and rarely presents negative trade-offs. While these finding are encouraging regarding the potential to simultaneously achieve SDG goals, they are also troubling given the lack of progress towards achieving SDG 14 based on early indicators [6], and the proportionately smaller funding from major foundations (< 1% of total foundation funds) dedicated to achieve SDG 14 [7].

Of all the 260 positive and 7 negative relationships characterized, 132 positive relationships and 7 negative relationships are considered "optional-context dependent" indicating that these relationships are

contingent on the social-ecological context. How actions taken to regulate the potential of ocean management to contribute to sustainable development are implemented can dictate whether co-benefits or trade-offs are realized. A corollary of the contingent nature of some of the relationships is that 38% of the positive relationships are obligate, meaning that these sustainable development targets require ocean sustainability to be achieved.

Some SDG goals are more dependent on achieving Oceans targets than others. There are also multiple synergies between Oceans targets, and the results presented here show that every Oceans target is a prerequisite for achieving at least one other Oceans target (e.g. regulating illegal harvest and overfishing – SDG 14.4 – is a prerequisite for restoring marine ecosystems – SDG 14.2). Ending Poverty (SDG 1) and Ending Hunger (SDG 2) are also highly dependent on ocean sustainability, as indicated by the number of obligate relationships between the targets of these diverse goals and the Ocean target. Considering also optional relationships (where a target is not a prerequisite for another), each sustainable oceans target contributes to most of the targets in each of SDGs 1 and 2 (ending poverty and hunger).

Similarly, some of the Oceans targets have more related co-benefits. For example, increasing economic benefits to SIDS and least developed countries (SDG 14.7) contributes to the largest number of other SDGs as there are co-benefits with all other SDGs. However, many of these relationships are classified as co-benefit-optional-context-dependent, indicating that realizing co-benefits is not guaranteed but dependent on the right social-ecological context and policy implementation (or that research to date has not suggested that such co-benefits are certain). This large number of context-dependent co-benefits may reflect the counterfactual nature of target 14.7: sustainable marine development is not currently the norm and so not currently tied to other targets, though if benefits are distributed correctly then many potential co-benefits can be achieved.

Ending overfishing (SDG 14.4) on the other hand, has the largest number of connections, and also the largest number of co-benefit-prerequisite-context independent relationships, with other SDGs. Fishing is an established activity in many coastal settings, and is intricately tied to many different peoples' cultures, livelihoods, and local environments [4,10,19]. For example, combating illegal fishing and overfishing includes combating illegal labour practices (making addressing this target a prerequisite for ending modern slavery – SDGs 8.7 and 16.2), will allow children and other people who otherwise would have spent their time working on boats access to education (SDGs 4.1 and 4.3), will allow for more reliable and bountiful seafood production needed for people to access food and end malnutrition (SDGs 2.1 and 2.2), and will lead to fishing systems guaranteed for future generations, preserving biological and cultural heritage (SDG 11.4).

This study has also identified trade-offs between achieving Oceans targets and other SDG targets. All trade-offs identified are classified as optional-context dependent, indicating that trade-offs may be avoided in some contexts. For example, ending overfishing (SDG 14.4) and harmful fishing subsidies (SDG 14.6) can contribute negatively to targets related to youth employment (SDG 8.6) through a reduction in fleet capacity, although this may only happen when people have no alternative employment options [20,21]. This trade-off may only result in a short-term effect, however, and in the long term, as fish productivity and abundance increases more fishing related jobs may be available. Short term trade-offs are recorded here because SDG 8.6 has a goal date of 2020, which coincides with the achievement dates of ending overfishing and harmful subsidies.

Similarly, designating marine spaces as marine protected areas (MPA) may preclude coastal people's access to local marine resources, which might limit progress on those SDG targets associated with ending hunger (SDG 1) and diminishing disparities that affect poorer people (SDG 10) [22–26]. Protecting given marine spaces may also merely displace fishing effort to other areas, further reducing the resources available to local people [27]. If resource disparities are enhanced through limiting access to marine resources, then the risk of resource-based conflict might also increase, negatively affecting SDG targets aimed at reducing conflict and violence (SDG 16) [28]. Proper consultation and implementation with local people might avoid many of these trade-offs [22,24–26,29]. Most trade-offs characterized here (5 of the 7) are associated with marine protection (SDG 14.5), which – despite increasing evidence for positive ecological outcomes [27,28,30] – has been linked with displacement of coastal communities [25,28] and conflicting visions of marine management objectives [22,28]. These trade-offs suggest that the current global emphasis on marine protected areas [31,32] may have unintended consequences for social equity if these are not identified and addressed appropriately and effectively during the implementation phase of protected areas.

Results from this study show that SDGs can be largely complementary and even dependent upon one another [33,34]. One hypothesis is that the Oceans goal (SDG 14) is one of a few SDG goals with wide-ranging co-benefits (and fewer trade-offs), which, if true, could lead to the argument that attention to ocean sustainability should be prioritized. A second hypothesis is that most (if not all) SDGs have wide-ranging co-benefits with other SDGs, in which case no SDG should be prioritized. Another hypothesis is that economies and societies are embedded parts of the biophysical environment [12], and SDG goals related to the biophysical environment may be more important in supporting other SDGs. Enhancing sustainability in the biophysical environment can contribute to asset-based development, providing local people with an enhanced capacity for development according to their specific ecological and cultural contexts [35]. Such an asset-based strategy is encouraged over "deficit-based" strategies of development – development that is focussed on needs and community insufficiency, and where resources are externally provided [36]. Asset-based strategies seek to capitalize on and enhance existing capacity to respond to priorities and do not depend upon input from exterior sources (such as outside charity) [37].

A final hypothesis is that the SDGs that tightly couple environment, society, and economy may be the most important for meeting/achieving diverse sustainability goals [33]. In this study, the marine targets that contributed positively across other targets and goals focus on fisheries (target 14.4) and benefit-sharing to develop sustainable marine uses (target 14.7), both of which inherently tie environment, culture, and economy together. These Oceans targets (14.4 and 14.7) affect more targets than solely biophysically focussed targets that have more loosely coupled connections to society and economy, such as marine pollution (target 14.1), marine restoration (target 14.2), and responding to ocean acidification (target 14.3). Often social and economic considerations may be as important as biophysical resource sustainability.

Determining whether the Oceans goal (SDG 14) is unusual in its widespread contribution to other SDGs, or similar to other SDGs, will require application of the framework proposed here to these other SDGs. In other words the Oceans goal may similarly be dependent on other SDG goals being achieved (e.g., sustainable consumption patterns – SDG 12 – are necessary to achieve sustainable fisheries [4]).

This paper introduces a rapid assessment methodology that can be applied to understand how progress on any one SDG goal can contribute to other SDGs. As a method to determine which SDG targets are associated with the most co-benefits and trade-offs, this framework can aid policymakers in understanding context specificity and allow for policy prioritization. Two of the Oceans targets (ending overfishing – SDG 14.4 – and increasing economic benefits to SIDS – SDG 14.7) are associated with a disproportionate number of targets and perhaps should be given global priority among all Oceans targets. This assessment highlights that increasing economic benefits to SIDS (SDG 14.7) is associated with many co-benefits that are context-dependent, indicating that effective policy implementation will be important to fulfill the co-benefit potential of this Oceans target. Careful consideration of where economic and development benefits are distributed among and within

SIDS can help realize co-benefits as diverse as access to resources (SDG 1.4), reducing maternal mortality through poverty and hunger (SDG 3.1), increasing leadership roles for women (SDG 5.5), enhancing scientific research (SDG 9.5), and reducing violence stemming from poverty (SDG 16.1). This framework can also be applied at national and regional scales to determine priorities for supporting SDG targets and goals at this context level. Policy is often set at the national level, and priorities will (and should) often follow national interests. Consequently, national priorities will differ between countries [38]. However, within each country, different targets within SDG 14 (as well as different SDGs) are under the purview of different administrative bodies, often with independent (and potentially conflicting) agendas. Additionally, national policy can be constrained by existing regional and international agreements. These governance considerations can modify how this framework can be applied. The applying of this rapid assessment can help determine how governance has to be modified to achieve goals. Alternatively, policy plans can consider the governance limitations in setting up which relationships can actually be acted upon, and prioritize policy given these limitations.

This framework has a number of strengths. As outlined, this framework can rapidly assess different categories of relationships from one SDG goal to others, be used to understand dependencies and context specificity, and help prioritize policy to achieve specific goals. As this framework characterizes relationships generally (and not SDGs specifically), it can also be used to understand connections between other policy goals, such as linking Aichi targets [13] or linking SDGs and Aichi targets. However, this framework also has important limitations. Namely, it is qualitative, not quantitative. It can only sort relationships into categories, and cannot determine how much a particular SDG target might contribute to another. Understanding the percentage of contribution from one SDG target to another (quantitatively) would then provide important information for policy makers in prioritizing decisions, and is an important next step for research. However, quantifying these contributions would require substantially more detailed data input, likely to be unavailable in most contexts. This framework also cannot represent uncertainty in the selection of relationship categories beyond considering it “optional-context dependent”, meaning that the relationship is not guaranteed either because of setting or uncertain knowledge. Future work to identify the confidence in category designation (such as documenting where experts initially disagree on categories) would help identify those relationships that are more confidently understood, which can provide additional information that is important for policy decisions.

The expert elicitation provided here (methodology stage 2.3) has been used to confirm (or refute) the relationships characterized in the workshops populating the matrices. Individual experts were consulted through one-on-one interviews or e-mails. To counter the possibility that experts might be over-confident and provide unreliable responses [16,17], experts were asked to provide literature examples in support of their evaluations. Other options to conducting this assessment process are possible. For example, relevant experts could populate the initial comparative SDG matrix through a rigorous expert workshop, foregoing the need for subsequent vetting and avoiding the potential for any anchoring bias in the initial workshop results [16]. Additionally, characterized relationships could be accepted only where relevant, peer reviewed findings or government and NGO reports exist as standards of evidence. Decisions makers could also use this framework to establish hypotheses for adaptive management, matching framework-derived results with data collection programs in order to help establish what relationships exist, and how strong they are [39].

5. Conclusions

Given the lack of progress towards achieving SDG14 [6], the framework provided here provides an initial overview of the relevance of Oceans targets to the advancement of other SDGs. It provides not only a strategic approach to finding co-benefits for given actions in achieving the SDG goals, but also concrete representation of existing connectivity in our efforts to pursue sustainable development. Notably, the framework demonstrates the potential benefits of prioritizing action on ending overfishing and providing economic benefits for SIDS (given proper policy implementation). The methods introduced in this paper shed light on the interrelated nature of sustainable development [33]. While the paper focuses on the relationships between the Oceans targets and other SDGs, the framework used can be applied to any of the other SDGs. The framework allows for the identification of important prerequisites for achieving SDGs and of relationships that depend on implementation and social-ecological contexts. Diverse environmental, social, and economic issues fit together in complex ways, and pursuing sustainable development will benefit from understanding these relationships.

Acknowledgements

Funding was generously provided by the Nippon Foundation Nereus Program (Grant No. 22R26001).

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2017.05.030.

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