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Table of Content

Preface

This report represents Roshni Mangar's M.Sc. research, which was shaped and developed collaboratively with Drs. Amanda Vincent and Sarah Foster. The idea for this research came from Drs. Amanda Vincent and Sarah Foster in the course of their work on bottom trawling, including through collaboration with Dr. Tanvi Vaidyanathan. Roshni Mangar was primarily responsible for developing the pragmatic literature review methods in Chapter 2. Roshni Mangar collected all the data and conducted all the analyses for Chapter 3 using peer-reviewed and grey literature, with input from Drs. Amanda Vincent and Sarah Foster. Roshni Mangar wrote this report with substantial input from Drs. Amanda Vincent and Sarah Foster. The majority of the analysis and writing took place on the traditional, ancestral, and unceded lands of the Musqueam, Squamish and Tsleil Waututh peoples.

Director's Foreword

Bottom trawling, characterized by dragging a weighted net along the seabed, indiscriminately catches and harms every organism in its path. With thorough and insightful analysis, this research paper delves into the complexities surrounding bottom trawling, revealing its profound effects on fishers.

Drawing from a meticulous, systematic literature review, the authors unravel the drivers and motivations that entice fishers and the fishery to start, engage in, and stop bottom trawling in India. Their efforts have resulted in formulating a new framework that distinguishes between stakeholders' diverse economic, social, and environmental motivations. Moreover, their study highlights a pressing reality: fishers do not always want to fish and are sometimes forced to remain in the bottom trawl industry. Recognizing and addressing these insights are paramount in effectively constraining bottom trawling.

The authors demonstrate that understanding the nuances within communities rather than viewing them as one entity is paramount for designing equitable policies. They show that fisheries management must transcend maritime activities, and encompass the development of public services that catalyze positive change and foster resilience in fisheries management efforts.

I commend the authors for their unwavering dedication and exemplary work, which has cast much-needed light on the destructive and indiscriminate nature of bottom trawling. May their research guide and offer invaluable insights into the diverse motivations of fishers, and help shape equitable fishery management policies in the future.

Prof. William Cheung
Professor and Director, Institute for the Oceans and Fisheries
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Abstract

This research analyses the nature of human dependence on bottom trawling as a necessary precursor to constraining its impact. Bottom trawling involves dragging a weighted net along the seabed, catching and/or damaging every organism in its path. Bottom trawling can negatively affect fishers, resulting in fewer opportunities for artisanal and small-scale fishers, diminished food security, increased human rights violations, and social and violent conflicts. This study focuses on India, where trawling started in 1956 and where 79% of total landings by trawls that targeted shrimp were already gathering unintended catches by 1979. While the obvious solution seems to be to limit bottom trawling, decision-makers are often challenged by conflicting economic, social, and environmental imperatives. The objective of the study was to understand fishers' motivations to start, stay in and stop bottom trawling to better address challenges faced by decision-makers. A mix of peer-reviewed and grey literature was used to conduct a systematic literature review. The results show that the fishery and fishers chose to begin bottom trawling and stay in the industry primarily because of offers of subsidies, potentially better income, and likely profits. The bottom trawl industry persisted despite declining resources because of (i) the industries' capacity to exert power which allowed them to extend a sunset business, and (ii) poor enforcement of regulations that should have constrained trawling. We underline the entrenched nature of the trawl industry, where fishers were trapped in bottom trawling because of accumulated debt to people higher in the trade. Fishers stopped trawling when constrained by regulations, resource depletion, and low financial returns. Fishers' motivations to participate in bottom trawling varied according to their role in the trawl industry, with owners often reaping more benefits from trawling than the crew. Recognizing and addressing these results will be crucial in determining how best to constrain bottom trawling effectively.

Acknowledgments

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We thank Terre Satterfield and Dianne Newell for their continuous support, feedback, and words of encouragement throughout this process. We are grateful to Tanvi Vaidyanathan for her unwavering commitment to reviewing our drafts and providing invaluable feedback, regardless of the time. Our gratitude goes to Naveen Namboothri and Aaron Lobo for their early contributions to brainstorming and discussing ideas at the project's outset.

Our heartfelt appreciation goes to our colleagues at Project Seahorse – Adam, Elsa, Ema, Joanna, Le, Lily, Marta, Miguel, Pax, and Regina – for their support and encouragement. We also thank Syd Ascione and Jerry Wong for their assistance in revising and formatting the document.

We are indebted to Sally Taylor, Eleri Staiger-Williams, and Levin Lindstrom from The University of British Columbia Woodward Library, as well as Kyle Gillespie and Caroline Graham, for guiding us through the systematic literature review process. Special thanks to Debra Sinarta and Shelly Wang, who were exceptional volunteers and provided help in searching and filtering the literature.

We are grateful to Amir Michalovich and Sara Cannon for their assistance with NVivo, to Patricia Angkiriwang for sharing visualization resources, and to Karly McMullen for her contributions to designing effective and creative visualizations.

Abbreviations/Terms

ASFA:	Aquatic Sciences and Fisheries Abstracts
CEE:	Collaboration for Environmental Evidence
CEESAT:	Collaboration for Environmental Evidence Synthesis Assessment Tool
CMFRI:	Central Marine Fisheries Research Institute
CMID:	Centre for Migration and Inclusive Development
CPUE:	Catch Per Unit Effort
CSV:	Comma-separated values
EBT:	Explicitly bottom trawling
EEZ:	Exclusive Economic Zone
EJF:	Environmental Justice Foundation
EQUATE:	Extensive, Qualitative, Universal, Accessible, Thematic, and Efficient
FAO:	Food and Agriculture Organization of the United Nations
GOMBRT:	Gulf of Mannar Biosphere Reserve Trust
ICSF:	International Collective in Support of Fish workers
INP:	Indo-Norwegian Project
INR:	Indian Rupee
IUU:	Illegal, Unreported, and Unregulated
Kg:	Kilogram
MARE:	Centre for Maritime Research
MPA:	Marine protected area
NGO:	Non-governmental organization
PBT:	Possibly bottom trawling
PDF:	Portable document format
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSA:	Program for Social Action
pSR:	Pragmatic systematic literature review
PT:	Possibly trawling
RIS:	Research Information System
ROSES:	Reporting standards for Systematic Evidence Syntheses
SDG:	Sustainable Development Goals
SEAFDEC:	Southeast Asian Fisheries Development Center
SIFFS:	South Indian Federation of Fishermen Societies
SPICE:	Setting, perspective, intervention, comparison, evaluation
SR:	Systematic literature review
SSF:	Small-scale fisheries
T:	Trawling
UBC:	University of British Columbia
UK:	United Kingdom
UN:	United Nations
UNESCO:	United Nations Educational, Scientific and Cultural Organization
US:	United States of America
USD:	United States Dollar

Glossary

Bycatch: Bycatch is non-target species caught by a fishery. If the bycatch is retained onboard, it becomes part of the landed catch, and if it is thrown overboard, it is known as discards. Some bottom trawl fisheries no longer have a target when they go to sea - or are targeting many / all forms of marine life - making any definition of bycatch very complex.

Crore: A crore equals to ten million Indian rupees or one hundred lakhs. For example, 1.5 crore rupees equal to 15,000,000 rupees. The average exchange rate for 2022 was 1 USD = 78.07 INR, where 1 crore = 128,090 USD. Examples of historical exchange rates: 1 USD = 4.76 INR (1950), 1 USD = 7.86 INR (1980), 1 USD = 44.94 INR (2000), and 1 USD = 45.73 INR (2010).

Lakh: A lakh equals to one hundred thousand Indian rupees. For example, 1.5 lakh rupees equals to 150,000 rupees. The average exchange rate for 2022 was 1 USD = 78.07 INR, where 1 lakh = 1280.90 USD. Examples of historical exchange rates: 1 USD = 4.76 INR (1950), 1 USD = 7.86 INR (1980), 1 USD = 44.94 INR (2000), and 1 USD = 45.73 INR (2010).

Mechanised: Vessels with inboard engines and machine power for fishing. Examples can include bottom trawlers, purse-seiners, and gill-netters.

Motorised: Vessels with outboards engines but no machine power for fishing. Examples can include mini-trawls.

Non-motorised: Vessels with no engines and no machine power for fishing. Examples can include push-nets and dragnets.

Panchayats: Informal Village Councils, comprised primarily of men with relatively higher status or greater power in the community. Play an essential role in the regulation and implementation of fishing rules.

Tonnes: 1 tonne = 1000 kilograms

1 Introduction

Bottom trawling is highly problematic socially, economically, and environmentally. This nonselective and destructive form of fishing is associated with human rights issues (Freedom United, 2022), modern slavery (Hodal & Kelly, 2014), and conflict with artisanal and small-scale fisheries. Socially, modern slavery, illegal human trafficking, and physical abuse have been documented on trawl vessels in Southeast Asia (Kelly, 2018; Suuronen et al., 2020). The persistent presence of trawl boats has created conflict with artisanal and small-scale fishers, destroyed passive and/or selective gear, and depleted the inshore fishing grounds (Gillett, 2008). Economically, trawling has become unprofitable and commercially nonviable but persists partly because of government subsidies and abusive conditions for labourers. Environmentally, trawling is responsible for 60% (437 million tonnes) of discarded fish in industrial fisheries (Cashion et al., 2018). Ecologically, trawling has caused habitat loss, change in species composition and diversity, and reduction in overall productivity (decline in biomass), amongst others (Wallace, 2007). The trawl industry is now moving the phase of biomass fishing, also termed "annihilation trawling" (sensu Vincent, 2017)(Vaidyanathan et al., 2017), when gear actively targets all life indiscriminately and catch is often sold as fish feed or chicken feed (Prentice, 2017; Vaidyanathan et al., 2017). Recovery of areas that have been trawled could take centuries, depending on the frequency and intensity of disturbance (National Research, 2002; Wallace, 2007). Bottom trawling is a problem in both the Global North and the Global South.

Efforts to reduce trawling have been ineffectual. Policymakers have implemented regulations such as trawl exclusion zones, larger mesh sizes, bycatch reduction devices, and limits on licences, amongst others (McConnaughey et al., 2019; Sadovy De Mitcheson et al., 2018). The premise of these regulations is that they allow for sustainable exploitation, minimal habitat impact and bycatch while still providing employment, income, food security, and maximising economic returns (Kumar & Deepthi, 2006; McConnaughey et al., 2019). However, these regulations have had a minimal effect because of ineffectual management, inadequate enforcement and compliance, and limited communication between government entities (Sumaila & Cheung, 2015). Many instances of such failed bottom trawling management have been reported in India (Munga et al., 2012; Sathyapalan et al., 2008), Thailand (Pauly & Chuenpagdee, 2003), Vietnam (Boonstra & Bach Dang, 2010; Nguyen et al., 2011; Nguyen, 2011; Southeast Asian Fisheries Development Center, 2016), European Union countries (Nemecky, 2022), United Kingdom (Dunkley & Solandt, 2020; García et al., 2021), and African countries (FAO, 2002; Stobutzki et al., 2006).

While trawling is detrimental, one of the challenges to imposing restrictions is the perceived human dependency and attachment the fishers have to fisheries. Perceived human dependence comes from the assumptions about fishing, such as fishers are the poorest of the poor, fishing is an undesirable and dirty occupation, fishing is a livelihood of last resort, fishers are only concerned about income (Pollnac et al., 2001), and/or fishers have a strong cultural and historical attachment to their fishery (Bavinck et al., 2012; Pascoe et al., 2015; Pollnac et al., 2001) – all of which can become impediments when devising policies. Yet, fishers' attachment and dependence vary greatly, and many fishers have no cultural attachment to fishing. Pollnac et al.(2001) found in 23 communities in the Philippines, Vietnam, and Indonesia that fishers stayed in the fishery even when the income and catches were low because of their strong attachment – often a universal assumption when developing policies. The fishers emphasised they got satisfaction from the act of fishing even when the catches were declining (Pollnac et al., 2001). However, results were different in Kenya (Versleijen & Hoorweg, 2009), Thailand, Cambodia, Laos, and Myanmar (Derks, 2013). A study in Kenya distinguished between (i) the new generation, which had no background in fishing, or one member of the family involved in fishing from the previous generation, and (ii) the old generation, where fishers belonged to families that had engaged in fishing or where fishing had been an occupation for many generations (Versleijen & Hoorweg, 2009). The new generation joined the fishery when their prior income was insufficient, there was a lack of other attractive employment

opportunities, and they had limited education, usually because parents could not cover education costs (Versleijen & Hoorweg, 2009). The study also showed that the new generation of fishers considered themselves, first and foremost, as fishers because in the community, fishing was considered more of a 'real' job than farming and had a male prerogative (Versleijen & Hoorweg, 2009). In Thailand, most of the crew on trawl vessels were migrants from Cambodia, Laos, and Myanmar and were attracted to the industry because of stories they heard about the higher income (Derks, 2013). For example, one crew member on a trawl vessel reported that he entered the industry with no fishing experience, had previously worked in a garment factory and had been a rice farmer (Derks, 2013).

If we are to plan an effective policy on bottom trawling, we need to know why the fishers are fishing and what it means to them. When considering the uncertain effects of conservation policies, much of the focus has been on ecology, with little consideration given to the human aspect (Fulton et al., 2011). Yet a significant challenge to imposing regulations on a community is the difficulty in predicting how people will react and what unintended consequences of regulations might arise (Fulton et al., 2011). We need to understand human behaviour to predict the outcomes of regulations. If we equate human behaviour to motivation, then motivations can provide insight into how fishers might react to policies (Fulton et al., 2011; Kriegl et al., 2021; Muallil et al., 2011; Young et al., 2016). We suggest that also understanding fishers' motivation to start, stay in and stop trawling would allow for a bottom-up approach, as well as gaining community buy-in and acceptance from fishers - which are both vital to achieving conservation goals.

The challenges of developing effective bottom trawl management - reconciling environment and employment – are particularly acute in India, where many people who depend on fisheries for their livelihood face diminishing catches. India is the world's sixth largest producer of biomass from marine capture fisheries (FAO, 2022), with trawling providing more than 50% of the catches (Dineshbabu et al., 2013). Trawlers initially (1950s - 1970s) caught highly economically valuable target species such as shrimp, squid, octopus, and various fish, mainly sold for exports; however, by 1979, 79% of total landings were already bycatch (George et al., 1981). Trawlers in India often openly flout fisheries laws, such as illegally using smaller cod-end mesh sizes, larger boats, and higher capacity engines to maximise catch (Davies et al., 2009; Gupta et al., 2019). This constant fishing pressure has resulted in overfishing, a steadily decreasing Marine Trophic Index (fishing down marine food webs) (Bhathal & Pauly, 2008), a decrease in catch per unit effort (CPUE) (Bhathal, 2014) and most likely irreversible habitat destruction (National Research, 2002; Wallace, 2007). For example, the diminishing trawl fishing catches in Tamil Nadu have resulted in fishers trawling in Sri Lankan waters, where such methods are illegal. Fishers risk their lives as they fish at night and can possibly be shot by the Sri Lankan Navy (Vivekanandan, 2003). The challenges in India show desperation, and we need to move forward.

This study analyses the human dependence on bottom trawling in India as a necessary precursor to developing fishing policies with better success based on understanding fishers' attachment to the trawl industry. In India, it has been estimated that 150,000 active fishers depend on the bottom trawl industry (Yadava, 2004). For example, in Tamil Nadu, it is estimated that for every trawl boat, up to 25 people are directly or indirectly dependent on the sector (Sridhar, 2017). Whilst some are directly reliant on the trawl industry, the lasting impacts of the industry also affect the 40 million people along the coastline of India who depend on the ocean (Creasey & Dsouza, 2019). While the obvious solution may seem to constrain bottom trawling, with tools such as MPAs and trawl exclusion zones, policymakers are often challenged by conflicting social, economic, and political imperatives. Policymakers in India are now faced with two questions: (i) how to reduce trawling with conflicting imperatives, and (ii) how much reduction is needed in the 30,772 trawlers (constituting 18% of all fishing vessels) in India, constituting 18% of all fishing vessels (DoF & CMFRI, 2020; Hemalatha, 2019).

Here we probe concerns that constraints on trawling might impose notable effects on people employed in trawl fisheries in India by looking at fishers' motivations for joining, persisting in and leaving the industry. We developed a pragmatic, systematic literature review where we generated hypotheses for why fishers start, stay in and stop trawling. By understanding why individuals join, remain, and leave the industry, we can understand fisher behaviour and address the excess fishing effort by focusing resources on the motivations, such as relieving people of ancestral debt or aiding with occupational hazards. Such an approach also allows policymakers to focus their resources on deterring the labour force from trawling before people enter the industry and/or to generate realistic alternate livelihood options. Such strategies would enable the conditions required to design and manage management practices, such as marine protected areas (MPAs), with better success. For example, policymakers could shift their attention to bolstering places like the Gulf of Mannar Marine National Park, where trawling continues despite it being illegal, to creating effective new MPAs in important marine areas. Such work would help India meet its commitment to the United Nations Convention on Biological Diversity and to the Sustainable Development Goals, particularly with regard to the 2030 target of protecting and conserving 30% of the world's terrestrial and marine ecosystems. Further, a pragmatic understanding of fisher motivation would help bring trawl fisheries in line with other occupations, where workers displaced by a policy change need help but are not treated as a reserved sacred group.

2 Methods

2.1 Step 1: Formulating the research question

We began by formulating a research question, the first step to any type of systematic review, the step that converts an idea to an investigation and focuses the scope of the research (Petticrew & Roberts, 2005). This process is vital for facilitating the next phase of the review, where we distil the research question into search terms.

Using a framework generates a logical flow that parses the research question into groups and drives the researcher to define the groups. For example, if we chose fisher and fishery as the perspectives of the study, the following questions may arise: What do you mean by fisher and fishery? Do you include individuals from the post-harvest? Do you include owners? This process forces the researcher to define the research question for the systematic review. The elements help drive the creation of the search strategy and create a tractable question.

The frameworks for research questions can differ based on the field of study and the type of data collected (Appendix A) (Cooke et al., 2012). They vary according to the elements employed, such as population, intervention, comparison, outcome, timeframe, context, type of question, type of study design, professionals, health care setting, exposure, duration, results, stakeholders, situation, client group, evaluation, environment, impact, perspective, and the phenomenon of interest (Appendix A) (Booth et al., 2019; Cooke et al., 2012; Davies, 2011; Petticrew & Roberts, 2006).

We chose the SPICE framework to formulate the research question, as this is commonly used in the social sciences and for qualitative data (Table 1) (Davies, 2011). The elements included setting/location (S), perspective (P), intervention (I), comparison (C), and evaluation (E). A group of experts in the field were consulted to develop the research question that drove this particular systematic literature review (SR) – Dr. Amanda Vincent, Dr. Sarah Foster, and Dr. Tanvi Vaidyanathan.

Table 1. SPICE framework and research question components.

Framework Elements	Definition	Research Question Components
Setting or Location	Where?	India, Vietnam, Thailand, and Cambodia
Perspective	Who?	Crew (Fisher), owners (Fisher)
Intervention or Interest	What?	Bottom trawling
Comparison	What are you comparing it to?	None
Evaluation	Result?	Motivations to start, stay and stop trawling and attachment to fishing

Primary research question: What were the fisher's motivations to start, stay and stop bottom trawling in India, Thailand, Vietnam, and Cambodia?

2.2 Step 2: Search Strategy

We next developed a search strategy (Figure 1). Section 2.2.1 provides the sources we used to search for the records. Sections 2.2.2, 2.2.3, and 2.2.4 outline the search terms, the string, and the filters used in the search. Section 2.2.5 delves into the process we used to evaluate the search strategy. Section 2.2.6 discusses how we searched, focusing on the differences between the bibliographic platforms, repositories, and specialist websites.

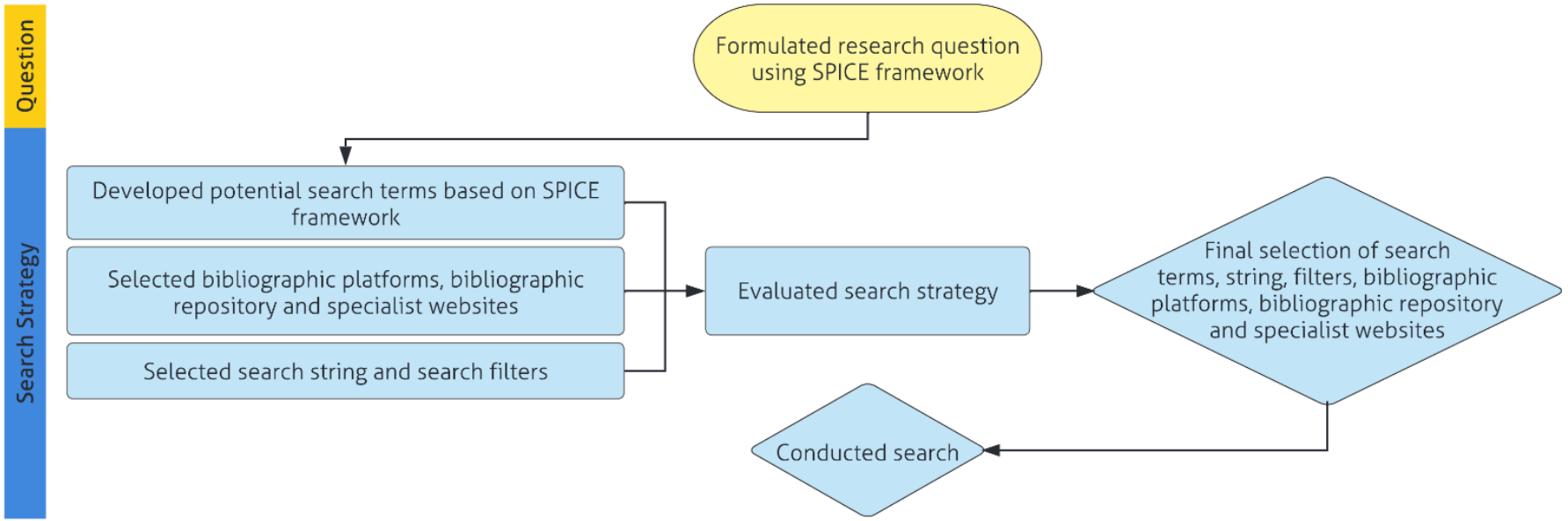


Figure 1. Outline of the search strategy.

2.2.1 Bibliographic platforms, bibliographic repository and specialist websites

In this case study, we included qualitative data from diverse sources, such as bibliographic platforms, bibliographic repositories, and specialist websites – with the latter often lacking in SRs. We compiled a list of fifty-five sources based on expert knowledge, suggestions from the UBC reference librarians and Hughes et al.(2014) database list.

Bibliographic platforms

We conducted trial searches to decide which bibliographic platform to use in the search (refer to section 2.2.5 for more information). Table 2 provides a list of the chosen bibliographic platforms. The bibliographic platforms provided information about the records, such as title, authors, year, journal, DOI, keywords, etc. (Livoreil et al., 2017). The platforms allowed for an advanced search, allowing us to include all the search terms, Boolean operators, and filters. The platforms also provided the URLs which redirected us to the record (Livoreil et al., 2017). For example, we could only retrieve the records from the Web of Science if we had access to the journal on the publisher's website, such as Elsevier. While searching for the records was free of cost, retrieving the full-text article depended on access to the journal subscriptions.

Bibliographic repository

We included one bibliographic repository, Aquatic Commons, a thematic bibliographic repository (Table 2). The bibliographic repository provided the bibliographic information and the PDF records. The records were available in the repository and did not require access to journal articles.

Table 2. List of the bibliographic platforms and the bibliographic repository and their area of focus.

List	Area of Focus
Bibliographic platform	
Clarivate (Web of Science databases)	The platform supported 256 disciplines and included multiple databases such as: Web of Science Core Collection: Sciences, social sciences, arts, and humanities Food Science and Technology Abstracts (FSTA): Food and nutrition MEDLINE: Lifesciences Zoological Record: Animal biology Korean Journal Database: Multidisciplinary database
Aquatic Sciences and Fisheries Abstracts (ASFA)	Marine environment, socio-economic and legal aspects
CAB Direct	Life sciences topics, including agriculture and conservation
Bibliographic repository	
Aquatic Commons	Marine, estuarine, brackish, and freshwater environments

Specialist Websites

The unusual use of specialist websites added considerably to the content available in this study. The compiled list included forty specialist websites, short-listed to thirteen websites based on expert recommendations (Table 3). Specialist websites included records from organizations, such as government reports, workshop summaries, conference proceedings, newsletters, magazines, reports, etc. Specialist websites provided the PDF record but did not provide the bibliographic information.

If websites had the option, we also subscribed for their monthly emails, these included Samudra News, FAO, and MARE. In addition, we subscribed to newsletters, such Human rights at sea, Marine Social Science, Mongabay-India, Global fishing watch, Environmental crime, Thomas Reuters Foundation, Too Big to Ignore, and UNESCO. we stopped the email subscriptions on the 30th of August, 2021. We aimed to include all the data from the monthly mailings and subscriptions; however, we finally only included Samudra News because of time constrains. We selected Samudra News as it had a greater global presence and focused on fishers. We included information from Samudra News from May 2020 to April 2021.

Table 3. List of specialist websites by location and the area of focus.

Specialist Websites	Area of Focus	Location
International Collective in Support of Fish workers (ICSF)	Livelihood of fishers and fishing communities	Global
Environmental Justice Foundation (EJF)	Intersection of environmental and human rights issues	Global
Southeast Asian Fisheries Development Center (SEAFDEC)	Sustainability of fisheries and aquaculture	Southeast Asia
WorldFish	Hunger, poverty, and malnutrition, focusing on aquatic food	Global
World Bank	Extreme poverty	Global
Food and Agriculture Organization of the United Nations (FAO)	Food security, including fisheries	Global
Centre for Maritime Research (MARE)	Interdisciplinary marine social science	Global
FishWise	People, oceans, and seafood enterprises	Global
Department of Fisheries Thailand	Fisheries	Thailand
Centre for Migration and Inclusive Development (CMID)	Migrant communities	India
Current Conservation	Conservation	India
South Indian Federation of Fishermen Societies (SIFFS)	Small-scale artisanal fish workers	India
Program for Social Action (PSA)	Governance, human rights, climate change, and environmental justice	India
Samudra News Report	Email subscription of fisheries news.	Global

2.2.2 Search terms

The SPICE framework helped us develop the search term categories: location, gear, human, and marine (Table 4). The location search terms included the names of the countries and the relevant water bodies. We initially developed the gear search terms based on the terms used by Hughes et al. (2014); however, when we tested the terms, we needed to adjust the category to include trawl gear commonly used in Asia (such as push nets and scoop nets). We chose the human search terms based on popular keywords in the marine social science literature and expert knowledge. The final search terms were decided after two weeks of trial searches and multiple reviews by Dr. Amanda Vincent and Dr. Sarah Foster. We provide more information on the process of the trail searches in section 2.2.5.

Table 4. Search terms.

Category	Terms
Thailand, Vietnam, and Cambodia (Setting or Location)	Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR "Asia-Pacific" OR "Asia Pacific"
India (Setting or Location)	India* OR "Indian Ocean" OR "Bay of Bengal" OR "Andaman Sea" OR "Arabian Sea" OR "South Asia" OR "Asia-Pacific" OR "Asia Pacific"
Gear (Intervention or Interest)	trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*"
Human (Perspective and Evaluation)	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR community* OR demographics OR human* OR slave* OR crew OR captain OR enslave
Marine	ocean* OR marine OR sea OR seafood

2.2.3 Search string

We consulted with the UBC librarians to develop the search string, which included truncations, Boolean operators, and wild cards (Bayliss & Beyer, 2015) (Table 5).

Table 5. Boolean Operators and Wildcards.

Type of Operator	Definition
Boolean Operators	"AND/OR/NOT". OR: Allowed for either topic in the search string. AND: Allowed for both topics in the search string. NOT: Excluded search terms or concepts
Wildcards	Wildcards helped with variations between American and British spellings. It can also be used to alter a single variable, such as wom#n, which includes “women” and “woman”. Each database used different symbols, for example, $, ? or #. Wildcards also allowed for truncations, which allowed multiple forms of the word to be searched. For instance, trawl* can include “trawlers”, “trawl” and “trawling”. The * symbol can also be placed at the beginning of the word (only of Web of Science).

Bibliographic platform and bibliographic repository

The bibliographic platforms and repository allowed for all search terms, but the wildcards and truncations differed based on the specificities of each platform (Table 6). We decided not to include the marine search terms for ASFA and Aquatic Commons as they already focused on the marine environment.

Table 6. Search string for the bibliographic platforms and bibliographic repository.

Countries	Name of Source	Search string
Bibliographic platforms		
Vietnam, Thailand and Cambodia	Web of Science	(Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (ocean* OR marine OR sea OR seafood) AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
India	Web of Science	(India* OR "Indian Ocean" OR "Bay of Bengal" OR "Andaman Sea" OR "Arabian Sea" OR "South Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (ocean* OR marine OR sea OR seafood) AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
Vietnam, Thailand and Cambodia	ASFA	(Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
India	ASFA	(India* OR "Indian Ocean" OR "Bay of Bengal" OR "Andaman Sea" OR "Arabian Sea" OR "South Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
Vietnam, Thailand, Cambodia	CAB Direct	(Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (ocean* OR marine OR sea OR seafood) AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
India	CAB Direct	(India* OR "Indian Ocean" OR "Bay of Bengal" OR "Andaman Sea" OR "Arabian Sea" OR "South Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (ocean* OR marine OR sea OR seafood) AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
Bibliographic repository		
Vietnam, Thailand and Cambodia	Aquatic Commons	(Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)
India	Aquatic Commons	(India* OR "Indian Ocean" OR "Bay of Bengal" OR "Andaman Sea" OR "Arabian Sea" OR "South Asia" OR "Asia-Pacific" OR "Asia Pacific") AND (trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*") AND (fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave)

Specialist Websites

Eight websites did not have a search bar, and five websites restricted the number of search terms (Table 7). We decided the search term "trawl" was the most important and used it as the single search term. The websites without a search bar were hand searched for the geographic and gear search term. We explain the screening process in section 2.3.

Table 7. Specialist websites search terms.

Specialist Websites	Search Terms
ICSF	No search terms: attempted keyword search was ineffective
EJF	No search terms
SEAFDEC	Allowed for a single search term: "trawl"
WorldFish	Allowed for a single search term: "trawl"
World Bank	Allowed for a single search term: "trawl"
FAO	Limited search terms: “trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*"
MARE	No search terms
Fish Wise	No search terms
Department of Fisheries Thailand	No search terms
CMID	Allowed for a single search term: "trawl"
Current Conservation	No search terms
SIFFS	No search terms
PSA	No search terms

2.2.4 Search filters

The search filters helped reduce the number of irrelevant records. We included only English records and did not specify a time range. We tested a variety of search filters for the bibliographic platforms and specialist websites. We provide more on information on the trial searches in section 2.2.5.

Bibliographic platform and bibliographic repository

The bibliographic platforms provided an array of search filters; We consulted with the UBC librarians to select filters that would reduce the number of irrelevant records. The bibliographic repository did not provide any search filters (Table 8).

Table 8. Bibliographic platforms and bibliographic repository search terms and filters.

Bibliographic platforms and repository	Filters
Bibliographic platforms	
Web of Science	Topic and Language: English
ASFA	Location (NOFT), Gear (NOFT), Human (Anywhere) and English
CAB Direct	All fields. Language: English
Bibliographic repository	
Aquatic Commons	No filters available

Specialist Website

The specialist websites provided limited search filter options (Table 9).

Table 9. Specialist websites search filters.

Specialist Websites	Limits and Filters
ICSF	Language: English
EJF	Language: English. Category: Oceans
SEAFDEC	Language: English
World Fish	No filters available
World Bank	No filters available
FAO	Language: English
MARE	No filters available
Fish Wise	No filters available
Department of Fisheries Thailand	No filters available
Centre for Migration and Inclusive Development	No filters available
South Indian Federation of Fishermen Societies	No filters available
Current Conservation	No filters available
Program for Social Action	No filters available

2.2.5 Evaluating the search strategy and sources

SRs commonly create a test list of known relevant records to compare against the search results. The test list helps assess the effectiveness of the search strategy and the source (Bayliss & Beyer, 2015; Haddaway et al., 2015; Kuusisto-Gussmann et al., 2021; Livoreil et al., 2017; Pullin & Stewart, 2006).

Bibliographic platforms and bibliographic repositories

While we aimed to create a test list, we were uncertain which records to include because of the novel nature of the study and the limited research on the socioeconomics of trawling. We instead decided on a broad approach, where the relevance benchmark was any record focused on bottom trawling.

We conducted trial searches to assess the search strategy (Munroe et al., 2012). In Table 10, we display how we evaluated the search strategy, using Web of Science as an example. We conducted twenty-five test search rounds, focusing on reducing the number of irrelevant records and obtaining a reasonable number of records to screen. The initial search strategy included the location, gear and human category search terms, which yielded an array of irrelevant records focused on chemical engineering, genetics, and computer science, amongst others. We decided to add the marine category to reduce the number of irrelevant records (Table 10). We also tested common types of bottom trawl gear in the search string (such as otter trawl and pair trawl) and found no change in the search results.

The first search yielded 97,813 records, and the last search yielded 110 records. We evaluated the following bibliographic platforms: Web of Science, CAB Direct, ASFA, Factiva, Sociology Collection, PAIS Index, ABI/Inform Collection, Agricultural and Environmental Science Collection, Dissertations and Theses UBC, Sociological Abstracts, JSTOR, and Elsevier Science Direct. To minimize time, we tracked the test searches by creating an account for each bibliographic platform. We chose Web of Science, ASFA, and CAB Direct as the bibliographic platforms as they had the highest number of relevant records. We had one bibliographic repository in the list, which was included as it focused on the marine environment.

Table 10. Evaluating the search strategy in Web of Science.

Search terms				Filters	Results	Notes
Location	**Gear**	**Marine**	**Human**			
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Southeast Asia*" OR "Asia Pacific" OR Asiapacific OR"Asia-Pacific" OR "Indo-Pacific" OR "Indo Pacific" OR "Indo-West Pacific" OR "Western Indo-Pacific" OR Pacific OR "Indian Ocean"	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR incidental OR bottom OR mobile OR towed OR commercial OR industrial OR large* OR small* OR mechanized OR benthic OR demersal OR trash OR forage OR "low value"	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR "socio-economics" OR manage* OR migrant* OR migration OR labour OR labor OR "fishing communities" OR demographics OR human* OR slave* OR crew OR captain OR enslave	All fields	97,813	Too many searches. This search included only Thailand.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Southeast Asia*" OR "Asia Pacific" OR Asiapacific OR "Asia-Pacific" OR "Indo-Pacific" OR "Indo Pacific" OR "Indo-West Pacific" OR "Western Indo-Pacific" OR Pacific OR "Indian Ocean"	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR incidental OR bottom OR mobile OR towed OR commercial OR industrial OR large* OR small* OR mechanized OR benthic OR demersal OR trash OR forage OR "low value"	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR "socio-economics" OR manage* OR migrant* OR migration OR labour OR labor OR "fishing communities" OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	27,498	Too many irrelevant searches. Finding information on ticks and malaria, etc. Only Thailand.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR Asiapacific OR Indo-Pacific OR "Indo-West Pacific" OR "Indian Ocean"	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR incidental OR bottom OR mobile OR towed OR commercial OR industrial OR large* OR small* OR mechanized OR benthic OR demersal OR trash OR forage OR "low value"	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	14,442	Altered the search terms for location. Only Thailand.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR Asiapacific OR "Indian Ocean"	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR incidental OR bottom OR mobile OR towed OR commercial OR industrial OR mechanized OR demersal OR trash OR forage OR "low value"	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	5,672	Removed "Indo-West Pacific", "large", "small", and "benthic". Only Thailand.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR incidental OR bottom OR mobile OR towed	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR	Topic, Refine by Web of Science Categories (for	3,452	This search included only Thailand. Refined the search using filters.

Search terms				**Filters**	**Results**	**Notes**
Location	**Gear**	**Marine**	**Human**			
Asiapacific OR "Indian Ocean"	OR commercial OR industrial OR mechanized OR demersal OR trash OR forage OR "low value"		migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	example, did not include Oncology studies)		
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR Asiapacific OR "Indian Ocean"	trawl* OR dredg* OR rak* OR drag* OR bycatch OR target OR bottom OR mobile OR towed OR mechanized OR demersal OR trash OR forage OR "low value"	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	3,728	This search included only Thailand. Removed "incidental", "commercial", "industrial".
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag* OR bottom OR mobile OR towed OR mechanized OR demersal	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	779	This search included only Thailand. Removed "bycatch", "target", "trash", "forage", "low value"
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag* OR bottom OR mobile OR towed OR mechanized OR demersal	Marine column was not yet created	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic. Filtered out categories such as nursing, virology, infectious, etc.	546	Same search as above but filtered out categories. This search Only Thailand.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag*	Marine column was not yet created.	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	196	Included Thailand and Cambodia.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR Southeast-Asia OR	trawl* OR dredg* OR rak* OR drag*	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR	Topic	91	Marine column created and included in search. tested Included Thailand and Cambodia.

Search terms				Filters	Results	Notes
Location	**Gear**	**Marine**	**Human**			
Asia-Pacific OR Asiapacific			demographics OR human* OR slave* OR crew OR captain OR enslave			
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag*	Not included in search	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	208	Altered how South East Asia is spelled. Included Thailand and Cambodia. Marine not included. Articles did not look relevant.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag*	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	97	Included marine column. Included Thailand and Cambodia. Articles look relevant and search terms appear in the abstract. Quite a few articles on species, as trawl used as survey method. Good search.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "bottom trawling"	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	97	Added "bottom trawling". Search results did not change. Included Thailand and Cambodia.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "otter trawl" OR "pair trawl" OR "beam trawl" OR "push net" OR "scoop net"	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	97	Added country specific trawl gear. Search results did not change. Included Thailand and Cambodia.
Thai* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR	trawl* OR dredg* OR rak* OR drag* OR "push net" OR "scoop net"	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR	Topic	97	Removed otter trawl, beam trawl, and pair trawl. Included Thailand and Cambodia.

Search terms				Filters	Results	Notes
Location	**Gear**	**Marine**	**Human**			
"South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"			labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave			
Thai* OR “Andaman Sea” OR “Gulf of Thailand” OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*"	ocean* OR marine OR sea	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	97	Originally forgot to add the star (*) to push net and scoop nets. Therefore, it was possible that the search could not find push nets and scoop nets. Included Thailand and Cambodia.
Thai* OR Vietnam* OR Cambodia* “Andaman Sea” OR “Gulf of Thailand” OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag*	Not included in search	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	242	Included Thailand, Vietnam and Cambodia. Did not include the marine column.
Thai* OR Vietnam* OR Cambodia* “Andaman Sea” OR “Gulf of Thailand” OR "Gulf of Tonkin" OR "South China Sea" OR Cambodia OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag*	ocean*OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	82	Included Thailand, Vietnam and Cambodia. Included the marine column.
Thai* OR Vietnam* OR Cambodia* “Andaman Sea” OR Gulf of Thailand OR Gulf of Tonkin OR "South China Sea" OR Cambodia OR Southeast-Asia OR Asia-Pacific OR Asiapacific	trawl* OR dredg* OR rak* OR drag*	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	82	Removed quotations around Gulf of Thailand and Gulf of Tonkin. Possibly the “of” would exclude studies. There was no change in search results. Included Thailand, Vietnam and Cambodia
Thai* OR Vietnam* OR Cambodia* OR “Andaman Sea” OR “Gulf of Thailand” OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR	trawl* OR dredg* OR rak* OR drag*	Not included in search	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR	Topic	260	Did not include the marine column in search. Altered how South East Asia is spelled. Articles did not look relevant. Included

Search terms				Filters	Results	Notes
Location	**Gear**	**Marine**	**Human**			
"South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"			demographics OR human* OR slave* OR crew OR captain OR enslave			Thailand, Vietnam and Cambodia.
Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag*	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	89	Included marine column, Thailand, Vietnam and Cambodia. Several search terms appear in the abstract. Quite a few results on species, trawl used as a survey method. Good search.
Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "bottom trawling"	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	110	Added "bottom trawling". Included Thailand, Vietnam and Cambodia
Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "otter trawl" OR "pair trawl" OR "beam trawl" OR "push net" OR "scoop net"	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	110	Tested types of trawl gear based on the country. Search results did not change. Included Thailand, Vietnam and Cambodia
Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR " Asia-Pacific" OR "Asia Pacific"	trawl* OR dredg* OR rak* OR drag* OR "push net" OR "scoop net"	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR human* OR slave* OR crew OR captain OR enslave	Topic	110	Removed otter trawl, beam trawl, and pair trawl. Search results did not change. Included Thailand, Vietnam and Cambodia.
Thai* OR Vietnam* OR Cambodia* OR "Andaman Sea" OR "Gulf of Thailand" OR "Gulf of Tonkin" OR "South China Sea" OR "Southeast Asia" OR "South East Asia" OR "South-East Asia" OR	trawl* OR dredg* OR rak* OR drag* OR "push net*" OR "scoop net*"	ocean* OR marine OR sea OR seafood	fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR communit* OR demographics OR	Topic	110	Included Thailand, Vietnam and Cambodia, and the marine column. Final search terms.

Search terms				Filters	Results	Notes
Location	**Gear**	**Marine**	**Human**			
" Asia-Pacific" OR "Asia Pacific"			human* OR slave* OR crew OR captain OR enslave			

Specialist Websites

We did not evaluate the search strategy for specialist websites as the websites limited the number of search terms.

2.2.6 Conducting the search

We searched the selected bibliographic platforms, the bibliographic repository, and the specialist websites. For each search, We recorded the following: date of search, time of the search, name of bibliographic platform or bibliographic repository or specialist website, database/website, the URL, search string, filters, total search results, and notes in an Excel sheet (Bayliss & Beyer, 2015). Before each search, we deleted all history and cookies to prevent biased search results.

Bibliographic platforms and bibliographic repository

We logged the bibliographic platform results by saving the RIS (Research Information System) file. The RIS files contained the bibliographic information of the records and were used to exchange bibliographic information between citation software. We recorded the search result in an Excel spreadsheet. We set monthly alerts to track any published records on the bibliographic platforms.

Specialist Websites

We recorded the specialist website search results in the Excel spreadsheet. The specialist websites did not provide RIS files. The inability to export the RIS files and, thus, the bibliographic information propelled us to develop an alternative method for specialist websites (section 2.3).

2.3 Step 3: Screening

The screening process involved sifting through the search results to find the relevant records (Figure 2). We had two reviewers screen for the title and abstract and one for full-text eligibility. The second reviewer was an undergraduate volunteer student with limited knowledge of the topic. Every couple of weeks, the reviewers randomly chose and appraised ten records. If there were discrepancies in the screening results, both reviewers discussed their reasons.

We separated the screening process for bibliographic platforms and bibliographic repositories, and specialist websites. The bibliographic platforms and bibliographic repository provided RIS files that were imported into bibliographic software and a screening website. However, the specialist websites did not offer RIS files (see next section), leading us instead to design a separate screening process.

Figure 2. Outline of the screening process.

2.3.1 Screening for title and abstract

Bibliographic platforms and bibliographic repository

We exported the search results as RIS files. The RIS files contained titles, abstracts, and bibliographic information and were compatible with bibliographic software. We imported the RIS file into EndNote and used the automated function to exclude duplicates. We tried several bibliographic software before choosing EndNote, for three reasons.

- Mendeley: Mendeley did not have the option to create multiple libraries, which made it difficult to organize the literature. While the application was free, a payment was required when the vast number of records exceeded the free storage space.
- RefWorks and Legacy RefWorks: The UBC reference librarians suggested RefWorks and Legacy RefWorks and were provided free of cost to UBC students. RefWorks and Legacy linked well with the bibliographic platforms, identified duplicates, and allowed for multiple libraries. However, we could not use RefWorks as we had over 1,000 references which is the limit for Refworks. We tried Legacy RefWorks, which allowed more than 1,000 references, but due to the sheer number of references, the webpage was slow and often failed to respond.
- EndNote: It allowed for multiple libraries, identified duplicates, did not have a limit on the number of references, and was fast. However, the application was not free of cost.

We exported the non-duplicates into Covidence, a website used for screening records. We screened the abstract and title for relevance. We excluded records with irrelevant geographic regions, subjects (e.g., genetics), and gear types (e.g., purse seining). We included records focused on trawling history, fishers, human rights, social justice, political conflicts, and international conflicts and specified qualitative survey methods. The relevant records or records with insufficient information were retrieved for full-text review. We created inclusion and exclusion criteria to minimize bias between reviewers (Figure 3). The inclusion criteria were broad and generally included any mention of social and economic factors.

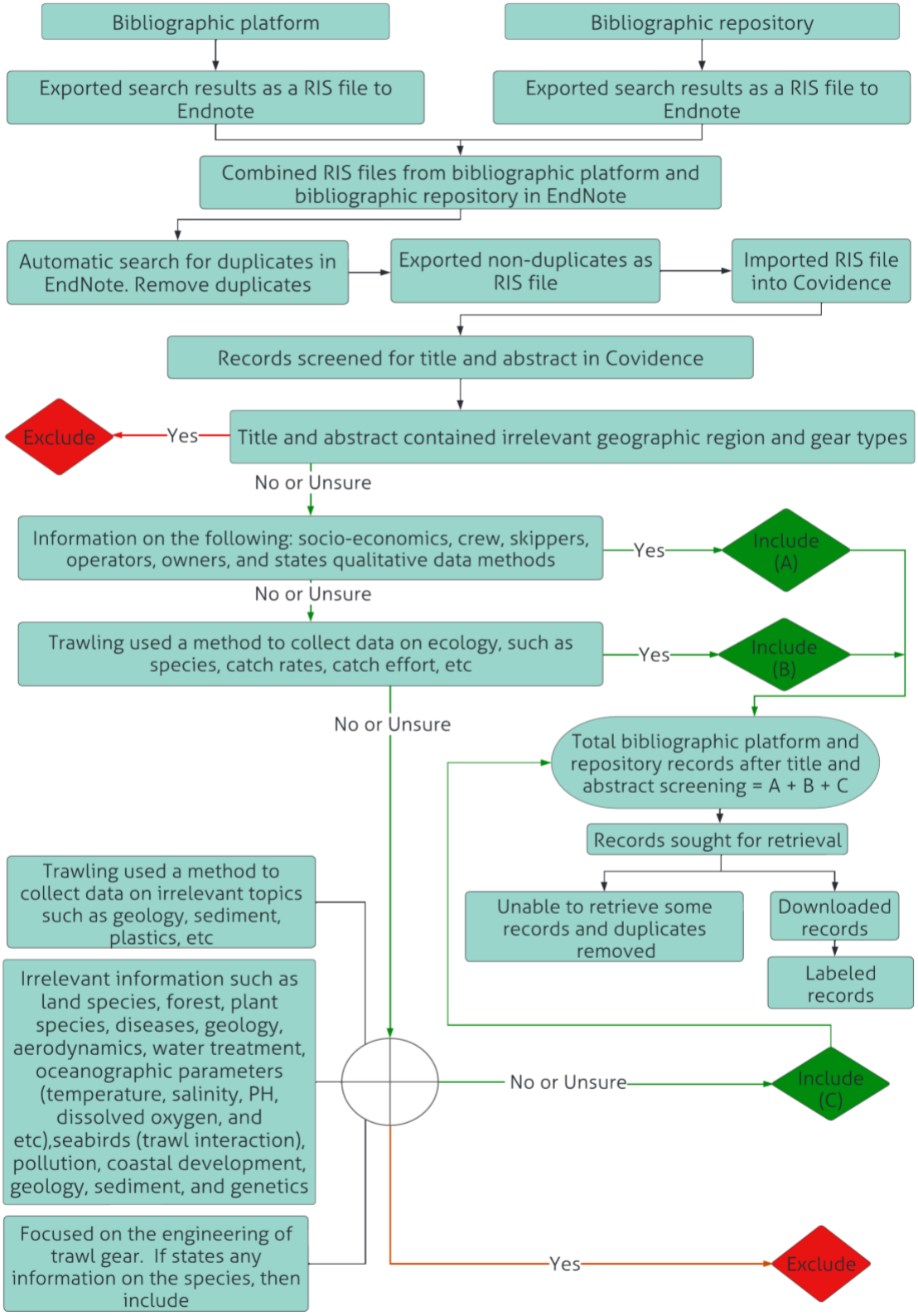


Figure 3. Screening for title and abstract with an inclusion and exclusion criteria for bibliographic platforms and repository.

Specialist Websites

The specialist websites did not provide RIS files and, therefore, could not check for duplicates using EndNote and screen the records in Covidence. Consequently, we created an alternative method to assess the relevance of the records (Figure 4).

1. The specialist websites most often did not have a language filter. We first assessed whether the record was written in English or not.
2. If the record was in English, we screened the title for the relevant geographic region. If the geographic region was not mentioned, we moved it to the unsure category.
3. If the relevant geographic region was present in the title, we searched for a gear keyword in the full text. For example, if the word trawl was mentioned in the full text, the record was included in the next stage.
4. If the geographic region was not present in the title, we searched for a gear and a geographic location keyword in the full text.
5. In the end, we combined the records from (D) and (E) to obtain the relevant records that passed the screening process for geographic location and gear (Figure 4).
6. We recorded all the relevant records in an Excel spreadsheet to prevent downloading duplicates. Before downloading each record, we searched for the record title in the Excel spreadsheet.

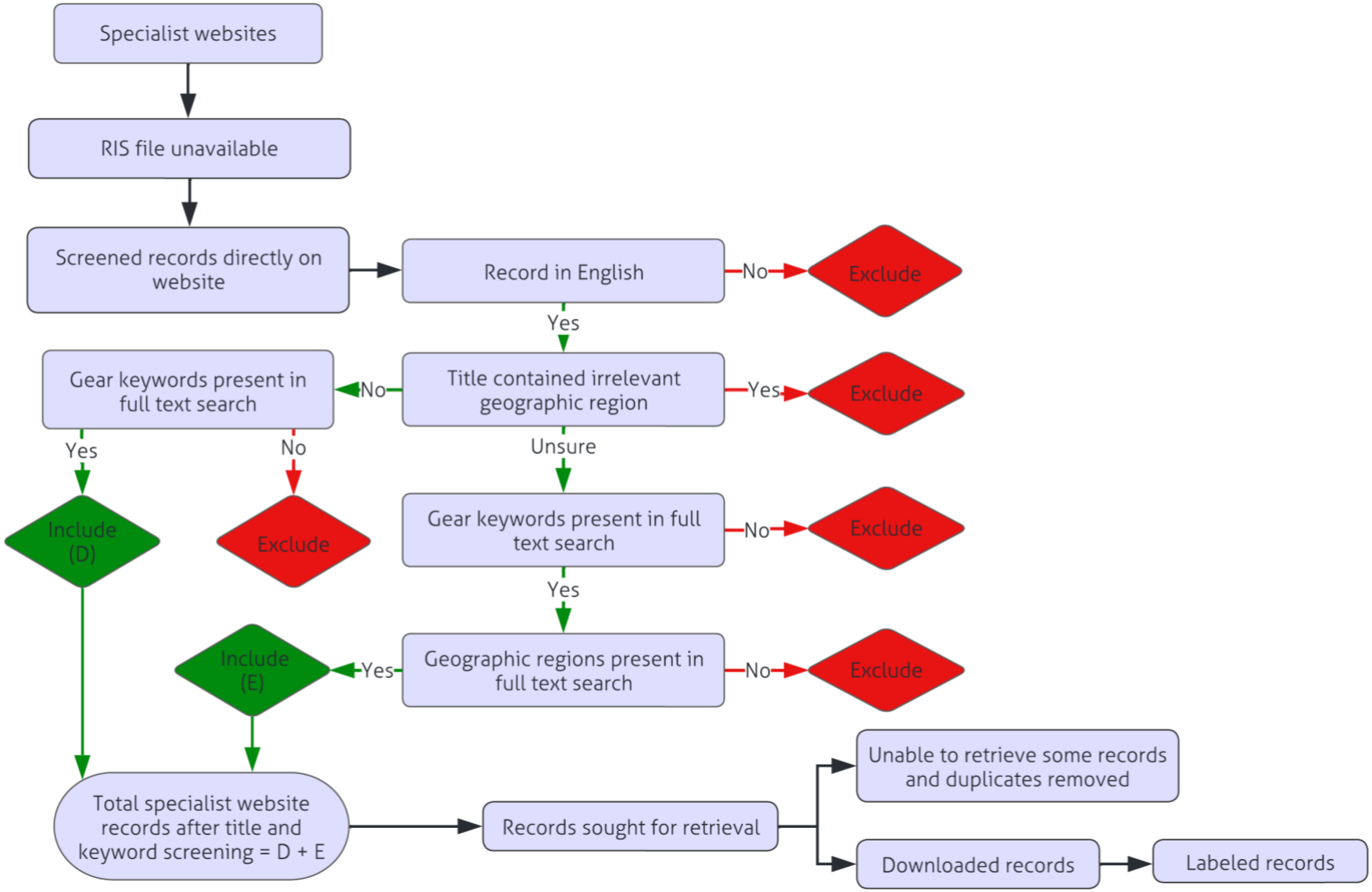


Figure 4. Screening with an inclusion and exclusion criteria for specialist websites.

2.3.2 Screening for full-text eligibility

At this stage, we had a list of records from bibliographic platforms, the bibliographic repository, and specialist websites that passed the title, abstract, and keyword screening. In this screening round, we focused on assessing full-text eligibility (Figure 5). We downloaded the retrievable records (refer to section 2.4). We labelled the records in the format of "author, year, and title".

We decided to introduce a novel step to reduce the screening time. We imported the records into NVivo, a qualitative data analysis computer software. NVivo is commonly used to organise and analyse qualitative data, such as surveys, interviews, and audio recordings. We used NVivo for full-text eligibility screening as a novel way to use the software in SRs. The text query highlighted and provided a frequency of the terms for each record.

We input the human search terms in the text query: "fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labour OR community* OR demographics OR human* OR slave* OR crew OR captain OR enslave." We reduced the screening time by skipping directly to the highlighted text to assess relevance. We screened the rest of the record if the highlighted areas were irrelevant. If the frequency was zero, no human terms, nor did NVivo recognise any of the text; we screened the text for relevance. We decided to use an extensive inclusion criterion where we selected any record which mentioned social and economic aspects concerning the trawl fisheries. We excluded records based on the following reasons: location, duplicates, resource availability, trawling statistics, gear design, species, ocean conditions, post-harvest sector, trawl disadvantages, and irrelevant subjects (Table 11) (Bayliss & Beyer, 2015).

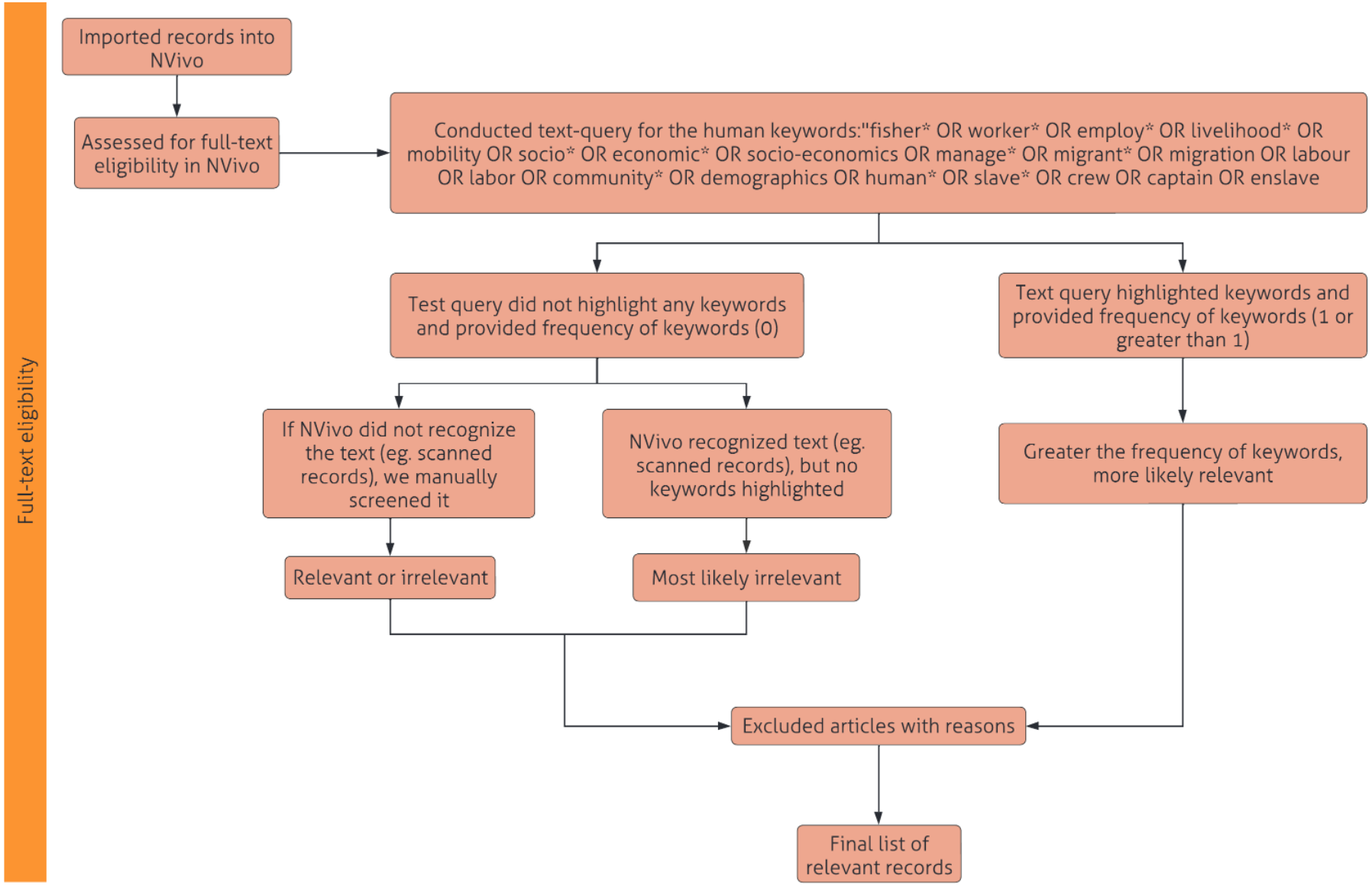


Figure 5. Full-text eligibility process.

Table 11. Exclusion criteria for full-text eligibility.

Category	Exclusion Criteria
Location	The records focused on irrelevant geographic regions
Duplicates	Duplicate records
Resource Availability and Trawling Statistics	The data was collected on demersal resources using trawl gear. Studies reported trawling statistics such as maximum sustainable yield, biomass, catch rates, catch per unit effort, and associated models. If the records had social and economic information, we included the records
Gear Design	The records focused on trawl gear design and improvement. The records focused on the mesh size, net size, efficiency of the boat, and other mechanical information. The records evaluated trawl design by assessing bycatch and catch rates, TED devices, and catch and release efficiency. Some records compared trawling to other fishing gears to determine the efficiency. If the records had social and economic information, we included the records
Species	The records focused on a group, or a single species caught via trawling with a focus on biological characteristics such as reproductive biology, length, weight, maturity, size at birth, sex ratio, gestation, and others. If the records had social and economic information, we included the records
Ocean Conditions	The study collected data on oceanic conditions, such as pH, temperature, and salinity, using trawl gear. If the records had social and economic information, we included the records
Post-Harvest	The records focused on the post-harvest sector, such as aquaculture and trade. If the records had social and economic information, we included the records
Trawl Disadvantages	The records stated trawling was a destructive fishing gear, created conflict between fishers, and should be eliminated. The records had a line or two about the disadvantages but did not delve into the social and economic aspects
Irrelevant subject	The record focused on a field unrelated to the research question. The records in this category were from specialist websites, where records were downloaded if they had the word trawl and a relevant geographic region.

2.4 Step 4: Search Outcome

The final list included 551 records, resulting in 601 articles (records with multiple articles) (Figure 6). At step 2 (section 2.2), the search revealed 9,851 and 3,094 records from the bibliographic platforms, bibliographic repository and specialist websites, respectively (Figure 6). We removed 2,158 duplicates from the bibliographic platform and bibliographic repository search. At step 3 (section 2.3) we screened 7,693 records for the title and abstract (section 2.3.1) from the bibliographic platforms and the bibliographic repository. We screened 3,321 records for the keywords from the specialist websites. We found 7106 records irrelevant to the study and excluded them. At step 3, we aimed to retrieve 3,908 records but could not retrieve thirteen from the Department of Fisheries Thailand and 492 from the bibliographic platforms. We also excluded 495 duplicate records. We assessed 2,908 records for full-text eligibility and excluded 2,357 records with reasons (section 2.3.2). Refer to Appendix B for flow diagram of the above steps.

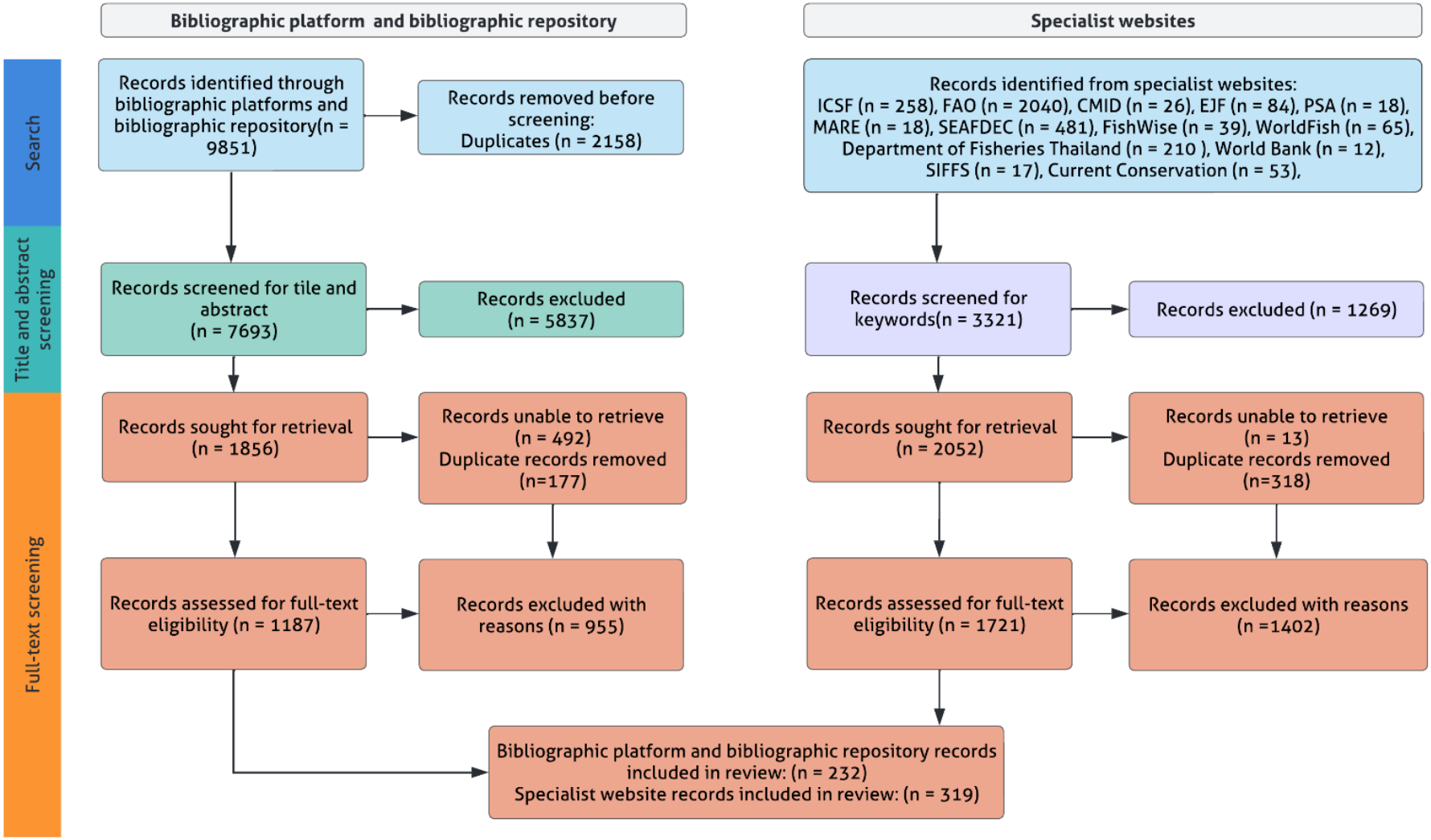


Figure 6. Search outcomes and total relevant records.

2.5 Step 5: Data Collection

In this section, we discuss the data extraction process from the records. We simultaneously extracted the qualitative data, noted the metadata for each record in Excel (section 2.5.1), and categorized the data by covariates (section 2.5.2). After we extracted the data, we linked the metadata from Excel to the records in NVivo (section 2.5.3).

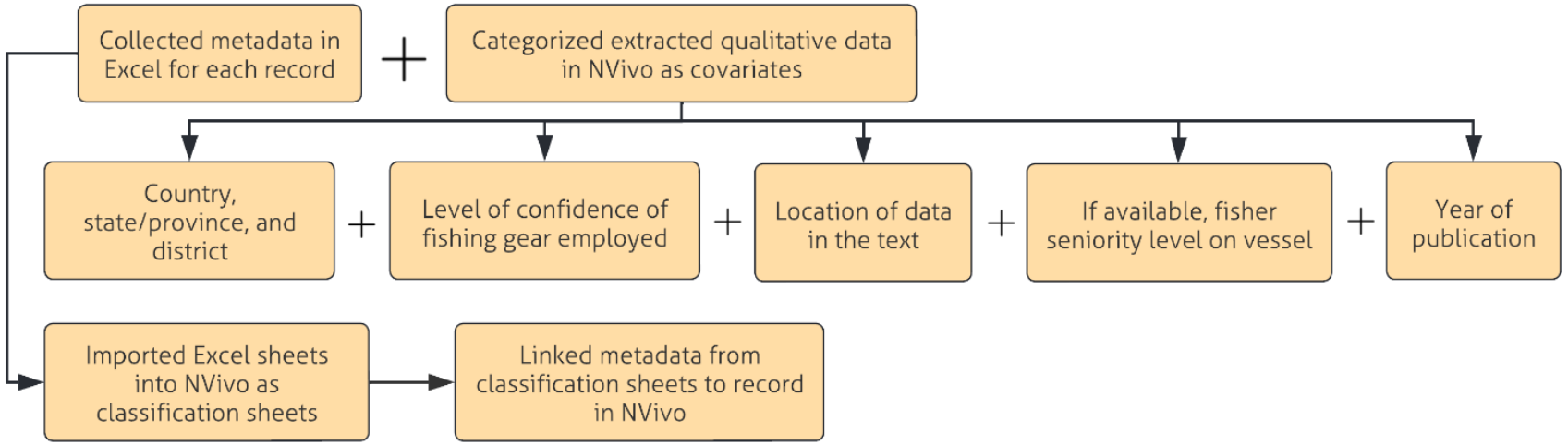


Figure 7. Data collection process.

2.5.1 Collecting the metadata

We documented each record's metadata, carried out simultaneously with section 2.5.2. We recorded the metadata on an Excel spreadsheet (Table 12). We created one spreadsheet tab for each country: India, Cambodia, Thailand, Vietnam, and Combined. The Combined Excel sheet included records with information from more than one country. We did not duplicate the PDF. If a record had multiple relevant articles, we noted each as a separate Excel entry. For example, record number 101 had three entries – the record number stayed the same, but the file changed to include the article number. We did this to keep track of the total records and articles.

Table 12. Definitions and an example of the attributes.

Attributes	Definition	Example of record 101
File name	The file name of the record. If a record had multiple articles, we distinguished the article in the record by adding a number at the end of the file name	FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers_2 FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers_3
Record and article number	Each record had a unique record number. A unique article number was assigned if a record had multiple relevant articles. The record number stayed the same regardless of the number of articles within the record	Record number 101 and article number 115: FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers Record number 101 and article number 116: FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers_2 Record number 101 and article number 117: FAO_1978_Project for the development of small-scale fisheries in the Bay of Bengal - Preparatory phase. Vol. 2- Working papers_3
Title	Title of the record and the title of the article (if applicable).	Record number 101 and article number 115: Record title: Project for Development of Small-Scale Fisheries in the Bay of Bengal. Article title: General Description of Marine Small-Scale Fisheries, RAS/74/0.31 – Working Paper No.13, 1977· Record number 101 and article number 116: Record title: Project for Development of Small-Scale Fisheries in the Bay of Bengal. Article title: Assessment of Problems and Needs in Marine Small-Scale Fisheries, RAS/74/031 - Working Paper No.14 1977. Record number 101 and article number 117 Record title: Project for Development of Small-Scale Fisheries in the Bay of Bengal. Article title: General Description of Marine Small-Scale Fisheries, RAS/74/031 - Working Paper No.9, 1977
Author	Authors of the record and the article (if applicable).	Record number 101 and article number 115: W.D. Hartmann Record number 101 and article number 116: C. Ratcliffe, W.D. Hartmann, G.E. Lierens Record number 101 and article number 117: G.E. Lierens

Attributes	Definition	Example of record 101
Year	Year the record was published	1978
Page number	Page numbers of the record and article (if applicable).	Record number 101 and article number 115: Pg 1-23 Record number 101 and article number 116: Pg 1-9 Record number 101 and article number 117: Pg 1-29
Source of record	Name of bibliographic platform or bibliographic repository, or specialist website	FAO India
Other bibliographic information	Bibliographic information of the record, such as journal name, volume, publisher, etc.	Swedish funds in trust, FAO, UNDP, Project for Development of Small-Scale Fisheries in the Bay of Bengal (1978) Development Report., Indian Ocean Programme, No. 44, Volume, 2.
Country and region	Name of country or region (if country not specified)	India. Western Bay of Bengal
Methods	Methods used in the study	Record number 101 and article number 115: Data collected when visiting fisheries institutions, fishing centres, and villages along the coast. States, "although the papers are believed to give a fair description of the situation, they should not be considered as final reports but as actual working papers for further elaboration in order more fully to describe the sector and to penetrate its problems and needs".
Year of Study	Year the data was collected	December 1976 and the first half of 19770
Study area	Study area, such as the name of a village	Record number 101 and article number 115: Andhra Pradesh
Sample size	Sample size	NA
Who	The perspective of the record: crew, fisher, owner, entrepreneur, women, post-harvest, mechanised, motorised, non-mechanised, mini-trawls, Sona boats, small-scale fishers, drag boats, etc.	Trawl, gillnets, SSF, mechanised, fishers, cooperatives, owners, and private entrepreneurs.
Home location	State of origin	Record number 101 and article number 115: Andhra Pradesh
Work location	State of work	Record number 101 and article number 115: Orissa, Madras, Kakinada and Visakhapatnam
Keywords	Unfamiliar words. For example, Sona boats (type of trawl boat)	NA
Notes	Summary and thoughts of the record	Record number 101 and article number 115: The article focuses on the role of cooperative and ownership. There is a general description of the socio-economic conditions of the fisher's community but does not explicitly state the association with trawling. The loans provided to the trawlers were better than the loans provided to traditional fishers

2.5.2 Categorising extracted data as covariates

We had one reviewer extract the data. We collected data on the social, economic, and environmental factors related to the individuals in the trawl industry. The extracted data could minimal or substantial, depending on the record, from one sentence to a paragraph, and from one table to a graph. The data included stakeholders such as fishers, women, children, individuals in the post-harvest, entrepreneurs, owners, government, institutions, NGOs, researchers, conservationists, etc. At this stage, we did not code for themes but instead focused on extracting potentially relevant data.

Covariates

- Geographic location: country, state/province, and region/district ('node' used to explain the hierarchy of categories)
    a) Parent node: the country name
    b) Child node: state or province
    c) Grandchild node: region or district

- Level of confidence in trawl gear: In the literature, we found that authors commonly used the word "trawling", which could signify either bottom trawling (touches the bottom) and/or midwater and pelagic trawling (does not touch the bottom). Therefore, the lack of specificity when defining trawling in the literature obliged us to create this covariate.
    a) Explicitly bottom trawling (EBT): the record explicitly stated the trawl gear was demersal.
    b) Possibly bottom trawling (PBT): the record did not mention if the trawl gear was demersal but provided information to conclude its highly bottom trawling. We inferred PBT in the following cases: i) stated that the trawl gear was used to catch shrimp species, most of which are essentially bottom dwelling; ii) referred to a bycatch issue known to be associated with bottom trawlers, such as the olive ridley turtles in Orissa, but only stated trawl; and, iii) referred to a known conflict associated with bottom trawlers, such as the conflict between Sri Lanka and Tamil Nadu, but only stated trawl.
    c) Trawling (T): the record stated trawling but did not provide additional information to deduce if they were referring to demersal gear.
    d) Possibly trawling (PT): we categorised the data as PT if the record stated mechanised or if the authors did not allude specifically to trawling in the extracted data record but mention trawling along with other gears, such that we could not decipher which gear they were referring to. As trawlers dominate the mechanised industry, we inferred possibly trawling. In India, the fishing industry consists of 26% of mechanised vessels, which includes trawlers (18%), gillnetters (4%), dollnetters/bagnetters (2%), liners (<0.0005%), ring seines (1%), and purse-seiners (1%) (DoF & CMFRI, 2020).
    e) Fisheries: Included information on the general trends of fishing industries that may affect trawl fisheries.

- Location of data in the record: categorised the relevant data on where it was found in the record. While this step was straightforward for research published in scientific articles, it became trickier for specialist websites. The records from the specialist websites often did not follow the scientific method's structure; therefore, we used our judgement to assess the category. It is important to note that if the same themes were coded in the intro, the results, and the discussion, NVivo would still count it as one record rather than three records.
    a) Abstract: Data extracted from the abstract
    b) Background: Data extracted from the introduction, background, overview, and preface.
    c) Methods: Data extracted from the methods
    d) Refers to other studies
        (i) Results or discussion or conclusion: Data extracted from the results, discussion, and conclusion. Data was not novel it cited other studies.
        (ii) Notes: Data extracted from the notes. Data was not novel it cited other studies.
        (iii) Appendix or Annex: Data extracted from the appendix and annex. Data was not novel it cited other studies.

e) Novel
   (i) Results or discussion or conclusion: Data extracted from the results, discussion, and conclusion. Data was novel and did not cite other studies.
   (ii) Notes: Data extracted from the notes. Data was novel and did not cite other studies.
   (iii) Appendix or Annex: Data extracted from the appendix and annex. Data was novel and did not cite other studies.

- Level of seniority on vessel: if available, categorised individuals on their level of seniority in the trawl industry.
  a) Crew: individuals with the lowest seniority on the vessel, often assigned to the task of fishing.
  b) Captain, operator, skipper, tindal (boat skipper), or driver: individuals with a higher seniority level than the crew but did not include owners.
  c) Owner: owners of the vessel. If available, owners were further categorised as
     (i) Owner and fisher: individuals who worked on the boat and were also owners.
     (ii) Businesspeople or entrepreneurs or capitalists or private industry: individuals who did not work on the boat were referred to as businesspeople, entrepreneurs, capitalists, or the private sector.

- Year of publication: data categorised on the year of publication. If a range date was provided, for example, 1984-1985, the latest date was used for the year of publication.

At the end of this step, the data in NVivo were categorised for geographic location, the level of confidence in the trawl gear, the location of the data, level of seniority and year of publication.

2.5.3 Linking records in NVivo with metadata

After we extracted the data from the records and assigned the covariates, we imported the metadata (Excel sheets) as classification sheets in NVivo. The classification sheets linked the metadata to the record, stored all the data in one central location, and minimised the time spent searching for metadata in Excel. In addition, it allowed us to manipulate the metadata and themes when searching for patterns in the later stages.

1. We converted the Excel sheets into comma-separated values files (csv file).
2. We imported the csv files into NVivo as classification sheets.
3. The file name of the record in NVivo was identical to the file name in the classification sheet (imported csv file). Therefore, the file name was used as the unique ID to link the record with the classification sheet.
4. If a single record had multiple relevant articles, each article was entered as a separate entry and the file name varied using a numeric value in Excel (Table 12), without duplicating the record. The articles in the classification sheet with the changed file name were not linked to the record as the record did not exist in NVivo. NVivo automatically created proxy files (blank documents) for the entries in the classification sheets that were not linked to a record.

Key to note that while the metadata were linked to the records, the individual pieces of data were not linked to the metadata and, therefore, had to be categorised manually. For example, we had to categorise the data for the year of the publication even though each record had the year of publication in the classification sheet

2.6 Step 6: Data Synthesis

This section discusses the thematic coding process and the process of translating codes into a framework.

2.6.1 Thematic Coding

We focused on developing and extracting themes from the data extracted. We took an inductive approach to develop the themes, in which codes were produced as we read. We constantly revised the thematic codes through multiple thematic coding cycles. This crucial reiterative process allowed the themes to evolve with the literature. We also coded the data for attributes such as age (years), education level, number of family members, geographical location, total boat investment, wages earned, spoken languages, refugee status, religion, scale and type of trawling, caste, education level, total years of fishing experience, and migrant fisher. This process took approximately four months for India, and the work will soon be turned on Thailand, Vietnam, and Cambodia as another tranche of work.

At this stage, a massive list of themes was created (Figure 8). Although we consolidated and reviewed the themes, we realised we needed to find a way to connect and articulate the information coherently. The next step outlines how we translated the massive list of themes into a framework and then re-coded the themes to align with the framework.

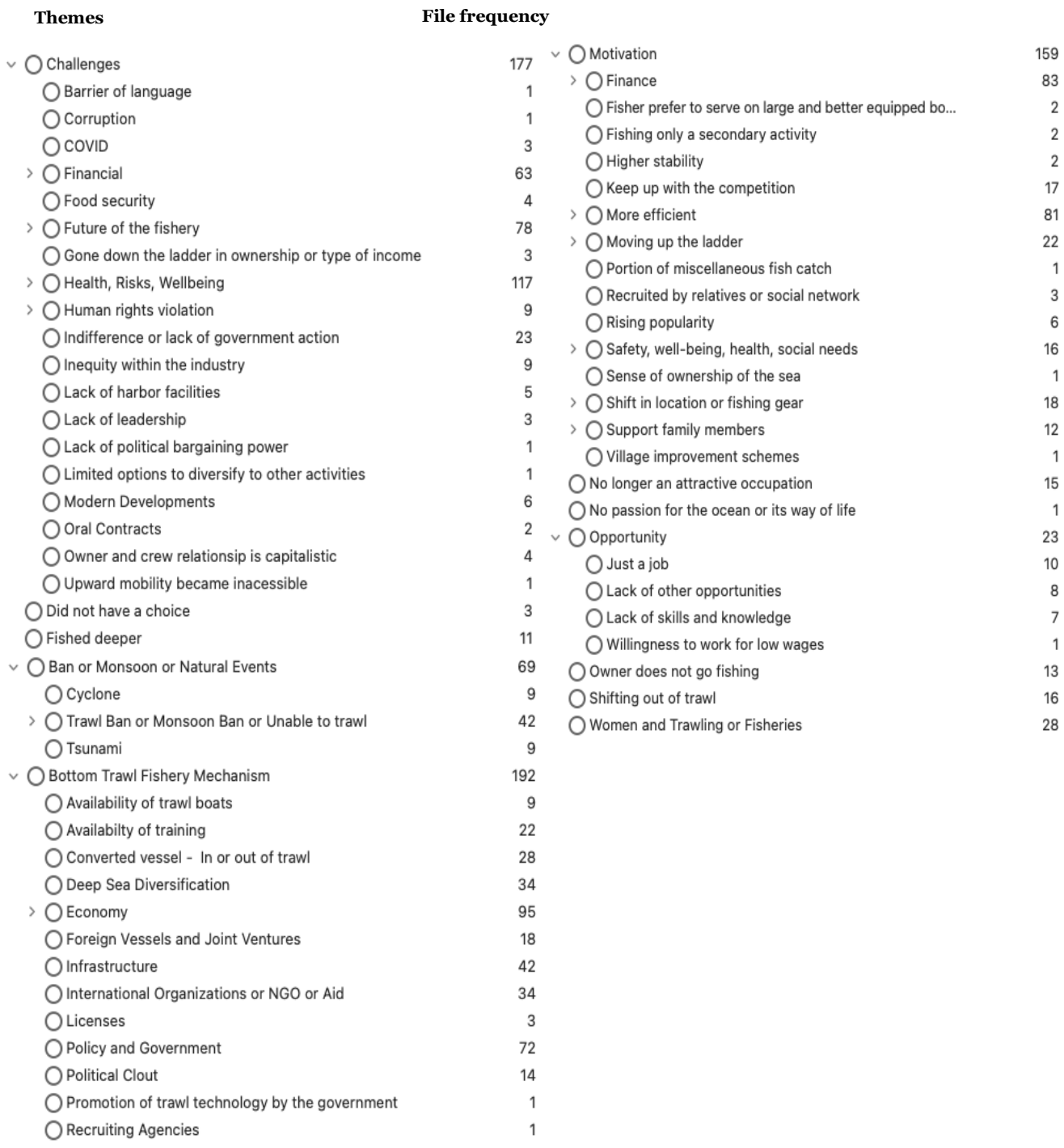


Figure 8. Initial parent and children nodes for India. The numbers in the figure represent the frequency of records.

2.6.2 Developing the framework

We translated the themes to create a novel framework for exploring the bases for people's engagement with this industry. We developed and discussed each framework variation through an iterative process and consulted with experts.

Framework step 1: We started the process by writing down all the codes on post-its and organised the codes into overarching codes. We organised the themes to fit into start, stay and stop categories (Figure 9). While the question in this review was assessing the trawl fisher's attachment to fishing, creating the framework guided us to formulate the three sub-questions: why did the fishers start, stay, and stop trawling?

Framework step 2: We were confronted by the question of perspective when categorizing the data into start, stay and stop. The SPICE framework (Table 1) stated the perspective was fishers; however, the data also provided information on the trawl fishery. Therefore, we categorised the data into two perspectives, the fisher and the fishery (Figure 9). We defined fishers as entrepreneurs, owners, crew, and labourers, where the focus was on the individual. We described fishery as the trawling institution or industry, where the data did not distinguish the individual and viewed the industry as one entity.

Framework step 3: As we coded for fisher and fishery, a new pattern emerged: the fisher and fishery either chose or were forced to start, stay, and stop trawling (Figure 9). We defined choice as a decision or action conducted by choice. For example, fishers shifted from non-motorised to motorised vessels to increase economic efficiency. We described "forced" when circumstances resulted in a lack of choice. For example, fishers who out took loans from intermediaries [1] were obligated/indebted to provide their fish catches at lower prices to the intermediaries.

Framework step 4: At this stage, the framework included three levels: i) start, stay, and stop; ii) fisher and fishery; and (iii) chose and forced. While we managed to categorise the themes under the three levels, we still remained with a vast list of themes. We decided the pillars of sustainability best described the range of the data, which resulted in economic, social, and environmental categories (Figure 9).

[1] Note: we decided to use the term intermediaries rather than middlemen

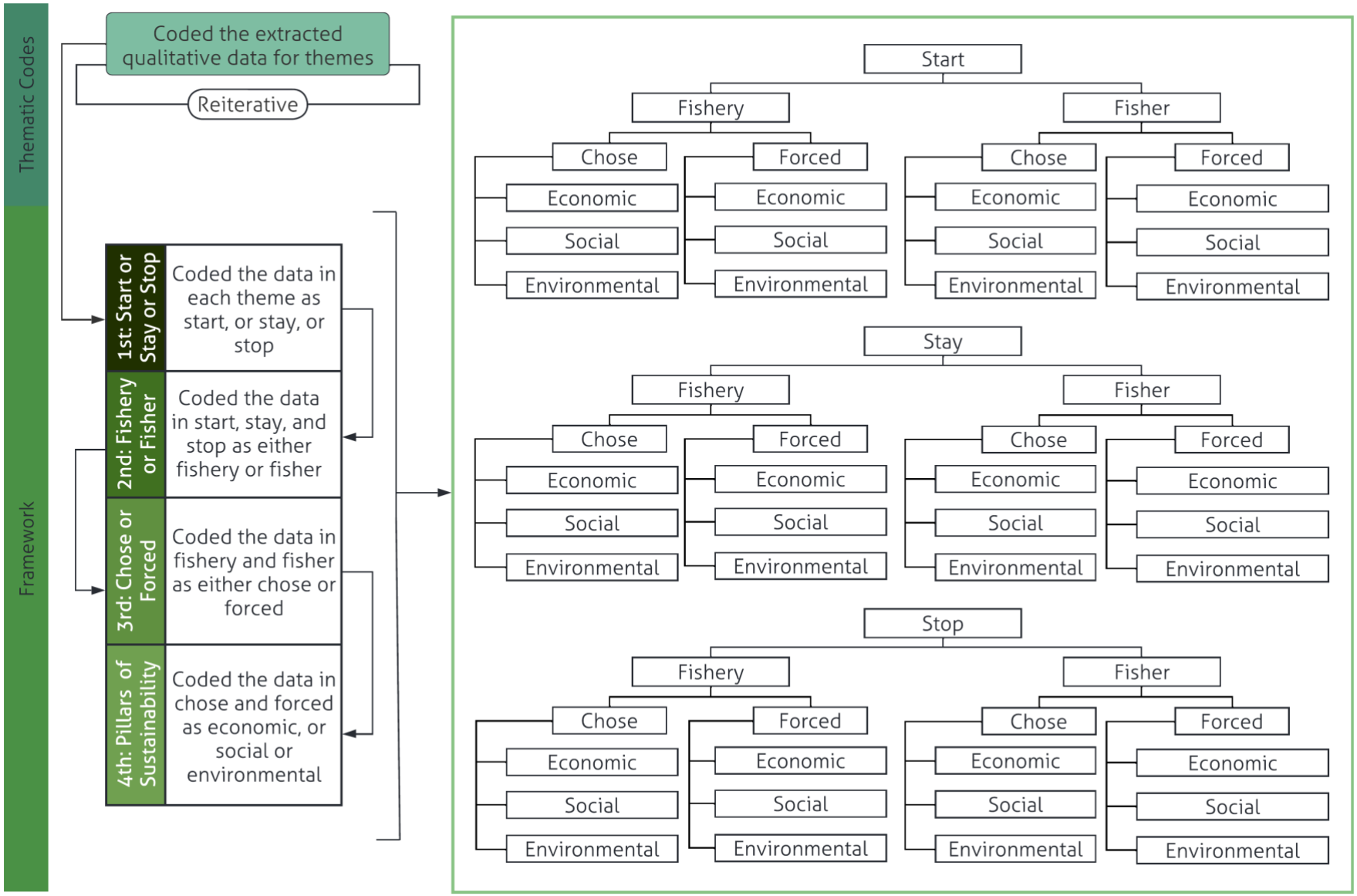


Figure 9. Development of the framework.

2.6.3 Categorizing the themes within the pillars of sustainability

Categorising the themes into economic, social, and environmental proved more complex than expected. While the pillars of sustainability were discussed in the literature, they were often combined, making it difficult to categorise the themes. For example, themes were classified as socio-economic, making it tedious to distinguish social and economic. We consulted and discussed any challenging themes with colleagues to minimise bias. We also reviewed the literature to assess how previous studies categorised their data into the pillars of sustainability. After we categorised the themes, we aggregated similar themes creating overarching categories (Table 13).

Table 13. Themes developed within the pillars of sustainability.

Economic	Social	Environmental
Subsidies	Governance	Presence of good catches
Bilateral Agreements	Culture, fishing skills, and family profession	Tsunami
Demand for prawn and foreign exchange earnings	Working conditions and living standards	Rich fishing grounds
Technical efficiency and upgrades	Recruitment ties	Monsoon
Profit and economic efficiency	Ease of access	Depletion of resources
Change in investment costs	Conservation measures and policy	Fished in different locations
Income and Incentives	Unable to fish in place of origin	Change in exploited resources
Availability of capital and credit	Competition between SSF and trawlers	COVID-19 Pandemic
Employment	Lack of government action, enforcement and violations of regulations	Availability of other species
Demand for shrimp, bycatch, and trash fish	Political clout, weight in local affairs, power, authority, and self-management	Resource depletion
Lack of employment opportunities	Wellbeing and values	Weather
Previous fishing occupation was unviable	Protests and resistance	Decline in catches
Export demand and market	Minimal occupational mobility	Sea-turtle conservation
Loan, interest rate and insurance	Exploitation and abuse of labour	Safeguarding resources
Debt and set price catches	Demands for dowry	
Increase in expenses	Education	
Rising costs, poor economic returns, and financial crisis	Societal pressure and conflict between stakeholders	
Alternative opportunities	Detained or arrested or boat seized	
Financial Desperation	Suicide or killed	
Supplemental Income	Insufficient knowledge	
	Migrants desire to go home	
	Mechanised boats not accepted	

3 India Data Summary

In this section, we summarise the data from the co-variates:

- the geographic location of the records (section 3.1);
- the frequency of date of publication (section 3.2);
- the location of the data in the records (section 3.3)
- the level of confidence in the stated trawl gear (section 3.4); and
- role in the trawl industry (section 3.5)

3.1 Geographical location

We extracted information from 283 distinct records for India.

Of the 283 records reviewed, most studies focused on Kerala (32%), Tamil Nadu (28%), and Andhra Pradesh (22%) (Figure 10).

Other states included Gujarat, Maharashtra, Odisha, Karnataka, West Bengal, Goa, Bay of Bengal, Puducherry, Assam, Jharkhand, Uttar Pradesh, Lakshadweep, and the Andaman Islands.

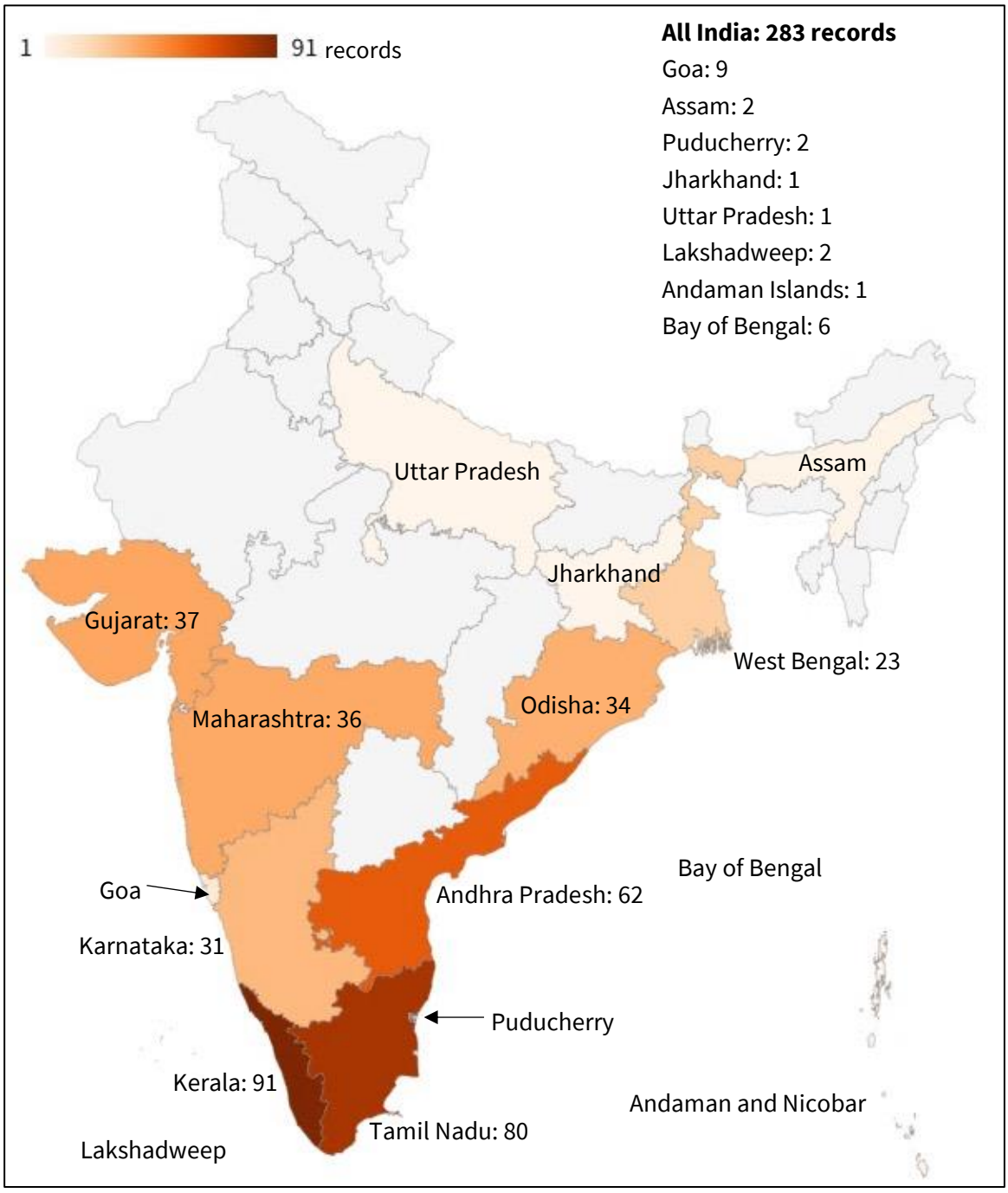


Figure 10. The frequency of records for each state in India (n=283 records). The darker the colour on the map the higher the frequency. Grey areas include regions where no information was found in the literature.

3.2 Date of publication

We did not limit the search by the date of publication. The data from the literature ranged from 1951 to 2021 (Figure 11). The majority of papers were from the 1980s to the 2010s. The minimal papers from the 1950s to the 1980s can be attributed to trawling only beginning in the 1950s.

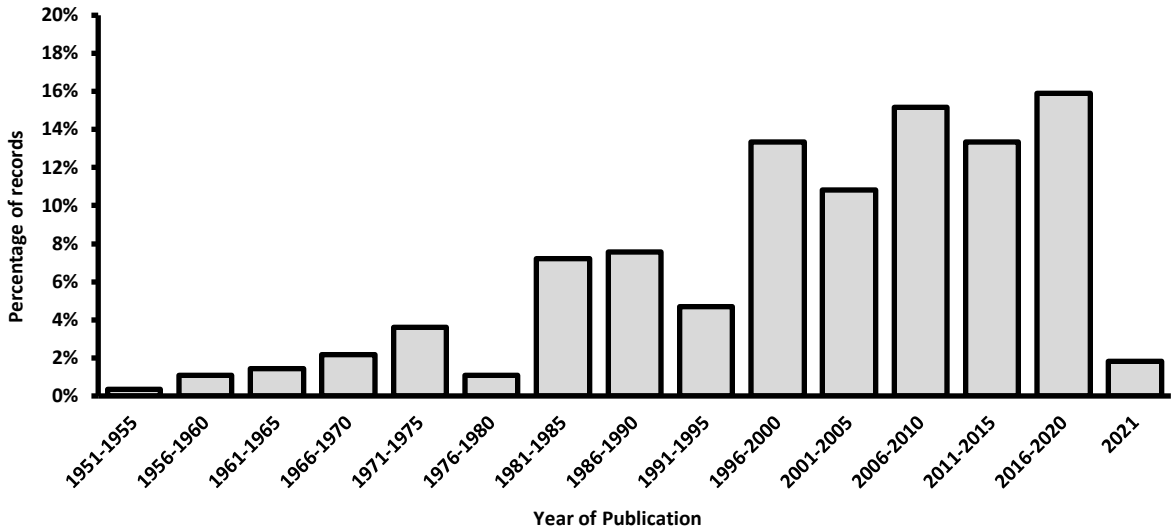


Figure 11. Percentage of the total records published based on the year of publication, ranging from 1951 to 2021 (n=283 records). Year of publication was categorized based on a five-year interval, with 2021 having its own category

3.3 Data location in text

We categorised the data based on their location in the text to prevent pseudo replication (Table 14). The percentage of records for each data location was calculated based on the total value rather than the distinct value, as we were more concerned about the individual data than the record. The total value included all the records; for example, if the data were extracted from the abstract and methods of the same record for start, it would be counted as 2 rather than 1. The distinct value was the total number of different records; for example, if the data were extracted from the abstract and methods of the same record for start, it would be counted as 1 instead of 2. The novel category covered 62% to 67% of the data, except for start, which was 52% (Table 15).

Table 14. Definitions of categories for the location of data.

Location of data		Definition
Abstract		Data were extracted from the abstract
Background or Introduction		Data were extracted from the introduction, background, overview, and preface.
Methods		Data were extracted from the methods
Refers to other studies	Results or discussion or conclusion	Data were extracted from the results, discussion, and conclusion. The data was not novel; it cited other studies.
	Notes	Data were extracted from the notes. The data was not novel; it cited other studies.
	Appendix or Annex	Data were extracted from the appendix and annexe. The data was not novel, and it cited other studies.
Novel	Results or discussion or conclusion	Data were extracted from the results, discussion, and conclusion. The data was novel and did not cite other studies.
	Notes	Data were extracted from the notes. The data was novel and did not cite other studies.
	Appendix or Annex	Data were extracted from the appendix and annexe. The data was novel and did not cite other studies.

Table 15. Percentage of records for each data location category. The percentages were calculated based on total values (start n=222, stay n=257, stop n=136, and what happens when fisher stop trawling n=61), rather than distinct values (n=283 records).

Location of data	Start	Stay	Stop	What happens when fishers stop trawling
Abstract	2%	1%	4%	5%
Background or Introduction	36%	21%	18%	18%
Methods	0%	2%	1%	2%
Total Refers to other studies	10%	12%	14%	13%
Total Novel	52%	64%	62%	62%

3.4 Level of confidence in trawl gear

In the literature, we found that authors commonly used the word “trawling”, which could signify either bottom trawling (touches the bottom) and/or midwater and pelagic trawling (does not touch the bottom). Therefore, the lack of specificity when defining trawling in the literature obliged us to create this covariate. We, therefore, categorised the data based on how confident we were that the gear was referring to bottom trawling. We calculated the percentage for each category based on the total value rather than the distinct value as we were more concerned about the individual data than the record. Most of the data extracted for start, stay, stop, and what happens when fishers stop trawling fell under EBT and PBT; the two categories covered between 65% to 74% of the data (Table 16). Therefore, we concluded that this study's data accurately referred to the bottom trawl industry.

Table 16. Percentage of records categorised based on the accuracy of the trawl gear (EBT = Explicitly bottom trawling, PBT = Possibly bottom trawling, T = Trawling, PT = Possibly trawling). Percentages are calculated based on the total value (start n=208, stay n=222, stop n=110, and what happens when fishers stop trawling n=49) rather than the distinct value (n=283 records). Note: mechanised vessels have inboard engines and machine power for fishing. Refer to Chapter 2 for more detailed definitions on the accuracy of trawl gear.

Accuracy of trawl gear	Definition	Start	Stay	Stop	What happens when fishers stop trawling
EBT	Explicitly stated the trawl gear was demersal	53%	63%	50%	65%
PBT	It did not state the trawl gear was demersal but provided information to conclude its bottom trawling.	14%	11%	16%	4%
T	Stated trawling but did not provide additional information to deduce if it was referring to bottom trawling	12%	14%	19%	14%
PT	Stated mechanised or did not allude specifically to trawling in the extracted data but mentioned trawling along with other gears (could not decipher which gear they were referring to).	20%	13%	15%	8%
Fisheries	Included information on the general trends of the fishing industry that may affect the trawl fishery	1%	0%	1%	8%

3.5 Role in the bottom trawl industry

If the information was available, we categorised individuals based on their role in the trawl industry (Table 17). Of the 283 records, we extracted data on the role in the industry from 230 distinct records. On average, crew constituted 51% of the data, and owners covered 41% of the data (Table 17). The data least represented the captains, operators, skippers and drivers. Where information was available, we further categorised owners into two sub-categories: i) owner and fisher, and ii) owner businesspeople, entrepreneurs, and capitalists. Note: we could not attribute a specific role in the industry to every piece of data. Therefore, this is only a partial representation of the data.

Table 17. Percentage of records categorised based on the role in the industry. Percentages calculated based on total values (start n=159, stay n=189, stop n=94, and what happens when fisher stop trawling n=47), rather than distinct values (n=283 records).

Boat Position	Definition	Start	Stay	Stop	What happens when fishers stop trawling
Crew	Individuals with the lowest seniority on the vessel are often assigned to the task of fishing	50%	49%	52%	49%
Captain, Operator, Skipper, Driver, Tindal	Individuals with a higher seniority level than the crew but did not include owners	9%	11%	5%	6%
Owner	Individuals who worked on the boat and were also owners, and individuals who did not work on the boat were referred to as businesspeople, entrepreneurs, capitalists, or the private sector	40%	40%	43%	45%

4 Results: Start, Stay and Stop

Among the significant themes, we found that (i) the lure of potentially better income accompanied by the availability of subsidies led fishers from diverse backgrounds to start trawling, (ii) fishers felt forced to start trawling because they lacked opportunities and experienced financial hardship, (iii) the fishery persisted even in the face of low returns because of the industry's power dynamics, and lack of enforcement of constraining rules, (iv) accumulated debts forced fishers to stay in trawling, and, (v) the fishery and fisher only stopped trawling when constrained by regulations, resource depletion, and low financial returns. We also found that fishers' motivations varied according to their role in the trawl industry, where owners often reaped more benefits than crew.

4.1 Start

The fishery and fishers predominately chose to start trawling because of economic factors (Table 18), denoted by the large blue area in Figure 12. In this section, we cover our findings, where the themes (Figure 13) are explained based on the framework and the pillars of sustainability. There are 10 sub-sections. Four are related to the fishery as a whole: fishery chose economic (section4.1.1), fishery chose social (section 4.1.2), fishery chose environmental (section 4.1.3), fishery forced economic (section 4.1.4), with no data for fishery forced social and environmental. Six are related to fishers' personal actions: fisher chose economic (section 4.1.5), fisher chose social (section 4.1.6), fisher chose environmental (section 4.1.7), fisher forced economic (section 4.1.8), fisher forced social (section 4.1.9), and fisher forced environmental (section 4.1.10).

The total used to calculate the percentage of each theme was the aggregate economic, social and environmental values. For example, Start – Fishery – Chose – Economic – Subsidies, we used the total of start to calculate the percentage for the theme of subsidies.

Table 18. Percentages of the pillars of sustainability within fishery chose, fishery forced, fisher chose, and fisher forced for START (percentages calculated using the total distinct value of start, n=165 records).

START Pillars	Fishery Chose	Fishery Forced	Fisher Chose	Fisher Forced
Economic	76%	1%	31%	12%
Social	4%	0%	15%	2%
Environmental	5%	0%	7%	3%

Figure 12. Frequency of the pillars of sustainability (economic = blue, social = yellow, and environmental = green) based on whether the fishery and fisher chose or were forced to START trawling (calculated using the total distinct value of start, n=165 records). Intervals on the radar chart represent 10%.

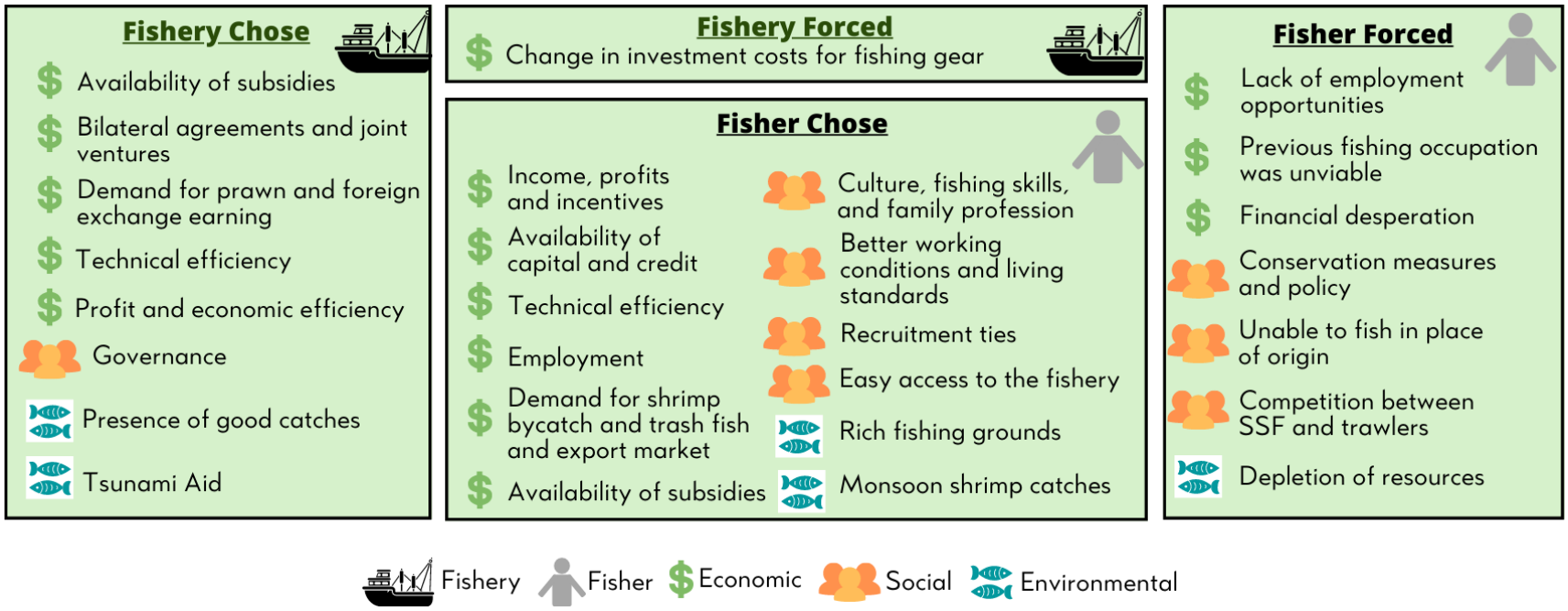


Figure 13. List of themes for why fishery and fishers START trawling

4.1.1 Start Fishery Chose Economic

The fishery predominately chose to start trawling for five economic reasons (76% of start, n=125 records, Table 18). Economic reasons included the increased availability of subsidies (most dominant) (section 4.1.1.1), the emergence of new bilateral agreements, opportunities for joint ventures, increased foreign aid (section 4.1.1.2), increased demand for shrimp[2], the potential for foreign exchange earnings (section 4.1.1.3), new technical efficiency (section 4.1.1.4), and likely profit and economic efficiency (section 4.1.1.5) (Figure 14). Subsidies, specifically harmful subsidies, were the most frequent theme (46% of start, n=76 records). The themes are discussed in further detail in the section below.

Themes	n	% of fishery chose economic	% of start	Section
Subsidies	76	61%	46%	4.1.1.1
Bilateral agreements, joint ventures, and foreign aid	46	37%	28%	4.1.1.2
Demand for shrimp and foreign exchange earnings	37	30%	22%	4.1.1.3
Technical efficiency	20	16%	12%	4.1.1.4
Profit and economic efficiency	17	14%	10%	4.1.1.5

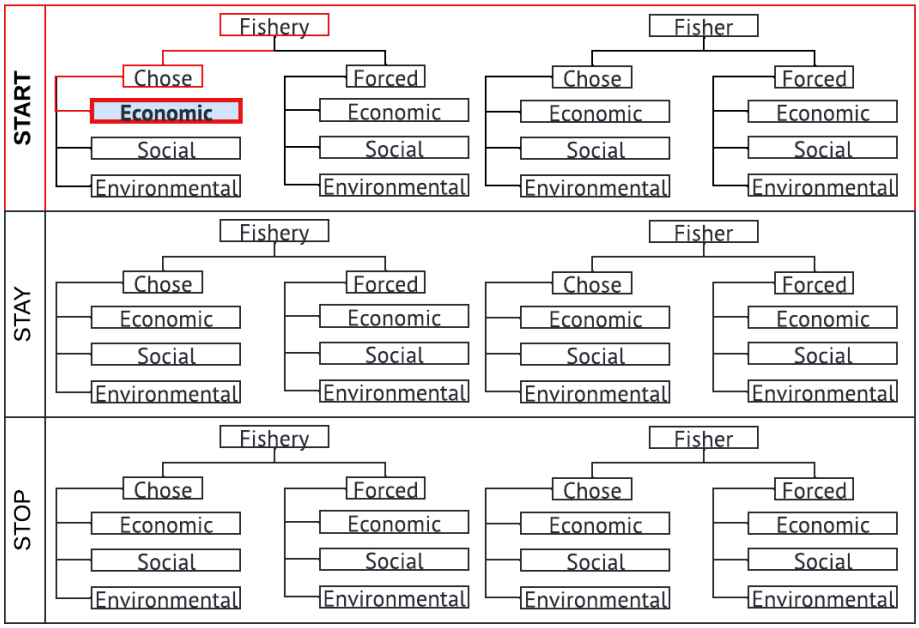


Figure 14. The total number of records (n) for each theme and percentages relative to fishery chose economic and start. The percentages for fishery chose economic (n=125 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.1.1 Subsidies

Our results showed that subsidies fuelled the mechanised (inboard engines and machine power for fishing) fishing industry. Most of the subsidies were harmful, also known as capacity-enhancing subsidies. We classified the harmful subsidies (*sensu* (Sumaila et al., 2019) and found that (a) 44% of the records focused on boat/vessel construction, renewal, and modernisation, (b) 30% on infrastructure, support, and harbour construction, (c) 21% on fishery development projects and services, and (d) 5% on fuel.

a. **Boat/vessel construction, renewal, and modernisation:** Financial support for boat/vessel construction, renewal, and modernisation played a significant role in launching and transforming the trawling industry in India. Subsidies were provided for various components of fishing vessels, including navigational instruments, hulls, engines, the installation of ice and cold storage plants, and fishing gear (Chidambaram, 1962; Nayak & Vijayan, 2003; Roshan, 2016). Trawl development was incorporated into

[2] In this report, shrimp and prawn are used interchangeably and we make no distinction between the two.

India's five-year fisheries policy plans, which were supplemented by foreign aid programs. In the first five-year plan (1951-1956), foreign aid programs helped mechanise and improve many indigenous boats. By the end of the first five-year plan, 650 boats were mechanised in India (Chidambaram, 1962). In India, between 1974 to 1979 (5th five-year plan), a Trawler Development Fund was proposed to help "smaller entrepreneurs and corporations to purchase and operate trawlers for marine fisheries", resulting in many conflicts between trawlers and traditional fishers (Nandakumar & Nayak, 2010). We now provide some examples of situations that enticed the fishery to start trawling.

Subsidy rates and loan repayments: The Indian government introduced low-interest loans and grants in 1950 to develop the mechanisation program.

i) The subsidy rates varied from regions; for instance Andhra Pradesh, Chennai, Kerala, Maharashtra, Mysore, and Orissa offered a 50% subsidy rate on outboard engines, 25% on improved boat designs, and 25% on winches, gurdies, and accessories, while Gujarat provided 33% on inboard engines, 25% on improved designs, and 12.5% on winches, gurdies and accessories (Chidambaram, 1962). In Kerala, traditional fishers motorised (boats with outboard engines but do not have machine power for fishing) their crafts with outboard engine subsidies. The fishers were provided with a base rate of INR 3,000 for the engines; the subsidy covered 15% of craft and gear costs (Achari, 1987).
ii) In the 1960s, subsidies were introduced to encourage the trawl fishery, but they didn't prove to be highly profitable for the fishers. If hypothetically a fisher received subsidies of INR 18,000 for a boat and INR 2,500 for fishing gear – the estimated value of the fish caught would be INR 25,000 (210 days in a year with the help of 5 fishers). Of the INR 25,000, INR 15,000 would be allocated as wages for fishers (around 5 fishers). After accounting for various expenses such as repairs, replacements, vessel and gear depreciation, the remaining balance would be INR 6,700. Additionally, considering the yearly costs of fuel, and boat maintenance at INR 4,000, the remaining would be INR 2700 (Chidambaram, 1962) (Refer to Appendix C for USD to INR conversion). This remaining balance would be used to pay off the loan installments and the accrued interest for the boat and gear. If INR 700 was paid towards the accrued interest on the loan and INR 2,000 towards the boat and gear loan instalments, a 10-year period would be required for the repayment of the loans. However, if fishers had difficulty in repaying back the loans, they would need to receive further subsidies until an increase in earnings from catches (Chidambaram, 1962).
iii) Repayment of the loans was poor in India. In Karnataka, banks advanced credit of 75% of the capital investment, but because of the increased costs and declining catches, there was a low loan repayment (Achari, 1987). In 1974, the cost of a mechanised boat in India was INR 100,000 (USD 12,500), a price greater than any average fisher could afford, resulting in the government issuing subsidies at a rate of 50% (George, 1974). In some instances, fishers were provided 50% loans and 50% subsidies; the ownership eventually changed to non-fishers if and when the fishers could not repay their loans (Sinha & Sampath, 1993). In 1979, INR 28 million was outstanding in loans in Kerala, which increased to INR 75 million by 1986. Of the INR 75 million, INR 58 million was the principal amount provided by the government in the form of low-interest loans to fishers, with an estimated INR 42,000 for each boat (Achari, 1987).

iv) The Government supplied mechanised boats through fishing cooperatives[3]. In Kerala, from 1961-62 to 1977-78, 1200 mechanised boats were supplied by the government to fish worker cooperative societies and groups of fishers. However, this scheme was a complete failure, as the cooperatives to which the boats were distributed to were *benami* cooperatives (Achari, 1987; Kurien, 1993). *Benami* translates to 'no name' or 'without a name', where the individual fisher's name was not used but instead, the name of another individual or a fictional person was used. This resulted in rich and influential individuals controlling the cooperatives (Kurien, 1993).

v) The requirement for loan security changed over time in India. In Kerala, the subsidy rate from 1961-62 to 1965-66 was 25% for trawlers, with a maximum of INR 25,000. While no security was required in the 1960s, this changed in 1972, when fishers were required to provide security. The security included 10% of the cost of the boat, which was provided in cash or landings. Loans taken out by fishers had to be repaid within eight years at a 7% interest. Fishers often paid 30% of their landings to the cooperative societies[4] after fuel costs were deducted as loan payments (Achari, 1987).

vi) The state government insisted mechanised boats be insured to safeguard the interests of the government and the fishers. In some instances, fishers with insurance were charged lower interest rates on their loans compared to those who did not have insurance (Chidambaram, 1962).

b. **Infrastructure, support, and harbour construction:** In support of bottom trawling, the government developed fishing ports and infrastructure facilities, such as ice plants, freezing plants, cold storage, canning plants, fish meal plants, transport, landing centres, and marketing facilities to enhance fishing exports (Achari, 1987; Bavinck, 2012; Bavinck et al., 2008; Nayak & Vijayan, 2003; Pattanayak, 1988). In some cases, breakwaters were constructed at the mouth of channels, such as Neendakara (Kerala), to allow for trawl operations (FAO, 1972).

Loans and subsidies for trawling were provided by the government to fishing cooperatives for infrastructure support. In Mumbai (Maharashtra), aid was provided to fishers and their cooperatives to help cover the costs of ice and cold storage plants (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1957b). In Chennai, Tamil Nadu, cooperatives were not charged interest rates on loans for mechanised boats and nylon nets (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1958). However, at the beginning of the fourth five-year plan (1969-1974), the government was no longer liable for meeting loan requirements, and the liability was transferred to other financial institutions like Agricultural Refinance Development Corporation (ARDC) and banks (Bapat & Kurian, 1981). ARDC provided loans to fishers' cooperatives. The commercial banks also provided loans, but preferred loaning to private enterprises than fishers per se, resulting in fishers benefiting very little from the change (Bapat & Kurian, 1981).

[3] Fisheries cooperatives and central societies are mainly created as "credit societies" where community members are provided loans. To be a member, the member needed to be at least 18 years old, purchase a share, and live in the same area as the "society". Becoming a member was difficult for migrant fishers.

[4] Cooperative societies were created with the purpose of producing and marketing fish, which evolved to provide financial assistance to fishers, and preserve, store, transport, and process fish. Cooperatives also supplied nets, ropes, oil, and other equipment at reasonable rates.

c. **Fishery development projects and services**[5]**:** In India, states were provided with boat-building programs and training centres (Bapat et al., 1972; FAO, 1970b; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok 1961; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963; Johnson & Bavinck, 2010; Kurien, 1993; Kurien & Paul; Miyamoto et al., 1963; Pattanayak, 1988; Vijayakumar & Chakravarty, 2018). Here we highlight some examples from the literature:

   i) Government schemes, the Food and Agriculture Organisation (FAO), the Indo-Norwegian Project (INP), and the UN Special Fund project facilitated training centres. For example, in 1954, at Indo Pacific Fisheries Council, an adopted resolution recommended focusing on programs that promoted training courses, the use of mechanised fishing methods by trained fishers and helping to provide trawl vessels to trained fishers (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1954).

   ii) In the 1950s, some of the trawling courses provided were extensive and covered many topics. The classes focused on technical knowledge, handling of mechanised boats, maintenance of boats, classification of trawl nets, designing trawl nets, knowledge of net sizes, currents, the behaviour of shrimp, and fabrication and construction of trawl nets (Bapat et al., 1972; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1957b; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok 1961). The practical training focused on two types of trawl operations with different training periods: i) one-month for hand trawl operation, and (ii) three months for winch-operated stern or bull trawls (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok 1961).

   iii) By 1958, the FAO had helped open six centres, 240 fishers had already been trained, and 120 more were said to be undergoing training (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1958).

   iv) In 1958, in Kakinada, Andhra Pradesh, fishers with practical fishing knowledge were recruited to train in trawl methods. The course lasted six months, and fishers were provided with a stipend of INR 75 per month. From 1958 to 1978, 691 fishers were trained, with most working on mechanised boats as crew members and owner-operators (FAO & Hartmann, 1978).

   v) In 1970, in Kakinada, Andhra Pradesh, the largest number of boats were issued through cooperative societies to fishers who had completed the training. More than 400 fishers passed the course; however, only 140 were given a boat. During the time, fishers could not buy mechanised boats at the government boat building yard in Kakinada and management was not allowed to sell boats directly to fishers (FAO, 1971). Interestingly, quite a large number of boats provided to the fishers were not used for these and other reasons: boats were destroyed in cyclones; boats were unworkable from lack of maintenance, boats were seized for non-payment of loans, and boats were sold by fishers to individuals in other states (FAO, 1971).

   vi) In 1973, in Tamil Nadu, boats were issued under the hire-purchase scheme, an instalment plan, where individuals initially paid a low percentage of the cost of the asset and the remaining balance was paid over a timeframe. To qualify for the scheme, at least one member of a group of 3-4 fishers had to be trained at a state training centre and the fisher had to be part of a cooperative. Once the loan was repaid, the boat was owned by the group of fishers (FAO & Directorate of Fisheries Tamil Nadu, 1978).

[5] Development grants for fishery projects and institutional support and services. Institutional support could include services for the day-to-day operations, such as bait programs, search and rescue programs, fish holds, safety and quality control, and fisher training Sumaila, U. R., Ebrahim, N., Schuhbauer, A., Skerritt, D., Li, Y., Kim, H. S., Mallory, T. G., Lam, V. W. L., & Pauly, D. (2019). Updated estimates and analysis of global fisheries subsidies. *Marine Policy*, *109*. https://doi.org/10.1016/j.marpol.2019.103695.

vii) In Kerala, between 1975 to 1981, potential difficulties in hiring skilled skippers and engineers to operate more extensive and more technologically advanced vessels resulted in government-sponsored training schemes (FAO, 1972).

viii) In Chennai, Colachel, Cuddalore, Mandapam, Nagapattinam, and Tuticorin in Tamil Nadu, individuals of ages 18 to 35 who knew how to read and write in Tamil were trained. By 1978, 3972 fishers had been trained and were mainly employed on mechanised boats. There was a competitive demand for training courses as the successful candidates were given preference in the allocation of mechanised boats under the loan scheme. Eventually, the scheme stopped, and the incentive to be trained diminished as fishers were only provided with INR 50 monthly and the course was long in duration (FAO & Directorate of Fisheries Tamil Nadu, 1978).

ix) By 1982, 10,000 fishers had been trained, and in groups of 4-5, fishers were provided loans and subsidies to purchase a small mechanised vessel (Bay of Bengal Programme & FAO, 1982; FAO & Hartmann, 1978). By 1983, there were 30 centres to train fishers to operate small mechanised vessels in Orissa (4), Gujarat (2), Maharashtra (4), Karnataka (4), Kerala (5), Tamil Nadu (6), Andhra Pradesh (2), Lakshadweep (1), Goa (1), and Andaman and Nicobar Islands (1). Candidates were ages 17 to 30 and had at least five years of fishing experience (Bay of Bengal Programme & FAO, 1982).

x) In 1993, the Government of India licensed three stern trawlers and five paired trawlers with two foreign companies from Taiwan and Spain. As part of the agreement, the Indian crew members were to be trained (FAO, 2000b).

d. **Fuel:** The government provided fuel subsidies (Bavinck & Kooiman, 2013; Chidambaram, 1962; Nandakumar & Nayak, 2010; Roshan, 2016). In 1994, diesel subsidies were introduced, resulting in more trawlers and fishers working as wage labourers on trawl boats (The communities of Chinnapalam and Bharathi Nagar et al., 2014). The government attracted foreign joint venture vessels by subsidising their fuel prices, which were below the fuel prices paid by traditional fishers (Brake, 2001). When large trawlers were introduced, trawler companies that exported shrimp had their fuel subsidised by the government (Gopal et al., 2008).

4.1.1.2 Bilateral Agreements, joint ventures, and foreign aid

India's mechanised industry received technological and financial support from bilateral agreements, joint ventures, and foreign aid. These agreements played a crucial role in the development of the industry. Below are some of the agreements that helped develop the industry. Examples from the literature:

a) In 1953, the first international tripartite development project called the Indo-Norwegian Project (INP) for Fisheries Development was created, and was jointly overseen by the United Nations, Norway and India (Kurien, 2000). Norway wanted to gain political recognition and create a positive image of its foreign policy to offset the negative image of Norway's policies at the time (Brake, 2001). INP was a community development project focusing on fisheries development and the exploration of viable fishing grounds and was initiated in Kerala (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1957a; Suseelan & Rajan, 1989). While INP was known for fisheries development and the introduction of mechanisation, it also tried to reduce infant and maternal mortality rates and birth rates, while providing safe drinking water. The provision of safe drinking water greatly benefited the lower castes (a hereditary social classification), as available safe wells were mainly found amongst the higher castes (Brake, 2001). Experts from FAO and INP guided the training of fishers to operate the mechanised trawl vessels. INP initially focused on the artisanal fishers. However, when the “pink gold rush[6]” occurred, INP shifted its focus to the export-oriented fishing business. This shift resulted in

[6] Pink referred to the colour of the prawns and pink gold rush was the profit made by trawlers from the demand for prawns.

small-scale fishers being abandoned as INP prioritized the large-scale trawlers and processing facilities. The change in structure allowed a new class of individuals to enter the realm of fisheries – entrepreneurs and capitalists – who had the financial ability to pursue production. The entrance of capitalism also opened the doors for a large migrant labour force from outside the fishery – making fishing no longer a caste-based occupation (Jadhav, 2018).

b) In 1953, the Indo-U.S. Operational Agreement was signed, introducing multipurpose mechanised vessels, dredgers, deep-sea trawl vessels, ice factories, storage plants, and other expenditures (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1954). In mid-1955, West Bengal received three bull-trawlers from the American Aid Programme (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1957b).
c) In 1980, the FAO-sponsored Bay of Bengal Program was established, funded by the Swedish International Development Authority (SIDA) (Pillai & Sathiadhas, 1982). The introduction of high-opening bottom trawls for pair trawls resulted in significant interest from fishers (Mahadevan et al., 1988). During 1980-1981, the new gear was demonstrated to the fishers, resulting in local fishers starting pair trawling in the Palk Bay Zone (Pillai & Sathiadhas, 1982).
d) Financial help from the World Bank increased mechanised units (Chidambaram, 1962; Sehara, 1998).
e) The desire for fisheries development resulted in the government allowing multinational companies and large industrial houses to participate in deep sea fishing via joint venture agreements. For example, during 1990-1992, of the 40 chartered boats, there were five stern trawlers and twelve pair trawlers. Unfortunately, during the time, 100 foreign trawlers were poaching in the Indian EEZ (Devaraj, 1995). In 1993, the Government of India licensed three stern trawlers and five paired trawlers with two foreign companies from Taiwan Province of China and Spain (FAO, 2000b).

4.1.1.3 Demand for shrimp and foreign exchange earnings

Since the 1960s, the global demand for shrimp has facilitated an export market in India and contributed to India's foreign exchange earnings (Nandakumar et al., 2005; Vijayakumar & Chakravarty, 2018). A variety of drivers boosted the export market demand in India, such as Japan losing access to fishing in Mexican waters (1962), loss of access to supply seafood from China, growth in the US and Japanese economies, liberalised export policies in India (1995-1996), and demand for ribbonfish by China (1995-1996) (Kurien, 1993; Kurien et al., 2016; Nayak & Vijayan, 2003; Sall et al., 2002). Exports from India to the US and Japan grew threefold from the late 50s to the early 60s. (Vijayakumar & Chakravarty, 2018). Initially used as manure for coconut palms, prawns became a highly demanded export item internationally (Achari, 1987). Below are some examples from the literature demonstrating the demand for shrimp in India and the foreign exchange earnings gained:

a) The Planning Commission of India developed India's five-year plans to focus on export trade, specifically the third plan from 1961 to 1966 (Nandakumar & Nayak, 2010). The export potential was abundant for the Western Indian Ocean and the Eastern Indian Ocean (Brake, 2001). Frozen prawn exports increased from 496 tonnes in 1957 to more than 54,000 tonnes by 1982 (1 tonne = 1,000 kilograms) (Jadhav, 2018). Shrimp exports generated a large amount of foreign exchange for India (Nandakumar et al., 2005; Nayak, 2006).
b) When the loss of Japan's access to fishing waters in Mexico coincided with the loss of seafood supply from China, the export value for prawns increased, resulting in India focusing its attention on the prawn market in Kerala (Kurien et al., 2016; Sall et al., 2002). Many prawn freezing and canning factories in Kerala were opened – and the state became a leading exporter – because of the international demand for prawns (Kurien, 1993; Kurien et al., 2016). From the mid-1960s to mid-1970s, efforts by the Indo-Norwegian Project contributed to increased foreign exchange earnings for prawns, with growth from INR 10 million to INR 637 million– of which INR 80 million was associated with Kerala (Achari, 1987).

c) Profitable trade in the Far East region for dried prawns contributed to the export demand (Miyamoto et al., 1963).
d) The export industry started to grow in Gujarat (the mid-1960s), Karnataka (since 1959), and Maharashtra (Chakraborty et al., 1983; Nayak & Vijayan, 2003; Sukumaran et al., 1982). Specifically, between 1986 and 1994, the number of trawlers increased drastically in Gujarat, partially because of India's liberalised export regulations and China's demand for ribbonfish (Nayak & Vijayan, 2003).
e) High demand for shrimp resulted in small-scale sector adopting outboard engines to travel greater distances and fish in deeper waters (Nandakumar & Nayak, 2010). The small-scale sector also modified existing gear used by the mechanized sector, such as the ring seine and the mini-trawl net. This shift was also driven by the competition and conflict between trawlers and artisanal fishers.
f) While shrimp was the gold commodity, the export market also sought cuttlefish, squid, sand lobsters, varieties of finfish, soft corals, frozen lobster tails, shark fins, frozen fish, fish maws, and whelk meat (Joel & Ebenezer, 1996; Philip & Appukuttan, 1997; Rao, 1973). Starting from 1990 to 1993, the market also shifted to trash fish[7], which for the first time, was sold to fish meal plants (Joel & Ebenezer, 1996).
g) The government issued licenses to foreign vessels to fish in the EEZ to generate more foreign exchange earnings (Brake, 2001).
h) In the 1990s, India's export trade shifted from a resource-based to a food-engineering-based industry. (Yadava, 2004).
i) While the availability and the potential of deep-sea shrimp had been known since the 1960s, there was not much incentive for private entrepreneurs to engage in the industry because of the lack of consumer demand (Jayaprakash et al., 2006). However, the industry quickly changed when the international demand for shrimp increased (Jayaprakash et al., 2006). The high-value demand for prawns and the export trade incentivised owners and the private sector to join the industry. This increased fishing boat numbers and the demand for trawl industry workers (Rao, 1973). However, the financial gain from export earnings remained with the wealthy few, and the fish workers remained in the "poor bracket" and did not see much financial growth (Achari, 1987).

4.1.1.4 Technical Efficiency

Technological intervention allowed trawlers to increase their fishing efforts, fish at greater depths, and increase the size and quantity of shrimp (Hiebert & Alvertson, 1971). The fishery shifted from a subsistence operation (employing exclusively traditional crafts) to a capital-intensive industry (Yadava, 2004). Technological interventions included fish-finding devices, geo-position equipment, communication systems, vessel storage facilities, offshore coverage, synthetic materials, and development or infrastructure for preservation, processing, and storage (Dineshbabu, 2013; Yadava, 2004).

High technical efficiency gained prominence over traditional methods (Thomas, 2000). The introduction of outboard motors reduced the drudgery of fishing, as some fishers shifted from oars and sails to total dependence on outboard motors (Kurien, 1993) that allowed vessels to drag small nets (Boopendranath & Hameed, 2013). The fishing industry saw a decline in non-mechanised boats and an increase in motorised and mechanised boats. Specifically, 15-meter and multiday vessels gained popularity (Sathiadhas, 2009). Below are some examples from the literature:

a) Shrimp trawling in Kerala with motorised crafts was attempted to try to have the most effective fishing technique in the area (Vijayan et al., 1990). In 1985, mini trawling was introduced in the industry and was in high demand within a year (Panikkar et al., 1998; Rao, 1988b). In Kerala, boats in the artisanal

[7] Trash fish included both the bycatch and discards. The unused portion of the bycatch was referred to as discards Jeyasanta, K. I., & Patterson, J. (2017). Survey on landing of trash fishes in the major fish landing centers of Tuticorin, South east coast of India. *Indian Journal of Geo-Marine Sciences*, *46*(5), 1022-1043.

fishery underwent a physical change, and by the mid-eighties, mini trawls, and mini purse-seines dominated the traditional gears (Panikkar et al., 1998). These gears contributed to more than 80% of traditional landings in Kerala. Motorisation transformed the trawl industry from subsistence to commercial in Kerala (Panikkar et al., 1998).

b) In Mangalore and Malpe, Karnataka, in the early 1990s, the success of multiday trawlers led to 35 purse-seiners being converted to multiday trawl boats (Zacharia et al., 1996). An economic evaluation conducted showed that multiday trawlers were far more economically efficient than single-day trawlers (Zacharia et al., 1996).

4.1.1.5 Profit and Economic Efficiency

In the early 1960s, high profits and economic returns attracted trawlers to enter the industry. An increase in the price of prawns, a need for a smaller crew on mechanised vessels, and a shift from single-day to multiday vessels contributed to the profit. A high operational profit and success over traditional fishing methods, where 170% of the investment was returned within the first year of operation, resulted in the rapid adoption of trawling[8] (Thomas, 2000). Below are some examples from the literature:

a) The increase in the price of prawns contributed to higher profits. In Ratnagiri, Maharashtra, from 1961-1962, the cost of prawns was fifteen paise (1 paisa = INR 0.01) per kg; however, with the export market and the introduction of canneries, the price doubled to thirty paise per kg. By 1966, the cost of prawns was sixty paise per kg because of the increase in competition from wholesale buyers, who bought prawns to freeze in Mumbai, Maharashtra. From 1968 to 1969, the price of prawns for medium-size prawns increased to INR 1.40 (140 paise) per kg (FAO, 1970c) (Appendix C).
b) Mechanised vessels could work with a smaller crew, thereby increasing fisher income threefold compared to local non-mechanised boats (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963).
c) Fishers in the mechanised sector earned a higher annual income than artisanal fishers; for example, mechanised fisher families located near good infrastructure facilities could earn up to INR 12,000 annually compared to INR 6,000 for artisanal fishers families (FAO, 1985).
d) In Kerala, high economic returns resulted in an increase from 300 trawlers in 1968 to 807 in 1972 (Devaraj & Smita, 1988).
e) Multiple types of trawl boats were developed in Andhra Pradesh, such as the “Roya” type (original 10 m for single-day fishing), “Sona” type (11-13 m, multiday fishing) and Mexican-type trawlers (23-25 m, multiday fishing). The Sona boats were the most popular as they were the most profitable and required a lower investment than the Mexican-type trawler (Gulbrandsen & FAO, 1998).
f) Multiday fishing vessels were economically more efficient than single-day vessels, yielding a higher profit/kg of catch. In Karnataka, the number of multiday trawlers increased from 167 in Mangalore and 46 in Malpe in 1990 grew hugely to 398 in Mangalore and 225 in Malpe by 1995. In addition, a few purse-seiners were converted to multiday trawlers (Zacharia et al., 1996)

[8] except on the southern tip of the East coast because of the steeper continental shelf and weather patterns in Kerala

4.1.2 Start Fishery Chose Social

Literature suggests that the fishery chose to start trawling for one social reason (4% of start, n=7 records, Table 18): the change in governing laws favouring trawling (section 4.1.2.1) (Figure 15). The theme is discussed in further detail in the section below.

Themes	n	% of fishery chose social	% of start	Section
Governance	7	100%	4%	4.1.2.1

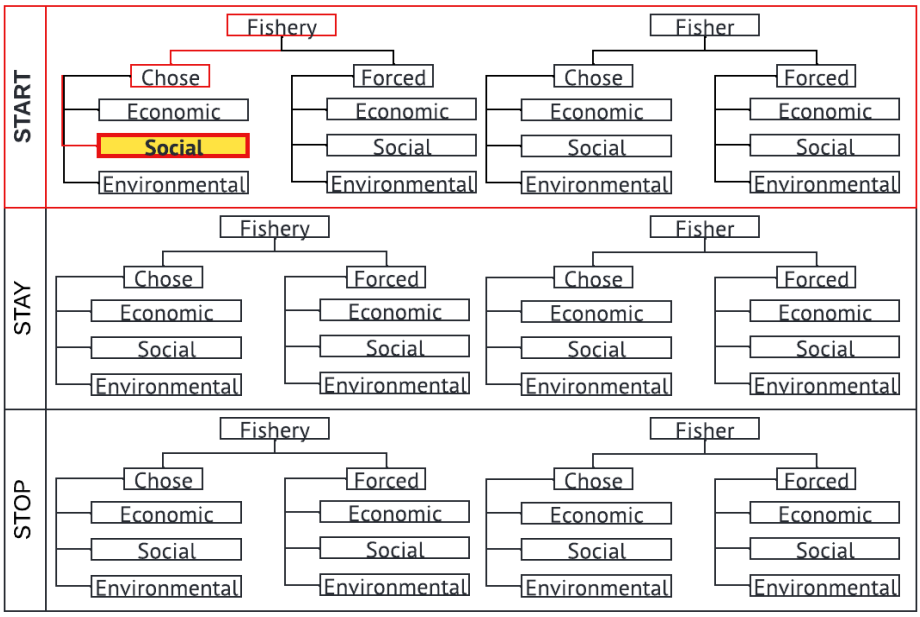


Figure 15. The total number of records (n) for each theme and the percentages relative to fishery chose social and start. The percentages for fishery chose social (n=7 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.2.1 Governance

Flexible governance in India resulted in trawlers entering the fishing industry, and in some instances, those who entered were non-fisher owners and foreign vessels. Below are some examples from the literature:

a) India's constitution allowed any Indian to join any occupation to foster the blue revolution (focused on increasing fish production). The entry of a new class of trawl fishers resulted in the traditional caste law applied to fishing being overridden by the governmental fishery laws. The traditional laws were used by fishers to govern the waters adjacent to their villages. However, the contradicting government law overruled it, which led to conflicts with the small-scale fishers (Bavinck & Kooiman, 2013). Post-1966, the ease of entry into the fishery and the push by the government resulted in a vast influx of non-fisher owners, who at the time had free and open access, and could operate the mechanised vessels without licenses or registrations (Kurien, 1993; Sinha & Sampath, 1993).

b) The government created the Joint Venture scheme to minimise conflict between local fishers and foreign trawlers. However, it only resulted in further conflict given the lack of monitoring and enforcement. The Joint Venture scheme aimed for Indian fishers to purchase deep-sea vessels from Taiwan and Thailand; however, Indian companies ended up creating partnerships with foreign companies. This resulted in the vessels fishing both in and out of the EEZ, resulting in illegal transhipments (Vijaykumar, 2017).

4.1.3 Start Fishery Chose Environmental

The fishery chose to start trawling for two environmental reasons (5% of start, n=8 records, Table 18): good catches (section 4.1.3.1) and an increase in aid because of the damaging effects of the 2004 tsunami (section 4.1.3.2) (Figure 16). The themes are discussed in further detail in the section below.

Themes	n	% of fishery chose environmental	% of start	Section
Presence of good catches	5	63%	3%	4.1.3.1
Tsunami	3	38%	2%	4.1.3.2

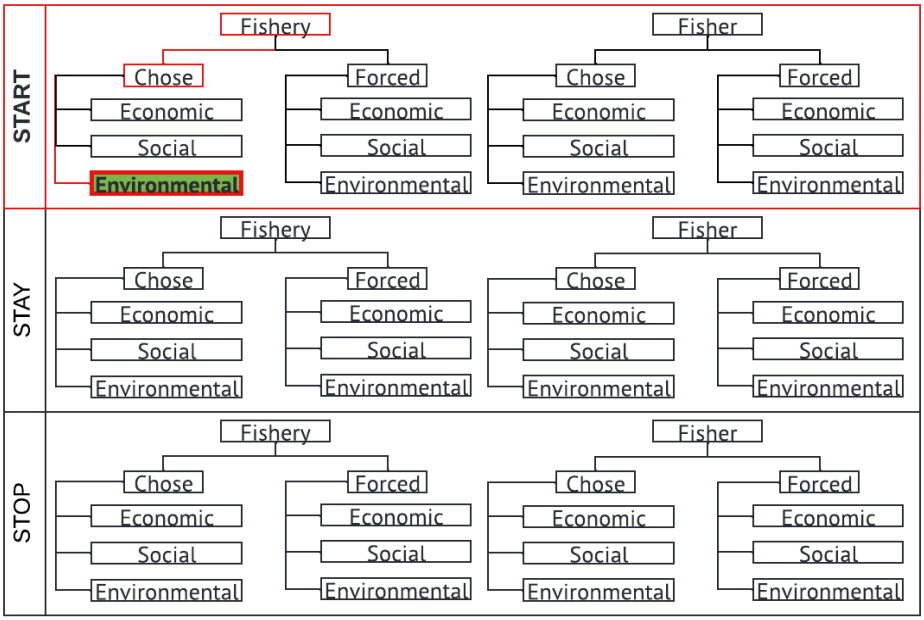


Figure 16. The total number of records (n) for each theme and the percentages relative to fishery chose environmental and start. The percentages for fishery chose environmental (n=8 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.3.1 Presence of good catches

The bottom trawl industry maximised shrimp catches by focusing on the high productivity in inshore grounds (Bavinck, 2012; Subramanian, 2003). Trawling permitted the industry to exploit more than just shrimp, such as lesser sardines (Pillai & Sathiadhas, 1982). Specifically, when trawling started, Kerala was known for its rich resources of penaeid prawns (Achari, 1987).

4.1.3.2 Tsunami

The physical damages caused by the Tsunami of 2004 led to an influx of aid streams, resulting in an increase in motorised, fibre-glass vessels mainly used for trawling (Bavinck, 2018; Bavinck et al., 2008). For example, 75% of the steel trawlers were introduced in Cochin after the Tsunami (Jeeva et al., 2012).

4.1.4 Start Fishery Forced Economic

The fishery was forced to start trawling for one economic reason (1% of start, n=1 record, Table 18): the increase in investment costs for other fisheries (section 4.1.4.1) (Figure 17). The theme is discussed in further detail in the section below.

Themes	n	% of fishery forced economic	% of start	Section
Change in investment costs	1	100%	1%	4.1.4.1

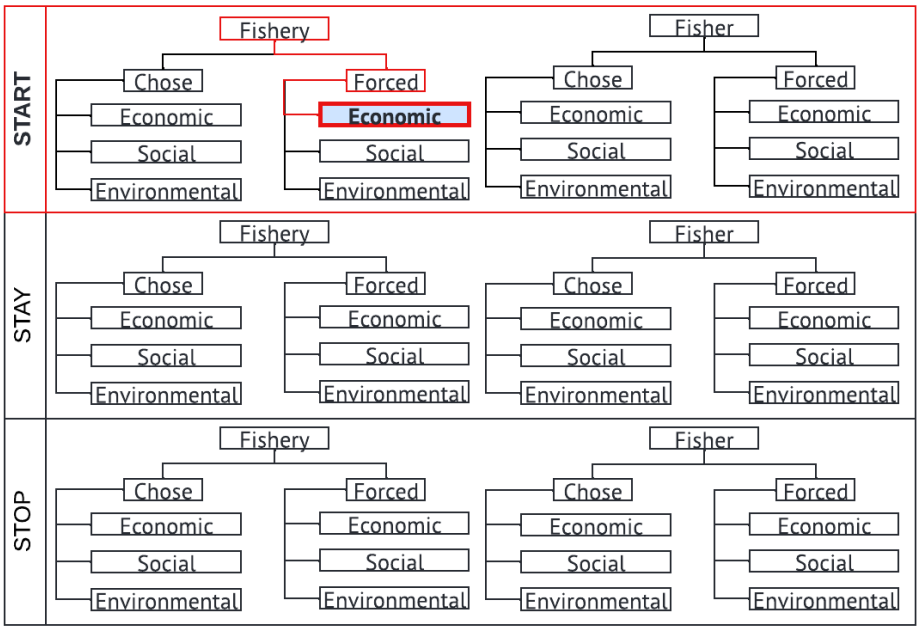


Figure 17. The total number of records (n) for each theme and the percentages relative to fishery forced economic and start. The percentages for fishery forced economic (n=1 record) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.4.1 Change in investment costs

The change in investment in fishing gear resulted in a shift towards trawling. For example, in 1993-1994, the initial investment for a canoe using a ring seine in Kerala was ~INR 500,000; however, around 2010 it costs INR 1.2-1.5 million, which is around the same investment amount as for a mechanised trawler (Nandakumar & Nayak, 2010).

4.1.5 Start Fisher Chose Economic

Fishers chose to start trawling for six economic reasons (31% of start, n=51 records, Table 18): potential for better income and higher profits (most dominant), and attractive incentives (section 4.1.5.1), increased availability of capital and credit (section 4.1.5.2), increased technical efficiency (section 4.1.5.3), a shortage of labour in trawling (section 4.1.5.4), increased demand for shrimp, the booming export market (section 4.1.5.5), and provision of subsidies by the government (section 4.1.5.6) (Figure 18). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose economic	% of start	Section
Income, profits, and incentives	31	61%	19%	4.1.5.1
Availability of capital and credit	15	29%	9%	4.1.5.2
Technical efficiency	12	24%	7%	4.1.5.3
Employment	7	14%	4%	4.1.5.4
Demand for shrimp, bycatch, and trash fish, and export market	5	10%	3%	4.1.5.5
Subsidies	5	10%	3%	4.1.5.6

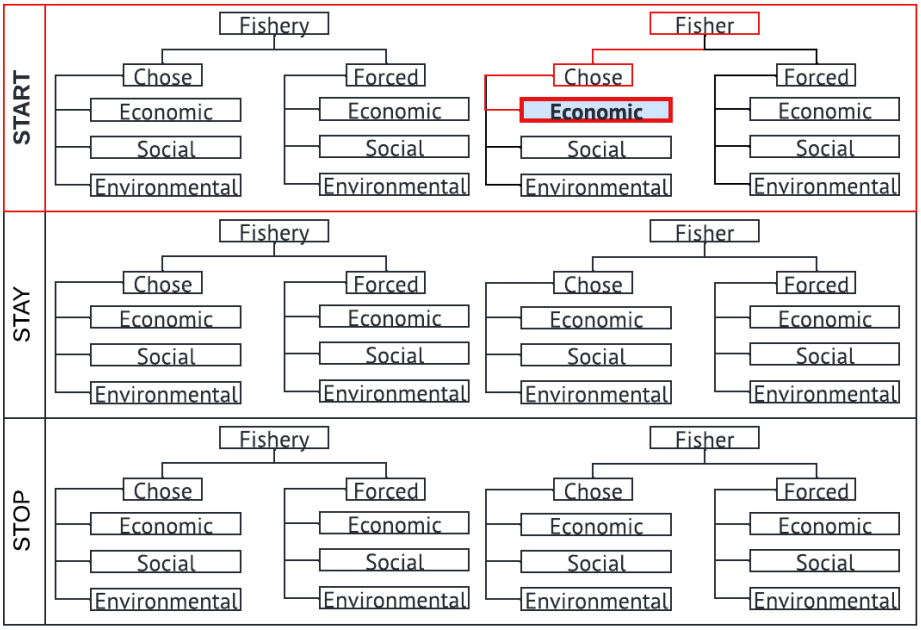


Figure 18. The total number of records (n) for each theme and the percentages relative to fisher chose economic and start. The percentages for fisher chose economic (n=51 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.5.1 Income, profits, and incentives

Trawling changed the economic realm of the fishing industry, from artisanal fishers earning their livelihood to investors expecting a return (Vivekanandan, 2005a). Individuals were drawn to the trawl industry because of high profits, increased earnings, incentives, support for dependents, and financial security (Bay of Bengal Programme & FAO, 1983; Geetha et al., 2014; Pajot et al., 1982).

Mechanised fishing provided a financial incentive. In 1980-81, the crew earned a marginally higher income than other skilled workers like carpenters and masons (Achari, 1987). Labourers shifted from their current fishery to trawling or from non-fishing occupations to trawling because of higher incomes. Incentives, such as small cash advances before the fishing seasons, were sometimes used to recruit crew members (Nayak & Vijayan, 2003).

The motivation to earn a higher salary and gain profits resulted in a diverse group of individuals joining the industry. We loosely grouped the individuals in four categories: a) traditional fishers who shifted to work as crew on trawl boats; b) fishers who converted their boats to trawl boats; c) non-fishers who shifted to work as crew on trawl boats; and, d) non-fisher owners or entrepreneurs who invested in the industry.

a) Traditional fishers shifted to working as crew or as owners on trawl boats. Below are some examples from the literature:
    i. In Malpe, Karnataka, in 1969, traditional fishers earned INR 5,000, and labourers on mechanised vessels earned INR 10,000 during the non-monsoon period (FAO, 1970a).

ii. In Kilakarai, Tamil Nadu, in the early 1970s, traditional fishers used shore seines; however, by the late 1970s-early 1980s, the gear was minimally used as fishers shifted to work on trawl vessels because of higher incomes (Silas et al., 1985).
iii. Towards the end of 1987, Sona boats[9] were introduced in Andhra Pradesh, attracting many fishers. The word Sona meant 'gold', as the boats brought back large quantities of prawns and earnings (Rao, 1999). Interestingly, Sona boats were a private initiative without the government help (Rao, 1999).
iv. In a personal account from a fisher who had worked in the fishing industry, including the trawl industry, since he was 14/15 years old, he stated that he did not have a passion for the oceans and its way of life. Instead, the fisher viewed it purely as a job, as trawling allowed him to not live an impoverished life like fishers using other fishing gears (Creasey & Dsouza, 2019).
v. In Nagapattinam, Tamil Nadu, the income system in the mechanised industry resulted in crew members earning a higher income on mechanised boats than as owners of artisanal boats (Vivekanandan, 2005b). In Nagapattinam, the crew in the artisanal fishery did not receive wages but a share of the net income from the fishing trip after expenses was deducted. The mechanised boats also functioned on a shared system, with the owners of mechanised boats receiving a much higher share (65%) than the owners of the artisanal boats. In addition to receiving a share, however, the crew also received "batta", a fixed amount per trip (average INR 200) regardless of the net income from the fishing trip (Vivekanandan, 2005b).
vi. In Orissa, fishers who worked on trawl boats were immediately assumed to have a better economic status as they received a fixed monthly wage whereas traditional non-motorised boats, did not provide this (Salagrama, 2006).
vii. In Andhra Pradesh, fishers were driven to earn higher incomes as it allowed for some to own land and, even in a generation, permitted families to move from mud and thatch houses to brick and cement houses (Roshan, 2016).

b) Fishers who owned boats were drawn to the trawl fishery and were incentivised to convert their boats. In 1990, in Tamil Nadu, as gillnet fishers saw the amount caught by trawlers and the profit gained, they started focusing on trawl vessels, rather than gillnets (Bay of Bengal Programme & FAO, 1983; Subramanian, 2003)

c) Non-fishers shifted to work as crew on trawl boats despite having no connection to the industry but were attracted to the higher income (Bavinck et al., 2008; Gordon, 1991). Below are some examples from the literature:
i. The Kharwas community in Gujrat was initially involved in the trade industry, and the poorer Kharwas (caste) did the actual fishing, with a larger focus on estuarine fisheries. Some of the poorer Kharwas had experience with traditional fishing, but most were workers for the rich Kharwar 'suppliers' (Nayak & Vijayan, 2003). The poorer Kharwas saw an economic opportunity; they took advantage of the government subsidies and put everything they had into the trawl industry. However, rather than being crew on vessels, they became shore managers and hired crew (Nayak & Vijayan, 2003). Around 40% Kharwas purchased one trawl boat, which was managed either by themselves or their sons (Nayak & Vijayan, 2003).
ii. The merchant class of Kerala moved from cashew exports to fishing, processing and exporting prawns (Kurien, 1993).

[9] "Sona boats are considerably larger than the existing small mechanised boats and are capable of covering distant areas. They operate one trawl net from the stern" (Roa, 1999).

d) Non-fisher owners, entrepreneurs, and investors invested in the trawl industry because of the financial opportunities and high export profits (Gopakumar, 1996; Kurien, 1993; Salim, 2007; Sehara, 1998).

Higher income and better payment systems in trawling increased occupational migration (Gordon, 1991). Below are some examples of occupational migration in India:

a) Individuals moved between states from West Bengal and Tamil Nadu to Kerala (Benoy & Vishnu, 2017b, 2017c). Fishers who moved from Tamil Nadu to Kerala were attracted to the shared income system. Captains received double the share and an allowance, while the crew received a single share. Workers travelled long distances for the possibility of earning a higher income (Benoy & Vishnu, 2017c).
b) Individuals also moved within states. In Maharashtra, most of the boat crew in Versova fishing villages (near Mumbai city) were from the Ratnagiri district[10] because of higher wages (Deveraj & Sreekrishna, 1987).
c) Individuals from multiple states migrated to Karnataka and Kerala, where they believed earnings were higher, even though the income system was commission based, and varied based on the catch (Roshan, 2016).
d) Fishers migrated from Andhra Pradesh to Gujarat, as the crew in Gujarat were paid in advance and received higher wages than in Andhra Pradesh (Roshan, 2016).

4.1.5.2 Availability of capital and credit

Fishers chose or were able to join the industry because of the availability of capital, the presence of private moneylenders and the options of loans. During the 1970s and 1980s, the trawl industry was dominated by external capital, and many boat owners had never fished (Nandakumar & Nayak, 2010; Salagrama, 2006). Trawlers were seen as a distinct group in the fishing industry. The difference in investment made it inaccessible to many fishers and opened the industry to investors and entrepreneurs with financial means (Vivekanandan, 2005a).

Entrepreneurs, processors and traders did not need subsidies or loans, resulting in 30% of mechanised crafts being owned by non-fishers (Sinha & Sampath, 1993). In some states, the entry of capitalists was facilitated by banks. Indirect support from the government resulted in upward success for the capitalist trawl owners with little fishing history (ICSF, 1986). Individuals who did not have the capital could enter the mechanised industry because of the credit supplied by moneylenders (Immanuel et al., 2003; Vijayan & Nayak, 1997b). Below are some examples from the literature on capital investment:

a) In the early 1960s, the high export demand in Kerala resulted in coastal waters being open access to investors who had the financial capability for new harvesting and processing technology – resulting in only a sliver of people benefiting from the industry and becoming rich (Kurien, 2000).
b) In 1967 in Gujarat, entrepreneurs started commercial trawling (Rao & Kasim, 1985). The Kharwa community in Gujrat were initially in the trade industry, and the poorer Kharwas did the actual fishing, focusing on estuarine fishing. However, in the mid-1950s, when the vahans[11] became unnecessary, the Kharwas invested in the trawl fishery. The enterprising Kharwas purchased trawl vessels, began to supply fish to the exporters, and became managers rather than fishers because of their lack of fishing experience (Nayak & Vijayan, 2003).
c) In the late 1970s in Andhra Pradesh, the government assisted fishers with loans to purchase trawlers (Ratcliffe, Hartmann, et al., 1978). As the industry became established, the government discontinued the

[10] Versova was closer to the Mumbai city markets than Ratnagiri district. Distance between Versova and Mumbai is 12.8 km. Distance between Ratnagiri district and Mumbai is 337 km.
[11] Vahans: sailing vessels carrying trade goods to the Middle East

credit service resulting in private entrepreneurs and the APFC (Andhra Pradesh Fisheries Corporation) supplying it (Ratcliffe, Hartmann, et al., 1978).

d) In Tamil Nadu, the introduction of trawling by the government was considered successful as individuals who were fishers and non-fishers joined the industry (Johnson & Bavinck, 2010). In the late 1970s, schemes by the government resulted in minimum repayment of loans by fishers, resulting in weary commercial banks and credit institutions (Ratcliffe, Andreasson, et al., 1978). The government and the Fisheries Department, which monopolised the industry, discontinued the trawl fishing programs (Johnson & Bavinck, 2010). However, the presence of private entrepreneurs meant that the development of the trawl industry did not halt (Johnson & Bavinck, 2010; Ratcliffe, Andreasson, et al., 1978).
e) In 1987, mini trawls were introduced by Alleppey fishers in Kerala for prawns in shallow waters (Ammini et al., 2004). Initially, the cost of investment for mini trawls was lower than other trawlers, which attracted fishers.

4.1.5.3 Technical Efficiency

Technological growth – such as the introduction of engines, motorized vessels, and vessel storage – increased fishing efficiency and incentivized fishers to join the fishery (FAO, 1972; Geetha et al., 2014; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963). Below are some examples from the literature:

a) In 1980, the Bay of Bengal Program conducted trawl trials to show diverse gear uses, such as a one-boat high-opening fish-cum-shrimp (OHFS) trawl, a two-boat high-opening bottom trawl (TH) and a mid-water trawl (TMW). The trials were conducted in Palk Bay, the Gulf of Mannar, and the Coromandel coast. In Tuticorin, Tamil Nadu, OHFS and TH were viewed as being economically viable, in comparison to TMW, which sparked the interest of fishers and boat owners (Pajot et al., 1982).
b) In Allepey district, Kerala, fishers in the traditional sector designed their own trawl gear, resulting in mini-trawls that increased their returns (Menon, 1996).
c) At the end of 1987, the private sector introduced economical Sona boats for fishers to better operate in deeper waters for 15 days (Rao, 1999).
d) In 1990, fishers converted their small gillnets to multiday fishing boats to access distant waters and earn better returns. Some fishers in Tamil Nadu (coastline 1,076 km) were able to carry out long-distance fishing trips off the coast of Andhra Pradesh (coastline 975 km) (Bay of Bengal Programme & FAO, 1983; Subramanian, 2003).

4.1.5.4 Employment

Individuals chose to join the trawl industry for employment purposes. Some traditional fishers and boat crew with fishing experience migrated to other states in search of employment on trawl vessels (Benoy & Vishnu, 2017b, 2017c; Deveraj & Sreekrishna, 1987; Salagrama, 2012). For example, from 2016 to 2017, some traditional fishers migrated to Kerala from Tamil Nadu, Odisha, West Bengal, Karnataka, and Andhra Pradesh to work on trawl boats because of the shortage of labour in Kerala (Benoy & Vishnu, 2017a, 2017b). Some traditional fishers also migrated within the states; for example, in Maharashtra, the fishers moved to Versova from Ratnagiri because of higher employment prospects (Deveraj & Sreekrishna, 1987).

4.1.5.5 Demand for shrimp, bycatch and trash fish and export market

The demand for shrimp, bycatch, and trash fish, as well as the boom in the export market attracted investors to the industry (Nayak & Vijayan, 2003). For example, Japan's demand for fish and prawns in the 1970s resulted in investors in India buying shrimp trawls (O'Riordan, 1995). In India, the increase in fish demand led to fishers employing different gears, such as drift gillnets, trammel nets, hook-and-lines, ring seines, and mini-trawls

(Immanuel et al., 2003). For example, in Maharashtra, export demand attracted traditional gillnet and seasonal dol net[12] fishers who shifted to shrimp trawling (Deshmukh et al., 2004).

4.1.5.6 Subsidies

Poorer fishers entered the fishery by benefiting from government subsidies such as diesel, nets, outboard engines, and construction schemes (Nayak & Vijayan, 2003). Below are some examples from the literature:

a) In the 1970s, in Veraval, Gujarat, the construction of modern landing centres and the availability of subsidies for trawlers resulted in traditional fishers shifting to trawling. Some fishers owned two to five boats, while most owned more than one trawler (Vijayan & Nayak, 1997a).
b) In the late 1970s, in Vishakhapatnam, Andhra Pradesh, subsidies such as diesel oil, lubrication oil, grease, etc., were provided to mechanised boats at reasonable rates which attracted boat operators (FAO & Hartmann, 1978).
c) In Tuticorin, Tamil Nadu in the early 1980s, boat owners and fishers witnessed the efficiency of new trawl nets, and at the time, two fishers were provided with the nets at no cost (Pajot et al., 1982).
d) In Tuticorin, Tamil Nadu, the government encouraged the motorisation of vessels, resulting in traditional fishers taking advantage of the outboard engines provided by the government (Diraviya Raj et al., 2017).

4.1.6 Start Fisher Chose Social

Fishers chose to start trawling for four social reasons (15% of start, n=24 records, Table 18): shifts in cultural norms, possessing the desired fishing skills, having a generational history (section 4.1.6.1), gaining better working and living conditions (section 4.1.6.2), recruitment ties (section 4.1.6.3), and easy access to the fishery (section 4.1.6.4) (Figure 19). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

[12] Bag net fishing in India.

Themes	n	% of fisher chose social	% of start	Section
Culture, fishing skills, and family profession	14	58%	8%	4.1.6.1
Better working conditions and living standards	10	42%	6%	4.1.6.2
Recruitment ties	6	25%	4%	4.1.6.3
Easy access	4	17%	2%	4.1.6.4

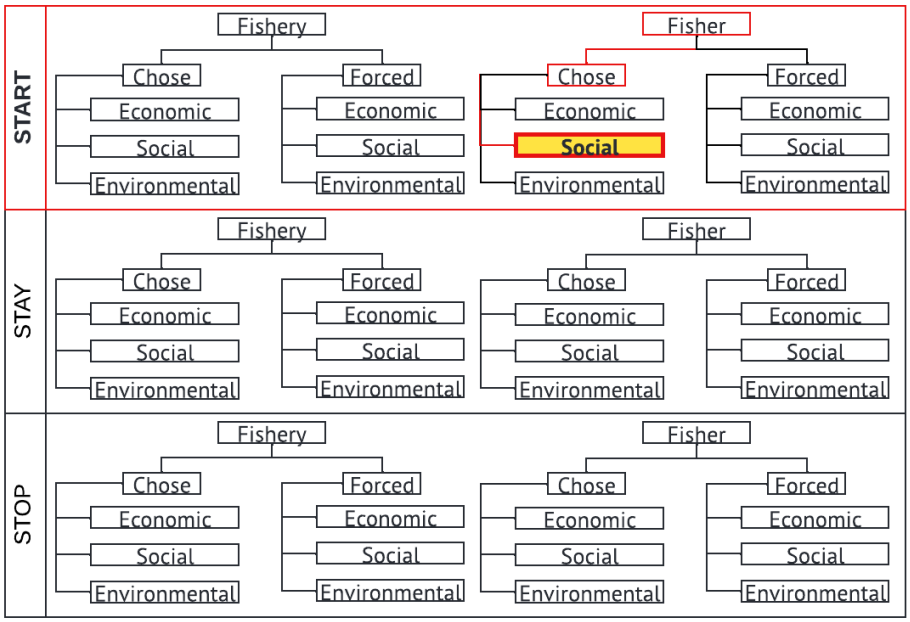


Figure 19. The total number of records (n) for each theme and the percentages relative to fisher chose social and start. The percentages for fisher chose social (n=24 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.6.1 Culture, fishing skills, and family profession

Some fishers joined the trawl industry because they were skilled, had generational fishing history, were from a fishing caste, or had enough capital to breakdown down the barriers of the caste system. Whilst the caste system prevented individuals from shifting occupations, the introduction of trawling broke down the social barriers allowing for non-fisher caste, usually entrepreneurs, to join the fishery (FAO, 2000b) and removed the technical barrier of needing fishing skills (Kurien, 1993). In cases where non-fishers owned vessels, there were still crew on the boats who had a generational history in the sector (Jadhav, 2018). Individuals joining the industry could be separated into a) traditional fishers, belonging to a fishing caste and having inherited the occupation, and b) individuals who had recently entered the occupation and were looking for a job (Bavinck et al., 2008). Below are some examples from the literature:

a) In Gujarat, the trawl fishery was limited to individuals from the same caste or individuals who came from extreme poverty (FAO, 2000b; Nayak & Vijayan, 2007).
b) In some regions, the dominant community[13] was synonymous with the caste controlling the fishery (Nayak, 2006). The members of this community were the owners of the trawl boats; most were found to be illiterate and did not go to sea (Nayak, 2006).
c) Fishers from Andhra Pradesh worked on trawl boats in Gujarat for over 25 years (Roshan, 2016).
d) Fishers from Kanyakumari, Tamil Nadu were known for their exceptional fishing skills, their willingness to deep-sea fish, and their historical presence (Benoy & Vishnu, 2017c; Marschke & Vandergeest, 2016). Fishers from the Kanyakumari district captained most of the trawlers in Kerela because of their fishing skills (Benoy & Vishnu, 2017a, 2017b).

[13] Note: the paper does not mention the community

e) Some skippers brought their children to work on the boats (Nayak & Vijayan, 2003). In some cases, parents actively encouraged their children to join the family operation, resulting in a minimal emphasis on their education (The World Bank, 2010).

4.1.6.2 Better working conditions and living standards

The opportunity to raise living standards and working conditions attracted fishers to the trawl industry. In the 1960s and 1970s, the income from the vast amounts of shrimp caught resulted in individuals moving up the financial ladder and provided a path for upward mobility (Salagrama, 2006). The crew were attracted to the better, bigger, and more equipped boats, such as trawls, compared to the old boats that often-needed repair (Bavinck, 2012; Nayak & Vijayan, 2003; Rao, 1987). The introduction of trawling created better infrastructure. Fishers living near city markets enjoyed a higher standard of living as it lowered the marketing costs, resulting in higher net returns (Deveraj & Sreekrishna, 1987; Kohli & Subba Rao, 1985). The socioeconomic status of fishers shifted, and they now had better access to clean drinking water, transport, and amenities than traditional fishers (Dey et al., 2008). In addition, some fishers were incentivised with free food, clothes, paid leave for 15 days a year, and rented rooms provided by owners for migrants (Benoy & Vishnu, 2017c; Deveraj & Sreekrishna, 1987; Jeeva et al., 2008).

4.1.6.3 Recruitment Ties

Fishers were hired through social networks and personal relationships (Benoy & Vishnu, 2017b).

4.1.6.4 Easy access

The ease of access to the fishery resulted in fishers entering the industry. Free access to the sea and as a common property resource resulted in a large entry of non-fisher owners focusing on trawl vessels post 1966 (Kurien, 1993). In the 1980s, boat owners did not have to register their boats and thereafter the lack of enforcement meant that fishers had no motivation to register their boats even into the 2000s (FAO, 1972; Remolà & Gudmundsson, 2018).

4.1.7 Start Fisher Chose Environmental

Fishers chose to start trawling for two environmental reasons (7% of start, n=11 records, Table 18): access to new, unexploited fishing grounds (section 4.1.7.1) and the increased availability of shrimp during the monsoon season (section 4.1.7.2) (Figure 20). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose environmental	% of start	Section
Rich fishing grounds	9	82%	5%	4.1.7.1
Monsoon	2	18%	1%	4.1.7.2

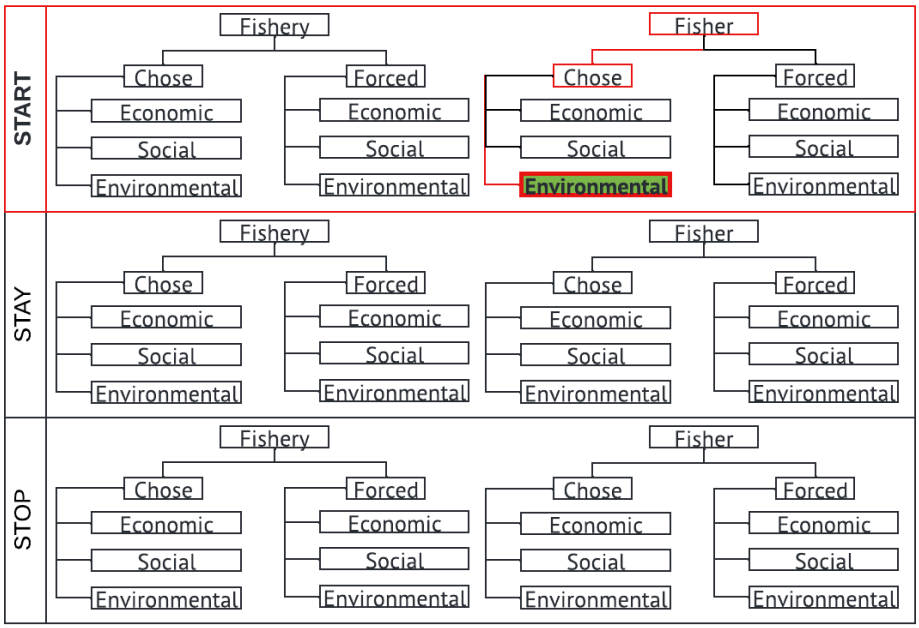


Figure 20. The total number of records (n) for each theme and the percentages relative to fisher chose environmental and start. The percentages for fisher chose environmental (n=11 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.7.1 Rich fishing grounds

Unknown and unexploited fishing grounds drove fishers to shift from traditional to mechanised fishing (Sathiadhas & Benjamin, 1990). The discovery of prawn beds in the early 1960's encouraged local fishers to start trawling. This shift towards trawling was further validated by preliminary surveys and the fishing grounds of traditional fishers demonstrating good catches from trawling (FAO, 1970c; Kizhakudan, 2002; Rao et al., 1980).

The location of the fishing grounds was a key driver for joining the fishery, especially for the small trawlers. Small trawlers relied on fishing grounds that were in shallow waters and only an hour away (Miyamoto et al., 1963). New shrimp grounds were also discovered when trawling (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1957a). In West Bengal, motorised gillnets adapted their boats to hand trawling to focus on shrimp catches. The small-mesh size allowed trawlers to catch valuable juvenile species and sell their bycatch as fishmeal (Bay of Bengal Programme & FAO, 1990).

4.1.7.2 Monsoon

Shrimp fishing prospects were excellent in certain areas during the monsoon season. In the '70s, monsoon trawling was carried out in Kerala (East Coast) because of the presence of a specific shrimp species (*P. stylifera*), which became a critical resource and a distinctive aspect of Kerala. While in other regions on the West Coast, trawlers remained idle during the monsoon season (Suseelan et al., 1998). In Kerala, artisanal fishers also operated mini trawls (small-wooden non-motorised boats) in estuarine systems during the monsoon season when the sea became rough, resulting in a growth in trawler numbers (Remesan & Ramachandran, 2005).

4.1.8 Start Fisher Forced Economic

Fishers felt forced to join the trawl industry for three economic reasons (12% of start, n=19 records, Table 18): the lack of other employment opportunities (section 4.1.8.1), their previous fishing occupation was economically unviable, (section 4.1.8.2) and financial desperation (section 4.1.8.3) (Figure 21). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced economic	% of start	Section
Lack of employment and opportunities	11	58%	7%	4.1.8.1
The previous fishing occupation was unviable	6	32%	4%	4.1.8.2
Financial desperation	5	26%	3%	4.1.8.3

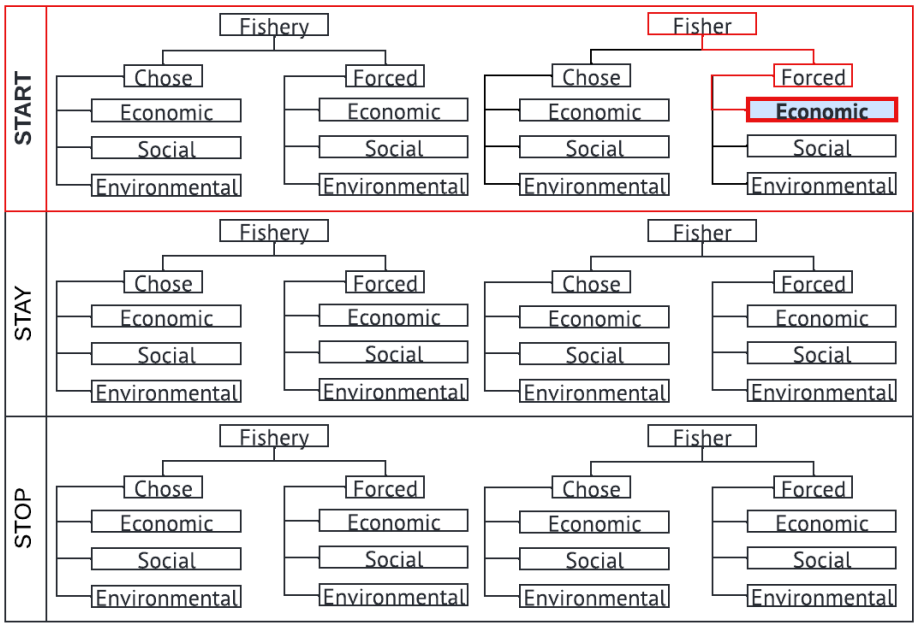


Figure 21. The total number of records (n) for each theme and the percentages relative to fisher forced economic and start. The percentages for fisher forced economic (n=19 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.8.1 Lack of employment and opportunities

Labour scarcity in some states increased occupational migration[14], with many working as crew on trawl boats, specifically multiday trawlers (Roshan, 2016; Salagrama, 2006). A lack of employment opportunities resulted in individuals with no fishing experience joining or migrating to the trawl industry. Below are some examples from the literature:

a) Most workers on the West Coast of India were migrants who trawled for the nine-month season. Whilst the migrants earned wages, they were often treated as invisible workers who had no rights (Nayak, 2006).

b) In Kerala, the retirement of senior individuals and the minimal motivation by young individuals to join the fishery resulted in a labour shortage, one that made the trawl industry dependent on migrant workers. In Munambam, Kerala, four to five migrants were employed as deckhands on each trawl boat (Benoy & Vishnu, 2017c). Individuals who had never worked in fisheries took several months to master the required skills and started by learning how to sort the fish on the deck.

[14] Occupational migration can be viewed from the lens of individuals being forced to migrate due to minimal employment opportunities Salagrama, V. (2006). *Trends in Poverty and Livelihoods in Coastal Fishing Communities of Orissa State, India* (9251055661). .

c) In Gujarat, the entrepreneurial culture shift resulted in a shortage of manual labourers and led to an influx of migrants to fill the gap (Nayak & Vijayan, 2003; Roshan, 2016). In Gujarat, over 60% of the crew on multiday trawlers were from Andhra Pradesh (Roshan, 2016).
d) In Gujarat, children worked as deckhands and cooks as they learnt how to fish. The reasons for children working on the boats were associated with the need for income and the lack of opportunities for educated youth. In some villages, even college-educated individuals lacked career opportunities and could not find employment once they graduated (Dey et al., 2008; Roshan, 2016).

4.1.8.2 The previous fishing occupation was unviable

Fishers shifted to trawling as their previous occupations became unviable. Below are some examples from the literature:

a) Versova was a famous landing centre in Mumbai, where 90% of landings were attributed to trawling (Chavan et al., 2004). Until the 1990s, Versova was known for its traditional dol net fishery, which targeted Bombay duck. However, the fishery became economically unviable because of high associated operational costs (Chavan et al., 2004). This propelled nearly 90% of the fishers to convert their dol netters into mechanised trawlers (Chavan et al., 2004).
b) In Goa, the introduction of trawling threatened the artisanal fishery, resulting in the fishers working as wage labourers on modern trawlers or purse seiners (FAO, 2013).
c) In Sargicode village, Maharashtra, the introduction of trawling left small crafts vulnerable and unable to compete (Vijayan & Nayak, 1997b). Groups of shore-seine fishers collectively bought trawlers resulting in 20 trawlers in the village, with some converting their vessels to trawl boats (Vijayan & Nayak, 1997b).
d) In Kerala, the introduction of mechanised trawlers resulted in the traditional fishery sector competing for catches, eventually leading to a decline in traditional fishery catches. Traditional fishers were forced to add outboard motors and operate mini-trawls (Thomas, 2000).
e) In 1994, the gillnet fishery collapsed in West Bengal, and there were no opportunities for the nets, resulting in the fishers switching to trawl nets (Vijayan & Nayak, 1997c).

In some cases, artisanal fishers had to decide between two options, either struggle with the drudgery of fishing in inshore waters or adapt their boats with outboard motors permitting them to use active gear such as mini trawl or mini purse-seine (Kurien, 1993).

4.1.8.3 Financial Desperation

Fishers were forced to work on trawl boats because of the lack of income (Nayak & Vijayan, 2003). Below are some examples from the literature:

a) A fisher called Rashyamaya Mandal committed suicide because of the financial stress, the burden of the fishing ban, and loans. After Mandal passed away, his eldest son Ganesh was left to look after the family. The family had to sell their country boat, and their land was confiscated because of the debt owed. Ganesh had to find work as a casual labourer, as he was the only source of income for the family. The limited opportunities in his village resulted in him travelling afar to find a job, occasionally working on trawl boats (Lahangir, 2006).
b) Birat Haldar killed himself by eating poison. His two sons were left to care for the family and did so by working on trawl boats (Lahangir, 2006).
c) In Gujarat, migrants from Andhra Pradesh brought their children to work as deckhands or cooks and to learn fishing[15] from the elders to supplement family income (Roshan, 2016).
d) Migrants at the end of their tether were recruited to go into deeper seas as they were willing to fish in areas where local fishers would not venture and work for low wages (Salagrama, 2012). While some

[15] Note: likely on trawl boats

migrants moved from the East to the West coast, others came from North India with a background in agriculture – demonstrating the necessity of working in the fishery (Salagrama, 2012).

4.1.9 Start Fisher Forced Social

Fishers felt forced to join the trawl industry for three social reasons (2% of start, n=4 records, Table 18): a consequence of implemented conservation measures (section 4.1.9.1), an inability to fish in their place of origin (section 4.1.9.2), and an inability of small-scale fishers to compete with trawlers (section 4.1.9.3) (Figure 22). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced social	% of start	Section
Conservation measures and policy	3	75%	2%	4.1.9.1
Unable to fish in place of origin	2	50%	1%	4.1.9.2
Competition between small-scale fishers and trawlers	1	25%	1%	4.1.9.3

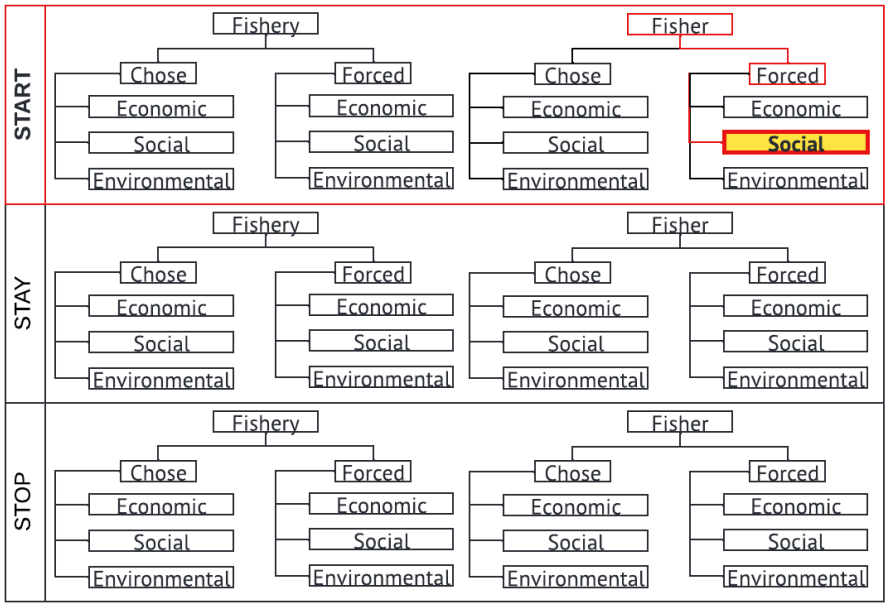


Figure 22. The total number of records (n) for each theme and the percentages relative to fisher forced social and start. The percentages for fisher forced social (n=4 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

4.1.9.1 Conservation measures and policy

Conservation measures and policies forced fishers to join trawling. Below are some examples from the literature:

a) Fishing restrictions imposed by the National Park in the Gulf of Mannar and the Gulf of Mannar Biosphere Reserve Trust (GOMBRT), coupled with economically unviable alternative livelihood options, led to a significant number of traditional fishers transitioning to trawling (The communities of Chinnapalam and Bharathi Nagar et al., 2014). The lack of economically viable alternatives pushed many traditional fishers to seek employment as wage laborers on trawlers rather than continuing to operate their own boats in the Gulf of Mannar. (The communities of Chinnapalam and Bharathi Nagar et al., 2014).

b) The protection of the Olive Ridley turtles along the Odisha coast resulted in many fishers being unable to fish. The fishing restrictions, the risk from the Forest Department patrol, turtles dying in nets, and damaged nets from turtles resulted in many fishers ceasing to fish and migrating to Kerala to work as deck hands on trawl boats (Benoy & Vishnu, 2017b, 2017c).

c) In 1980, the Kerala Marine Fisheries Regulation Act was introduced and declared that 10km of the coastal belt was for traditional fishers and did not allow trawling by the mechanised sector. While this

was good news, it prompted the other fishers to find a way to exploit demersal species in the 10km area without using mechanised vessels – resulting in the introduction of mini-trawls in inshore areas (Thomas, 2000).

4.1.9.2 Unable to fish in place of origin

Fishers could not fish in their place of origin and were forced to join trawling. For example, migrant fishers from Kakdwip (Sundarbans, West Bengal) working in Kerala could not fish in their native place because of the exploitation by boat owners and the lack of infrastructure to support the landings (Benoy & Vishnu, 2017b, 2017c).

4.1.9.3 Competition between small-scale fishing and trawlers

Introducing mechanised vessels, such as trawlers, put pressure on traditional non-mechanised vessels. Non-mechanised vessels could not compete with trawlers when fishing in the same areas. Therefore, small-scale fishers could improve their catch when outboard motors were introduced, resulting in fishers modifying their vessels to mini-trawls (Kurien et al., 2016).

4.1.10 Start Fisher Forced Environmental

Fishers felt forced to join the trawl industry for an environmental reason (3% of start, n=5 records, Table 18): depleted resources in their previous fishing occupation (section 0) (Figure 23). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The theme is discussed in further detail in the section below.

Themes	n	% of fisher forced environmental	% of start	Section
Depletion of resources	5	100%	3%	0

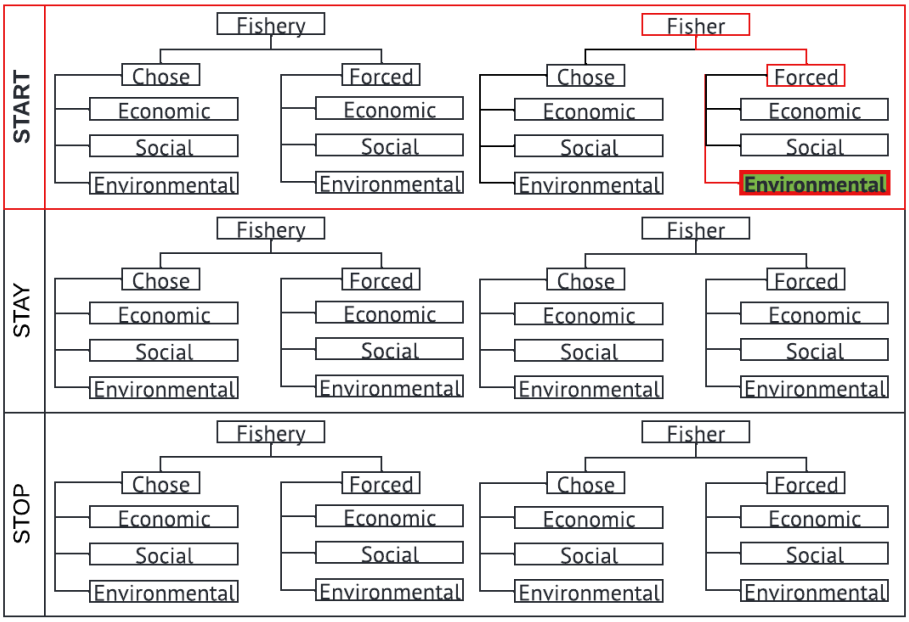


Figure 23. The total number of records (n) for each theme and the percentages relative to fisher forced environmental and start. The percentages for fisher forced environmental (n=5 records) and start (n=165 records) were calculated based on the distinct value rather than the total value.

Depletion of resources

Lack of resources forced fishers to join the trawl industry. Below are some examples from the literature:

a) In 1989, the decline of oil sardines in Kerala made the fishery economically unviable, resulting in traditional fishers introducing mini trawls. Mini trawls also had a lower initial investment than the other vessels (Panikkar et al., 1998).
b) In West Bengal, some gillnetters had to switch to trawl nets because of decreased resources (Nayak, 1997).
c) The introduction of mechanised vessels in Bhitarkanika, Odisha decreased shrimp for traditional fishers, forcing many to join mechanised vessels as daily wage labourers (Pattnaik & Shekhawat, 2020).
d) Fishers in South Gujarat suggested that the depletion of resources in the area was associated with pollution. Small-scale fishers transitioned to migrants working in neighbouring fishing centres; poor fish workers started to work as labourers on trawl boats in Saurashtra and Kutch, Gujarat (Ishita on behalf of The Research Collective, 2017).

4.2 Stay

Both the fishery and the fishers chose to remain in trawling for economic reasons despite declining resources. However, we also found that fishers were forced to stay in trawling for yet more economic reasons (Table 19). We did not find any data on fishery forced social and environmental but. compared to START, there was a greater presence of social and environmental themes for the fishers (Figure 24). In this section, we cover our findings, where the themes (Figure 25) are explained based on the framework and the pillars of sustainability. There are ten sub-sections. Four are for the fishery itself: fishery chose economic (section 4.2.1), fishery chose social (section 4.2.2), fishery chose environmental (section 4.2.3), and fishery forced economic (section 4.2.4). As with START, we did not find any data for fishery forced social and environmental. Six subsections are for related to fishers personal decisions: fisher chose economic (section 4.2.5), fisher chose social (section 4.2.6), fisher chose environmental (section 4.2.7) , fisher forced economic (section 4.2.8), fisher forced social (section 4.2.9), and fisher forced environmental (section 4.2.10).

The total used to calculate the percentage of each theme was the aggregate economic, social and environmental values. For example, Stay – Fishery – Chose – Economic - Technical Upgrades, we used the total of stay to calculate the percentage of the theme technical upgrades.

Table 19. Percentages of the pillars of sustainability within fishery chose, fishery forced, fisher chose, and fisher forced for STAY (calculated using the total distinct value of stay, n=191 records).

STAY Pillars	Fishery Chose	Fishery Forced	Fisher Chose	Fisher Forced
Economic	48%	5%	33%	23%
Social	16%	0%	23%	13%
Environmental	14%	0%	24%	1%

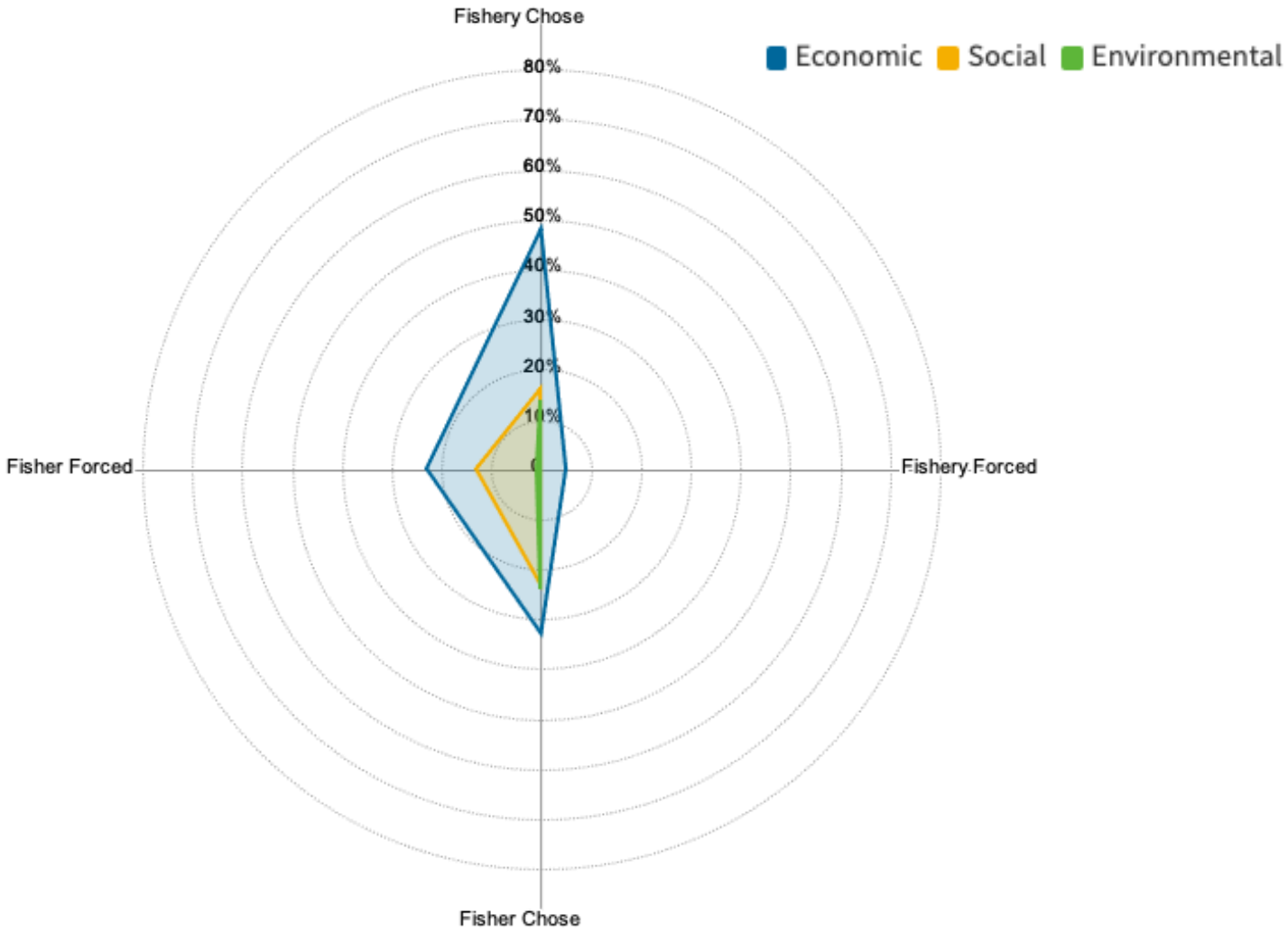


Figure 24. Frequency of the pillars of sustainability (economic = blue, social = yellow, and environmental = green), based on whether the fishery and fisher chose or were forced to STAY in trawling (calculated using total distinct value, n=191 records). Intervals on the radar chart represents 10%.

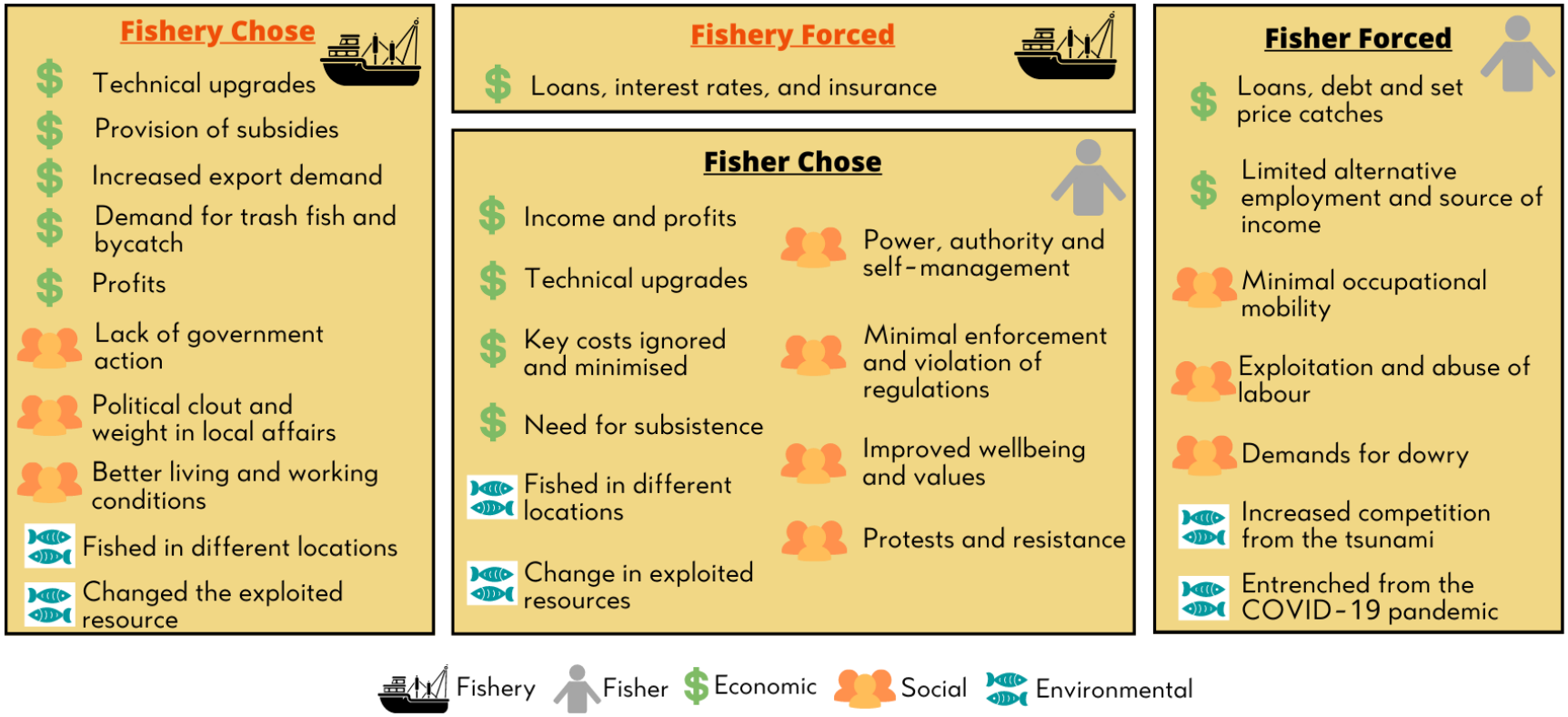


Figure 25. List of themes for why fishery and fishers STAY in trawling.

4.2.1 Stay Fishery Chose Economic

The fishery chose to stay in trawling for economic reasons (48% of stay, n=92 records, Table 19): upgrading vessels to fish more efficiently (dominant) (section 4.2.1.1), continued provisions of subsidies (section 4.2.1.2), increased export demand for shrimp (section 4.2.1.3), increased demand for trash fish and bycatch (section 4.2.1.4), and continuing profits (section 4.2.1.5) (Figure 26). The themes are discussed in further detail in the sections below.

Themes	n	% of fishery chose economic	% of stay	Section
Technical upgrades	53	58%	28%	4.2.1.1
Subsidies	37	40%	19%	4.2.1.2
Export demand	19	21%	10%	4.2.1.3
Demand for trash fish and bycatch	15	16%	8%	4.2.1.4
Profits	14	15%	7%	4.2.1.5

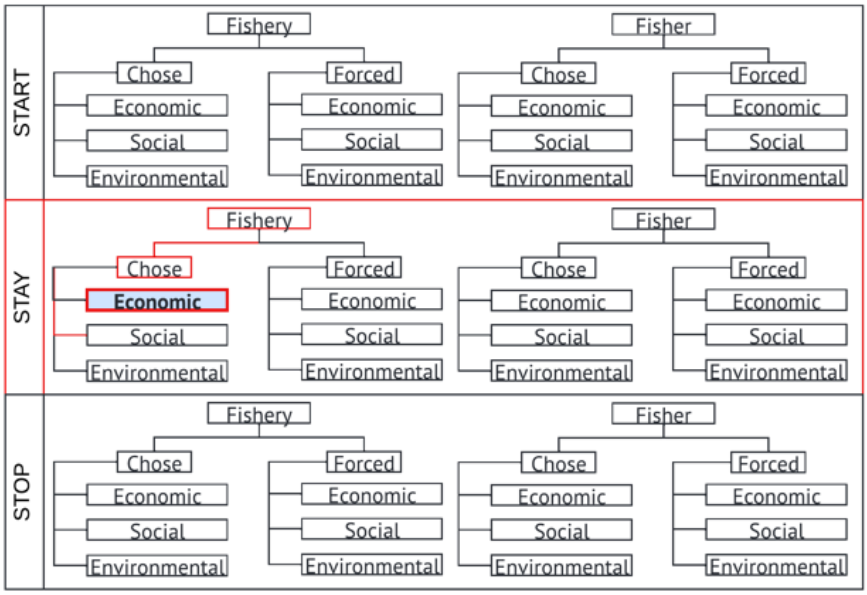


Figure 26. The total number of records (n) for each theme and percentages relative to fishery chose economic and stay. The percentages for fishery chose economic (n=92 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.1.1 Technical Upgrades

Vessels continued to trawl even when resources declined because of technical upgrades. Such upgrades expanded the varieties of shrimp caught, allowed for new fishing grounds to be explored, and increased the number of fishing hours, even though the fish caught per hour (catch per unit effort) was declining (Dineshbabu et al., 2001; S. Mathew, 2004). The fishery chose to persist because of the technical upgrades. Below are some examples from the literature on the technological advancements:

a) Introduction of synthetic materials (Mahadevan et al., 1988), global positioning systems, echo-sounders (FAO, 1971), bigger vessels, increase in engine power (Achari, 1987; Dineshbabu, 2013; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok 1961; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963), and introduction of fuel tanks and fuel-efficient vessels (Subramanian, 2003) enhanced profits even in the face of diminishing catches.
b) The fishery adopted freezer fish holds and increased fish-hold capacities, allowing fishers to remain at sea longer and transfer fish at sea (Gordon, 1991).
c) A change in construction material, from wood to steel, improved manoeuvring, and fuel efficiency (Dineshbabu, 2013; Hassan & Sathiadhas, 2009).

d) Declining resources and increased fishing pressure resulted in using smaller mesh sizes to increase fish catches, which led to increased bycatch and discards (Samanta et al., 2018).
e) Trawl effort and catches increased with the shift from single-day trawl to multi-day trawl (Dineshbabu, 2003, 2013; Dineshbabu & Manissery, 2009; Dineshbabu et al., 2001), the change from day to night trawling (Deveraj & Sreekrishna, 1987; Dineshbabu, 2013; Dineshbabu & Manissery, 2009) and the introduction of deep-sea trawlers (Bay of Bengal Programme & FAO, 1984).
f) Diversifying bottom trawls (e.g., Sona boats and pair-trawling) increased the quantity of prawn caught and profits (Pillai & Sathiadhas, 1982; Rao, 1999).

4.2.1.2 Subsidies

The trawl industry continued with the help of subsidies, which were dominated by capacity-enhancing subsidies.

a) Boat/vessel construction, renewal, and modernisation: The government continued to subsidise the cost of vessels, promoting more and larger trawls (Subramanian, 2003). For example, in 2004, the coast of Tamil Nadu was affected by the tsunami, after which 70-80% of the aid was provided as loans and subsidies. The government provided "35% of assessed value or INR 0.5 million whichever was less as subsidy and 65% as bank loan for fully damaged vessels and 60% of assessed value or INR 0.3 million whichever was less as subsidy and 40% loan for partly damaged vessels" (Jeeva et al., 2012).
a) Fishery development projects and services: Under the charter policy, the government enhanced the fishing industry by allowing entrepreneurs to contract foreign vessels and import deep sea vessels (FAO, 1985). In addition, from 1997 to 1999, sea safety training was provided to the fishers (Westlund et al., 2007).
b) Fuel: The fishery partially persisted because diesel subsidies reduced the operational costs (Bavinck et al., 2008; Nayak & Vijayan, 2007). In 1962, India subsidised up to 10% of fuel for fishing (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963). In 2004, in Tamil Nadu, the government provided a diesel subsidy scheme to compensate for the increase in diesel prices. The scheme helped reduce operational costs by 10 to 20% (Bavinck & Kooiman, 2013).
c) Port Construction and Renovation: The growth of harbour facilities increased profits in the trawl industry. Fishers increased their average fishing days as they could access the harbour to service their boat (FAO, 1970b, 1972). In Kerala, boats could land catches safely during the rough monsoon season and dock their vessels in harsh conditions, allowing them to increase fishing activity (Nandakumar et al., 2001; Yohannan et al., 1999) (note: the temporary trawl closure during the monsoon season was ineffectual until 1996).

4.2.1.3 Export demand for shrimp

Increased international demand for shrimp and the opening up of export markets have helped the trawl fishery persist (George et al., 1981; Hassan & Sathiadhas, 2009; Immanuel et al., 2003; Jayaprakash et al., 2006; Nayak & Vijayan, 2007; Panikkar et al., 1990; The World Bank, 2010; Vivekanandan, 2013; Yohannan et al., 1999). Increased export demand for shrimp resulted in changes in the fishery, such as the shift of fishing grounds from coastal waters to deeper waters, the adoption of night trawling, and the use of small cod-end mesh sizes to maximise shrimp catches (Suseelan & Pillai, 1993). Below are some examples from the literature:

a) In the early 1980s, investors provided capital for the prawn fishery in Tamil Nadu for the export market. However, over time, catches declined, rendering the industry uneconomical except during the short prawn season (Pajot et al., 1982).
b) In Kakinada (Andhra Pradesh), the development of the export market after 1970 prompted the trawl industry to take as much as possible (Rao et al., 1980).
c) In Orissa, the fishery focused solely on the export of high-value species, specifically prawns, to maximize its returns (Salagrama, 2006).

4.2.1.4 Demand for trash-fish and bycatch

Demand for trash fish and bycatch fuelled the persistence of the fishery. This demand was propelled by the development of surimi[16] plants (Nayak & Vijayan, 2007), fish meal plants relying on low-value fish (Aswathy et al., 2017; Pravin & Manohardoss, 1996), processing companies seeking 'value-added products' (trash-fish) (Gordon, 1991), and income from its sale (Lobo et al., 2010). Below are some examples from the literature:

a) In Gujarat, by the early 1990s, approximately 80% of the marine fish landings originated from trawling, with 60% used for low-value fish meal (Pravin & Manohardoss, 1996). In Veraval, Gujarat, from 1991 to 1992, the low-value catch included 87 species belonging to 42 families (Pravin & Manohardoss, 1996).
b) Since 1993, whelk meat has been exported to Japan and Singapore (Sabu et al., 2006). In 1996, shrimp landings declined off the coast of Kollam, Kerala, leading trawl owners to rely on bycatch for income, specifically whelks, because of an increase in demand in the meat export trade (Philip & Appukuttan, 1997).
c) Initially, cephalopods were considered merely bycatch in trawlers, but as shrimp catches declined and export demand for cephalopods increased, so did cephalopod catches. In Karnataka, trawlers caught 755 tonnes of cephalopods in 10 years, from 1976 to 1985. However, after 1988, as demand for cephalopods increased, trawlers expanded their fishing grounds and trawled deeper. Cephalopods rapidly shifted from being regarded as bycatch to target catch. In Karnataka, cephalopod catch increased from 246 tonnes in 1985 to 2,160 tonnes in 1986, eventually reaching 16,197 tonnes in 2006 (Geetha & Mohamed, 2012).
d) In Nagapattinam, Tamil Nadu, target species started declining in the 1990s, and the fishery only remained economically viable only because of the increased bycatch landings (Lobo et al., 2010).
e) Coastal fishing communities in Orissa depended on lower-priced seafood, primarily composed of bycatch from gill netters and trawlers (Salagrama, 2006).

4.2.1.5 Profits

An increase in prawn prices (Panikkar et al., 1990), utilisation of fuel-efficient vessels (Unnithan et al., 2004), efficient trawl gear, improved harbour facilities and enhanced working conditions (FAO, 1970b, 1972) allowed the trawl industry to continue to be profitable. Below are some examples from the literature:

a) An increase in price for trawl catches, specifically prawns, with prices per kilogram being higher on the East Coast than on the West Coast. For example, Kakinada and Visakhapatnam (Andhra Pradesh) experienced higher prawn prices than on the West Coast due to the demand for specific prawn species (FAO, 1971).
b) Trawl vessels were more successful than small-scale vessels by capturing five times more catch, and targeting high-value species (Johnson & Bavinck, 2010).
c) In Visakhapatnam, Andhra Pradesh, during 2001-2002, mini-trawls and Sona boats were assessed for economic efficiency. Despite a decline in catch per unit effort, the trawl boats remained profitable, partially due to subsidised fuel costs (Jeeva et al., 2008).

[16] Paste made from low-cost fish or other meats

4.2.2 Stay Fishery Chose Social

The fishery chose to remain in trawling for three social reasons (16% of stay, n=31 records, Table 19): lack of government action (dominant) (section 4.2.2.1), advantage of political support, boat owner associations and panchayats' dominant weight in local affairs (section 4.2.2.2), and better living and working conditions (section 4.2.2.3) (Figure 27). The themes are discussed in further detail in the section below.

Themes	n	% of fishery chose social	% of stay	Section
Lack of government action	23	74%	12%	4.2.2.1
Political clout and weight in local affairs	15	48%	8%	4.2.2.2
Living and working conditions	3	10%	2%	4.2.2.3

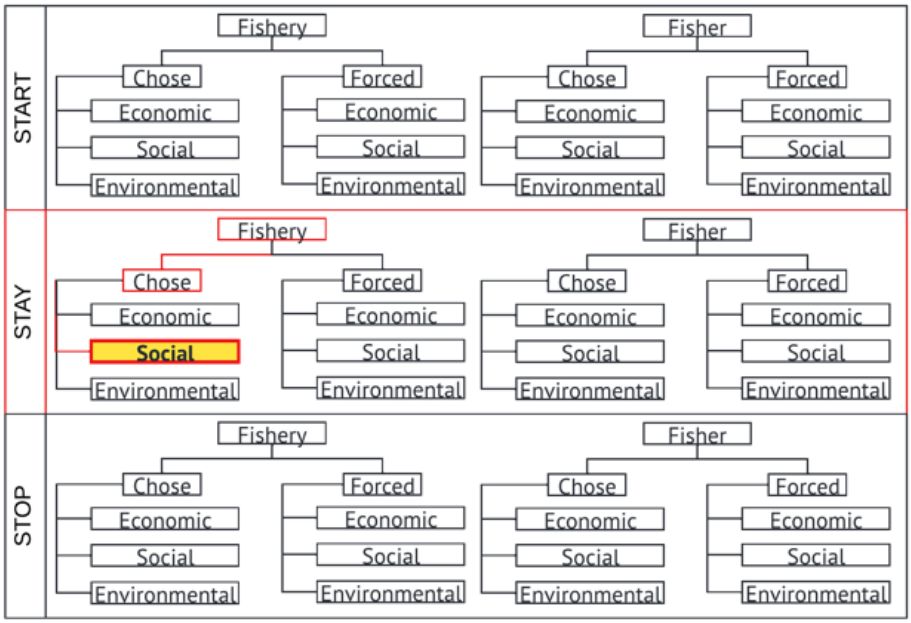


Figure 27. The total number of records (n) for each theme and the percentages relative to fishery chose social and stay. The percentages for fishery chose social (n=31 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.2.1 Lack of government action

The trawl fishery persisted because of a lack of government action. Enacted regulations were usually dismissed and ignored (Action for Food Production, 2008; Bavinck et al., 2008; FAO, 2016b; Gunakar et al., 2017; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1958; Kurien, 1993; Macfadyen & Corcoran, 2002; Menon, 1996; Nandakumar & Nayak, 2010; Nandakumar et al., 2001; Rajagopalan, 2008; Ramesh & Rai, 2017; Salagrama, 2006; Scholtens & Bavinck, 2013; Sinha & Sampath, 1993; Stephen, 2014; The World Bank, 2010; Vijayan & Kurien, 1994; Vivekanandan, 2013; Vivekanandan & Meiyappan, 1999; Vivekanandan et al., 2019). Below are some examples from the literature:

a) Trawl vessels in Tamil Nadu ignored fishing regulations, such as fishing within three nautical miles of the shore (where trawling was officially excluded), because enforcement was missing (Bavinck et al., 2008).
b) Traditional fishers in Karnataka filed complaints (2014-2015) against bull trawling[17] (Kumar, 2020), but the fisheries department ignored the issues. Discussions with the fisheries department showed a need for more monitoring of illegal fishing activities (Hegde & Menon, 2017).

[17] Bull trawling: "The mouth of trawl net held open horizontally by two boats pulling in opposite direction"

c) In 1980, the Kerala Marine Fisheries Regulation Act delineated specific areas for artisanal fishers using non-mechanised craft. However, the Act was not strictly enforced, apparently because the government needed more technical and financial resources, so trawlers continued fishing in the area (Kurien, 1993).
d) In the late 1980s, artisanal fishers in Orissa faced many conflicts with the trawlers from Andhra Pradesh who fished illegally in their waters. Orissa state took a passive stance, resulting in violent confrontations among fishers (Salagrama, 2006).
e) The absence of coordination in implementing the trawl ban[18] among states resulted in trawlers being able to freely navigate along the coast and continue trawling in states where the closed season had yet to start (Bavinck & Kooiman, 2013).

4.2.2.2 Political clout and weight in local affairs

The influence of mechanised boat owner associations[19],the power of *panchayats* on local matters, and the effect of caste and religion on policies helped the fishery to persist (Archari, 1994; Bavinck et al., 2008; FAO, 2016b; Scholtens, 2015; Stephen, 2014).

a) Village councils, known as 'Panchayats', made decisions regarding fishing matters in each fishing village (Bavinck, 2018). And the council responsible for the fishing business in each fishing village was known as '*ur panchayat'*. Bavinck (2018) stated, "In the end, the influence of *ur panchayats* depends firstly on their jurisdiction over the fishing population. The legitimacy of their authority rests on a shared, historical identity of belonging to the same caste and community. In this perspective, the *ur panchayat* is an expression of a social contract, with authority delegated to its council for the common good". For example, in Tamil Nadu, *panchayats* played a dominant role in the regulatory mechanism (Bavinck et al., 2008). Fines were imposed by the *ur panchayat* on individuals who filed a case with the police without the approval of the *ur panchayat* (Bavinck, 2018), allowing them to maintain authority and prevent the state from intervening (Bavinck, 2018).
b) The capacity and influence of boat owner associations varied depending on the region and the landing centre. The influence of the boat owner association was weaker in areas with a more diverse population (Scholtens & Bavinck, 2013). For example, Rameswaram, Tamil Nadu – which had a population with diverse caste, religion, and geographic origins – also had thirteen boat owner associations (Scholtens & Bavinck, 2013). However, in Jegathapattinam, Tamil Nadu, there was only one boat owner association, giving it significant weight in the local affairs (Scholtens & Bavinck, 2013).
c) Politics, influenced by caste and religion, played a significant role in the trawl fisheries management (Kurien, 1993; Stephen, 2014). In Mandapam, Tamil Nadu, the substantial Muslim community had a greater influence on local politics due to their significant presence in comparison to other communities (Kurien, 1993; Stephen, 2014). Specifically, despite not being directly engaged in fishing activities, the traditional leader, Thanga Marakayar, held a position of authority that was recognised by the trawl owners as the ultimate adjudicating power. In contrast, in Rameswaram, Tamil Nadu, the dominant community was a Hindu caste known as Thevars, who held political and economic clout, exerting power in the local politics (Stephen, 2014).

Government policy was challenged and changed based on societal pressure and political patronage by the trawl industry. The interplay between government policy and political influence allowed trawling to persist. Below are some examples from the literature:

a) In Nagapattinam in 2000, the Fisheries Department banned pair trawling; however, trawling persisted because politicians supported the operators (FAO, 2016b).

[18] Trawl ban or trawl closure: a temporary trawl ban during the monsoon season in India. In Kerala it's 52-days and in other states its 61 days annual closure.
[19] Boat owner association: refer to section 3.3.6.1 for definition

b) The National Fishworkers' Forum (NFF)[20] in Maharashtra opposed India's joint venture initiative. The government issued 170 licenses to 800 offshore and deep-sea fishing vessels between foreign and Indian companies in the EEZ (O'Riordan, 1995; Sall et al., 2002). Protests by the NFF, with trawlers and gill-netters leading the way, pressured the government to stop issuing further licenses. This permitted Indian trawlers and gillnetters to continue trawling without external competition (Sall et al., 2002).
c) In Kerala, the introduction of the seasonal fishing ban in the 1980s prompted years of political manoeuvring (Gunakar et al., 2017). Political agendas undermined the efforts of the Kerala Independent Fish Workers Federation, delaying the implementation of the ban (Macfadyen & Corcoran, 2002).

4.2.2.3 Living and Working Conditions

The trawl industry played a role in bettering living and working conditions. The improvement was reflected in various aspects of life, including education, health, sanitation, and access to safe drinking water (Immanuel et al., 2003; Vijayan & Nayak, 1997c). The lower castes obtained access to safer drinking water, leading to a shift in power dynamics with landowners (Brake, 2001). The construction of harbours and safe anchorage further enhanced working conditions (Vivekanandan, 2005b).

4.2.3 Stay Fishery Chose Environmental

The fishery chose to remain in trawling for two environmental reasons (14% of stay, n=27 records, Table 19), such as shifting fishing to other locations (section 4.2.3.1) and changing the exploited resource (section 4.2.3.2) (Figure **28**). The themes are discussed in further detail in the section below.

Themes	n	% of fishery chose environmental	% of stay	Section
Fished in different locations	20	74%	10%	4.2.3.1
Changed the exploited resource	9	33%	5%	4.2.3.2

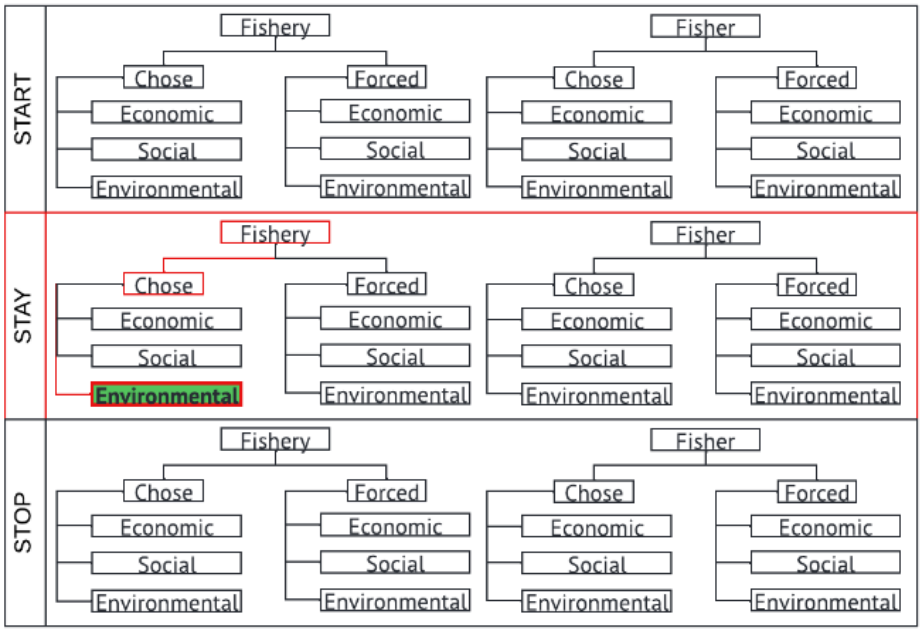


Figure 28. The total number of records (n) for each theme and percentages relative to fishery chose environmental and stay. The percentages for fishery chose environmental (n=27 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

[20] NFF (National Fishworkers Forum), created in 1979, is a trade union consisting of nine coastal states of India; each state has its own government and jurisdiction over its marine waters, which is up to 12 nautical miles.

4.2.3.1 Fished in different locations

The fishery persisted by shifting its fishing effort to new locations. Below are some examples from the literature:

a) In India, the maximum production in inshore waters was reached by the 1990s, resulting in a shift towards trawling in offshore and deep-sea areas. (Najmudeen & Sathiadhas, 2007). Decreased catch rates prompted trawlers to shift to other areas, mainly observed among multi-day trawlers who moved to areas for deep-sea shrimp fishing. (Jayaprakash et al., 2006; Nandakumar et al., 2001).

b) In Tamil Nadu, the oversaturated trawl fleet resorted to illegal fishing in Andhra Pradesh, Kerala and (illegally) Sri Lanka to sustain their operations (Vivekanandan, 2005a). Similarly, trawlers from Karnataka operated in other jurisdictions such as Kerala, Goa, and Maharashtra (Dineshbabu, 2013).

4.2.3.2 Changed the exploited resource

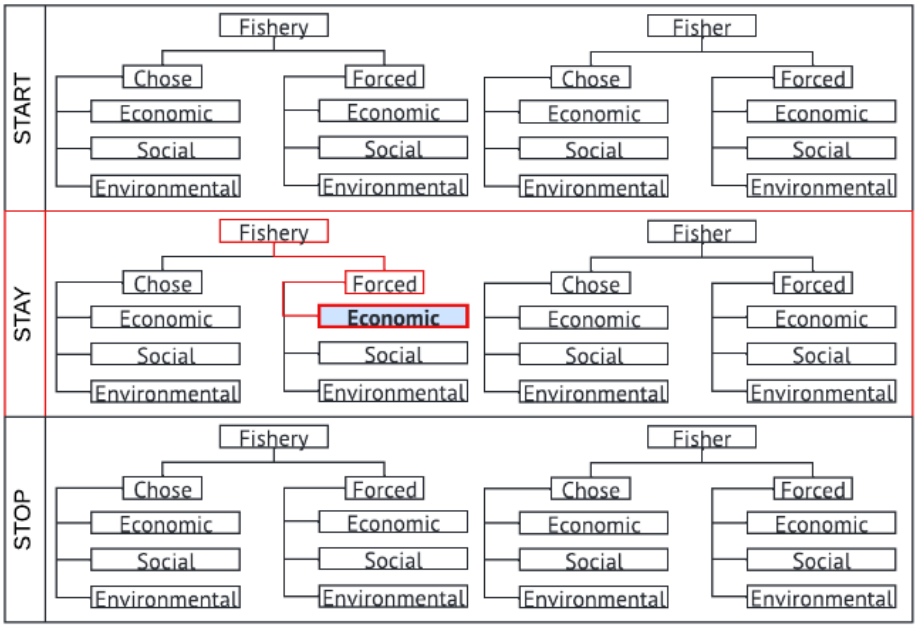
The trawl fishery shifted to demersal finfish, larger sciaenids, ribbonfish, pomfret, mackerel, crabs, whelks, shellfish, cephalopods, and deep-sea shrimp as a result of declining shrimp (FAO, 2000b; Geetha & Mohamed, 2012; Ghosh et al., 2010; Gillett, 2008; Gupta et al., 2020; Sabu et al., 2006; Thankappan et al., 2007; Unnithan et al., 2004). Fishing shifted from targeting high-value groups to low-value resources, leading to fishing down the food web (Najmudeen et al., 2014).

4.2.4 Stay Fishery Forced Economic

The fishery was forced to stay for one economic reason (5% of stay, n=9 records, Table 19): the burden of loans, interest rates and insurance (section 4.2.4.1) (Figure 29).The theme is discussed in further detail in the section below.

Themes	n	% of fishery forced economic	% of stay	Section
Loans, interest rates and insurance	9	100%	5%	4.2.4.1

Figure 29. The total number of records (n) for each theme and percentages relative to fishery forced economic and stay. The percentages for



fishery forced economic (n=9 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.4.1 Loans, interest rates and insurance

Loans, interest rates, and the need for insurance resulted in the fishery being forced to stay in trawling. Below are some examples from the literature:

a) In Mumbai, Maharashtra, individuals taking out a loan were required to provide collateral security equal to twice the loaned amount. This remained until the loan was repaid with interest (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1958).
b) Certain states mandated the inclusion of an insurance policy for government loans[21] meant for mechanisation purposes, such as the construction of new boats or the purchase of new engines. In the absence of insurance, these states would increase the interest rates for the loans (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963). The rationale behind this requirement was to ensure that if the boat were to encounter an accident, the insurance company would compensate the government, thereby protecting both the interests of the fishers and the government. For example, in Gujarat, the interest charged with insurance was 5%, but it increased to 9% without insurance (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963). The insurance available for fishing vessels was considered expensive and inadequate. In cases where insurance was compulsory, fishers were obligated to renew the policy until the loan was completely repaid. Many fishers faced difficulties renewing these policies due to their financial constraints. Moreover, the insurance provided by companies primarily focused on marine vessels, such as ships used for trade, which were not always suitable for fishing vessels. Fishing vessels carried higher risks due to factors like limited maneuverability during fishing, especially in adverse weather conditions, and the limited availability of qualified crew in certain places. Insurance claims for fishing vessels were often not entertained by insurance companies, leading to a significant number of claims being rejected. For instance, if a fishing boat encountered an accident during rough monsoon months, the insurance companies were not liable to provide compensation (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963).
c) In 1962, in Maharashtra, loans for engines required a group of three to eight people to submit a collective application. Furthermore, the individual applying for the loan had to offer security in the form of immovable assets worth 1.5 times the loan amount (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1968). The loans had to be paid back within seven years, but for larger loans, the repayment period was extended to 15 years. The interest rates applied were 4% for insured assets and 7.5% for assets without insurance. These rates were relatively high due to the risks associated with the fishing industry. Consequently, many fishers found themselves in debt, leading them to resort to borrowing money from moneylenders and private merchants (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1968)
d) In West Bengal, cooperative societies that received government loans for mechanised boats were required to sell their landings to Central Fisheries Corporation Ltd (CFC)[22]. This arrangement resulted in cooperative societies being financially constrained until they could repay their loans or generate sufficient revenue from their catch to cover the loan amount (FAO & Lierens, 1978).

Based on the examples provided, it appears that the trawl fishery faced considerable challenges due to financial difficulties in repaying loans, the weight of high interest rates, and the lengthy loan periods. These factors blurred the distinction between the fishery as an industry and the individual fishers. The government, acting as the representative of the fishery, compelled both the trawl fishery and the fishers to persist with trawling, partly

[21] loans of INR 5000 and above
[22] CFC: Central Fisheries Corporation Ltd was established in 1965 by the Government of India to help with fish supply and prices, focusing on Calcutta.

because of the insurance policies and high interest rates. Assuming, the fishers wanted to leave the industry, they would be constrained by the burden of loans, interest rates, and insurance policies.

4.2.5 Stay Fisher Chose Economic

Fishers chose to stay in trawling for four economic reasons (33% of stay, n=63 records, Table 19): continued better income and profits (most dominant) (section 4.2.5.1), continued technical upgrades to increase fishing efficiency upgrades (section 4.2.5.2), ignored expenses to reduce total operational costs (section 4.2.5.3) and subsistence for fisher's livelihoods (section 4.2.5.4) (Figure 30). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose economic	% of stay	Section
Income and profits	46	73%	24%	4.2.5.1
Technical upgrades	16	25%	8%	4.2.5.2
Key costs ignored and costs minimised	8	12%	4%	4.2.5.3
Subsistence	1	1%	1%	4.2.5.4

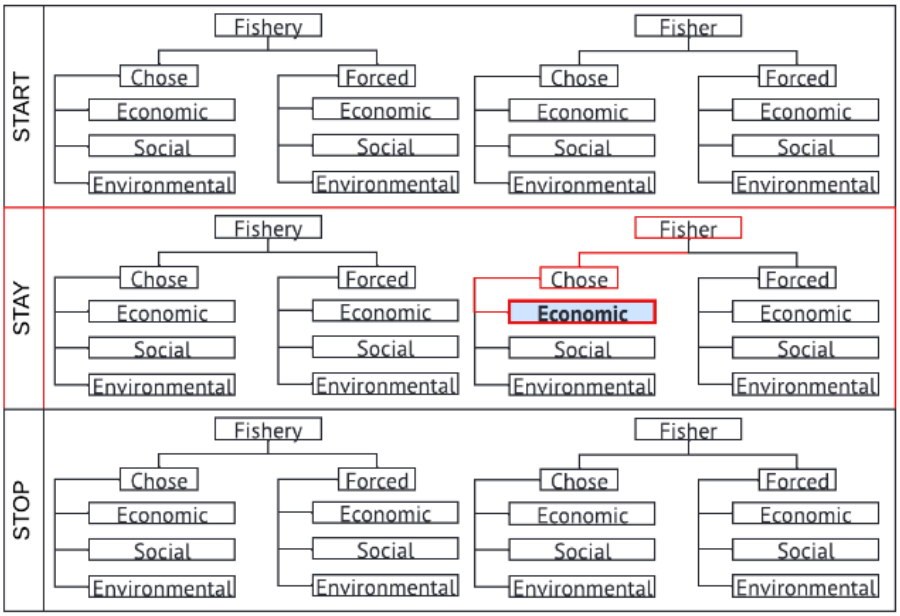


Figure 30. The total number of records (n) for each theme and percentages relative to fisher chose economic and stay. The percentages for fisher chose economic (n=63 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.5.1 Income and profits

Fishers (crew and owners) remained in trawling because they valued their income and at times, multiple sources of income. In Kerala, fish prices increased from INR 1,260 per tonne in 1974 to INR 2,300 per tonne in 1982 (Kurien, 1993). Despite declining resources and rising operational costs, the increase in fish prices allowed owners and crew to continue their involvement in the trawl industry (Kurien, 1993).

Trawlers caught five times more than small-scale boats and targeted high-value species (Johnson & Bavinck, 2010). From 1990 to 1994, Colachel's (Tamil Nadu) trawl industry boomed because of the unusual catch of cuttlefish, and even though profits were low, it was enough to appeal to owners and crew (Joel & Ebenezer, 1996).

Income and profit differed based on the level of seniority in the industry. The disparity between owners who did not fish and fishers on trawl boats increased over the years (Kurien, 1993). In Orissa, during the late 1980s, the

unequal income distribution resulted in only upper-income individuals benefiting from mechanisation with minimal benefits for lower-income individuals (Salagrama, 2006). People often perceived the mechanised sector as accessible only to those with substantial financial resources, stating that "only individuals with sufficiently deep pockets to invest large sums consistently were able to survive" (Salagrama, 2012), with fishers who worked on boats reaping very little benefits (FAO, 1971). Below are some examples from the literature where owners remained in the industry because of profits:

a) In 1970, owners in Ratnagiri, Maharashtra generated a substantial profit, earning a 15% rate of return on capital invested (FAO, 1970c). The rate of return varied depending on the amount of capital invested since owners were also responsible for paying accrued interest on borrowed funds, which stood at 9% per annum (FAO, 1970c).
b) In 1983, in Mumbai, Maharashtra, boat owners gained high profits because of increased fish prices. Trawlers obtained an 18.28% return on the capital employed (Deveraj & Sreekrishna, 1987).
c) The main operating costs for mechanised vessels were fuel and wages. Between 1982 to 1986, operational costs for trawlers doubled, driven by a 60% increase in fuel costs and increased wages (Panikkar et al., 1990). However, despite the rise in operating expenses, revenue of boat owners were not negatively impacted because of simultaneous increases in fish prices and unchanged crew shares over the years (Panikkar et al., 1990).
d) Trawl owners received higher incomes than crew members and traditional boat owners (The World Bank, 2010).
e) Trawl owners who possessed multiple vessels and were financially stable did not have fixed price agreements with traders. Instead, they had the flexibility to sell their catch to the trader offering the best price (Siar et al., 2011). Sometimes, owners provided part of their catch (20-25 kg) to their wives to sell at the local market (Siar et al., 2011).
f) In Maharashtra and West Bengal, the number of vessels owned resulted in a shift of ownership in the trawl industry. Individuals unable to purchase more than one boat opted to sell their existing boat. The boat owners who sold their vessel became crew members, facing reduced earnings but also diminished financial risk (Salagrama, 2012). Boat owners with multiple boats could, however, hope to offset losses and revenue among their vessels. Traders, who might own over 14 boats, ice plants, and other input-supply sources, enjoyed considerable control in the industry (Salagrama, 2012).
g) Many owners pursued other occupations, and some even held salaried jobs, as they found could not earn enough solely by managing boats (Nayak & Vijayan, 2003). Owners involved in shrimp trawling also began investing in shrimp farming/mariculture as catch rates and economic returns diminished (FAO, 2000b).
h) When prawn catch was low at the season's beginning or end, boats also worked as gillnetters (FAO, 1970c). Entrepreneurs who had mainly invested in shrimp trawling attempted to get boats to try gill nets, which was believed to be more profitable than trawling (FAO, 1972).

Despite receiving minimal benefits and profits compared to boat owners, crew members in the trawl industry were influenced by various incentives to stay in the industry. The following examples highlight how wages and incentives played a role in their decision to stay:

a) Skilled crew members in the trawl industry found that alternative occupations such as agriculture provided meagre wages and often only offered highly seasonal work. Consequently, they chose to remain in trawling, earning an average of INR 30,000 to INR 40,000 for a 10-month trawling operation (Salim et al., 2010). In some areas, the tindal (boat skippers) received INR 10,000 to INR 12,000 per month, the crew earned INR 2,000 to INR 4,000 per month, and trained skippers received INR 13,000 to INR 14,000 per month (Siar et al., 2011).

b) In Rameswaram, Tamil Nadu, the crew members received both a salary and gratuities. The weekly salary covered three fishing trips, amounting to INR 400 per week. If the crew members showed up for all three fishing trips in the week , they would receive a "tip", ranging from INR 100 to 150. (Stephen, 2014).
c) In Gujarat, seths (boat owners) made an advance payment ranging from INR 60,000 to INR 80,000 at the end of one season to secure recruitment services of the boat skippers for the following season (Nayak & Vijayan, 2003). The skippers recruited the khalasis (crew) for the next season by providing small advances to the crew (Nayak & Vijayan, 2003). Sometimes, skippers and crew received a small commission on extra earnings and/or received a bonus (Roshan, 2016). Generous owners would occasionally provide a bonus of INR 60,000 to skippers and INR 40,000 to crew (Roshan, 2016). Note: The wives of skippers usually stayed home to cook, clean, and spent time with their children (Roshan, 2016). Some fishers said they would be ashamed if their wives worked as they earned enough money to support the family (Roshan, 2016).
d) In Gujarat, local fishers were paid higher salaries than the migrants from Andhra Pradesh (Roshan, 2016).
e) Workers believed there would be an increase in landings after the seasonal ban, which incentivised them, as their wages were based on shares of landings, allowing them to earn more (Aswathy & Sathiadhas, 2005). Boat workers stated that the high season was sufficient to recover the costs incurred during the low seasons' (Bavinck et al., 2008).
f) Cooperatives helped fishers overcome financial difficulties (FAO & Lierens, 1978). For instance, one cooperative directly purchased lime shells from shell dredges[23], eliminating the middle dealers and protecting the financial interest of shell collectors (Rao, 1983).
g) In some areas, fish traders incentivised trawlers, such as a 'gift' of INR 800 to INR 1,000 for each small trawler during the Dussehra season (a Hindu festival). However, this arrangement also granted traders access to the trawlers' fish (Nayak & Navta, 1997).

Fishers continued in the trawl industry because of their additional sources of income and diversification of occupations (Salagrama, 2006). Below are some examples:

a) Trawlers engaged in other fisheries, with some using gillnets and hook-and-line operations for seer fish and tuna. During the rough weather and the fishing ban, trawlers engaged in shore-seine fishing (Diraviya Raj et al., 2017; Mohanraj et al., 2012).
b) Fishers persisted in trawling because of the supplemental income from their wives. Working wives of trawl owners earned a daily income ranging from INR 3,000 to INR 4,000. The income significantly contributed to the overall family earnings, as it was used to pay for the fishing supplies and operations (Siar et al., 2011).
c) Families involved in mechanised fishing had more diversified income sources than those engaged in motorised fishing (Dey et al., 2008). For example, in 1978, some fishing families earned additional income from agriculture, such as paddy fields (FAO & Copper, 1978).
d) In Tamil Nadu, fishing was a secondary occupation for the Seruvai and some Thevars. The Seruvai were the dominant caste resulting in political clout and making them leaders in fishing associations (Stephen, 2014).

Aquaculture development resulted in high demand for fish meal, prompting fishers to increase their landing of trash fish and low-value bycatch (Dineshbabu, 2013; Dineshbabu et al., 2013). Fishers capitalised on the

[23] A shell dredge, locally known as a "machine", was a semi-circle iron ring with a spike place and an iron chain dragged along the bottom Rao, G. S. (1983). Exploitation of clam shell deposits in the Kundapur Estuary. *Marine Fisheries Information Service Technical and Extension Series*(49), 20-22. .

commercialisation of bycatch to sustain their income (Gordon, 1991; Lobo et al., 2010; Mahesh et al., 2017; Sabu et al., 2006). Below are some examples from the literature:

a) In India, in 2001, the quantity of fish meal landed was 41,000 tonnes for shrimp culture and 200,000 tonnes for Indian carp culture (Dineshbabu, 2013). In West Bengal, 10-20% of the discards collected from trawlers were high enough in value to sell to retail markets (Gordon, 1991). Smaller trawlers in West Bengal found it financially viable to land more by-catch as long as it did not hinder the time fishing for shrimp. However, some trawlers faced difficulties because of the limited vessel capacity, and were unable to retain additional bycatch. Local fishers became collectors, purchasing the catch at no cost to the trawlers (Gordon, 1991). Gillnetters also approached trawlers at sea, travelling 6 to 7 hours to collect the discards and would repeat the journey four to five times a day. In exchange, gillnetters provided fresh provisions to the trawlers. The operating cost for gillnetters collecting fish from trawlers off West Bengal was INR 1,055, resulting in net revenue of INR 505 per day, with each gillnetter crew earning around INR 63 (Gordon, 1991). While revenue from collecting was not idea, it was comparable to their regular fishing activity for gillnetters.
b) In Nagapattinam, Tamil Nadu, interviews with trawler owners, trash fish dealers, and poultry feed manufacturers revealed that during the initial decade of trawling in the region, the trash fish was either discarded or sold as cheap manure for agricultural fields (Lobo et al., 2010). However, between 1990 and 2010, as the demand for trash fish grew, trawl owners sold to dealers (Lobo et al., 2010).
c) From January to May 1996, poor shrimp landings along the West Coast led to boat owners mainly depending on bycatch from trawl nets, especially whelks, for daily income (Philip & Appukuttan, 1997).
d) In 2019, in Mumbai, Maharashtra, approximately 60% of the catch from the trawling fishermen cooperative was sold to the fishmeal industries (Immanuel, 2020). In Tuticorin, Tamil Nadu, the development of fishmeal industries increased trash fish[24] auctions. The shrimp feed industry purchased trash fish at INR 15/kg, while the poultry industry bought the remaining trash fish at INR 10/kg (Immanuel, 2020).

4.2.5.2 Technical Upgrades

Fishers began to experience the depletion of fish resources and used technical upgrades to continue exploiting these resources (Dineshbabu, 2003; Dineshbabu & Manissery, 2009; Dineshbabu et al., 2001; Naomi et al., 2011; Narayanakumar & Sathiadhas, 2005; Raj et al., 2017; Stephen, 2014; Subramanian, 2003; Suseelan & Pillai, 1993; Unnithan et al., 2004). Fishers built onboard fish holds with ice to facilitate longer fishing trips (Subramanian, 2003). Additionally, they transitioned from 32 ft to 40 ft boats, with an engine capacity of 120hp (Subramanian, 2003). The technical upgrades instilled confidence among fishers, especially with the introduction of fibre coating on the boats' exteriors, providing greater buoyancy to the vessels (Subramanian, 2003). Fishers also modified their regular shrimp trawl nets by adding additional lead weights at closer intervals on the foot rope and some attached iron chains to disturb the shrimp from their burrows (Dineshbabu & Manissery, 2009).

4.2.5.3 Key costs ignored and costs minimised

Fishers chose to remain in the trawl industry by ignoring necessary expenses and seeking ways to reduce costs. This section primarily focuses on boat owners. Below are some examples found in the literature:

a) In Chennai, Tamil Nadu, boat owners formed alliances with the ruling political party, enabling them to avoid paying berth charges and neglect renewing their boat registration requirements (Nayak & Vijayan, 2003).

[24] In this case, the trawling fishermen cooperative in Mumbai, defined trash fish as “fish not fit for human consumption and fish offal which otherwise would have gone waste is purchased by this industry” (letter to the Chief Minister of Maharashtra) (Immanuel, 2020).

b) Owners minimised costs by investing little in safety equipment, resulting in substandard conditions of lifejackets, missing or improperly installed navigation lights, and the presence of safety equipment solely during inspections (Calvert, 1999; Gulbrandsen & FAO, 1998). A study conducted in 2000 on Sona boats found that improving safety measures would cost INR 72,000. This would include adequate bulwarks to protect the boat's sides and scuppers to allow excess water on deck to drain, complete installation of VHF (very high frequency) radios, raise hatch coamings to prevent water entry, secure hatch covers, doors and windows, improvements in watertight integrity, and the inclusion of life floats (Yadava et al., 2000).
c) In 2011, an assessment of the occupational health of fishers on trawlers in the Bay of Bengal highlighted the financial constraints faced by trawlers, resulting in the use of non-refined diesel. Non-refined diesel contains hazardous compounds, such as naphtha, kerosene, and volatile hydrocarbons, which pose risks to respiratory health. Fishers working on trawl boats had a greater likelihood of experiencing respiratory symptoms such as chronic phlegm, prolonged coughing, breathing difficulties, and reduced lung function compared to fishers not exposed to the fuel exhausts (Subhabrata et al., 2015).
d) In 2015, square-mesh trawl nets were introduced in Malvan, Maharashtra to reduce the bycatch of juvenile fish. Boat owners received these nets when promoted; however, only a few used them occasionally. One boat owner stated, "The problem is, we also catch fish that are small, to begin with, like anchovies and sole fish. The square mesh nets reduce our catch of these and decrease our profits" (Gupta et al., 2020).
e) In Ratnagiri, Maharashtra, trawl owners' knowledge of safety practices was assessed. While trawl owners demonstrated an awareness of ways to improve safety, many were reluctant to adopt safety devices. Most trawl owners used navigational equipment such as magnetic compasses but acquired few communication equipment, fish-finding and life-saving devices (Suryavanshi et al., 2014).

4.2.5.4 Subsistence

Only one study demonstrated the need to stay in trawling for subsistence (Rao, 1990). Fishers in the Godavari estuary and adjacent backwaters (mangrove mudflats in a network of tidal creeks) (Andhra Pradesh) irregularly used push and drag nets (non-motorised) to fish for subsistence (Rao, 1990).

4.2.6 Stay Fisher Chose Social

Fishers chose to stay in trawling for four social reasons (23% of stay, n=43 records, Table 19): persuasive power and authority of caste, boat owner association, and *ur panchayats* (informal village councils) on management in favour of trawling (section 4.2.6.1), minimal enforcement of trawl regulations (section 4.2.6.2), benefits from improved well-being, upholding values (section 4.2.6.3), and government succumbing to protests by trawlers (section 4.2.6.4) (Figure 31). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose social	% of stay	Section
Power, authority and self-management	17	40%	9%	4.2.6.1
Minimal enforcement and violation of regulations	15	35%	8%	4.2.6.2
Wellbeing and values	14	33%	7%	4.2.6.3
Protests and resistance	5	12%	3%	4.2.6.4

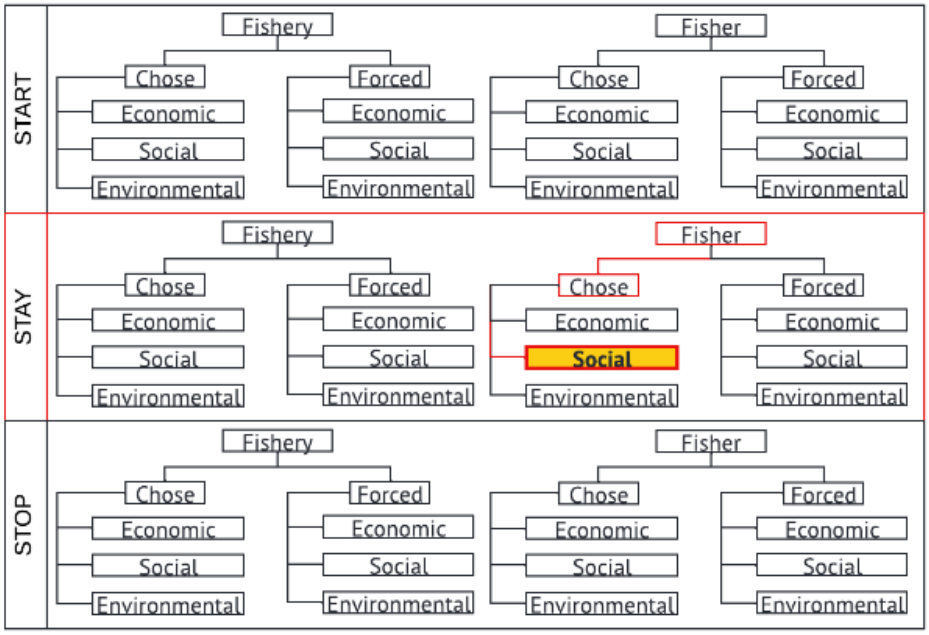


Figure 31. The total number of records (n) for each theme and percentages relative to fisher chose social and stay. The percentages for fisher chose social (n=43 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.6.1 Power, authority and self-management

Fishers often chose to remain in trawling because of the power and authority associated with it. Social groups, boat owner associations, *panchayats*, and political advantage fostered an environment for fishers to stay in the trawl industry.

Social groups and caste dynamics: Social groups played a significant role in determining power and authority, with areas dominated by a particular group or caste exhibiting greater control and improved management (Stephen, 2014). For example, Mandapam, and Rameswaram, two neighbouring trawl landing centres in Tamil Nadu, displayed contrasting outcomes. Mandapam exhibited higher compliance with regulations, better fish prices, and reduced discard, as opposed to Rameswaram. In Mandapam, Tamil Nadu, various social groups coexist, including Muslims, Paravars, and Konars, with the dominant community being Muslims. As a result of this dominance, local regulations, such as restrictions on new entrants into fishing, limitations on larger boats, and adherence to seasonal pair trawling, were strictly enforced (Stephen, 2014). On the other hand, in Rameswaram, Tamil Nadu, four primary social groups exist, namely Seruvai, Kadayars, Paravas, Thevars. However, here, the Seruvai, Thevars, and Paravas hold equal dominance, creating a situation where no single social group can fully exert control. Consequently, decisions made by one social group were often not followed by others, leading to a lack of a central authority and minimal compliance with regulations related to boat capacity and seasonal bans on pair trawling (Stephen, 2014).

Boat owner associations: Boat owners created boat owner associations that managed daily trawl operations, developed their fishery management approaches, exerted political influence, and engaged in lobbying efforts with both State and Central governments (Dialogue for Action, 2013; Scholtens, 2015). Below are some examples from the literature:

a) In some regions, the boat owner associations empowered themselves and self-managed the fisheries. The associations prohibited midwater trawling, molluscan conch shell (chank) fishing, the addition of new boats, and longline fishing by gillnet boats (which operated on the same rocky grounds as bottom trawling) (Subramanian, 2003). However, shrimp trawling remained unregulated despite its proximity to the shore, use of small-mesh sizes, and potential damage to fishing grounds (Subramanian, 2003).
b) In 1993, boat owners contested the monsoon trawl ban implemented in 1989 (Vijayan & Kurien, 1994). Although the boat owners failed to overturn the ban, they were granted permission to conduct "deep sea fishing" in the "open seas" during the trawl ban period, enabling them to continue fishing (Vijayan & Kurien, 1994).
c) The Fisheries Department banned pair trawling in Tamil Nadu in 2000, but the associations agreed to permit pair trawling from January to March in Palk Bay (Tamil Nadu), thus demonstrating their control over fisheries regulations (Stephen, 2014).
d) In Mandapam, Tamil Nadu, conflicts between trawl fishers and the small-scale gillnetters of Palk Bay were addressed by the boat owner associations and their leaders rather than the fisheries department (Stephen, 2014).
e) The boat owner association in Chennai, Tamil Nadu gained prominence within the ruling political party, resulting in fishing regulations not being implemented upon the association's request (Subramanian, 2003).

Ownership: Boat owners were known for their political connections, which granted them economic and political power in the trawl industry (Bavinck, 2018). By the late 1960s, trawl vessels were primarily owned by individuals outside the fishing community, particularly intermediaries (Vijayakumar & Chakravarty, 2018). The owners' political connections allowed the industry to persist despite declining profits. Owners received subsidies and long-term loans from the state; however, many owners defaulted on loan repayments due to their political connections. Loan repayment became contingent upon personal connections rather than the operational performance of the vessels, allowing owners to continue reaping lucrative returns even when defaulting on loan repayments (Kurien, 1993).

Ur Panchayats: The *ur panchayats* sometimes had control over the mechanised boat operators. In Puducherry, trawl fishers belonged to the "village elite" and were well-represented in many *ur panchayat,* giving trawl fishers power in the decision-making process. (FAO, 2016b).

4.2.6.2 Minimal enforcement and violation of regulations

Fishers remained in the industry partly because they could take advantage of the lack of enforcement by the government. The literature provides examples of how fishery regulations such as trawl exclusion were not enforced, resulting in mechanised boat owners exploiting the inshore fishing grounds (Achari, 1987; Hegde & Menon, 2017). This led to conflicts between trawlers and artisanal fishers.

a) The seasonal fishing ban prevented trawling, but *vallam* (country vessels) were allowed to keep fishing. In 2017 in Tuticorin, Tamil Nadu, catches included trash fish even during the ban period, which suggested that fishers were operating trawl nets from *vallam* (Jeyasanta & Patterson, 2017).
b) The Gulf of Mannar National Park and Biosphere Reserve affected many livelihoods. Individuals who used to fish and collect seaweed and shellfish were prohibited from going near the islands, causing severe disruptions to their lives. However, trawling continued unabated (Sharma, 2010), as trawl vessel owners – who had higher earnings – could bribe guards to allow them to keep fishing (Muralidharan & Ramesh, 2017; Scholtens et al., 2019).
c) Trawl owners overwhelmingly influenced harbours, and the port department lacked the authority to control their numbers (Siar et al., 2011).

d) Despite the Tamil Nadu Marine Fisheries Regulate Act being in force in Palk Bay, fishers blatantly increased the length and engine capacity to an illegal level (Stephen, 2014).
e) Trawlers from Rameswaram, Tamil Nadu engaged in illegal fishing activities in Sri Lankan waters at night (Stephen, 2014).
f) Large trawl boats violated curfews and restrictions imposed by the government during the COVID-19 pandemic lockdown. While traditional fishers adhered to the rules and regulations, trawlers continued fishing, resulting in detrimental impacts on the livelihoods of thousands of traditional fishers (Gokhale, 2020).
g) In Gujarat, Tamil Nadu, and Kerala, between 2016 and 2018, gillnet fishers were unsatisfied with the government's lack of enforcement for the ban on night trawling (Thomas et al., 2020)
h) When the sanctuary was declared in Orissa in 1997, the enforcement level was minimal, increasing turtle mortality because of continued trawling (Lahangir, 2006).

4.2.6.3 Wellbeing and values

Fishers chose to stay in trawling because of improved well-being and aligning their values with the occupation. Below are some examples from the literature:

In terms of well-being:

a) Fishers obtained better well-being by using large, imported trawl boats that provided spacious and hygienic accommodation and sanitation facilities, enhancing their overall living conditions (Bavinck, 2012; Roshan, 2016).
b) Technical upgrades such as fibre coating of the boats increased fishers' confidence because of the improved buoyancy (Nayak & Vijayan, 2003).
c) Fishers increased their use of mobile phones as service prices decreased, permitting them to stay connected with their families rather than experiencing prolonged isolation (Raj et al., 2017).
d) Trawl fishers enjoyed being their own bosses, having the time to spend with their families, and being part of a close-knit community, which was influenced by the caste-based aspect of the occupation (Bavinck, 2012).
e) Different regions in Tamil Nadu experienced diverse types of conflict. For example, fishers in Mandapam had a larger fishing area, avoiding encounters with the Sri Lankan Navy, unlike those in Rameswaram. The larger fishing area provided a better experience for the fishers and eased the process of sorting catch, which allowed for better catch quality and prices. Increased reliability of catch also allowed the fishers to earn a stable income, making them happy (Stephen, 2014). Additionally, protected harbour facilities in certain areas attracted trawlers from other regions during the monsoon season (Stephen, 2014).
f) In Maharashtra, trawlers shifted to deeper fishing areas and began engaging in group-based operations for mutual safety and information exchange (Salagrama, 2012).
g) The type of housing fishers had reflected their socioeconomic status. A study comparing traditional and mechanised fishing villages found that only 50% of mechanised fishers lived in huts while 80% of traditional fishers did (Bavinck, 2012). Villages with mechanised fishing likely had better housing (Bavinck, 2012).

Regarding values:

a) Owners had a sense of ownership of the sea (Stephen, 2014).
b) In some situations where owners ill-treated crew members, crew members had the autonomy to decide whether they wanted to work for the same owner the following year. Indeed, very few crew members worked for the same owner for three years (Nayak & Vijayan, 2003).

c) In some areas, such as Pentakota, Andhra Pradesh, marriages were arranged based on economic status. Within the boat-owning category, the social status differed based on the type of vessel owned, from non-motorised wooden catamarans to large Sona trawlers (Salagrama, 2006).
d) Fishers with the right fishing skills, or the "good" fishers, gained profits from their knowledge of good fishing grounds (Salagrama, 2006).
e) Caste-based occupation continued to impact certain regions of India, with interactions between caste, religion, and trawl vessel ownership. For example, in Rameswaram, Tamil Nadu, different castes had varying percentages of trawl ownership, Pravars (fishing caste) owning 60%, Seruvai (traditional occupation related to temples) owning 10%, Thevars (recent migrants and the dominant caste in lending money) and Kadayars (history of small-scale fishing) having minimal ownership (Stephen, 2014). Similarly, in Gujarat, the similarity between caste and economic status reduced conflicts among trawl boat owners (Johnson & Bavinck, 2010).

4.2.6.4 Protests and Resistance

Protests and resistance from trawlers exerted pressure and influenced government actions. Protests by fishers forced the government to return confiscated trawlers seized due to corruption charges. Pressure from trawl operators resulted in the government halting joint ventures and the foreign trawler policy (Brake, 2001; Gopakumar, 1996; Sall et al., 2002). Additionally, mechanised fishers protected their interests by influencing the government to reduce the fishing ban from 90 days to 65 days (Gunakar et al., 2017).

4.2.7 Stay Fisher Chose Environmental

Fishers chose to stay in trawling for two environmental reasons (24% of stay, n=46 records, Table 19): they could trawl in other locations (section 4.2.7.1) and exploit other species (section 4.2.7.2)(Figure 32). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose environmental	% of stay	Section
Fished in different locations	40	87%	21%	4.2.7.1
Change in exploited resources	9	20%	5%	4.2.7.2

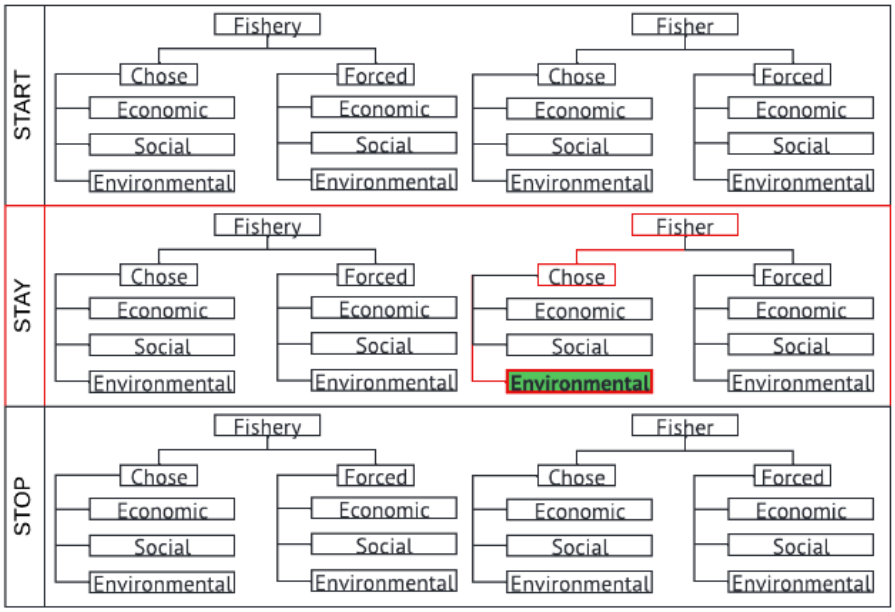


Figure 32. The total number of records (n) for each theme and percentages relative to fisher chose environmental and stay. The percentages for fisher chose environmental (n=46 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.7.1 Fished in different locations

Trawl fishers chose to stay in trawling because they could deploy several strategies: shifting their fishing location horizontally and vertically. They ventured into neighbouring states, fished in deeper waters, and engaged in illegal fishing (Bavinck, 2017; Bavinck et al., 2008; ICSF; Nandakumar et al., 2001; Pajot et al., 1982; Pravin et al., 1998; Rajan et al., 2001; Rao, 1988a; Rao et al., 1980; Salagrama, 2012; Samanta et al., 2018; Sehara, 1998; Suseelan & Pillai, 1993). The literature provides several examples of these strategies:

a) Initially, fishers focused on inshore grounds due to their productivity. However, as the fishing grounds in Chennai became depleted, fishers shifted their operations to the inshore waters of Andhra Pradesh, where the fishing grounds were less exploited and fishers could stay for longer (Bavinck, 2012; Suseelan et al., 1998). This presence of trawlers in inshore waters resulted in conflicts with traditional fishers (Pillai et al., 1998; Suseelan et al., 1998). Chennai fishers were also seen along the coasts of Orissa and Kakinada (Subramanian, 2003).
b) In Mangalore, Karnataka, between 1989 and 1990, fishers started fishing in deeper waters, to 150 meters. However, poor economic returns meant that fishers had to venture into even deeper waters by 1999-2000 (Dineshbabu et al., 2001). Eventually, in 2000, deep-sea trawl fishers started fishing at a depth of 500 meters, specifically targeting shrimp and lobsters (Dineshbabu et al., 2001). The initial success of deep-sea trawling resulted in more fishers modifying their trawlers for deep-sea fishing. The Mangalore deep sea trawlers landed their catch in Kerala because of competitive prices and the proximity of the harbour, allowing them to preserve the freshness of the catch (Dineshbabu et al., 2001).
c) In the early 1990s, during the trawl ban in Kerala, trawlers shifted their efforts to the coast of Kanyakumari District instead of remaining idle onshore (Gunakar et al., 2017).

The above examples primarily focused on trawlers fishing in Indian waters; there were also cases where trawlers illegally fished in foreign countries, specifically Pakistan and Sri Lanka.

a) Trawlers from Rameswaram and Nagapattinam, Tamil Nadu in the Palk Strait trawled illegally in Sri Lankan waters, especially during the seasonal trawl ban in Tamil Nadu (ICSF, 2004; Scholtens, 2015; Scholtens & Bavinck, 2013; Scholtens et al., 2019; Stephen, 2014). It was estimated that around 500 trawlers from Rameswaram were conducting fishing operations in Sri Lankan waters (Vivekanandan, 2003). Despite the Sri Lankan Navy guarding the seas during the day, the Rameswaram trawlers took advantage of the navy's absence after dusk, allowing them to fish in Sri Lankan territory until the morning (Stephen, 2014). Sri Lankan fishers protested against the Indian trawlers, stating that around 3,000 Indian trawlers were fishing in their waters and were negatively affecting their catch (PTI, 2020).
b) Fishers from Gujarat faced depleted fish stocks and declining fish quality within a 13 nautical miles radius because of climate change and industrial pollution. This resulted in fishers venturing into Pakistani waters in search of fish (Dialogue for Action, 2013; Ishita on behalf of The Research Collective, 2017; The Research Collective, 2018).

4.2.7.2 Change in exploited resources

Fishers initially focused on shrimp as their target species, but over time, declining catches led trawlers to shift their attention towards other species. Several instances highlight these shifts:

a) In 1982, in Palk Bay, Tamil Nau, pair trawlers adjusted their target species based on profitability, shifting among pomfrets, rainbow sardines, and prawns. Between February and April of 1982, Tamil Nadu boat owners focused on various fish, such as sardines and pomfrets. The large catches of pomfrets and rainbow sardines were unusual for the area. However, as yields declined in April, trawlers shifted back to prawns (Pillai & Sathiadhas, 1982).
b) In 1988 and 1989, trawlers from Visakhapatnam switched from prawns to deep-sea lobster because of low prawn catches (Rajan et al., 2001).
c) In Orissa during the 1990s, declines in fish resulted in fishers carrying a variety of nets on their boats, allowing them to select an appropriate fishing net based on the catch and fishing grounds (Salagrama, 2006). This approach allowed at least a minimal return on their investment or permitted them to target high-value species such as shrimp and seer fish (Salagrama, 2006).
d) In Gujarat in 2001, with declining shrimp catches, growing demand for the blue swimming crab (*Portunus pelagicus*) and development of a meat extraction unit, trawlers shifted their attention to crabs (Kizhakudan, 2002). The blue swimming crab became a high-value export item (Kizhakudan, 2002).
e) Along the Tuticorin, Tamil Nadu coast between 2016 and 2017, a few single-day trawlers with engine power ranging from 200 to 600 hp started catching a small amount of tuna (Kumar et al., 2019).
f) In Kerala, in the early 1980s, night-time trawling resulted in the capture of new species of prawns (Suseelan et al., 1982).
g) In 1996, in Quilon, Kerala, low shrimp catches resulted in local fishers using trawl nets to focus on bycatch, such as gastropods in the genus *Babylonia* (Philip & Appukuttan, 1997).

4.2.8 Stay Fisher Forced Economic

Fishers were forced to stay in trawling for two economic reasons (23% of stay, n=43 records, Table 19): accumulated loans, a never-ending cycle of debts, low set catch prices by buyers (section 4.2.8.1), and limited alternative employment (section 4.2.8.2) (Figure 33). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced economic	% of stay	Section
Loans, debt, and set price catches	39	91%	20%	4.2.8.1
Limited alternative employment and source of income	9	20%	5%	4.2.8.2

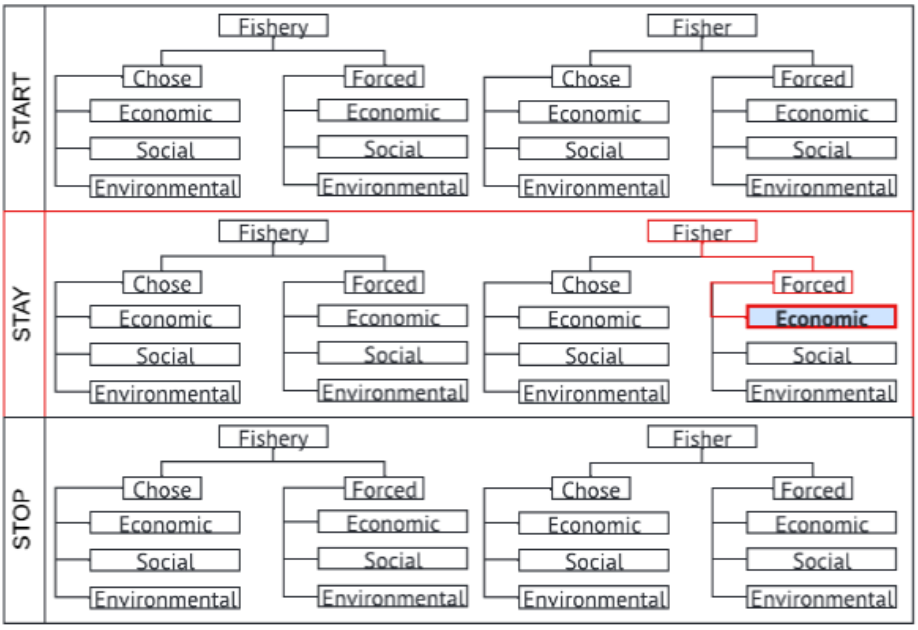


Figure 33. The total number of records (n) for each theme and percentages relative to fisher forced economic and stay. The percentages for fisher forced economic (n=43 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.8.1 Loans, debt, and set price catches

Accumulated loans, a never-ending cycle of debt and fixed catch prices trapped fishers in the trawl industry (Scholtens, 2015). The trawl fishing boom stopped in the 1998-1999 season when catches declined, resulting in financial hardship for trawl fishers (Johnson & Bavinck, 2010).

In 1950, loans and subsidies were introduced to relieve fishers of high equipment costs (Chidambaram, 1962). The method of loan recovery varied across states. In Chennai, Gujarat, and Maharashtra, fishers or cooperative societies directly repaid the loans, with fishers required to contribute 30% of their catch to the cooperative society after deducting fuel cost (Achari, 1987). In Kerala and Mysore, a percentage of the catch was paid to the government to repay the loan (Chidambaram, 1962); the loan repayment period ranged from five to eight years with variable interest rates (Achari, 1987; Chidambaram, 1962; Ratcliffe, Andreasson, et al., 1978; Ratcliffe, Hartmann, et al., 1978).

We classified the cycle of debt based on the level of seniority: i) owners indebted to merchants, intermediaries, and institutions, and ii) crew indebted to owners. Generally, owners and fishers obtained cash advances and loans from non-institutional agencies, such as merchants, intermediaries or traders, for various purposes such as diesel, operational costs, and survival during the off-season (Jeeva et al., 2012). A study on household debt in Sakthikulangara and Neendakara fishing villages in Kerala, where mechanisation was introduced, found that families were beholden to moneylenders (Silas & Alagarswami, 1980; Yadava, 2004). In Neendakara, 263 out of 429 families (61%) were in debt, and in Sakthikulangara, 770 out of 1209 families were in debt (64%)(Immanuel et al., 2003). Advances from non-institutional agencies and moneylenders only increased their debt because of higher interest rates than state banks and market rates. Banks were reluctant to loan to fishers to purchase boats, resulting in fishers relying on relatives and moneylenders for loans (Dialogue for Action, 2013).

Below are some examples of debt based on the seniority level:

a) Owners
   i. The Asian financial crisis in the 1990s decreased demand and catch prices, resulting in financial constraints. Trawl owners reduced their fishing time, and some had to sell their assets (Bavinck et al., 2008; Johnson & Bavinck, 2010). While the demand and prices recovered, trawlers then faced financial hardship because of increasing costs, such as diesel (Bavinck et al., 2008; Johnson & Bavinck, 2010). These economic struggles resulted in many owners wishing they could leave the industry.
   ii. In some regions of Tamil Nadu, owners attributed their financial hardship to inadequate diesel subsidies. Mechanised boats received a diesel subsidy of INR 1,500 per month, which covered only 43% of the cost, as the average fuel consumption was INR 3,500 per month (Jeeva et al., 2012).
   iii. In Chennai, Tamil Nadu, boat owners took out loans from merchants to sustain their fishing operations (Bavinck, 2012). In some instances, this resulted in traders and intermediaries gaining the rights over landings and setting low prices for the catch, exploiting the boat owners (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1968; Joel & Ebenezer, 1996; Sathiadhas, 2009; Siar et al., 2011; Silas et al., 1984; Vijayan et al., 1997; Vijayan & Nayak, 1997b). In Gujarat, trawl owners only retained 15 to 20 kg[25] of their catches, and the remaining was given to traders to repay for cash advances (Siar et al., 2011).
   iv. In Kerala, from 1981-1982, catches were very poor, resulting in negative net returns. This resulted in a depreciation of capital assets and fishers defaulting on insurance payments, signifying that fishers took the loss (Devaraj & Smita, 1988).
   v. In Gujarat, some boat owners were at the mercy of the skippers, who collected their seasonal advances and did not return to work (Nayak & Vijayan, 2003).
   vi. In Neendakara and Sakthikulangar, there were no public facilities available for boats to land their catches. Consequently, most boats had to land their catches on privately owned land, which often belonged to the owners of prawn processing facilities. To utilize these private jetties, fishers were estimated to pay the equivalent of 5% of the value of the fish they landed (FAO, 1972). Additionally, the fishers were obliged to surrender the prawns they caught to the landowner or the agent, who would then auction them at a standardized rate. This practice affected the income earned by the fishermen, as they did not receive the best market price for their landings, resulting in reduced earnings (FAO, 1972).
   vii. In some cases, fishers fell into a debt trap because of their poverty, with their current income from trawling used to repay loans. However, with prawn catches decreasing, fishers then had to take out more loans to own and operate their vessels (Brake, 2001; Salagrama, 2006). To further complicate the matter, when trawl boats were confiscated from fishers, fishers were still required to repay their loans, plunging them further into debt (Dialogue for Action, 2013).

b) Crew
   i. Crew members accumulated large loans from trawl owners; in some cases, the weight of the debt caused depression and even suicide (Lahangir, 2006).
   ii. Some crew members took out loans and became indebted when the trawl ban was imposed, as they required money during their time of unemployment (Bavinck et al., 2008; FAO & Directorate of Fisheries Tamil Nadu, 1978; Infantina et al., 2017; The World Bank, 2010).
   iii. Fishers faced higher interest rates when borrowing from sources other than state banks. Although the Fisheries Directorate assisted fishers with bank loans, a significant portion of the financing came from private entities such as moneylenders, who charged a higher interest rate

[25] A big trawler approximately landed 2.5-3 tonnes per trip and day boats landed 400 kg per day (Siar et al., 2011).

(Ratcliffe, Hartmann, et al., 1978). The high-interest rates permanently kept fishers indebted to intermediaries (Chidambaram, 1962). Moneylenders also charged fishers higher interest rates when they borrowed money during the trawl ban (Salim, 2007; Salim et al., 2010).

iv. Boatowners were responsible for sending the money to the workers' families, but payment was only made at the end of the season, leaving the workers' payment at the mercy of the owners (Nayak & Vijayan, 2003). Owners sometimes deceived skippers and did not provide the full settlements at the end of the fishing season (Nayak & Vijayan, 2003).

v. In Veraval, Gujarat, workers lacked contracts, and salaries were paid in advance, making the fishers indebted to the owners. Workers were sometimes subjected to exploitative work terms (Roshan, 2016).

4.2.8.2 Limited availability of alternative employment and source of income

Fishers were forced to continue trawling because of the scarcity of alternative employment opportunities (FAO, 1970b; Kurien, 1993; Scholtens, 2015). Below are some examples from the literature:

a) Most fishers other than trawl owners lived below the poverty line with fishing as their primary source of income (FAO & Directorate of Fisheries Tamil Nadu, 1978). A trawl fisher, age 61, expressed the fishing situation, stating, "If any fishing grounds close, we'll have to shut down our boats and go hungry" (Gupta et al., 2020).

b) In Ernakulam district, Kerala, among operators of large mechanised steel trawl boats, 91% (n=110) had fishing as their primary occupation (Jeeva et al., 2011). In Cuddalore and Nagapattinam, Tamil Nadu, 80% (n=30) of the owners of mechanised boats had fishing as their primary occupation (Jeeva et al., 2012). Therefore, the owners and operators primarily depended on trawling as their main source of income (The World Bank, 2010).

c) Labourers had limited alternative employment, with agricultural labour and boat repair and maintenance the only available options. Those jobs were highly seasonal and provided meagre wages (Salim, 2007; Salim et al., 2010).

d) In Kerala, the working fishers were more affected by diminishing catches than the capitalists/non-fisher owners. Capitalists had financial mobility and could move in and out of the fishery, but fishers were tied to the fishery by the lack of alternative economic opportunities (Kurien, 1993).

4.2.9 Stay Fisher Forced Social

Fishers were forced to stay in trawling for three social reasons (13% of stay, n=24 records, Table 19): minimal occupational mobility (section 4.2.9.1), exploitation and abuse making fishers beholden to employers (section 4.2.9.2), and the need to raise more money to afford dowry demands (section 4.2.9.3) (Figure 34). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced social	% of stay	Section
Minimal occupational mobility	20	83%	10%	4.2.9.1
Exploitation and abuse of labour	5	21%	3%	4.2.9.2
Demands for dowry	3	13%	2%	4.2.9.3

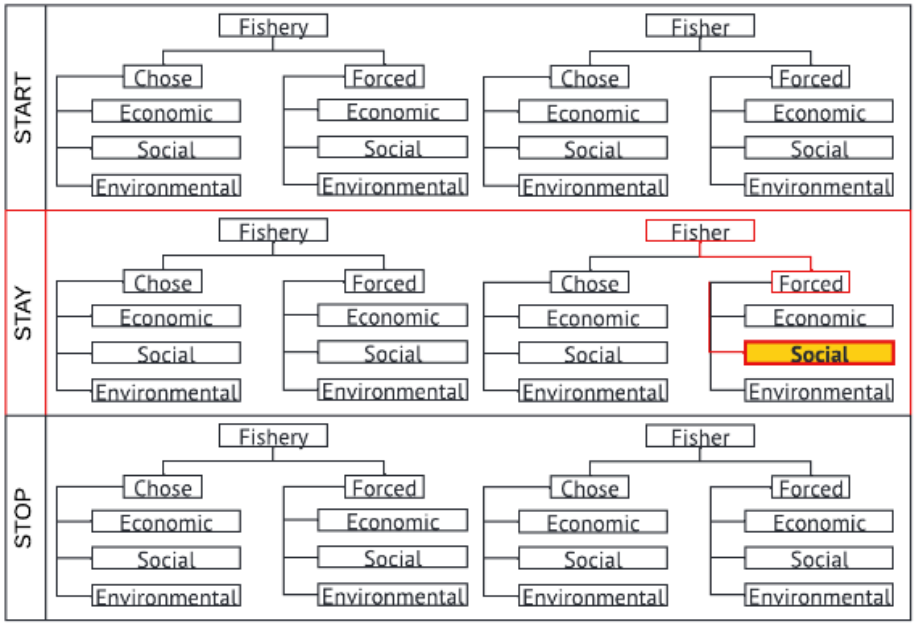


Figure 34. The total number of records (n) for each theme and percentages relative to fisher forced social and stay. The percentages for fisher forced social (n=24 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.9.1 Minimal occupational mobility

Restricted occupational mobility, influenced by caste, lack of skills, and poor education, forced fishers to remain in the trawling industry. Fishers were confined to their profession (Silas & Alagarswami, 1980).

a) The caste system played a role in determining employment opportunities, discouraging individuals from non-fishing castes from entering the fishing industry, except for entrepreneurs (FAO, 2000b). Similarly, it also discouraged the exit of fishers to other occupations.

b) Crew members struggled to develop alternative skills as most of their time was spent at sea (Salagrama, 2006). Trawl labourers from Gujarat, Southern Maharashtra and North India who migrated to Mumbai, Maharashtra had only extensive trawling experience, making it challenging for them to gain employment in other jobs (Salim, 2007; Salim et al., 2010; The World Bank, 2010).

c) Fishers and boatowners with limited education or literacy skills had difficulty leaving the trawl industry and struggled to find potential schemes for their development in other sectors (Bavinck, 2012; Gopakumar, 1996; Immanuel et al., 2003; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1968; Jeeva et al., 2011; Nayak, 2006; Nayak & Vijayan, 2003; Roshan, 2016; Salim, 2007; Salim et al., 2010; Silas & Alagarswami, 1980; Suryavanshi et al., 2014; The World Bank, 2010; Wasave & Sharma, 2016; Yadava, 2004).

4.2.9.2 Exploitation and abuse of labour

Fishers were exploited and abused, forcing them to remain in the industry. Migrant workers, in particular, faced even greater mistreatment than local labourers, being marginalised and exploited for cheap labour. Below are some examples from the literature:

a) The Inter-State Migrant Workmen Act (India) required formal contracts between employers and migrant workers. However, in Veraval, Gujarat, fishers did not have formal contracts, relying instead on oral agreements that made it difficult to dispute with authorities (Roshan, 2016). Conversely, Veraval fishers

with formal contracts and who were paid salaries in advance became indebted to owners, which resulted in the owners creating harsh work terms (Roshan, 2016).

b) Wageworkers suffered from exploitative practices related to wages, work hours, and rest hours, but the situation was even more dire for migrant workers. Specifically, mechanised vessels in Goa, Gujarat, Karnataka, Maharashtra, Mangalore, Rameswaram, and Tamil Nadu employed migrant workers who were susceptible to labour abuse (ICSF & South Indian Federation of Fishermen Societies, 2004).
c) Migrant fishers from Andhra Pradesh working in Gujarat were exploited by owners (Roshan, 2016). Migrants felt coerced to work on boats when the conditions were rough, and the boat owners were abusive when the target catch was not met (Roshan, 2016). Fishers preferred the salary-based system over commissions based on fish caught, given that owners could alter fish prices. (Roshan, 2016).
d) Trawlers increased fishing distances and trip durations, adding pressure for the crew (Salagrama, 2012). With limited representation in fisheries policies, migrants were particularly susceptible to harsh working conditions. However, because migrants were willing to work under challenging conditions and on longer voyages, they became key to the survival of the industry (Salagrama, 2012).

4.2.9.3 Demands for dowry

The practice of dowry forced fishers to remain in the trawl industry. Dowries, gifts from the bride's family at the time of marriage, consisted of money but also included assets such as crafts and gear. As the fishing industry became more capital-intensive, the practice of dowry became increasingly prevalent (Nayak, 2006; Nayak & Vijayan, 2007). Fishers had to raise large amounts of money to afford the dowry, and the amount paid varied depending on the social status or the hierarchy of the groom's family (G. Mathew, 2004). Unfortunately, families unable to pay a dowry ended up with unmarried daughters (Nayak, 2006).

4.2.10 Stay Fisher Forced Environmental

Fishers were forced to stay in trawling for two environmental reasons (1% of stay, n=2 records, Table 19): negative impacts of the tsunami (section 4.2.10.1) and the COVID-19 pandemic (section 4.2.10.2) (Figure 35). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced environmental	% of stay	Section
Tsunami	1	50%	1%	4.2.10.1
COVID-19 pandemic	1	50%	1%	4.2.10.2

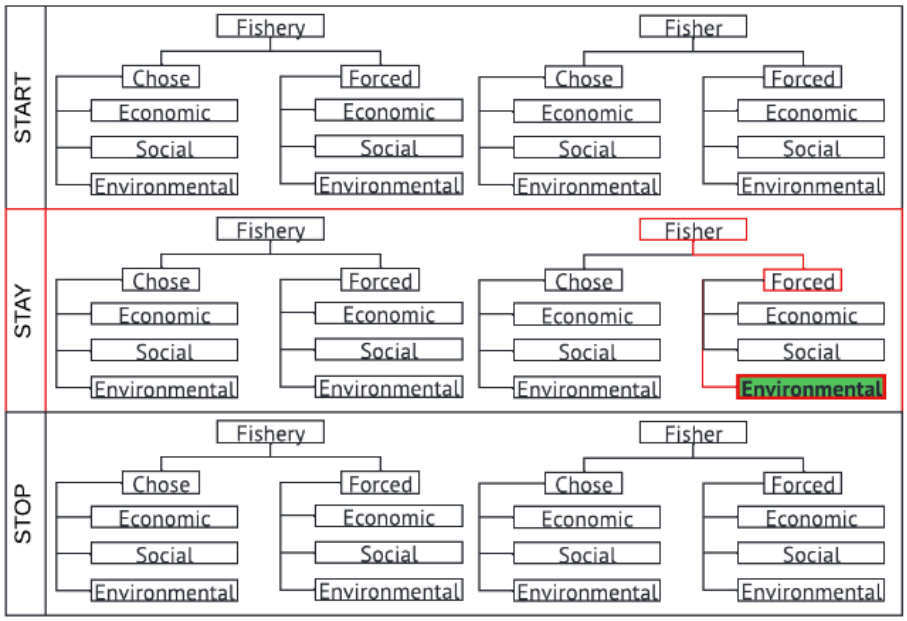


Figure 35. The total number of records (n) for each theme and percentages relative to fisher forced environmental and stay. The percentages for fisher forced environmental (n=2 records) and stay (n=191 records) were calculated based on the distinct value rather than the total value.

4.2.10.1 Tsunami

The negative impacts of the tsunami forced fishers to remain in the trawl industry. After the tsunami, there was an increase in competition for better catches and fishing pressure, which forced fishers to modify their vessels. Fishers adopted fuel-efficient vessels, larger boats, improved fishing gear, and steel trawlers (Jeeva et al., 2012). Fishers who lost their vessels during the tsunami were burdened with debts ranging from INR 6 to INR 12 lakhs[26] (Jeeva et al., 2012), in addition to the new investments made post-tsunami.

4.2.10.2 COVID-19 Pandemic

The negative consequences of the COVID-19 pandemic forced fishers to stay in the trawl industry. In Veraval, Gujarat, in the mechanised sector, 4,000 fish workers from Andhra Pradesh were stranded at the harbour, facing many challenges. Many were not paid their wages and lost their accommodations (Vohra, 2020). Furthermore, the lack of transport coordination between states further complicated matters for migrant fishers, leaving them desperate. This resulted in fishers borrowing money from boat owners to travel back home and falling into more debt.

[26] Refer to the glossary for a definition

4.3 Stop

This section shows a different trend from the start and stay. Social reasons dominated in stop rather than economic, as seen in start and stay (Figure 36) (Table 20). In addition, we see a greater frequency of fishers being forced rather than choosing, as seen in start and stay. This section covers the findings for each theme (Figure 37). There are 12 sub-sections. Six of them relate to the fishery stopping: fishery chose economic (section 4.3.1), fishery chose social (section 4.3.2), fishery chose environmental (section 4.3.3), fishery forced economic (section 4.3.4), fishery forced social (section 4.3.5), and fishery forced environmental (section 4.3.6). A further six sections relate to the fishers themselves: fisher chose economic (section 4.3.7), fisher chose social (section 4.3.8), fisher chose environmental (section 4.3.9), fisher forced economic (section 4.3.10), fisher forced social (section 4.3.11), and, fisher forced environmental (section 4.3.12).

The total used to calculate the percentage of each theme was the aggregate economic, social and environmental values. For example, in Stop – Fishery – Chose – Economic - Subsidies, we used the total of stop to calculate the percentage of the theme subsidies.

Table 20. Percentages of the pillars of sustainability within fishery chose, fishery forced, fisher chose, and fisher forced for STOP (percentages calculated using total distinct value, n=93 records).

STOP Pillars	Fishery Chose	Fishery Forced	Fisher Chose	Fisher Forced
Economic	10%	2%	10%	16%
Social	9%	24%	5%	45%
Environmental	2%	2%	5%	29%

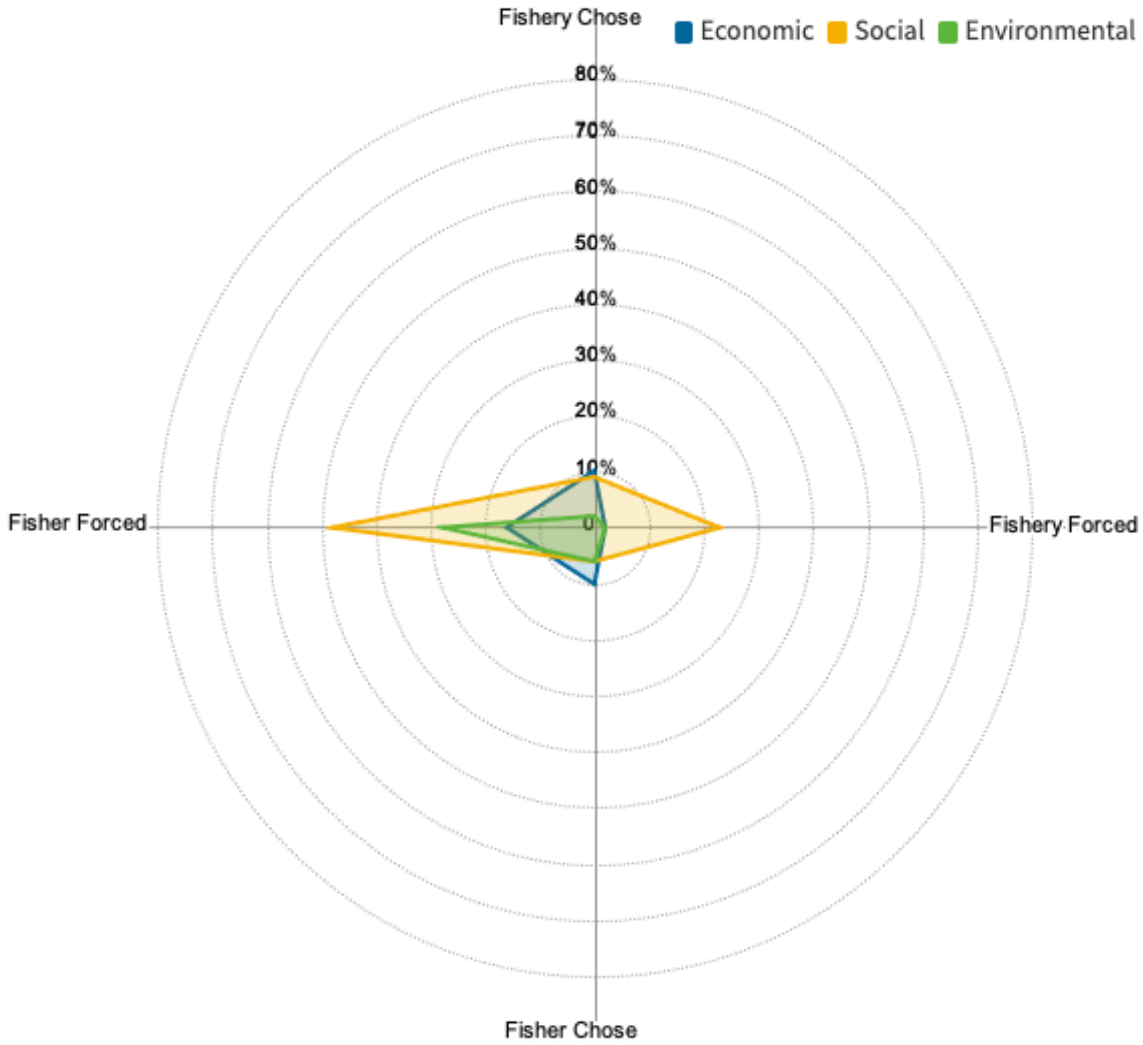


Figure 36. Stop: comparing the pillars of sustainability within fishery chose, fishery forced, fisher chose, and fisher forced (percentages calculated using total distinct value, n=93 records)

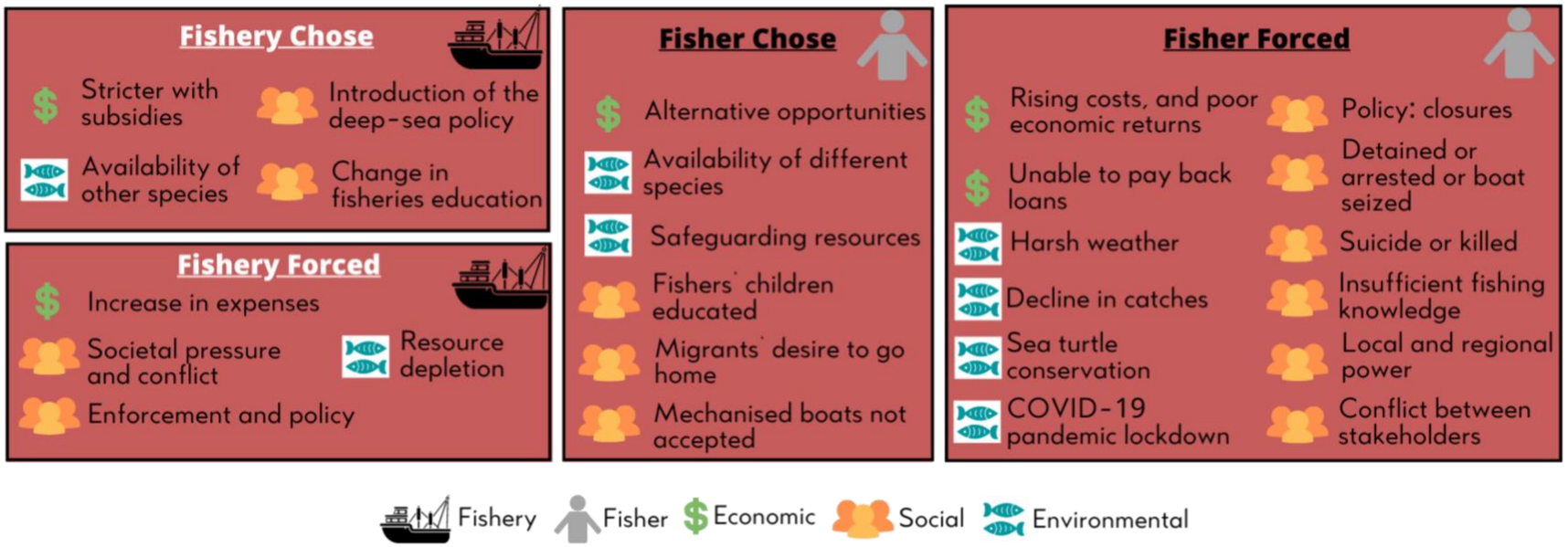


Figure 37. List of themes for why fishery and fishers STOP trawling.

4.3.1 Stop Fishery Chose Economic

The fishery chose to stop trawling for one economic reason (10% of stop, n=9 records, Table 20): diminished subsidies by the government (section 4.3.1.1) (Figure 38).The theme is discussed in further detail in the section below.

Themes	n	% of fishery chose economic	% of stop	Section
Subsidies	9	100%	10%	4.3.1.1

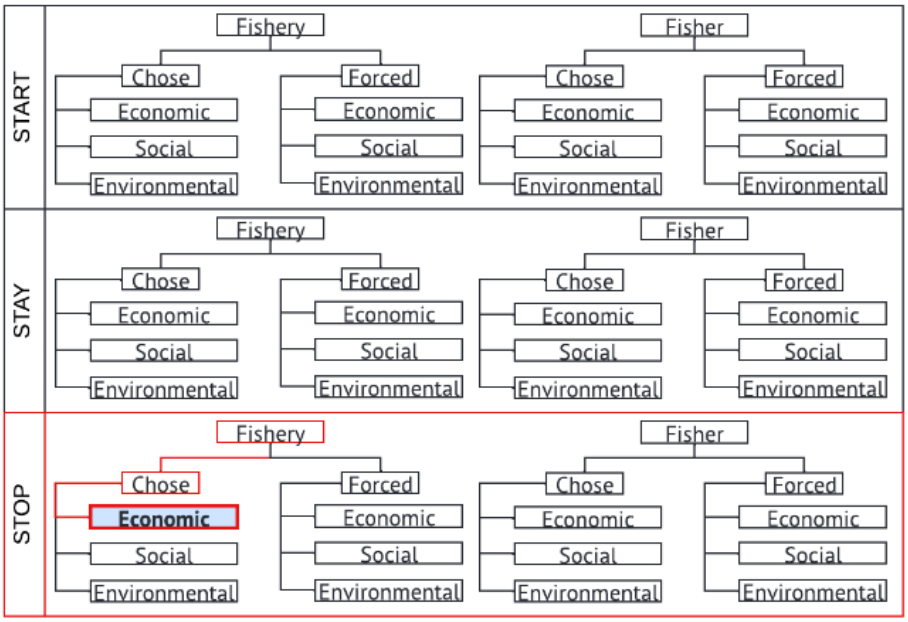


Figure 38. The total number of records (n) for each theme and percentages relative to fisher chose economic and stop. The percentages for fishery chose economic (n=9 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.1.1 Subsidies

The fishery chose to stop trawling as the government became stricter about diesel subsidies and, in some cases, discontinued tokens for subsidised diesel (Bavinck et al., 2008; Nayak & Vijayan, 2007). For instance, in Veraval, Gujarat, the trawl fishery sustained itself with state diesel subsidies, export markets, and surimi plants (Nayak & Vijayan, 2007).

The Indian government addressed the overcapacity in the shrimp trawl fisheries by implementing financial assistance and subsidy schemes aimed at converting trawlers into longline vessels for tuna fishing (APFIC, 2009; Premchand et al., 2015; Premchand et al., 2013; Premchand et al., 2014; Vivekanandan, 2013). An example of this initiative took place in Palk Bay in 2017, where the plan involved removing 2,000 trawlers by 2020 and replacing them with deep-sea boats, with the state contributing INR 350 crore[27] towards the effort (Vijaykumar, 2017).

[27] Refer to the glossary for a definition

4.3.2 Stop Fishery Chose Social

The fishery chose to stop trawling for two social reasons (9% of stop, n=8 records, Table 20): appeal of the deep-sea policy focusing on the introduction of resource-specific vessels such as longliners (section 4.3.2.1) and shift of the education system from manual fishing labour to entrepreneurship such as fish processing units and aquaculture farms (section4.3.2.2) (Figure 39). The themes are discussed in further detail in the section below.

Themes	n	% of fishery chose social	% of stop	Section
Deep-sea policy	7	88%	8%	4.3.2.1
Change in fisheries education	1	13%	1%	4.3.2.2

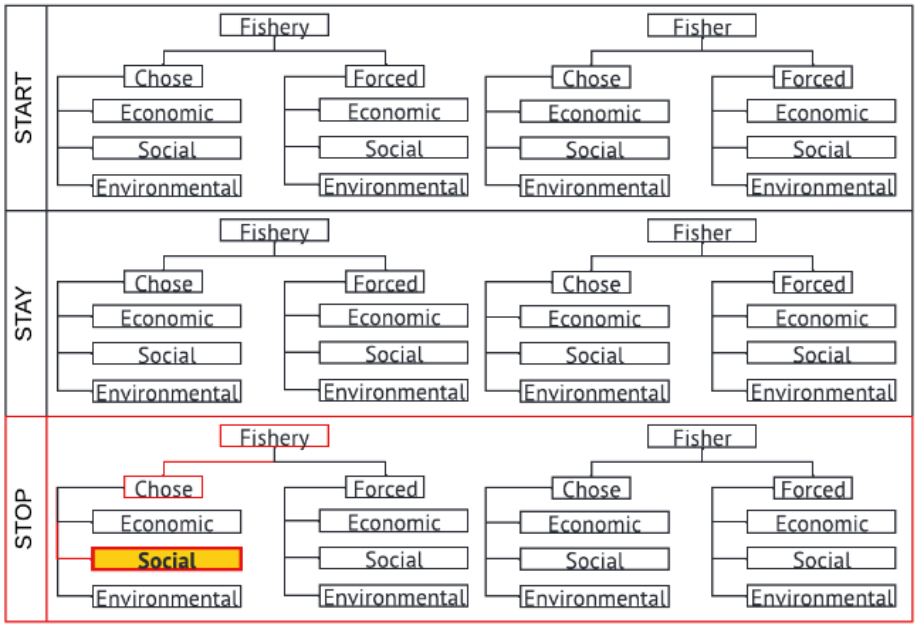


Figure 39. The total number of records (n) for each theme and percentages relative to fisher chose social and stop. The percentages for fishery chose social (n=8 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.2.1 Deep-sea Policy

The government introduced the deep-sea policy, which shifted the focus to deep-sea resources rather than trawling (APFIC, 2009; FAO, 2007; Premchand et al., 2015; Premchand et al., 2013; Premchand et al., 2014; Vijaykumar, 2017; Vivekanandan, 2013). For example, during the 10th five-year plan (2002–2007), the Government of India, through the Ministry of Agriculture, provided financial help to coastal trawlers, mainly shrimp trawlers to convert their vessels into tuna longlining operations (Premchand et al., 2013).

4.3.2.2 Change in fisheries education

Fishery chose to stop trawling because of a shift in the education system. For example, the Veraval, Gujarat education system promoted and supported change from manual labour to entrepreneurship. In fisheries college, the undergraduate courses focused on business models, aquaculture, fish processing, marketing, supply chain and culinary aspects – with minimal focus on labour (Roshan, 2016).

4.3.3 Stop Fishery Chose Environmental

The fishery chose to stop trawling for one environmental reason (2% of stop, n=2 records, Table 20): good returns from other species (section 4.3.3.1) (Figure 40). The theme is discussed in further detail in the section below.

Themes	n	% of fishery chose environmental	% of stop	Section
Availability of other species	2	100%	2%	4.3.3.1

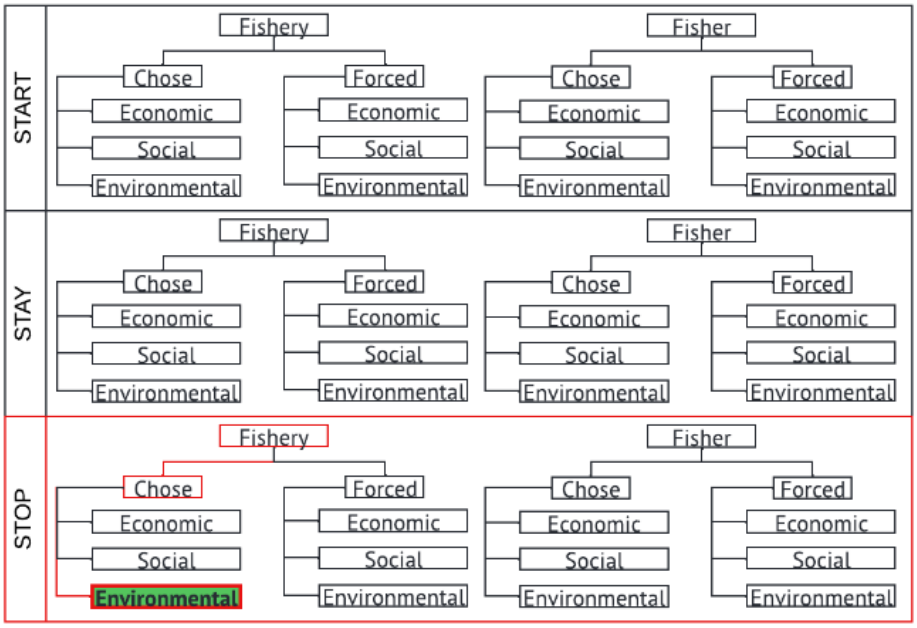


Figure 40. The total number of records (n) for each theme and percentages relative to fishery chose environmental and stop. The percentages for fishery chose environmental (n=2 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.3.1 Availability of other species

Fishery chose to stop trawling because of the good returns from other species. For example, in Andhra Pradesh, in the early 2000s, good returns on yellowfin tuna prompted trawlers to convert their boats to longliners (Abdussamad et al., 2012; FAO, 2007).

4.3.4 Stop Fishery Forced Economic

The fishery was forced to stop trawling for one economic reason (2% of stop, n=2 records, Table 20): increased expenses (section 4.3.4.1) (Figure 41). The theme is discussed in further detail in the section below.

Themes	n	% of fishery forced economic	% of stop	Section
Increase in expenses	2	100%	2%	4.3.4.1

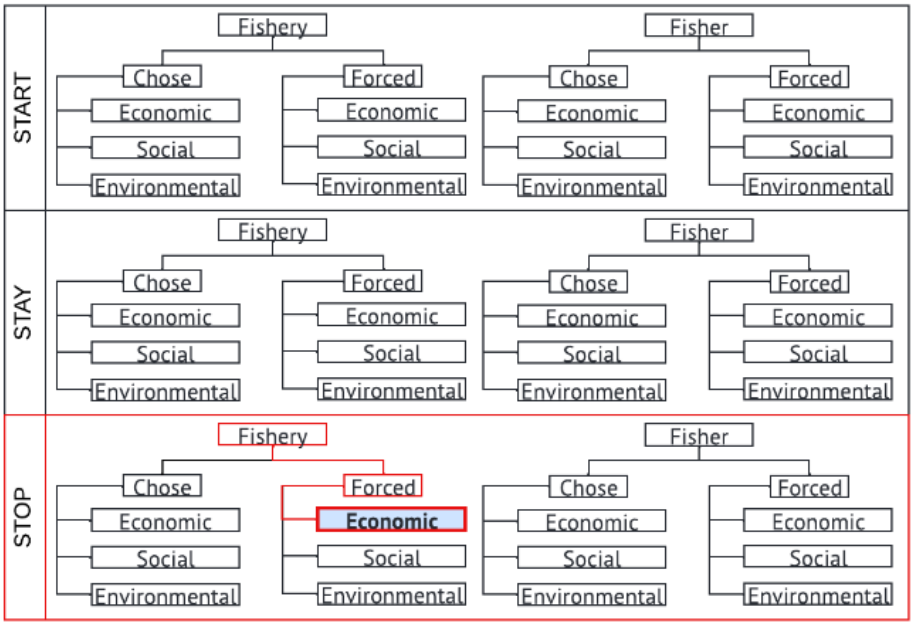


Figure 41. The total number of records (n) for each theme and percentages relative to fishery forced economic and stop. The percentages for fishery forced economic (n=2 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.4.1 Increase in expenses

The fishery was forced to stop as a result of increasing expenses. Rises in global market fuel prices increased operational costs even while shrimp prices declined (Bavinck et al., 2008). In the early 1900s, attempts were made to engage in deep-sea trawling, but these were unsuccessful (Rao, 1968). While several factors contributed to the lack of success, the primary reason was that costs were high compared to yields (Rao, 1968).

4.3.5 Stop Fishery Forced Social

The fishery was forced to stop trawling for two social reasons (24% of stop, n=22 records, Table 20): societal pressure from unions, small-scale fishers, artisanal fishers and conservationists pushing the government to introduce fisheries legislations to end trawling (section 4.3.5.1), and enforcement of policy (section 4.3.5.2) (Figure 42). The themes are discussed in further detail in the section below.

Themes	n	% of fishery forced social	% of stop	Section
Societal pressure and conflict	19	86%	20%	4.3.5.1
Enforcement of policy	5	23%	5%	4.3.5.2

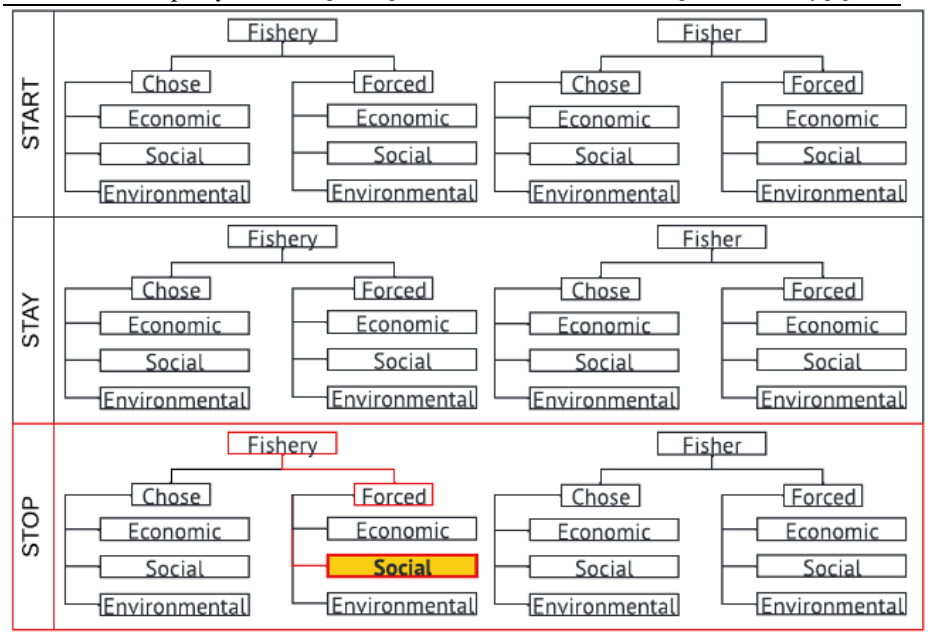


Figure 42. The total number of records (n) for each theme and percentages relative to fishery forced social and stop. The percentages for fishery forced social (n=22 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.5.1 Societal pressure and conflict

Societal pressure from unions, small-scale fishers, artisanal fishers, and conservationists pushed the government to introduce fisheries legislations which forced the fishery to stop trawling (Archari, 1994; Bavinck, 2018; Bavinck et al., 2008; Bavinck & Kooiman, 2013; Brake, 2001; FAO, 1991, 2011, 2016b; Gunakar et al., 2017; Hegde & Menon, 2017; Kurien, 1993, 1995; Lahangir, 2006; Ramesh & Rai, 2017; Scholtens & Bavinck, 2013; Sridhar, 2015; Suseelan et al., 1982; Vijaykumar, 2017; Vivekanandan et al., 2019). For example, in 1978, protests by artisanal fisher unions against trawlers propelled the development of the monsoon trawl ban, which started in 1989 (Brake, 2001).

4.3.5.2 Enforcement of policy

The fishery was forced to stop trawling because regulations long standing regulations were better enforced. Below are some examples from the literature:

i. The government enforced fishing depth limitations in 1983, requiring deep-sea vessels to fish beyond the 80-meter depth line (Devaraj, 1995; Vijaykumar, 2017). This limitation affected the deep-sea chartered and joint venture trawlers, which typically fished up to depths of 50 meters, resulting in the vessels leaving the country (Devaraj, 1995; Vijaykumar, 2017). However, big Indian trawlers, which essentially operated as deep-sea vessels, from Visakhapatnam, Andhra Pradesh kept operating in the shallow areas (Devaraj, 1995). Therefore, whilst the enforcement reduced the number of foreign vessels, it did not do much to help the local vessels.

ii. In 1997, the Gahirmatha marine sanctuary was established in Orissa to protect marine turtles. However, for the initial two to three years, regulations were minimally enforced, increasing turtle mortality. Between 1993 to 2006, more than 129,000 turtles were found dead in Orissa, resulting in pressure from conservationists. Subsequently, the Coast Guard and Forest Departments started strictly patrolling the area (Lahangir, 2006).

iii. In the year 2000, the High Court in Goa took decisive action against violations of the trawl ban. The licenses of all registered trawlers were suspended with the Fisheries Department of Goa and closed the seven official jetties used for unloading trawl catches (ICSF, 2000).

4.3.6 Stop Fishery Forced Environmental

The fishery was forced to stop trawling for one environmental reason (2% of stop, n=2 records, Table 20): resource depletion (section 4.3.6.1) (Figure 43). The theme is discussed in further detail in the section below.

Themes	n	% of fishery forced environmental	% of stop	Section
Resource depletion	2	100%	2%	4.3.6.1

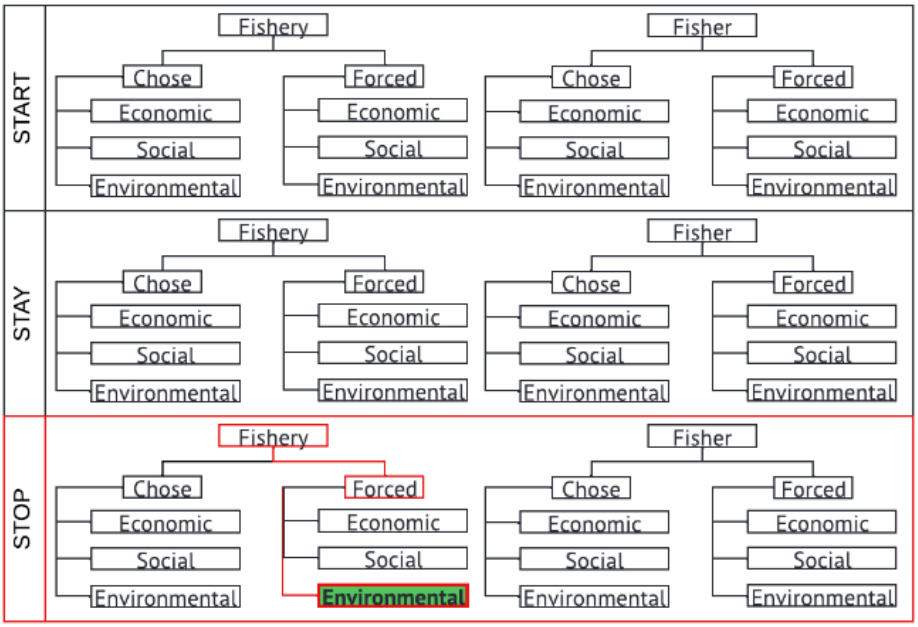


Figure 43. The total number of records (n) for each theme and percentages relative to fishery forced environmental and stop. The percentages for fishery forced environmental (n=2 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.6.1 Resource Depletion

The rapid exploitation of fishery resources during the 1990s resulted in resource depletion (Bavinck et al., 2008). In Gujarat, a reduction in shrimp caught per boat, along with increased fuel prices, bad weather conditions, the ban imposed by seafood-importing countries, resulted in a decrease in the number of trawl vessels (Dineshbabu, 2003).

4.3.7 Stop Fisher Chose Economic

Fishers chose to stop trawling for one economic reason (10% of stop, n=9 records, Table 20): awareness of other economic opportunities (section 4.3.7.1) (Figure 44). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The theme is discussed in further detail in the section below.

Themes	n	% of fisher chose economic	% of stop	Section
Alternative opportunities	9	100%	10%	4.3.7.1

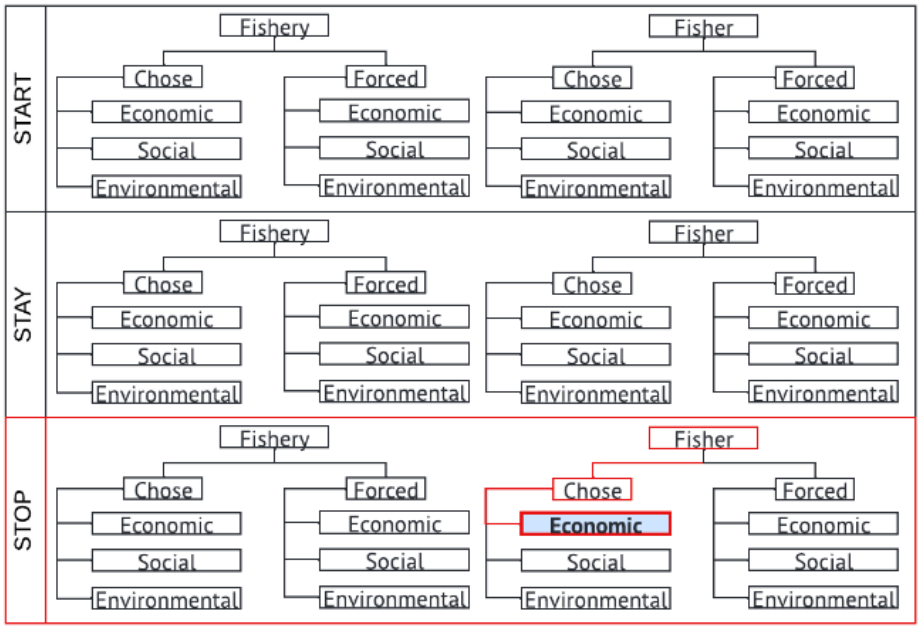


Figure 44. The total number of records (n) for each theme and percentages relative to fisher chose economic and stop. The percentages for fisher chose economic (n=9 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.7.1 Alternative opportunities

Some fishers chose to leave trawling because of a pessimistic outlook on the future of the trawl fishery and the recognition of alternative economic opportunities (Bavinck, 2012; FAO, 2016b). Entrepreneurs, for instance, shifted from shrimp trawling to gillnet fishing as it was a more lucrative (FAO, 1972). Some boat owners moved to other businesses after generating sufficient funds from trawling (Nayak, 2006). Young fishers started searching for more lucrative job opportunities in Singapore and the Gulf countries (Vivekanandan et al., 2019).

4.3.8 Stop Fisher Chose Social

Fishers chose to stop trawling for three social reasons (5% of stop, n=5 records, Table 20): increase in the education level of fishers' children (section 4.3.8.1), migrants' desire to go home (section 4.3.8.2), and mechanised boats not being accepted by some fishers (section 4.3.8.3) (Figure 45). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose social	% of stop	Section
Fisher's children educated	4	67%	4%	4.3.8.1
Migrants desire to go home	1	17%	1%	4.3.8.2
Mechanised boats not accepted	1	17%	1%	4.3.8.3

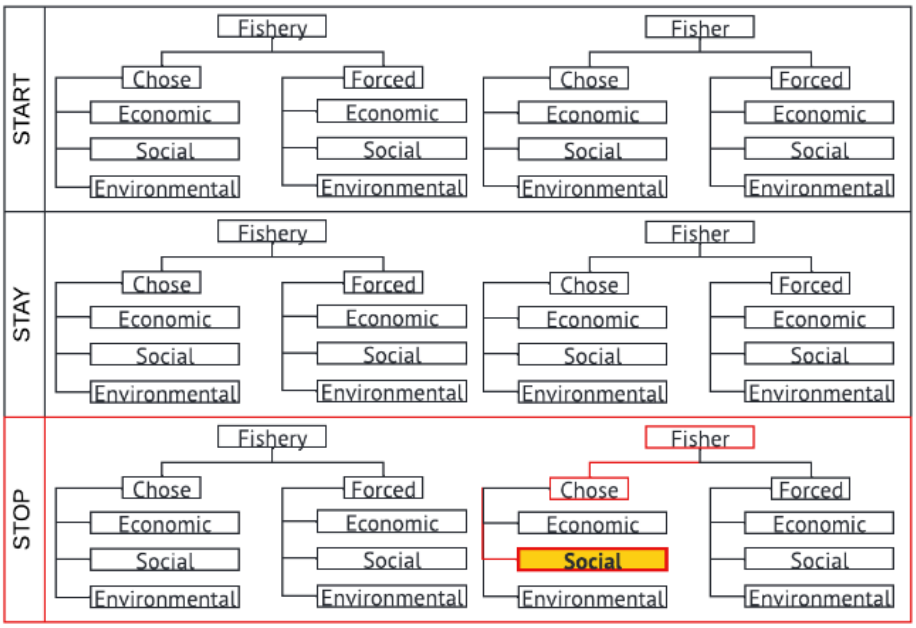


Figure 45. The total number of records (n) for each theme and percentages relative to fisher chose social and stop. The percentages for fisher chose social (n=5 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.8.1 Fisher's children educated

The next generation of fishers often chose not to enter the fishing industry. A value placed on education resulted in some fisher's children not following in their father's footsteps. Below are some examples from the literature:

i. Within the mechanised industry, families of migrant fishers prospered, resulting in changes for the next generation. The education of children increased, resulting in a generation that pursued college degrees and non-fishing careers (FAO, 2016b; Vivekanandan et al., 2019). Fishers who had 25 years of fishing experience but were fifth-grade drop-outs or had only studied until secondary school now had children with a college education, sons who had never gone fishing, or children with jobs in the city (Roshan, 2016; The World Bank, 2010).
ii. In Andhra Pradesh, the younger educated generation was not eager to go to sea or work in a dangerous and physically demanding occupation (The World Bank, 2010).
iii. In Karnataka, it was mainly the children of the boat owners and traders who pursued professional degrees in engineering, medicine and management (The World Bank, 2010).
iv. In Gujarat, more prosperous fishing communities sent their children to pursue higher education, with some pursuing business degrees to open processing plants (The World Bank, 2010).

4.3.8.2 Migrants' desire to go home

Fishers chose to leave trawling temporarily because of their desire to go home. The demand for the closed fishing season in Andhra Pradesh was said to have come from the migrant trawl fishers of Kerela, who wanted to use the time from March to May to return home (Nayak & Navta, 1997).

4.3.8.3 Mechanised boats not accepted

In the early 1980s, in Tuticorin, Tamil Nadu, when some boats were mechanised for experimental purposes, some fishers did not accept them, and the use of such boats was discontinued, at least at that time (Bapat & Kurian, 1981).

4.3.9 Stop Fisher Chose Environmental

Fishers chose to stop trawling for two environmental reasons (6% of stop, n=6 records, Table 20): availability of other species (section 4.3.9.1) and protecting marine resources (section 4.3.9.2) (Figure 46). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher chose environmental	% of stop	Section
Availability of other species	5	83%	5%	4.3.9.1
Safeguarding resources	1	17%	1%	4.3.9.2

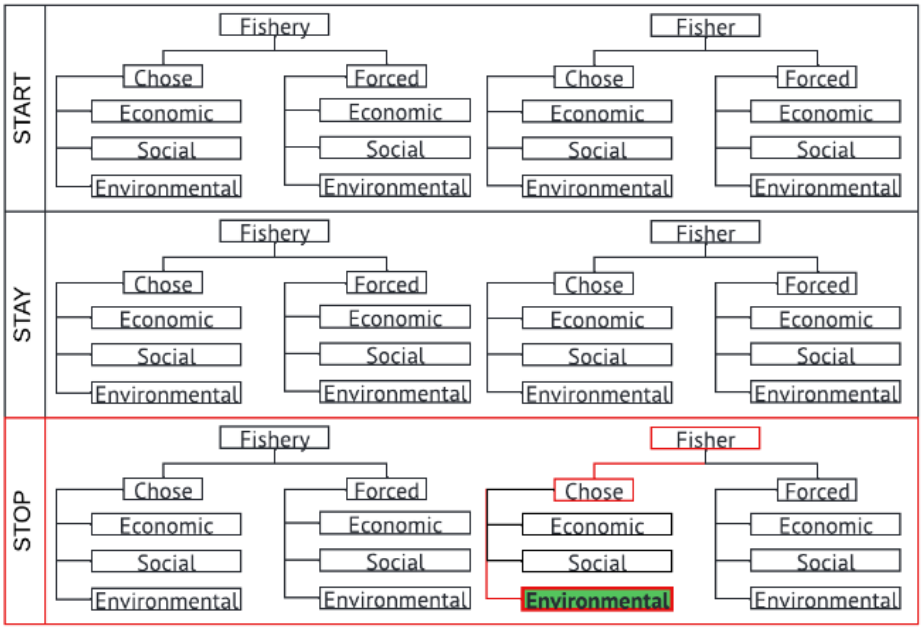


Figure 46. The total number of records (n) for each theme and percentages relative to fisher chose environmental and stop. The percentages for fisher chose environmental (n=6 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.9.1 Availability of other species

Fishers chose to leave trawling because of the availability of other species. For example, in Tamil Nadu, a small yet significant number of trawlers (39%) shifted to gillnetting to target high-value pelagic species (Bavinck, 2012; Bavinck et al., 2008). Also, in Chennai, rich fishing grounds of yellowfin tuna (*Thunnus albacares*) encouraged entrepreneurs to convert large trawlers to longliners (Anrose et al., 2013; Prathibha et al., 2008; Rohit & Rammohan, 2009).

4.3.9.2 Safeguarding resources

Some fishers chose to stop trawling as they wanted to protect marine resources. The trawlers in Pudukottai, Tamil Nadu used push nets, and the small traditional boats used mini trawls. While trawler captains agreed to fish only three days a week, the catches continued to decrease. Traditional fishers from 32 villages in Pudukkottai District decided to stop trawling; this was not an easy decision for their

livelihood (FAO, 2016a). However, owners with large trawl boats were against the ban because of their considerable investment in trawling (FAO, 2016a).

4.3.10 Stop Fisher Forced Economic

Fishers were forced to stop trawling for two economic reasons (16% of stop, n=15 records, Table 20): rising costs and poor financial returns (section 4.3.10.1) and inability to pay back loans (section 4.3.10.2) (Figure 47). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced economic	% of stop	Section
Rising costs, poor economic returns, and financial crisis	11	73%	12%	4.3.10.1
Unable to pay back loans	4	27%	4%	4.3.10.2

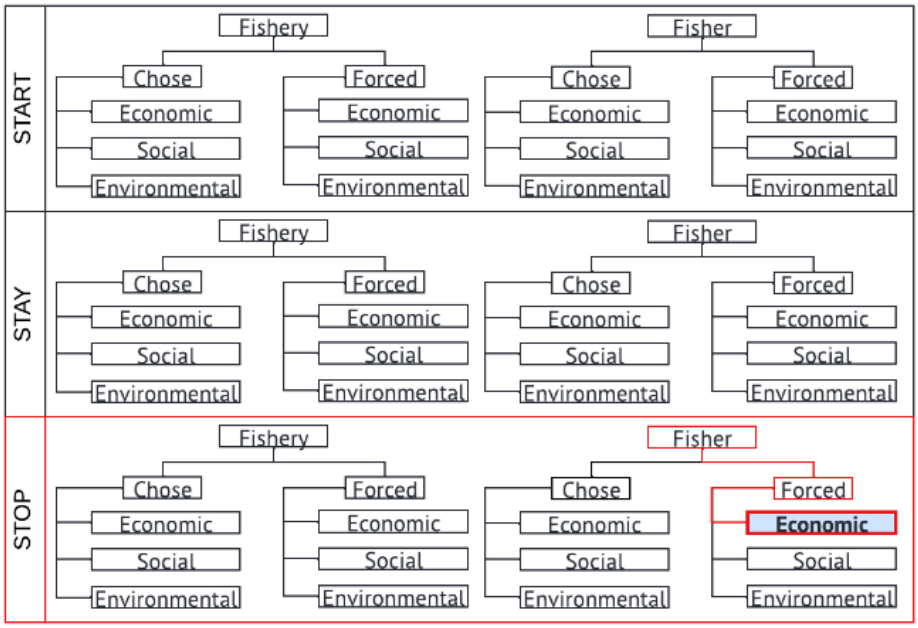


Figure 47. The total number of records (n) for each theme and percentages relative to fisher forced economic and stop. The percentages for fisher-forced economic (n=15 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.10.1 Rising costs, poor economic returns, and financial crisis

Fishers were forced to leave the trawling industry because of increased oil prices (~70-90% of trawl operational costs) (Scholtens & Bavinck, 2013), decreases in shrimp prices, seafood bans by importing countries (Dineshbabu, 2003; FAO, 2017), and/or increased expenses. The poor economic returns resulted in idle boats (Bavinck, 2012; Bavinck et al., 2008). Below are some examples from the literature:

i. As part of the fisheries development process, 180 foreign trawlers were introduced in India, owned by Indian entrepreneurs. However, the entrepreneurs owed large debts to the Shipping Credit and Investment Corporation of India and the project failed, with only 20 vessels continuing to operate (Kocherry et al., 1996).

ii. In Tuticorin, Tamil Nadu, some shrimp trawlers decided to sell their vessels because of minimal returns. While the owners initially purchased the boats for Rs 15-20 lakhs, they were sold at a price as low as Rs 5-7 lakhs. Some other trawl-owning entrepreneurs decided to modify their trawl boats for drift gillnet fishing or longline fishing (Balasubramaniam, 2000; Bavinck, 2012; Dineshbabu, 2003).

iii. In 1973, 556 trawlers remained idle in Kerala (Devaraj & Smita, 1988). The shrimp trawling industry became unprofitable for entrepreneurs and owners, resulting in idle fleets and owners willing to participate in buy-back programs (FAO, 1972; The World Bank, 2010).
iv. In Palk Bay, between 2002 and 2007, fuel prices increased by more than 50%, resulting in decreased profits and the sale of 400 trawlers to boat breakers (Scholtens & Bavinck, 2013).

4.3.10.2 Unable to pay back loans

Fishers were forced to leave the industry because they could not repay their loans. The inability to pay back loans led to seized boats (FAO, 1971; Sinha & Sampath, 1993) and the purchase of boats by fish traders from owners (Johnson & Bavinck, 2010). As a result, there was a shift in trawl ownership, transitioning from fishers to non-fishers (Lahangir, 2006; Sinha & Sampath, 1993). For example, the government introduced a refinancing scheme in Kerala to assist fishers with mechanised boats through soft loans. Unfortunately, due to improper channels and corruption, the scheme did not effectively reach the fishers (Sall et al., 2002). Fishers ended up with low quality boats, reducing their ability to secure sufficient catches. Inadequate catches led to delinquency on the loans and their boats being confiscated. In this case, fishers protested, and their boats were released (Sall et al., 2002).

4.3.11 Stop Fisher Forced Social

Fishers were forced to stop trawling for social reasons (46% of stop, n=43 records, Table 20): enforced annual trawl closures (dominant) (section 4.3.11.1), being detained or arrested and having boats seized for illegal fishing (section4.3.11.2), committing suicide from debt pressure, being killed at sea by dangerous weather events, or being killed when fishing illegally because of misidentification by authorities (section 4.3.11.3), drowning because of minimal safety equipment onboard (section4.3.11.4), local and regional power deterring trawlers from fishing (section 4.3.11.5), insufficient trawl knowledge to maintain good catches (section 4.3.11.6), and conflict between stakeholders preventing trawling (section 4.3.11.7) (Figure 48). Fisher includes crew, captain, operator, skipper, driver, tindal, and owner. The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced social	% of stop	Section
Policy	17	40%	18%	4.3.11.1
Detained, arrested, or boat seized	11	26%	12%	4.3.11.2
Suicide or killed	7	16%	8%	4.3.11.3
Minimal safety equipment	6	14%	6%	4.3.11.4
Local and regional power	3	7%	3%	4.3.11.5
Insufficient knowledge	2	5%	2%	4.3.11.6
Conflict between stakeholders	2	5%	2%	4.3.11.7

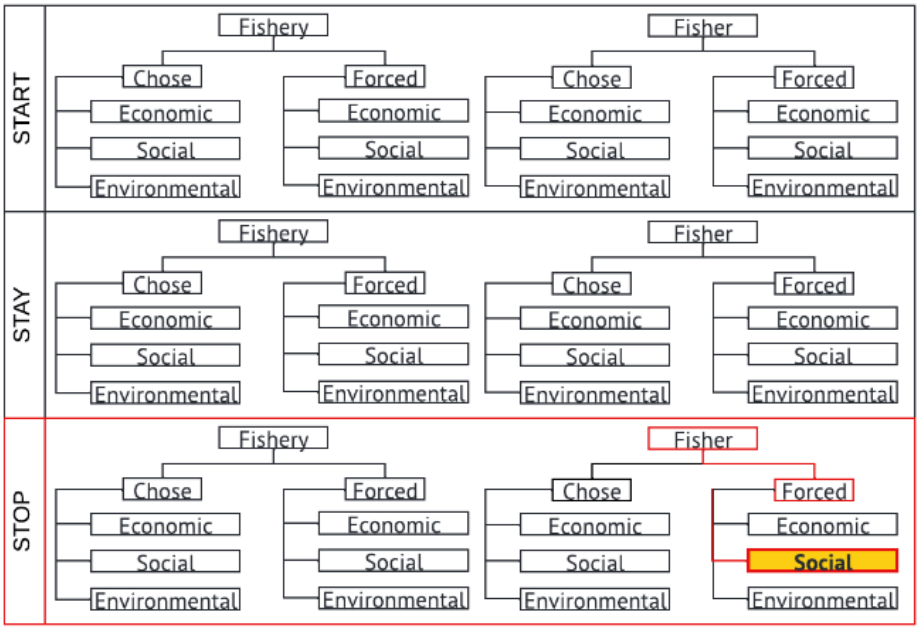


Figure 48. The total number of records (n) for each theme and percentages relative to fisher forced social and stop. The percentages for fisher forced social (n=43 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.11.1 Policy

Policies, such as the annual trawl closure, forced fishers to stop trawling for several months (Aswathy & Sathiadhas, 2005; Bavinck et al., 2008; FAO, 1970a; Gunakar et al., 2017; Immanuel et al., 2003; Infantina et al., 2017; IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963; Kurien, 1993; Lahangir, 2006; Nandakumar et al., 2005; Salim, 2007; Salim et al., 2010; Sehara, 1998; Srinath et al., 2002; Stephen, 2014; Vijayan et al., 2000; Vivekanandan, 2013).

4.3.11.2 Detained or Arrested or Boat Seized

Fishers were forced to leave trawling as they were detained or arrested, or their boats were seized.

i. Trawlers from Tamil Nadu fished illegally in Sri Lankan waters by crossing the International Maritime Boundary Line (IMBL), resulting in fishers being arrested or detained or their boats being seized (Bavinck & Kooiman, 2013; ColomboPage News Desk, 2020; ICSF; Srikrishna, 2020; Vivekanandan, 2003). In 2013, the Sri Lankan navy arrested 730 Indian fishers, and 200 boats were impounded (Scholtens, 2015).
ii. Trawlers from India fished illegally in Pakistani waters, resulting in the fishers being arrested and trawlers being seized (The Research Collective, 2018). In July 2011, more than 700 Indian

trawlers were in Pakistani custody (Dialogue for Action, 2013); the boats were owned by fishers, which affected the livelihoods of around 100 fishers per boat (Dialogue for Action, 2013).

iii. In Orissa, the Forest Department in the Gahirmatha Marine Sanctuary seized trawlers and arrested fishers for illegally fishing in areas designated for turtle protection (Kendrapada, 2020; Lahangir, 2006).

4.3.11.3 Suicide or killed

Fishers were forced to stop trawling when they were killed by dangerous weather events or during illegal fishing or died by suicide. Additionally, past acts of terrorism created fear among fishers, leading to their reluctance to assist each other at sea.

i. Fishers fishing illegally faced not only arrest but also the risk of losing their lives (Arthur & Shanker, 2010; PTI, 2021; Scholtens & Bavinck, 2013; Stephen, 2014; Vivekanandan, 2003). Between 1983 and 2001, around 105 fishers were killed, and 286 fishers were injured by the Sri Lankan navy when fishing illegally (Vivekanandan, 2003).

ii. Implementing the fishing ban resulted in some fishers committing suicide (Lahangir, 2006). For example, a fisher from Orissa named Bidyadhar Ram committed suicide as he could not repay his loans; he owed INR 10,000 (USD 225) to a trawl owner. Ram worked on trawl boats; however, when the fishing ban was extended, he could not find employment and borrowed money from the trawl owner he worked for (Lahangir, 2006). He accumulated INR 10,000 in loans.

iii. In 2008, Mumbai suffered a series of terrorist attacks. Terrorists from Pakistan hijacked an Indian fishing trawler to travel to Mumbai, which led to an increased reluctance of fishers to help other fishers at sea (Dialogue for Action, 2013). For example, two fishers stranded on a buoy at sea were left by a passing trawler; luckily, another trawler with a pre-existing relationship rescued them. The fishers on board stated that if they had not had a pre-existing relationship, they would likely not have returned to land safely (Dialogue for Action, 2013).

4.3.11.4 Minimal safety equipment

Fishers were forced to leave because of a lack of safety equipment. Below are some examples from the literature:

i. The limited safety equipment and poorly designed vessels resulted in many fishers drowning during the 1996 cyclone in Andhra Pradesh when trawling boats capsized (Calvert, 1996; FAO, 2000a; Gulbrandsen & FAO, 1998; Westlund et al., 2007; Yadava et al., 2000). Boat owners, unfortunately, did not feel it was necessary to carry life jackets, transistor radios, and flotation devices on board (Calvert, 1996; FAO, 2000a; Gulbrandsen & FAO, 1998; Westlund et al., 2007; Yadava et al., 2000). Furthermore, the crew members were unaware of the correct usage of life jackets (Calvert, 1996). A total of 569 fishers were reported lost in the aftermath of the cyclone, mainly operating Sona boats (trawlers)(FAO, 2000a; Yadava et al., 2000).

ii. In Orissa, poorly maintained life jackets that were ten years old resulted in fishers drowning when their boat capsized (ICSF & South Indian Federation of Fishermen Societies, 2004).

4.3.11.5 Local and regional power

Trawl fishers were forced to stop trawling because of the influence exerted by local and regional powers. Below are examples from the literature:

i. In Valinookkam, Tamil Nadu, the owners of beach seines held considerable power at village and regional levels. The owners prohibited trawling during the beach seine season, despite the absence of any governmental law or regulation supporting such a restriction (Bavinck & Kooiman, 2013).
ii. Before 1970, in some areas of Andhra Pradesh, local fishers (who did not trawl) prohibited owners from trawling in what they considered "their waters" (FAO, 1971).
iii. Along the Coromandel Coast, a village where small-scale fishers longline, fishers impeded trawl fishing in inshore areas near trawl centres (Vivekanandan et al., 2019).

The above examples highlight how local and regional powers played a significant role in halting trawling operations. The owners of beach seines, local fishers, and small-scale fishers effectively stopped trawl fishing through their authority and actions at the village and regional levels.

4.3.11.6 Insufficient knowledge

Some fishers were forced to suspend trawling because of their insufficient fishing knowledge. In the 1950s, private boats only trawled for a limited period because they did not have enough experience and knowledge to obtain reliably good catches (Miyamoto et al., 1963).

Although the introduction of mechanisation resulted in technological advancements in fishing vessels, the navigation of boats still heavily depended on the fishers' knowledge and skills. Boat crews lacking these skills would have unknowingly travelled into illegal waters, leading to instances where they were misidentified and, in some cases, even shot by naval personnel (Salagrama, 2012; Vivekanandan, 2003).

4.3.11.7 Conflict between stakeholders

Fishers were forced to leave because of conflicts with stakeholders. Below are some examples from the literature:

i. The introduction of trawling led to conflict between small-scale fishers and trawlers, occasionally escalating to violent interactions. In Tamil Nadu, the shared fishing areas between small-scale fishers (not using trawls) and trawlers destroyed small-scale fishing gear (Johnson & Bavinck, 2010). In retaliation, small-scale fishers hijacked and held trawl boats for ransom (Johnson & Bavinck, 2010).
ii. In 2005, the Tiger Task Force was implemented in Sundarban (the confluence of rivers in the Bay of Bengal). There were multiple cases of the Forest Department violating human rights and imposing arbitrary fines. The harassment by the Forest Department in the Sundarban areas increased competition between trawl operators (The Research Collective, 2017). For example, one fisher left Sundarban because of harassment and relocated to Orissa, where he fished for eight years. When he returned to Sundarban to operate a trawl boat, the competition between trawl operators and the difficulty of obtaining a boat license certificate made his trawl boat unusable. (The Research Collective, 2017).

4.3.12 Stop Fisher Forced Environmental

Fishers were forced to stop trawling for four environmental reasons (29% of stop, n=27 records, Table 20): severe weather events (dominant) (section 4.3.12.1), declines in catches (section 4.3.12.2), protection and conservation of sea turtles preventing trawling (section 4.3.12.3), and negative impacts of the COVID-19 pandemic (section 4.3.12.4) (Figure 49). The themes are discussed in further detail in the section below.

Themes	n	% of fisher forced environmental	% of stop	Section
Weather	14	52%	15%	4.3.12.1
Decline in catches	7	26%	8%	4.3.12.2
Sea turtle conservation	5	19%	5%	4.3.12.3
COVID-19 pandemic	1	4%	1%	4.3.12.4

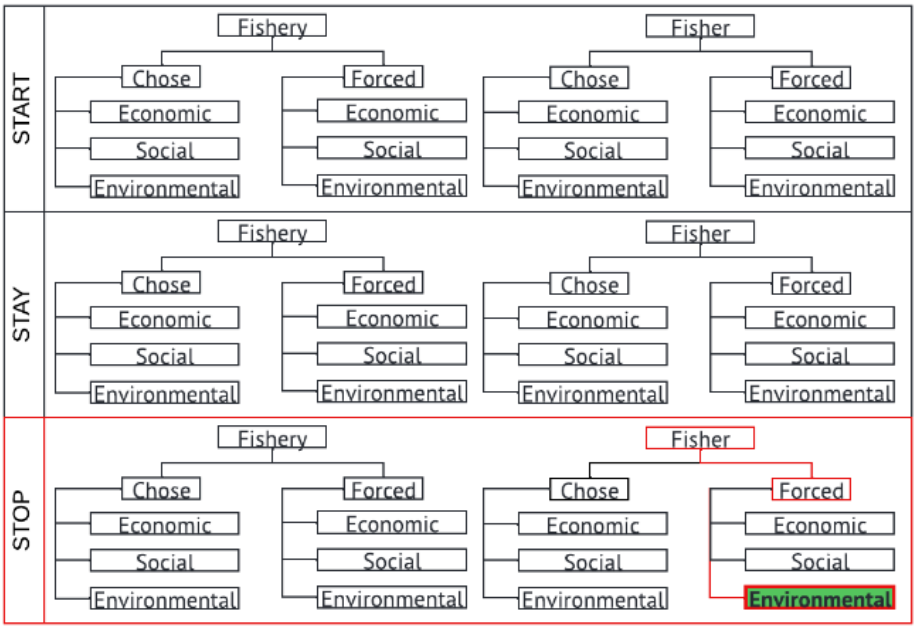


Figure 49. The total number of records (n) for each theme and percentages relative to fisher forced environmental and stop. The percentages for fisher forced environmental (n=27 records) and stop (n=93 records) were calculated based on the distinct value rather than the total value.

4.3.12.1 Weather

Fishers were forced to leave the trawl industry because of the negative effects of adverse weather conditions. Below are some examples from the literature:

i. Cyclones caused significant losses to fishers, including the loss of their trawl boats and even loss of life (Action for Food Production, 1998; Calvert, 1996; FAO, 1971, 2000a; Gulbrandsen & FAO, 1998; Westlund et al., 2007; Yadava et al., 2000).
ii. During Cyclone Ockhi in 2017, three migrants and 33 fishers from Kanyakumari, Tamil Nadu died at sea. Failure to maintain an updated crew register meant that the fishers lost at sea were never identified (Roshan, 2018).
iii. In 2004, the tsunami in India resulted in fishers losing their trawl boats. Some trawl owners chose not to reinvest in the industry and shifted to small-scale fishing and gillnetting (Jeeva et al., 2012).

4.3.12.2 Decline in catches

Declines in fish catches resulted in fishers leaving the trawl industry. In Chennai, fishers and their wives stated that hardly any fish were left in the sea (Gorez, 2003). Previously, they could consume the landed fish and sell the surplus, but they noted that now the scarcity of fish made it difficult to even have enough for their own meals (Gorez, 2003). Young fishers stated that nothing was left in the sea (Vivekanandan et al., 2019). Aware of the fishery's bleak future, women who fished said they did not want their children to suffer as they had (Gorez, 2003; Vijayan et al., 1997). Even the deep-sea trawl venture promoted by the government resulted in reduced catches (Vivekanandan, 2013). With minimal catches, many fishers sought jobs elsewhere (Gorez, 2003).

4.3.12.3 Sea turtle conservation

Trawl fishers were forced to leave trawling in some areas because of the protection and conservation of sea turtles. In the 1990s, conservationists and biologists pushed for the protection of the Olive Ridley turtle (*Lepidochelys olivacea*) because of the high mortality from trawl fishing, which resulted in the creation of the Gahirmatha Marine Sanctuary (Orissa) in 1997 (Arthur & Shanker, 2010). The sanctuary prevented all types of fishing in the area, including both mechanised and non-mechanised fishing (Lahangir, 2006; Ramesh & Rai, 2017; Sridhar, 2015), affecting 500 bottom trawl fishers (S. Mathew, 2004).

4.3.12.4 COVID-19 Pandemic

The global COVID-19 pandemic resulted in a nationwide lockdown on 24th March 2020 in India. Employers abandoned fishers, and migrants were stranded on boats at sea or in harbours (Vohra, 2020).

4.4 What happened to fishers when they stopped trawling?

In this section, we extracted information from records that addressed the outcomes and consequences for fishers when they stop trawling for economic, social, and environmental reasons. We extracted data from 40 records. We classified fishers leaving the industry as either temporary (seasonal trawl closures) or permanent: 22 records addressed what happened to fishers when they stopped trawling temporarily, and 20 records addressed what happened to fishers when they stopped trawling permanently.

In brief, we found that fishers who temporarily stopped trawling faced financial hardship, were unemployed or lacked alternative opportunities, enjoyed their break, and/or moved to occupations within and outside the fishing industry (Table 21). Fishers who permanently stopped trawling moved to other fisheries such as long-lining for tuna, sold their trawl boats because of poor economic returns, and/or found employment in other non-fishing industries (Table 22).

Table 21. Outcomes and consequences of fishers who stopped trawling TEMPORARILY (n=total number of records).

Outcomes and consequences of fishers who stopped trawling TEMPORARILY (# of records)		**Explanation**
Financial hardship (6)		The fishing ban resulted in financial hardship and increased debt and loans, burdening some fishers, and leading to suicide (Lahangir, 2006; Salim, 2007). Boat workers minimized household expenses and their number of meals per day. There was a high demand for credit (Bavinck et al., 2008). Tamil Nadu only relieved the fishers after the ban, which defeated the purpose (Infantina et al., 2017).
Unemployed or lack of alternative employment (10)		Fishers faced unemployment or a lack of alternative opportunities during the trawl ban (Lahangir, 2006; Vivekanandan, 2013). For example, in 1992, on the West coast during the monsoon season, the number of mechanized boats was reduced by 10% and non-mechanized, including motorized vessels, by 25% (Immanuel et al., 2003). Some migrant fishers returned to their place of origin and were unemployed (Bavinck et al., 2008). Individuals in the industry skilled at trawling found it challenging to find other jobs, especially those with a low education level (Salim, 2007).
Wealthy boat owners take a complete break (1)		Wealthy boat owners had the financial freedom to take a break during the trawl ban and did not switch to other occupations (Bavinck et al., 2008)
Fishers moved to other occupations within the fishing industry	Small-scale or traditional fishing (8)	Individuals from a fishing caste or those who were connected to the small-scale sector tried to find work in small-scale fishing, shifted to work on the West Coast (had a different ban period), or worked as crew on motorized boats (Bavinck et al., 2008; FAO, 1970a; Jadhav, 2018; Kurien, 1993; Srinath et al., 2002). Migrant workers returned to their place of origin for small-scale fishing. The ban period reduced the competition between mechanized and non-mechanized vessels, permitting small-scale fishers to earn higher incomes (Bavinck et al., 2008). In Kerala, 10% of mechanized workers were employed in the traditional sector during the trawl ban (Aswathy & Sathiadhas, 2005). In Munambam, Kerala, only one-third of the labourers in the trawl industry worked in other occupations during the trawl ban. Of the alternatively employed workers, 70% originated from Colachel, Tamil Nadu and would return to their place home fishing villages during the ban (Bavinck et al., 2008; Srinath et al., 2002). The other 30% from other locations in Kerala also returned to their villages to work on traditional crafts (Bavinck et al., 2008; Srinath et al., 2002).

Outcomes and consequences of fishers who stopped trawling TEMPORARILY (# of records)		**Explanation**
Fishers moved to other occupations within the fishing industry	Boat repair (6)	Boat owners performed repairs and relied on their savings (Aswathy & Sathiadhas, 2005; Bavinck et al., 2008; Sehara, 1998). Some crew members also helped with repairs and maintenance, but wages were much lower (Salim et al., 2010; Srinath et al., 2002).
	Seasonal employment in fishing (3)	The East and West coasts followed different ban periods resulting in fishers migrating to other states for seasonal employment (Infantina et al., 2017). Some workers from Tamil Nadu migrated to Kerala during the ban for seasonal work (Infantina et al., 2017).
	Mini trawl (2)	Mini trawls were sometimes defined as motorized gear employed by artisanal fishers. In some areas of Kerala, at least three of 12 workers on mini-trawls were redeployed trawler workers (Srinath et al., 2002). The estuarine system in North Kerala had ten fishers engaging in non-motorized mini-trawl; however, during the monsoon season, the number of fishers venturing into mini-trawling increased (Remesan & Ramachandran, 2005).
	Ring-seine (2)	In Kerala, during the trawl ban, around 10% of the trawl workers worked on ring seines (Aswathy & Sathiadhas, 2005; Srinath et al., 2002).
	Braiding of nets (1)	Braiding nets provided supplemental income to fishing families (FAO & Directorate of Fisheries Tamil Nadu, 1978).
	Carrier boats (1)	Mini-trawl boats were used as carrier boats by ring-seine boats (Nandakumar et al., 2005).
	Midwater trawl (1)	Bottom trawls boats were modified during the season to catch shrimp at the surface. In 1963, fishing trials showed that prawns were more likely to be caught in the water column during the monsoon season than at the bottom (IPFC Secretariat & FAO Regional Office for Asia and the Far East Bangkok, 1963).
	Shore-seine (1)	Fishers switched to shore seines in Tuticorin (Diraviya Raj et al., 2017).
	Shell collection (1)	A pair of boats (1 pair = 1 unit) dredged for shells in the Kundapur estuary (Rao, 1983). It was found that the number of units increased from 85 to 125 during the monsoon season as it employed workers from the off-season.
	Trawling in unrestricted waters (1)	In Kerela (the early 1990s), trawlers shifted their operations to unrestricted waters off Tamil Nadu (Gunakar et al., 2017).
Fishers moved to non-fishing occupations	Agriculture (3)	Labourers in Tamil Nadu without a traditional fishing background and small-scale fishing skills found alternative opportunities in agriculture (Bavinck et al., 2008). Individuals from an agricultural background returned to their home villages (Salim, 2007; Salim et al., 2010), but were still faced with taking out loans (Bavinck et al., 2008). Agricultural jobs were seasonal, and the transplanting or harvesting of paddy did not overlap with the trawl ban, resulting in trawl labourers not receiving enough employment to sustain themselves (Salim, 2007).
	Construction, transport, and manual labour (2)	Labourers in Tamil Nadu without a traditional fishing background and small-scale fishing skills found alternative opportunities in construction or transport (Bavinck et al., 2008). In Ponnani, Kerala, very few individuals worked on small-scale vessels and chose to work as manual labourers (Srinath et al., 2002).

Table 22. Outcomes and consequences of fishers who stopped trawling PERMANENTLY (n=total number of records).

Outcomes and consequences of fishers who stopped trawling PERMANENTLY (# of records)	**Explanation**
Changed fishing gear (12)	India's vision of the blue economy focused on the deep-sea fishing industry. The fishing industry made efforts to convert trawlers into longlines, gillnetters, and troll vessels to target the tuna fishery (Herrera et al., 2012; Kumar et al., 2019; Moreno & Herrera, 2013; Ramalingam et al., 2019). In 2012, in India, 397 trawlers were converted to longliners and troll vessels for yellowfin tuna (Herrera et al., 2012). In Palk Bay, around 2,000 trawlers were to be replaced by deep-sea vessels, requiring considerate financial investments from the state and boat owners (Vijaykumar, 2017). Deep sea vessels, such as the tuna longliner, would cost the boat owner INR 8 lakh upfront and an additional loan of INR 16 lakh (Vijaykumar, 2017), with the stipulation of not being able to resell the boat within five years (Vijaykumar, 2017).
Sold trawl boat (7)	In Tuticorin, Tamil Nadu, trawl owners sold their boats because of poor economic returns. Unfortunately, they had to sell their boats much lower than the purchase price. For example, trawlers that cost between INR 15 to INR 20 lakhs were sold for between INR 5 to INR 7 lakhs (Balasubramaniam, 2000). Trawl owners in Tamil Nadu were open to alternative employment and were willing to participate in buy-back schemes if provided with sufficient compensation (ICSF, 2005; Vivekanandan, 2010). Owners unable to pay their creditors resulted in fish traders buying their boats (Johnson & Bavinck, 2010). In Andhra Pradesh, boats initially provided to fishers by the government were sold to individuals in other states (FAO, 1971).
Occupations in other industries (3)	Fishers felt no more fish were left in the sea and tried to find work in shoe-making companies (Gorez, 2003). Some fishers in Chennai advised young people not to join the fishery. They believed their children had no job prospects in the fishery as no more fish were left in the sea (Bavinck, 2012; Gorez, 2003). The trawl owners had greater financial flexibility than the crew and shifted their resources to other sectors when profits decreased (Kurien, 1993).

5 Discussion

The romantic notion of "once a fisher, always a fisher" (Froese, 2011; Peñas Lado, 2016; Urquhart & Acott, 2013) can erroneously result in policymakers assuming less mobility and fishers more tethered to their fishing occupation than other resource extraction workers. Our findings show great variation in why a person started, stayed in or stopped bottom trawling depending on a person's background, circumstances, and role within the fishery. The results from this review should be viewed as hypotheses to be field tested; the literature can provide knowledge only to a certain extent compared to directly communicating with the fishers. Our study reveals that the fishery and fishers chose to begin bottom trawling and stay in the industry primarily because of offers of subsidies, potential income, and likely profits. The bottom trawl industry persisted despite declining resources because of (i) the industries' capacity to exert power that allowed them to extend a sunset industry, and (ii) poor enforcement of regulations (or violation of regulations) that should have constrained trawling. We underline the entrenched nature of the trawl industry, where fishers were trapped in bottom trawling because of accumulated debt to people higher in the trade and the need to repay those loans. Fishers only stopped trawling when constrained by regulations, resource depletion, and low financial returns. We also found that fishers' motivations to participate in bottom trawling varied according to their role in the trawl industry, where owners often reaped more benefits from trawling than crew did. Recognizing this diversity, and addressing it in management and policy decisions, will be crucial in determining how best to constrain bottom trawling effectively.

Fishing Culture and Skills

It seems clear that fishing culture and skills are essential elements that might determine a fisher's attachment to bottom trawling. We find that distinguishing between fishing culture and skill can result in different definitions of attachment. For example, captains from traditional fishing villages with past fishing experience and cultural association may have a stronger attachment to fishing than captains who initially joined the industry as cooks or crew with no past fishing experience (e.g. worked in agriculture and construction) and eventually learnt the necessary fishing skills over time to become a captain (Nayak & Vijayan, 2003). In both cases, the captains have an attachment to fishing, but the level of attachment differs – where one has a cultural attachment, and the other is bound to fishing because of skills developed, which can affect where the labour force shifts to when constraining bottom trawling.

Subsidies

Our discovery that capacity-enhancing subsidies drove people to start bottom trawling and stay in bottom trawling strengthens the global argument that countries, in this case, India, need to eliminate such subsidies (Sumaila et al., 2019; Sumaila et al., 2008). We found that when trawl fishing started, the government focused on capacity-enhancing subsidies such as boat modernisation, renewal and construction, infrastructure and support, and fishery development and training services, with little focus on fuel subsidies. However, as the trawl industry progressed, a different pattern emerged, where fuel subsidies were on par with boat modernisation, renewal, construction, infrastructure, and support. Fuel subsidies appeared in the literature mainly post-2000s, which matches the global narrative of the fishing industry where subsidies are required to aid with one of the highest costs, fuel, to continue trawling (Sumaila et al., 2016). From fiscal year (FY, begins in April and ends in March) 2016 (INR 1,550 crore = USD 231 million) to FY 2019 (INR 2,225 crore = USD 316 million), the Indian government increased marine subsidies by 43% (Sharma et al., 2021). Fuel subsidies were the largest expenditure by State Governments, amounting to 32% of the total fisheries support in FY 2019 (INR 736 crore = USD 104.5 million) - a 142% increase from FY 2016 (INR 304 crore = USD 45.2 million) (Sharma et al., 2021). Eliminating fuel subsidies would largely reduce trawling capacity as vessels would be unable to sustain themselves financially. It was found that removing fuel subsidies would affect 12-36% of the net operating income of trawlers but have a minimal effect on the income of small-scale fishers (Arasu, 2020). In addition, such a change would help India meet its commitment to SDG 14, specifically, goal 14.6, which aims to eliminate

fisheries subsidies that "contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported, and unregulated fishing" (UN General Assembly, 2015).

Financial opportunities and pressures

Our findings demonstrated that fishers started and stayed in trawling because of both financial opportunities and financial pressures. While income incentivised fishers to begin and remain in trawling, it also resulted in an entrenched trawl industry, where fishers were trapped in bottom trawling because of accumulated debt to people higher in the trade and the need to repay those loans. Fishers sometimes chose to join the trawl industry in India because bottom trawling offered higher income than either other fisheries or manual labour industries. This is particularly true for more skilled fishers, such as captains, who were provided higher wages than crew and were more reluctant to leave the industry. In this, bottom trawling is similar to other sectors, such as the oil/gas industry, where labourers are motivated by financial gains to start and remain in the industry (Goldenberg et al., 2010). As well as motivating people to join resource extraction industries, financial incentives have sometimes resulted in individuals contributing to bettering the environment, such as the farmers in Pakistan who were willing to plant trees to reclaim degraded forest lands because of the perceived increase in income (Zubair & Garforth, 2006). Similarly, in Wales, farmers and land managers supported biodiversity, improved the quality of water, air, soil, and landscape enhancement by participating in a government scheme which provided payments for their actions (Ingram et al., 2009). In the context of fisheries, providing financial incentives for fishers to engage in less destructive fishing methods would certainly lure some back to traditional methods from bottom trawling; some only began bottom trawling because they could not survive financially in their former, more selective fisheries.

Debt

In India, debt incurred by bottom trawling led to confiscated lands, greater poverty, suicide, seized boats, and exploitative work conditions. In some instances, fisher owners' inability to repay their loans resulted in the ownership of trawl vessels moving from fishers to non-fishers. Unfortunately, such an entrenched fishing industry can also be seen in other countries, such as Thailand, where debt bondage forces fishers to remain in the industry (EJF, 2015). We also see a pattern of indentured workers in other industries, such as construction, agriculture, manufacturing and the sex industry (Urbina, 2015). Indentured labourers may end up having an unwanted attachment to fishing, where the years they were forced to remain in the industry could lead to having only fishing skills making it harder for them to leave the fishing industry and find jobs in other industries.

Power

Our findings show that the power of trawl owners, boat owner associations, and political affiliations extended a faltering industry. Boat owners who were vocal political supporters of the ruling political party were allowed to avoid renewing their boat registration or paying berth charges (Nayak & Vijayan, 2003). In instances where a boat owner association became important to the ruling party, the association benefited from minimal enforcement of fishing regulations (Subramanian, 2003). We also found a connection between power in the trawl industry, caste group, and religion – where certain castes had greater political connections (Stephen, 2014). The influence of politics has also affected other fisheries, such as in the EU, where from 1987 to 2011, politicians have set annual total allowable catches higher (~33%) than recommended scientifically (O'Leary et al., 2011). In that study, the influence of politics severely increased the likelihood of a stock collapsing within 40 years, such that politics and management clearly needed to be decoupled to sustainably manage resources (O'Leary et al., 2011). Our findings demonstrate that even if attachment or lack of attachment of fishers is integrated into fisheries management, we also need political will.

Ineffectual fishing regulations

In our research, we found that bottom trawl fishers in India commonly ignored fishing regulations, rendering such restrictions largely ineffectual. We suggest that for an increased likelihood of success, policies should incorporate an awareness of individuals' motivations and how they might respond to the policy. In addition, understanding motivations can help managers better address reasons for illegal behaviour and prioritise the motivations that would enhance compliance (Castilho et al., 2018). For example, the creation of the Gulf of Mannar Marine National Park (marine protected area) drove many traditional fishers to bottom trawling because the alternative livelihood options provided through the MPA process were economically nonviable; they shifted to work as wage labourers on trawlers rather than operating their boats (The communities of Chinnapalam and Bharathi Nagar et al., 2014). Unfortunately, artisanal fishers bore the burden of reduced fishing rights inside the MPA, while bottom trawlers continued to violate regulations (Muralidharan & Ramesh, 2017). The traditional fisher communities, who saw themselves as guardians of the sea and its resources, were not included in the planning and decision-making process of the Park (The communities of Chinnapalam and Bharathi Nagar et al., 2014). Understanding the motivations and incorporating them in the planning process, such as consulting the communities who saw themselves as guardians, could have indicated to policy planners that the fishers' traditional fishing background would eventually result in fishers returning to fishing. Policy planners can use motivations and attachment as indicatives of fisher behaviour to develop policies that will allow for community buy-in and account for unintended consequences of policy (Andrews et al., 2021; Fulton et al., 2011). Community buy-in and acceptance are vital to achieving conservation goals, where fishing motivations can provide insight into how fishers may behave in response to policy (Fulton et al., 2011; Kriegl et al., 2021; Muallil et al., 2011; Young et al., 2016).

Forced to stop trawling

Fishers only stopped trawling when constrained by regulations, resource depletion, and low financial returns. We see a similar trend of serial resource depletion in other fisheries and extractive industries, where the industry shifts to another species or a new location (Benton et al., 2021). Our assessment of fisher outcomes when trawling stopped temporarily, such as the trawl ban, showed that traditional fishers often went back to small-scale fishing (now that trawlers weren't competing) while other crew found jobs in non-fishing industries or became unemployed because of poor opportunities and low education levels. When fishers stopped trawling entirely, they moved to other fisheries, primarily focused on shifting to deep-sea fishing, commonly associated with subsidies from the government and significant financial investments from owners. In this way, bottom trawling's poor pattern of fisheries development plays out again with the focus on deep-sea fishing in India's Blue Economy initiatives.

Diverse nature of people's motivations

Efforts to constrain bottom trawling in India must address the diverse nature of people's motivations to fish. We found fisher's background interspersed through several themes, which we classified into three categories: (i) traditional fishers who shifted to work as crew (including migrants) or owners on trawl boats and had fishing experience; (ii) crew, often migrants, who joined trawling for employment and had no fishing culture or skills; and, (iii) owners and entrepreneurs who had no fishing culture and actively did not fish but remained in the trawl industry because of their investments and profit. We can hypothesise that crew, owners, and entrepreneurs with no fishing culture may be more willing to leave trawling and fishing entirely. At the same time, traditional fishers who shifted to work as crew on trawlers or became trawl owners might be able to go back to conventional fishing, should opportunity allow, because of their fishing skills and cultural connections.

Lack of information on background of captains

We found minimal information in the literature on the background of captains, which is a severe knowledge gap, as we can assume that most of the decision-making of where, how, and when to bottom trawl comes from the captains (Viswanathan et al., 2001), under the influence of owners who set the fishing targets (Roshan, 2016). We can assume that captains have some fishing experience because of the knowledge required to make decisions (Benoy & Vishnu, 2017b) (Derks, 2013) and may, therefore, be one target for communication to seek change in bottom trawling. If captains have a fishing culture or skills, that might be associated with caring for the ocean, compared to crew and owners who lack a fishing culture or skills and might be one target for communications that seek to change bottom trawling. For example, on the Southwest coast of India, an awareness program demonstrated that trawl captains were knowledgeable of the adverse effects of bycatch and catching juveniles and showed concern over the fishery's future. The trawl operators volunteered to share GPS data with CMFRI, where the results allowed CMFRI to identify seasonal grounds of juvenile species (Dineshbabu, 2013). Another example is the traditional fishers from Pudukottai who used push nets and mini trawls, where conflicts with traditional boat operators resulted in small-scale trawl captains agreeing to fish only three days a week. Later on, traditional fishers chose to stop trawling altogether, even though it affected their livelihoods, because of their desire to safeguard resources for the next generation. While the trawl operators of the smaller vessels stopped trawling to safeguard resources, the desire to protect resources was not found in the trawl owners with large boats as they felt they had to recoup the significant investments they had made (FAO, 2016a). Another target of communication to seek change in bottom trawling might be fisher owners or crew who also have a fishing culture and return to small-scale fishing during the monsoon ban, as improved small-scale fishing prospects would incentivise them.

Concluding remarks

The findings from this study expanded our realisations that fishing communities should not be viewed as one entity, an injustice to those involved (Delgado-Ramírez et al., 2022) and that fisheries management needs to go beyond the fisher. Community is often regarded as representing one group with similar social, economic, and environmental motivations. Drawing from the findings of this and other studies, we find that a fishing community can be heterogenous and understanding the nuances within a community can contribute to designing equitable policies (Delgado-Ramírez et al., 2022). Fisheries management needs to extend beyond maritime activities and into the development of public services (Pomeroy, 2012) that can help catalyse change and help bolster and retain change in fisheries management.

This systematic literature review provides a crucial foundation for understanding the underlying factors that drive fishers to start, stay, and stop bottom trawling in India, as a case study for trawling in general. Moving forward, we are transitioning into field studies aimed at validating and refining our findings from the literature. Employing the systematic literature review as a guiding framework, we are collaborating with Indian colleagues to co-develop the research questions and approaches. Our next step is to conduct surveys in India, consulting trawl fishers and others in the trawl industry about their decision-making and their plans. We will then apply our findings to help shape policy decisions for fisheries that are focused on sustainable use, biodiversity conservation, and social justice.

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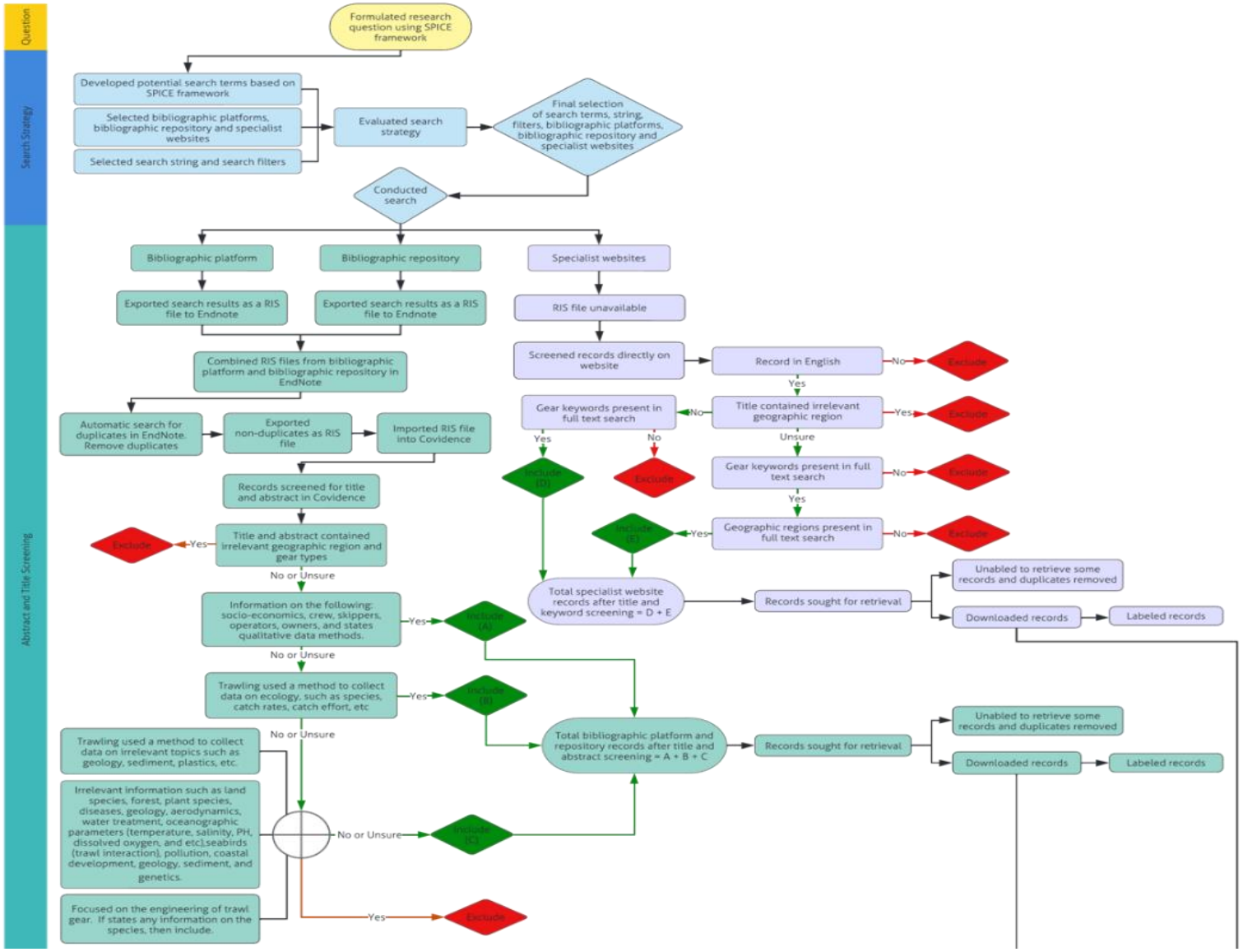
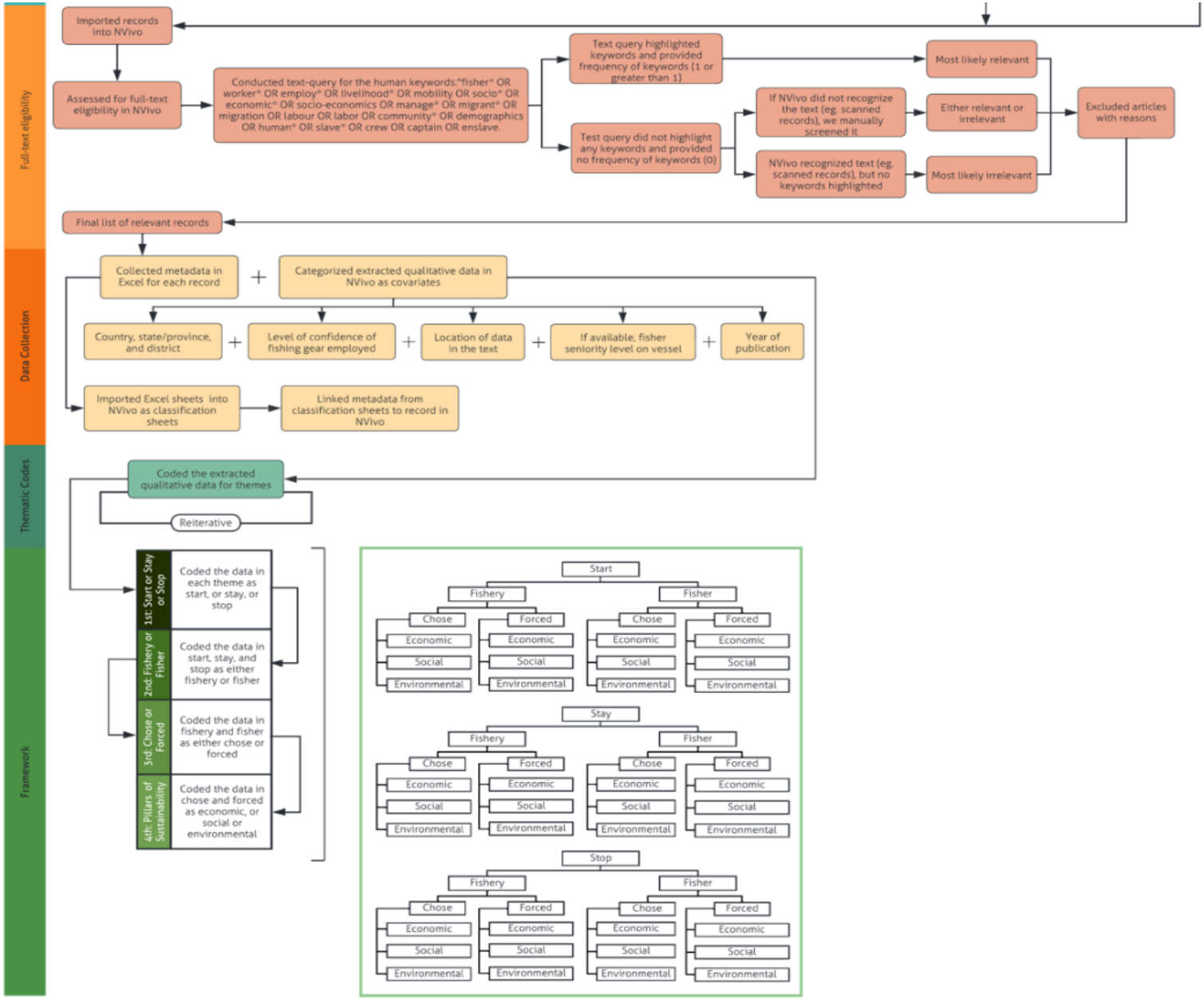
7 Appendices

7.1 Appendix A - Frameworks to formulate research question

Question Formulation Guideline	Type of research
PICO: Population or Problem, Intervention, Comparison and Outcome	Quantitative research and commonly used in epidemiology (Davies, 2011)
PICOC: Population, Intervention, Comparison, Outcomes, and Context	Qualitative and used in the social sciences (Petticrew & Roberts, 2006)
PICOT: Population, Intervention, Comparison, Outcomes, and Time-frame	Health-related studies where time-related variables are used (Davies, 2011).
PIPOH: Population, Intervention, Professionals, Outcome, and Health care setting and context.	Oncology (Davies, 2011).
PECODR: Population, Exposure, Comparison, Outcome, Duration, and Results	Medical (Davies, 2011).
PESICO: Population, Environment, Stakeholders, Intervention, Comparison and Outcome	Fluency disorders and speech-language pathology (Davies, 2011).
PS: Population and Situation	Qualitative (Davies, 2011).
ECLIPSE: Expectation, Client Group, Location, Impact, Professionals, Service	Health policy and management (Davies, 2011)
SPIDER: Sample, Phenomenon of Interest, Design, Evaluation, and Research Type	Qualitative or a mixed methods approach (Cooke et al., 2012)
SPICE: Setting, Population, Intervention, Comparison, and Evaluation	Qualitative or Quantitative research. It is used in social sciences and health care (Davies, 2011)
PerSPEcTiF: Perspective, Setting phenomenon of interest/problem, Environment, Comparison (optional), Time/timing, and Findings	Qualitative evidence synthesis (Booth et al., 2019)

7.2 Appendix B - Pragmatic systematic literature review process




Full-text eligibility
Data Collection
Thematic Codes
Framework
Imported records into NVivo
Assessed for full-text eligibility in NVivo
Conducted text-query for the human keywords:"fisher* OR worker* OR employ* OR livelihood* OR mobility OR socio* OR economic* OR socio-economics OR manage* OR migrant* OR migration OR labour OR labor OR community* OR demographics OR human* OR slave* OR crew OR captain OR enslave.
Text query highlighted keywords and provided frequency of keywords (1 or greater than 1)
Test query did not highlight any keywords and provided no frequency of keywords (0)
Most likely relevant
If NVivo did not recognize the text (eg. scanned records), we manually screened it
Either relevant or irrelevant
NVivo recognized text (eg. scanned records), but no keywords highlighted
Most likely irrelevant
Excluded articles with reasons
Final list of relevant records
Collected metadata in Excel for each record
Categorized extracted qualitative data in NVivo as covariates
Country, state/province, and district
Level of confidence of fishing gear employed
Location of data in the text
If available, fisher seniority level on vessel
Year of publication
Imported Excel sheets into NVivo as classification sheets
Linked metadata from classification sheets to record in NVivo
Coded the extracted qualitative data for themes
Reiterative
1st: Start or Stay or Stop
Coded the data in each theme as start, or stay, or stop
2nd: Fishery or Fisher
Coded the data in start, stay, and stop as either fishery or fisher
3rd: Chose or Forced
Coded the data in fishery and fisher as either chose or forced
4th: Pillars of Sustainability
Coded the data in chose and forced as economic, or social or environmental
Start
Stay
Stop
Fishery
Fisher
Chose
Forced
Economic
Social
Environmental

7.3 Appendix C – USD to INR Currency conversion from 1950 - 2023

Year	1 USD to INR
1950-1965	4.76
1970	6.36
1975	8.38
1980	7.86
1985	12.37
1990	17.5
1995	32.43
2000	44.94
2005	44.1
2010	45.73
2015	62.97
2020	76.38
2023	81.94