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Defining Small-Scale Fisheries and Examining the Role of Science in Shaping Perceptions of Who and What Counts: A Systematic Review

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Small-scale fisheries (SSF) have long been overshadowed by the concerns and perceived importance of the industrial sector in fisheries science and policy. Yet in recent decades, attention to SSF is on the rise, marked by a proliferation of scientific publications, the emergence of new global policy tools devoted to the small-scale sector, and concerted efforts to tally the size and impacts of SSF on a global scale. Given the rising tide of interest buoying SSF, it's pertinent to consider how the underlying definition shapes efforts to enumerate and scale up knowledge on the sector—indicating what dimensions of SSF count and consequently what gets counted. Existing studies assess how national fisheries policies define SSF, but to date, no studies systematically and empirically examine how the definition of SSF has been articulated in science, including whether and how definitions have changed over time. We systematically analyzed how SSF were defined in the peer-reviewed scientific literature drawing on a database of 1,723 articles published between 1960 and 2015. We coded a 25% random sample of articles ($n = 434$) from our database and found that nearly one-quarter did not define SSF. Among those that did proffer a definition, harvest technologies such as fishing boats and gear were the most common characteristics used. Comparing definitions over time, we identified two notable trends over the 65-year time period studied: a decreasing proportion of articles that defined SSF and an increasing reliance on technological dimensions like boats relative to sociocultural characteristics. Our results resonate with findings from similar research on the definition of SSF in national fisheries policies that also heavily rely on boat length. We call attention to several salient issues that are obscured by an overreliance on harvest technologies in definitions of SSF, including dynamics along the wider fisheries value chain and social relations such as gender. We discuss our findings considering new policies and emerging tools that could steer scientists and practitioners toward more encompassing, consistent, and relational means of defining SSF that circumvent some of the limitations of longstanding patterns in science and policy that impinge upon sustainable and just fisheries governance.

Keywords: small-scale fisheries, capture fisheries, fisheries governance, fisheries policy and management, fisheries science, systematic review, FAO, small-scale fisheries guidelines

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INTRODUCTION

For many the term "small-scale fishery" (SSF) evokes a mental image of small, traditional fishing craft equipped with low-tech gear requiring labor-intensive fishing methods. Fisher*men* are typically the central subjects of this platonic scene, operating boats individually or in small-crews in the pursuit of fish. Even individual fishing strategies are often presumed to follow one of several archetypical models of behavior, whether inherently ecologically and socially harmonious, and therefore sustainable, or conforming to the economically rational, competitive fisher of fisheries bioeconomic models (St. Martin, 2005). This dominant imaginary of SSF is often spatialized, presumably limited to the tropical seas of the Third World, as opposed to the fully capitalist, industrial fisheries that inhabit the First World (St. Martin, 2005).

This prototypical image of fishermen adrift in a sea of small boats is easily conjured, yet it obscures the broader assemblage of diverse livelihood activities that occur along the SSF value-chain. We consider SSF as encompassing these wide-ranging activities undertaken throughout the value chain by both men and women in inland and marine fisheries, including harvesting from boats and on foot, along with pre- and post-harvest labor that occurs on land (FAO, 2015). However, even the term "value chain" can become a misleading metaphor, suggesting tidy relations organized into discrete and equivalent links. In practice, the meshwork of actors and relationships that comprise the value chain are not so clear-cut or orderly, but are rather diffuse, tangled and contingent—assembling and re-assembling into new alignments along an uneven and shifting terrain (Li, 2007; Anderson and Mcfarlane, 2011). The geographic and temporal extent of SSF value chains defy common assumptions about their smallness. The reach of small-scale value chains is not limited to the global south: SSF are found in inland waterways and seas across the globe, spanning different freshwater and marine ecosystems, development contexts, and political arrangements. Nor are they confined to the past, despite conventional associations between SSF and traditional practices: SSF have persisted as a way of life throughout human history through adaptation to changing social, environmental, and economic conditions.

In this paper we probe the gap between the heterogeneous and dynamic existence of SSF in practice and the one-dimensional caricature typically portrayed and embedded within the dominant imaginary of SSF. We take the definition of SSF as an entry point to explore this enduring paradox and consider how practices of knowledge production have shaped perceptions of what SSF are, and therefore, how they should be valued and governed.

Dividing Capture Fisheries Into Small-Scale and Industrial Categories

Fish resources are one of the last hunted commodities on earth, pursued through a variety of tools and techniques ranging from spears and traps to sonar detection (Campling et al., 2012). Collectively these activities are known as capture fisheries, a motley grouping that includes seemingly disparate fishing enterprises, including families or collectives gleaning on foot in the intertidal zone, hired crews of 3–5 fishers working from wooden or fiberglass boats fashioned with outboard motors, and industrial trawlers the size of a football field with onboard processing facilities (World Bank, 2012). For the purposes of studying and managing these activities, the full spectrum of capture fisheries is often simplified and divided into "small-scale" and "large-scale" or "industrial" fisheries: categories that are presumed at first glance to be distinct and mutually exclusive. Exactly where to draw the line between these categories is contested, but typically the division hinges on assumptions about the role of fishing technologies and the nature of human progress. Rather than depicting SSF and industrial fisheries as coextensive categories, representing "disaggregated and diverse sets of practices unevenly distributed on the economic landscape" (Gibson-Graham, 1997), this binary template is tacitly understood as both a spatial and temporal hierarchy—where industrial fisheries are the dominant category, located in the First World and temporally ahead of SSF along a unilinear path toward progress. Arrayed this way, industrial fisheries appear to succeed SSF in an evolutionary-like model of fisheries development as the naturally dominant and more efficient mode of production (Gibson-Graham, 1997; p. 115). With each category defined by their presumed technological differences, this division circumscribes SSF as the subordinate category—an inefficient mode of fisheries production from the past—while industrial fisheries are depicted as the natural progression and future of fishing. "Against this narrow imagination of an industrial fishing future" (Jadhav, 2018a), SSF are implicitly (and at times explicitly) treated as the subordinate category and conferred a more marginal status and a lower priority on national and global fisheries agendas.

Disregard for SSF is evident in the history of the modern institutions of fisheries science and management, which arose to address the challenges of industrial fisheries and intensifying resource exploitation in the early twentieth century (Cushing, 1988; Smith, 1994; Johnsen et al., 2009). Meeting the demands of the rapidly expanding fishing industry after the turn of the century required new kinds of data and scientific expertise focused on quantitative understandings of individual stocks and their relationship to fishing effort (Cushing, 1988). Scientific techniques of translation were needed in order to transform fish into natural resources—inputs suitable for capitalist production (Luke, 1995; St. Martin, 2005). In addition to new methods of discursive representation and calculation, implementation of scientific management plans required centralized oversight and the creation of new government bodies to administer fisheries (Jentoft et al., 1998). Ideologically this new mode of fisheries management was founded upon an innate optimism and trust in experts' ability to translate unruly fish, fisher folk, and technologies into abstract objects that could be ordered and managed through the application of economic rationality and mathematical models (Mccay and Finlayson, 1995; Johnsen et al., 2009). Attempts to extend these techniques designed for industrial fisheries to SSF have resulted in repeated failures, both in terms of ecological and social outcomes (Berkes, 2001). Meanwhile the existence of longstanding local institutions for fisheries governance and sea tenure in SSF were systematically

discounted as non-scientific (Johannes, 1981; Cordell, 1989; Berkes, 2018), archaic practices with no place in the modern reconfiguration of fisheries science and management.

The Imminent Rise of Small-Scale Fisheries

Despite longstanding asymmetries between SSF and industrial fisheries, recent changes indicate that another future is possible. Scientific attention to SSF is on the rise as evidenced by a marked increase in peer-reviewed publications on SSF in the last two decades (Purcell and Pomeroy, 2015; Basurto et al., 2017b) and the development of global partnerships for collaborative SSF research such as the Too Big to Ignore network (Chuenpagdee et al., 2017). The passage of the Food and Agriculture Organization's (FAO) Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF-Guidelines) in 2014 marked a historical turning point for SSF. As the first globally negotiated policy specifically for the small-scale sector, the SSF-Guidelines differed from other fisheries instruments because they were developed through an inclusive, participatory process and took a human rights-based approach to fisheries governance (Allison et al., 2012; FAO, 2015; Willmann et al., 2017). While the arrival of the SSF-Guidelines marked a profound departure from fisheries policy-as-usual, this shift was regarded as long overdue: fishers, fishworker organizations and related civil society organizations (CSOs) began calling for the development of a specific set of guidelines over a decade earlier (Jaffer and Sunde, 2006; ICSF, 2007; Sharma, 2008, 2011; Pictou, 2017). Discontent among fisher organizations coalesced over the passage of Code of Conduct for Responsible Fisheries in 1995—guidelines which purportedly set standards for global best practices pertaining to all capture fisheries yet only contained four mentions of the specific needs of SSF (Johnson, 2006). It took nearly 20 years to ratify a corollary set of guidelines for SSF at the Committee on Fisheries (COFI). However, in contrast to their longstanding marginal status within global policy, SSF now command their own standing agenda item at the biennial convening of COFI, where 2022 was designated the Year of Artisanal Fisheries and Aquaculture and an expanding cohort of member states have made public commitments to implement the SSF-Guidelines in their national fisheries (FAO, 2018).

As the tides of attention appear to be shifting toward SSF, we believe it is timely to ask: if SSF are on the rise as a subject of interest in science and policy, then what, exactly, counts as small-scale fisheries? On the surface, this appears to be a simple question and matter of straightforward classification: a specific fishing enterprise or wider fishery is better suited either to the small-scale or to the industrial category. Yet upon closer consideration it becomes evident that the definition beneath each category is linked to more fundamental issues about the relationship between nature, technology and society that are not so clear-cut or ethically neutral (Johnson, 2006; Arbo et al., 2018). Defining SSF is not a mere technical matter of where to draw the line between small-scale and industrial fisheries; it is, rather, a value-laden decision with political implications and material consequences both for the environment and for humans who depend on fishing for their livelihoods and food security (Johnson, 2018). Based on our own observations at different international fisheries fora, the issue of the definition often presents a stumbling block for efforts to achieve mutual dialogue and consensus agreements on fisheries governance at national, regional, and global levels. While ostensibly speaking of the same category—SSF—dialogue often unravels when the definition is unpacked in practice, and divergent perspectives arise over which characteristics of SSF are most salient and worthy of inclusion at the expense of others. Scientists play an important role in these debates as an influential community widely regarded as experts in the matters of environment and natural resource management, yet the situatedness of knowledge and the effects they produce often go unscrutinized (Haraway, 1988; Turnhout, 2018). We believe it is pertinent to explore the relationship between scientific knowledge production and the definition of SSF, asking: How have scientists navigated defining SSF as a subject of study? Can we identify any common traits among scientific definitions, and do commonalities vary over time and space? Lastly, what can a closer look at these patterns reveal about the relationship between the definition, presumed priorities and present blind spots in SSF research and policy?

One way to approach these interrelated questions empirically is to analyze the growing body of scholarship on SSF. In doing so, the overarching goal of this paper is to examine how scientific knowledge has shaped the definition and perceptions of who and what counts as SSF through a review of scientific literature on SSF.

The Emerging Global Picture of Small-Scale Fisheries

How SSF are defined is pertinent considering the recent push to scale up knowledge on the sector. Constructing a global picture of SSF requires amassing and aggregating different sources of data, a major challenge for a sector that has long been considered data-poor. Within fisheries, SSF have historically gone uncounted, underestimated, or undifferentiated—overlooked or hidden within national fisheries statistics. The reasons for this data gap are multiple. The diversity and plurality of SSF frustrate efforts to systematically and reliably count them at higher scales, and these challenges are further exasperated by a chronic lack of institutional capacity and meager political will to prioritize SSF, their specific data needs, and unique methodological challenges (Welcomme et al., 2010; Kittinger et al., 2013; Basurto et al., 2017a). However, in recent decades global momentum is building to prioritize counting SSF through innovative methodologies to combat the chronic inaccuracies of existing data and the sector's subsequent invisibility. In 2012, the FAO collaborated with the World Bank and WorldFish researchers to generate better global estimates of SSF independent of self-reported national fisheries statistics. Through use of country-level case studies and assimilation of existing data sources, the resultant "Hidden Harvest" report and the forthcoming "Illuminating Hidden Harvest" unveil previously underestimated contributions of SSF to human well-being, providing new figures on the magnitude and impacts of SSF that avoid some of the limitations of official government statistics (World Bank, 2012; Worldfish, 2018).

The global picture of SSF emerging from these efforts suggests that, despite the name, SSF are by no means "small." On the contrary, SSF are much larger than previously thought

and appear to have an outsized impact on human health and nutrition, poverty alleviation, jobs, and the structure of seafood markets (Jentoft et al., 2017). Emerging accounts affirm that SSF likely land nearly half the world's seafood, playing a critical role in food security and nutrition, especially for those living in poverty (Kawarazuka and Béné, 2010; World Bank, 2012; Bennett et al., 2018). The nutritional value of wild-caught fish is manifold, providing a high-quality source of protein, fatty acids and micronutrients vital to combatting malnutrition and disease (Béné et al., 2015; Golden et al., 2016). Access to fish is especially important for the diets and health of pregnant women, infants and lactating mothers (Bogard et al., 2015; Thilsted et al., 2016), for the populations of many small island developing states (SIDS) (Béné et al., 2016), and for sociocultural groups with longstanding ties to the sea or inland waterways (Mccay, 1987; Funge-Smith, 2018). Further, new evidence suggests that the nutritional value of wild-caught fish may exceed that of farmed fish (Belton and Thilsted, 2013; Thilsted et al., 2016; Bogard et al., 2017), underscoring the continued importance of capture fisheries even alongside the rise of aquaculture.

In terms of employment, SSF are by far the oceans' largest employer—greater than industrial fisheries, oil and gas, shipping, and tourism combined (World Bank, 2012; OECD, 2016). Experts suggest that inland SSF likely provide even more jobs than their marine counterparts (56 verses 52 million) and play an especially important role in local nutrition and food security (Welcomme et al., 2010; World Bank, 2012; Bennett et al., 2018; Funge-Smith, 2018). The composition of the SSF workforce is also more diverse than previously thought, with women representing nearly half of SSF workers globally (World Bank, 2012). From the net to the plate, women are found along the entire SSF value chain and dominate the post-harvest sector in many parts of the world (Choo et al., 2008; World Bank, 2012; Kleiber et al., 2015). Once landed, fish are transformed into an array of products and become highly traded commodities—some of the most traded food items in the world (FAO, 2018). While often associated with subsistence use and barter exchange, fish landed by SSF circulate within markets at various scales, including in local fishing communities, through extensive networks of regional markets, and in an increasingly globalized system of international trade (FAO, 2018). Greater granularity is needed to better understand the distributional and nutritional consequences of changing trade relations in SSF and interactions of markets at different scales (Bennett et al., 2018).

Beneath each of these generalized figures rests a definition of SSF that served as the foundation for tallying the size and contributions of the sector. As these facts and figures are borrowed, repeated, and circulate beyond their original context, the underlying definition rarely travels with them. As a formidable yet often invisible force, how does the underlying definition shape efforts to accumulate knowledge on SSF as the sector garners greater attention and an increasingly global status? As we begin to illustrate the true size and scope of SSF, the question remains, what are we counting?

The growing body of scientific knowledge on SSF is an important site to explore how SSF have been defined, because "critical awareness of the categories that guide fisheries governance is extremely important" where ongoing reflection can improve their application (Johnson, 2006). Even as the lines between science, policy and politics in the environmental sphere are increasingly interconnected and blurred, sciences maintain a privileged position in environmental debates, shaping how we conceptualize the environment and the policies we enact to manage and maintain it (Chilvers and Evans, 2009; Turnhout, 2018). Taking the performativity of knowledge as a starting point, this scientific knowledge is not merely reflecting reality "as it is" but constituting and shaping that reality while attempting to represent it (Law, 2009). Therefore, rather than assuming what SSF are, we explore how the category has been constructed from its constituent definitional parts. In this pursuit, we work to uncover interwoven patterns and simultaneous blind spots, potentially illuminating opportunities to "cast the analytic net wider" toward more inclusive approaches (Arbo et al., 2018). For example, fisheries have long been erroneously perceived as a masculine space dominated by male workers (Choo et al., 2008; Williams, 2008). The prevalence of this assumption is evident in both fisheries science and policy, where the mere presence of women has rarely been acknowledged, let alone deeper consideration of the intersections between gendered dimensions of environmental knowledge, identity, power, and occupational health and safety. Only in the last decade is the hegemony of "fishermen" starting to crack as the significant number and manifold contributions of women are repeatedly demonstrated and increasingly accepted (Neis et al., 2005; Choo et al., 2008; Gerrard, 2008; Weeratunge et al., 2010; Harper et al., 2013; Branch and Kleiber, 2017).

Debating the Definition of Small-Scale Fisheries

Debates about the nature of SSF and the role of the definition have unfolded over several decades. Early work by Kesteven (1973, 1976) and Smith (1979) acknowledged that some common attributes could be used to distinguish SSF from more industrially oriented fishing operations, but that attributes should be understood as variants along a continuum rather than as belonging to hard and fast categories. Instead of gravitating toward the ease and symmetry of singular distinctions, these scholars advocated early on for a framework based on combinations of technical and socioeconomic characteristics to define SSF (Smith, 1979). The publication of Thomson's (1980) influential table depicting "two distinct world fisheries" provided the first visual illustration of a clear division between small- and large-scale fisheries. The table's two columns contrasted the size and relative value of "large-scale company owned" and "small-scale artisanal" fisheries, symbolized by different types of boats—the former large and modern-looking and the latter a small sail-powered outrigger craft. Thomson's table helped popularize the term "small-scale fishery" and has been repeatedly borrowed, amended, and expanded by scholars over the decades, including Ruttan et al. (2000), Berkes (2001), Sumaila et al. (2001), Pauly (2006) and Fréon et al. (2014).

Over the years, many attributes essential for defining and valuing SSF have been proposed, including the size and type of boat, engine horse power, equipment type, time commitment, catch rates and disposal, environmental knowledge, significance of fishing as a livelihood, and marginality, among others (Kurien,

1996; Berkes, 2001; Kittinger, 2013). Some lists emphasize the importance of technological aspects of SSF (Pitcher et al., 1998), while others address combinations of technological, environmental, social, and political parameters to explore finer variations within SSF and between these two, taken-for-granted categories (Johnson, 2006; De Melo Alves Damasio et al., 2016). Several in depth studies grapple with the specifics and limits of national fisheries definitions, including in India (Jadhav, 2018b), Brazil (De Melo Alves Damasio et al., 2016), Peru (Fréon et al., 2014), Azores islands (Carvalho et al., 2011), and Canada (Gibson and Sumaila, 2017), while others address regional challenges such as in the EU (García-Flórez et al., 2014; Natale et al., 2015; Davies et al., 2018). Other scholars deconstruct common paradigms for understanding fisheries, including supposed divisions between "First World" and "Third World" fisheries (St. Martin, 2005) and the meaning of the term "subsistence fishing" in global fisheries scholarship (Schumann and Macinko, 2007). To date, the only large-scale systematic and empirical study of the definition of SSF on a global scale was conducted by Chuenpagdee et al.'s (2006), who analyzed the definitions of maritime SSF in the national policies of 140 countries. The authors found that only 70% of countries articulated a clear definition of SSF, and where SSF were defined, the most common characteristic used was boat length (65% of definitions). Their analysis illuminates the simultaneous absence of clear definitions of SSF in many parts of the world, and yet an overall degree of consistency in characteristics used, suggesting that sufficient commonalities exist to speak of a generalized approach to defining SSF in policy.

Still others are skeptical of systematic efforts to define SSF, finding the category too elusive and relative to warrant a common definition. From this vantage point, the search for a shared definition is an exercise in futility because SSF are too diverse and locally specific to enable any wider generalizations and useful comparisons (Béné, 2006; Johnson, 2006; Carvalho et al., 2011). However, practically, most researchers and practitioners inevitably need to draw some distinctions and categorize fisheries, whether they use the common divisions of large- and small-scale or other variants, and could benefit from the guidance of shared signposts. Most who discuss the merits and drawbacks of defining SSF strike a balance amidst this debate—acknowledging issues and limits to defining SSF but also finding it possible and useful to cull some common characteristics that bridge different contexts and scales, thus enabling wider conversations on SSF that transcend the particularities of place (Kurien, 1996; Chuenpagdee et al., 2006; Charles, 2011).

It's not clear that any definition of SSF is inherently preferable to no definition, nor that any given definition of SSF will lead to homogenously good or bad outcomes for the diverse workers and environments of SSF at different scales. Scalar specificity matters, and yet the desire to share some common language for defining SSF that transcends scale persists, particularly given the overwhelming mandate to scale-up approaches within environmental governance. Rather than searching for an elusive and ultimately unsatisfactory fixed definition that universally applies, an imprecise definition may be preferable, leaving room to maneuver while signaling some shared traits (Gibson and Sumaila, 2017). Even imprecise definitions could help augment several interrelated issues that stem from the absence of a definition: data deficiencies, paucity of research, political marginalization, and a lingering low-status stigma that often plagues the sector (Chuenpagdee and Pauly, 2008; Carvalho et al., 2011). Meanwhile, the space afforded by an imprecise definition could enable comparisons at the global-level without imposing exclusionary and inflexible boundaries.

Scientific Literature as an Unexplored Site to Study the Definition

Amidst the diverse range of actors with a stake in this debate, scientists continue to play an outsized role in categorizing, ordering and managing natural resources such as fisheries. Environmental policymaking has become thoroughly scientized in the push for more evidence-based interventions, where science is simultaneously posited as the cause, means of detection, and generator of viable solutions to a range of environmental problems (Chilvers and Evans, 2009; Turnhout, 2018). Since the rise of modern fisheries science, the conclusions and recommendations of scientists have been regarded as legitimate, expert knowledge in matters of fisheries classification and governance—in charge of the facts and the problem definitions (Johnson, 2006; Basurto et al., 2017b; Turnhout, 2018). It's now well-recognized that the narrow approach of modern fisheries science alone is insufficient to understand SSF. In response, an increasingly diverse pool of scientific perspectives have joined in the dialogue on the best course for governing SSF, including community ecologists, common-pool resource scholars, political ecologists, and post-structural approaches (Berkes, 2015; Mather et al., 2017).

However, despite the recent expansion of SSF as a topic of scientific interest, no systematic studies have critically examined the workings of scientific knowledge production and the role of the definition of SSF. The goal of this study was to assess how scientists have defined SSF and whether dominant ways of defining SSF have changed over time. More specifically, we endeavored to: (1). Assess the dominant characteristics used to define SSF; (2). Determine whether any patterns present in the definition have changed over time or vary by study geography, aquatic system, or journal outlet; (3). Compare any patterns identified in the scientific literature to results from similar research on the definition of SSF in policy; and (4). Consider the advantages and limits of dominant ways of defining SSF alongside prospects for future improvements.

METHODS

Study Design

The methodological foundation of this study is based on the principle that peer-reviewed publications can serve as indirect measures of knowledge produced on a topic because they are a well-established means through which scientific information is communicated and codified across scholarly communities (Van Raan, 2004). Peer-reviewed journals inevitably provide an incomplete picture of knowledge produced on any topic and are certainly not the only means through which scientific findings are communicated. Nonetheless, scientific journals are

longstanding: scientists have used international journals since the seventeenth century (Van Raan, 2004). Further, as opposed to other tacit forms of communication and knowledge exchange, journals are codified and amenable to systematic searches—serving as an accessible and searchable archive of knowledge produced. Scientometric studies have become a popular means to quantitatively assess scientific output on a range of different topics, including fisheries science (Jarić et al., 2012; Natale et al., 2012; Aksnes and Browman, 2015; Syed et al., 2018). Such studies are typically limited to assessing available bibliometric information and quantitative article-level metrics extracted through automated modes of analyses. In contrast to existing bibliometric studies of fisheries science, this study combines qualitative coding with elements of bibliometric analysis to decode common characteristics used to define SSF and to disaggregate these findings based on other article- and journal-level metrics.

Systematic Review Materials and Protocol

To retrieve relevant literature on SSF, we conducted an extensive search using the Web of Science (WOS) database produced by Thomson Reuters and the following the keywords: "small-scale fisher*," "artisanal fisher*," "fisher folk," or "fishing communit*"—asterisks were used to broaden the search to include variations on each word stem. These keywords were chosen to ensure coverage of both common terms in use today (e.g., small-scale fisher, artisanal fisher; Johnson, 2006) and terms popular in earlier decades that preceded the publication of Thomson's (1980) table that helped popularize the term "small-scale fisher." WOS is a widely used and venerated database in systematic literature searches and scientometric studies (Moed, 2006), including reviews of fisheries research (Jarić et al., 2012; Johnson et al., 2013; Aksnes and Browman, 2015; Syed et al., 2018). However, WOS has several limitations, including underrepresentation of certain social sciences and humanities research and a general bias toward English language journals (Moed, 2006). To supplement our primary search, and attain greater coverage of the social sciences, we conducted additional targeted searches to identify relevant social science journals not indexed in WOS with the help of a marine science librarian (see **Supplementary Materials**). Together, our primary and supplementary searches yielded a total of 2,653 articles. Despite our efforts to address the limitations of WOS and to identify all relevant literature for this study, no search database is complete, and our data set likely underestimates the total peer-reviewed publications on SSF and does not include gray literature such as FAO reports or long-standing specialized outlets like *Samudra* or *Yemaya*. Notwithstanding these important contributions, given our explicit focus on the role of scientists and scientific knowledge production, peer-reviewed literature was deemed the most appropriate and accessible form of data for this study.

The full text for each reference was retrieved and evaluated to determine whether it belonged in the study based on the following criteria: sufficient coverage of SSF in the body of the article, accessibility of the full text in digital format, English as language of publication, and the article's peer-reviewed status (see **Supplementary Materials**). After eliminating articles that did not meet one or more of the study criteria, the final data set contained 1,723 articles. Qualitatively assessing the characteristics used to define SSF at the article-level required the coder to read each article until they encountered the section where SSF were defined (or not). Given the time required to locate the definition within each article, a stratified random sample was used to select articles for in-depth coding. Due to the uneven distribution of articles over time, sampling was stratified by decade and different levels of sampling intensity were used. As a rule, we sampled 20% of articles per decade with a minimum of 50 articles per strata. For strata with <50 articles (e.g., the 1960s and 1970s), all articles were read and coded. Across the

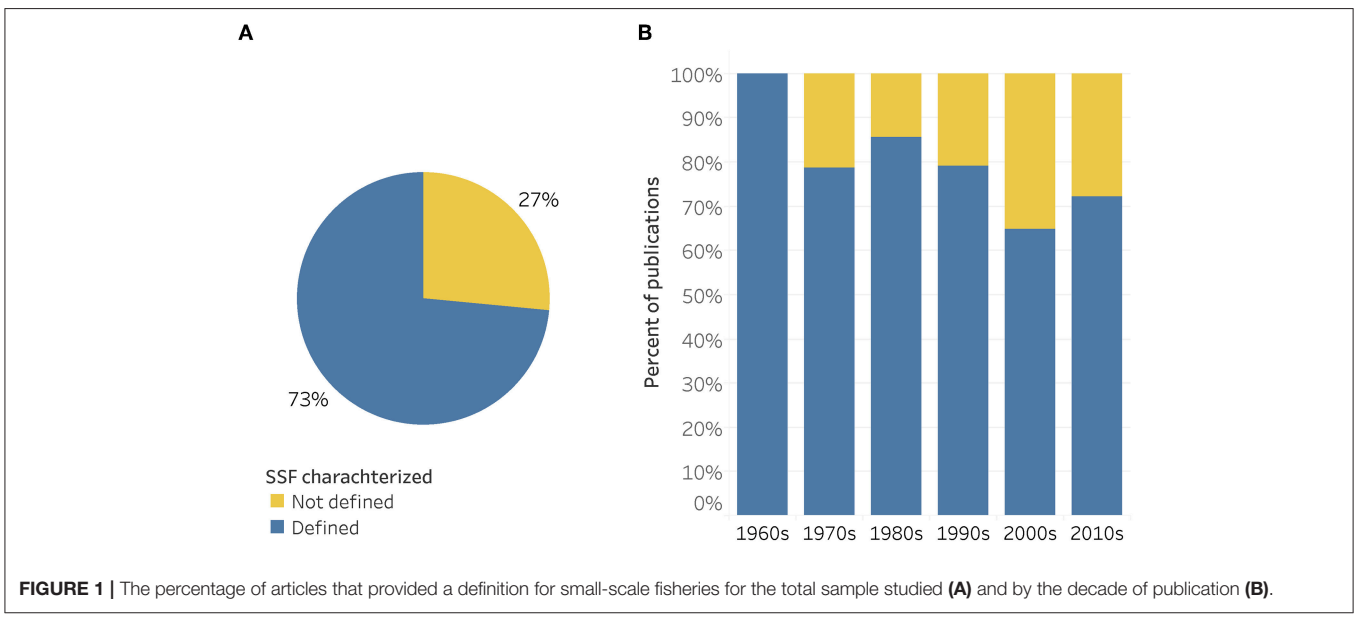

FIGURE 1 | The percentage of articles that provided a definition for small-scale fisheries for the total sample studied **(A)** and by the decade of publication **(B)**.

entire data set, this mixed strategy means that 25% of articles were read and coded ($n = 434$). By oversampling we ensured the study included sufficient literature from earlier decades when SSF publications were sparser. This stratified random sampling approach was deemed the best strategy to compare patterns in the definition over time given the paucity of literature on SSF in the 1960–1980s and the rapid upturn in publications after the late 1990s.

All sampled articles were deductively coded against a set of common characteristics used to define SSF that were derived from the existing literature (Chuenpagdee et al., 2006; Funge-Smith, 2018) and from preliminary research done by the authors (Basurto et al., 2017b) using the qualitative analysis software NVivo 12. We used the following coding structure for each article: whether or not the SSF studied was defined, which characteristics were used to define SSF, the study location, and whether the SSF studied were inland or marine (or both). Each article was also coded for its journal's general audience (natural or social scientists), depending on which citation database indexed that journal (Science Citation Index Expanded or Social Science Citation Index) using the Journal Citation Reports.

The final coded dataset ($n = 434$) was exported into Tableau 12 software for data analysis. Analysis focused on whether the percent of articles defining SSF and the most common characteristics used to define SSF differed by decades and other article-level dimensions (i.e., geography, aquatic system, journal type).

RESULTS

Variability in Definitions of Small-Scale Fisheries Over Time and Space

The majority (73%) of articles provided a definition and or characterization of the SSF studied (**Figure 1A**). The percent of articles that defined SSF varied by decade, with a decrease in articles that defined SSF in the last two decades and an overall downward trend in the proportion over time (**Figure 1B**). The percent of articles that defined SSF for each decade from 1960 to 1990s ranged from 100 to 79%, whereas the proportion of articles that defined SSF were lower for the 2000s (65%), and 2010s (72%). Despite variations between decades, we observed an overall downward trend in the proportion of articles that defined SSF over time.

The percentage of articles that defined SSF varied by the geographic region of study (**Figure 2A**). South Asia (87%), North America (87%), Latin America and the Caribbean (78%), Europe

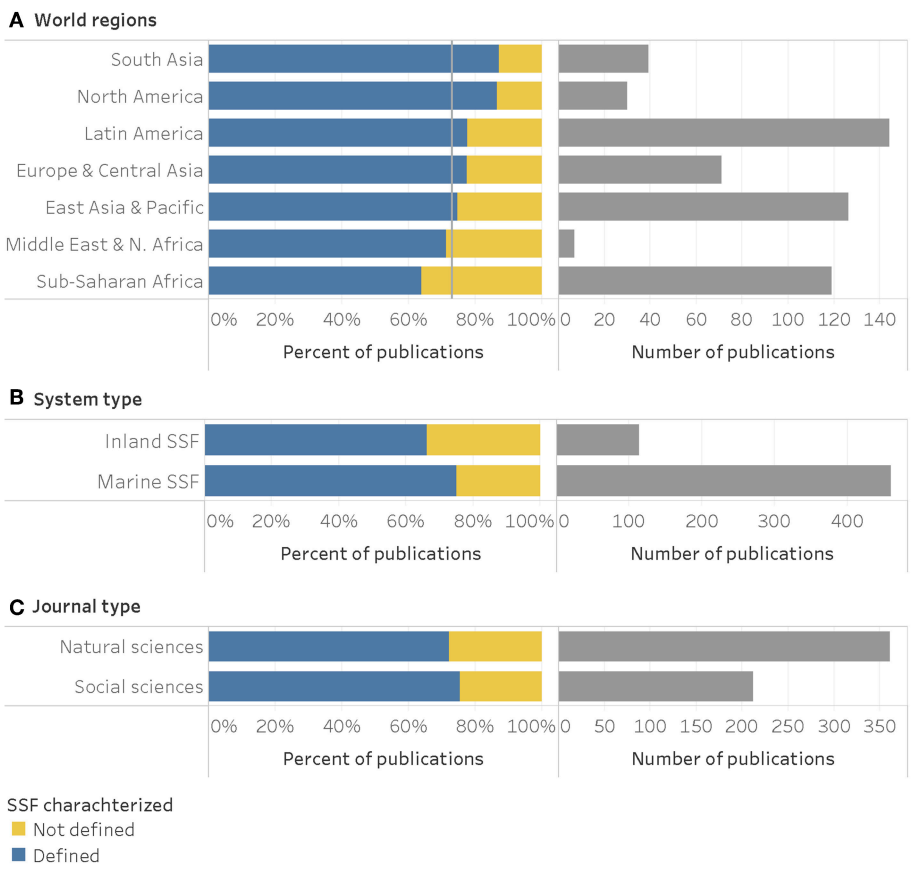

FIGURE 2 | Percentages of articles that defined small-scale fisheries by world regions **(A)**, aquatic system type **(B)**, and journal outlet **(C)**. The gray vertical line indicates the average (73%) for the overall sample.

and Central Asia (77%), and East Asia and the Pacific (75%) were regions where SSF were more often defined. All African regions were below average, with SSF defined in 71% of articles from the Middle East and North Africa and only 68% of SSF studied in Sub-Saharan Africa. Inland SSF were less commonly defined than marine SSFs, with only 66% defined compared to 75% (**Figure 2B**). Lastly, the percentage of articles that defined SSF differed somewhat based on the journal outlet, where SSF were defined in 75% of social science journals and 72% of natural science journals (**Figure 2C**). The number of articles published in social science vs. natural science journals also varied over time in the sample, where social science journals were the most common outlet for SSF publications between 1960 and 1980s, with a marked shift to natural science journals prevailing as the most common outlet from the 1990s to present (**Figure 3**).

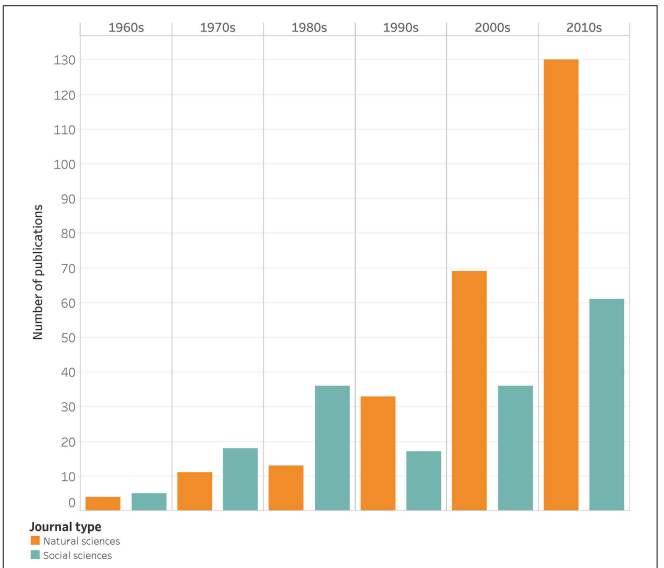

FIGURE 3 | Total number of publications by journal type and decade published in the sample ($n = 434$).

Characteristics Used to Define Small-Scale Fisheries

The most common characteristics used to define SSF (**Figure 4**) were the type of fishing gear (58%), boat (51%; e.g., length, type or material, capacity or tonnage), or sociocultural factors (35%; e.g., ethnic group, religion, caste, class, etc.). Other characteristics used moderately (in 10–20% of articles) included species (19%), motorization (19%; e.g., presence or size of engine), catch disposal (18%), ecology and habitat (16%), distance from shore (13%), and organization of labor and crew (11%). Other characteristics—such as ownership of fishing gear or vessel (6%), trip duration (4%), value chain (4%), time commitment (3%), market integration (<1%), on board storage/refrigeration (zero instances)—were less commonly used to define SSF (i.e., used in <10% of publications).

The relative frequency and relationship among the most common dimensions in definitions varied over time (**Figure 5**). Sociocultural characteristics were the most common dimensions used to define SSF in the 1960–1980s, used in over half of all definitions, but usage declined in the 1990–2010s. Popularity of fishing boats and gear in definitions fluctuated but remained common over the decades, ascending to the top of the list by the 2000–2010s. Motorization was commonly used to define SSF in the 1960–1970s but occurred less frequently in definitions from the 1980s to the present.

Dimensions used to define SSF also varied by world region (**Figure 6A**), where fishing boats appeared most frequently in definitions of SSF in East Asia and Pacific (60%) and Europe and Central Asia (56%), followed by Latin American and the Caribbean (52%) and Sub-Saharan Africa (51%). Boats were less common in definitions of SSF in South Asia (38%) and North America (38%). Motorization was used most frequently in defining SSF in Sub-Saharan Africa (29%) and Latin American and the Caribbean (28%). Fishing gear was most commonly used to define SSF in the Middle East and North Africa (100%), where all other regions had a similar percentage of articles that used this characteristic to define their SSF (between 55 and 65%), except North America where fishing gear was used in only 27% of articles. Sociocultural dimensions were used most frequently to describe SSF in North America (77%) and South Asia (56%), and were less common (e.g., used in a quarter to a third) for all other regions. Comparing the dimensions used to define SSF by the system type (**Figure 6B**) revealed that inland fisheries were more commonly defined by motorization (32%) and sociocultural factors (47%) than were marine SSFs (16 and 32%, respectively). Comparing the dimensions used by the type of journal (**Figure 6C**), publications in natural science journals relied more on technological dimensions (boat, motorization and fishing gear) to characterize SSF, while social science journals, not surprisingly, relied more on sociocultural factors (used in 54% of definitions verse 23% in natural science journals).

Different Features of Fishing Technologies Used in Definitions

Given the importance of technological dimensions in the definitions studied, we also coded for the use of different features of fishing boats, engines, and fishing gear used in definitions of SSF (**Figure 7**). Among articles that used fishing boats to define SSF (**Figure 7A**), the most common features highlighted were boat length (59%), boat type or material (36%), and capacity and tonnage (6%). For motorization, most articles indicated that SSF boats used engines but did not provide further detail on the engine type or horse power. However, 25% defined SSF as boats with outboard engines of 100 hp or less, with few SSF characterized as vessels with inboard motors (**Figure 7B**). SSF defined by fishing gear were most commonly described as labor intensive gear (44%), passive gear (39%), or highly active gear (10%; **Figure 7C**).

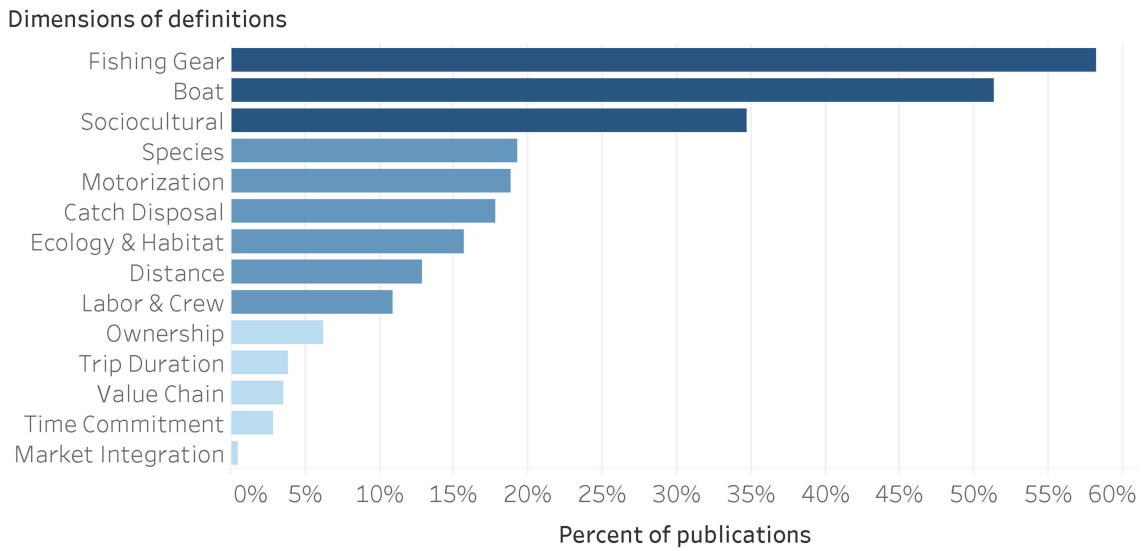

FIGURE 4 | The percentage of publications that used different characteristics to define SSF. The blue shading indicates three natural groupings that emerged from the data based on the frequency of use: commonly used characteristics (35% or more), moderately used characteristics (10–20%), and those infrequently used (occurring in <10% of definitions).

DISCUSSION AND CONCLUSIONS

Deconstructing Dominant Patterns in the Definition

By tracing how different assemblages of potential characteristics are deployed in definitions, our foregoing analysis uncovered several persistent themes and points of divergence in the way scientists have constructed SSF as a subject of study in peer-reviewed literature over the last 65 years. We focus our discussion on the most prominent points of convergence among definitions and consider how they serve to stabilize SSF as a category inscribed by certain essential characteristics, such as fishing boats and fishing gear. We also highlight instances of instability where the definition appears to have shifted over time and space, and finally we consider the implications of these changes and how SSF are understood and governed in practice.

Defining Patterns That Cross-Cut Science and Policy

Overall, we observed that more than a quarter of articles left SSF undefined, which echoes the findings of Chuenpagdee et al.'s (2006) study of national-level definitions of SSF in fisheries policy. Despite using different methodologies, focusing on distinct communities of experts (scientists vs. policymakers), and different types of data (peer-reviewed publications vs. national policies), their study found a similar proportion (70%) of documents that left SSF undefined. The results of these two studies indicate that the absence of a clear definition of SSF is a shared challenge that spans the supposed science-policy divide. Taken together, the findings of these two studies indicate that greater collaboration between scientists and policymakers is needed to clarify what SSF are and exactly whom scientific studies and policies pertain to. The present ambiguity and absence of clear definitions can obscure meaningful variations between different fisheries. Within the same country, and even within the same fishery, resource access and dependency on fisheries' livelihoods among stakeholders varies, making it no longer "sufficient to discuss issues, concerns and challenges in fisheries without being sector- and scale specific" (Chuenpagdee et al., 2006). Presenting scientific findings or policies on SSF without clarifying the intended social and ecological scale, portion of the value chain, and rightful stakeholders muddles national and international debates about the status and best course of action for SSF governance. In the absence of guidelines, room is left to easily repeat past-patterns of excluding pre and post-harvest sector workers, especially women. Presenting scientific findings or policy prescriptions that pertain to and potentially affect SSF without clearly defining the subject of study—a common pattern we observed—can obscure important differences and inequalities between different fisheries and among actors along the value-chain.

For example, in the absence of a clear definition all coastal and inland fisheries in Tanzania are assumed to be "small," which has proven problematic. In Lake Victoria's fisheries, it makes a difference whether you are referring to the endemic *dagaa* (*Rastrineobola argentea*) fishery—where women's small enterprises dominate processing and marketing and fish is traded for local and regional consumption—vs. the export-oriented fishery for the invasive Nile perch, which is controlled by foreign processors and outside money. Left undifferentiated, at present small-scale *dagaa* processors in Tanzania face the same permitting requirements as large-scale processors fileting Nile perch for export. Yet, whereas Nile perch are processed in immaculate facilities certified for export to the EU, *dagaa* processing often occurs along the beach, within individuals' homes, or in small collective compounds. Yet, regulations do not differentiate between the different socioeconomic context,

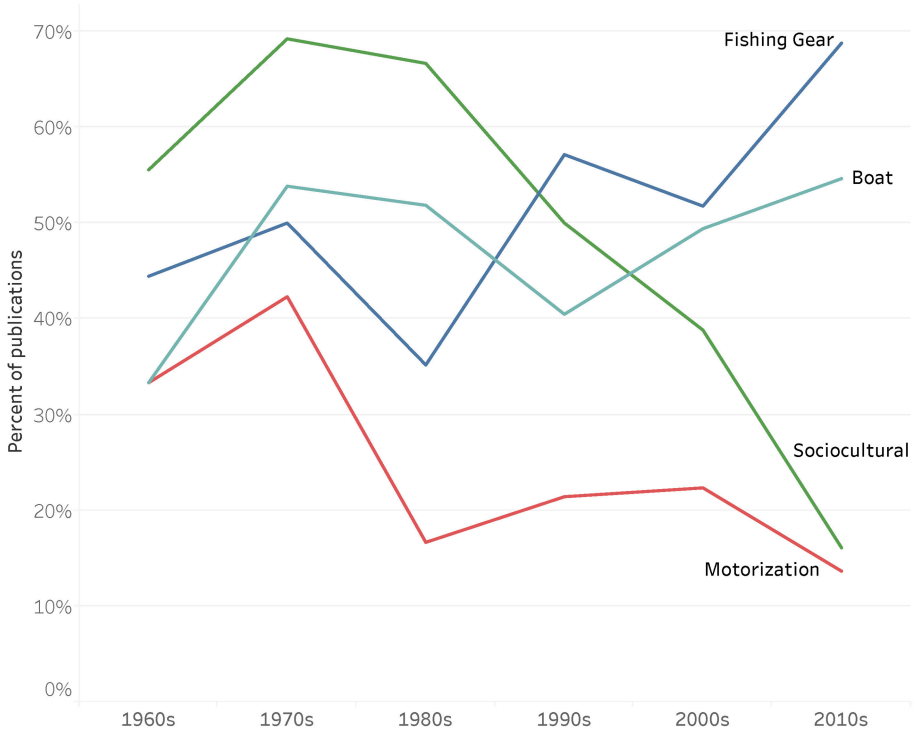

FIGURE 5 | The percentage of articles that defined SSF by different dimensions and decade. Only technological dimensions and sociocultural dimensions were included.

scale and needs of these two fisheries and their post-harvest sector workers. Permitting requirements are set using Nile perch as the standard, creating significant impediments for small-scale processors to gain formal registration, and therefore, to be considered legitimate businesses and rightful participants in fisheries governance. Leaving SSF undefined, and tacitly biased toward the needs of the more profitable Nile perch industry, lumps these drastically different fisheries together despite differences in their relationships to their communities, the economy and the environment. In the absence of a clear definition that distinguishes between these two fisheries, workers in the *dagaa* sector are disadvantaged and overshadowed by more powerful interests.

Secondly, we found that fishing gear and boats were the most common characteristics used to define SSF across our dataset, resonating with Chuenpagdee et al.'s (2006) review of fisheries policies. They found that boat size was the most common factor (65%) in policy definitions, compared to 51% of articles in our study. As a defining metric, boat size was typically formulated as fixed limits on vessel length in both studies. Meanwhile, a host of other possible characteristics proposed in the literature were not frequently observed in SSF definitions, such as organization of labor, relations of ownership, the makeup of the value chain, disposal of catch, and degree of market integration. Defining SSF through fixed technical limits on boat length and gear has implications in the interpretation of scientific research, in policy design and implementation, and in determining who gets to participate in fisheries governance.

Returning to the above example from Lake Victoria, this case further illustrates how fixating on technological limits may fail to address substantial differences among fisheries actors and impacts. Both the Nile perch and *dagaa* fisheries use similarly sized small boats and labor-intensive gear, yet they differ substantially along other dimensions, including capital invested, relations of ownership, and links to markets. Ownership of fishing boats and gear for Nile perch is often highly consolidated, where local and regional businessmen may own up to 100 boats (interview comment, 2/14/18). The fact that both these fisheries are considered "small" by the rubric of boat size and fishing gear underscores that, while the technological means may be similar, the "social organization of production and distribution are very different" (Johnson, 2006). Ecologically these fisheries also differ. Nile perch is an invasive species introduced under colonial rule to dire ecological consequence for the wider lake ecosystem (Pringle, 2005). While the *dagaa* fishery is not immune to sustainability issues, this fishery is focused on endemic cichlid species. Categorizing *dagaa* and Nile perch together within fisheries science and policy conceals substantial differences in the webs of social, economic and ecological relations these two fisheries are embedded within.

Temporal and Geographic Differences

The general downward trend in articles that defined SSF and the simultaneous increase in reliance on certain technologies to characterize them are temporal patterns that emerged from our analysis of peer-reviewed publications over the last 65-years. As

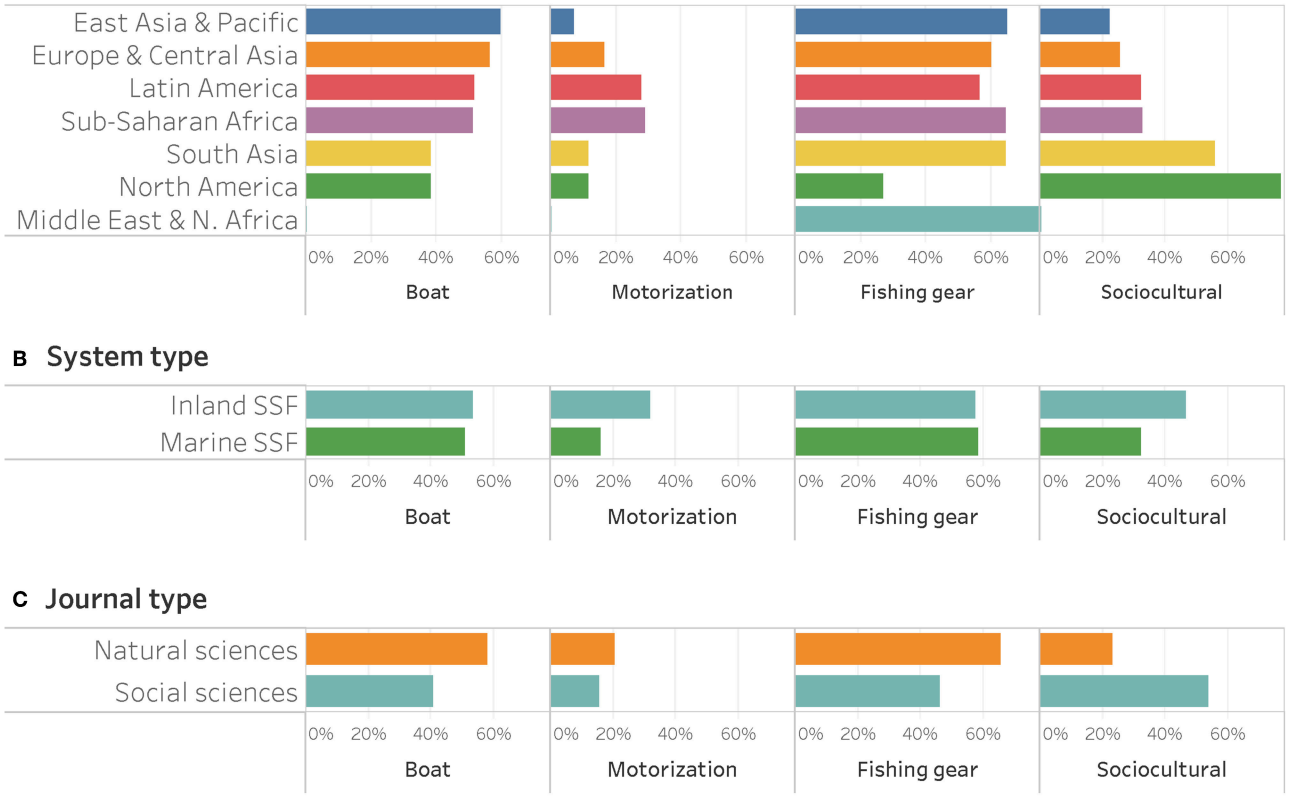

FIGURE 6 | The percentage of publications using different dimensions to define SSF by world region **(A)**, aquatic system type **(B)**, and journal outlet **(C)**.

SSF has expanded as a topic of scientific inquiry, marked by a prolific rise in publications on the topic, scientific knowledge produced on SSF appears to be increasingly detached from a clearly articulated definition of the term. At the same time, scientific knowledge is also more likely to be based upon a narrow conception of SSF, understood in terms of fishing technologies. The spread of technological definitions stands in contrast to the relative decline in the use of sociocultural characteristics, such as ethnicity, religion, caste, class, gender, and history or fishing culture, which were dominant criteria for defining fisheries in earlier decades. While future studies are needed to statistically confirm the significance of the temporal trends we observed, next we consider the import of these patterns in light of existing studies and theory.

While Chuenpagdee et al.'s (2006) study concluded that the patterns they observed in policy definitions were "remarkably stable," they did not explore the potential for historical differences. Our results add nuance to the role of technology in the definition of SSF—indicating that factors such as boat length were not always universal or stand-alone. Indeed, sociocultural dimensions were the most common characteristics used in definitions of SSF in earlier decades (1960–1980s)—observed in more than half of all sampled articles. One possible explanation for this observation is that fisheries scientists focused on industrial fisheries and largely ignored SSF during the rise of modern fisheries science in the 1950–1980s, subscribing to a popular development paradigm that assumed SSF would naturally evolve into or be replaced by an industrial mode of production (Johnson, 2006; Carvalho et al., 2011). While SSF were overlooked by fisheries scientists, who perhaps considered them too trifling to bother with, social scientists dominated the sparse literature on SSF, published their research in social science journals, and focused on understanding the sociocultural dimensions of SSF. Much of this early work applied ethnographic observation to study SSF, offering descriptive, detailed accounts of fishing methods (Craig, 1969; Mccay, 1978; Poggie, 1978; Poggie and Pollnac, 1988), studies of the social structure of fishing households and communities (Davidson and Davidson, 1969; Breton, 1973; Yoshida et al., 1974; Davis, 1986), and of maritime culture (Macdonal.Js, 1973; Bundy, 1977; Byron, 1988). Our results suggest that the expansion of scholarship on SSF in the 1990s was marked by a shift toward publishing in natural science journal outlets and toward a greater reliance on technological dimensions as the defining characteristics of SSF.

Looking at patterns by study region, we also found an inverse relationship between the use of boats and sociocultural dimensions in definitions of SSF—where, for example, North America was the region where sociocultural factors were the most

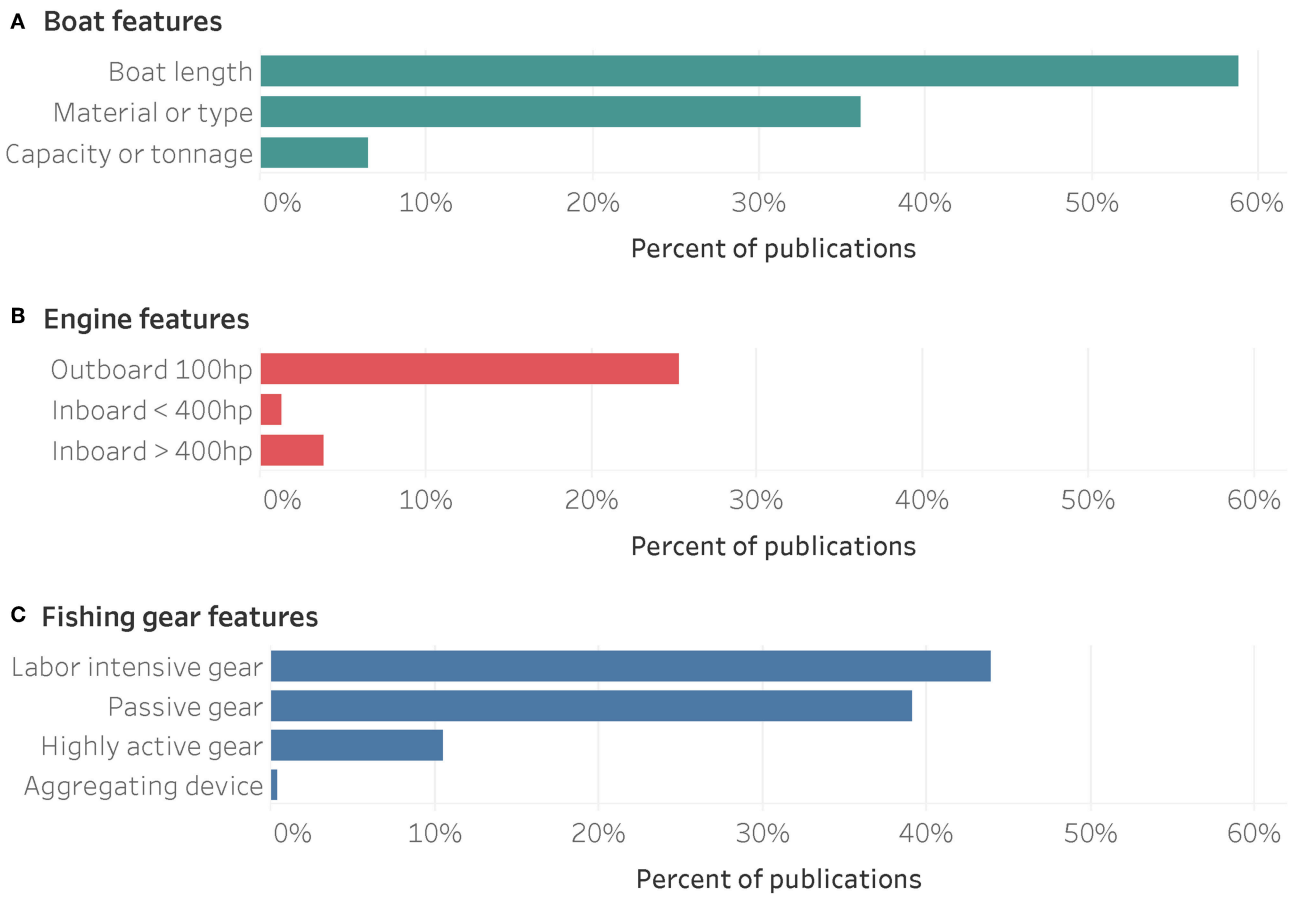

FIGURE 7 | The breakdown of different features used in definitions that relied on fishing boats **(A)**, engines **(B)**, and fishing gear **(C)** to define SSF.

common; it was also the region where boats, fishing gear, and engines were the least prevalent in definitions. Further research is needed to confirm and qualitatively understand this geographic discrepancy we observed in SSF scholarship, including why SSF in regions such as East Asia and the Pacific were more often defined by boat size rather than by sociocultural characteristics. This pattern can be interpreted as stemming from the deep-seated belief that technologies are asocial artifacts that can be isolated from their social domain, a socially constructed duality well-documented by Science and Technology Studies (STS) (Barry and Slater, 2002). Treating fishing technologies as "value-neutral chunks of hardware" (Harding, 2008) denies their existence as deeply social projects, permeated with history and political consequences. For example, in the data set utilization of engines in definitions was popular in the 1960–1970s but declined in use after the 1980s. This peak could be explained by dominant modes of fisheries development that focused on modernizing SSF by introducing motorized engines in many post-independence development packages pushed in the global south in the 1950–1980s (Basurto et al., 2017b). Engines were incorporated into many SSF around the world during those decades, whereas development interventions in the 1990s shifted focus away from technological and infrastructure inputs of previous decades and toward addressing the "problem of property" in fisheries (Campling and Havice, 2014) through interventions such as Individually Transferrable Quotas (ITQs) (Mansfield, 2004; Holm and Nielsen, 2007; Pinkerton and Davis, 2015). However, defining SSF by the presence and mechanics of engines alone (such as horsepower) misses the wider context of development interventions that spread their use throughout many SSFs, and also ignores the more recent shift away from technologically-centered fisheries development in favor of neoliberal governance techniques (Basurto et al., 2017b).

Moving Beyond Technological Determinism

Technological determinism (i.e., defining SSF through a limited focus on certain fishing technologies) is prevalent and possibly on the rise, essentializing SSF as a category inscribed by certain fixed technological characteristics that can be separated from their social context. While dimensions of social life were central to definitions and studies of SSF in earlier decades, the sociality of SSF is presently understudied (Batista et al., 2014), treated as static or inconsequential to the definition of SSF amidst the widening field of scholarly attention. Classifying SSF this way has certain advantages for the outside observer, reducing the less-than-legible characteristics of SSF in favor of traits that are easily identified as "small" (Jadhav, 2018b). This helps

stabilize our understanding of the wider field of capture fisheries, translating the unwieldy spectrum of fishing activities into discrete categories that can be ordered and described through a limited reliance on capture technologies.

Here we outline two related issues that stem from technological determinism: First, this mode of defining SSF places undue emphasis on harvesting activities at the expense of the rest of the value chain. Second, centering harvest activities and related technologies embeds a gendered bias in the definition. These two points are discussed in turn, but we see them as mutually implicated.

Linking Value-Chains and Gender Relations to the Definition

Centering capture technologies in the definition equates "fisheries" with "fishing," where SSF are narrowly understood as catching fish at sea, from a vessel, using certain gear types (Harper et al., 2017). Viewed within this narrow technological scope, SSF are reduced and simplified, isolated from the wider web of relations that fish harvesters are embedded within, including their bio-physical environments, management regulations, forms of organization, kinship ties, social norms, and exchange relations (Murray et al., 2006; St. Martin et al., 2007). Relational networks that extend beyond the boundaries of fishing vessels are largely omitted, as SSF are translated into a few observable, measurable traits (boats, gear and engines) that make SSF legible (Scott, 1998). However, as Reed and Christie (2008) put it, fishing enterprises are "not solely undertaken by men and cannot simply be defined in terms of people on boats." Rather, as harvested fish circulate within and between communities, and increasingly regional and global markets, it's clear that the status and future of SSF depends on more than understanding the material technologies and effort of harvesting fish at sea (or on the lake). Rather, just as "every word in conversation is half someone else's, every fish that gets caught is partly that of others" (Pálsson, 2015). Fisheries are made possible by a constellation of livelihood activities and related labor, requisite environmental knowledge, and technologies that traverse land and sea. Moving beyond harvesting to include relationships that span the land-sea divide along the SSF value chain is one way we can expand our understanding of SSF beyond the boat and our imagination of what sustainable governance might look like.

At present, research attention remains focused on technological aspects of the male-dominated harvest sector as the key to addressing the "over-exploitation" problem in fisheries, overlooking value chain dynamics beyond harvesting including post-harvest activities (Bennett, 2005). For example, the *dagaa* and other small pelagic fisheries in Tanzania suffer from high rates of post-harvest loss, estimated to be upwards of 50% (Ibengwe and Kristófersson, 2012). While illegal, unregulated and unreported (IUU) fishing are considered major threats to the sustainability of these fisheries (Agnew et al., 2009; Luomba et al., 2017), little attention has been paid to improving post-harvest processing and storage capacity as an entry point to alleviate resource pressure and to meet growing food demands. Further, post-harvest loss disproportionately affects the livelihoods of small-scale processors who are often women (Bradford and Katikiro, 2019). A single unanticipated rain event can ruin a small business enterprise and jeopardize an entire household's livelihood, leaving many women fishworkers in a state of perpetual precarity. Supporting the social and ecological well-being of this fishery depends on understanding and tackling problems along the value chain like post-harvest loss—not merely manipulating fishing boats and gear. Including actors along the value chain in the dialogue on fisheries sustainability could illuminate new avenues for ecologically and socially just governance interventions.

Given that segments of the value chain beyond harvesting are where women tend to work, it's not surprising that they have been overlooked as fisheries research has historically been gender-blind (Kleiber et al., 2015). However, "gender-blind" does not mean that fisheries research has counted both men and women's efforts equally under one androgynous heading, rather fisheries research has systematically focused on and centered men. This gendered bias is not especially unique to fisheries: androcentricism is evident in the philosophies, methods, and key questions pursued by modern western sciences (Harding, 2016), including the wider fields of environment studies and resource management (Banerjee and Bell, 2007; Reed and Christie, 2008). Despite deep-seated ontological assumptions that masculinity is the default gender (of both scientists and subjects; Harding, 2016), we now know that women constitute a large share of the labor force in SSF globally, but that they work predominantly in shore-side efforts such as gear mending, trip preparation, accounting, financing, fish processing, trading and marketing (Odotei, 1992; Walker, 2002; Shannon, 2006; Weeratunge et al., 2010; Matsue et al., 2014). Women also harvest fish in many parts of the world (Gammage, 2004; Porter and Mbezi, 2010; Hauzer et al., 2013), but men and women often interact with different parts of the ecosystem and may target different species using distinct methods and technologies (Kleiber et al., 2015). Based on a meta-analysis of fisheries research, Kleiber et al. (2015) found that in many cases women's fishing effort exceeds that of men for invertebrates, especially in the intertidal and shallow water zones. But women's fishing effort is often categorized as "collection," "gathering," or "gleaning"—activities that are excluded from what counts as "real" fishing (Pálsson, 1989). Wherever women work in the value chain, their efforts are more likely to be informal and/or unpaid, and consequently either overlooked or considered a "natural" extension of women's reproductive roles and responsibilities rather than "real work" (Harper et al., 2017).

Further research is needed that decenters masculinity as the presumed gender and default identity of fishworkers and the latent subject of scholarly attention. Thoroughly redressing anodrcentricism requires a deeper reconsideration of the underlying epistemologies of fisheries science, rather than merely tacking on gender to existing data collection and analysis strategies. However, broadening perspectives and representation within fisheries science will need to take multiple forms, and we do not advocate that all SSF research needs to explicitly focus on women and gender relations, nor take up a feminist lens (Williams, 2008). Value chains and gender merit greater attention as interlinked issues that can be addressed, at least in part, by approaching SSF beyond a limited focus on the technologies

and labor of fishing at sea. Reworking the definition to reflect a more inclusive understanding and representation of SSF is a place to start.

Bright Spots and Prospects for Redefining Small-Scale Fisheries

Despite moments of apparent stability, words are not immobile nor immutable. As words move across space and time and their meanings shift they "inscribe the arcs of our past and present" (Gluck and Tsing, 2009). By tracing these arcs in the meaning of the term SSF our research aims not only to address the limitations of enduring patterns in the underlying definition, but to uncover meaningful fluctuations over time and space. By exposing these shifts and moments of instability, our aim is to deconstruct the apparent naturalness of this dominant mode of ordering and defining SSF, undermining the inevitability of technological determinism in the division of capture fisheries to make space for emergent alternatives. Two promising developments that exemplify the potential for an expanded approach to defining SSF are the implementation of the SSF-Guidelines and the FAO's development of a matrix approach to relationally characterize SSF (Funge-Smith, 2018).

Since the adoption of the SSF-Guidelines, the main challenge ahead is whether and how this voluntary tool will be implemented at the national-level (Jentoft, 2014). The text of the SSF-Guidelines offers the framework for a common definition and shared understanding of SSF as including "all activities along the value chain—pre-harvest, harvest and post-harvest—undertaken by men and women" in both inland and marine systems (FAO, 2015). Building from this broad and inclusive definition, the SSF-Guidelines outline ethical principles that should guide SSF governance without any strict prescriptions for their implementation. Its relatively open stance makes the SSF-Guidelines unique among wider global environmental policy tools; many global conservation agreements rely on universally prescribed targets, narrow definitions of success, and tight monitoring requirements (Campbell et al., 2014a,b). In contrast, the SSF-Guidelines were intentionally designed to be flexible and broad in scope to leave room for their interpretation in place, only mandating wide-ranging stakeholder participation during the national implementation process (Jentoft et al., 2017). Amidst discussions about the promise, possibility and challenges of implementing the SSF-Guidelines, whether and how the definition of SSF might change through this process has received little attention. As countries work toward implementing the guidelines, the various stakeholders involved will be obliged to consider whether their existing definition of SSF suffices, or if it demands reconsideration. Since most national fisheries policies rely on technological dimensions like boat length, and many lack a clear definition to start with (Chuenpagdee et al., 2006), it seems likely that the implementation process will inevitably entail rethinking the definition of SSF as a first step in the governance reform process.

Another FAO tool under development is a relational matrix designed to help characterize SSF at different scales. The "SSF characterization matrix" provides a methodological approach and diagnostic tool designed to "avoid inappropriate classifications that can emerge when relying on a single characteristic or a highly-constrained number of characteristics, such as gear and vessel length" (Funge-Smith, 2018). Developed to augment the problem of simplistic technological definitions, the matrix approach eschews singular metrics and rigid divisions between small and large-scale fisheries. Instead, the matrix is used to score a range of qualitative characteristics on a finer scale, aggregating them to an overall score that can then be used to assess SSF in a particular country or to compare fisheries globally. Decisions about the exact cut off between "large" and "small" can then be made within a given context. In the structure of the matrix different characteristics are taken into consideration and weighted together, which means that engines, fishing gear and vessel length matter, but not more than a host of other characteristics. We see the matrix tool as a positive development in the search for better ways to define and characterize SSF with applications for science and policy, and we believe it provides a practical alternative to the current limited reliance on harvest technologies. The matrix is still being field tested in several countries and adapted accordingly, based on user feedback (Funge-Smith, 2018). As it becomes available to researchers in the future, we see great potential in the SSF characterization matrix as it enables consistent but relational ways of defining SSF that work at multiple scales.

Re-envisioning Small-Scale Fisheries in Tanzania

Lastly, we illustrate the potential for renegotiating the definition of SSF in practice, drawing upon our own research on the implementation of the SSF-Guidelines in Tanzania. Here we briefly examine the central yet contested role the definition plays in fisheries fora, exposing and refracting different sets of underlying values and related politics. Yet, even as the definition rouses controversy, the saliency of the issue is generally not disputed. We highlight the potential difference the definition can make toward alleviating unsustainable and unjust policies in the sector, potentially redressing historical inequities and invisibility long cast upon the sector.

Defining a national plan of action to implement the SSF-Guidelines in Tanzania has required addressing the vexing issue of how to define SSF, outlining which activities will count in relation to policy implementation. At the 2018 national inception workshop toward the implementation of the SSF-Guidelines in Tanzania held in Bagamoyo, a high-ranking government official opened the workshop of over 75 participants from across the country and the sector, posing the question: "Who is a fisher? Someone pulling a net or sitting in an office in Dar es Salaam? With the SFF-Guidelines implementation, we get to identify this in our own context and be one of the first countries in the world to do so" (comment from meeting participant, 2/14/2018). With this opening declaration, the definition was immediately positioned as a fundamental issue that would shape the coming days discussion and any decisive actions toward implementation. Further, the opportunity to implement the guidelines and rework the definition were presented as dual opportunities for Tanzania to be on the leading edge of global fisheries reform.

As the workshop ensued, discussions continued to circle back to the fundamental issue of the definition. Rather than a dry topic of technical classification, discussions were animated, revealing disparities in everyday experience and underlying values placed on the sector broadly labeled as SSF. As we noted in the introduction, the issue of the definition can become a stumbling block to reaching consensus policy agreements. While the text of the SSF-Guidelines mandates that wide-ranging stakeholders participate in implementation, diverse assemblages of actors may not be accustomed to working together to negotiate priorities where policy is usually set in a top-down manner. Further, in Tanzania there are significant differences across inland and marine fisheries, and even within inland fishers, between the development and dominance of Lake Victoria's fisheries compared to other inland water bodies. Actors brought different experiences from their home fisheries and positions within the sector to the table—enlivening conversations. But a lack of familiarity with each other's circumstances also created obstacles to mutual agreement. One fisher from Lake Victoria raised the issue of consolidated ownership of fishing vessels, where he claimed that one man can even own 200 boats yet be classified as "small." In response, another fisher from the coast responded: "We agree that we need to find a *real* definition. The rich people aren't fishers, the real ones go to the water and land fish and work with the fish themselves to get them to market. But some of the problems raised here about Lake Victoria don't apply everywhere, like on the coast. These problems are foreign to me." This interchange reflects the simultaneous potential for identifying common ethical ground, and yet how different geographic and development contexts within one country make articulating a shared definition cumbersome. While both fishers seemed to agree that relations of ownership matter in determining who counts as a real small-scale fisher, how meaningful class differences should be articulated was controversial, where answers to the question of "how much is too much" regarding ownership differed. When actors are unaccustomed to working together, identifying shared values and common language for a nationally representative definition is a substantial hurdle to reaching consensus agreement on policy implementation. The definition can become a thorny subject that simultaneously generates common ground and reveals fault lines.

One issue that generated greater mutual agreement was the need to address the long-standing marginalization of women and post-harvest workers through the implementation of the guidelines. Here, it became clear that altering the definition of SSF beyond a limited focus on harvesting was a necessary component of a multi-pronged strategy to alter historical injustices and treatment of fishworkers, where fisher*men* have long been prioritized. Several ideas emerged and attained consensus as viable strategies to address the interlinked issues of underrepresentation of women and post-harvest workers by making their presence and claims more visible. First, to conduct a national-level mapping study of existing women's organizations in the sector. Second, to use outputs from the mapping study to help build a national platform for women fishworkers. Lastly, to create a Gender Desk at the ministry to help support the platform and existing women's groups and to address gender-specific challenges present in the sector (Bradford and Katikiro, 2019). Whether and how these activities are enacted and affect a shift in the balance of power in SSF remains to be seen.

Yet workshop participants from across the sector and the country mutually agreed that these steps could potentially help ameliorate the cycle of women's invisibility in fisheries research and policy if the identified tasks lead to an alternate definition of SSF that becomes the basis for data collection, decision making, and stakeholder participation in the future. The hope is that these efforts not only lead to revisions of the definition on paper, but a more substantive re-envisioning of the underlying values of SSF in place.

Defining Small-Scale Fisheries for the Future

While scholarship on SSF has been around since at least the 1960s, defining SSF remains an ongoing challenge even as the field of SSF studies expands and diversifies. The diversity of SSF and their illegibility to outsiders has prompted certain techniques of simplification, including the use of reductionist definitions that focus on aspects most easily identified as small-scale, such as boats and fishing gear (Jadhav, 2018b). As perceptual guides, definitions work as metaphorical "maps" that detail which elements are important along the infinite complexity of a given social and ecological terrain. Reading the landscape of SSF through this narrow definition places undue emphasis on male-dominated harvesting at the expense of a more expansive view of the social and ecological relations along the SSF value chain that span land and sea. In the absence of a clear definition, a blank map leaves the reader to fill in the landscape themselves, often inadvertently drawing on simplistic tropes embedded in our mental imaginary of SSF as small-time activities from the past.

Motivated by similar research on the definition of SSF in policy, the results from our systematic review of the scientific literature echo some of the same worrying patterns while also revealing new temporal and geographic trends and disparities that are worthy of deeper consideration. The temporal shifts we observed indicate that, despite dominant practices present in both science and policy, the definition of SSF is not an immutable category fixed in time and space. Rather from a historical perspective, the definition beneath the word "small-scale fisher" is a process-in-motion, where boundaries are contested and mutable over time. In recent decades, these boundaries may be contracting around a tighter and more technologically determined view of SSF in the influential realms of science and policy. Yet, in addition to thinking about what the boundaries of the definition enclose—who and what is included—we can also contemplate the potential for counter hegemonic definitions and knowledge projects that expand our understanding of what constitutes SSF. Particularly as unorthodox actors are invited to the table, such as fishers and post-harvest sector workers themselves, the space for political action and the power to shape knowledge produced on SSF is potentially broadened. Both the SSF-Guidelines and the characterization matrix developed by the FAO offer an alternative conceptual "counter map" of SSF

that can be read against the dominant technological definition, offering a more encompassing and dynamic re-reading of the possibilities and place of SSF (Gibson-Graham, 1996; St. Martin, 2009). The application of these tools is also a process-in-motion, one to be followed. Where these tools are applied, alternate definitions could be leveraged that reflect different sets of values or ethical coordinates (Gibson-Graham, 2006)—where SSF are depicted as more than the sum of their harvesting technologies and productivity. How these tools reshape the definition of SSF and unfold in practice, and to what effects, are key areas for future research. Here we have provided some initial insights into this process from our own research in Tanzania.

To understand SSF research priorities for the future, it is important to "review and understand science and research agendas undertaken on SSF in a historical perspective" (Pomeroy, 2016), including how the category of SSF has been constructed and deployed alongside narratives of fisheries problems and solutions (Johnson, 2006). We hope our initial analysis of the historical construction of SSF as a category in science and policy can help shift the discourse on the definition beyond current assumptions that "smallness" is obvious, where "you can know a SSF just by looking at it" (Gibson and Sumaila, 2017). Instead of relying on old tropes that equate SSF with small boats, we beckon scientists and policy makers to take another look—and consider the wider and more lively assemblage of possibilities hidden beneath the surface of the definition.

AUTHOR CONTRIBUTIONS

HS and XB developed the initial concept for the study. XB initially built the database. HS completed data retrieval and organized the database. HS conducted the analysis and interpretation of results with input from XB. HS wrote the first draft of the manuscript and both authors contributed to revisions, read and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2019.00236/full#supplementary-material

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