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Global significance of seagrass fishery activity

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Abstract

Seagrass meadows support fisheries through provision of nursery areas and trophic subsidies to adjacent habitats. As shallow coastal habitats, they also provide key fishing grounds; however, the nature and extent of such exploitation are poorly understood. These productive meadows are being degraded globally at rapid rates. For degradation to cease, there needs to be better appreciation for the value of these habitats in supporting global fisheries. Here, we provide the first global scale study demonstrating the extent, importance and nature of fisheries exploitation of seagrass meadows. Due to a paucity of available data, the study used a global expert survey to demonstrate the widespread significance of seagrass-based fishing activity. Our study finds that seagrass-based fisheries are globally important and present virtually wherever seagrass exists, supporting subsistence, commercial and recreational activity. A wide range of fishing methods and gear is used reflecting the spatial distribution patterns of seagrass meadows, and their depth ranges from intertidal (accessible by foot) to relatively deep water (where commercial trawls can operate). Seagrass meadows are multispecies fishing grounds targeted by fishers for any fish or invertebrate species that can be eaten, sold or used as bait. In the coastal communities of developing countries, the importance of the nearshore seagrass fishery for livelihoods and well-being is irrefutable. In developed countries, the seagrass fishery is often recreational and/or more target species specific. Regardless of location, this study is the first to highlight collectively the indiscriminate nature and global scale of seagrass fisheries and the diversity of exploitative methods employed to extract seagrass-associated resources. Evidence presented emphasizes the need for targeted management to support continued viability of seagrass meadows as a global ecosystem service provider.

KEYWORDS

fishing gear, fishing vessel, gleaning, recreational fishing, small-scale fisheries, subsistence fisheries

1 | INTRODUCTION

Fisheries are vital for the maintenance of global food security (Pauly, Watson, & Alder, 2005; Rice & Garcia, 2011). The ecosystems that support fisheries productivity are therefore essential for maintaining global food supply. Available information on small-scale artisanal and recreational fisheries is, however, scarce compared to industrial fisheries, which is because catches are poorly reported, harder to track, and the available data less accessible and more difficult to interpret (Worm et al., 2009). Here, small-scale artisanal fisheries are defined as traditional fisheries involving fishing households, using relatively small gear size and vessels and low-level technology. They can be subsistence or commercial fisheries (Cochrane & Garcia, 2009). Reconstructed global fisheries statistics suggest that these forms of fisheries could be responsible for at least 20% of the global fisheries catch (Pauly & Zeller, 2016).

For improved fisheries management, we need a much greater level of understanding about small-scale artisanal and recreational fisheries. We also need to take a holistic view with an ecosystem approach that recognizes the relative productivity of different habitats (including seagrass meadows) throughout the coastal seascape and the consequences of habitat damage to productivity. Given the vast extent of unreported catches globally and the rapid decline in fish catches (Pauly & Zeller, 2016), filling such knowledge gaps is a critical basis for developing appropriate management actions for global food security. For example, if environmental policy makers and managers are aware of the species targeted and the extent to which seagrass is fished, informed governance and management decisions can be made that aim to maintain food security.

It is important to recognize the value of different habitats in supporting fisheries productivity and to understand how fishery activity influences different habitat types. For example, different types of fishing gear and methods target different species and have varying environmental impacts. For fisheries management, it is also useful to understand what drives the use of any given fishing method (Watling & Norse, 1998; Thiele & Prado, 2005; Sethi, Branch, & Watson, 2010) in order to address these drivers and implement management strategies with improved chances of success. Seagrass ecosystems contribute to fishery productivity globally, but information about the intricacies of how this productivity is directly exploited from seagrass meadows themselves is lacking. Seagrasses are marine flowering plants that form extensive coastal meadows and are found along all continents except Antarctica (Green & Short, 2003; Nordlund, Koch, Barbier, & Creed, 2016; Figure 1). Seagrass support for fishery productivity occurs in three interacting ways: (*i*) seagrass meadows function as nursery habitat for fisheries species, (*ii*) they provide foraging and refuge habitat for exploited species and (*iii*) they provide trophic subsidy to fisheries in adjacent and deep-water habitats (Gillanders, 2006; Heck et al., 2008; Lilley & Unsworth, 2014; Nordlund et al., 2016). Seagrass meadows represent extensive fishery grounds with both invertebrates and finfish targeted, for both subsistence and commercial purposes, thus they play a multifunctional role in human well-being (Cullen-Unsworth et al., 2014).

There is increasing appreciation for the fact that small-scale fisheries are "too big to ignore," with evidence suggesting that small-scale fisheries catch makes up one-quarter of the global total catch, and the majority of the catch in many developing countries (Too Big To Ignore 2017; Chuenpagdee, 2011; Pauly & Charles, 2015). Many small-scale and artisanal fisheries are, however, still not included in such statistics. A specific example of this is the extensive shallow-water fishery conducted within seagrass ecosystems (Jackson, 2001; Nordlund, Erlandsson, de la Torre-Castro, & Jiddawi, 2010; Nordlund & Gullström, 2013; Kleiber, Harris, & Vincent, 2015). This shallow-water fishery includes "gleaning" activities. Here, we define gleaning as fishing with basic gear, including bare hands, in shallow water (not deeper than that one can stand); this activity is conducted by men, women and children. Improving our knowledge about these fisheries is important for their long-term management and sustainability, and subsequently for human- and ecosystem wellbeing. Thus, there is a need to highlight the extent, importance and status of fisheries exploitation of seagrass meadows.

Where documented, seagrass fisheries use a variety of gears with different efficiencies and associated environmental impacts (Unsworth & Cullen, 2010; Nordlund & Gullström, 2013). The effects on the environment of different fishing gears differ particularly with respect to fishing method and the habitat of application (Pauly et al., 2002). There are insufficient data on types of fishing gear used, particularly within small-scale fisheries (Watson, Revenga, & Kura, 2006) and even more so within seagrass meadows (Figure 1).

The aim of the study was to determine the importance and variability of seagrass fishery activity globally. This was performed by specifically focusing on four key areas: the purpose of fishing in seagrass habitats, the methods used, target species and how fishers access seagrass fishing grounds. We investigated 36 case studies across the globe and analysed data across the six seagrass bioregions (Figure 2; Short, Carruthers, Dennison, & Waycott, 2007) and the Human Development Index (HDI) categories (UNDP 2017). Based on the findings, we highlight the need for improved management of an underappreciated but widely exploited resource.

2 | METHODS

The present study examined fisheries activity in seagrass meadows globally using empirical data based on expert elicitation (see e.g., Martin et al., 2012 and Grech et al., 2012) and a literature search. A questionnaire was used to collate expert knowledge on seagrass fishery activity across the globe during June-July 2015 and July 2016 (Appendix S1). Experts are defined as "anyone with relevant and extensive or in-depth experience in relation to a topic of interest" (Krueger, Page, Hubacek, Smith, & Hiscock, 2012). Based on these criteria, experts included managers, practitioners and researchers working with (i) issues related to the fisheries in seagrass habitats and/or (ii) issues relevant to seagrass ecosystems. The questionnaire asked experts to specify their experience and knowledge of seagrass meadows and associated fishery activity in their specific research region. The geographical area on which the experts based their responses was decided by each respondent's own research/conservation experience. Four overarching questions about seagrass fisheries were used: (i) For what purpose are fishers fishing in the seagrass habitats? (ii) Which fishing methods are used in seagrass meadows? (iii) What does the seagrass fishery target? and (iv) How do fishers access the seagrass areas? Experts were also asked to provide evidence of seagrass fisheries where possible through published literature and photographic

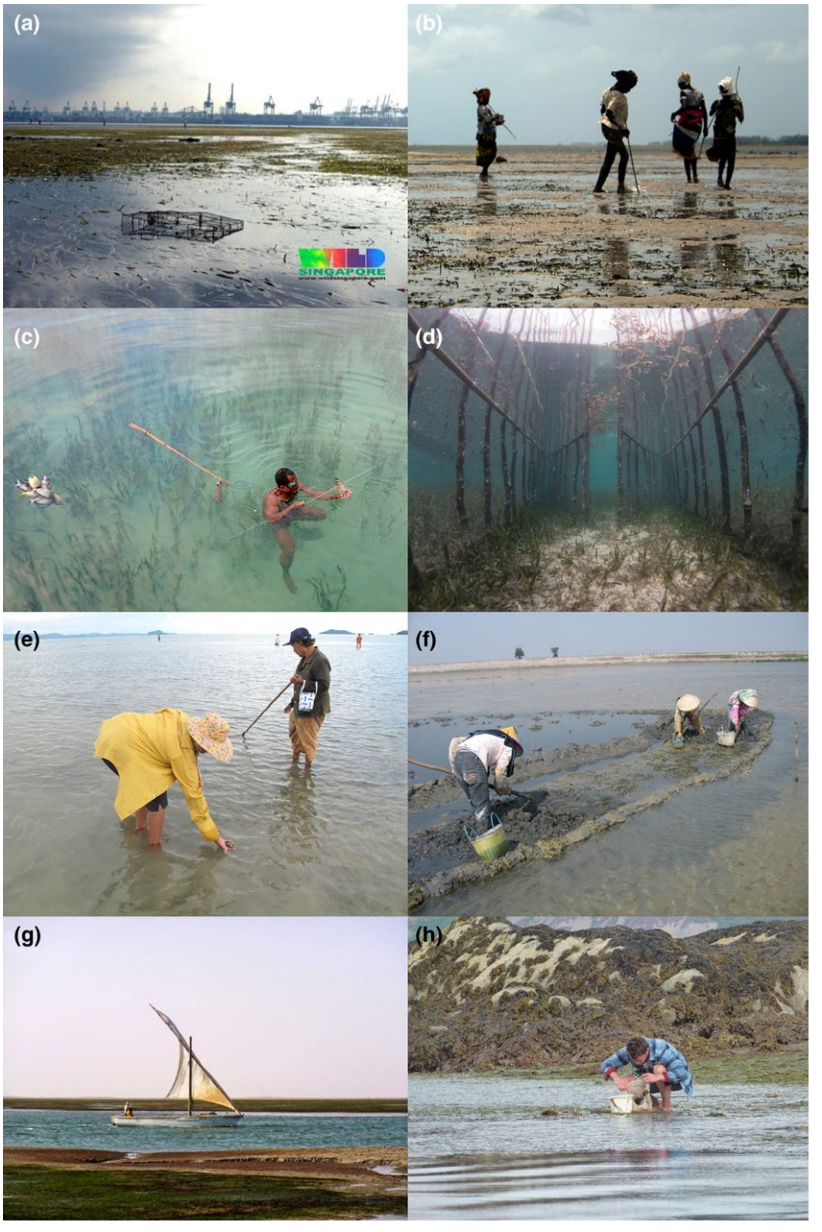

FIGURE 1 (a) Fish trap in Singapore (Bioregion 5), photograph by Ria Tan. (b) Women fishing with sticks in Mozambique (Bioregion 5), photograph by Richard Unsworth. (c) In many places in the world, fishers still utilize spearfishing as a subsistence means of catching food. The Bajo of SE Asia is an indigenous group who still commonly practice such activity in Wakatobi, Indonesia (Bioregion 5), photograph by Richard Unsworth. (d) Fixed fyke nets >100 m in length are commonly placed in many seagrass meadows in Eastern Indonesia and unselectively catch everything moving with the tidal currents in Wakatobi, Indonesia (Bioregion 5), photograph by Benjamin Jones. (e) Invertebrate collection by hand and use of rake, Thailand (Bioregion 5), photograph by Lina Mtwana Nordlund. (f) Raking for food in *Halophila ovalis* seagrass beds in Zhulin, Beihai City, Guangxi, China (Bioregion 5), photograph by Guanglong Qiu. (g) Sailboat surrounded by exposed seagrass during low tide in Mauritania (Bioregion 2), photograph by Laura Govers. (h) Push netting for shrimp in North Wales, United Kingdom (Bioregion 1), photograph by Richard Unsworth [Colour figure can be viewed at wileyonlinelibrary.com]

records. Expert opinions were gathered and considered with respect to global seagrass bioregions (Short et al., 2007) and the Human Development Index (HDI). Global seagrass bioregions are based on species assemblages, species distributional ranges, and tropical and temperate influences (Figure 2; Short et al., 2007). The HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living (UNDP-HDR 2016). This approach enabled us to investigate both ecological and social aspects of seagrass fisheries. Experts, if not already known to the authors, were identified by searching for authors of published scientific literature about seagrass- and/or coastal fisheries. The response rate was around 75%. In total, 35 experts responded, of which three responded more than once. Twenty-three of the respondents assigned themselves a background as academic, seven as Government, NGO and/or consultant and five as academic combined with the latter category. Each case is based on the responses of one respondent. For example, one expert corresponds to case Brazil 1 and another expert to case Brazil 2. With one exception where the responses were few and almost identical for the same geographical region, these were combined into one case. Two responses were not included in the statistical analysis as they were submitted after closing of the survey, but as one of these cases overlapped with another geographical region its additional information was included in the description of case studies (the total number of individual cases was 38 before combining and discarding).

To determine the validity of the findings, as well as to fill outstanding knowledge gaps (if possible), additional information, such as small-scale fisheries data from seagrass publications, was collated by searching the academic literature using EBSCO Discovery Service, which includes databases such as Web of Science and Google Scholar. This literature search was conducted during July and August 2015 and August 2016.

2.1 | The case studies

In total, we examined 36 case studies, with the geographical distribution and spatial scale of the case study areas indicated on the world map in Figure 2. The cases are from around the globe and arranged by the six seagrass bioregions (Figure 2). A bioregional approach was taken because each bioregion reflects differences in seagrass community composition (Short et al., 2007). There are seven cases from Temperate North Atlantic (bioregion 1), six cases from Tropical Atlantic (2), four cases from the Mediterranean (3), four cases from Temperate North Pacific (4), eleven cases from Tropical Indo-Pacific (5) and four cases from Temperate Southern Ocean (6).

The distribution of seagrass species differs across the world's bioregions, as described by Short et al. (2007). Bioregion 1 has typically low seagrass diversity with five temperate seagrass species, which all grow primarily in estuaries and lagoons. Bioregion 2 has a relatively high diversity of ten tropical seagrass species. In this region, the seagrass often grows on back reefs and shallow banks in clear water. Bioregion 3 has nine seagrass species comprising a mix of temperate and tropical species that grow in clear water in vast and relatively deep areas. Bioregion 4 encompasses high seagrass diversity with 15 species, mostly growing in estuaries, lagoons and coastal surf zones. Bioregion 5 has very high seagrass diversity with 24 tropical species that grow mostly on reef flats. Bioregion 6 also shows a high seagrass diversity and has 18 temperate species spread across the region.

Furthermore, all countries represented by the 36 case studies were categorized according to the HDI, which reflects low, medium, high or very high human development (Human Development Index (HDI) | Human Development Reports 2017). There are four cases categorized as low human development, four cases as medium human development, seven cases as high human development and 21 cases as very high human development (Table 1).

2.2 | Data analysis

The statistical analyses are based on the expert opinion data for each of the cases compiled in Table 1. The possible answers in the questionnaire were as follows: no, unlikely, rare, common, yes, very common and I don't know. Summary statistics of these answers were calculated by determining the total number of answers to each question (e.g., types of transport methods, different taxa fished). Summary data were used to examine potential correlations within the dataset (using Minitab v17). The data were further analysed based on converting answers to presence and absence of occurrence (i.e., 1 or 0). This created what we term to be "occurrences data." The answers rare, common, yes and very common were considered as presence, while no, unlikely and I don't know were considered as absence. The term absence here reflects 0, which means that the answer is not included in the calculations (i.e., presence is not evaluated for these answers). In order to examine variation and to observe patterns throughout the whole dataset, a principal components analysis (PCA) was conducted on answers to each question. We conducted five separate analyses, one for each of the four key questions and one for the overall dataset. Each variable included in the analysis reflected a different answer to the questionnaire (e.g., modes of transport). PCA was used to visualize the similarities among cases. To interpret the principal components (PCs), variable coefficients of <−0.3 and >0.3 in each component were

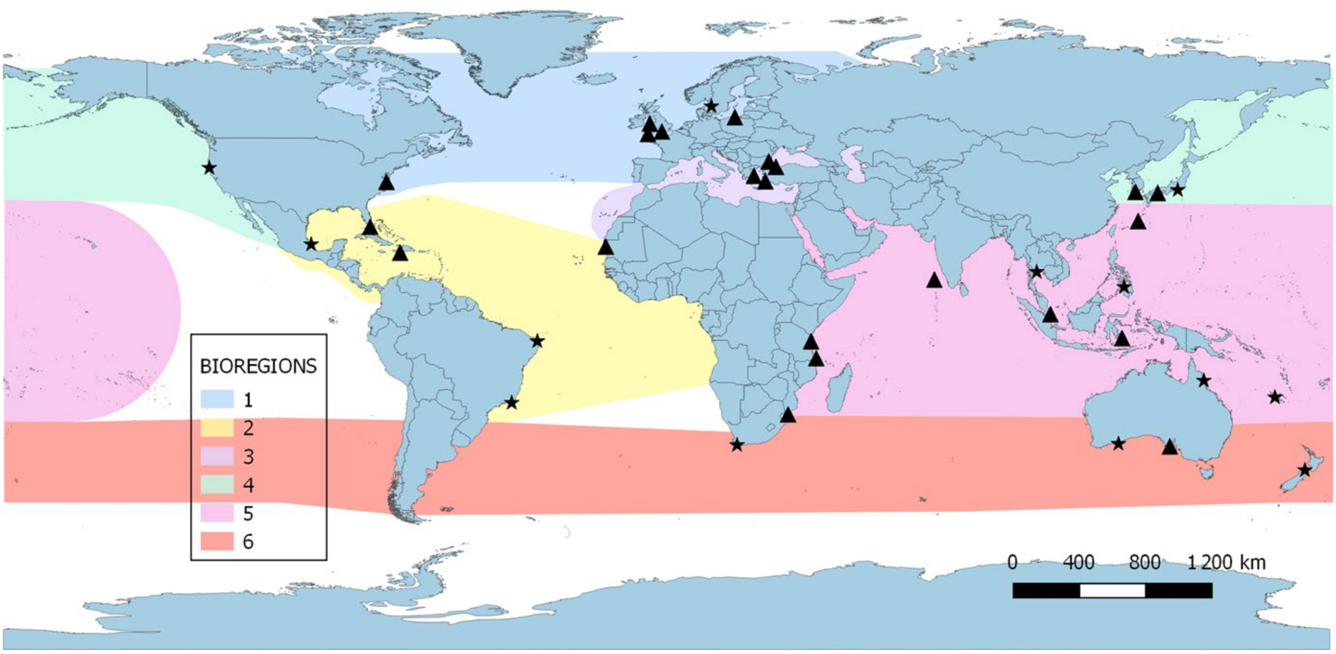

FIGURE 2 The geographical distribution and the spatial scale of the 36 case study areas of seagrass fisheries presented in this study. Stars indicate regional cases (scale >500 km) and triangles indicate local cases (scale <500 km). Bioregions are indicated with areas of different colours. Bioregion 1: Temperate North Atlantic; Bioregion 2: Tropical Atlantic; Bioregion 3: the Mediterranean; Bioregion 4: Temperate North Pacific; Bioregion 5: Tropical Indo-Pacific; Bioregion 6: Temperate Southern Ocean [Colour figure can be viewed at wileyonlinelibrary.com]

selected as dominant and these are displayed as vectors. All multivariate PCA analyses were made with Primer v7.

Patterns within the data displayed in Table 1 were also broadly summarized through the use of correlation analysis. All combinations of correlations between the "occurrences data" of the four key questions were completed. For example, number of different gear types used in seagrass fisheries versus number of different types of transport modes. The data in Table 1 are also summarized in boxplots with respect to answers to the key questions and HDI. Furthermore, we compare all seagrass fishery gear types with those of the international standard statistical classification of fishing gear, that is surrounding nets, seine nets, trawls, dredges, hooks and lines, lift nets, falling gear, gillnets and entangling nets, traps, grappling and wounding, and harvesting machines (FAO Fisheries & Aquaculture 2017).

2.3 | Seagrass fisheries—a global review

Our study shows that seagrass fisheries are present in all seagrass bioregions. These are commonly multispecies and multigear fisheries (Table 1). An overview of all 36 cases, with a minimum of four cases per bioregion, arranged according to bioregions can be seen in Table 1. The same table but arranged according to HDI can be seen in Appendix S2. Details of all cases (including the findings from the literature review), arranged after country of geographical area, and additional information about seagrass fisheries from the experts are presented in Appendix S3.

2.4 | Purpose of fishing in seagrass habitat

Across the globe, fishing in seagrass is conducted for income and subsistence, as well as for recreational purposes (Table 1; Appendix S3). Our study reveals that subsistence fishing is very important, especially in the Tropical Indo-Pacific bioregion (5), while in the bioregions of Temperate North Atlantic and Tropical Atlantic (1 and 2), it is less so. Recreational fishing (when not catch and release) favours eating of the catch rather than selling the catch. PCA of the purpose data determined three principal components, with an eigenvalue greater than 1. These accounted for 73% of the variability in the data, of which 39% is within PC1, which shows no clear separation of bioregions (Figure 3a). Five variables correlate with PC1 with the Pearson's correlation coefficients of ≥3, including fish for subsistence, fish for income, invertebrates for income, invertebrates for subsistence and fishing for the curio trade (Figure 3a).

The richness of purpose of fishing activity (i.e., the number of purposes) does not appear to change with respect to HDI, however, countries with higher HDI tend to use the seagrass more commonly for recreational purposes and less for commercial purposes or subsistence use (Table 1; Figure 4a; Appendix S2).

2.5 | Seagrass fishing methods

Across all cases, the most common gears used are (in descending order) hook and line (by hand and rod), gill nets, seine nets, collection by hand and spear guns (Table 1). Although mentioned in a few locations (e.g., Turks and Caicos), destructive and intense fishing methods such as explosives and poisons, as well as rake, pump, mosquito nets and hand trawls, are not widespread (Table 1; Appendix S3). PCA of the methods data determined five principal components, of which only one (PC1) had an eigenvalue greater than 1. This accounted for 22% of the variability in the data and shows a general trend from bioregion 5 (Tropical Indo-Pacific) with higher diversity of gear to bioregions 1 and 2 in the Atlantic (Figure 3b) with lower diversity of gear. The first three principal components accounted cumulatively for 44% of the variability. Five variables correlate with PC1 with the Pearson's correlation coefficients of ≥3, including seine net, beach seine, purse seine, fish fence and natural traps, in other words, these fishing gears are largely the cause of the separation among cases.

The richness of fishing gear in seagrass fisheries (i.e., the number of types of gear) does not change with respect to HDI; however, there is a tendency for countries with high HDI to use a lower richness of gear and gear that is less destructive (Table 1; Figure 4b; Appendix S2). The data from the questionnaires show that all fishing gear types listed by international standard statistical classification of fishing gear are used in seagrass.

2.6 | Target species in the seagrass

Globally, the most commonly targeted invertebrates in seagrass appear to be crabs (e.g., Portunoidea) and bivalves (e.g., Anadara and Modiolus). The most commonly exploited finfish in seagrass are mullet (Mugilidae), herring (Clupeidae) and snapper (Lutjanidae), although at species level, this varies substantially among regions as well as among case areas within regions. Least targeted taxa across all cases are sea cucumbers, small fish for drying, aquarium trade species, seahorses and sharks (Table 1). PCA of the target data determined five principal components, which all had eigenvalues greater than 1 and together accounted for 62% of the variability in the data. The first two principal components accounted cumulatively for 37% of the variability. Within the dominant component (PC1), no variables correlate with PC1 with the Pearson's correlation coefficients of ≥3. Within PC2, there were four variables that correlated with Pearson values >3, including shellfish, bivalve, seahorses and mullet, in other words, those species groups to some extent cause the separation among cases. PC1 shows a general trend (-ve scores) from bioregion 5 (Tropical Indo-Pacific), with higher diversity of target species, to bioregions 1 and 2 (+ve scores) in the Atlantic, with lower diversity of target species (Figure 3c).

The richness of target taxa in seagrass fisheries does not statistically change with respect to HDI, but countries with a higher HDI tend to target fewer species (Table 1; Figure 4c; Appendix S2).

2.7 | Accessing seagrass fishing grounds

Seagrass meadows are most commonly accessed by motor boat, thereafter by foot and snorkelling. The most unlikely way to access the seagrass is by SCUBA, thereafter swimming and sailboat (Table 1; Appendix S3). Bioregion 5 (Tropical Indo-Pacific) is characterized by higher diversity of gear, and a wider diversity of target species and

TABLE 1 Summary of the questionnaire responses by seagrass experts. In total, 36 cases, representing six bioregions, are presented

Legend	
N	No
U	Unlikely
R	Rare
C	Common
Y	Yes
V	Very common
I	I don't know/NA

	South East England, UK	North Wales, UK	Solent, UK.	Gulf of Gdańsk, Poland	Sweden	Chesapeake Bay, USA 1	Chesapeake Bay, USA 2	Brazil 1	Brazil 2	Mexico	Florida, USA	Caribbean	Mauritania	Lipsi, Dodecanese, Greece	Aegean Sea	Black sea, Bulgaria	SW Black Sea	Seto Inland Sea, Japan
BIOREGION	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4
HDI	4	4	4	4	4	4	4	3	3	3	4	3	1	4	4	3	3	4
For what purpose are fishers fishing in the seagrass in your country, region or locality?																		
Finfish, subsistence	I		Y		N	R	N	C	R	Y		C	C	V	C	Y	R	Y
Finfish, income	Y		Y	C	N	Y	V	C	R	Y	Y	C	C	V	V	Y	V	Y
Invertebrates, subsist.	Y		N		N	R	U	C	N	Y		R	R	V	R	R	U	Y
Invertebrates, income	C		Y		N	V	V	C	C	Y	Y	R	N	V	V	R	U	Y
Recreation (eaten)	Y	V	Y	C	R	V	C	C	I	Y	Y	C	N	R	C	C	C	Y
Recreation (sold)	I		Y		R	V	U	N	I	Y		U	N	R	C	R	I	Y
Curio trade, e.g. shells	N		N		N	R	R	R	C	N		R	N	R	I	C	U	Y
Bait collection	Y		Y		N	V	R	R	R	Y	Y	U	N	C	C	I	I	Y
Which of the following fishing methods are used in the seagrass fisheries in your country, region or locality?																		
Collection by hand	C	U	N	N	N	U	Y	C	R	Y		U	R	N	N	N	N	I
Pump	Y	R	I	N	N	Y	I	I	N	N		N	N	N	N	N	N	I
Rake	I	N	I	N	N	Y	V	N	N	N		N	N	N	N	N	N	I
Stick, not sharp	I	N	I	N	N	U	U	Y	I	N		R	N	N		N	I	I
Seine net	N	N	N		N	Y	V	C	U	I		N	C	N	V	C	V	I
Mosquito net	N	N	I		N	U	N	N	I	Y		N	N	N	N	N	I	
Beach seine (by foot)	U	N	N		N	Y	Y	C	U	I		C	C	N	N	U	R	I
Purse seine/Ring net	N	N	I		N	Y	V	I	U	I		N	Y	N	V	I	I	I
Trawls /dragged nets	C	N	N		N	Y	V	N	C	Y	Y	N	R	V	V	R	I	Y
Hand trawls	N	V	N		N	Y	R	Y	U	N		N	R	N	N	N	U	I
Fish fence	N	N	I		N	Y	V	C	R	N		N	Y	N	N	R	C	I
Gill nets	I	R	N	R	N	V	V	N	C	Y		C	R	V	V	V	V	Y
Spear, sharp tip	N	V	N		N	N	U	Y	U	Y		R	N	N	V	R	N	I
Spear gun	R	V	N		N	Y	R	Y	U	Y		C	N	C	V	R	U	I
Traps, natural materials	N	V	N		N	R	N	N	U	Y		V	R	C	N	U	N	I
Traps, non-natural	C	V	N	R	R	V	V	Y	U	Y	Y	R	R	R	V	R	I	Y
Hook and hand line	N	V	I		R	R	V	C	R	Y	Y	C	R	U	V	R	C	Y
Hook and line with rod	Y	R	Y		R	V	V	C	I	Y	Y	R	N	C	N	C	C	I
Long line (many hooks)	N	R	I		N	R	U	N	N	Y		U	N	V	V	V	V	I
Explosives	N	N	N		N	N	Y	R	U	N		N	N	U	R	U	I	I
Cyanide	N	N	N		N	N	Y	N	N	N		N	N	N	N	I	N	I
Bleach	N	N	N		N	N	Y	N	N	N		N	N	N	N	I	N	I
Poison	N	N	N		N	N	Y	N	N	N		N	N		N	I	I	I

	Korea	Japan and South-east Asia	NE Pacific Coast, USA	Okinawa, Japan	India, Lakshadweep	Singapore	Gulf of Thailand and Andaman Sea	Southeast Asia (Philippines)	North Eastern Australia	New Caledonian lagoon	Indonesia (Wakatobi)	Zanzibar, Tanzania	Palma bay, Mozambique	Inhaca, Mozambique	South Africa	New Zealand	South Australian Gulf waters	South Australia
BIOREGION	4	4	4	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6
HDI	4	4	4	4	2	4	3	2	4	4	2	1	1	1	2	4	4	4
For what purpose are fishers fishing in the seagrass in your country, region or locality?																		
Finfish, subsistence	V	R	Y	N	Y	N	V	V	R	Y	V	V	V	V	V	U	R	
Finfish, income	V	V	Y	N	C	N	V	V	Y	Y	V	V	V	C	C	R	C	C
Invertebrates, subsist.	V	R	Y	N	R	N	V	V	R	Y	V	V	V	V	N	U	R	
Invertebrates, income	V	V	Y	N	R	N	V	V	Y	Y	V	V	R	C	C	U	Y	C
Recreation (eaten)	V	R	Y	Y	C	Y	V	C	V	Y	V	U	U	U	C		V	V
Recreation (sold)	R	R	Y	Y	R	U	V	C	N	Y	V	U	U	N	N		R	
Curio trade, e.g. shells	I	N	Y	N	C	N	V	C	R	Y	V	V	U	C	N		R	N
Bait collection	U	R	Y	N	V	Y	V	C	V	Y	R	R	U	R	V	U	I	R
Which of the following fishing methods are used in the seagrass fisheries in your country, region or locality?																		
Collection by hand	C	N	N	Y	R	C	V	V	R	Y	V	V	C	V	R	U	R	R
Pump	R	N	C	N	N	N	I	U	R	I	U	N	N	I	V		U	R
Rake	C	R	U	N	I	N	C	C	R	I	U	N	N	N	N	U	U	C
Stick, not sharp	U	N	U	N	N	U	I	R	U	I	V	C	V	V	N		U	N
Seine net	N	V	C	N	Y	C	C	C	C		R	V	C	C	N		V	C
Mosquito net	N	N	I	N		U	C	R	N	U	R	C	V	C	N		I	N
Beach seine (by foot)	N	C	R	N	Y	U	C	C	C		R	C	V	U	N		U	N
Purse seine/Ring net	N	V	C	N	R	U	I	C	U		C	V	N	U	N		U	N
Trawls /dragged nets	N	C	C	N	N	U	V	C	C	U	U	R	N	U	N		V	R
Hand trawls	N	N	I	N	Y	R	I	C	N	I	U	C	N	U	N		U	N
Fish fence	R	V	I	N	R	V	I	C	R	U	V	C	N	U	N		U	N
Gill nets	V	V	C	N	C	N	V	C	V		V	C	N	U	N	R	V	R
Spear, sharp tip	N	N	I	N	R	N	C	C	R	Y	V	C	C	U	N		U	N
Spear gun	N	N	C	N	U	N	U	C	V	Y	V	R	C	U	N		U	R
Traps, natural materials	N	R	I	N	R	R	V	C	R	I	V	V	R	U	N		U	N
Traps, non-natural	V	V	I	N	R	V	V	R	V	I	U	N	U	N	N		V	C
Hook and hand line	C	C	R	N	Y	C	V	C	V	Y	V	V	C	V	C		V	C
Hook and line with rod	C	N	C	N	Y	C	V	R	V	Y	U	U	U	N	V		V	C
Long line (many hooks)	C	N	C	N	Y	U	V	U	R	I	V	C	I	I	N		V	R
Explosives	N	N	I	N	N	U	U	C	N	N	R	N	I	N	N		U	N
Cyanide	N	N	I	N	N	U	U	C	N	N	R	U	I	N	N		U	N
Bleach	N	N	I	N	N	U	U	R	N	N	U	U	I	N	N		U	N
Poison	N	N	I	N	N	U	U	R	N	N	C	U	I	N	N		U	N

Legend	
N	No
U	Unlikely
R	Rare
C	Common
Y	Yes
V	Very common
I	I don't know/NA

	South East England, UK	North Wales, UK	Solent, UK.	Gulf of Gdańsk, Poland	Sweden	Chesapeake Bay, USA 1	Chesapeake Bay, USA 2	Brazil 1	Brazil 2	Mexico	Florida, USA	Caribbean	Mauritania	Lipsi, Dodecanese, Greece	Aegean Sea	Black sea, Bulgaria	SW Black Sea	Seto Inland Sea, Japan	Korea	Japan and South-east Asia	NE Pacific Coast, USA	Okinawa, Japan	India, Lakshadweep	Singapore	Gulf of Thailand and Andaman Sea	Southeast Asia (Philippines)	North Eastern Australia	New Caledonian lagoon	Indonesia (Wakatobi)	Zanzibar, Tanzania	Palma bay, Mozambique	Inhaca, Mozambique	South Africa	New Zealand	South Australian Gulf waters	South Australia
BIOREGION	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6
HDI	4	4	4	4	4	4	4	3	3	3	4	3	1	4	4	3	3	4	4	4	4	4	2	4	3	2	4	4	2	1	1	1	2	4	4	4
What does the fishery target in seagrass habitats in your country, region or locality?																																				
Invertebrates	Y		Y	N	N	Y	U	C	N	Y		C	R	I	Y	U	N	Y	C	V	Y	N	Y	V	V	V	C	Y	V	V	V	V	N			R
Shellfish	Y	C	Y	N	N	Y	C	C	N	N	Y	C	N	R	N	R	N	Y	V	V	Y	Y	Y	R	V	V	R	Y	V	V	V	V	N	U		R
Squid	N		N	N	N	N	N	N	N	N		U	R		C	N	N	Y	U	V	Y	N	Y	R	V	V	R		U	V	Y	I	N			C
Octopus	N		N	N	N	N	N	N	N	Y		R	I	C	C	N	N	Y	R	R		N	Y	R	V	V	R		V	V	I	I	N			R
Lobster/crayfish	I		Y	N	N	N	N	N	N	Y		R	U	R	R	N	N	Y	N	N		N	Y	R	V	R	C		U	V	I	I	N			N
Crab	I		Y	N	N	Y	V	C	N	Y		R	N		R	R	N	Y	C	V	Y	N	Y	R	V	V	C	Y	V	V	V	V	N			C
Sea cucumber (Holothurian)	N		N	N	N	N	N	N	N	Y		N	N	N	N	N	N	Y	C	V	Y	N	N	R	V	V	C	Y	V	C	I	I	N			N
Bivalves, clams, oysters	C		Y	N	N	Y	V	C	N	N		R	N	R	N	R	R	Y	V	V	Y	N	Y	V	V	V	R		V	V	N	V	N	U		C
Aquarium trade species	N		N	N	N	N	R	R	C	N		N	N	I	U	U	N	Y	U	N	I	N	N	R	U	C	R	I	U	U	N	I	N			N
Seahorses	N		N	N	N	N	R	N	N	N		N	N	N	N	V	R	Y	U	N	I	N	N	R	R	V	R	U	U	U	N	C	N			N
Shark	N		N	N	N	Y	R	N	N	Y		N	C	N	N	N	N	I	U	N	Y	N	R	U	I	R	N	U	U	R	N	I	N			C
Rays	I		N	N	N	N	Y	N	R	Y		U	C	N	R	N	N	Y	C	C	I	N	R	R	I	R	R	U	U	C	N	I	N			N
Fish, in general			Y	Y	Y	Y	V	C	R	Y	Y	C	C	V	V	C	V	Y	V	V	Y	N	Y	C	V	V	C	Y	V	V	V	V	C		Y	V
Juveniles	N		N	N		Y	U	N	R	Y		R	I	N	C	I	N	I	N	V	I	N	N	U	C	V	R		V	V	V	V	N			N
Very small fish for drying	N		N	N	N	N	U	N	N	N		N	N	N	N	I	N	I	R	N	I	N	N	U	I	V	N	U	V	V	V	V	N			N
Rabbit fish (Siganidae)	N		N	N	N	N	U	N	N	I		N	N	V	V	N	N	Y	U	C	I	N	Y	R	V	V	R	Y	V	V	V	V	N			N
Parrot fish (Scaridae)	N		N	N	N	N	U	C	N	N		C	N	V	V	N	N	I	R	N	N	N	C	R	I	C	I	Y	V	V	V	I	N			N
Snapper (Lutjanus)	N		N	N	N	N	C	C	R	I		R	N	N	N	I	N	I	R	C	N	N	Y	R	V	C	C	Y	V	V	V	V	N			R
Emporer (Lethrinidae)	N		N	N	N	N	I	I	N	I		N	N	N	V	I	N	I	U	C	N	N	Y	U	V	R	I	Y	V	V	Y	I	N			R
Goatfish (Mullidae)	N		N	N	N	N	I	I	R	I		C	N	V	V	I	N	I	N	C	N	N	Y	U	V	C	I	Y	V	V	Y	I	N			N
Garfish (Belone)	N		N	Y	N	N	R	I	R	I		R	I	Y	R	I	N	I	N	R	N	N	Y	U	V	Y	C		V		I	I	N		Y	C
Mullet (Mugil)	I		N	N	N	N	R	R	N	Y	Y	R	C	Y	V	C	I	I	C	V	N	N	Y	U	V	C	I	Y	V	C	Y	I	C	R		R
Herring (Clupeidae)	I		N	Y	N	N	C	N	N	Y	Y	R	I	N	V	C	I	I	C	C	Y	N	Y	U	V	C	C		U	I	N	I	N			N
Perch (Perca)	N		N	Y	N	N	C	N	N	I		N	I	N	V	I	I	Y	R	N	I	N	Y	U	I		I		U	V	N	I	N			N
Grouper (Serranidae)	N		N	N	N	N	R	N	N	Y		R	Y	U	V	I	I	I	U	R	N	N	C	R	V	V	I		V	V	Y	V	N			N
How do fishers access the seagrass when fishing in your country, region or locality?																																				
By foot	C	V	Y	N	N	R	R	C	N	Y	Y	U	R	N	N	N	N	Y	C	N	N	Y	Y	Y	V	V	R	Y	V	V	V	V	C	U	R	C
By swimming	N		I	N	N	R	N	C	N	N		R	N	Y	N	U	N	I	U	N	N	N	Y	N	V	V	R	Y	U	V	V	I	N		R	N
By snorkeling	N		I	N	N	Y	N	C	N	Y	Y	C	N	C	C	U	N	I	U	N	Y	N	Y	N	U	V	R	Y	U	V	V	I	N		R	R
Canoe (no engine)	I		Y	N	N	Y	R	C	R	N	Y	U	N	N	N	U	N	I	U	N	R	N	Y	R	U	V	N	I	V	V	V	V	R		R	R
Sail boat	I		Y	N	N	Y	R	U	N	N		U	Y	N	N	U	Y	I	N	N	I	N	Y	N	U	R	N	I	V	V	C	V	N		R	N
Motor boat	C	C	Y	Y	Y	Y	V	C	C	Y	Y	C	U	V	V	C	Y	Y	V	V	Y	N		Y	V	V	C	Y	V	R	N	I	V	R	V	V
Scuba diving	U		Y	N	N	R	R	N	N	Y		N	N	U	R	R	N	I	N	N	Y	N		N	U	R	N	I	U	R	N	I	N		C	N
Free diving	R		I	N	N	N	R	Y	N	Y	Y	C	N	C	C	R	N	I	C	R	Y	N	Y	N	U	V	R	I	V	V	N	I	N		R	R
Other				N	N		I		N				N				N	I		N		N			I						N		C		I	

See caption of Figure 2 for geographical bioregions. Response key: N, no; U, unlikely; R, rare; C, common; Y, yes; V, very common; and I, unknown. HDI key: 1 = low, 2 = medium, 3 = high, 4 = very high human development. The table is arranged according to bioregion 1–6. The same table arranged according to HDI can be viewed in Appendix S2. More information about each case can be viewed in Appendix S3.

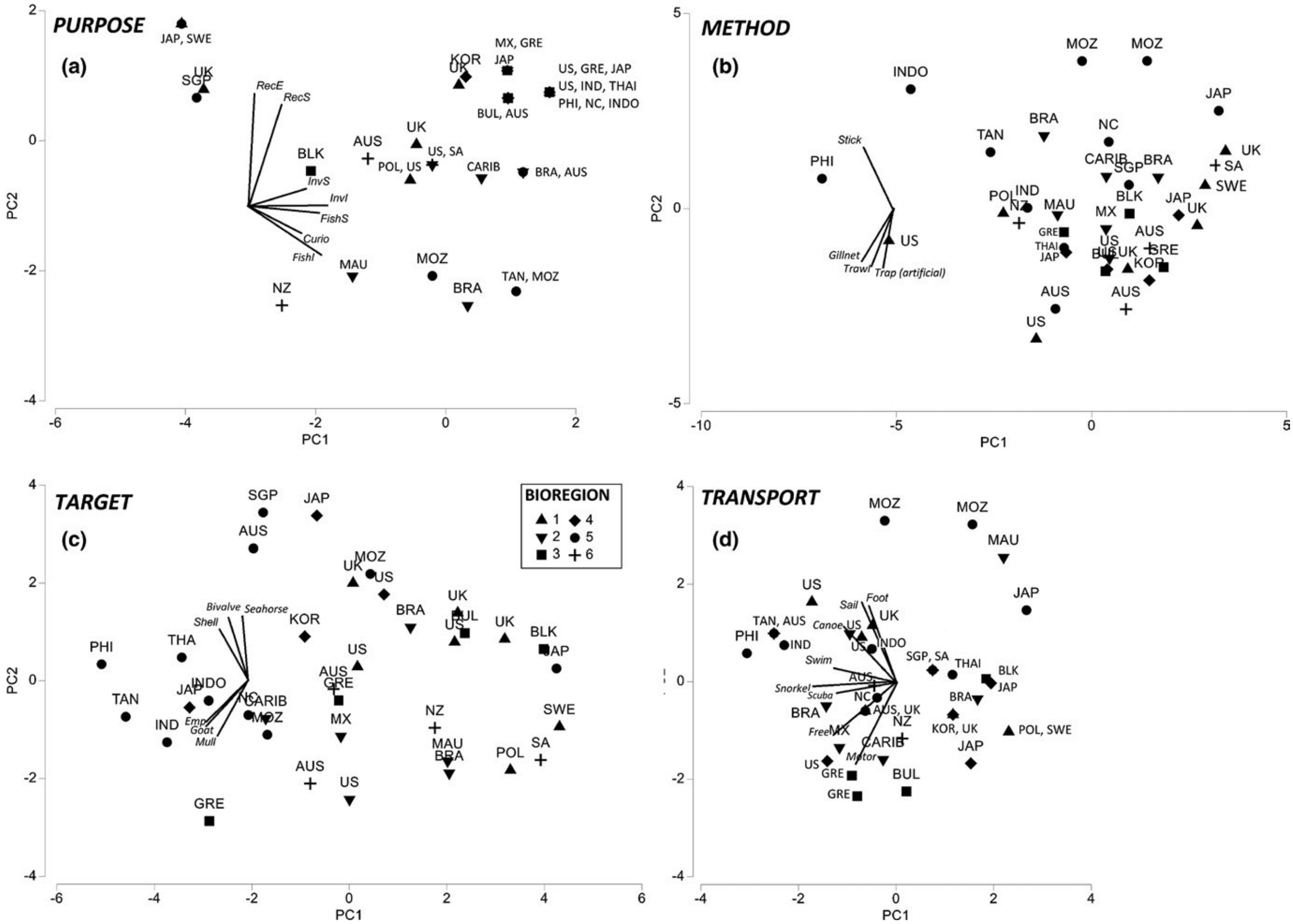

FIGURE 3 Principal component analysis (PCA) on number of occurrences of presence answers in all 36 case studies for (a) purpose, (b) method, (c) target and (d) transport. Abbreviation-case study site: UK-South-East England, UK; UK-North Wales, UK; UK-Solent, UK.; POL-Gulf of Gdańsk, Poland; SWE-Sweden; US-Chesapeake Bay, USA 1; US-Chesapeake Bay, USA 2; BRA-Brazil 1; BRA-Brazil 2; MX-Mexico; US-Florida, USA; CARIB-Caribbean; MAU-Mauritania; GRE-Lipsi, Dodecanese, Greece; GRE-Aegean Sea; BUL-Black sea, Bulgaria; BLK-SW Black Sea; JAP-Seto Inland Sea, Japan; KOR-South Korea; JAP-Japan and South-East Asia; US-NE Pacific Coast, USA; JAP-Okinawa, Japan; IND-India, Lakshadweep; SGP-Singapore; THA-Gulf of Thailand and Andaman Sea; PHI-South-East Asia (Philippines); AUS-North-eastern Australia; NC-New Caledonian lagoon; INDO-Indonesia (Wakatobi); TAN-Zanzibar, Tanzania; MOZ-Palma bay, Mozambique; MOZ-Inhaca, Mozambique; SA-South Africa; NZ-New Zealand; AUS-South Australian Gulf waters; AUS-South Australia. Bioregion 1: Temperate North Atlantic; Bioregion 2: Tropical Atlantic; Bioregion 3: the Mediterranean; Bioregion 4: Temperate North Pacific; Bioregion 5: Tropical Indo-Pacific; Bioregion 6: Temperate Southern Ocean. Vector abbreviations in (a) FishS-Finfish, subsistence; FishI-Finfish, income; InvS-Invertebrates, subsist.; InvI-Invertebrates, income; RecE-Recreation (eaten); RecS-Recreation (sold); Curio-Curio trade, for example Shells. (b) Stick-Stick, not sharp; Trawl-Trawls /dragged nets; Gill-Gill nets; TrapA-Traps, non-natural materials. (c) Shell- Shellfish; Biv-Bivalves, clams, oysters; Seah-Seahorses; Emp-Emporer (Lethrinidae); Goat-Goatfish (Mullidae); Mull-Mullet (Mugil). (d) Foot-By foot; Swim-By swimming; Snor-By snorkelling; Canoe-Canoe (no engine); Sail-Sail boat; Motor-Motor boat; Scuba-Scuba diving

the way to access seagrass areas. PCA of the transport data determined three principal components, which all had eigenvalues greater than 1 and together accounted for 64% of the variability in the data (Figure 3d). The first two principal components accounted cumulatively for 49% of the variability. Five variables correlate (using the Pearson's correlation coefficients of ≥3) with the dominant component PC1. These were swimming, snorkelling, canoe, SCUBA and freediving, thus largely the cause of the separation among cases. There are no clear trends with respect to bioregion across PC1; however, in PC2, the majority of sites from Bioregion 5 (Tropical Indo-Pacific) have much greater +ve scores than other bioregions, and the vector correlates suggest that this is the difference between more dependence upon motor boats in regions other than the Indo-Pacific.

The richness of transport method to seagrass fishing grounds does not change with respect to HDI, but in description of these show a slight tendency that countries with lower HDI use very basic modes of transport (Table 1; Figure 4d; Appendix S2).

2.8 | Global patterns

Seagrass fisheries around the world are fairly similar as can be seen by the collected distribution within the PCA, representing all information

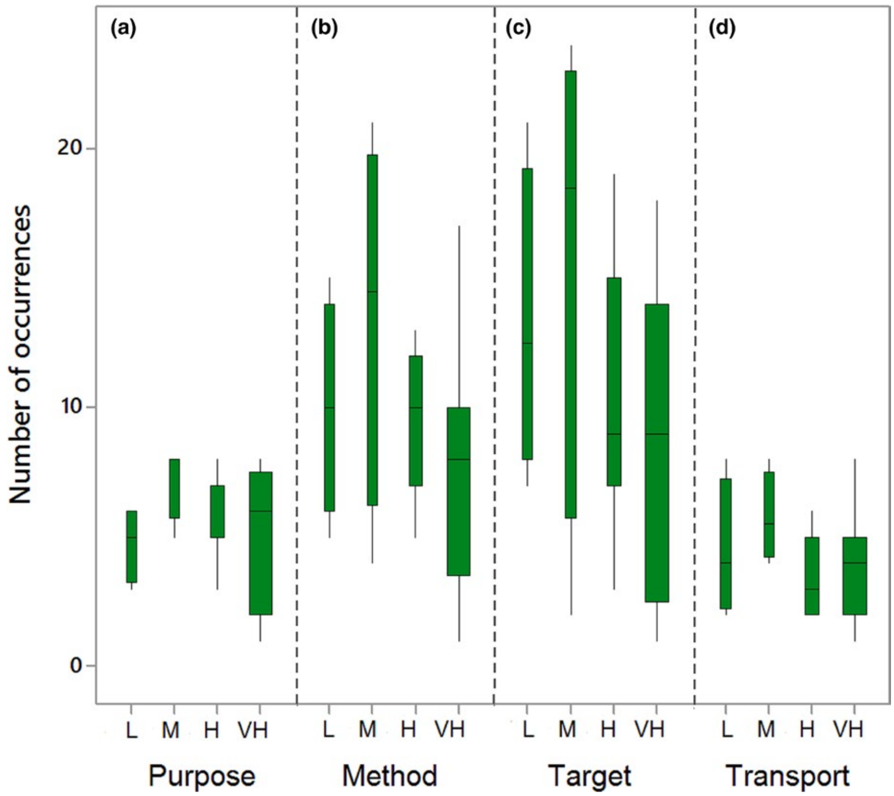

FIGURE 4 Median values of occurrences of presence responses for all 36 case studies classified by research question: (a) purpose, (b) method, (c) target, and (d) transport, arranged after Human Development Index (HDI). L, low human development (based on 4 cases); M, medium human development (4); H, high human development (7); VH, very high human development (21). The box plots show the interquartile range and the extent of the data, a wider box represents a larger sample size [Colour figure can be viewed at wileyonlinelibrary.com]

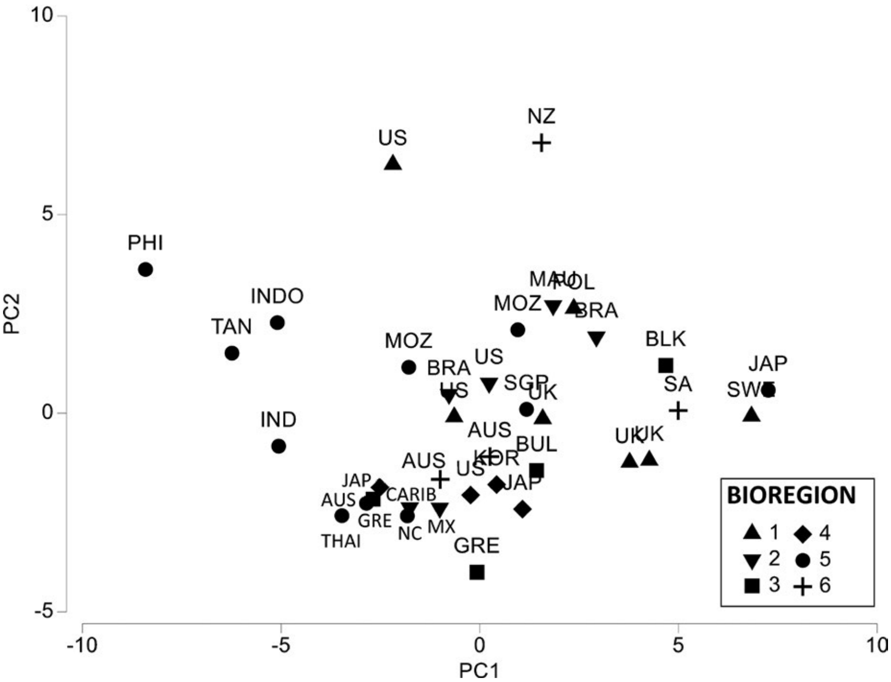

FIGURE 5 Principal component analysis (PCA) on number of occurrence of presence answers in all 36 case studies combining purpose, method, target and transport. See captions of Figure 3 for abbreviations of case study sites and geographical bioregions

(purpose, method, target and transport) from all the 36 case studies (Figure 5). This overlapping pattern, with no significant explanatory variables clearly separating the data, indicates high similarity in seagrass fishery activity. PCA of the data determined five principal components, which all had eigenvalues greater than 1 and together accounted for 48% of the variability in the data (Figure 5). The first two principal components accounted cumulatively for 27% of the variability with no variables correlating (using the Pearson's correlation coefficients of ≥3) well with any of the dominant components (PC1 and PC2).

Correlations analyses based on data from Table 1 (number of occurrences) show the presence of a series of positive relationships

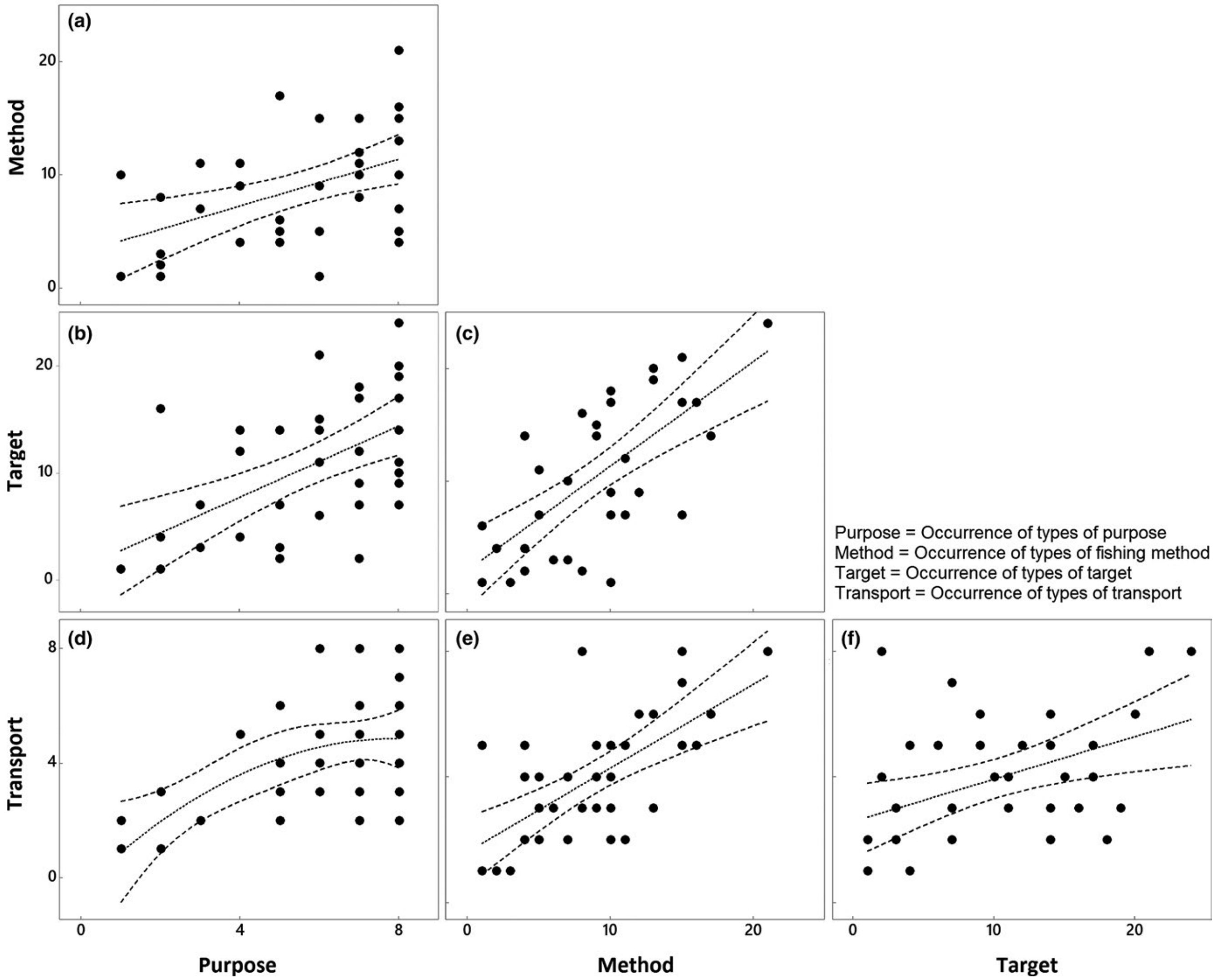

FIGURE 6 Correlations on number of occurrences of responses (y- and x-axes) for purpose, method, target and transport, based on all 36 case studies. Correlations between (a) purpose and method (b) purpose and target (c) method and target (d) purpose and transport (e) method and transport (f) target and transport. The dotted lines are 95% confidence intervals

between purpose-method, purpose-target, purpose-transport, method-target, method-transport and target-transport (Figure 6). Although this quantitative approach only provides a very broad assessment of the systems in question, these correlations indicate that when target species are diverse then people adapt to this and use different gears and transport means in order to exploit those resources.

Overall total richness of occurrence across all questions (purpose, method, target and transport) reveals limited differences with respect to the HDI (Figure 4). Experts associated with cases with higher income countries answered questions in broadly the same way as those in lower- and middle-income nations. Some slight tendencies indicate that countries with high HDI more often fish for recreational purposes, use less diversity of gear and target fewer species, while countries with lower HDI use more basic gear and modes of transport (Table 1; Figure 4). Our data presented releative to HDI (a revised version of Table 1) can be seen in Appendix S2.

3 | DISCUSSION

This study provides the first evidence of the circumglobal extent of the multispecies, multigear fisheries active in seagrass meadows. On a global scale, we find all capture fishery gear types described by the FAO (FAO Fisheries & Aquaculture 2017) are practiced in seagrass ecosystems, spanning small-scale, artisanal, recreational (sport), commercial, subsistence, traditional and industrial fisheries. Based on our findings, we argue that most of this fishing activity is small scale and potentially critical for the livelihoods and food security of many hundreds of millions of people (Barnes-Mauthe, Oleson, & Zafindrasilivonona, 2013). In all regions (with some local minor exceptions), we record invertebrates and finfish to be extensively caught in seagrass meadows. The pattern we find is that where seagrass is present, people fish in it, and seagrass is often the fishers preferred habitat. Seagrass meadows are recognized for their importance as juvenile habitats (Beck et al., 2001; Heck, Hays, & Orth, 2003), but the extent of their role as fishing grounds has been scarcely acknowledged with implications for their poor recognition in conservation management (Duarte, Dennison, Orth, & Carruthers, 2008). This study highlights that seagrass meadows form fishing grounds for adult fish and invertebrates in all bioregions across the world. The research emphasizes, like artisanal fisheries as a whole (Pauly & Charles, 2015), that seagrass fisheries are "too big to ignore" (Too Big To Ignore 2017) and need to be considered in their own right. In simple terms, environmental policy makers and managers around the world need to acknowledge that (i) seagrass is a common fishing ground, (ii) a large diversity of fish and invertebrate species are targeted in seagrass meadows, and (iii) seagrass meadows are important for subsistence, recreational and industrial fisheries. The benefits of seagrass in terms of providing such critically important fisheries habitats need to be communicated to environmental policy makers, managers and the public (Nordlund et al., 2017). This will increase their appreciation for this valuable fisheries habitat.

We show that fishery activity in seagrass areas includes almost all available methods and gear, with the exceptions of techniques suitable for only very deep waters; this highlights the many ways in which seagrasses can be and are exploited. Our data from expert elicitation suggest that the wider diversity of gear used in seagrass habitats the higher the diversity of target taxa are caught in seagrass fisheries. The intertidal and subtidal growth of seagrass together with its soft sediment and soft structure allows for all beach-based fishing activities and numerous tidally dependent fishing methods. Importantly, many of these methods require limited (if any) equipment (e.g., walking at low tide with a bucket). Seagrasses found in deeper water lends itself to almost all other fishing methods including those used on coral reefs as well as the deep sea trawls (e.g., in Australia). On a global scale, this multiple method and gear use targets everything that can be useful to humans, including food, bait and curios, as well as supporting cultural well-being (through recreation, livelihoods and a general way of life) (Cullen-Unsworth et al., 2014; Nordlund et al., 2016, 2017). Such a diverse variety of methods and gears as used in seagrass fisheries implies that there may be possibilities to change gear use and providing options that are considered more sustainable in terms of catch, bycatch and direct habitat effect. For example, "hook and line," which is one of the most common fishing methods in seagrass, is considered a more sustainable gear as it is more selective than many other gear types and with little direct impact on the surrounding habitat. Gillnets and traps, which are also commonly applied techniques, are often considered to have fewer broad-scale environmental impacts than active (mobile) fishing gears, but still cause unwanted mortalities at population level (Uhlmann & Broadhurst, 2015). Traps, if used correctly and following appropriate legislation, have the potential to be more sustainable than other gear (Figure 1a). Mobile fishing gears, such as bottom trawls, have been compared to gear used in forest clear-cutting as they sharply reduce benthic structural diversity (Watling & Norse, 1998). Our data suggest that destructive trawls are still used in seagrass habitats, although to a lesser extent than many of the other gear types. Furthermore, other damaging gear, such as explosives, poisons and rake (Figure 1f) appear to be used in seagrass meadows in some localities but are globally uncommon. An example of such is the widespread use of bleach fishing in seagrass in the Turks and Caicos Islands of the Caribbean (Baker et al., 2015).

Our study finds that there is a general trend that countries with a higher Human Development Index (HDI) target fewer species (e.g., Western Europe, Australia, Singapore, USA, Japan, Brazil and Bulgaria) and use more advanced (and expensive) gear and fishing vessels than countries with a lower HDI (e.g., East Africa, Indonesia, many Central American countries and India). This is most likely a consequence of the varying needs, dependencies and preferences shown between countries with high and low HDI, but also due to factors such as biodiversity. For example, in parts of Indonesia and East Africa, seagrass meadows provide a consistent and low cost means of obtaining food and income (e.g., by collecting gastropods or sea cucumbers) for even the poorest members of the community. As the number of reasons (purposes) in a location for fishing in seagrass habitats increases so does the diversity of methods used, diversity of target and ways of accessing the seagrass fishing grounds.

Countries with higher HDI tend to use the seagrass more commonly for recreational fishing and less for commercial or subsistence fishing. Such higher HDI nations tend to also utilize less destructive gear. Exceptions do, however, exist such as the large-scale commercial penaeid shrimp fishery off the coast of Florida or the alleged use of poisons in Chesapeake Bay, USA (Table 1). Throughout the tropics, the diverse nature of the fauna of seagrass meadows means that associated fisheries are equally as diverse (Gullström et al., 2002; Nordlund et al., 2010; Unsworth, Hinder, Bodger, & Cullen-Unsworth, 2014; Kleiber et al., 2015). Given the high variability within our data that potentially masks any key differences with respect to HDI, it is important that further research in this topic considers the influence of socio-economic context on the importance and structure of seagrass fisheries. In addition, given the increasing global trend of fisheries overexploitation (FAO 2016), it is reasonable to expect that seagrass fisheries are similarly in a poor state.

Data on the status and possible changes within seagrass fisheries are largely limited to local case studies (Tomascik, Mah, Nontji, & Moosa, 1997; Exton 2006; Unsworth et al., 2014). Given the importance of the seagrass fishery effort, there is clearly a research need to more fully examine the status of these activities. The global extent of seagrass fishery activity revealed here indicates that the global decline of seagrass (Waycott et al., 2009) may also be negatively impacting this provision of ecosystem services of seagrass.

The lack of available information about seagrass fisheries opens up widespread future research opportunities and is the reason why we conducted an expert elicitation study in combination with a literature search. Studies based on expert elicitation are highly useful in data-deficient environments, but further research about seagrass fisheries in general would add more certainty, improve validity and fill knowledge gaps. In this study, because of the nature of the data, only presence and absence of occurrence were analysed, with very general conclusions drawn as levels of uncertainty may exist in each specific case. Existing literature demonstrates that there is a particular lack of research on why people fish in seagrass habitats, how they access the fishing grounds and what gear they use.

Seagrass meadows are vital ecosystem service providers, but for these services to be maintained, more effective and proactive management is necessary, especially given the alarming rates at which seagrasses have been documented to be lost globally (Waycott et al., 2009; Nordlund et al., 2017). We do know from limited seagrass fishery data and from other similar inshore fisheries (Exton 2006) that there are multiple overlapping challenges for sustainable management of seagrass fisheries. These challenges include multiple stock harvesting, multiple gear use, a diversity of users/stakeholders with differing needs creating different pressures (e.g., boat mooring, seaweed farming and overharvesting of associated faunal species), severe poverty among fishers in many places, easy and open access to fishing grounds, lack of knowledge and understanding of seagrass values and lack of finances to manage the resources (Duarte et al., 2008; Nordlund et al., 2010, 2014; Nordlund & Gullström, 2013; Jennings, Smith, Fulton, & Smith, 2014; Lefcheck, Wilcox, Murphy, Marion, & Orth, 2017). These challenges are clearly needed to be addressed in a site- and context-specific manner.

The ecosystem approach to fisheries (EAF) is a strengthened approach towards sustainable development of fisheries, recognizing more explicitly the interdependence between human well-being (HWB) and ecosystem well-being (EWB) (Garcia, Zerbi, Aliaume, Do Chi, & Lasserre, 2003). The challenging question is how to balance (maintain or improve) the well-being of people dependent on seagrass habitats with the well-being of seagrass ecosystems (McClanahan, Allison, & Cinner, 2015). There is no doubt that there is a need for multiple approaches across scales from local to global. Ideas for improved management approaches to seagrass exist (Coles & Fortes, 2001; Cullen-Unsworth & Unsworth, 2016), but these are largely focussed on the needs of seagrass rather than the needs of an interconnected social–ecological system or for larger areas such as the intertidal zone. Such approaches need to be tailored to the specific local context. As we have shown here seagrasses are exploited using a highly diverse range of methods across scales. The diversity and intensity of exploitation therefore needs to be considered when developing management strategies for these systems. Gear-based management is one option that has the potential to be adaptive, to address multiple objectives and be crafted to the socio-economic setting (Hicks & McClanahan, 2012). Advances in knowledge are also required to better understand the differences in impact between seagrass areas fished with different methods and gear. Furthermore, an increased understanding of the importance of seagrass-associated fisheries can create a means of developing effective marine protected areas and conduct spatial planning that is fit for purpose so that management actions can be created that are locally appropriate.

To conclude, we show that seagrass fisheries occur all over the world; if there is seagrass (and people), there is most certainly fishing. The seagrass fishery has subsistence, commercial and recreational value, and almost all available fishing methods and gear are used in seagrass meadows. Depending on location, the diversity of target species varies from a few species to basically anything one can find that can be eaten, sold or used as bait. Given that seagrass meadows are widely threatened and loss occurs at alarming rates, further degradation of these ecosystems should not be an option as it may severely diminish seagrass fisheries. Measures need to be taken to improve the seagrass resilience into the future (Cullen-Unsworth & Unsworth, 2016) so that seagrass meadows can continue to support productive fisheries that provide an essential food source. There is no doubt that seagrass meadows are fishing grounds of high significance to human well-being around the world, making it very clear that seagrass fisheries need to be considered, reported and managed in their own right.

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