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# Fishing for health: Do the world's national policies for fisheries and aquaculture align with those for nutrition?

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## Abstract

Aquatic foods are rich in micronutrients essential to human health, and fisheries and aquaculture are increasingly recognized for their capacity to contribute to reducing global micronutrient deficiencies and diet-based health risks. Whether fisheries and aquaculture sector and public health nutrition policies align to meet this goal, however, is unclear. Do fisheries and aquaculture policies have explicit nutrition and public health objectives? Do public health nutrition policies recognize the contribution of aquatic foods? Using content analysis, we assessed the alignment of objectives in national fisheries and public health nutrition policies. We further determined conditions associated with varying levels of cohesion among policies in these sectors or domains. We found that 77 of 158 national fisheries policies identified nutrition as a key objective in the sector, and 68 of 165 public health nutrition policies identified the importance of fish and shellfish consumption as key objectives. More recent policies were associated with improved coherence among sectors. International organization presence in policy development was also associated with greater coherence. Countries with higher overweight prevalence had fisheries and public health nutrition policies that were not aligned. There has been a promising recent trend for improved alignment of objectives between fisheries and public health nutrition policies, but more targeted and systematic policy approaches are needed to realize the potential contribution of nutrient-rich fish and shellfish to healthier food systems.

## KEYWORDS

aquatic foods, content analysis, food system, nutrition, policy, public health nutrition

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## 1 | INTRODUCTION

Aquatic food production can help decrease global malnutrition and build healthier food systems. In recent decades, advances in fisheries management open the possibility of sustainable fisheries production increasing over time by an estimated 16 million metric tons (Costello et al., 2016). Aquaculture is also growing rapidly; the sector's production increases finfish supply to an estimated 15 billion metric tons, a hundredfold increase over current global seafood consumption (Gentry et al., 2017). Each sector is likely to play distinct roles in food and nutrition security (FNS) in different socio-economic contexts (Vianna et al., 2020). In marine sectors alone, increases in the aquaculture and capture fisheries sectors could account for 12%–25% of all flesh food (meat, poultry, aquatic animals) needed to feed an estimated 9.8 billion people in 2050 (Costello et al., 2020). The formal and informal institutions that govern the flow of these resources will determine how this production is consumed and by whom. Stakeholders representing conservation and economic interests have ensured their values are accounted for in policy and well codified in policy objectives. Fisheries policy research and policy reform have thus been largely on improving conservation outcomes, increasing resource rents or maintaining fisheries sector employment (Béné et al., 2016).

More recently, human health and nutrition have also begun to feature in fisheries policy research (Allison et al., 2016; Garcia & Rosenberg, 2010; Gurung, 2016; Thilsted et al., 2016), and fisheries scientists have worked with FNS scientists to make the case for greater inclusion of aquatic foods in food system and public health nutrition (PHN) policies (Béné et al., 2015; Thilsted et al., 2016); these policies explicitly focus on the nutritional health of human populations (Uauy, 2007). Critically, aquatic foods could greatly alleviate micronutrient deficiencies for millions in coastal regions where malnutrition is highest. Hicks et al., (2019) estimate that utilizing just 20% of coastal finfish catch in 22 countries could alleviate micronutrient deficiencies for all children under 5 years old in those countries. Despite this potential, policy mechanisms to improve alignment between fisheries, nutrition and PHN sectors are often weak, or missing (Farmery et al., 2021).

Empirical evidence of the potential of fish and other aquatic foods to improve human health supports the inclusion of these foods in consumption advisories, nutrition programming and private sector engagement. Many fish and shellfish species have high levels of vitamin A, calcium, iron, zinc and omega-3 fatty acids, and all are nutrients critical for childhood development (Kawarazuka & Béné, 2011). Decades of studies suggest that modest fish consumption reduces the relative risk of diet-based cardiovascular disease—though the exact mechanisms of these benefits are still debated—and have led to fish occupying a prominent place in many dietary guidelines (Mozaffarian, 2016; Zhao et al., 2016). Nutritional interventions also show promise. One case study in Bangladesh found that eating indigenous and culturally appropriate small fish was critical in the first 1,000 days of life for mothers and children by providing significant amounts of vitamin A, zinc and iron (Bogard et al., 2015). Another model-based

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study indicated a nationwide programme to improve small-scale production in Bangladesh would increase vitamin A intakes and save thousands of lives, and could be implemented more cheaply than a national wheat flour fortification programme, with similar aims (Fiedler et al., 2016). On the U.S. West Coast, a number of non-profit organizations and for-profit fish distribution businesses have found novel approaches to overcome obstacles to distribute fish to low-income communities, for example, sending affordable fish to nearby schools (Koehn et al., 2020). While specific programmatic interventions show impressive results, and industry advertising stresses the healthfulness of aquatic foods, there are few examples of nutrition-sensitive national fisheries policies (Koehn et al., 2017; Thilsted et al., 2016). This paper is a first attempt to explore that perception.

The global push for improved policy coherence for sustainable development is codified in Sustainable Development Goal (SDG) 17.14 (OECD, 2019). Integration of national policies to reduce inconsistencies and promote synergies among agencies and their policy instruments is seen as a critical accelerator of progress towards SDG 2, to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. The intersection of national fisheries and public health nutrition policy is one such domain where there are increasingly strong calls for coherence, and a growing evidence base that makes connections between fisheries, nutrition and health outcomes, and climate change, population growth and other external vulnerabilities (Golden et al., 2016; Hicks et al., 2019). Food and nutrition security concerns have traditionally been underrepresented or absent from fisheries sector policy, possibly because food and nutrition security is often tied to agricultural production, whereas fisheries tend to be conceptualized as natural resource commodities (Bennett et al., 2021; Kurien & Ríos, 2013; Love et al., 2017; Olson et al., 2014; Seto & Fiorella, 2017). This reflects a broader trend in food systems policy, which pursue profitability influenced by strong economic and political interests and not health and nutrition-sensitive objectives (Pinstrup-Andersen, 2013). As a result, the nexus between biodiversity conservation and fisheries has been increasingly targeted by international development and conservation organizations (Foale et al., 2013; McShane et al., 2011; Selig et al., 2019).

While some regional case studies exist, a global-level analysis of the contribution of fisheries to food and nutrition security is needed (Allison et al., 2016; Béné et al., 2016). Moreover, there has yet to be a systematic global review of policy inclusion (or lack thereof) between fisheries and aquaculture sectors and food, nutrition and public health policies and advisories. The growing number of calls for nutrition-sensitive fisheries is therefore operating without an assessment of existing policy (Thilsted et al., 2016). This paper reviews evidence for the inclusion of food and nutrition concerns into fisheries sector policy and reciprocally the evidence for inclusion of aquatic food into food and nutrition-focused PHN policies. We focus our analysis on the content of national fisheries policies or legislative Acts in all countries for which such policies are available, and on national-level food security, nutrition and health policies in those countries. We also analyse whether more recent policies, developed since nutrition became more of a focus in fisheries literature, are more aligned with PHN than older policies. We then attempt to identify some of the factors that may be associated with the degree of cross-referencing or inclusion, such as the relative importance of fish in national diets and the presence of key international actors such as FAO and WorldFish in promoting the nutritional value of aquatic foods in national policy arenas.

## 2 | METHODS

A three-step process, described in more detail below, was used to analyse national policies for inclusion of inter-sectoral objectives in fisheries and PHN policies. First, a global search identified available policy documents for each country. Second, the texts of fisheries sector and food and nutrition-focused health sector policies were scanned to identify the incidence, context and prevalence of words

and phrases related to the other sector, with a scoring rubric used to estimate the level of inclusion. Third, inclusion levels of policies and national indicators of wealth, malnutrition, governance and fish reliance were analysed using an ordinal logit statistical model to estimate degrees of association with the level of inclusion.

### 2.1 | Identifying and prioritizing policy documents for inclusion

Fisheries policies were sourced through the UN Food & Agricultural Organization (FAO) Fishery and Aquaculture Country Profiles database (UN Food & Agricultural Organisation, 2019). This search was supplemented with country-specific Internet searches for “fishery policy,” “aquaculture policy,” “fishery plan,” or “aquaculture plan”. Health policies with a nutrition and food security focus were primarily sourced from the UN World Health Organization’s Global database on the Implementation of Nutrition Action (World Health Organization, 2019). Additional Internet searches were done using keywords “food and nutrition policy,” “public health nutrition”, or related to any policies specific to diet-based diseases (i.e. obesity or type II diabetes) for each country.

The analysis was based on one policy document per sector per country. When there were multiple relevant policy-related documents for a country, we selected a single policy following a prioritization protocol. For fisheries, priority went to the most recent national policy. We also prioritized policy documents over laws and acts; policies generally had greater detail and their content was often based on legislation or drawn up to guide legislation. Unless explicitly stated, “fisheries policies” refers to both capture fisheries and aquaculture sub-sectors, as well as any hybrid production system. The same document sometimes contained fisheries and aquaculture policies. When one policy governed both sub-sectors, that policy was prioritized over the sub-sector-specific policies.

For public health nutrition policies, priority was given to the most recent policy. Highest priority went to policies specifically addressing the food system or nutrition (e.g. nutrition policy, national policies on food and nutrition, national plans to tackle malnutrition) over more general public health policies. The next priority included policies on encouraging healthier diets by either reducing diet-based disease or setting dietary guidelines. In a few cases in which the above policies were not available, general policies that included a food system component were used, particularly, poverty reduction policies. While we were able to translate to English a number of documents from their original language (e.g. Chinese, French), some could not be translated within the time and resource frame of our study (e.g. Arabic, Czechoslovakian) and were omitted from the analysis.

### 2.2 | Evaluating cross-sectoral policy linkages (“policy inclusion”)

The content of policies from each country was assessed using summative content analysis, which tracks particular keywords and

assesses their usage within the context of a document (Hsieh & Shannon, 2005). Content analysis often relies on rubric-based approaches, enabling simple comparisons of a large sample of documents (Bowen, 2009). Such rubric-based approaches have been used in the fisheries sector to evaluate the alignment of national fisheries policies with national poverty reduction strategies (Thorpe et al., 2006). The scoring rubric developed and applied to each document in this study evaluates how well (a) national fisheries policies include FNS objectives and (b) public health nutrition policies identify the role of aquatic foods in intervention strategies (see Table 1).

Initial data collection was conducted in 2017, by postgraduate students at the University of Washington in a class run by one of the co-authors (Allison) of this study. Students were asked to pick a region and search for relevant national policies, which were then evaluated using the scoring rubrics (Appendix S1: Tables S1 and S2). If policies were not found or were found to be published in a language not spoken by any of the students, students entered either "NA" for not available or "NT" for not translated. Students with specific language fluency were asked to review policies in their original languages. Using a keyword approach enabled us to evaluate most policies in their original language. The initial student-based scores were then reviewed by the lead author, Koehn, for quality and to ensure the validity and reproducibility of scoring values; each policy was independently scored and any potential differences from the student scores were reconciled. While no formal inter-coder reliability assessment was conducted, the scoring metric was kept as simple as possible to reduce potential ambiguity. Ultimately, each fisheries and public health nutrition policy was scored between no (0), low (1), moderate (2) and high (3), based on the level of inclusion of FNS in fisheries and aquaculture policies or the level of inclusion of aquatic foods in public health nutrition policies. Policies with low inclusion mentioned keywords only in passing; policies with moderate inclusion had keywords in objectives but did not provide further detail; policies with a high score included keywords in objectives and provided further detail on how that objective would be met. For more detail on scoring along with examples, see Table 1. The justification for each policy score was included for each document reviewed.

Analysed policies were coded for a range of attributes: the year the policy was published or enacted; the type of document (e.g. national policy, law or act, national action plan); whether there were partners in the development of the policy, external to the government, who provided technical or financial support (e.g. WHO, World Bank, a bilateral aid agency such as USAID, a large NGO such as Save the Children or Worldwide Fund for Nature, a regional development bank (e.g. the Asian Development Bank) or a foundation or programme such as the Bill and Melinda Gates Foundation; and which fisheries sector the policy addressed (i.e. capture fisheries sector only, aquaculture sector only, or both sectors combined). These variables were included in the statistical model described below. The median and standard deviation of policy scores were calculated for each variable (Appendix S1: Table S5).

Publication details associated with policies varied by inclusion level for fisheries and PHN policies (Table 2). Most policies were developed

without the presence of an international organization providing technical or financial support, or at least these partners were not included as authors of documents, or in acknowledgements. For PHN policies, the most available (and thus reviewed) type of document was dietary guidelines with national policies or laws being reviewed an order of magnitude fewer times despite prioritization of nutrition-specific national policies over dietary guidelines during the search. For fisheries policies, laws or acts were more frequently found and reviewed than national policies. Policies covering both fisheries and aquaculture sectors were most often found and reviewed, followed by capture fisheries and then aquaculture with just 11 national policies.

### 2.3 | Conditions associated with cross-sectoral policies

To improve our understanding of conditions associated with the inclusion of PHN concerns in fisheries policy, or vice versa, a series of national-level indicators of wealth (i.e. GDP per capita), malnutrition, governance effectiveness and fish consumption were collected for each country where an evaluated policy existed. National health status indicators were focused on malnutrition in childhood because it may lead to a plethora of adverse health outcomes on growth, development and function (Mehta et al., 2013). Two indicators representing distinct conditions of malnutrition were included in the model. The first was the proportion of children classified as overweight or obese, indicating over-consumption of energy, often indicative of dominance of energy-dense foods in their diets, with such diets often being deficient in nutrient-dense foods such as fish and shellfish. Childhood overweight and obesity can elevate risk of cardiovascular disease (CVD) in adulthood (Umer et al., 2017), which may be reduced by fish consumption (Mohan et al., 2021). Furthermore, increased fish consumption is associated with decreased risk of abdominal obesity (Schlesinger et al., 2019), and potentially in weight loss, but more research is needed to understand the specific mechanisms (Bender et al., 2014). The second was the proportion of stunted children due to undernourishment, which can indicate either or both energy and macronutrient (e.g. carbohydrates, protein or essential fatty acids) deficit diets, and deficiencies in micronutrients (e.g. minerals or vitamins). Oftentimes this is due to households being unable to access sufficient food (Tzioumis et al., 2016). In regions where undernutrition is prevalent, local fish resources may provide a critical source of nutrients when they are seasonally abundant or affordable (Dasgupta et al., 2021). For more details on the variables used as predictors of policy inclusion in fixed or random effects models, see Table 3. Fixed effect variables are termed "policy-level" effects, and random effect variables are termed "group-level" effects.

### 2.4 | Statistical analysis

To test the association of these variables with policy cross-referencing or inclusion levels, an ordinal logit model was implemented, using

**TABLE 1** Scoring rubric for public health nutrition and fisheries policies

Score	Description	Example
<b>Public health nutrition policy scoring rubric:</b> Extent of fisheries and aquaculture keyword inclusions <i>Search terms:</i> fish, seafood, shellfish, algae, fisheries, fishing, fish farming, aquaculture, mariculture		
0 - No inclusion	None of the search terms appear in health, nutrition or food policy documents. There is no mention of fisheries or aquaculture, or fish/seafood in the health document or policy being considered	No mention
1 - Low inclusion	One or more of the search terms appear in preambles, annexes or mentioned in passing with no specifics, suggesting that fisheries were not a focal issue or concern	<b><u>Kenya National Nutrition Action Plan 2012-2017</u></b> Keyword fish appears in passing mention, "The analysis focused on efforts in health sector as set out in the KHSSP and the FNSP and other sectors notably agriculture, water, livestock, education and fisheries that contribute to realization of the goals of national nutrition agenda" (Page 24)
2 - Moderate inclusion	One of more of the search terms appear in either overall aims or in one or more policy objectives, suggesting a recognition of the role of fish/seafood in healthy diets but there were no programmatic specifics	<b><u>Solomon Islands National Food Security, Food Safety and Nutrition Policy 2010-2015</u></b> Fish are mentioned throughout this plan, recognizing that fish is an important component of the diet (Page 3), and recognizes these resources can have issues with overexploitation (Page 4) and finds that the policy should help guide sustainable use of these resources (Page 5). The plan recognizes fishery plans (8) and sets specific policy aims to promote sustainable use of fish and agriculture for food security and economic development (Page 10) in a changing climate (Pages 11-12), with more details provided on (Pages 13-14) as well as setting the place for the development of the policy with associated ministries. There are no further specifics for on-the-ground implementation
3 - High inclusion	At least one objective of nutrition and health policy with a clear analysis of the role of aquatic foods in addressing that concern, as evidenced by clear identification of aquatic foods in health policy aims and objectives; and discussion of concepts and keywords included, in clear connection to the role that aquatic foods can play in these health concerns	<b><u>Niue Food and Nutrition Security Policy 2015-2019</u></b> Fisheries are recognized as means of gathering food and generating income in background. Note that there is interest among youth to engage in fishing as both a viable employment opportunity and a way to reconnect with traditional culture (Page 16). There is a 4-day work week which is seen as a way to allow time for household gardens or fishing. Fishing is named as part of policy area [or policy objective] 1 as way to strengthen subsistence practices and encourage self-sufficiency, recognizing the opportunity given youth interest (Page 25-26). As part of the policy areas, the focus is to increase competitiveness of fisheries products in domestic markets, sets planned action/indicators/responsible agencies for that focus (Page 31) as well as to promote livelihood opportunities via high value products (Page 32) and develop acumen of small-scale fishers to negotiate business (Page 33). Oceanic fisheries are also recognized as important, including increasing catch of offshore resources and the use of FADs (Page 33), promoting traditional fishing practices (Page 35). From this evidence, fish play a considerable role in meeting policy objectives  For example, in order to meet the policy objectives, the policy sought "Increased contribution of oceanic fisheries resources to domestic food supply" and sought to do so by increasing "catches of offshore tuna and related species by commercial coastal fishermen to substitute for reef fish using FADs" (Page 33)
<b>Fisheries policy scoring rubric:</b> Extent of food and nutrition security objective inclusion <i>Search terms:</i> food security, nutrition, health, healthy diet		
0 - No inclusion	No mention of search terms in fisheries and aquaculture policy documents	No mention
1 - Low inclusion	Search terms appear in general preambles or as passing mentions in various parts of the documents but not in the overall aims or specific objectives of the policies, suggesting that food and nutrition security concerns were not the focus of the document	<b><u>Fishery Management Plan of Ghana: 2015-2019</u></b> Food security listed in executive summary (page v), and is referenced in the overarching goals of the policy in the Introduction under Goal (page 1) but not listed again. Nutritional value of fish is not discussed  "The goal of the Management Plan is to rebuild fish stocks to enhance the socio-economic conditions of fishing communities, create employment within national and international frameworks and standards and improve food security as well as contribute to GDP and foreign exchange earnings" (Page 1)

(Continues)

TABLE 1 (Continued)

Score	Description	Example
2 - Moderate inclusion	Search terms appear in the stated overall aim of the policy, but no detail is presented in subsequent specific policy objectives that focus on the role of fisheries/aquaculture in food and nutrition security	<b>EU Common Fisheries Policy</b> Keywords <i>food security</i> and <i>nutritional</i> appear in the stated overall aim of the policy. For example, how aquaculture should contribute to long-term food security (page 6, 23), and how the CFP should contribute to supplying highly nutritional food to the European Union market (page 2). No further detail is presented in subsequent specific policy objectives For example, "The CFP should also contribute to the supplying of highly nutritional food to the Union market and to reducing the Union market's dependence on food imports. It should also foster direct and indirect job creation and economic development in coastal areas" (Page 2)
3 - High inclusion	Search terms appear in clearly stated policy objectives and are discussed in the policy narrative and/or plans to fulfil objectives. There was clear discussion in the document of how fish contribute to food security, nutrition, and health. There are likely to be specific technical words and phrases used (see list in Appendix S1: Table S1)	<b>Master Plan for Fisheries and Fish Farming in Rwanda</b> The Ministry of Agriculture and Animal Resources is in charge of fisheries management in Rwanda nutritional security is mentioned in the policy's narrative and is included in the overarching goal that mentions the food security of the communities. Two of the policy's specific goals, mention food and nutrition security: "Enhance job creation, food and nutritional security as well as contribute to economic growth" (Page 39) and "Provide Rwanda consumers with domestically produced, high quality, safe, competitively priced, and nutritious aquaculture products" (Page 39) One expected outcome is the "Increased income and food nutrition security amongst aquaculture producers and the population" (Page 39) From the <i>Proposed Production Systems, Sport Fishing, Inputs, Markets and Product Development</i> section of the policy: "Consumers have increasingly recognized the health and nutritional benefits of eating fish. Fish is comparatively low in calories, fat, and harmful forms of cholesterol, and comparatively high biological value protein, vitamins, and Omega-3 fatty acids which are implicated in the prevention of heart disease and others. The most immediate aspect of this plan shall be to make fisheries production in the country market led based on ensuring and guaranteeing the quality and safety of the fish and fishery products traded locally or regionally" (Page 60). Suggested short-term measures include "Research can lead to new techniques to improve the freshness, colour, flavour, texture, taste, nutritional characteristics, and shelf-life of cultivated fish as well as new or improved value-added products" (Page 60)

the Bayesian modelling software STAN, which implements a No-U-Turn Markov Chain Monte Carlo sampler, implemented through the R package *brms* (Burkner, 2017). The independent variable, policy inclusion level, was operationalized as an ordered categorical variable. Ordering considered the zero or "no inclusion" score as the lowest level and the three or "high inclusion" score as the highest level. The prior distribution for each dependent variable in the logit was set to a weakly informative Cauchy distribution, thereby assuming the priors are contributing less to the model than the data itself (Gelman et al., 2008). Cauchy distributions were then fitted to the posterior distributions using the R package *fitdistrplus* (Delignette-Muller et al., 2019) for each of the numeric variables to estimate the location and scale parameters of those distributions, and a second set of models was run using these updated priors.

Models were run with three chains each with 6,500 post-warmup samples. While indicator variables in Table 3 were selected to maximize the sample size, national-level indicators were not available for all of the 165 PHN and 158 fisheries national policies. As a result, the fisheries model was run on 72 national policy documents and the PHN model was run on 75 national policy documents for which there was complete data across all variables. To determine model

fit and convergence, we examined posterior traces and Gelman-Rubin statistics. The models converged and the posterior predictive distributions were consistent with the observed data and fisheries and PHN models. Both models had stable posterior traces across all three chains (Appendix S1: Figure S1 and Figure S2), and Gelman-Rubin statistics for the fisheries model parameters (Appendix S1: Table S3) and the PHN model parameters (Appendix S1: Table S4) were very close to one.

The posterior distributions of these parameters were used to determine the relative influence of each parameter. Bayesian analysts use decision rules for accepting or rejecting the null that there is no effect of the parameter based on whether the majority of the posterior distribution—known as the high-density interval (HDI) falls above or below the region of practical equivalence (ROPE) (McElreath, 2018). Following Kruschke (2018), the ROPE limits of  $\pm 0.055$  for parameters in a logistic regression. Parameter posteriors were accepted if the majority of their distribution fell inside the ROPE, rejected if the majority of their distribution fell outside of ROPE or undecided if it fell partly within the ROPE (Kruschke, 2018). Marginal effects were calculated with a 80% credibility interval, again using the *brms* package (Burkner, 2017).

**TABLE 2** Count of variables present in each of the policies reviewed

	International partner presence		Type of policy			Sector—Fisheries policies only		
	No	Yes	Law	National policy	Dietary guidelines	Aquaculture only	Both sectors	Capture only
Public health nutrition policies ( <i>n</i> = 165)								
No inclusion	49	4	0	6	47	NA	NA	NA
Low inclusion	35	9	3	5	36	NA	NA	NA
Moderate inclusion	31	4	6	3	26	NA	NA	NA
High inclusion	20	13	5	0	28	NA	NA	NA
Total	135	30	14	14	137	NA	NA	NA
Fisheries policies ( <i>n</i> = 158)								
No inclusion	57	1	51	7	NA	3	17	38
Low inclusion	19	4	13	10	NA	2	15	6
Moderate inclusion	43	1	36	8	NA	1	36	7
High inclusion	23	10	5	28	NA	5	21	7
Total	142	16	105	53	NA	11	89	58

### 3 | RESULTS

#### 3.1 | Alignment between fisheries and public health nutrition policies

PHN policies for 165 countries and fisheries policies for 158 countries were analysed (Table 1). For fisheries policies, most countries had one document reviewed, except for eight countries (Australia, Colombia, Fiji, Namibia, Peru, South Africa, Timor-Leste and Vanuatu) where specific policy documents for individual fisheries sectors were found (e.g. Fiji had two plans, one for fisheries and another for aquaculture). Most fisheries policies covered both sub-sectors (56%), and among sector-specific policies, 37% of policies reviewed focused on capture fisheries.

On average, both PHN and fisheries policies had low levels of inclusion of keywords from the other policy domain. PHN policies tended to briefly mention fish and shellfish but typically not include them in their objectives, 59% of national diet or nutrition plans had no or low inclusion of aquatic food keywords. Similarly, 51% of fisheries policies had no or low inclusion of FNS keywords. The low level of inclusion across policies indicates there is a low level of coherence, or joint planning, between these sectors' policy documents (Appendix S1: Table S5).

Inclusion of aquatic foods in PHN policies ranged from “none” to “moderate” (Figure 1, Appendix S1: Table S5), and scores for inclusion of FNS in fisheries and aquaculture policies were even lower (Figure 2, Appendix S1: Table S5). When looking at median fisheries policy scores by region, a range of regions had at least a moderate inclusion of FNS objectives. For fisheries policies, these included Northern and Eastern Africa, South and Central America, Southeastern and Eastern Asia, and Northern, Eastern and Western

Europe (under the Common Fisheries Policy). When considering the median health policy scores in each region, Central and Western Africa, Eastern Asia, the Caribbean, Eastern Europe and Melanesia had at least moderate levels of inclusion of PHN concerns in the fisheries and aquaculture sector.

Conclusions concerning some sub-regions were derived from fewer documents than others, either because documents were not available online, or policies could not be translated (e.g. Arabic, Greek, Slavic language group). For fisheries and for PHN policies, this was true for Eastern Asia, Southern Europe and Western Asia. For PHN policies, this was especially true in Eastern and Southern Europe. For fisheries policies, lack of online availability was evident in Southern Asia, Eastern Asia and especially Western Asia.

#### 3.2 | Policy- and group-level effects on policy inclusion

Fisheries policy parameters with posterior distributions completely outside of ROPE indicated the strongest association with higher levels of policy inclusion. For fisheries policies, the strongest associations were found in publication year, domestic supply of fish to total animal protein and the prevalence of overweight children. Fisheries policy parameters with the weakest association—most of the posterior distribution fell inside of ROPE—included GDP per capita, and the prevalence of stunted children.

Group-level effects were also estimated for the aquatic food sector being addressed in fisheries policies (Figure 3), but it did not appear that sector-specific policies explained higher or lower levels of inclusion of FNS objectives in policies. Policies that were

**TABLE 3** National-level indicators used in fisheries and public health nutrition policy models

Indicator (metric)	Effect type in model	Testing hypothesis	Data source
Wealth (GDP growth per capita)	Policy-level	We hypothesize that higher GDP per capita would lead to decreases in inclusion because policymakers in wealthier countries might have less need to rely on individual sources of protein to improve public health, and might also rely on other mechanisms outside of diets, such as health care	UN SDG Database (UN-iLibrary, 2021)
Malnutrition (% children with stunting)	Policy-level	We assume that regions where stunting is most problematic are more likely to recognize the benefits of nutrient-rich seafoods, but given much of the recognition that seafood is a source of micronutrients is recent, we do not expect a clear signal. Thus, we hypothesize a weak but positive association between policy inclusion and the per cent of children who are experiencing moderate or severe stunting	UN SDG Database (UN-iLibrary, 2021)
Malnutrition (% children overweight)	Policy-level	We expect to see a stronger, negative association between policy inclusion and the per cent of children who are overweight. In developed regions, that tend to have higher proportions of children who are overweight, weekly seafood has long been included in dietary recommendations.	UN SDG Database (UN-iLibrary, 2021)
Governance (Governance effectiveness index)	Policy-level	We expect that countries with strong governance will have the ability to focus across multiple sectors and, therefore, may have capacity to focus on FNS alongside other objectives. As a result, we expect there to be a positive association between governance effectiveness and policy inclusion.	World Bank (The World Bank, 2019)
Fish reliance (Domestic supply ratio of fish per total animal protein)	Policy-level	We expect that countries that produce a high volume of fish relative to other animal proteins will have more inclusion in policies.	FAO Statistical Collection (FAO, 2019)
Recency of policy	Policy-level	For publication year, the null hypothesis is inclusion levels would not exhibit increasing trends over time.	Policy review
Evidence that an international or other external organization aided policy development.	Policy-level	For development partners, the null hypothesis is that there is no increase in probability of higher levels of inclusion in the presence of development partners during the policy development process.	Policy review
Subregion	Group-level	Categorized using UN Geoscheme (United Nations Statistical Division, 2019)	Policy review
Policy type	Group-level	Noted the type of policy document. Public health nutrition policies included dietary guidelines, laws and national policies. Fisheries policy documents included laws and national policies.	Policy review
Sector of fisheries policy	Group-level	Categorized whether fisheries policy document was specific to aquaculture or to capture fisheries, or covered both sectors.	Policy reviews

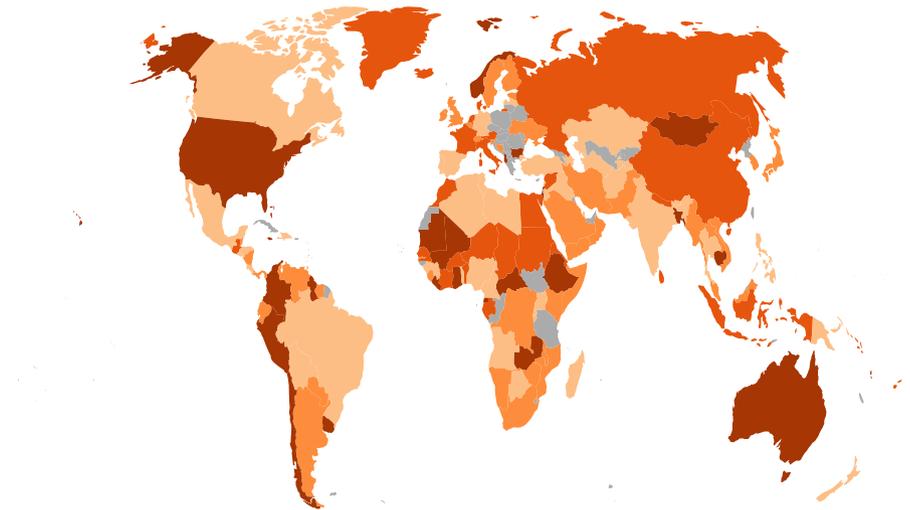
specific to either aquaculture or the capture fisheries sector tended to have a slight negative effect on policy score. If the policy covered both aquaculture and capture fisheries sectors, there was a very slight positive effect on policy inclusion. The weak effect sizes

of the fisheries sector variable in the model show that, relative to other group-level effects, aquaculture or fisheries sector policies did not have a strong influence on FNS inclusion. However, when considering the medians across all policies for each sector group,

**FIGURE 1** Degree to which aquatic foods are included in public health nutrition policies

**Inclusion of aquatic food-related goals in national public health nutrition policies**

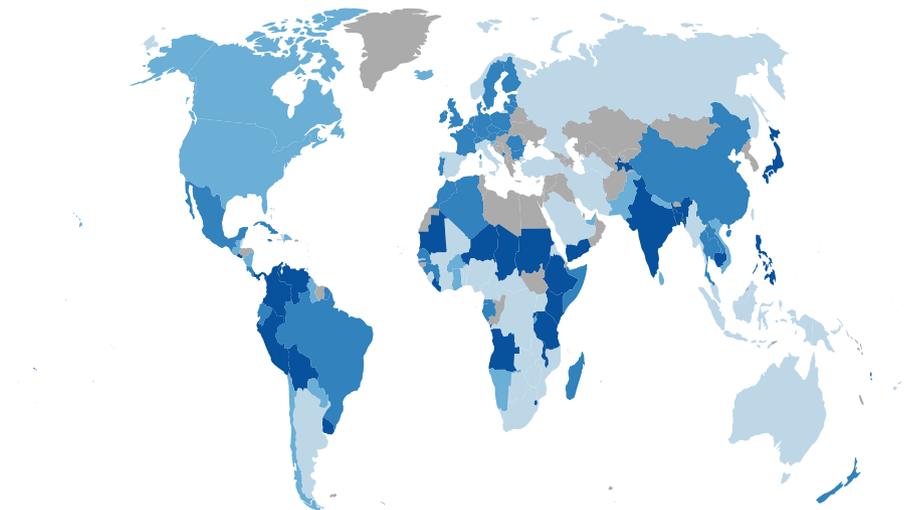
■ No ■ Low ■ Moderate ■ High ■ NA



**FIGURE 2** Degree to which food and nutrition security objectives are included in fisheries policies

**Inclusion of food & nutrition security goals in national fishery policies**

■ No ■ Low ■ Moderate ■ High ■ NA



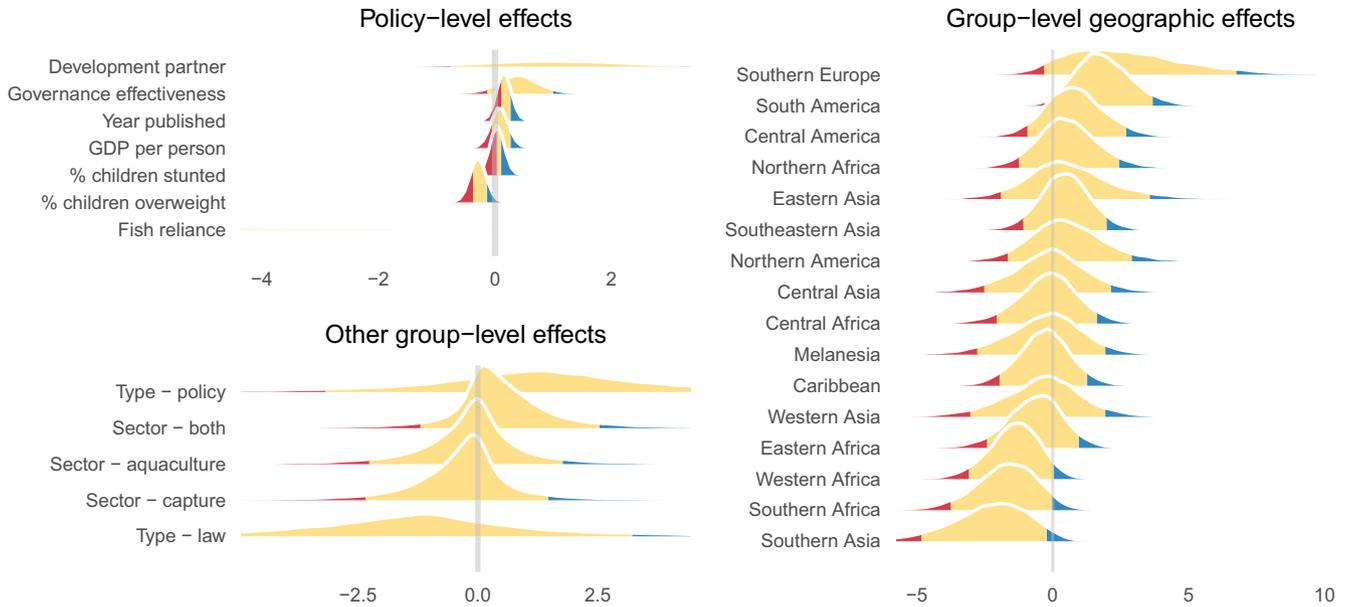
aquaculture and policies addressing both sectors had higher levels of inclusion with FNS objectives than capture fisheries (Appendix S1: Table S5).

In the PHN model, parameters that completely rejected the null (i.e. 0% overlap with ROPE) were governance effectiveness and prevalence of overweight children (Figure 4). Parameters with the next strongest effects on PHN policy inclusion of aquatic food-based objectives included domestic supply of fish to total animal protein and prevalence of a development partner. Parameters with the weakest effects included the per cent of stunted children and the per cent of the total population undernourished, publication year and GDP per capita (Figure 4).

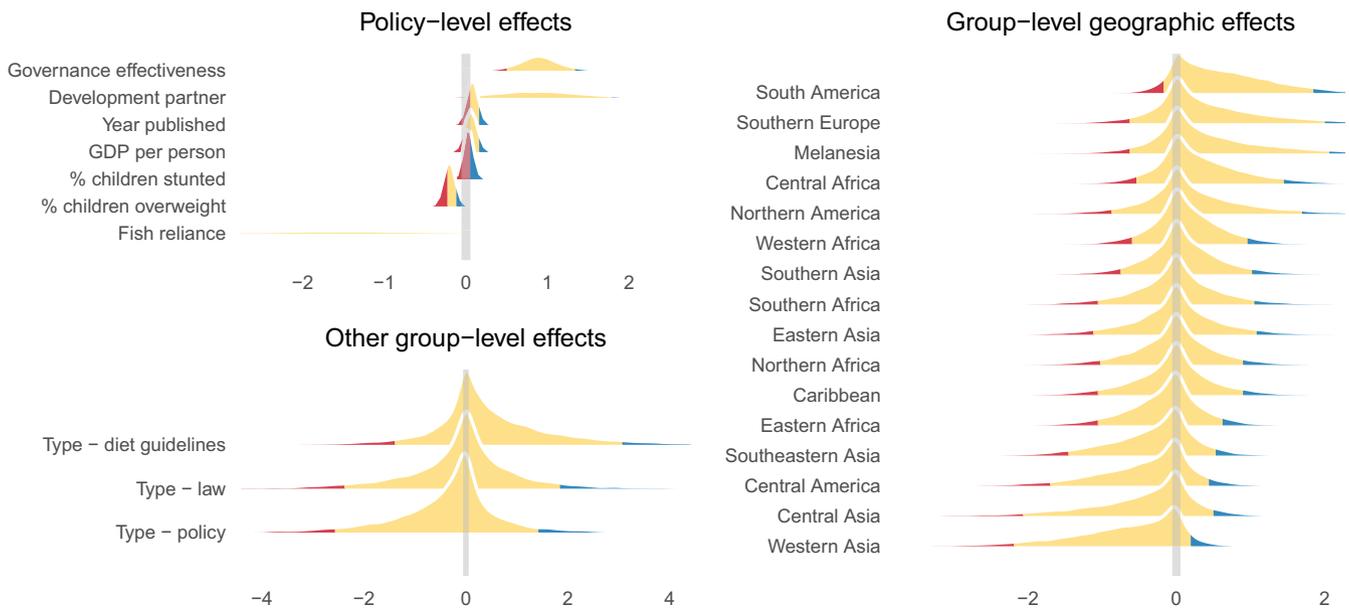
The ROPE test was also used for the group-level variables policy type, fish sector and subregion (Figures 3 and 4). For the fisheries policy model, group-level effects for specific sectors were not

strong. Policy type indicated a stronger effect in the fisheries model than it did in the health model. Group-level effects for subregion indicated a stronger effect in the fish model than in the PHN model. Only the group-level effect for South America indicated an effect strong enough to completely reject the null that subregion had no effect on policy inclusion.

There were strong effects of “year of publication”, “domestic supply of fish as a proportion of animal source food” and “prevalence of stunted children” in the fisheries model but not in the PHN model. In contrast, governance effectiveness had a strong effect in the PHN model but not in the fisheries model. There was a very weak effect of the prevalence of stunted children in the fisheries model, but the null hypothesis of no effect of stunting on policy inclusion with aquatic food objectives could not be rejected in the PHN model. Both fisheries and PHN policy inclusion shared strong effects for the



**FIGURE 3** Fisheries model posterior distributions of policy-level and group-level effect on inclusion ROPE indicated by shaded bar. Tails indicate intervals for the upper and lower 5%



**FIGURE 4** Public health nutrition model posterior distributions of policy-level and group-level effect on inclusion ROPE indicated by shaded bar. Tails indicate intervals for the upper and lower 5%

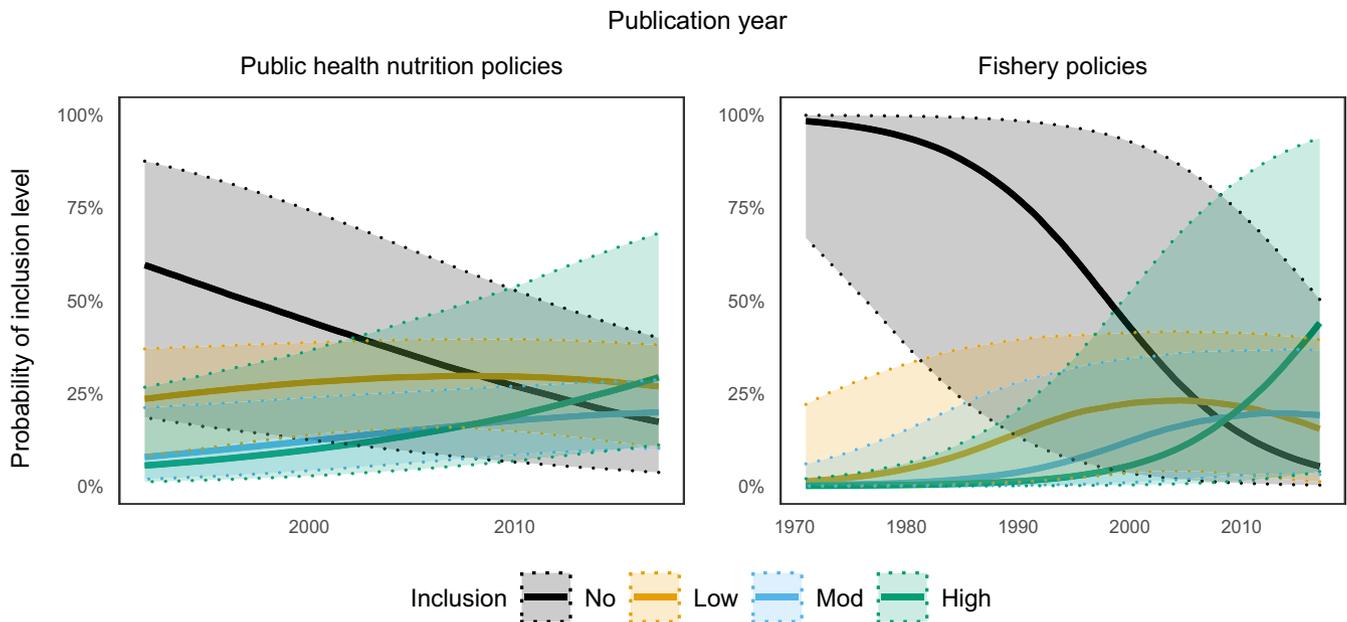
prevalence of overweight children on policy inclusion levels. Both models had weaker effects on the presence of a development partner and per capita GDP. Credibility intervals for many effects were broad, indicating increased variability in the relationships between predictor effects on the inclusion of policy keywords.

With this understanding of the overall effect of the parameters on policy inclusion, we can look at the marginal effect of the parameters on the probability of a policy having no, low, moderate or high inclusion given each of the parameters. The focus here will be on parameters found to have strong effects on the inclusion of PNH in fisheries policy and vice versa.

### 3.3 | More recently published policies indicated higher levels of inclusion

Publication year had a strong marginal effect on the degree to which food security and/or nutrition objectives were included in national fisheries and aquaculture policies. Inclusion of aquatic foods in national food security, nutrition and health policies was less strongly affected by publication year but, in both cases, more recently published policies were more likely to be integrated (Figure 5).

For fisheries policies, this indicates that more recently published policies are associated with higher levels of inclusion of PHN objectives or



**FIGURE 5** Marginal effect (Median  $\pm$  80% CI) of publication year on policy inclusion for public health nutrition and fisheries models, where the median marginal effect of a change in the probability of a no, low, moderate or high inclusion associated with a change in publication year leads to specific increase—or decrease—in the probability of that level of inclusion

terminology. Between 1995 and 2017, the probability that a national fisheries policy did not mention food security, nutrition or health at all decreased from 60% to 5%. For the same time period, the probability that a national policy for food security, nutrition and health would not include any mention of the health benefits of aquatic food consumption went from 53% to 17%. For fisheries policies published during the same period, the probability of high inclusion—including aquatic foods not only in overall objectives but also in specific policy action items—increased from 3% to 44%. With PHN policies, a less noticeable but similar trend occurred. As the probability of no policy inclusion declined, the probability that FNS terms had low levels of inclusion—where aquatic foods were briefly mentioned in the policy—gradually increased to a peak of 30% between 2004 and 2005 before decreasing. Overall, recent publication years were associated with higher levels of inclusion in both fisheries and PHN policies.

### 3.4 | Where overweight in childhood was prevalent, national policies had low inclusion levels

The prevalence of overweight children had a strong negative association with the degree to which policies cross-referenced each other, in both fisheries and PHN models (Figure 6). The probability that PHN policies had high levels of inclusion of aquatic foods increased as prevalence of overweight children decreased, from 45% to 4%. The probability that fisheries policies include FNS objectives and provide clear strategies to meet those objectives (*i.e.* “high” inclusion level) decreases as prevalence of overweight children increases in country, from 49% to 1%. In both PHN and fisheries models, as prevalence of overweight children increased, the probability of policies with no inclusion increased from 9% to 75% in PHN policies and 5% to close to 100% in fisheries policies.

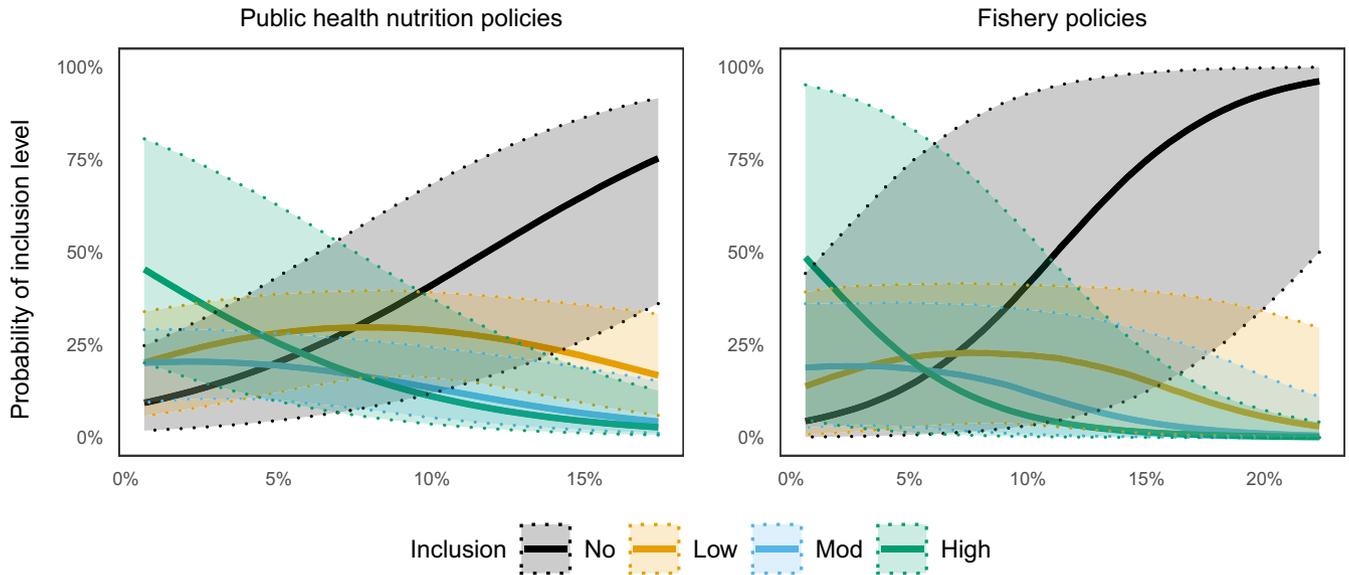
### 3.5 | Development partner presence is associated with high levels of policy inclusion

There was a moderate association between policy inclusion and development partner presence (Table 3). In both models, recognizing the contribution of a development partner in the policy document most noticeably affected the probability of a high inclusion level, but there was considerable uncertainty in this relationship, particularly in the fisheries policy model (Figure 7). For the PHN policy model, the presence of a development partner increased the probability of high inclusion from 21% to 40%. For fisheries policy models, contributions by a development partner increased from 16% to 36% the probability that it had high levels of inclusion of FNS terms.

### 3.6 | Higher governance effectiveness was associated with inclusion of aquatic foods in public health nutrition policies

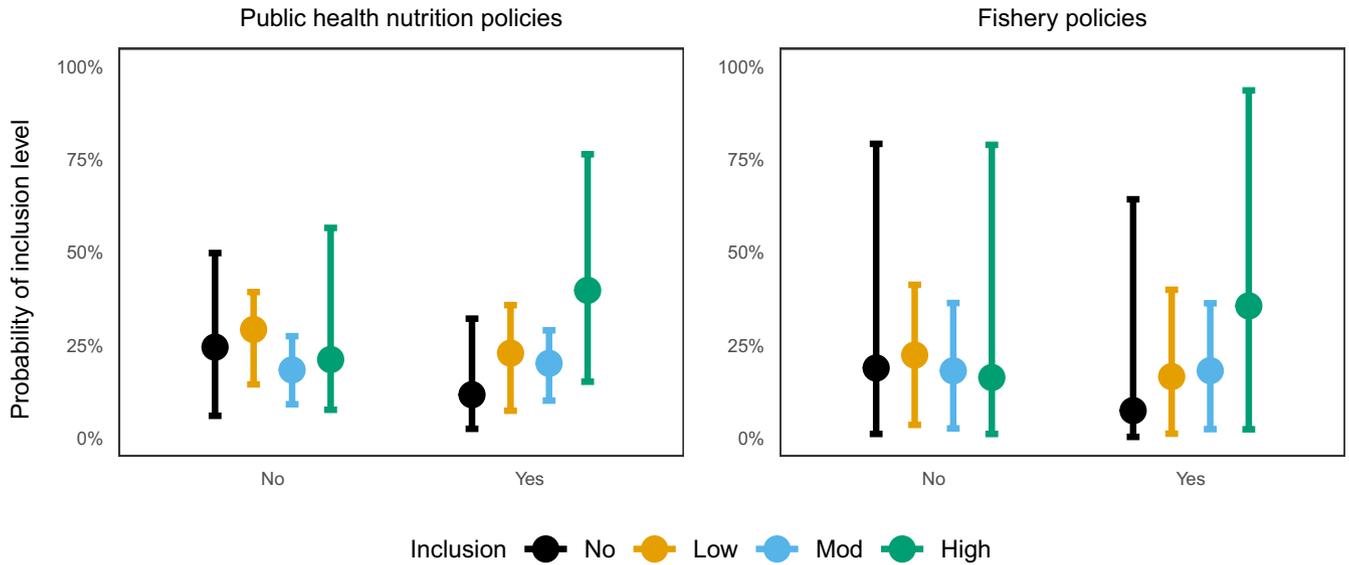
Governance effectiveness was not strongly associated with inclusion in the fisheries model (Figure 8). For the PHN model, as the governance effectiveness index of the country creating the policy increased, so too did the probability—from 8% to 62%—that the policy document included aquatic foods. For fisheries policies, countries with higher governance effectiveness tended to have policy documents with more inclusion of FNS objectives, but the uncertainty of this parameter in the fisheries model makes any definitive statements tenuous.

Prevalence of overweight children



**FIGURE 6** Marginal effect (Median  $\pm$  80% CI) of the proportion of children who are overweight on public health nutrition policy inclusion levels, where the median marginal effect of a change in the probability of a no, low, moderate or high inclusion associated with a change in prevalence leads to specific increase—or decrease—in the probability of that level of inclusion

Development partner presence

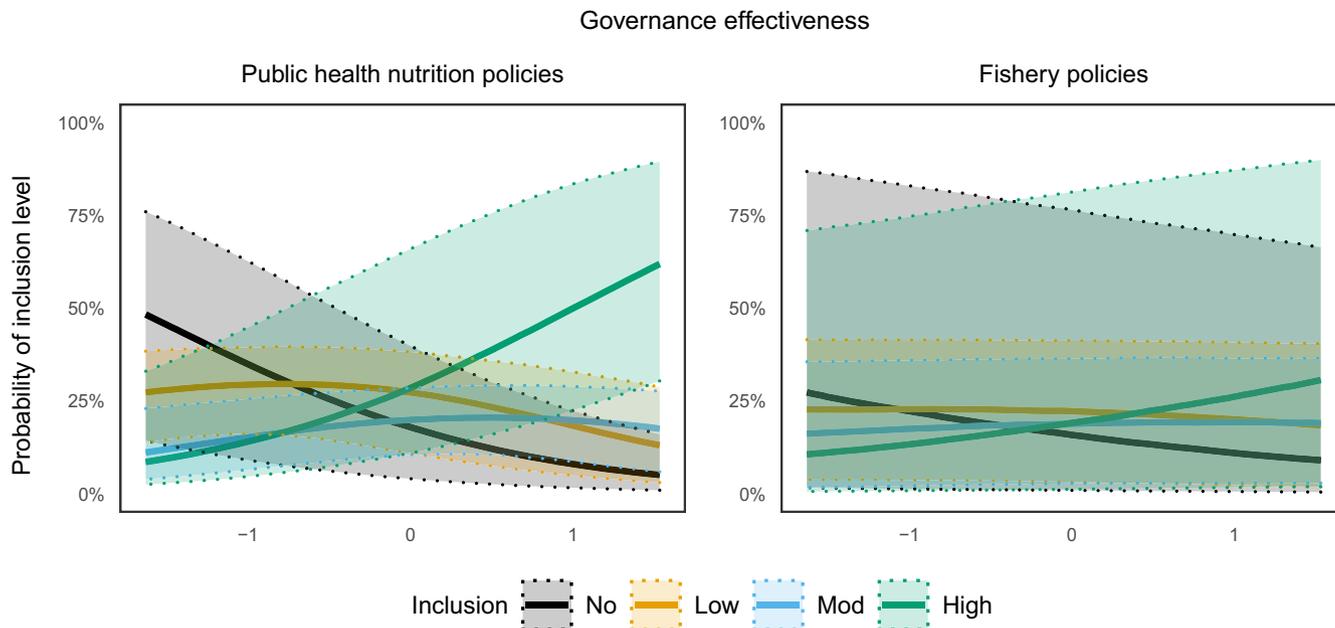


**FIGURE 7** Marginal effect (Median  $\pm$  80% CI) of the presence of a development partner on fisheries and public health nutrition policy inclusion levels, where the median marginal effect of a change in the probability of 'no', 'low', 'moderate' or 'high' inclusion associated with the presence of development partners leads to specific increase or decrease in the probability of that level of inclusion

**3.7 | Group-level effects of subregion, policy type and fisheries sector on policy inclusion**

Fisheries policies from Southern Europe and South America included the most FNS objectives, while those in Southern Asia and Southern Africa had the fewest (Figure 3). In PHN policies, South America, Melanesia and Central Africa included more aquatic food-based

objectives and Western Asia, Central Asia and Central America the fewest (Figure 4). Subregions with more positive effect estimates indicate that policies originating from that subregion have higher levels of aquatic food inclusion (e.g. PHN policies in Melanesia), whereas a more negative effect indicates that policies originating from that subregion have lower levels of inclusion (e.g. inclusion of FNS terms in fisheries policies in Southern Asia). As indicated above,



**FIGURE 8** Marginal effect (Median  $\pm$  80% CI) of governance on public health nutrition policy inclusion levels, where the median marginal effect of a change in the probability of a no, low, moderate or high inclusion associated with a change in governance effectiveness index score leads to specific increase—or decrease—in the probability of that level of inclusion

only fisheries policies from South America had a positive effect when controlling for other policy- and group-level effects (Figure 3). Group-level effects of policy document type—whether the document was a national policy, a law or a dietary guideline—indicated that policies tended to include more cross-sectoral objectives than laws. PHN documents that were dietary guidelines tended to have greater inclusion of aquatic food keywords in their objectives than other document types. There is a slight negative effect on the inclusion of aquatic food-related terms in national policies and national laws, and a slight positive effect of dietary guidelines on inclusion of aquatic foods in PHN policy (Figure 4).

## 4 | DISCUSSION

Our analysis of 165 PHN and 158 fisheries policies at the national level revealed generally low levels of cross-sectoral integration. The model-based approach indicated four interesting policy-level associations with respect to the level of inclusion. First, there is evidence that food and nutrition security terminology—as an indicator of PHN objectives—are better integrated in more recent fisheries policies, and, to a lesser extent, this is also true of fisheries and aquatic food terminology in PHN policies. Second, there is a nuanced and inverse association between children who are overweight and policy coherence between fisheries and PHN policies, where countries that have higher prevalence of overweight children do not emphasize the dietary importance of aquatic foods in their policies. Third, when development partners are present, that country has a higher probability of high levels of cross-sector integration of its fisheries and PHN policies. This suggests that agencies such as UN FAO and WorldFish,

which promote aquatic foods in healthy diets, appear to be having an impact on improving the level of inclusion between fisheries and health policies. Finally, countries with high levels of governance effectiveness tended to include nutrition concerns in fisheries policies but there was a less noticeable effect on the inclusion of aquatic foods into their PHN policies. This suggests that countries with stronger governance recognize the nutritional value of fish and seek to align fisheries and aquaculture sectors to meet FNS goals, whereas those with weak governance are less likely to align the sectors to meet those goals.

### 4.1 | More recent policies have higher coherence between fisheries and FNS goals

Progress is being made: the fisheries policy model and to a lesser extent the PHN policy model found there was a much higher probability of high coherence between the two policies in countries with more recently published policies. More recent fisheries policies were more likely to have clearer objectives related to FNS (*i.e.* moderate or high inclusion levels). Policies are moving towards more specific terminology and objectives, suggesting decision-makers are becoming more proactive about managing fisheries for FNS. It is important to note that without systematic ground-truthing and finer-scale data (Fisher et al., 2017; Kurien & Ríos, 2013), it is difficult to know whether these policies are as effectively implemented as fisheries management objectives (e.g. if actions required to meet nutrition-sensitive policy objectives are monitored and enforced to the same degree as objectives related to biological sustainability of the stock are). The results provided here nevertheless suggest that fisheries

policies are moving in a promising direction that echoes calls for greater inclusion of nutrition-sensitive policies in capture fisheries and aquaculture (Golden et al., 2016; Thilsted et al., 2016).

PHN policies also showed that more recently published documents tended to consider more often the role of aquatic foods in healthy diets. This suggests that the rapid increase in academic literature and policy briefings on the potential contribution of fish to human health is being translated to key national policy documents in both sectors and that policies are becoming more aligned. This is an encouraging step in creating the enabling context for action to use fish to tackle micronutrient malnutrition (Hicks et al., 2019). This global assessment only analysed the most recent fisheries policy and the most recent health sector policy in each country. Future work could investigate this issue further by focusing on policy formulation and adoption over time in individual countries, where a succession of policies across years is present. Further research will also need to demonstrate whether higher level of integration keywords in policy documents indeed indicates more fisheries and PHN integration *in practice*, and whether inclusion of food and nutrition goals in fisheries policies are not merely used as new justifications of policies primarily geared at scaling up production or conservation (see Fabinyi et al. 2016). Our results indicate that there is still considerable room to guide future policy development towards effective action to better realize the nutritional benefits of aquatic foods in diets.

## 4.2 | Childhood malnutrition—understanding the conditions for improving alignment?

A motivating reason for this research was to determine whether fisheries and PHN policies had complementary objectives that enabled aquatic foods to be acquired and consumed to help reduce malnutrition. Namely, do we see more coherence in policies from countries with elevated malnutrition among children? We learned that of the two health indicators related to the dual burden of malnutrition, only countries with a higher proportion of overweight children had associated fisheries and PHN objectives in their respective national policies. Surprisingly, countries with high overweight prevalence were associated with *low* levels of inclusion. While the proportion of overweight children is only a proxy, and not a perfect analogue, for diet-related diseases caused by malnutrition, the negative association suggests aquatic foods are not currently considered for their role in addressing nutrient deficiencies and diet-based diseases that arise from diets rich in nutrient-poor foods. Other factors may also explain why countries with a higher proportion of overweight children do not strongly call for aquatic foods in PHN policy or for FNS in fisheries policy. For example, in fisheries policy, the focus may centre on revenue-based objectives or livelihoods over nutrition-sensitive objectives, echoing agricultural policy (Pinstrup-Andersen, 2013). In addressing obesity and CVD, PHN policy may focus less on details related to specific food groups and more on strategic interventions into the diet as a whole. Nevertheless, this presents an opportunity where such diseases are prevalent. In contexts where overweight

prevalence is highest, access to affordable fish and shellfish may provide nutrient-dense alternatives to the energy-dense, nutrient-poor foods that compound diet-based disease burdens.

In some cases, national fisheries policies make no mention of aquatic food despite having a large fisheries sector and high prevalence of overweight children (e.g. Indonesia). In other cases, where overweight prevalence is high but catches are small—for example in Kazakhstan's lakes where there was a history of Soviet and post-Soviet era overfishing—the opportunity is in aquaculture production, which is beginning to improve supply to local markets (Graham et al., 2017). In such regions where fish stocks are depleted, aquaculture may present an alternative to improve aquatic food consumption. The contexts underlying the negative association between overweight prevalence and policy inclusion are diverse, as are their potential solutions. There are many opportunities for context-specific policy changes to improve alignment across the sectors to alleviate diet-based disease.

The lack of association between childhood stunting and fisheries or health policy inclusion levels was unsurprising given the complex causes of undernourishment. Some of the highest rates of fish consumption in the world occur in Cambodia—where fisheries policies are highly aligned with nutrition—yet malnutrition remains because of high incidence of poverty—meaning that many households cannot access adequate quantities of food, and/or their diet quality (or nutrient richness) may be low. Behaviours that elevate health risk outside of the consumption of aquatic foods, such as low consumption of vegetables or a lack of nutritional education, may also be a contributory cause (Vilain et al., 2016). This example highlights the importance of placing aquatic food in a broader context. A suite of broader social factors, such as gendered disparities in access to food, poverty, access to clean water and infectious disease prevalence all may have an overriding influence on childhood health and nutrition (Development Initiatives, 2020).

In instances where undernourishment is prevalent, pathways to connect aquatic food production to the food system may not exist even if there is a policy that supports inclusion between fish and shellfish and nutrition objectives. For example, Yemen has some of the highest stunting rates in the world, approximately half its population cannot secure access to healthy food, due to ongoing conflict (El Bcheraoui et al., 2018). The 2012 Yemeni policy sought to improve the management of its fisheries resources so that it can improve current methods “directly reflected in loss of market value and loss of nutritional opportunity” and contribute towards a domestic food supply of high nutritional quality (Ministry of Fish Wealth, 2012). The Yemeni policy exemplifies an important point: even policies with strong support for public health nutrition can be ineffective if the objectives cannot be implemented due to influences external to policymaking process, such as civil war.

A lack of clear evidence on the association between keyword inclusion in countries where malnutrition is prevalent maybe because the focus of these countries is on improving diets, as a whole, rather than a focus on specific healthy foods (e.g. shellfish or leafy greens). The focused role on diets, rather than specific foods, may help to

explain why model results indicated a strong association only with low levels of inclusion. Fish may be mentioned in passing, only as an important feature of the broader diet, with the diet being the focus of the PHN policy. The lack of a clear association between malnutrition and keyword inclusion in PHN policies may also indicate that other healthy foods may be encouraged instead of aquatic foods (e.g. fruit and vegetable consumption). If so, the degree to which aquatic foods are included in PHN relative to other healthy foods may be an important avenue to pursue in future research. It must be recognized that improving fish consumption, alone, will not remedy malnutrition, but it will certainly play a role in alleviating it where the fisheries resources are available and affordable (see Hicks et al., 2019).

While there is thus considerable room for alignment of fisheries and health policies to combat malnutrition, this can only form part of coherent policy. The UN sustainable development goals are high-level attempt align key policies to address interlinked challenges of environmental governance (such as fisheries management) and human well-being including the elimination of malnutrition in all its forms (UN General Assembly, 2015).

### 4.3 | Development partner presence influences fisheries and health policy inclusion

The presence of development partners such as United Nations agencies, international organizations, NGOs and development banks was associated with higher levels of coherence between PHN and fisheries policies. This pattern reflects recent shifts in development paradigms among large development groups from singular objectives such as economic development to a multidimensional goal approach that may include livelihood, conservation and food security objectives (Hamilton et al., 2021). Given the explicit focus of many development agencies on food and nutrition security, the weak association between the presence of development partners and higher levels of inclusion of FNS concerns in fisheries policies was surprising. Numerous international organizations are working to improve the supply of sustainably produced aquatic foods for food and nutrition purposes.

Relative to PHN policies, fewer national fisheries policies acknowledged the role of development partners in their documents, despite an explicit focus of food security by mission-driven organizations such as FAO or WorldFish collaborating on national and sub-national policy development. One explanation is there were fewer fisheries policies that acknowledged development partners than there were in health policies, relative to those who do not have any such partners. It is possible that, compared to other model parameters, there were simply too few examples to have a statistically significant population-level effect; development partners were visibly present in 22% of PHN policies but only 11% of fisheries policies. Another explanation for the absence of development partners might be a shift in partner preference over whether they wanted to be visible in the national policy document, which should, in principle,

reflect national priorities and voices, rather than the agendas of external agents. For fisheries policies, it could also be the case that some international development organizations steered national policy away from FNS objectives (e.g. stronger focus on rent maximization via export-oriented fisheries (Béné et al., 2010). Ownership of national and sub-national policies and programmes has been a key aim of donor-funded policy reform initiatives in the natural resources sector (Hayman, 2007), and the technical agencies and consultants assisting governments with these reforms may remain invisible as part of that process of encouraging national ownership.

Despite the weak associations found in the statistical models, international organizations do have a role to play in policy development in providing the capacity to support policy actions that improve the connection between fisheries and aquaculture production and FNS outcomes. In some cases, international organizations serve as “bridging organizations” that connect local, regional or international actors with new collaborators, financial resources or new information that facilitates the success of policy interventions (Berdej & Armitage, 2016). In other cases, international partners supplement policy and intervene directly in the supply chain by providing infrastructure, materials and training. These resources are often needed to open new market channels, either to increase the flow of nutritious aquatic food to food-insecure communities or to support the livelihoods of nutritionally dependent fisherfolk (Fiedler et al., 2016). While international organizations can create the capacity needed to stimulate interventions, reliance on external fundraising creates risk to the longevity of the arrangement. As such, policymakers and international development partners should identify sources of funding to ensure that such programmes create lasting benefits.

## 5 | CONCLUSION

Pathways towards sustainably managing capture fisheries are becoming clear: good stewardship futures can be envisioned where there is higher abundance of species in our oceans and inland water bodies and more aquatic food (Hilborn et al. 2020). Aquaculture's growth indicates another pathway by which aquatic food can meet demand for nutrient-dense, healthy food. At the same time, malnutrition remains a serious concern; while global stunting prevalence is slowly declining, diet-related diseases associated with overnutrition are on the rise (Development Initiatives, 2018). Fish and shellfish, as rich and diverse sources of micronutrients, could contribute to improving global public health, and efforts to improve the contribution of fish to the diets of malnourished people are a focus of fisheries research for development (Allison et al., 2016; WorldFish, 2020).

More coherent policies among sectors that establish clear pathways linking fish production and distribution to consumers are needed to increase the contribution of aquatic foods to food and nutrition security. Without such policy direction, fish will continue to be produced and managed for revenues, jobs and conservation—all of which are important, but will not by themselves ensure that

fish reaches people most vulnerable to malnutrition. Despite widespread recognition of aquatic food's nutrient richness, we conclude that there is considerable potential for greater coherence between fisheries sector policies and public health nutrition policies, to help get aquatic foods into the diets of nutritionally vulnerable people.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in supplementary materials (Appendix S2).

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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