



# Food system perspective on fisheries and aquaculture development in Asia

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## Abstract

This paper reviews development research and policies on freshwater fish in South and Southeast Asia. We conduct a systematic review of academic literature from three major science-based policy institutions to analyze development research and policies that have accompanied the ongoing transition from freshwater capture fisheries to aquaculture in the region. Using a ‘food fish system’ framework allows for the identification and systematic comparison of assumptions underpinning dominant development policies. We analyze the interrelations between the production, provisioning, and consumption of wild and farmed fish and demonstrate a shift toward food fish systems thinking in the sampled literature. We discuss gaps and weaknesses in the literature, as identified through the application of the food fish systems framework and present an agenda for future research aimed at securing the potential of fish as food.

**Keywords** Asia · Development policy · Food security · Food systems · Freshwater fish

## Introduction

‘Food systems’ are receiving renewed interest as means of moving beyond the productivist agendas that tend to dominate food policy (Béné et al. 2019). Central to food systems thinking is the transdisciplinary analysis of social and environmental trade-offs and synergies across the whole set of

production, provisioning, and consumption activities that affect food security (Ericksen 2008; Ingram 2011; Eakin et al. 2016). Here, food security is understood as a condition related to the availability, accessibility, and use of food (Eakin et al. 2016). Such approaches are increasingly being promoted in policy circles as a way of identifying and understanding the effects of broader drivers of change such as urbanization and globalization on sustainable food provisioning (HLPE 2017; IPES 2017).

Despite growing attention, food systems thinking has yet to be applied in a systematic way to fish production, provisioning, and consumption (Olson et al. 2014; Béné et al. 2015). Recent policy discussions have marginalised or overlooked the role of fish, in comparison with conventional agricultural commodities (HLPE 2014; Willett et al. 2019). This is a major oversight given the significant contribution that fish makes to global food security: fish is a relatively cheap and accessible micronutrient-rich food that provides over 3 billion people with almost 20% of their average per capita intake of animal protein, and a further 1.3 billion people with about 15% of this intake (Beveridge et al. 2013; HLPE 2014). Golden et al. (2016) further predict that over 10% of the world population is vulnerable to micronutrient and fatty acid deficiencies due to declining fish supply over the next decade, with developing nations being particularly exposed.

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Moreover, when fish is considered, it is articulated predominantly in terms of marine ‘seafood’, leaving freshwater food fish marginalized (Cooke et al. 2013; Lynch et al. 2019). Limited attention to freshwater fish production can be attributed to its relatively dispersed nature, the poor consistency of associated data, and the bias of northern-dominated research towards exported seafoods (FAO and WorldFish 2008; McIntyre et al. 2016; Bush et al. 2019; Tlusty et al. 2019; Belton and Bush 2014). This omission is particularly problematic in the context of South and Southeast Asia, which account for over a quarter of global fish production, the bulk of which is comprised of freshwater fish species (Chan et al. 2017; FAO 2018).

There is a rapid ongoing shift in the supply of freshwater fish in Asia, from wild to farmed sources, constituting an important, yet poorly understood food transition. Throughout inland areas of Asia, fish has been historically supplied by the harvest of wild fish from extensive networks of rivers and floodplains (Delgado et al. 2003; Brummett et al. 2013). The same region now accounts for the majority of global aquaculture (or farmed fish) production, most of which also takes place in freshwater environments. China, South and Southeast Asia are expected to remain the largest suppliers of farmed fish globally for the foreseeable future (Edwards 2015; FAO 2016; Ottinger et al. 2016). Integrated understandings of this transition are rare. Literature on the contribution of freshwater fish to food security tends to emphasize two polarizing narratives. As summarized by Little et al. (2016), the first narrative stresses trajectories of decline in wild capture fisheries production, while the second emphasises the role of a ‘booming’ aquaculture sector in meeting growing future demand for food fish.

The production focus central to both narratives, risks limiting how policy makers understand freshwater food fish in the context of rapid urbanization, rising incomes and changing diets (Reardon et al. 2014; Béné et al. 2016). A ‘food fish system’ approach, in contrast, integrates the role that provision and consumption play in shaping different demands for fish as food, and examines how these demands can be met through existing or potential capture fisheries and/or aquaculture production. We argue that this perspective can support the formulation of more proactive food security policies to address healthy and sustainable food fish provisioning at national, regional, and even global scales (see for e.g. Jennings et al. 2016).

Developing a food fish system perspective is especially relevant for South and Southeast Asia, as a major fish producing and consuming region that is undergoing rapid economic and social change. This raises the question of whether, in line with the wider food production literature, a shift towards food systems thinking is taking place in the science-based development literature on freshwater fish as food in this region. In other words, are science-based

policy institutions with a mandate to support the fish sector development in South and Southeast Asia moving away from productivism toward more integrated approaches? To what degree are their perspectives locked in the two polarizing narratives of capture fisheries and aquaculture? And to what extent do associated development policies integrate and leverage interrelations across freshwater fish production, provision, and consumption activities?

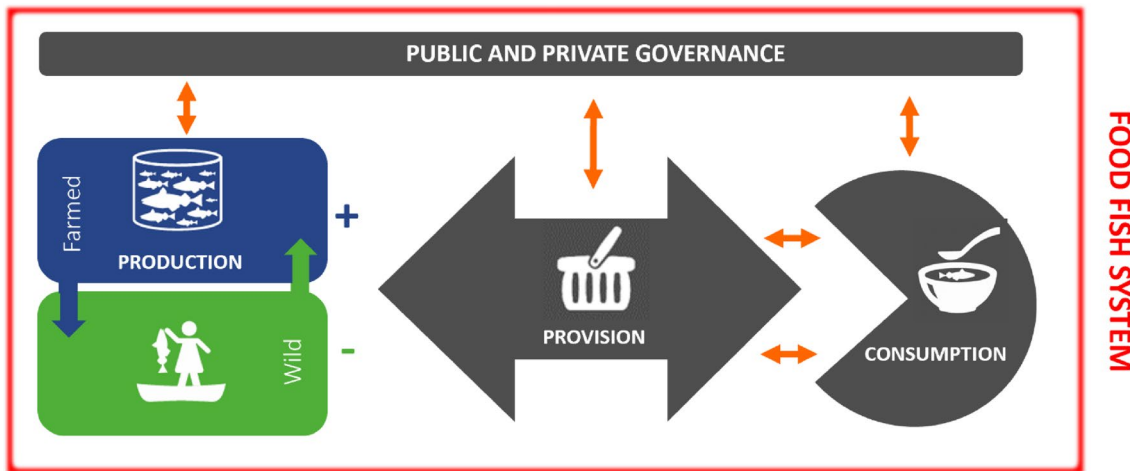
In this paper we address these questions by reviewing the past 45 years of science-based development-policy literature on freshwater fish as food in South and Southeast Asia. Our investigation builds on a systematic review of the academic literature affiliated with three international organizations—FAO, SEAFDEC, and WorldFish—that have a long history of providing policy advice for fisheries and aquaculture in the region. The evolution of their academic positions provides a basis for identifying and systematically assessing evidence of progress from polarized narratives to more integrated understandings of freshwater fish as food.

The following section introduces the food fish system framework used for the review and positions it within the wider literature on food systems research. Section 3 then describes the methodology used for the review. Sections 4 and 5 present the results of the analysis, identifying and comparing literature focused on farmed or wild fish production, provisioning and consumption. Section 6 evaluates progression towards food fish systems thinking. The remaining sections discuss the broader implications of the results, and the emerging opportunities for revitalizing development agendas around food fish security.

## The food fish system

The concept of food systems was formulated as early as in the 1980s, but it remained relatively marginal in food policy over subsequent decades (Kneen 1989). Renewed interest in food systems in recent years provides a framework for understanding trade-offs and synergies between food production with diverse consumer demands and complex provisioning systems that affect food security (Ericksen 2008; HLPE 2017). As argued by Béné et al. (2019), in policy terms this means moving beyond a focus on productivist technology and extension to pay greater attention to the full range of social and environmental concerns that affect how food is distributed and consumed.

‘Commodity chain’ and ‘value chain’ perspectives constituted an important first step away from productivist approaches by extending the scope of research and policy beyond the production ‘node’. These perspectives emphasize multi-directional flows of products, finance, and information between actors connecting sites of production and consumption, as well as extra-transactional actors that shape these



**Fig. 1** The food fish system conceptual framework

flows (Ponte and Sturgeon 2014; Bush et al. 2015). Recent years have seen a broadening in the scope of value chain research with increasing consideration for social equity (see for e.g. Barrientos et al. 2003; Kaplinsky 2000). Yet, associated approaches largely conceive governance as a process of linking codified norms to economic value in order to leverage improvements in production (Marsden et al. 2000; Geroffi 2005; Ponte and Sturgeon 2014). Food systems thinking goes beyond value chain-based approaches by recognizing the multidirectional relations between interrelated sets of production, provision, and consumption practices (Spaargaren et al. 2012), and the possibilities for coordinating these practices and relations for achieving outcomes that extend beyond the performance of producers alone, such as food security or sustainability (Ericksen 2008; Ingram 2011). In addition, the food systems approach extends beyond value chain approaches by incorporating broader societal transitions such as urbanization and globalization and their influence on where and how food is produced, distributed, and consumed (HLPE 2017; IPES 2017).

Our review is based on a simplified food system framework that focuses on the interactions between wild and farmed freshwater fish across activities related to the production, provisioning, and consumption of food fish. The framework is used to identify governance approaches used to steer these activities toward normative goals such as food security or sustainability (Fig. 1). Each of these components is explained in turn below.

First, production is defined as the entire set of activities involved in the production of freshwater fish and derived foodstuffs. Production activities related to wild capture fisheries and aquaculture are highly differentiated. Capture fisheries use fishing gears to harvest wild fish and other aquatic organisms (i.e. originating from naturally reproducing, self-sustaining populations) from public or common access water

bodies (FAO 2015). Aquaculture is a form of farming. This implies active management interventions to enhance biological productivity (e.g. artificial reproduction, stocking and feeding), and private property relations—i.e. private ownership of fish stocked in enclosed water bodies (FAO 2015; Edwards et al. 2002). However, in practice, the lines between these forms of production are often blurred. For example, aquaculture systems can rely to varying degrees on natural or stocked recruitment of wild fingerlings to ponds, fenced off habitat, or rice fields, while capture fisheries in lakes and reservoirs may rely on stocking of artificially spawned and raised fingerlings (FAO 2015). The review explores the diversity of these production activities and the degree to which they are differentiated from the perspective of provisioning and consumption.

Second, food provisioning refers to the organization of social and economic practices involved in the delivery of goods and services (Fine 1993; Evans 2011). These practices encompass activities related to the transmission and transformation of fish from raw material to marketable products—such as sourcing, transport, storage and trade, as well as processing and packaging. Provisioning practices also include social relations amongst chain actors that enable the flow of goods and/or preservation/transformation of products, including credit and finance, cultural and food safety norms and standards, and the use of cooperation and/or contractualization to set prices and supply (Reardon and Timmer 2014; HLPE 2017). Combined, these food-provisioning practices set the conditions for producers to access markets, information, and resources necessary for production. They also condition consumption practices while at the same time translating consumer demands to producers.

Third, consumption is defined as the entire range of activities related to the selection, purchase, preparation, and eating of fish. Consumption, as such, is influenced by economic

determinants, such as price, but also by a range of practices that determine which species of fish are purchased, in what forms (e.g. fresh, processed, or prepared), from which outlets (e.g. wet markets, supermarkets, or restaurants), and with what consideration to quality—related to food safety, taste or culture (Spaargaren et al. 2012). From a systems approach, consumption is shaped by wider processes of urbanization, globalization and/or food (in)security rather than individual choice alone (HLPE 2017).

Finally, governance is defined as the rules, authority and institutions that coordinate, manage, or steer the food system. These include governments, and non-state institutions such as markets, traditions, networks, and civil society (van Bers et al. 2019). Among these governing entities, the present review focuses on science-based development policy actors and explores the logic of their efforts to move the system toward delivering food security. Food security here is understood as a condition related to the availability, accessibility, and use of fish as food. From a food fish systems perspective, governing food security requires incorporating the multiple ways in which production, provisioning and consumption interact (Ericksen 2008; Ingram 2011). The challenge of accounting for the full range of food system activities is in sharp contrast to the productivist paradigm that permeates much of the science underlying food policy in developing countries (Ickowitz et al. 2019). This focus on production has meant that the governance of food security has relied heavily on the extension of technologies to increase output, with the assumption that food availability would shape provisioning and consumption practices (Ickowitz et al. 2019; Gómez et al. 2013). However, as we explore further in this paper, a shift to a food fish systems thinking calls for understanding production as bound up with both the diverse demands of consumers and the complex factors influencing the development of provisioning systems in between.

## Methodology

We undertook a systematic review (Arksey and Malley 2005; Levac et al. 2010) to assess the extent to which the development policy literature on freshwater fisheries and aquaculture in South and Southeast Asia reflects a shift to food systems thinking. We acknowledge that this literature does not provide a complete picture of how fish has been taken up in food systems thinking. But, aligned with our objective, this literature does represent the extent to which academic thinking has been translated into policy-directed science. As we describe below, this methodology follows a two-step process, comprised of: (1) document selection; and (2) content analysis.

## Document selection

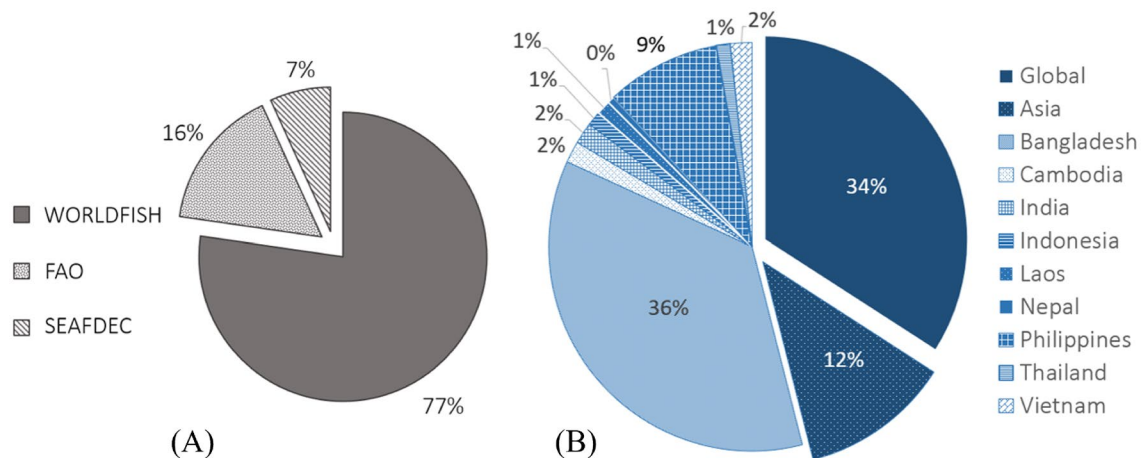
For the purpose of narrowing the scope, the review of the science policy landscape was limited to a selection of ‘boundary organizations’ that straddle politics and science (Guston 1996). As such, we only selected documents published by FAO, SEAFDEC, and WorldFish—three multi-lateral science-based policy organizations with more than 40 years of experience advising governments on improving fisheries and aquaculture for food security. The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations established since 1945. The Southeast Asian Fisheries Development Center (SEAFDEC) is an autonomous intergovernmental body established in 1967 with membership of 11 Southeast Asian countries.<sup>1</sup> WorldFish was established in 1973 as the International Center for Living Aquatic Resources Management (ICLARM) and integrated into the Consultative Group on International Agricultural Research (CGIAR) in the 1980s (cf. Pullin and Neal 1984).

Scientific publications from these organizations addressing freshwater fisheries and/or aquaculture in South and Southeast Asia were sourced through Scopus and Aquaculture Science and Fisheries Abstract (ASFA) databases. The search included all reviews, conference papers, and articles published between 1975 and 2018<sup>2</sup> in academic journals, using the search terms: AF-ID (“WorldFish” OR “ICLARM” OR “FAO” OR “SEAFDEC”) AND (“Cambodia” OR “Myanmar” OR “Vietnam” OR “Thailand” OR “Laos” OR “Indonesia” OR “Malaysia” OR “Philippines” OR “Bangladesh” OR “India” OR “Pakistan” OR “Nepal” OR “Bhutan” OR “Sri-Lanka” OR “South Asia” OR “Southeast Asia”) AND (“Freshwater Fisheries”) OR (“Inland Fisheries”) OR (“Aquaculture”) in titles, abstracts, and keywords. The pooled search returned a total of 457 ( $N_T$ ) distinct documents published in English.

Metadata for all articles was imported to Excel and titles, abstracts, and keywords were screened to select documents. First, we removed articles that were not fisheries or aquaculture related ( $n_1 = 19$ ). We then excluded books and book chapters ( $n_2 = 48$ ) as well as non-peer-reviewed documents ( $n_3 = 38$ ) based on the observation that institutional reports from FAO, WorldFish and SEAFDEC were

<sup>1</sup> Brunei, Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam

<sup>2</sup> The search was initially done using 1960 as a starting date, corresponding to the beginning of the Green Revolution. 1975 was eventually retained as the start point because it corresponded to the earliest publication in the sample fitting the review inclusion criteria. The end date of 2018 was used as it corresponded to the year when the review process was initiated.



**Fig. 2** Institutional (a) and geographical (b) coverages of the sampled literature

largely replicated in the peer-reviewed literature. We further excluded literature focusing only on geographical areas outside the scope of the study ( $n_4 = 37$ ), as well as articles focusing solely on marine and coastal production systems ( $n_5 = 138$ ). The final sample included 177 ( $N_{S1}$ ) articles.

### Content analysis

The data extraction and analysis was carried out in two-steps.

First, a scan of the literature was conducted over all 177 ( $N_{S1}$ ) articles. Titles, abstracts, introductions, and conclusions were used to classify articles in terms of their relevance to (1) aquaculture and/or capture fisheries, and (2) production, provision and/or consumption. Papers focusing exclusively on wild or farmed fish were categorized as ‘segregated’. Papers focusing on both wild and farmed fish were categorized as ‘integrated’. Similarly, the coverage of production, provision and/or consumption supported a further classification: papers that did not explicitly refer to production, provision or consumption, or did refer to one component but did not provide any analytical focus on that component; and papers that effectively covered production, provision and/or consumption as an integral part of their analysis. In case of uncertainty, the screening of the text extended to the results and discussion sections of the paper.

Second, a content analysis of articles cited at least 15 times ( $N_{S2} = 85$ ) was undertaken. For each category defined in the first step, the papers were read and assessed for the degree to which they focused on wild and/or farmed fish, and the extent to which production, provisioning and/or consumption were analysed, including the relationship between them.

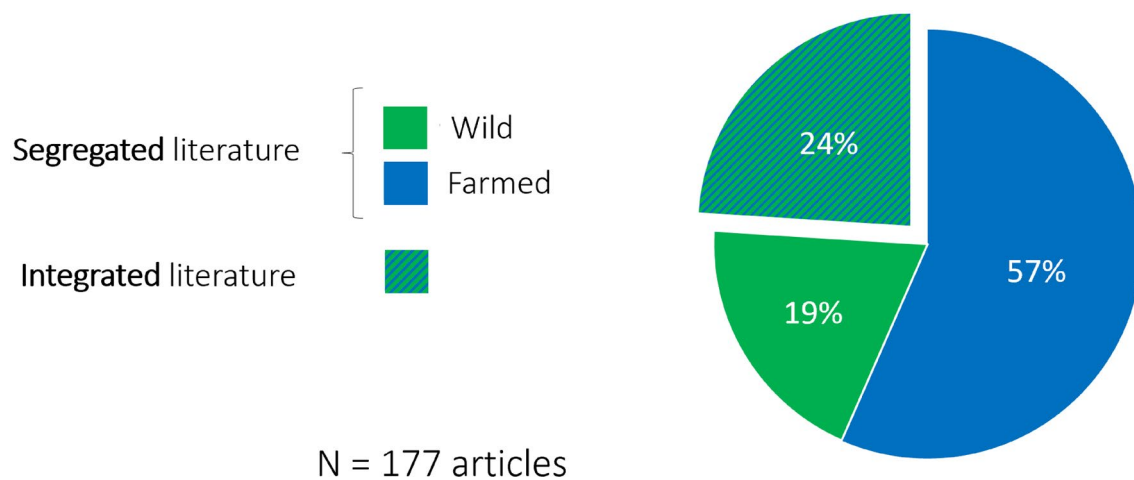
Finally, both stages of the analysis took into consideration the change in food systems thinking over time, breaking

the literature into five evenly distributed time-periods from 1975 to 2018.

### Overview of the sampled literature

The first overall observation about the sampled literature is the institutional bias. The selection of documents is heavily skewed to WorldFish, which represents 78% of all documents compared to FAO and SEAFDEC making up 15% and 7% respectively (Fig. 2). This bias is caused by the higher prevalence of publications by WorldFish staff in international peer-reviewed journals compared to the higher proportion of institutionally published reports by FAO and SEAFDEC. Nevertheless, the review indicates that themes covered in the review are shared across the three organizations and, as a result, our analysis does not make any comparison between them. A detailed comparative analysis of the science policy interface that scrutinizes the contributions of these institutions to the complex process of policy-making (Gluckman 2018) goes beyond the scope of this study.

The second observation is the bias in the geographical scope of the documents sampled. Bangladesh, which has received more development attention than other South and Southeast Asian nations over the past 40 years, represents over 35% of the documents reviewed. The Philippines, which hosted both ICLARM (now WorldFish) and SEAFDEC, makes up close to 10% of the articles reviewed. Meanwhile other major freshwater fisheries and aquaculture countries, such as Thailand and Vietnam, make up only 3% of the papers reviewed (Fig. 2). Overall, however, the sampled literature indicates that development policies and perspectives surrounding fish as food are largely shared across all countries covered in the review. Hence, while we are mindful that our choice of treating the great diversity of



**Fig. 3** Proportions of segregated and integrated articles in the sampled literature

South and Southeast Asian contexts as one group implies important simplifications, we contend that our approach paints a faithful (albeit general) description of research and development policy around freshwater fisheries and aquaculture in the region.

The third and most significant observation is that the segregated literature (i.e. analytical focus on wild or farmed fish) represents 76% of the literature sampled, while the integrated literature (analytical focus on wild and farmed fish together) represents only 24% (Fig. 3). This confirms that freshwater fish production is largely understood as either farmed or wild caught, with limited understanding of how these two modes of production relate to each other. The division also confirms the polarization of narratives associated with farmed and wild fish production and their expected contribution to food security (cf. Little et al. 2016).

In the following section we present the results of the review by food fish system components (i.e. production, provisioning and consumption). In doing so we only reference papers categorized under the respective food fish system component and not papers that, even while relevant to the observations made, are not categorised under that component.

## Coverage of the segregated literature

### Production

An observation shared across both the wild and farmed fish literature is the disproportionate and persistent focus on production. Nearly all (99%) the articles reviewed included analysis of production, creating a clear division between capture fisheries and aquaculture respectively (Fig. 4). This production focus was absolute from the 1970s into the

2000s. As the following shows, provision and consumption became more prevalent themes from the 2000s onwards. Nevertheless, a clear division between wild and farmed fish persists. The following outlines the main themes and topics covered under associated bodies of literature.

The starting point of our review, in the mid-1970s, coincides with a redefinition of the capture fisheries research and development agenda. While the early literature from the 1960s-1970s had focused predominantly on increasing production through improved technology and infrastructure,<sup>3</sup> the new agenda emerged from the recognition that resources were not endless and that small-scale operators were the most impacted by their exhaustion (Smith 1981). This new agenda, commonly labelled “small-scale fisheries” largely developed around perspectives from both coastal and freshwater fisheries. From the 1990s onwards, this literature largely put the emphasis on overfishing as the main factor driving fisheries decline (Smith 1981; Sultana and Thompson 2004; Ratner 2006). Subsequently, in the late 2000s the scope of factors driving fisheries decline expanded to include environmental degradation and fish habitat destruction derived from industrial, agricultural developments, or climate change (Allison et al. 2009; Baran and Myschowoda 2009; Beard et al. 2011).

In parallel, a body of capture fisheries literature emerged in early to mid-2000s focusing on solutions for improving the status of wild fish stocks. The literature on solutions for fisheries decline can be further divided into two main themes. In the mid-2000s a broad range of resource management options were focused on, with co-management

<sup>3</sup> Refer to Smith (1979) and the more recent sequel article of Pomeroy (2016) for a contextualization of the research agenda prevailing at the time.

emerging as a leading approach for promoting the empowerment of fishing communities in the management and help to address broader inter-sectoral conflicts (Thompson et al. 2003; Nielsen et al. 2004; Andrew et al. 2007). In the mid to late 2000s, this management-focused literature broadened to include more attention to the social and economic conditions of fisheries production. Most notably, this literature has moved beyond conflict resolution to include social welfare (Béné et al. 2010), resilience (Ratner and Allison 2012), human rights (Allison et al. 2012) and well-being (Weeratunge et al. 2014). This ‘social-turn’ in freshwater capture fisheries contrasts markedly with the early literature in placing fishing communities as centrally important for the persistence of the fisheries as a source of food security.

In contrast to capture fisheries, the aquaculture literature has persisted from the 1970s with a strong productivity agenda (Pullin and Neal 1984). Throughout this early literature, the focus on production was justified by perceptions of declining wild capture fisheries, the assumption that aquaculture would replace declining stocks, and a broader agenda to further ‘the tropics’ as central to the development of the sector on a global scale (Coche 1978; Pullin and Neal 1984). The alignment of aquaculture under the wider ‘blue revolution’ narrative emphasizes the ‘untapped biophysical potential’ of the sector and (reflecting green revolution rhetoric) the need to advance the production technologies and cost-efficiency of a variety of production systems. This narrative of technical efficiency has persisted in the literature as a guiding principle for farmed fish research and development in South and Southeast Asia to the present (Dey et al. 2000b, 2005b; Katiha et al. 2005; Karim et al. 2016).

The focus on the technical efficiency of production is observed in the sampled literature through two further persistent narratives around Asian aquaculture. First, in line with the priorities of the three institutions studied, calls for technical efficiency have been made predominantly in relation to small-scale rural aquaculture (Dalsgaard 1997). The assumption underlying this focus is that these producers dominate the overall production in Asia and make the most direct contribution to food security (Ahmed and Lorica 2002; Dey et al. 2005a, b). Second, the focus on technical efficiency has meant that a significant proportion of the literature sampled (33%) has been on fish breeding. Associated research has concentrated on single species’ yield maximization, denoting a change from earlier conceptualization of aquaculture as “an extremely diverse means of food production” (Pullin and Neal 1984, p. 227). While still including a number of species overall (see Lind et al. 2012), fish breeding research has been dominated by tilapia (Eknath et al. 1993; Khaw et al. 2008; Dey et al. 2000b; Bentsen et al.

2012); a species that now contributes over 20% of freshwater farmed fish in the region<sup>4</sup>.

In contrast with fisheries, and the wider literature on industrial (largely marine) aquaculture in other parts of the world<sup>5</sup>, the sampled literature on freshwater aquaculture gives limited consideration to environmental impact. This apparent gap may be explained by assumptions expressed in some papers around the limited environmental impact of production of low trophic-level freshwater carps (Prein 2002; Dey et al. 2005b). These papers assume a high efficiency of such systems, with only limited attention to the gradual intensification of carp production systems. This is particularly evident in the research around terrestrial ingredients used in their diets,<sup>6</sup> where the emphasis has essentially consisted in ascertaining “economically optimal” feeding rate (Tacon and Silva 1997; Karim et al. 2011).

In addition to a sustained focus on production, the sampled science-policy literature is characterised by two persistent narratives. The fisheries literature has emphasized the decline of fish resources and the need for more effective stewardship and management through the empowerment of fishing communities. The aquaculture literature, in contrast, has persisted with a narrative of unfulfilled potential and the need for improved technical efficiency. As a result of their distinct narratives, a division is also observed between the disciplines underlying these two literatures: social scientists for wild fish, and natural scientists and economists for farmed fish research. As the following sections demonstrate, this dichotomy is also apparent across other food fish system components.

## Provision

Research related to provisioning is evident in papers published from 2000 onwards but represents less than 20% of the literature reviewed (Fig. 4). Hence, provisioning represents the least documented food fish system component across both the wild and farmed fish literature. Provisioning activities are commonly observed as being related to, and of importance for consumption and production, rather than being a direct analytical focus of research. Nonetheless, the sampled literature does make various assertions around the importance of provisioning for addressing development priorities for both wild and farmed fish production.

Only 11% of wild fish-related papers integrate provisioning in their analysis (Fig. 4). Although not explicitly articulated, activities associated with moving and marketing

<sup>4</sup> \*Statistics calculated with FAO-FIGIS (<http://www.fao.org/figis>) for 2017.

<sup>5</sup> Refer to Naylor et al. (2000), or Natale et al. (2013) for a discussion on the environmental impacts of (marine) aquaculture.

<sup>6</sup> Refer to Pahlow et al. (2015) for a discussion on the terrestrial feed demand of (marine and freshwater) aquaculture.

## DIRECTIONALITY OF THINKING

FOCI	PRODUCTION	PROVISION	CONSUMPTION
<b>Wild</b>	Decreasing contribution. Collapsing stocks/intersectoral conflicts. Priority = empowering communities	Largely immovable trade/barter informal networks serving consumption close to landing sites	Emphasis on direct consumption. Consumption-based studies increasingly suggesting a “hidden harvest” scenario.
<b>Total (35 articles)</b>	<b>100%</b>	<b>11%</b>	<b>37%</b>
FOCI	PRODUCTION	PROVISION	CONSUMPTION
<b>Farmed</b>	Increasing contribution. Untapped biophysical potential. Priority = advancing technology	Prevalence of global value chain perspectives influencing ideals of 'upgrade' (incl. certification)	Emphasis on direct consumption. Growth of aquaculture leads to increased affordability and availability of fish.
<b>Total (98 articles)</b>	<b>99%</b>	<b>18%</b>	<b>35%</b>

**Fig. 4** Proportion of segregated articles and key messages by food fish system components

freshwater fish are often assumed to be mostly traditional and homogenous by nature and therefore not worth further examination. For example, Thompson et al. (2003) do not consider market attributes related to community-based fisheries management in Bangladesh because “they are not significantly different between inland wetlands in Bangladesh” (p. 310). This is in direct contrast to more recent research which gives greater attention to complex and fragmented informal networks of trade and bartering that shape wild fish provisioning and catches (Cooke et al. 2016). As shown in the following section, there is mounting evidence of wild fish consumption far beyond the communities that catch them, but little research has been done on the provisioning practices that distribute this food fish.

The literature on farmed fish pays relatively greater attention to provisioning, with 18% of the papers reviewed making analytical reference in some way to provisioning related activities (Fig. 4). This literature can be further divided into papers focused on global provisioning (to major export markets like the EU and US), representing 12% of the sampled papers, and provisioning activities related to domestic and regional markets, representing only 6% of the sampled papers.

The main focus of the global provisioning literature addresses broad questions around the role of aquaculture in meeting global demands for export-oriented species like shrimp and pangasius (Ahmed et al. 2008; Little et al. 2012). Building on such a global perspective, it is often implied that Asian producers should target global export markets to benefit from enhanced profits compared to domestic or regional markets (Ahmed et al. 2010; Haque et al. 2010) and ideals of ‘upgrading’ trajectories are essentially articulated

around international trade (Ponte et al. 2014). However, a smaller proportion of the literature raises questions around the merits of international trade, especially with regards to regulation and certification aimed at improving the environmental and social performance of the sector (Bush et al. 2013; Jonell et al. 2013; Troell et al. 2014). This literature acknowledges the limits of existing regulatory tools and points towards the necessary complementarity of public and private governance to address these challenges.

Papers focused on domestic and regional provisioning have been published from 2010 onwards and highlight the growing importance of aquaculture to food security and social wellbeing. Two major themes emerge from the literature sampled. First, the papers emphasize the development of farmed fish supply chains towards the provisioning of cities (E-Jahan et al. 2010; Karim et al. 2011; Toufique and Belton 2014; Belton et al. 2016). These papers show that urbanization translates into increased demand for (farmed) fish, rendering the development of the sector largely a peri-urban phenomenon, with fast-developing supply chains and associated services.<sup>7</sup> Second, this literature indicates a growing attention to gender in domestic supply chains, emphasizing on the one hand the more important roles women play in farmed fish post-harvest activities compared to men, and on the other the existence of formal and informal barriers limiting equal benefits from the sector for women (Morgan et al. 2017; Kruijssen et al. 2018). These papers, however, tend to focus on gendered roles and benefits from provisioning

<sup>7</sup> See Bush et al. (2019) for a recent synthesis of aquaculture research on domestic and regional supply chains in the Global South.



fish rather than the performance or conduct of provisioning activities themselves, such as processing, transportation or trade.

While some food system-related themes like the effects of urbanization on farmed fish demand are emerging, the sampled literature remains largely focused on international trade, regulation and social dynamics that condition but do not explain provisioning activities. This has consequences for understanding the relative contribution of wild and farmed fish to food security beyond the sites of production, especially in Asian domestic markets. As the following section demonstrates, this also has consequences for the attention paid to fish consumption.

## Consumption

Consumption is analysed substantively in 35% of the articles reviewed (Fig. 4). However, these studies only emerged from 2000 onwards, indicating a relatively late recognition of the importance of freshwater fish as food in the region. Reflecting the dearth of attention given to provisioning, consumption is commonly considered in conjunction with production, which emphasizes subsistence or semi-subsistence production and thereby overlooks the wider contributions of fish to food security. The following outlines the overarching themes covered under consumption in the literature on wild and farmed fish respectively.

In line with the overall sample, only 37% of wild fish-related articles integrate fish consumption in their analysis (Fig. 4). This overall bias can be explained by the predominant focus on production, which views fish as a resource to be conserved rather than as a food source (Hall et al. 2012). As demonstrated by Evans et al. (2011), less than 10% of studies on co-management consider fish consumption. Our review indicates that even when the wild fish literature considers consumption, the attention tends to be limited to direct or ‘subsistence’ consumption by fishing communities (Thompson et al. 2003; Badjeck et al. 2010). This subsistence focus also tends to reinforce assumptions that fishing communities are highly vulnerable (Allison et al. 2009; Badjeck et al. 2010), which is underpinned by the lack of knowledge on provisioning and, as such, their engagement with the wider (food) economy.

A more recent key theme in the wild fish literature is the assessment of freshwater production on the basis of consumption data (Fluet-chouinard et al. 2018). These consumption-based approaches build on a wider “hidden harvest” narrative of FAO, WorldFish and other international policy organizations<sup>8</sup> that advocates that up to 80%

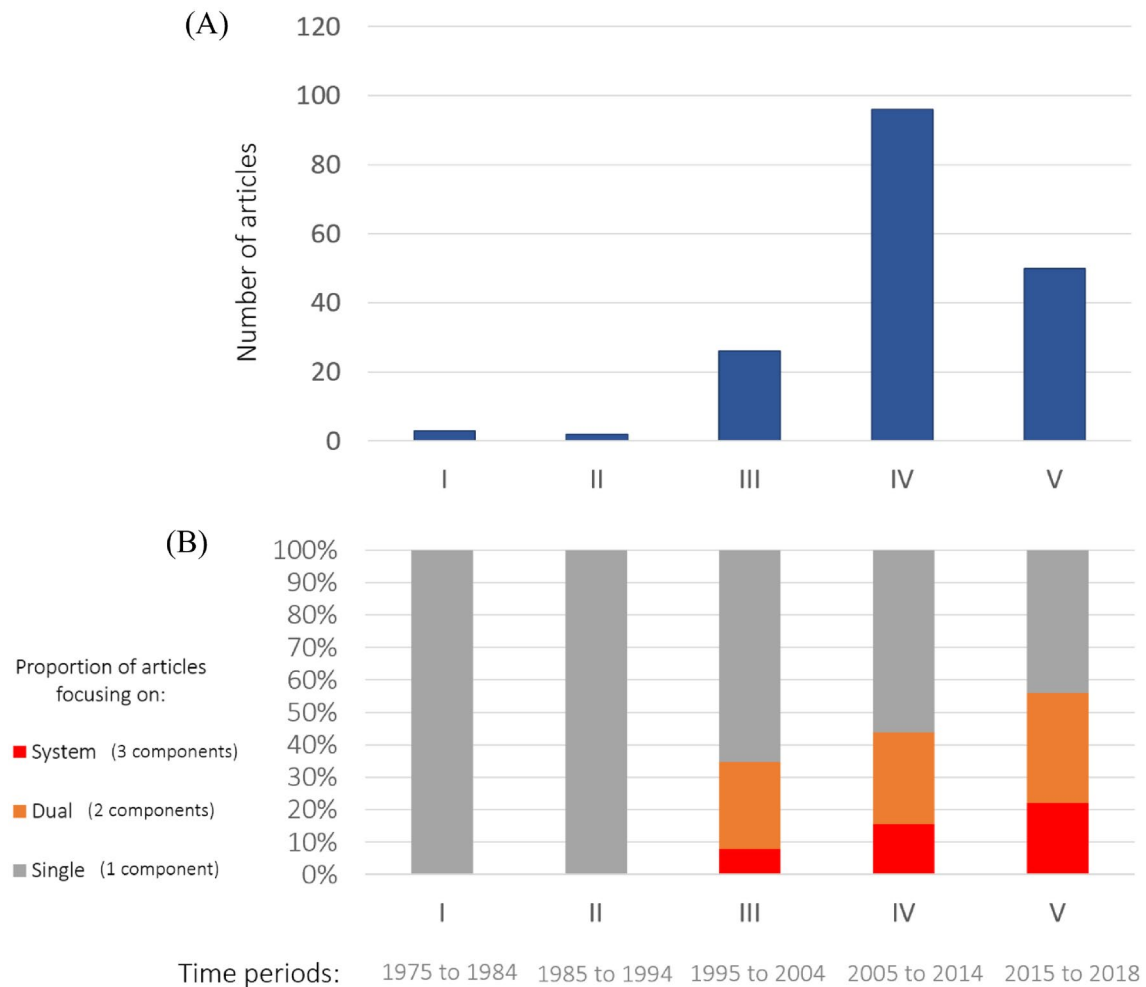
of freshwater fish landing volumes are not recorded, with the consequence that the contribution of wild fish to food security is fundamentally misunderstood (Hall et al. 2012; Youn et al. 2014). Studies focused on nutrition have also emphasized the importance of species diversity for healthy fish-based diets, which in turn reaffirms the need for production-oriented management strategies to maintain biodiversity (Nurhasan et al. 2010; Youn et al. 2014).

Also in line with the overall sample, 35% of sampled papers from the farmed fish literature cover consumption in their analysis (see Fig. 4). An overarching theme in this subset of papers, in direct support of the productivist ‘blue revolution’ narrative, is that farmed fish is compensating for the decreasing availability of wild fish (e.g. Ahmed and Lorica 2002; Prein 2002). Except for a few papers that explore how vulnerable (poor) consumers access fish (E-Jahan et al. 2010), the literature places considerable emphasis on increasing the overall affordability and accessibility of farmed fish supply across the region (Dey 2000; Dey et al. 2000a). This literature overwhelmingly refers to a generic category of ‘fish’ rather than giving details on consumer preference for different species (Morgan et al. 2017). Instead, claims of consumer preference lead to distinctions of preference that provide generalized and often unsubstantiated claims. For example, “common carp has traditionally been a preferred cultured species [...] tilapia are proposed as an alternative because these fish are cheap to raise, give high yields and are also quite palatable” (Fernando and Halwart 2000, p. 45) or “prices of fish [...] are the driving force that influence consumers’ decision to buy a particular species” (Dey et al. 2005a, p. 105).

Similar to the wild fish literature, another persistent theme is farmed fish consumption by producers, often framed as a benefit of aquaculture development interventions (Prein 2002; Karim et al. 2011; Pant et al. 2014).<sup>9</sup> Following Ahmed and Lorica (2002), increased fish consumption is positioned next to two other ‘linkages’ (income and employment) by which aquaculture contributes to food security of producing households. Increased direct consumption is the only linkage that has been documented in the sampled literature (E-Jahan and Pemsil 2011). Claims that increased income from aquaculture increases the consumption of nutritious foods, or that the nutritional benefits brought by aquaculture extend to the hired labour, are not well supported in the sampled literature (Kawarazuka and Béné 2010). Nevertheless, these assumptions are commonly advanced to legitimize aquaculture development interventions in the interest of food security (E-Jahan et al. 2010),

<sup>8</sup> See Kelleher et al. (2012) for more on the “Hidden harvest” narrative.

<sup>9</sup> Refer to Belton and Little (2011) for an analysis of the aquaculture development narrative in Asia.



**Fig. 5** **a** Number of sampled articles and **b** their proportional focus on food fish system components in the sampled literature from 1975 to 2018

including when the production target is oriented towards export (Ahmed et al. 2010).

Finally, there is a strong bias in favour of rural farmed fish consumption, despite relatively early acknowledgement of the growth and importance of urban fish consumption (Dey et al. 2000a; Ahmed and Lorica 2002). Studies that do focus on urban consumption highlight the role of higher urban purchasing power as a means of driving rural development, rather than the importance of fish consumption to urban food security (e.g. Karim et al. 2011). More recently, albeit to a lesser extent, attention has been given to the wider influence of urbanization as a key driver of aquaculture development, with attention going to the effects growing urban demand will have on both the volume and kinds of fish produced (Belton and Bush 2014).

Overall, however, the science-policy literature treats consumption in relatively limited respects, placing emphasis on direct and spatially proximate consumption rather than the wider contribution of food fish, both wild and farmed, to

domestic and regional economies of South and Southeast Asia. Our comparative review of the segregated fisheries and aquaculture literature shows how this segregation has had a foundational role in the articulation of development policies associated with the two sectors.

### Coverage of the integrated literature

While most papers segregate wild and farmed fish production, consumption and provisioning, a small but growing set of papers takes a more integrated perspective. In breaking down the distinction between wild and farmed fish, this literature has increasingly drawn attention to the interlinkages between production, provisioning and consumption, thereby giving rise to progressively more food system-oriented perspectives on fish (Fig. 5).

In stark contrast to the segregated literature, nearly two thirds of the articles in the integrated literature focus on

DIRECTIONALITY OF THINKING			
FOCI	← CONSUMPTION	PROVISION	PRODUCTION →
<b>Integrated</b>	Wild and farmed fish are not substitutable. The transition to farmed fish is accompanied by a reduction in diversity and likely in nutritional quality.	Wild and farmed fish are subject to the market forces brought by urbanization. Interrelations of their supply chains is poorly understood.	'Continuum' across wild and farmed fish production systems. Increasing human intervention is accompanied by a change of ownership from public to private.
<b>SCORE</b> (44 articles)	64%	36%	89%

**Fig. 6** Proportion of integrated articles and key messages by food fish system components

consumption as a main area of inquiry (see Fig. 6). Also, in direct contrast with the segregated literature, these papers emphasize the degree to which wild and farmed fish are not substitutable. Belton and Thilsted (2014), for example, demonstrate the complementarity of wild and farmed fish in contributing to food security in Asia and other developing regions. In doing so they challenge the prevailing policy narrative that aquaculture will gradually replace declining wild fish stocks by showing that wild fisheries continue to make an important contribution to nutrition, particularly for the most vulnerable consumers. This is supported by a number of other papers that underscore the relatively higher nutritional value of wild fish and, as such, the importance of maintaining species diversity, particularly highly nutritious small fish that are consumed whole (Welcomme et al. 2010; Kawarazuka and Béné 2011; Beveridge et al. 2013; Belton and Thilsted 2014; Youn et al. 2014; Bogard et al. 2017).

Similar to the segregated literature, relatively few papers (36%) in the sample give analytical attention to provisioning (see Fig. 6). Although the integrated literature has the merit of being more focused on regional dynamics, farmed fish in this literature is still more commonly framed as a cash crop than a food crop (Kawarazuka and Béné 2010). This tendency has contributed to steering development efforts towards the production of larger-sized fish aimed at the urban middle-classes rather than smaller and economically accessible fish aimed at poorer rural and urban consumers (Beveridge et al. 2013). While this literature emphasizes the value of wild fish for rural food security, it also recognizes that wild fish are increasingly traded to meet growing urban demand (Kawarazuka and Béné 2010). These general observations, however, lack empirical evidence and underlines a need for increased attention to how the transition to farming affects access to and use of food fish by different consumers. As argued by Toufique and Belton (2014), the greater the recognition given to fish as food in domestic markets, the more important it will be for the science-policy literature to

shift the understanding of consumption beyond the producers and beyond categories of 'wild' and 'farmed'.

Like the segregated literature, 89% of papers in the integrated literature focus their analysis on production (see Fig. 6). In opposition to the segregated literature however, the integrated literature challenges the dichotomy commonly assumed between farmed and wild fish. From the late 1990s onwards, the integrated literature has emphasised a continuum based on increasing human inputs and control over freshwater fish production and increasing private ownership moving from fisheries to aquaculture (Welcomme and Bartley 1998; Lorenzen et al. 2012). More recently, Little et al. (2016) explain the origin of aquaculture by describing the transition from fishing as "a gradual process" developing in "responses to times when demands for wild foods outstripped supplies" (p. 275). Despite its analytical power to rethink freshwater fisheries and aquaculture as closely inter-related production processes, it is evident from the review that such continuum perspective has had very little influence on the science-policy literature surrounding South and Southeast Asian freshwater.

Across consumption, provision, and production the integrated literature emphasizes the different contributions of wild and farmed fish as food, highlighting their complementarity rather than their substitutability. While this perspective underlines the importance of food fish systems thinking, it also shows that further evidence is still needed on the linkages between the three food system components, especially with respect to access and use of food fish by poor consumers in both rural and urban settings.

## Discussion: towards food (fish) systems thinking

Our review of the science-policy literature on freshwater fish reveals a gradual shift toward understanding freshwater fish in South and Southeast Asia from a more integrated

perspective. Historically, the science-policy literature has focused heavily on fish production and maintained a clear division between capture fisheries and aquaculture. However, attention is increasingly being paid to the provisioning and consumption of freshwater fish, and an emerging strand of ‘integrated’ literature is beginning to break down the dichotomy between wild caught and farmed fish. Though these emerging strands still represent a small proportion of the literature, and are not framed explicitly in terms of food systems thinking, they demonstrate the complementarity of wild and farmed fish as food, and lay the foundations for a more precise understanding of freshwater food fish in the region. We argue that the main value of the food fish systems approach, as applied to the Asian freshwater fish science-policy landscape in this review, is to reveal weaknesses and lacunae in the existing literature and identify agendas for future research.

Three points stand out. First, the science-policy literature on capture fisheries and aquaculture are heavily siloed. The two sectors are erroneously framed as separate, and in opposition, while their overlapping and highly complementary contributions to food security are rarely recognized. Second, the strongly productivist bias of the literature results in inadequate understanding of the system of provision and consumer behavior and their mutually constitutive and recursive relationships with the system of production. Moreover, a focus on specific types of production (subsistence, export) means that many important forms of production and associated systems of provision and consumption are overlooked. Third, the literature on freshwater fish largely assumes simplistic relations from production to consumption with the consequence that governance is conceived predominantly around production. Such framing ignores the multidirectional relations between the production, provision, and consumption of freshwater food fish and, as a result, falls short in leveraging other important entry points for governing food security. We address these points in greater detail below.

First, the deep disciplinary and epistemological disconnect between scientists working in freshwater fisheries and aquaculture, and the framing of the two sectors as separate and distinct policy spheres, often in competition or opposition to one another, has severely curtailed the terms in which policy-makers and researchers understand the relative roles and contributions of wild and farmed fish. In contrast, the food fish system perspective stresses the complementarity of these forms of production within the same food system, making it possible to appreciate their overlapping (albeit differentiated) contributions to food security in the region. As such, the food fish system perspective lays the ground for reconciling the siloed research agendas surrounding wild and farmed fish, suggesting multidisciplinary perspectives that combine elements from social and natural sciences. Such a reassessment notably calls for a better recognition of

intermediate forms of production, that are still largely disregarded, and which understandings could help leveraging ecological synergies across wild and farmed fish production (Lynch et al. 2019). For instance, the food fish system would help moving the aquaculture research agenda beyond technical efficiency to pay greater attention to species diversity and become more sensitive to the ecology of local fish communities. By articulating a more integrated perspective on production, a food fish system perspective holds the promise to not only better tackle food security, but also to put greater emphasis on agroecological integrity rather than production efficiency alone (Eakin et al. 2016).

Second, a focus on fish production—and on specific types of production—has contributed to inadequate and distorted understandings of fish provision and consumption. Except for the literature on global value chains dealing with production for export, fish provision has been largely overlooked, creating a ‘missing middle’ in food fish system science-policy literature. Processing, distribution and consumption of fish, and the ways that changes in these spheres (e.g. technological and institutional innovations, new forms of retail, evolving consumption practices) ultimately shape production practices have been overlooked. Excessive attention towards export-oriented production in aquaculture has framed freshwater fish more as a global commodity for revenue generation than as a foodstuff contributing to food security in producing nations. Similarly, emphasis on the role of subsistence production in freshwater capture fisheries and aquaculture has contributed to ignoring the wider contribution of food fish to domestic and regional economies of South and Southeast Asia. As a result of these biases, understandings of fish consumption in the region fall short of grasping the socio-cultural factors that underpin where, how, and why, wild and/or farmed fish are consumed (see for e.g. Jennings et al. 2016), and their contributions to food security. In short, a food fish system perspective gives rise to clearer recognition of the specific nature of provision and consumption, implying a reconsideration of how these in turn shape and structure the system (Koc and Dahlberg 1999; Béné et al. 2019).

Third, our review demonstrates the value of understanding multidirectional interrelations between production, provisioning and consumption that make up a food fish systems approach. As such, the food fish system thinking goes beyond ‘chain’ approaches where the emphasis is on bi-directional flows of products and finance and where governance is predominantly perceived in terms of leveraging improvements around production (Ponte and Sturgeon 2014). In contrast, by recognizing interrelated sets of production, provision, and consumption practices, a food fish system perspective reveals multiple entry points for governing outcomes associated with food. Seen from this angle, achieving food security or sustainability requires incorporating and coordinating the

multiple ways in which these different sets interact (Ericksen 2008; Ingram 2011). In the context of rapid societal transitions such as those occurring in South and Southeast Asia, acknowledging such multi-directionality has the potential to better anticipate what changing consumer demands and systems of provision mean for the relative contributions of wild and farmed fish to consumers in the region; both vulnerable and affluent (IPES 2017).

We have articulated our food fish system approach here around freshwater fish, the marginalized bulk of food fish in the region, and argued that it makes a compelling case for advancing food systems thinking. Yet, more research is needed to complement these understandings with a food systems-based analysis of marine food fish, which is another substantial component of the regional food basket. It will be even more important for future research to move beyond these two broad aggregate categories of food fish in order to fully account for diversity within them, and better appreciate the differentiated contributions that individual species and products make to the overall food fish system (Tlusty et al. 2019). Going even further, we argue that a food fish systems thinking can be advanced by engaging with the turn to ‘diet-thinking’. The latter works back from the practice of consuming meals or dishes to integrate the multiple and extended systems of ingredients (Haddad et al. 2016; Willett et al. 2019). A diet approach can also help avoid the common export bias surrounding food fish (see Belton and Bush 2014; McClanahan et al. 2015; Bush et al. 2019) by articulating the geographic scope of production through consumption and provisioning (Béné et al. 2019).

## Conclusion

A partial shift towards a food fish system perspective is apparent in the freshwater fisheries and aquaculture literature in South and Southeast Asia. The approach appears to be useful in explaining and reconciling polarizing narratives surrounding freshwater food fish by questioning key assumptions around what drives their production, provisioning and consumption in the region. The science policy literature is yet to frame future directions in ‘food fish systems’ terms. Nevertheless, there are indications that this literature, and the organizations it represents, are starting to open up to the value of systemically linking production, provision and consumption and translating these linkages into the policy landscape. By doing so they hold the potential to shift policy towards more integrated perspectives, moving beyond the simplistic productivist narratives to better consider how food fish is distributed and consumed in the region.

There remains considerable opportunity to further develop a food fish systems approach in Asia and beyond. While food systems research has generated considerable

enthusiasm in recent years, such studies are still for the most part limited to the ‘temperate minority’<sup>10</sup> from where most academic contributors originate (see for e.g. Jennings et al. 2016). In advancing the food fish system agenda, it will be essential for academics to make sure that they account for the realities of the ‘tropical majority’,<sup>9</sup> in particular Asia, where most of the world’s fish is produced and consumed (FAO 2018). In that regard, the present study should be taken as a preliminary broad-brush assessment. Because food fish systems (however global) are dependent on local conditions, further attention should be given to fine-grained place-based studies that dissect and document how complex and interrelated sets of production, provision, and consumption practices affect the availability, accessibility, and use of food fish in particular places.

Notwithstanding this ongoing shift towards food fish systems thinking, we contend that the latter needs to be more explicitly fostered and adopted by research and development actors at the center of our review. Only then will it have a substantial influence in framing how the contribution of fish to food security is understood and translated into policy in regions such as South and Southeast Asia. It is worth noting that some of the criticisms stemming from our review have been recurring. It has been over 20 years since Bailey (1988) wrote in this same journal: “international development agencies have promoted a dualistic pattern of fisheries development within the Third World [...] fisheries development and resource management need to be seen as complementary aspects of a single process”. To do so effectively, we have argued here for a food fish system as a promising framework for revitalizing fisheries and aquaculture development agendas towards food security.

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<sup>10</sup> This terminology is borrowed from Bavinck et al. (2018) to refer to the global north and the global south respectively.

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