

Tangled lines

Examining Western and Central Pacific Tuna
Social-ecological Systems

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Abstract



This thesis responds to the need to re-conceptualise the way in which oceans and the SESs they support are understood and governed. Contrary to traditional fisheries management frameworks, this thesis focusses on developing and testing an integrated transdisciplinary framework to examine SES networks. Western and Central Pacific (WCP) tuna fisheries are faced with complex and interlinked social and ecological challenges including high seas management issues, setting sustainable limits, climate change impacts, human rights violations, and illegal, unreported, and unregulated activities. At odds with this complexity, strong but narrow disciplinary fisheries science-based decisions dominate governance decisions. Effective governance across complex multi-scale systems in the WCP tuna fishery requires a more integrated understanding of social-ecological systems (SES).

Transdisciplinary problem solving informed by participatory, SES research, and political ecology has the potential to reveal (and solve) complicated interactions and connections across ocean SES networks. A Social-Ecological-Oceans Systems Framework (SECO) was developed to capture the complexity, breadth and depth of the system and address interactions and connections between separate system components. *The overarching research hypothesis for my thesis is that a transdisciplinary approach using political ecology and SES research can be used to assemble diverse theories, knowledges, methods, and analytical techniques. Such an approach can reveal and make sense of complicated interactions and connections across ocean SES networks.* The hypothesis is tested using SECO in two place-specific studies; undertaken in Fiji and Solomon Islands, both of which are classified as Small Island Developing States. Place-specific studies are good for exploring interlinkages and complex causality in a ‘real life’ context. I argue that establishing fisheries management systems that are appropriately embedded into SES networks is critical to avoiding unintended outcomes. My research discovers drivers, key interlinkages, and systemic causes of unintended outcomes of tuna fisheries development and governance. Moreover, findings confirm Pacific-led grass-roots multi-scalar governance is key to overcoming systemic barriers and taking hold of opportunities to achieving multiple societal goals. Future research could leverage the SECO contribution within the WCP tuna SES or other ocean SES networks.

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Glossary



The following provides a brief glossary of terms used in this thesis. This provides context for how terms are used rather than providing in-depth definitions. Other terms such as vulnerability, resilience, and social-ecological systems are explored in-depth within the main text of the thesis.

Equality is a deeply contested and multifaceted concept. In this thesis, I draw on Sandra Fredman's four dimensional framework: to redress disadvantage; to address stigma, stereotyping, prejudice and violence; to enhance voice and participation; and to accommodate difference and achieve structural change (Fredman, 2016). For more information about this framework, see my summary at <https://www.genderaquafish.org/2020/10/03/substantive-equality-a-useable-framework-for-assessing-human-rights-allocation-and-more-in-fisheries/>.

Fisheries development and governance includes nation states, industries, coastal communities, and other actor's (such as non-governmental organisations) efforts to scale up fisheries processes, maximise revenues, while conserving, protecting, and restoring fisheries populations and the social and ecological systems from which fisheries are derived. In development studies, governance is included under a single development 'umbrella', however, I separate these to signal the antagonistic relationship between development and fisheries in the Pacific.

Small Island Developing States (SIDS) are defined by the United Nations as a group of developing countries that are described as islands having small populations, economies with limited resources, and being remote with susceptibility and vulnerability to natural disasters and climate change and are therefore heavily dependent upon international trade, aid, and their environment (<https://www.un.org/ohrlls/content/about-small-island-developing-states>). SIDS are located within three geographical regions, the Caribbean region, the Pacific region, and the Atlantic, Indian Ocean, and South China Sea region (AIS). Pacific SIDS are listed by the United Nations and those who are within the WCP include, Fiji, Kiribati, Marshall Islands, Federated States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

Unintended outcomes are outcomes not intended during development and governance, often due to context-dependent, unpredictable, and non-linear processes of social-ecological systems.

Western and Central Pacific Tuna (WCP) include the four main commercially harvested tuna species; bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), yellowfin (*T. albacares*), albacore (*T. alalunga*) found within the western and central Pacific Ocean.

Statement of Contribution



This thesis contains no material accepted for the award of any other degree or diploma in any university. The thesis is wholly my own work except where otherwise acknowledged.

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Nature of contribution by PhD candidate	Design and conceptualisation, field work, analysis
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CO-AUTHORS

Name	Nature of Contribution
Associate Professor Karen Fisher	Provided ideas, data, edited and reviewed all papers
Professor Simon Thrush	Provided ideas, data, edited and reviewed all papers

Certification by Co-Authors

The undersigned hereby certify that:

- ❖ the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- ❖ that the candidate wrote all or the majority of the text.

Name	Signature	Date
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Nature of contribution by PhD candidate	Design and conceptualisation, field work, analysis
Extent of contribution by PhD candidate (%)	80%

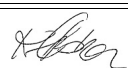

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- ❖ that the candidate wrote all or the majority of the text.

Name	Signature	Date
Associate Professor Karen Fisher		6/4/22
Professor Simon Thrush		1/3/22

Chapter 1 Introduction



1.1 Introduction

After centuries of dominating terrestrial ecosystems, marine ecosystems are the new frontier and cornerstone to solving contemporary global challenges for food, medicines, new sources of clean energy, climate regulation, job creation and inclusive growth (Wenhai et al., 2019). In 2010, the global ocean economy contributed US\$1.5 trillion annually, providing 31 million jobs (Organisation for Economic Co-operation and Development, 2016). It is projected to reach US\$3 trillion, and to support 40 million jobs by 2030 (although the global COVID-19 pandemic will most certainly influence these projections) (Organisation for Economic Co-operation and Development, 2016). Safeguarding and protecting the health of marine ecosystems is increasingly urgent to support the mounting use of marine resources and increasing rates of environmental change and biodiversity loss. Understanding complex social-ecological system (SES) networks and how to design and apply governance will play a key role in reconciling these two objectives.

At one third of the globe (161.76 km²), a mere 2% of land area, and 28 million km² of exclusive economic zone (EEZ), the Pacific Ocean contributes significantly to global fisheries, ocean–atmosphere interactions, climate control, and global carbon fluxes (Bardach et al., 2021; Flanders Marine Institute, 2018; Longhurst, 2006). The western and central Pacific (WCP) tuna fishery exemplifies this contribution, providing just over half the world’s tuna supply (Williams & Ruaia, 2020). Tuna fisheries form the backbone of Pacific Small Island Developing States’ (SIDS) economies (worth US\$4.9 billion in 2020 (Williams & Ruaia, 2020)), society, and culture. Yet the fishery faces complex and interlinked social and ecological challenges including high seas management issues, setting sustainable limits, climate change impacts, human rights violations, and illegal, unreported, and unregulated activities.

Pacific ecosystems, economies, cultures, biogeography, and political landscapes are intricately linked to form a complex and multi-scalar SES. Threats from impacts from emerging oceanic sectors and land-based activities, over-exploitation, pollution (including from land-based activities), declining biodiversity, and climate change (Organisation for

Economic Co-operation and Development, 2016) are coupled with nuanced interlinkages and present ‘wicked problems’ to ocean users and managers.

1.2 Thesis Rationale, Focus and Approach

This thesis responds to the need to re-conceptualise the way in which oceans and the SESs they support are understood and governed. Contrary to conventional fisheries management frameworks, this thesis focusses on developing and testing an integrated transdisciplinary framework to examine SES networks to contribute a step towards holistic governance. The research comes at a critical time when Pacific Island decision makers are faced with unique opportunities for ocean development and governance. Decision makers must confront multiple threats such as climate change, overfishing, and land-based sources of marine pollution degrading their environments, while also supporting the advancement of their societies and economies.

Drawing on a range of theories, this thesis seeks to examine people’s connection to the Pacific Ocean and to understand WCP tuna SES networks. Specifically, the main objectives are to examine interlinkages within WCP tuna SES, reveal unintended outcomes, and to understand how and why they occur. The main contribution of this thesis reveals drivers, key interlinkages, and systemic causes of unintended outcomes from tuna fishery management and governance. It is hypothesised *that a transdisciplinary approach using political ecology and SES research can be used to assemble diverse theories, knowledges (social and physical sciences, local knowledge), methods, and analytical techniques. Such an approach can reveal and make sense of complicated interactions and connections across ocean SES networks.* A Social-Ecological-Ocean System’s (SECO) Framework tests the hypothesis in which two place-specific studies are undertaken in Fiji and Solomon Islands, both of which are SIDS. Place-specific studies enable identification and exploration of interlinkages and complex causality by allowing assessment of historical and social contexts, such as path dependencies (George, 2005). An over-arching theme of the thesis is that collaborative forms of governance are fundamental to building societal as well as environmental resilience. A series of recommendations relevant to tuna fisheries and oceans management are also provided in Chapter 3 and Chapter 4.

Primary data for the place-specific studies were collected using mixed-methods including participant observer methods (semi-structured interviews, focus group discussions,

observations). Positionalities of all researchers, especially in cross-cultural/trans-cultural contexts, inevitably influences knowledge exchange, interpretation, and representation of research findings and is important to recognise and acknowledge (Fisher, 2015; Rose, 1997; Twyman et al., 1999). These considerations are compounded when language interpretation and translation are involved (Twyman et al., 1999). Moreover, researcher positionality occurs within the backdrop of geopolitical processes. Globally, the Pacific Ocean has geopolitical strategic importance, climate change relevance, provides protein essential to global food security, and was ‘a stomping ground’ for historic experimentation such as nuclear testing (Underhill-Sem, 2020). Yet the Pacific Ocean, as a large, diverse, and productive place is positioned on the global stage as vulnerable and homogenous SIDS. This has allowed the claiming of property rights which can be traced from early colonialism through to more contemporary efforts to minimise SIDS international discourse (Underhill-Sem, 2020). Being mindful and understanding how these geopolitical processes interacts with researcher positionality to influence research findings is important.

As a researcher from a nation of relative wealth and power, and with geopolitical interests in the Pacific, the position of the researcher as an ‘expert’ or as having power (over participants) required ongoing negotiation, reflection, and care. I had pre-existing contacts and networks in the Pacific (including the place-specific study locations) that facilitated access to interview participants, as well as working with local guides/assistants during data collection. These networks and the support and assistance of local people were especially important given the rapid nature of data collection.

While I aimed to reduce the burden for participants and to make them feel at ease, I recognise limitations in this approach. Significantly, in all villages, little English was used in discussions which affected the depth of understanding for the research despite the assistance of a translator. I was also reliant on gatekeepers, and there are additional power dynamics associated with that. Moreover, unspoken communication such as customary norms and cultures may not have been ‘heard’ since these are not well known to the researcher. In addition, while scientists and managers were willing to share their views and experiences as part of their roles, some may have withheld or embellished information due to industry sensitivities, political agendas, or being part of their social and cultural norms and values (Twyman et al., 1999).

1.3 Research Objectives and Questions

The **‘real world’ questions** that fisheries managers and decision makers ask that drives this research are:

How can Small Island Developing States best provide for the wellbeing of their people while enhancing value across multiple dimensions including sustainable wealth generated from their tuna resources?

At the centre of this; how do individual nation states, and states collectively, allocate tuna fisheries’ benefits and costs between their multiple societal values?

Answering these ‘real world’ questions, (a key principle of transdisciplinary research is to answer ‘real world’ questions), requires identifying *what is missing that constrains fisheries managers ability to deliver useful and relevant answers to decision makers*. The **research hypothesis** thus explores a possible way (SECO) to answer this ‘real world’ question:

A transdisciplinary approach using political ecology and SES research can be used to assemble diverse theories, knowledges, methods, and analytical techniques. Such an approach can reveal and make sense of complicated interactions and connections across ocean SES networks.

Fisheries governance, gender inequality and perceived and actual climate change impacts are examined with a focus on who benefits (and who loses). This approach evaluates the influences of variables acting at and across several scales (local, regional, global) on decisions impacting use and conservation of tuna fisheries (Robbins, 2012).

Offering a way (SECO) to answer these ‘real world’ questions is guided by the following four objectives and associated questions:

Objective 1: To contribute to the development of a transdisciplinary social-ecological framework for analysis of pelagic tuna fisheries.

***Question 1:* How can transdisciplinary and mixed-method research approaches be integrated to examine complex ocean SES and unintended outcomes of fisheries development and governance?**

Question 2: *How can transdisciplinary research be tailored to provide strategies for achieving multi-dimensional goals across the different levels of governance?*

Complex systems require plural approaches to understand the different ways in which multiple layers of environment, society, and economic relationships intersect and interact. Stirling (2010) highlights the risk of applying a narrow approach to complex problems as this can lead to oversimplified and therefore inadequate responses to incomplete knowledge. SES research is multi-faceted and postulates that social systems are interdependent with life-supporting ecological systems (Avriel-Avnia & Dick, 2019). Transdisciplinary research is championed for its knowledge integration, team inclusion, cooperation with non-academic stakeholders and knowledge sharing (Holzer et al., 2018). Moreover, SES research is designed to include multiple knowledge domains from diverse stakeholders to inform and influence governance and policy and improve understandings of ecosystems (Holzer et al., 2018). Transdisciplinary analysis blending quantitative, qualitative, and participatory methods allows for in-depth examination and illumination of complex SES networks. As the research progressed it became apparent that a tailored approach was required to meet the needs of the research and unique case studies. Research methods are described in Chapter 2.

Objective 2: *To understand WCP tuna SES.*

Question 3 *How is the WCP tuna SES characterised and how does this characterisation (and other challenges identified) influence the implementing of holistic approaches to governance?*

This objective seeks to characterise the SES, to understand the impacts and relationships of the WCP tuna SES. Characterisation of the SES forms the foundations of analysis and is presented in several aspects included how the SES is defined (see Figure 3 presented in Chapter 2), key drivers in SECO (see Figure 5 in Chapter 3 and Figure 10 in Chapter 4). Barriers to governance are explored in Chapter 3 and Chapter 4.

Objective 3: *To explore unintended consequences of fisheries development and governance processes on SES networks.*

Question 5: *What are the impacts on gender, the roles of women, and exposures women and men have to unintended outcomes of fisheries governance and development?*

Question 6: *What are the impacts and perceived impacts of climate change on the WCP tuna SES and its resilience and how does this relate to unintended outcomes of fisheries development and governance?*

Gender is used as a lens to explore the social dimension and implications of unequal power relations within the SES, while climate change is used to focus analysis on the dynamics of pelagic tuna ecosystems. I focussed in on unintended outcomes of development and governance as a way of exploring systems pathways, dynamics, and feedback loops in terms of processes of change for both gender and climate change. By characterising the SES and exploring interlinkages, and processes of change, the research provides ways of identifying undetermined linkages leading to unintended outcomes (Chapter 3 and Chapter 4).

Objective 4: *To assess the adequacy of current tuna fisheries management regimes in the Pacific and identify opportunities to strengthen governance.*

Question 7: *To what extent do fisheries management take into consideration unintended outcomes of fisheries development and governance processes?*

Question 8: *How might governance processes be strengthened to better reflect the whole system?*

The research examines current tuna fisheries management to assess effectiveness in identifying and resolving impacts of unintended outcomes and to identify any shifts towards more holistic, socially inclusive modes of governance (Chapter 3 and Chapter 4). The research also examines how governance processes could be strengthened to deliver better outcomes and avoid those unintended consequences.

Research contributions include:

Theoretical: This thesis contributes to scholarship that explores unintended outcomes, gender, political ecology, holistic approaches to fisheries management, SES and examines the intersection between these fields and disciplines. By applying a transdisciplinary approach, I create a new transdisciplinary SES framework by fusing political ecology with other action-oriented theories. Firstly, political ecology is used to critically analyse unintended outcomes. Secondly, SES-based thinking and concepts such as vulnerability and resilience are employed to identify solutions for governance.

Empirical: This thesis uses primary data obtained from participants to gain stories and information about the WCP tuna SES. In discussing challenges to governance or daily life, I identify knowledge gaps and seek to fill this by providing them with critical concepts and links to the SES. Solutions are identified and provided to research participants, communities, and organisations.

Methodological: The thesis contributes an empirically based framework that is appropriately embedded in a particular social and environmental context. The framework integrates multiple methodologies and methods to understand broader SES than mainstream fisheries management approaches. This approach therefore seeks to help policy makers, scientific experts, and fisheries managers in problem definition and governance.

1.4 Understanding and governing fisheries

1.4.1 Trends in understanding fisheries

The ways in which human-environment relationships are considered within governance arrangements are often oversimplified. In fisheries, overfishing is often explained by human population growth, technology advances, and overcapacity when a more SES perspective is required to ensuring sustainability and building resilience (Figure 1) (Finkbeiner et al., 2017). These fisheries management systems are focussed on singular, compartmentalised, stock-by-stock systems that externalise environment and social aspects (e.g., single species fisheries management (SSF), gender).

Efforts to understand SES interlinkages and how compounding effects affect minority groups such as Pacific communities or women remain in their infancy (Bavington et al., 2004; Bennett, 2005; Kawarazuka et al., 2017; Yanda & Mung'ong'o, 2019). More recently, there has been growing interest in human rights issues globally (e.g., issues of slavery, health, debt bondage). Moreover, gender is fast becoming a topical debate in the realm of natural resources policy (Barclay et al., 2021; Fortnam et al., 2019; Gallardo-Fernández, 2018; Lau et al., 2021; Prügl & Joshi, 2021; Rocheleau, 2008; Rocheleau & Edmunds, 1997; Sultana, 2011). Women play an important role in fisheries; however, there has been little attention paid to their role especially in the Pacific, and even less in the WCP tuna fishery. Within this context, stories circulate of the empowerment of women as fisheries managers, but equally there are negative stories of prostitution, slavery, and disenfranchisement (Biswas, 2011; Gallardo-Fernández, 2018; McNamara & Westoby, 2014; Teh et al., 2019).

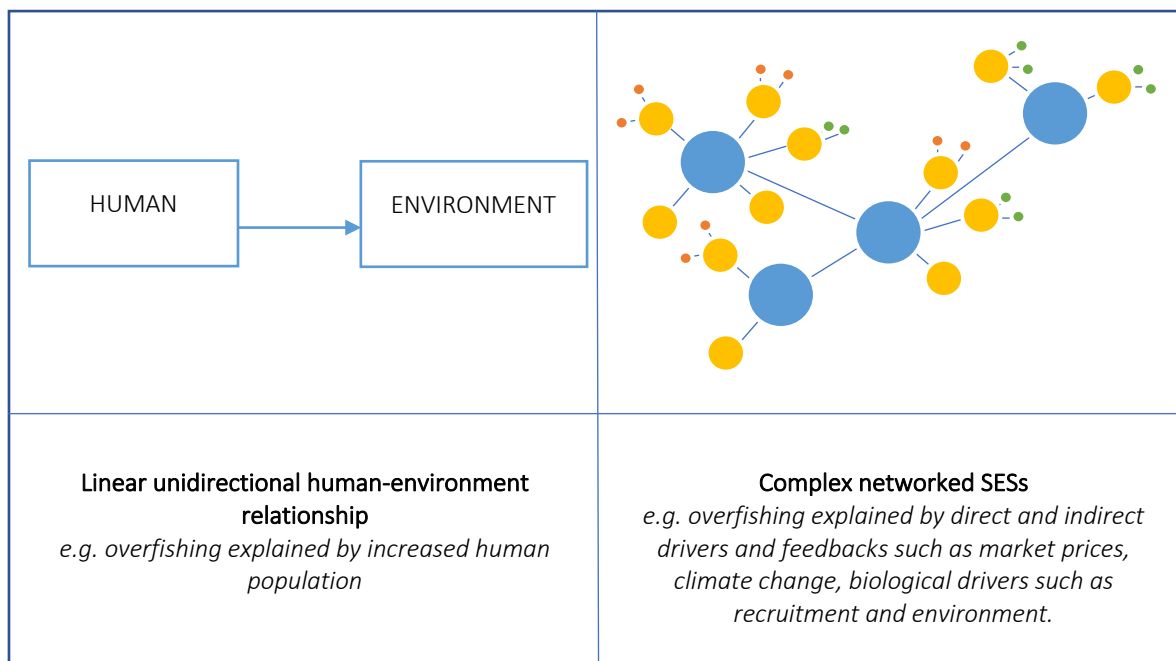


Figure 1. Exploring human to environment interlinkages to uncover environmental degradation: orthodox approaches (left) versus reconceptualised and holistic SES approaches (right)

1.4.2 Trends in governing fisheries

There is a tendency to continue to employ outdated neoliberal approaches to governance (e.g. deregulation, privatisation, use of market mechanisms) of environmental problems and this leads to unintended outcomes (Fabinyi & Barclay, 2022). Pursuing social and environmental goals in the Pacific often involves what are traditionally considered to be efficient market mechanisms coupled with institutional improvements (e.g., compensation schemes, subsidies to fisheries, preferential access to SIDS, good governance principles). These neoliberal environmental approaches to governance continue to externalise many important elements of society and the environment and fail to incorporate critical linkages. For example, women are often excluded from these analyses yet play an important role in fisheries management globally. Excluding women is particularly apparent in fisheries management systems around the developed world, such as New Zealand (Cryer et al., 2016) and the United States (Marshall et al., 2018).

Figure 2 shows an example of a fisheries governance framework where science and management of the four main commercially harvested tuna in the Pacific Ocean are compartmentalised by area and by species. The way in which these places and species are

governed can give rise to unintended outcomes (e.g., further environmental degradation, social inequality, and poverty). The use of technologies such as fixed and free-floating fish-aggregating devices (FAD) to improve economic efficiency of the fishery has increased in parallel with the development of the purse-seine fishery. FADs, however, have been found to influence behaviour and movement patterns of three tuna species as well as increase vulnerability of juvenile and small sized tunas as well as other species such as sharks (Leroy et al., 2013). Moreover, although canneries and ports provide jobs and revenue for nearby villages around the Pacific, they have negatively impacted village life in Pacific island communities (Barclay, 2010). How conservation and management measures (CMM) impact the social, economic, and political sub-dimension of the SES are also poorly understood (e.g., the CMM 2020-01 for bigeye, yellowfin and skipjack tuna in the WCPO places a seasonal ban on the use of FADs).

Over time there has been a shift towards incorporating ecosystem-based information for fisheries management globally in response external pressures (international and NGO watchdogs) and as part of the acknowledgement that fisheries are part of an ecosystem (Godinot & Allain, 2003). This includes the development of several multi-species assessment models and whole-of-ecosystem models to estimate stock biomass and trends (Godinot & Allain, 2003; Moffitt et al., 2016). Management practices have also incorporated ecosystem goals such as conserving food-web resources, maintaining biodiversity, and reducing bycatch (Moffitt et al., 2016). Limits applied to reach these goals include maximum annual harvested groundfish caps, minimum biomass thresholds, limits to forage species well below maximum sustainable yield to account for predator's nutritional needs (e.g., eastern Bering Sea, Gulf of Alaska, and California Current ecosystems; (Moffitt et al., 2016)).

In the Pacific, the tuna regional fisheries management organisation, the Western and Central Pacific Fisheries Commission (WCPFC), reports bycatch, incidental mortality of endangered, threatened or protected species, and impacts on the environment (e.g., ghost fishing, impacts on benthos). While some efforts to understand ecosystem dynamics in a changing environment due to climate change have been made (see SPC's models EcoPath and Spatial Ecosystem and Population Dynamics Model (SEAPODYM; (Christensen & Walters, 2004; Godinot & Allain, 2003; Lehodey et al., 2008)), other considerations such as human rights, gender, pollution, geopolitics, and globalisation are yet to be examined. Furthermore, these ecosystem models (e.g. SEAPODYM) have not proven themselves as effective management

tools, but are paving the way to future design and implementation of more holistic approaches to management of fisheries (Benson & Stephenson, 2018). Nevertheless, these approaches fall short of genuine holistic ecosystem-based management and have been applied in a piecemeal and ad hoc manner (Benson & Stephenson, 2018; Crowder & Norse, 2008; Fogarty, 2014; McLeod & Leslie, 2009).

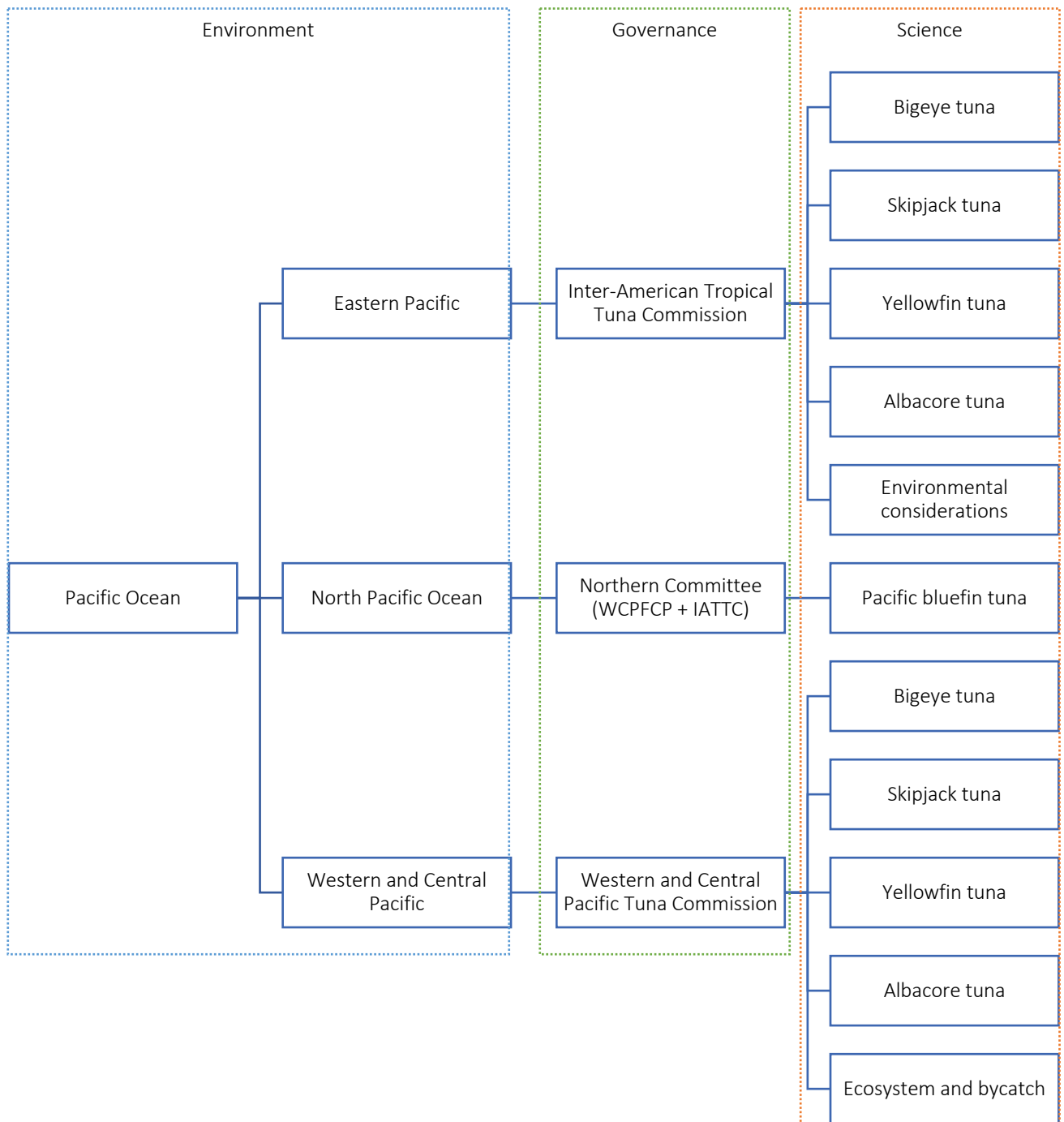


Figure 2. Pacific tuna regional governance framework

Note: This is a simplified diagram of Pacific tuna fisheries governance to illustrate the compartmentalised approach to assessing and managing tuna stocks. There are multiple scales of governance (local, national, sub-regional, regional, international) as well as science-governance interrelationships that are further explored in this thesis.

1.4.3 Integrating SES Research and Political Ecology

SES research focusses on coupled ecological and social systems and advances solutions for environment management challenges (Holzer et al., 2018). The concept emerged from the acknowledgement of the importance of understanding interdependent relationships between ecological and social systems (Berkes & Folke, 1998). SES networks are inherently complex and becoming increasingly open (Avriel-Avnia & Dick, 2019; Costanza et al., 2014). SES frameworks have been developed to investigate and model complex coupled systems; however, they differ markedly in their contextual and structural criteria (Binder et al., 2013). For example, Binder et al. (2013) offer a classification of frameworks based on the following criteria:

- 1) Whether relationships between social and ecological systems are conceptualised as being uni- or bidirectional.
- 2) Whether an anthropocentric or an ecocentric perspective is taken on the ecological system.
- 3) Whether the framework is an action-oriented or an analysis-oriented framework.

Several frameworks are reviewed using these criteria. Of particular note is the SES framework (SESF) developed by (Ostrom, 2007, 2009) which has been applied across a diverse array of methods, contexts, and thematic areas (e.g. small-scale fisheries, forestry, and irrigation). This is helpful as a starting point when thinking about examining the WCPO tuna fishery using SES frameworks. The Pacific Ocean pelagic ecosystem is unique; multiple species of tuna are harvested across a vast area by a diverse combination of small-scale to industrial-scale, local to distant water fishing nations (DWFN) using multiple fishing gear types across a range of latitudes, longitudes, and water column depths. Globalisation compounds complexity and intensifies disconnections between regions where fisheries are harvested and experiencing impacts, and those where fish are consumed (Avriel-Avnia & Dick, 2019). Changes to these ecosystems occur across multiple temporal and spatial scales, through multiple parts of the SES and do so rapidly and often unpredictably. Moreover, unintended outcomes (defined further below) of governance and development occur because many of the relationships, processes, and functions of the system are widely unknown or poorly understood (and therefore poorly managed). This uncertainty challenges sustainability goals as well as increases risk in SIDS which are reliant upon tuna fisheries for their wellbeing and livelihoods.

To be useful, an SES framework needs to be multi-faceted and must be able to be integrated across different scales. It also must allow for the consideration of the complexities of power-relations and culture and provide a wider analysis than that directly involved in the SES. Something current SES frameworks do not do, but what political ecology can do.

Political ecology is a critical framework that examines the relationship between society and environment in the context of power (Robinson, 2004). Emerging from Marxian roots and theories of cultural ecology (Walker, 2005, 2006), political ecology is a broad field for understanding environmental problems, particularly in the developing world. It offers a wide range of theoretical approaches, including gender analysis (Rocheleau et al., 1996), analysis of scale (Campbell, 2007) and has been adopted and applied in anthropology, forestry, development studies, environmental sociology, environmental history, marine policy, and geography (Jones, 2008; Peet & Watts, 1993; Walker, 2006).

Political ecology focusses on the subjects that drive environmental change, rather than change itself (Robinson, 2004; Veuthey & Gerber, 2012). It explores themes of politics, power in human-environment relationships including examining the role of human agency and the complexities of cultural and political practices (Bryant & Bailey, 1997; Peet & Watts, 1996). A common assumption inherent in political ecology is that benefits and costs of environmental change are distributed unevenly, and research examines winners and loser of that change (Bryant & Bailey, 1997). Political ecology refutes apolitical theories such as Ostrom's 'tragedy of commons' (Chapman, 1989; Turner, 2017) and argues that environmental degradation is too easily explained as tragic outcomes of failures in collective governance and management and that complex ecological systems are arguably too difficult to divide into individual units of ownership to exclude use. Political ecologists claim such rhetoric legitimises capitalist acts of the elite, the state, and non-residents in an alignment of political and economic interests (Turner, 2017). Political ecology seeks to expose fundamental flaws in the dominant approaches of corporate, state, and international bodies in both governance and management.

Although inclusive of many thematic fields, political ecology has been criticised for being too broad (Walker, 2003) or for being too policy or ecology-focused (Walker, 2005, 2006). However, its main shortfall is that political ecology is a critique; it does not seek to offer

action or solutions (Sultana, 2021). By aligning political ecology with SES analysis, this research addresses this critique by providing a framework that both identifies environmental and societal management issues and challenges, as well as potential solutions.

Political ecology allows for the adoption of transdisciplinary research, mixed methodology (quantitative and qualitative), and reveals reasons as to *why* particular social and environmental outcomes can occur. This blend of qualitative and quantitative analysis offered through transdisciplinary research is critical to evaluating human-environment interactions. This is because SESs are comprised of intricate and complex interlinked relationships and in an increasingly globalised world, purely local analysis could not effectively give a holistic representation or unveil reasons behind unintended outcomes. Unintended outcomes are defined in SES research as feedbacks of dynamic, unpredictable, and non-linear interactions between social and ecological system (Berkes, 2011; Scholes et al., 2013). They are sometimes explained as consequences of sustainable development and conservation practice (Larrosa et al., 2016). Moreover, unintended outcomes can occur when a narrow management framework is employed by actions/inactions result in 2, 3, 4th order consequences. Fisheries often frame issues such as bycatch as unintended, incidental, or accidental (Berkes, 2011; Komoroske & Lawison, 2015). From a political ecology perspective, however, such outcomes are not necessarily unanticipated or ‘collateral damage’ to an economic and/or political goal because of the influence of power dynamics and politics in mediating such interactions. There is a need to reconceptualise the way in which unintended outcomes are understood and governed. Thus, while SES analysis grasps effects on the whole system by allowing the research to measure impacts throughout the SES, political ecology illuminates the context of power-relations in which they came about. Political ecology is therefore used as an over-arching analytical framework for its breadth, to allow for storytelling, and for its ability to cross-cut SES networks. This research contributes to the field of political ecology in a way that brings some focus to the literature and offer a new framework for integrating multiple disciplines, many different types of information, in an information imperfect world.

1.5 Thesis structure

Chapter 1: *Introduction* provides the research hypothesis, objectives, and questions. A rationale, focus, and approach including a brief overview of political ecology and SES research is also described as well as a discussion on positionality of the research. Combining political ecology and SES research is argued to provide a two-pronged approach to allow for

the critical examination of coupled ecological and social systems and provide solutions to governance. This blend of qualitative and quantitative analysis offered through transdisciplinary research is critical to evaluating human-environment interactions.

Chapter 2: *Transdisciplinary analysis of Pacific tuna fisheries: A research framework for understanding and governing oceans as social-ecological systems* presents Social-Ecological-Oceans-Systems Framework (SECO), a transdisciplinary SES framework developed to capture the breadth and depth of WCP tuna SES and address interactions and connections between separate system components. I argue the need for more of a transdisciplinary methodological approach to understanding and governing tuna fisheries to set the scene for the examination of the WCP tuna SES.

Chapter 3: *What does gender have to do with the price of tuna? Social-ecological systems view of women, gender, and governance in Fiji's tuna fishery* examines the social dimension using gender as a lens. It contributes a 'first step' to understanding gender issues in the WCP tuna SES by exploring the role of women in WCP tuna SES in Fiji. It adds to understanding behaviours, gender roles, power relations, policies, programmes, and services that may differentially impact on social, ecological, economic, cultural, and political realities of people. In doing so, how gender shapes, defines, enables, or constrains women's engagement and agency in fisheries-based development premised on economic growth, social development, and wellbeing is considered. Through this examination, the chapter provides an evaluation of the impact of fisheries development and governance on gender equality in Fiji and offers ways in which Fiji and the wider WCP tuna fisheries could be more successful in developing a more gender equal WCP tuna SES.

Chapter 4: *Collaboration a solution for Small Island Developing States to address food security and economic development in the face of climate change* explores Solomon Islands tuna SES resilience and vulnerability with a focus on examining efforts towards coordination, cooperation and collaboration within both small-scale and industrial-scale fisheries and their governance frameworks to alleviate impacts of climate change. Climate change is used as a lens to identify and reveal the drivers of change, interrelationships, and likely impacts on the wellbeing of coastal communities. Current and future policies, and adaptation strategies are identified and evaluated. This research contributes to understanding climate change impacts in Solomon Islands (and WCP tuna fisheries' SES more broadly) and identifies how climate change intersects with other dimensions to result in fisheries development and policy

outcomes (that are sometimes unintended). A multi-scalar concerted effort is called for to support and promote resilient and sustainable livelihoods.

Chapter 5: *Synthesis* draws together the different strands of research presented in Chapter 2, Chapter 3, and Chapter 4. Research objectives and questions are revisited alongside the development of the methodology, key learnings, in relation to the hypothesis and wider research. Key learnings, limitations, and research contributions to the fields of transdisciplinary SES and Political Ecology is provided, followed by suggested future research. Collaborative forms of governance are confirmed fundamental to building societal as well as environmental resilience.

Chapter 2 Transdisciplinary analysis of Pacific tuna fisheries: A research framework for understanding and governing oceans as social-ecological systems



The previous chapter provided an outline of the research, including research aims, hypothesis, objectives and questions. It also gave an overview of theoretical frameworks and concepts used to frame the research. An in-depth literature review was not provided but further provided in this chapter as well as in Chapter 3 and Chapter 4. This chapter is a peer-review published paper that presents a social-ecological research framework used in the research. I developed a transdisciplinary SES framework informed by political ecology, marine science, and social-ecological systems research to investigate the hypothesis and research questions. The methodology and methods used as well as the successes, limitations, and challenges of the research process are reflected on. Further information is provided in Appendix A, including an overview of the WCP tuna fishery, arguments applied from Political Ecology, research methods and ethics procedures, and place-specific characteristics.

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2.1 Introduction

A fundamental challenge for fisheries managers is understanding fisheries as complex social-ecological systems (SES, Figure 3). To do so, managers must move beyond species-based fisheries approaches to more system-based or integrated place-based approaches to management (Berkes, 2011; Bograd et al., 2019; Fogarty, 2014; Karkkainen, 2004; Perry et al., 2010; Swyngedouw, 2010a). Fisheries, such as the productive, valuable, and transboundary Western and Central Pacific (WCP) tuna fishery, operate within the context of ecological, economic, social, and political processes. Understanding interactions within and between the elements of the SES is a key step for Pacific Small Island Developing States

(SIDs) which must balance sustainability and wellbeing goals with economic growth and sovereignty. The WCP tuna fishery is cooperatively managed by a tuna Regional Fisheries Management Organisation (RFMO); the Western and Central Pacific Fisheries Commission (WCPFC).

The WCPFC is supported by some of the most advanced and ‘cutting edge’ fisheries science as well as collaborative management that enables multi-scale collaborative governance of tuna (Jollands & Fisher, 2018). However, this falls short of an integrated, transdisciplinary, and place-based approach required to deal with its complexity. For the WCP tuna fishery, governance largely, but not entirely, follows a species-based fisheries management approach supported by single disciplinary approaches (Haas, 2020; Seto & Hanich, 2018; Williams & Reid, 2019). For example, biology (e.g. monospecific stock assessments for each species of commercially harvested tuna; (Western and Central Pacific Fisheries Commission, 2019)), ecology (e.g. bycatch impacts focussed on single species such as sharks (Hutchinson & Bigelow, 2019)); and economics (e.g. prices, catch value, and economic conditions siloed for each fishery and species (Williams & Ruaia, 2020)).

Furthermore, like many other fisheries, the WCP tuna fishery has moved towards market friendly institutions, policies, and investment (Petersen, 2002). The Parties to the Nauru Agreement (PNA) Vessel Day Scheme (VDS) and Marine Stewardship Council (MSC) have strengthened some SIDs’ ability to obtain high economic returns and demonstrate a shift from regulatory (political) to economic modes of governance. Nevertheless, catch rates continue to increase. Total WCP tuna catch for 2019 was estimated at 2.9 million metric tonnes, the highest on record. Of this, 2.0 million metric tonnes were skipjack, also a record for the fishery (Post & Squires, 2020; Williams & Ruaia, 2020; Yeeting et al., 2018). For these fisheries, the full picture of the SES network is unknown.

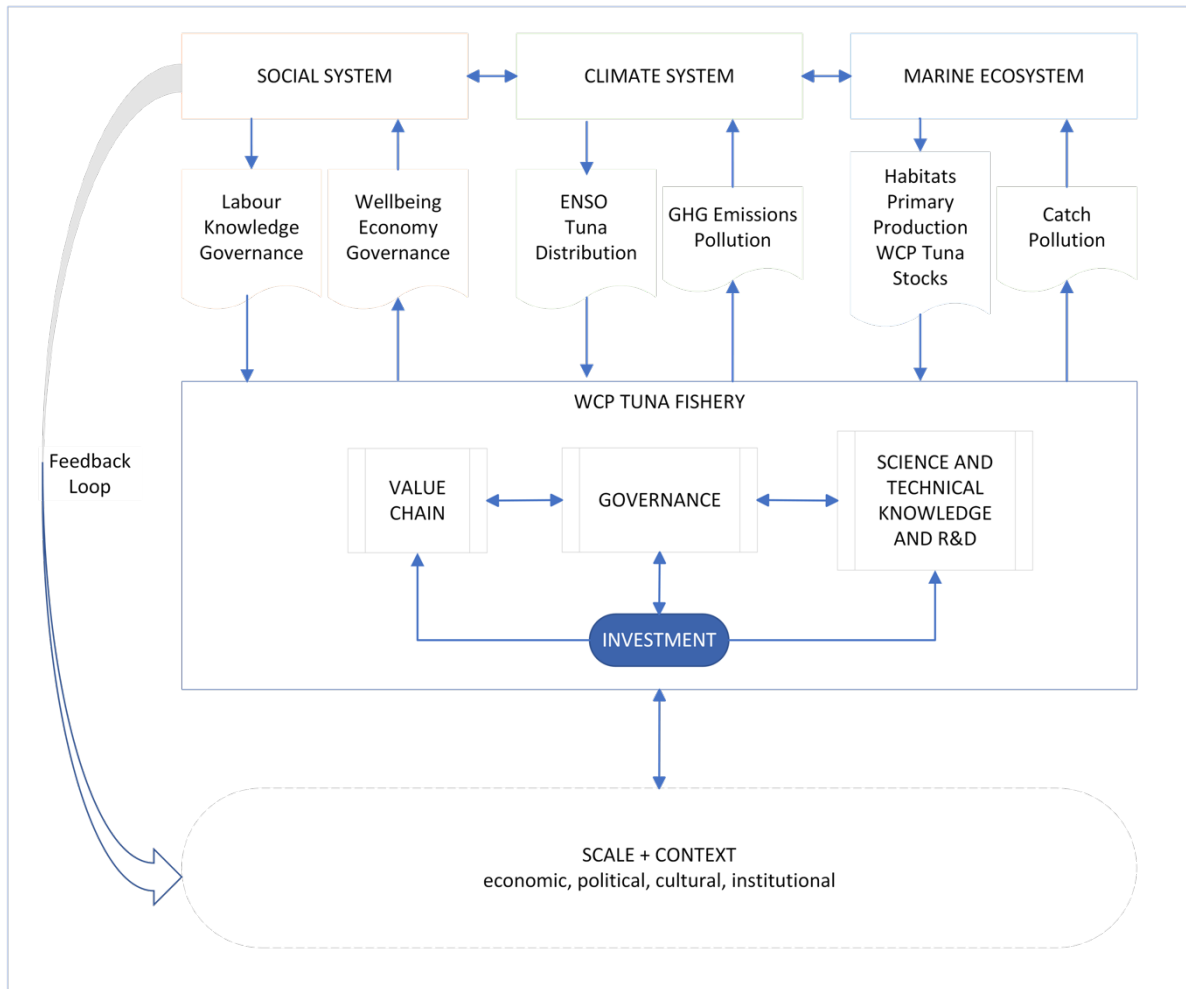


Figure 3. Pacific Tuna Social-Ecological System showing high level collection of systems.

Note: SES's are nested, multi-level systems with interlinkages that occur between three main systems (social, climate, and marine ecosystem) that are interdependent of each other. They involve system processes such as feedback loops, drivers and face multiple stressors and cumulative effects (Gain et al., 2020). Feedback processes are a critical element of the SES and influence its dynamics (Folke, 2006).

How marine SES are conceptualised influences the opportunities for intervention among the social and ecological dimensions of fisheries (Arlinghaus et al., 2017). Engagement with the humanities (e.g. arts, philosophy, history) and social sciences (e.g. political science, law, economics, geography, anthropology) is increasingly seen as important to understand how people are affected and potential barriers and opportunities related to the future of oceans and their sustainable use (Holzer et al., 2018; Sörlin, 2013). People in society, and specifically those interested in the SES because they live, study or use parts of it, have unique ideas and positions within the SES that can form more complete understandings (Daniell et al., 2020; Funtowicz & Ravetz, 2009). New frameworks that enable society to work together with

academia and practitioners to transcend specialisations and create new understandings of marine SES are needed (Brown et al., 2010).

Participatory processes, such as those described and promoted in community-based fisheries management and in transdisciplinary research, are crucial for finding common problems and solutions of complex systems (Arnold, 2013; Espinoza-Tenorio et al., 2013; Reed, 2008; Sultana & Abeyasekera, 2008; Wiber et al., 2004). Transdisciplinary research aspires to transcend disciplines to provide new approaches and solutions to complex problems (Holzer et al., 2018; Klein, 2017) and is especially relevant to complex social-ecological systems (Avriel-Avnia & Dick, 2019).

Core features of transdisciplinary research include:

- an intention to tackle real-world complex problems;
- collaboration and integration with all stakeholders including non-academics and knowledge; and
- an openness to adapting methodologies as projects proceed (Holzer et al., 2018).

This research hypothesises that a transdisciplinary approach using political ecology and SES research can be used to assemble diverse theories, knowledges, methods, and analytical techniques (refer to supplementary information for key arguments used from political ecology; Table 9, Appendix A). Such an approach can reveal and make sense of complicated interactions and connections across ocean SES networks (Berkes, 2010; Berkes & Folke, 1998; Bograd et al., 2019; Fischer-Kowalski & Weisz, 2016; Holzer et al., 2018; Huber-Sannwald et al., 2020; Perry et al., 2010; Robbins, 2004). In this chapter, a framework is developed to address the challenges of the WCP tuna fisheries management, a real-world complex problem.

The Social-Ecological-Ocean System's (SECO) Framework seeks to deepen understandings of marine SES networks and their governance. The specific research objective explored how SIDs in the WCP can best provide for the wellbeing of their people while enhancing value across multiple dimensions including sustainable wealth generated from their marine environment. The objective of the research seeks to contribute to the development of approaches for achieving goals and strategies set out in the Pacific Islands Forum Fisheries Agency's (FFA) *Regional Roadmap for Sustainable Pacific Fisheries* (Pacific Islands Forum Fisheries Agency, 2014) and the United Nations Food and Agriculture Organisation's (FAO)

Global Blue Growth Initiative and Small Island Developing States (Food and Agriculture Organization of the United Nations, 2014). The SECO Framework is analogous to a rapid transdisciplinary assessment to guide later in-depth work on selected issues.

SECO was designed to integrate across many different scales (Figure 4). Scale is used to measure and study any phenomenon (e.g., geographical space, institutions, networks). It is socially constructed and dependent on the dynamic social processes such that scale shapes politics and politics shapes scale (Cash et al., 2006; MacKinnon, 2011). Levels are found within scales at different locations (e.g., local, national, global for geographical space). Scale is a useful concept to apply to the WCP where impacts of globalisation and environmental issues are seen as international matters requiring international regulation meanwhile displacing the 'local' and 'national' interests (Bulkeley, 2005; Marston, 2000; Moore, 2008).

Cross-scale and cross-level linkages therefore describe interactions between scales and/or levels that can create complex dynamics (Cash et al., 2006). For example, applying Cash et al. (2006) to the WCP tuna fishery using fish-aggregating devices (FADs), a subsistence fisher in Gizo, Solomon Islands may be fishing for tuna using handlines 2 kilometres offshore to feed the family and village, selling surplus to the local market. This fishing will be governed by village norms and rules, national law and WCPFC regulations, and the catch influenced by oceanographic processes, overfishing, and climate change.

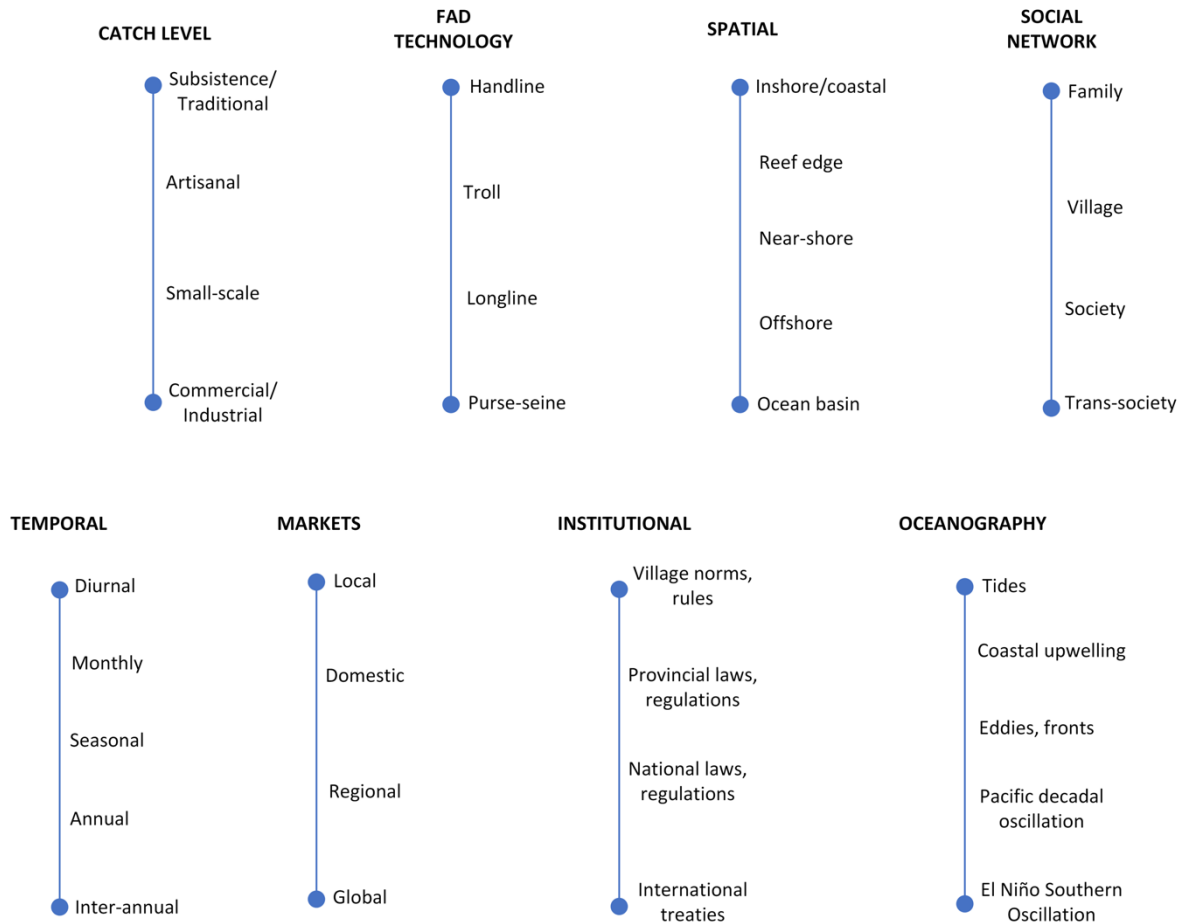


Figure 4. Schematic illustration of scales and levels of a tuna FAD fishery in the WCP

Source and adapted from Cash et al (2006)

2.2 Background to the Western and Central Pacific Tuna Fishery

The WCP tuna fishery is located within the WCP Convention Area (WCP-CA, <https://www.wcpfc.int/doc/convention-area-map>). It comprises a diverse collection of pelagic ecosystems, home to the four main commercially harvested tuna species; albacore (*Thunnus alalunga*), bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*), and fisheries constituting 81% of Pacific Ocean tuna catch (Williams & Reid, 2019) (refer to supplementary information providing an overview of the WCP tuna fishery; Appendix A). Associated economic, cultural, and political landscapes are intricately linked to tuna, its oceanic environment (Bell et al., 2011), and the benefits that it generates for coastal states and distant water fishing nations. The greatest benefit of the WCP tuna

fishery to SIDs are resource license and access fees (US\$535 million in 2018) and harvesting income (more than US\$400 million in 2018) (Pacific Islands Forum Fisheries Agency, 2019). Next is employment particularly from tuna processing facilities such as canneries and loining plants (Barclay, 2010). Management is replete with challenges across various economic, social, and ecological aspects. Priority challenges the WCPFC faces in meeting its objectives of long-term conservation and sustainable use of highly migratory species include management of the high seas and setting sustainable limits of commercially harvested tuna species (Azmi & Hanich, 2021; Crothers & Nelson, 2006; Western and Central Pacific Fisheries Commission, 2020b). For example, while the four main commercially harvested tuna stocks are considered “healthy”, Pacific Bluefin tuna stocks are designated endangered (Wakamatsu & Managi, 2019) and some fisheries are considered economically unsustainable (Williams & Ruaia, 2020). This is the case for the southern longline fishery’s where economic returns have declined (Skirtun et al., 2019). The WCPFC has also failed to make long-term strategic decisions (Abolhassani, 2018) and to design equitable conservation and management measures that do not place a disproportionate burden on SIDs (Azmi et al., 2016). Increasingly, concerns over IUU activities and human rights violations on board tuna fishing vessels are raised (Western and Central Pacific Fisheries Commission, 2020a; Wold & Cook, 2019). Despite being considered one of the best-managed tuna fisheries, problems are still apparent and shifting from a fisheries’ specific to SES perspectives may open up new solutions. Place-specific studies (Suva, Fiji and Gizo and Honiara, Solomon Islands) were undertaken to test this premise. The studies are presented in Chapter 3 and Chapter 4, but selected parts of the studies are used in the present chapter to illustrate the use of the SECO Framework.

2.3 Place-specific studies

Fiji is made up of more than 300 islands in the south-west Pacific Ocean with an exclusive economic area of 1.29M km². Fiji’s fishing grounds are not as productive as neighbouring and more equatorial countries such as tuna rich countries of the PNA. In 2019, longline catch by Fiji national vessels was just over 15,000 mt of which was predominately albacore (~8,500 mt), and yellowfin (~3,500 mt) (Ministry of Fisheries Fiji, 2020). Catch is distributed to processing facilities such as PAFCO that supplies tuna loins and canning products to local and export market, while other companies supply sashimi grade tuna and other products primarily to Japan, US, EU, Australia, and New Zealand. Although small volumes of tuna are

caught, Suva is a ‘gateway to the Pacific’ providing infrastructure and logistics networks and local and international labour to encourage tuna vessels in the region to come to Fiji (Barclay & Cartwright, 2007a).

Solomon Islands consists of over 1,000 islands made up of nine main groups, also in the south-west Pacific Ocean, with an exclusive economic zone (EEZ) of around 1.34M km². Solomon Island’s Least Developed Country status is scheduled to graduate in 2024 (The United Nations Committee for Development Policy, 2018). However, the country remains vulnerable to multiple economic and environmental stressors because of its high exposure to natural disasters, remoteness, and reliance on the logging industry for exports. The tuna fishery significantly contributes to the country’s economy and, for some villages, to subsistence lifestyle such as those visited in Gizo, Mbabanga and Titiana villages. Catch is significantly higher than that for Fiji. In 2019, annual domestic catch was 83,000 mt, of which the foreign fleet caught just under 28,000 mt. Tuna caught in Solomon Island’s EEZ is predominately caught by the purse seine, and to a lesser extent the pole and line fleet, domestic fishery targeting skipjack, employing mostly local crew and supplying the Noro’s cannery (Ministry of Fisheries and Marine Resources Solomon Islands, 2020). The longline fleet, most of which are chartered vessels, are crewed by foreign national’s and supplies most of its catch to overseas markets. The pole and line fleet also supplies tuna catch to the European markets as frozen products (Ministry of Fisheries and Marine Resources Solomon Islands, 2020).

2.4 Methods

2.4.1 Research design

SECO was iteratively developed using critical reflection and expert opinion to refine and improve the framework. This chapter focuses on Steps 1-3, however, Steps 4 and 5 are included since the data obtained through empirical research ultimately informed the evolutions of the framework.

Step (1) involved a focus group comprised of six experts with a wide range of knowledge selected based on their experience with social science, marine conservation, marine science and ecology research, ecological economics, tuna fisheries management, and consultancy. The focus group deliberated on marine issues and threats faced by Pacific island SIDs; relevant theoretical frameworks; methodologies; and the disparate ideologies held by

fisheries managers, conservationists, and resource owners and users. Based on these discussions, quantitative and qualitative methods (including semi-structured interviews and focus group discussions) were employed to investigate tuna fisheries SES using Fiji and Solomon Islands as place-specific studies. Step (1) informed Step (2), in which the SES network was characterised in terms of the (a) state of selected social and ecological dimensions, (b) interlinkages, and (b) change in response to policy and development. In Step (3) the SECO Framework was trialled in three place-specific studies.

Step (4) entailed carrying out an assessment and development of management tools. Using the findings from Steps (1)-(3), current tuna fisheries management at regional, sub-regional, and national levels was examined to assess its effectiveness in identifying and resolving impacts of unintended consequences. As part of this analysis fisheries management systems were examined for how they could be embedded into social and ecological systems that deliver better outcomes and avoid unintended consequences. Finally, the development and refinement of a SECO conceptual model specifically for the Pacific tuna fishery was undertaken in Step (5). The empirical study contributes to the theory of SES models and extends understanding of oceans providing a nuanced approach for how they may be governed.

2.4.2 Data collection and analysis

Primary and secondary data were collected in Steps (2) and (3) between January 2018 and December 2019. A mixed methods approach (qualitative and quantitative) was adopted, which allowed a broader perspective; multiple research questions to be addressed; multiple data to be collected from different groups of representatives; and, a transdisciplinary focus (Denzin & Lincoln, 2005; Terrell, 2012) (see also Appendix A: Supplementary Information Table 10). Prospective participants were identified using existing networks and snowballing techniques. Research ethics were approved by The University of Auckland Human Participants Ethics Committee.

For Step (2), fourteen semi-structured interviews were carried out in April 2018 with representatives from industry, academia, the Pacific Community (SPC), non-governmental organisations (NGOs), governmental and international governmental organisations (IGOs), and independent consultants. Data (both qualitative and quantitative) were also collated from secondary sources from country reports, scientific journals and reports from science providers and other research or NGOs. To organise and analyse qualitative data, data were

subsequently transcribed and coded using nVivo (QSR International). Specifically, key themes were identified at the regional level about the (a) state of the fishery (fishing, culture, economic contributions, governance, history), (b) key interlinkages between social and ecological dimensions, and (c) changes in respect of changes to human activities, attitudes, beliefs, knowledge, relationships (including power relations) to characterise the SES network. Having a representation of policy, industry, advocacy, consultant, and scientist expertise allowed for an inclusive assessment of ideas, issues, and themes within the fishery.

SES analysis in Step (2) also highlighted gaps in social-ecological research that required addressing for WCP tuna fisheries. This included the role of women in tuna fisheries in Fiji and climate change impacts on tuna fisheries in Solomon Islands. For Step (3), see Table 11 Supplementary Information for detailed information on place-specific studies (Appendix A). In Fiji, nineteen semi-structured interviews were undertaken in May 2019 with key representatives including tuna fishing industry representatives, independent consultants involved in fisheries management, regional fisheries managers, staff of non-governmental organisations, academics, recreational fishers, and fishers in Waiqanake Village. A semi-structured focus group was also undertaken with six women from Kalekana Village. In Solomon Islands, thirteen interviews and two semi-structured focus-group were carried out in Honiara, Guadalcanal Province and Gizo, Western Province in Solomon Islands (see Appendix B for interview and focus group guidelines). Interviews and focus group discussions were transcribed. All data were coded using nVivo to identify key themes and interlinkages. Using characterisation information from Step (1), data from Fiji and Solomon Islands studies was cross-referenced using a matrix that applied the SES framework (including key identified interlinkages). The matrix provided a structured approach to examine the (a) state of the SES, (b) key interlinkages, and (c) transitions of development to explore gender with particular attention paid to unintended outcomes. Using a political ecology approach, questions guided the identification of gender and climate change issues including: 1) Who benefits from tuna fisheries development and policy; 2) What are the benefits and impacts; and 3) What are the unintended impacts?

Secondary data were collected for textual analysis including fisheries specific data (e.g. catch data, ecosystem data, fishery and country reports, relevant policies, regulations and legislation), gender and other social data (e.g. population statistics including education statistics), and climate change data (Bell et al., 2011; Intergovernmental Panel on Climate

Change, 2014b; Senina et al., 2018). Data were used to support primary data and a set of themes and data packages were created to provide a platform for substantive research for exploring, analysing, and theorising data.

2.4.3 Concepts and Principles

SECO draws theories and concepts from the field of political ecology (Robbins et al., 2012), complexity theory (Dann & Barclay, 2005; Gummesson, 2006), scale (Cash et al., 2006; MacKinnon, 2011) and brings together relevant biological, chemical, geological, and physical oceanographic reference data through the multidisciplinary field of study, marine sciences. It draws on research frameworks from social-ecological resilience studies such as Gunderson et al. (2005) and those reviewed in Holzer et al. (2018) that gave a structured approach to the analysis (analysis of state, interlinkages, and changes of the SES).

Key principles required for research of complex real-world social-ecological ocean systems were identified and applied in the development of SECO (Table 1). Working with participants and adapting the development of SECO assisted in developing a holistic understanding of complex SESs. A focus on equality and transparency (of knowledge systems and research approach), ensured all parties were informed and engaged with the research aims and objectives.

Table 1. Principles of transdisciplinary research of complex social-ecological ocean systems

Principle	
Transdisciplinary Contextualisation	Facilitates a recognition of the unknown components of the SES.
Appreciating Complexity	Using mixed-methods to support equity in the definition of different components of the SES (Popa et al., 2015).
Adaptive, reflexive, iterative research	Allows the co-development ideas and themes identified <i>in situ</i> to be incorporated, explored and analysed for better problem-framing, co-evolution, learning and refining the SECO Framework.
Equality and transparency	Participatory research methods research to develop trust (Farr et al., 2018; Popa et al., 2015).

2.5 Results

The SECO Framework gave a relevant bird's eye view of the SES (Step 1), a characterisation of the WCP SES (Step 2), while Step (3) drilled into specifics using the place-specific studies, and Steps (4) and (5) went into depth on the issues identified and their potential

solutions, mainly at the regional and national level (Table 2). The research questions developed from the focus group discussion in Step (1) was used to develop research outputs, methods and research scales of Steps (2)-(5) (Table 2). The overall research question was: *How can Small Island Developing States best provide for the wellbeing of their people while enhancing value across multiple dimensions including sustainable wealth generated from their tuna resources? At the centre of this; how do individual nation states, and states collectively, allocate tuna fisheries' benefits and costs between their multiple societal values?*

Table 2. Research outputs, methods, and research scales

Step #	Research Outputs and Questions Developed in Step 1	Research Methods	Typical Scales and Levels of Data Gathering and Research
(2)	<p>Characterisation of Pacific tuna SES with key linkages and issues identified for further examination.</p> <p><i>Questions focusing on how the WCPO is defined and by whom, what and who are the key drivers, players, processes, functions, and feedbacks within the SES network.</i></p>	<p>Coding of qualitative data using nVivo to identify key themes and interlinkages using semi-structured interviews with key representatives in management and use of tuna fisheries.</p> <p>Examination of relevant fisheries, social, and ecological data, and documentation.</p>	<p>High level view of the SES spanning global to local scales with a regional focus looking at the WCP within oceanographic and governance processes e.g., ENSO, WCPFC.</p>
(3)	<p>Field work demonstrating the role of women in Fiji tuna fishery and the perceptions of climate change impacts in Solomon Islands tuna fishery on Pacific tuna SES in the case studies.</p> <p><i>Questions focusing on exploring unintended outcomes of fisheries policy and development.</i></p>	<p>Place-specific study approach to explore social and ecological dimensions in-depth using gender and climate change issues identified in Step (2).</p> <p>Application of a matrix to identify key interlinkages between the fishery, gender/climate change issues, and the SES (a) state, (b) interlinkages, and (c) transitions of development.</p> <p>Examination of fisheries, social, and ecological data, and documentation.</p>	<p>Drilling down from Step (2) to regional to local scales with a focus on the local i.e., households, villages, industry organisations, but also regional and national processes and policies and how they impact on local.</p>
(4)&(5)	<p>Identifying ways in which unintended outcomes are taken into consideration at multiple scales of fisheries management.</p> <p>Identified opportunities and barriers for strengthening current and future management and develop SECO conceptual model.</p>	<p>Evaluation of EBM and tuna fisheries as a potential management pathway for Pacific SIDs using issues and place-specific study learnings.</p>	<p>National to regional scales with a focus on scaling up learnings from Step (3).</p>

Questions focusing on to what extent fisheries management takes into consideration unintended outcomes of fisheries development and how management processes may incorporate unintended outcomes.

2.5.1 Identifying key interlinkages and issues for further exploration

The characterisation of the WCP tuna fishery as an SES (Step 2) identified key linkages, issues, and concerns of representatives, and ways to further explore these in further depth. This step provided an entry into understanding the multiple interactions and dynamic workings of scale that create complexity. To simplify these interactions, key interlinkages were characterised based on themes of discussions with participants (politics, scale, energy (e.g. biophysical and fossil fuels), knowledge, and equity). These interlinkages revealed drivers of spatial and temporal boundaries, flows of resources, and how rights, access, and ownership to those resources were determined. For example, energy is a key driver of the ocean's ecosystems (e.g. food chains, ENSO), supply chains (e.g. fuel, labour, distribution), and livelihoods (e.g. food security). To illustrate, the cross-scale linkages revealed social impacts of the conservation and management measure CMM2020-01 of the WCPFC that focuses on stock and bycatch management and SIDS arguments centred on a 'disproportionate burden'. CMM2020-01 displaced fisheries into areas where their fishing generated conflict with other established fisheries. The characterisation of the WCP tuna fishery as a SES network became the baseline for re-examination and further exploration of SES components and their interlinkages across scales.

2.5.2 Place-specific case studies, TD contextualisation and revealing unintended outcomes

In Step (3), place-specific studies focussed on issues identified in Step (2) revealed cross-scale linkages 'on the ground'; validated statements made by representatives about the issues identified (gender and climate change); and, showed in more depth unintended outcomes of policy and development within the tuna fishery. Applying SECO Steps (1) and (2) showed how to find important but overlooked issues. But Steps (3) identified some of the "why" questions as to why they are overlooked but also, why they should be revealed to policy and decision makers. Applying the matrix of the (a) state, (b) interlinkages, and (c) changes across politics, scale, energy, knowledge helped identify key interlinkages such as power, for example, that has led to unintended negative outcomes for women and their families.

SECO provided important revelations around understanding the SES network and unintended outcomes of fisheries policy and development. Focussing on issues pathways, dynamics, and feedback loops were explored in terms of processes of change and drivers of uncertainty and resilience and unintended outcomes of fisheries development and policy were revealed. For example, gender was identified as a particular issue in the fishery requiring further examination. In Fiji, important issues that are overlooked in the management of tuna fisheries include the invisible, low paid or exploited roles of women in value chains or supportive roles while men are away fishing. Being a country with less fertile waters, an unintended outcome of having ships in port was the underground sex tourism; or to offer labour on board which led to the exposure of Fijian men to unsafe and at times treacherous working conditions resulting in injury or even death. SECO revealed that the women interviewed in Kalekana and Waiqanake Villages are overlooked, their welfare is not supported, let alone enhanced as a consequence of the unintended outcomes of policy and development. Interview data, including the stories of Fijian women, were linked to policy and development initiatives, marine ecosystem surveys, political events (e.g. coups), and industry data on women participation, catch, and challenges (e.g. Fijian businesses competing with Chinese fleets that have access to subsidies and cheaper labour).

Steps (2) and (3) together also highlighted issues around the lack of knowledge of the SES as a network which is a threat to management. There is a lack of understanding of SES tipping points (also known as thresholds and defined as system's boundaries which beyond which it will become an alternative system, see Holling (1973)), unpredictability, and uncertainty. For example, the ecosystem that supports tuna now and under future climate scenarios is still not adequately understood (The Pacific Community Oceanic Fisheries Programme, 2020). In interviewing key stakeholders to characterise the fishery, the threats to the fishery were universally known; however, there was a general lack of understanding about the health of the ecosystem and the social and ecological impacts from the fishery. In terms of ecosystem health, the Chief Scientist of SPC noted *“we are not very well developed in terms of characterising ecosystem health as a whole, it has mostly been done in a piecemeal species-by-species basis and so that's probably an area that WCPFC needs to develop some competency in.”* These findings are corroborated in Juan-Jordá et al. (2018) who note that while tuna RFMOs have made considerable progress monitoring the impacts of fisheries on target species, moderate progress has been made for bycatch species, and little progress made for understanding and managing ecosystem properties and trophic relationships and habitats.

Likewise, the social impacts of tuna fisheries are poorly known, and knowledge is patchy, or absent. For example, little is understood about implications of policy and development for women although women play important roles throughout the value chain. This includes women's role in the household whose husbands/fathers/sons are absent for months or years with a high risk of serious injury or death. In the Fiji place-specific case study, a group of women from Kalekana and Waiqanake villages spoke of their experiences where they have been left worse off than before their family members worked on Chinese and Taiwanese tuna fishing vessels. These women spoke of the impacts it has placed on their homes, their families, and their bodies. Women described the impacts of multiple jobs including night fishing to supplement incomes and food which impacted their bodies (e.g., migraines from the cold being in the water several hours per day). One woman who was part of the focus group had her story written up by Human Rights at Sea (Human Rights at Sea, 2019a). A review is also provided by Human Rights at Sea who provide recommendations to address human and labour rights abuses of workers at sea (Human Rights at Sea, 2020).

In Steps (4) and (5), gender and climate change issues were assessed against current fisheries management frameworks, mainly at the national and regional scale. Largely, unintended outcomes of regional conservation and management measures are known but not dealt with in any formal capacity (as described by the Director of Fisheries, Aquaculture and Marine Ecosystems Division of SPC).

Gaps were identified between a set of policy principles and current practice across scales of fisheries management. Recommendations were also given for how fisheries management systems could be embedded into social and ecological systems that deliver better outcomes and avoid unintended consequences. Data were also gathered to develop a final SECO conceptual model specifically for the Pacific tuna fishery and this was shared and refined with participants of the research.

2.5.3 Challenges of transdisciplinary research and SECO

Refining SECO using the WCP tuna fishery illuminated challenges of transdisciplinary research. Challenges observed included insufficient problem framing; lack of skills and resources (e.g., funding); barriers for collaboration (e.g., requirements of long-term participation, communication barriers, access to participants, social and cultural barriers, lack of participant buy-in and trust, researcher, and interviewer fatigue); and political challenges (e.g., misalignment of political agendas or interests and political climate or context).

A particular challenge of the research was the development of trust and the experience of facing researcher and interviewer fatigue. Research revealed how villages in the Solomon Islands were experiencing a continuous stream of researchers at masters, doctoral, and post-doctoral level coming to their shores which impacted on their daily lives (personal communication with a governmental official, December 2019). The approach partly worked for carefully navigating the socio-political complexities of place-specific studies such as that experienced in the Solomon Islands.

Moreover, data collection and synthesis, both social and ecological, at multiple scales (WCP regional, global markets, national, and fishing village levels) required information from a diverse range of individuals and groups (in this case from data-poor fisheries and countries with limited local and national data (The Pacific Community Oceanic Fisheries Programme, 2020)). For example, in the Solomon Islands, this required the breaking of political barriers, language and cultural barriers, overcoming researcher and interviewer fatigue, and the development of trust (particularly within governmental organisation and villages) (Clark, 2008; Hviding, 2003; Teaiwa, 2006).

As a rapid appraisal, a major limitation of SECO is relying on secondary data, some of which is not available. For example, more information around sex work is needed to further understand the impacts of the tuna fishery on women in Fiji. In addition, some key participants in Fiji and Solomon Islands were unable to be interviewed due to limited time and resources, and equally, due to some participants not having the time or being available for interview when invited. Nor was SECO able to be tested in other place-specific studies. More place-specific studies would yield a greater breadth and depth of materials. Furthermore, due to COVID-19, locations were unable to be revisited to evaluate any changes that might have occurred over time, or report back to villages on any key emerging themes. However, contact was maintained via email correspondence with participants such as NGO representatives who have close relationships with the villages and others who had access to email to gather any further data and clarification needed. To strengthen SECO and understand the multi-faceted impacts on women and society in general, more testing is required in places, for example, Kiribati where tuna is also very important to the countries' economy but also, as this study has found, has social impacts, for example, sex work where children were reported to go on boats for sex (interview with independent consultant).

2.6 Discussion

SECO allowed for a rapid assessment of social-ecological networks to understand how key interlinkages such as politics, scale, energy, knowledge, and equity are at play and how development and policy changes influence the SES network. Furthermore, SECO enabled place-specific investigations that can provide useful information regarding trade-offs between wellbeing and economic development within and across specific locations. Using these key interlinkages, cross-scale linkages could be examined and revealed that influenced the construction of power and scale relationships in the SES and impact equity, knowledge, and energy outcomes. Tuna fisheries were able to be shown *how* they are tightly interlinked to individuals, villages and markets, and reef ecosystem as a system of relationships that are not necessarily unidirectional or experiencing equal distribution of benefits. These findings highlight *why* it is important to move beyond single disciplinary approaches to fisheries management, and argue for more of a transdisciplinary methodological approach, such as SECO. The transdisciplinary research approach allowed for knowledge integration, team inclusion, cooperation with non-academic stakeholders and knowledge sharing for a more in-depth examination and illumination of complex SES networks (Holzer et al., 2018). The openness to adapt methods as the research proceeded was an advantage when time was limited in place-specific study locations (Holzer et al., 2018). The following sub-sections provide a discussion of SECO's utility for transdisciplinary research of oceans governance.

2.6.1 SECO is a means for an initial step towards transdisciplinary analysis when, so far, navigating and combating individual challenges of transdisciplinary research

Although transdisciplinary and integrated marine governance including research is increasingly being promoted and adopted around the world (Dickinson et al., 2010; Newton & Elliott, 2016; Van Tatenhove, 2011), implementation remains a gap for research conducted on large complex oceans (Berkowitz et al., 2020; Weiland et al., 2021). Challenges remain including long-term commitments of stakeholders, building trust (Weiland et al., 2021), and navigating disciplinary boundaries (Arkema & Ruckelshaus, 2017). These challenges are also confirmed in Mattor et al. (2014) and van Breda, Musango & Brent (2016). Typically, transdisciplinary research requires teams of experts from varying academic and practical backgrounds, to be carried out over a series of years (Mattor et al., 2014). The SECO Framework does not seek to offer a replacement of these intensive and lengthier approaches. SECO remains data heavy and relies on original work to inform the framework. SECO

therefore provides a way in which a lighter footprint for transdisciplinary research to be carried out when resources are constrained, and decisions are urgent.

Weiland et al. (2021) identify key aspects for overcoming common challenges, including the need for contextualisation. The SECO Framework helped to navigate challenges of transdisciplinary research using contextualisation and ground truthing strategies buttressed by a multi-method, transdisciplinary approach (use of case studies, characterisation of the SES network, and issue focussed). Firstly, while cumbersome, gathering diverse data gives strength to the breadth and depth of understanding of the system and key interlinkages (Brown et al., 2010). Secondly, the diversity of data and the ways in which the data was collected alleviated some of the challenges of data poor fisheries as it allowed different sources of knowledge to fill gaps in information and connections of the SES. For example, as illustrated earlier in the case of women's role in Fiji's tuna fishery. Thirdly, more and better data gathering storage and analytical tools are available in the social sciences for handling large volumes of qualitative and quantitative data together (Lune & Berg, 2017).

Gender was useful for examining behaviours, gender roles, power relations, policies, programmes, and services that may differentially impact upon social, ecological, economic, cultural, and political realities of women (Fortnam et al., 2019; Kawarazuka et al., 2017). Exploring women's role in tuna fisheries revealed gender division of labour across supply chains based on entrenched social norms. Moreover, social, cultural, and economic situations of individuals are determined by a combination of complex social constructions including: identity, hierarchy, and difference, along with gender, class, disability, race, ethnicity, religion, and sexuality (Folbre, 1995). Strengths of gender research are noted for its ability to overcome "biases and distortions in disciplinary accounts" (Lapniewska, 2016). Moreover, it assists in the understanding of human behaviour, providing "less partial and distorted accounts of people's actual lives in all their diversity" (Lapniewska, 2016). As such, it is said to be essential in the theory of commons and for research "aiming to create a social change and represent human diversity" and "promote socially progressive policies" as well as promoting new debates on equal and effective management of resources (Lapniewska, 2016). Thus, employing gender-sensitive understandings may allow for more SES approaches to policy and practices in oceans governance.

In addition to gender, climate change was identified as useful in its relevance to cross-scale examination (Deppisch & Hasibovic, 2013). For example, in the case of tuna artisanal fishing

in Gizo, Western Province Solomon Islands, Pacific-wide tuna fisheries regional programmes (such as the FAD programme) that seek to provide food security can have a major positive impacts on resilience of coastal villages including food security, household income, and welfare (findings from research in Gizo, also see (Albert, Warren, et al., 2014; Prange et al., 2009). Cross-scale examinations were incidental where people were interested in the local/regional impacts of climate change (distribution of tuna in the region and impacts on the local communities or national economies of SIDS), which is a global issue. Identifying climate change as an issue in Step (2), and then identifying a local situation to explore the tangled web of climate relations, SECO allowed us to look at the locality embedded in other scaled processes. Future transdisciplinary ocean's research can build on investigations into gender and climate change or widen understandings of other areas of interest such as human rights issues or environmental threats.

SECO is a means for an initial step towards transdisciplinary analysis when, so far, efforts continue to devote towards single disciplinary work. As the results reveal, there is a lack of knowledge of the SES. While knowledge is fundamental to understanding SES' and having a framework to develop that knowledge is integral, there are considerable barriers which keep contextualisation's of social and ecological issues, such as those revealed in this chapter, suppressed, and further, not acted upon. Financial, institutional, and political barriers are often cited as key barriers to achieving sustainable development of tuna resources in the Pacific (Parris & Grafton, 2006). Moreover, culture of the fishery and of its governance is also a major barrier that can be explained by path dependency (Mahoney, 2000). Path dependency is defined as "that what has happened at an earlier point in time will affect the possible outcomes of a sequence of events occurring at a later point in time" (Sewell 1990 cited in (Mahoney, 2000, p. 510). In the WCP tuna fishery's case, decisions made on *the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on The Law Of The Sea Of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks* and the subsequent *2000 Convention of the Conservation and Management of High Migratory Fish Stocks in the Western and Central Pacific Ocean* establishing the WCPFC, reinforced and solidified a fisheries ethos. Furthermore, while the Convention includes reference to Food and Agriculture Organisation's 1995 Code of Conduct for Responsible Fisheries, Commission member's efforts to implement it are blocked by member's who seek to progress their nation's interests. For example, member states continue to block advancements towards

improving labour standards on board fishing vessels as was the case in 2020 at the WCPFC's 17th annual meeting where China did not support Indonesia's proposed CMM, Labour Standards for Crew on Fishing Vessels (Western and Central Pacific Fisheries Commission, 2020a, 2020b). Institutions need the impetus and clout to affect fisheries management changes in respect of broader social and ecological issues that are directly or indirectly impacted by tuna fisheries, only then will SES issues be heard and acted upon.

Adaptive, reflexive, and iterative approaches used in SECO have potential risks, for example, time commitment, loss of power, loss of certainty. However, in the author's opinion based on the work reported in this chapter, the trade-off is weighted towards the advantages. These approaches help to identify new problems, methods, and knowledges that can be used to understand complex systems and the complexity of systems. The approach is open for applying and adapting diverse methods or methodology as research proceeds. Furthermore, SECO is an initial breakthrough into transdisciplinary analysis when so much of the present analysis is devoted to fish stocks (and to a limited extent on bycatch, climate, and economics). SECO's replication will provide an ever-increasing disciplinary base of knowledge and will provide new questions to answer. While getting priority for transdisciplinary work is difficult because of the heavy commitment to current scientific and economic methods and risk of changing, an initial foray using SECO approaches may help open up or 'test the transdisciplinary waters' for ways forward.

2.7 Conclusions

The SECO Framework allowed us to deepen understandings about the social dimensions and connections with ecological dimensions that may not have been able without them in a typical, siloed, characterisation exercise. The transdisciplinary nature of the research meant that both expertise and the value of other dimensions/components are incorporated. The key contribution made by SECO here is the framework enabled experts/others to identify issues of relevance. SECO also enabled us to make connections across scales, to show how policies/practices elsewhere have bearing in specific locations, and how specific histories intersect with larger social/political/economic processes to give rise to a range of consequences (intended and unintended). Currently, the fields of transdisciplinary research, marine science, and SES research offers little in the way of frameworks to guide researchers into the field and forms of analyses. The call for more social science is strong, but this call will not be answered without frameworks, such as SECO.

Fisheries issues (such as stock biomass depletion, IUU, etc) and challenges that come with ventures to maximise economic gains from the fishery, occur against the backdrop of a wider social, economic, and environmental setting that interact across multiple scales. Essentially, fisheries are the perfect case for exploring why and how wicked problems halt endeavours towards sustainable development. While the WCP tuna fishery's four main tuna species, albacore, bigeye, skipjack, and yellowfin are deemed to currently exhibit a 'healthy stock status', the industry and communities who rely on them for their income generation and food security are experiencing far from sustainable outcomes. The impacts WCP tuna fisheries have on other ecosystems linked to them are showing signs of environmental degradation and associated social impacts. These signs are symptomatic of a much larger governance and policy challenges.

SECO helps to understand the complexities that occur across multi-scalar SES networks and sets a baseline for further research to build on that will start to (and continue to) offer policy and decision makers a tool for governance that recognises the importance of connections in SES networks.

Chapter 3 What does gender have to do with the price of tuna? Social-ecological systems view of women, gender, and governance in Fiji's tuna fishery



This chapter is a peer-review published paper which reports on applying gender as a lens to explore Fiji's tuna SES. This chapter also critically evaluates governance including efforts to mainstream gender equality in the tuna fishery. The research also contributed to Barclay et al. (2021).

Syddall, V., Fisher, K., & Thrush, S. (2022). What does gender have to do with the price of tuna? Social-ecological systems view of women, gender, and governance in Fiji's tuna fishery. *Maritime Studies, In press.*

3.1 Introduction

Western and central Pacific (WCP) tuna fisheries form part of much larger social and ecological system (SES). These fisheries contribute just over half of the world's tuna supply while also supporting Pacific island countries' economy (Williams & Ruaia, 2020), food security (Pilling et al., 2015), and sovereignty (Hanich et al., 2010). Developing policies that consider these broader SES and their complex interaction is important. Until recently, however, research on WCP tuna fisheries has focused primarily on biology, stock assessment, environmental and climate research, with scant attention to gender or the gendered dimensions of fisheries (Evans et al., 2015; Keen et al., 2018; Moore et al., 2020). To date, social research on tuna fisheries has focussed on human rights issues on board vessels and is considered gender blind (Finkbeiner et al., 2017) or focussed on the roles of women in tuna processing factories (Prieto-Carolino et al., 2021). This excludes women's participation onshore in pre- and post-harvest activities and in reproductive (cooking, cleaning, caring for elderly, disabled, and children) and unpaid support roles. The lack of research into the role of women indicates their social and political marginalisation leaving them socially and economically disadvantaged (Bavington et al., 2004). A growing body of evidence reveals

women play key roles in contributing to food security through the harvest and processing of fish, linking poverty reduction and food and nutrition security to Agenda 2030 Sustainable Development Goal (SDG) 5 (Agarwal, 2018; Harper et al., 2013).

SES is a concept focused on the interconnectedness of social and ecological systems (Folke et al., 2005). SES networks are inherently complex and becoming increasingly open because of globalisation (Avriel-Avnia & Dick, 2019; Costanza et al., 2014). The WCP tuna SES is no exception, with multiple species of tuna harvested across a vast ocean by distant water fishing nations and Pacific island countries using multiple fishing gear types to access fish in shallow and deep waters. Globalisation compounds complexity and intensifies the disconnect between regions where fish are harvested and consumed (Avriel-Avnia & Dick, 2019). Changes to the SES occur across multiple temporal and spatial scales and through multiple SES components, which are sometimes rapid and unpredictable. Moreover, unintended consequences of policy and development occur because many of the relationships, processes, and functions of the system are unknown. This uncertainty not only challenges sustainability of the resource and broader ecosystems, but also presents risks for Pacific Small Island Developing States reliant upon the tuna SES for their wellbeing and livelihood.

SES research highlights the need for more focus on the social dimension (Ban et al., 2013; Folke et al., 2005). Furthermore, emphasis is increasingly being placed on gender equality to achieving sustainable development (Lawless et al., 2022; Leach et al., 2018). To date, research on implementation and impact on policies and practices to achieve gender equality are limited and primarily focus on analysis of small-scale fisheries (Lawless et al., 2022). Research focused on exploring the role of women in WCP tuna SES is useful for examining behaviours, gender roles, power relations, policies, programmes, and services that may differentially impact on social, ecological, economic, cultural, and political realities of people (Fortnam et al., 2019; Kawarazuka et al., 2017). We focus on gender relations and how the social construction of gender influences how people relate to one another and, in an SES context, to their ecosystem (Delgado-Serrano & Semerena, 2018). Power is integral to these processes as it shapes and coproduces these gender relations (Delgado-Serrano & Semerena, 2018). Power is “a social relation built on an asymmetrical distribution of resources and risks” (Hornborg, 2001, p. 1; Paulson et al., 2003). Paying attention to gender can broaden understanding of SES networks and how unintended consequences occur.

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Research focused on gender and fisheries identifies the male-centric nature of fisheries, the gendered division of roles and how gendered roles are differentiated spatially and according to resource use (de la Torre-Castro et al., 2017; Fortnam et al., 2019; Prieto-Carolino et al., 2021; Williams, 2008). For example, men fish ‘far and deep’ while women stay close to shore (e.g. via gleaning, handlining; (Fortnam et al., 2019)). These generalised assumptions are increasingly challenged by researchers seeking a more nuanced approach to gender in fisheries beyond descriptive accounts of women’s (and men’s) contributions to national economies. Indeed, a shift to consider gender enables greater recognition of the diverse ways in which women participate in, and contribute to, fisheries at multiple scales. As part of this shift, researchers have considered the roles played by women in both historical and contemporary fishing contexts. For example, Manez and Pauwelussen (2016) report research in Oceania dating back to the 1920s revealed women who fished and dived had equal abilities to men, though this varied across Melanesia, Micronesia, and Polynesian cultures (Manez & Pauwelussen, 2016).

Research has considered the roles of women in tuna processing factories (Prieto-Carolino et al., 2021), women as intermediaries and financiers of fishing expeditions in Ghana, West Africa (O’Neill et al., 2018), and the gendered division of labour whereby women occupy roles requiring attention to detail, receive less money than men, and women’s experiences of sexual harassment (Prieto-Carolino et al., 2021). Moreover, research focused on fisheries

governance with roots in equality, such as Ghana's improved gender policy in fisheries, found increased capacity, confidence, and engagement of women in fisheries management (Torell et al., 2019).

Diffusion of gender into national level policy of Pacific island countries is difficult. In a review of gender policy diffusion in the Pacific region, Song et al. (2019) reveal minimal implementation of global level gender-focused policy commitments in national level policy by Pacific island countries due to a lack of willingness, interest, and importance placed on gender equality in fisheries. This is not confined to Pacific island countries or resource types, however, as Acosta et al. (2019) highlight gender policies within climate change and agriculture sectors of Uganda are watered down at the national level and through policy cycles. Okereke (2008) identify how the diffusion of global equity norms relies on the extent to which norms align with neoliberal ideas and structures. Lawless et al. (2020) highlight how social meta-norms (e.g., human rights, gender equality, equity and environmental justice) face multiple drivers that affect the process of policy diffusion. Drivers include compliance mechanisms, economic benefits, functional interactions, institutional normative environment, norm source, norm issue framing, cultural resonance, and social temper. For example, compliance mechanisms (e.g. treaties, policies and regulations) are challenged by gender equality, equity and human rights scholars for their ambiguity and their lack of specific obligations and have seen shifts toward soft laws such as codes of conduct or voluntary guidelines (Lawless et al., 2020; Okereke, 2008). These 'soft laws' are arguably easier to establish and change, but are more effective when coupled with hard law rules. Soft regulatory approaches such as advocacy, encouragement, raising awareness, and benchmarking in the education sector were identified to be successful in New Zealand's strategy for gender policy (Casey et al., 2011). Lawless et al. (2020) provide important insights into gender policy strategies and frameworks and for gaining necessary buy-in from industry, government, and regional fisheries agencies.

Although there has been more attention given to gender in fisheries management and governance, fisheries lags behind other fields such as development studies (Desai & Rinaldo, 2016; Nightingale, 2017; Oberhauser, 2017); agriculture (Acosta et al., 2019); education (Manion, 2016); water (Khalid Md & Huq, 2018); and feminist political ecology (Paulson et al., 2003; Rocheleau, 2008; Rocheleau & Edmunds, 1997; Rocheleau et al., 1996; Sultana, 2011)). Relevant learnings that can be applied to fisheries include the need for flexibility in

policy and practice to allow for the multiple ways gender can be contextualised through intersections with age, marital status, poverty, and health status. Intersectionality is a critical feminist theory and method and focuses on elucidating how multiple axes of difference (and the uneven power relations associated with those differences) give rise to different forms of oppression (Thompson, 2016). Understanding this will avoid interactions that might deepen fisher's and their family's vulnerability to the tuna industry. This is highlighted in Alexeyeff (2020) who notes the complexity of intersections between age, socio-economic status, as well as hereditary rank, and argues that gender interventions often produce new forms of inequality and obscure others.

Development projects to improve gender equality focused on financial and technical developments are argued to fall short of empowering women (Underhill-Sem et al., 2014). This chapter responds to the gender gap in fisheries research by examining the multiple roles of women in WCP tuna fisheries using Fiji as a place-specific study. Drawing on a range of theoretical perspectives, including development theory, gender studies and feminist studies, I consider how gender shapes, defines, enables, or constrains women's engagement and agency in fisheries-based development premised on economic growth, social development, and wellbeing. To accomplish this, I use a transdisciplinary SES framework to elucidate the role of women, and the gender dimensions of WCP tuna SES in Fiji. This chapter shows:

- 1) the persistence of gender-based stereotyping and implications for women and gender-based violence;
- 2) the limitations of gender mainstreaming policy and practice despite evidence of a transition towards more equal outcomes for women; and,
- 3) the potential for unintended outcomes due to failure to consider gender within the context of WCP tuna SES.

I give attention to understanding power relations between fishers located within households, communities, industry, and wider scales but also between women and men.

3.2 Place-specific study: Fiji's tuna fishing industry

Starting in 1970s, large-scale commercial tuna fishing in Fiji was late to develop compared to the rest of the WCP region (beginning in the first half of the twentieth century) (Barclay, 2014). Prior to this development, Fiji's traditional and commercial fishing was focussed inshore (DeMers & Kahui, 2012; Gillet, 2007). Fijian Government and industry has grasped

its geographical opportunity (a south Pacific hub due to its geographic location) and since 2000 has aimed to develop the necessary infrastructure and logistics networks to encourage tuna vessels in the region to come to Fiji (Barclay & Cartwright, 2007a). Fiji's national longline fleet predominately targets albacore and in 2018 was made up of:

- 13 vessels less than 21 metres in length targeting the fresh sashimi market;
- 36, 21-36 metre vessels using slurry and freezers for three weeks to two-month fishing trips; and,
- 46 vessels that are greater than 30 metres using freezers that targets albacore, spending more than three months on each trip in and outside of Fiji's EEZ. Nine of these were charter vessels.

Fiji's largest cannery is PAFCO based on the island of Levuka. It plays an important role in the economy through the manufacture of canned tuna, as the largest employer in Levuka, and a key economic driver for the Lomaiviti Province. While Fiji's fishing grounds are not as productive as its Pacific counterparts, they provide a more suitable business environment for foreign countries to invest due to their adequate freight connections, infrastructure, and labour force. This is due to its larger and diversified economy, including tourism that connects the country well to the Pacific and beyond (Mawi, 2015) and provides a range of opportunities for employment and for direct and indirect involvement in tuna fisheries across the supply chain.

3.3 Materials and methods

A mixed-method, place-specific, case study approach was applied to conduct research in 2018 to 2020. The identification and selection of Fiji as a case study to explore gender in relation to tuna fisheries was determined based on expert opinion of research participants. Participants including WCP fisheries managers, independent consultants, and NGO representatives highlighted the important and increasing roles that Fijian women play in the supply chain (e.g. marketing, processing), current gender-based issues that required further investigation but also noted Fiji as being the home base for gender experts and NGOs such as the Women in Fisheries Network. The place-specific study included a two-week visit in May 2019 to Fiji's capital Suva and two small villages, Waiqanake and Kalekana. Research questions included: what role(s) do women play in tuna fisheries in Fiji; and, how has the development of the fishery impacted these roles? Particular attention was given to

understanding who benefits from tuna fisheries development and associated policies, and what the unintended impacts are on women. Research ethics were approved by The University of Auckland Human Participants Ethics Committee.

Nineteen semi-structured interviews were undertaken with representatives of Fiji's tuna fishery, who were identified using snowballing techniques (refer to Appendix B and C for interview guides and a list of participants). Participants included industry representatives, independent consultants, regional fisheries managers, non-governmental organisations, academics, recreational fishers, and fishers in Waiqanake Village. One particular NGO representative, Pacific Dialogue (an NGO dedicated to preventing human trafficking in Fiji), was instrumental in locating fishers and fisher's wives within villages close to Suva, organised meetings, and translated Fijian as well as facilitated the cultural protocol (e.g. *sevu sevu* ceremony performed for gaining entrance into a Fijian village). Due to the economic, cultural, and political ties of the WCP tuna fishery and the application of snowballing techniques, this led to interviews with observers and fisheries managers from other countries including Federated States of Micronesia, Papua New Guinea, Solomon Islands, and Tonga. These participants undertook observer training in Fiji or managed WCP tuna fisheries at the regional level. Data collected from these interviews were used to understand and analyse the wider WCP tuna SES.

A semi-structured focus group was conducted with six women from Kalekana Village (refer to Appendix B and C for interview guides and a list of participants). This village is close to industry ports and therefore a target of recruiting agents for longline fishing vessels (or via word-of-mouth). Participants were from varied backgrounds, nationality, age, or other identities. Key discussion points included their family member's employment, stories of their experience on tuna fishing vessels, the impact of tuna fisheries on the local communities, the women's lives, and their families. During this focus group, the SES network was imagined and drawn together on paper to explore their role in tuna fisheries. Because these women were indirectly involved in tuna fisheries, this was a useful exercise for the women to see how they fitted within the wider WCP tuna SES (see Appendix B for interview and focus group guides).

Interviews and focus groups were conducted in English with the assistance of interpreters, who were on hand to clarify statements for participants and the researcher. Following the interviews and focus groups, the lead researcher met with the interpreter to clarify what was

discussed including the translation of terms. Participants' quotes used in this paper have been translated into English but have not been edited.

Data were also collated from primary and secondary sources from country reports (e.g. see WCPFC's Scientific Committee meeting pages to access annual reports from each member <https://meetings.wcpfc.int/meetings/sc17>), scientific journals (e.g. Albert, Beare, et al. (2014); (Schwarz et al., 2011)) and reports from science providers (e.g. reports found on the WCPFC Scientific Committee website given above) and other research or NGOs and field observations (e.g. informal discussions with NGOs, independent consultants, and field observations made in fishing villages, markets, ports, hotels) were collated. Quantitative data were also sourced and analysed including fisheries catch data analysis using FAO FishStatJ (<https://www.fao.org/fishery/en/statistics/software/fishstatj/en>), CPUE analysis in Gizo tuna SSF (data obtained from focus group questionnaires and (Albert, Beare, et al., 2014)), and sex-disaggregated employment data analysis (tables directed sourced from FFA but also reported annually in the Tuna Fishery Report Card (FFA & Pacific Community, 2020)).

Interviews and focus group discussions were transcribed and inductively coded using nVivo 12 to identify key themes. In addition, data were coded for language that suggested relationships such as "dependence" as well as stories about impacts. A matrix applying a SES framework was used (developed and outlined in Chapter 2; see Figure 5) to explore gender with a focus on gendered roles, policy and governance, and social and cultural norms. Using the matrix, a structured approach was used to examine (a) the state of the SES; (b) interlinkages, and (c) changes. Data were cross-referenced with key drivers of the SES identified in Chapter 2. Key drivers include scale (geographical space, institutions, networks), power (power relations between fishers located within households, communities, industry, and wider scales), knowledge (e.g. indigenous, technical, scientific), energy (e.g. biophysical, fossil fuel), and equality. Refer to Appendix E for a summary of coding and analysis. The matrix in Figure 5 provided a systematised approach to examine gender impacts of the WCP tuna SES on women and men.

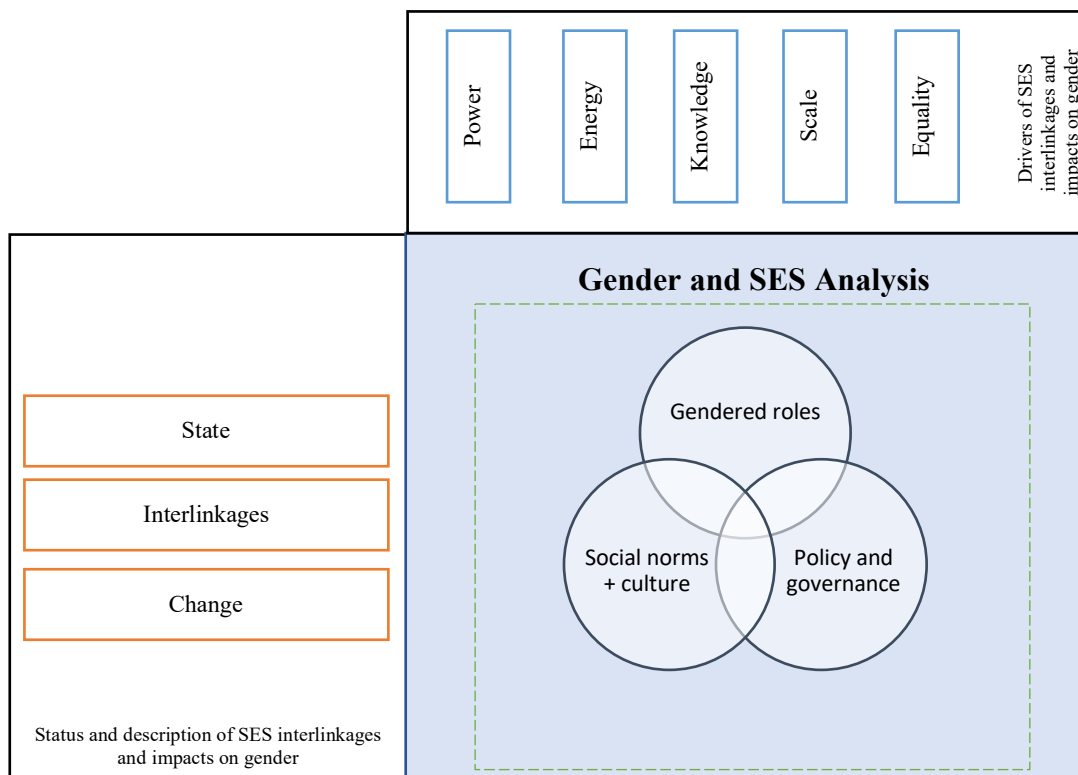


Figure 5. SES analysis matrix to explore gender within Fiji's tuna fishery (adapted from Chapter 1)

3.4 Results

This research reveals Fiji's tuna fishery SES is made up of several key components, namely the marine environment and its ecosystems, the tuna fishing industry, villages, Government. The SES is influenced by various key drivers with strong or weak interlinkages including international policy and advocacy, globalisation and culture, technology, and household roles. Power-relations and culture act on these interlinkages and influence how benefits and costs of the fishery are distributed. Figure 6 shows Fiji's tuna fishery SES which was partly developed during the focus group discussion exercise to imagine it and then further evolved as part of the SES matrix analysis (including political ecology analysis) (refer to Appendix E for a Summary of Coding and Analysis).

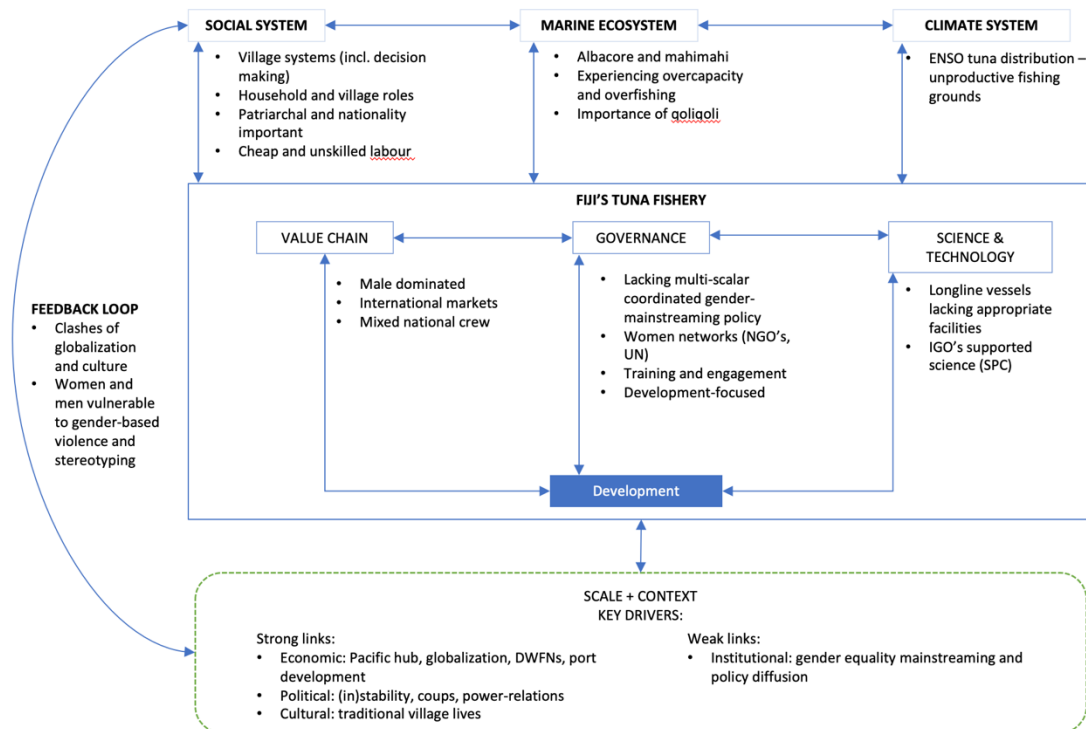


Figure 6. Fiji's tuna fishery SES

3.4.1 Gendered direct and indirect roles within the WCP tuna SES

Gender-based issues, including gender-based stereotyping and gender-based violence, were found in roles that are directly and indirectly involved in Fiji's tuna SES. Overall, Fiji's tuna fishery is 'women intensive but male dominated' with women workers consistently over-represented in low skilled, poorly paid, undervalued positions while men dominate more powerful (i.e. higher skilled, better paid, more valued) positions.

Figure 7 shows Pacific Islands Forum Fisheries Agency (FFA) 2016-2018 data reporting the proportion of women in the most visible roles within the supply chains – processing, harvest, observer, and public sector. Total employment of men and women within these roles in Fiji in 2018 was 4,193 representing 19% of the Pacific region's employment in tuna fisheries. Of this, 1,432 or 34% were women. Women dominated processing and ancillary services roles where women represented 61% (1,368) and men 39% (875) of these roles. Men were 100% employed in all other roles including at-sea harvesting, observers, and 73% in public sector roles were men. As shown in Figure 7, there has been no substantive changes over time to

these roles. In terms of indirect and less visible roles, no data exists to summarise those involved.

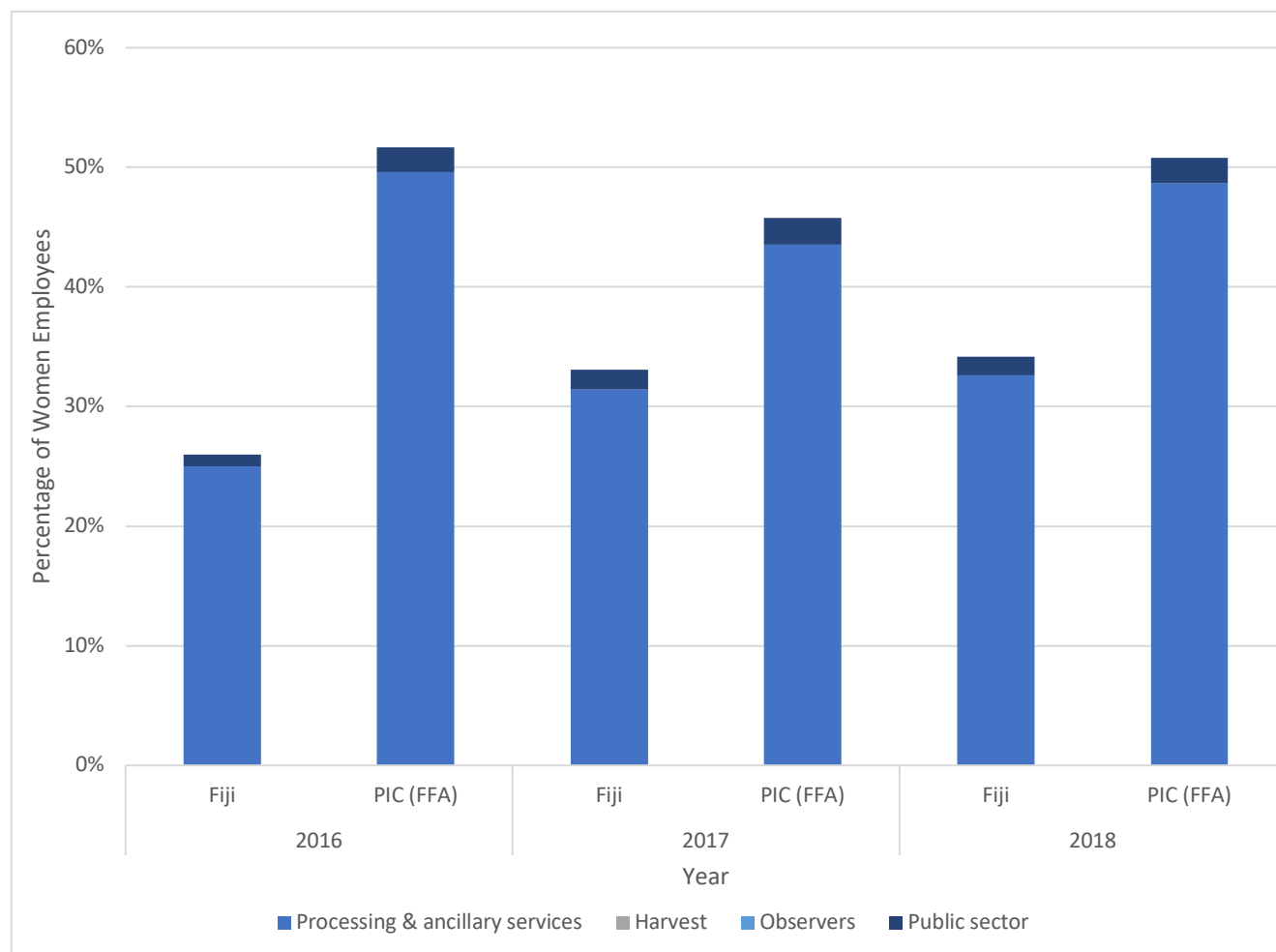


Figure 7. The proportion of women employees in roles (where data are known) in tuna fishery in Fiji and FFA PIC member countries from 2016-2018 (Sources: data from FFA)

Notes:

2019 data for Fiji was provisional for Fiji and therefore excluded.

'FFA PIC member countries' includes the 15 FFA PIC members: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu.

3.4.2 Women's increased opportunities at-sea roles met with obstacles including gender-based violence

At-sea roles are almost exclusively men on board tuna fishing longline vessels; however, this research revealed women were beginning to occupy these roles. Ten women were reported by

industry representatives to work as crew for New Zealand owned Solander Limited (seven women) and Fijian owned Fiji Fish Marketing Group Limited (Fiji Fish; three women, Table 3), representing 0.6% of the total employment of the harvesting sector in Fiji. Women are also becoming observers on board tuna longline vessels. Upskilling (inhouse industry-led and through the Fiji Maritime Academy) has meant there are opportunities for women to go to sea on board tugboats and longline vessels. The Fiji Fish representative said women enjoyed their roles as deckhands and work in the icehouses on board. A change of culture was reported where “it’s definitely changed the attitude of the male crew having a female crew on board, in a good way, the boys, they end up treating her like their sister, you know how close the Fiji families are” (Fiji Fish Interviewee, Fiji, 2019).

Barriers remain to women in harvesting roles including cultural beliefs and norms, on board conditions, particularly on smaller longline vessels, and the length of fishing trips that continues to deter women from joining as crew members, observers, or captains. In Fiji, longline vessels are also notoriously bad for workers' conditions with shared facilities (sleeping, eating, bathing) or no facilities (bathrooms may be absent on smaller vessels). Women who are studying for their Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel qualifications are impacted by these constraints and cannot get sea time on fishing vessels. On the Fiji Fish’s larger vessels, there are toilets available for the women; however, all facilities are shared, including the bunks. Participants also reported instances where women were assaulted and harassed while on board vessels.

A PNG observer identified and interviewed through an interviewee from the Women in Fisheries Network commented on her experiences on board a purse-seine vessel where she had been attacked in 2003. While generally being “treated the same” on board by crew, this observer noted the [attacker who was a](#) PNG national young crew member “had no experience with female observers before”. Purse-seine vessels were noted by Fiji industry representatives and other interviewees to provide better living standards (e.g., separate facilities). Nevertheless, this did not deter the assault where she was “strangled from behind with rope” because the attacker wanted her camera that had photos of illegal fishing activity. Moreover, while the number of women on vessels are low in Fiji due to barriers to get on these boats, this was an example of where even if barriers are removed, gender-based violence can still deter involvement.

3.4.3 Women targeted for lower paid and less skilled post-harvest and administrative roles Regionally, and in Fiji, women's involvement in the offshore fisheries sector has been predominantly in the processing and post-harvest sector (Figure 7, Table 3). In small-scale fisheries, participants highlighted women's role was selling fresh and value-added reef fish (and FAD caught tuna e.g. Rakiraki) in markets, roadsides, and other outlets. In larger scale industrial fisheries, companies hiring the most women within Fiji's tuna processing sector include PAFCO, Viti Foods, and Tri-Pacific (Industry Interviewee, Fiji, 2019). PAFCO is the largest employer of women in the tuna industry in Fiji (Sullivan & Ram-Bidesi, 2008). In 2017, women represented 64% of the total employees at PAFCO, primarily in production roles but also in 'back office' roles (664 of the 1,036 workers) (Parliament of the Republic of Fiji Standing Committee on Economic Affairs, 2019). In an earlier study, jobs held by women included butchery, canning, cleaning, drivers, labellers, moulders, skimmers, sorters, supervisors, unloaders, mechanics, and day carers (Sullivan & Ram-Bidesi, 2008). Male dominated roles in PAFCO included skinning of the fish whereas women dominated the processing lines (Sullivan and Ram-Bidesi, 2008). Ninety percent of workers at PAFCO were non-salaried women on an hourly paid rate (Sullivan & Ram-Bidesi, 2008). Workers were then estimated to earn between FJ\$2.75 (floor workers) and FJ\$3.50 (senior staff) per hour. These rates are influenced by a combination of the minimum wage, marketplace, and employee-employer bargaining (Sullivan and Ram-Bidesi, 2008). Dominance of women in processing may be due to men refusing to undertake 'monotonous and demeaning' tasks whereas women who are unskilled, accept lower wages, and have minimal education are more willing and see these jobs as opportunities for earning income for the family (Sullivan and Ram-Bidesi, 2008).

Conversely, companies including Solander, Golden Ocean and Fiji Fish were reported by one industry representative to have "mandatory physical work in their processing factories, lifting and carrying of frozen/fresh fish" and therefore hire more men than women. In 2019, Fiji Fish had 10 women and 10 men (50:50), Golden Ocean had 127 men and 18 women (88:12), and Solander had 13 men and 1 woman (93:7) in their processing and packing departments. A representative of Golden Ocean explained that when hiring factory line workers "we try to get them [sic] men" due to the "dangerous high-risk job." The representative noted that they do hire women but that they are restricted to "the vacuum machine and [sic] make the easy job for the female, easy careful job for them". Women hired at Fiji Fish were reported to have

generally completed secondary school. No women were reported to own or manage longline vessels at either Golden Ocean, Solander, or Fiji Fish.

Several participants acknowledged that women are increasingly taking up fisheries administrative roles and were considered by an independent consultant to be the ‘bedrock’ of fisheries administration. Women traditionally hired as “data entries” (data administrators) in the offshore division within the Ministry of Fisheries, are increasingly being hired in senior management roles (e.g. the Director of Fisheries at the Ministry of Fisheries was a woman). Until the early 2000s, Pacific region fisheries policy was “very much male dominated” (previous Chair of the Western and Central Pacific Fisheries Commission, WCPFC, Online, 2019).

3.4.4 Changes to the stereotypes met with doubt and other barriers

Regional fisheries manager representatives from the WCPFC and Tonga corroborated changes in hiring practices and workforce composition within national administrations. Both representatives noted the increased participation of women in national administrations, regional organisations, and international forums including in lead delegations. For example, as one participant reported, “it’s no longer a novelty to see an all women delegation” (WCPFC Interviewee, Online, 2019). Although, in reporting their own experiences, they have experienced gender-based stereotyping. For example, one woman participant who at the time was working in an administrative role for the Cook Islands Ministry of Marine Resources reported being asked to enter a beauty pageant by her boss. This was at a time when she was considering further studies and therefore felt this made her decision easier. She felt there was generally “quite a lot of chauvinism in some of the fishery’s circles” and linked this to her experience of gender-based stereotype. Another participant reported her experience of “a lot of doubt from others, a lot of scepticism” in her abilities to be Chair (WCPFC Interviewee, Online, 2019). She explained:

“I was more determined to prove any doubters wrong, a women couldn’t handle a fishery meeting that I couldn’t handle a commission meeting and I know that people were surprised by the reactions I got because the compliments were always sort of, “oh, good job” kind of like “I am surprised you were able to do it” ... I could just tell from the tone of the feedback that there was surprise that I could manage it, but I try really hard not to make generalities and stereotype, but I do feel fairly strongly that women have a stronger skill in multitasking and organising.”

Other roles within industry include CEOs, marketing managers, accounts administration and other administrative roles (Table 3). In FAD fishing villages, such as those in Ra Province women are also community representatives that monitored the FAD caught tuna catch for the Ministry of Fisheries’ records (Conservation International Interviewee, Fiji, 2019). There are also many women and organisations who lead policy advocacy work in the tuna fisheries domain. This includes the Women in Fisheries Network, established in 1993, which “facilitates networks and partnerships to enable opportunities for women to be informed about all aspects of sustainable fisheries in Fiji and to increase the meaningful participation of women in decision-making and management at all levels of sustainable fisheries in Fiji.” Its focus is on lobbying the Government to change policies in relation to its mission. In addition, WWF-Fiji, Pacific Dialogue, Women in Fisheries Network, Conservation International, and other local NGOs advocate for gender equality and equity in tuna and other fisheries.

Table 3. Gender division of labour of three companies interviewed (Fiji Fish, Golden Ocean, Solander)

Job type	No. of men	%	No. of women	%	Total
Company/managers	13	81	3	19	16
Processing/packing	150	84	29	16	179
Company/boat owners/managers	20	100	0	0	20
Skippers	20	100	0	0	20
Engineers	20	100	0	0	20
Crew	470	98	10	2	480
Office (harvesting)	14	58	10	42	24
Workshops and other	118	93	9	7	127
Total	825	93	61	7	886

3.4.5 Unequal power relations and social and economic disempowerment

Roles indirectly linked to the WCP tuna SES are also less visible than tuna fishery supply chain roles, because less quantitative data exists. Research revealed these roles include sex work and carer roles. Both these roles are excluded from formal labour frameworks (sex work is considered illegal in Fiji and carer work is unpaid) and are not measured in gross domestic product (GDP). Research highlights the negative gendered effects of these roles where women, who typically carried out these roles in the Pacific (Mathew, 2019) are more vulnerable to experience social and economic disempowerment (UN Women, 2018). For example, sex workers are vulnerable to abuse, violence and health threats such as HIV (Shannon et al., 2009).

Sex work and sex trafficking was described as the “underbelly” and part of the tuna fisheries “fabric” and was one of the more talked about roles by participants for women (compared to other roles overall), but one with the least amount of data. This is particularly prevalent for Fiji as an important hub of the Pacific shipping and tuna industry. Sex work in the Pacific region is reported in ports where fishing vessels are docked (McMillan & Worth, 2017; UNICEF et al., 2006; United Nations Office on Drugs and Crime, 2011). The place-specific study in Fiji confirmed this role with stories shared by participants that sex trade and sex work is used as a touristic attraction using hotels/motels and bars for Chinese and other foreign boats to come into Fiji ports for economic growth (Pacific Dialogue Interviewee, Fiji, 2019). A Women in Fisheries Network representative and independent consultant also shared their experience of witnessing schoolgirls working on tuna fishing vessels while in port as sex workers in Kiribati. Sex workers have been associated with the tuna fishery in Kiribati (McMillan & Worth, 2019; Vunisea, 2005c), Marshall Islands (Vunisea, 2005a), and Fiji as well as many other Pacific Island countries (Barclay, 2010; McMillan & Worth, 2019).

Sex work in tuna fisheries is largely an under-researched area with little concrete evidence (Barclay, 2010) and thus gender inequalities are less well known. Earlier research has commented on the social problems experienced by sex workers (unplanned pregnancies, violence, sexually transmitted infections such as HIV) (Barclay, 2010; Vunisea, 2005b). McMillan and Worth (2011) discuss the complexity of issues and argue they are dependent on the livelihoods of the women themselves. For example, women in Kiribati undertake sex roles onboard foreign tuna fishing vessels due to “overcrowded living conditions, a culture of hardship, the domestic oppression of women, and the endemic nature of physical and sexual abuse” (McMillan & Worth, 2019, p. 1942). In Fiji, studies note the economic, education, family violence context as a key factors driving choices to undertake sex work (McMillan & Worth, 2011).

While family members are away for long periods of time, carer roles are exclusively carried out by women. Another important yet overlooked role described by participants included women who are mothers / wives / daughters / sisters to crewmen aboard tuna vessels who are away at sea from two weeks to years at a time. These women reported relying on their family member’s employment in tuna fisheries for income for their household. The interrelationships between these women and their seafaring husband / son / brother / father is complex. Here, I focus on violence perpetrated against men and the flow-on impacts this

gender-based violence has on men and women's gender-based roles in the household. Violence is an ambiguous term (Stanko, 2003) and is considered contextual based on legal, political, social, cultural, personal, and temporal contexts (Kaladelfos & Featherstone, 2014). It also involves acts that result from an uneven power relationship and includes threats and intimidation, neglect or acts of omission (as in the case of men who did not receive adequate access to clean water, sanitation, food, and medical attention) as well as the more obvious acts (physical, psychological, and sexual) (Bott et al., 2005; World Health Organisation, 2022). Gender-based violence is commonly discussed and researched in reference to violence against women and girls (Carpenter, 2006). The little research that examines gender-based violence against men tends to centre on sexual violence or military violence (Carpenter, 2017; Christian et al., 2011; Peretz & Vidmar, 2021). We therefore adopt the following definition of gender-based violence, 'violence that is targeted at women or men because of their sex and/or their socially constructed gender roles' (Carpenter, 2006, p. 83). This paper uses an inclusive definition of gender-based violence to discuss a range of harms that are not currently understood as such within the fisheries industry community.

Jobs onboard tuna fishing foreign vessels are generally acknowledged as risky and violent. When disaster strikes (men are killed, or kill their boss when their treatment is unbearable, or disappear at sea, or are badly maimed in the course of their work) the event is generally framed within human rights discourse (for example, as part of transnational organised crime (Chapsos & Hamilton, 2019)). However, the everyday violence that precedes the most violent acts is documented in "slavery at sea" literature, but not tagged as gender-based violence. We, however, characterise violence on board tuna fishing vessels as gender-based violence, noting that the strong gender divisions of labour in tuna (and other fish) value chains results in certain workspaces that are highly masculine or feminine in their composition (Barclay et al., 2021). Violence by men against men tends to be positioned as a manifestation of hegemonic masculinity (Cornwall & Lindisfarne, 2006), along with gender-based assumptions whereby 'dangerous' seafaring roles are the domain of men (Fortnam et al., 2019). Cornwall and Lindisfarne (2006) investigate taken-for-granted assumptions regarding men (as an unmarked category) and masculinity (as social construction) to distinguish variants of masculinity and to elucidate how gender and power are negotiated in relation to social interactions. In dismantling hegemonic masculinity, Cornwall and Lindisfarne (2006) also argue the need to problematise the essentialist male/female dichotomy because it doesn't allow for different conceptions and performances of gender to be recognised and it disregards

how cultural and historical context can give rise to gender variants in different places at different times. Thus, they emphasise seeing notions of masculinity (and femininity) as fluid and situational (Cornwall and Lindisfarne, 2006). From this perspective, violent acts on board fishing vessels between men are gendered but the fact they are men-to-men is less important than how violence reflects social differences between men with unequal power (driven by economic, social, and racial/ethnic factors), which conditions social interactions from the moment of recruitment and is used to dominate and justify violent acts. Carpenter (2006) asserts this argument by stating that gendered roles (such as seafarer roles in our example) intersect with race, ethnicity, class, and economic status and that these intersections justify the act.

This research revealed men, all in their 20s and 30s, to have been mistreated and/or injured and therefore unable to work, or worse, they had been murdered or died while on the job. Fijian women in focus discussion groups reported injury, death and murder on board Chinese, Fijian, Korean and Taiwanese vessels typically with mixed nationality crews (including Philippines, Taiwan, China, Vietnam, Indonesia, and India). The women also referred to the Fijian vessel that sunk during a cyclone and had an all Fijian crew (Pacific Islander deaths on board tuna fishing vessels are reported in Komaisavai & Magick (2019) and include some of these women's husbands). Violence was also reported by a representative of Fiji Fish, who noted the troubles they encounter from the Taiwanese and Chinese vessels which use its processing facilities. Instances were reported by Fiji Fish representative where murders and stabbings have almost occurred during fights at Fiji Fish premises where alcohol has been involved. The Fiji Fish representative commented on how "they come and drink, and you know, and it's just all the pressure gets released and they just fight... they are not my crew, they are contracted."

Women reported how their husbands loved fishing from their early childhood (Focus group, Kalekana Village, 2019). Fishing was valued by men to support their family. However, the impact that tuna fisheries have on men and their bodies and the flow on impacts this has on their families is immense and should not be overlooked. In 2019, Human Rights at Sea showcased the experiences of Josaia Cama, from Waiqanake fishing village who was crew on a CKP Fishing company (south Korean) tuna longliner (Human Rights at Sea, 2019b). Josaia was also a participant of this study. His experience of forced labour, which led to the loss of all his fingers, is instructive for this study. Forced labour, according to the International

Labour Organisation, 1930 (No.29) is “all work or service which is exacted from any person under the threat of a penalty and for which the person has not offered himself or herself voluntarily.” Josaia’s account of his experiences draws attention to how power and social constructions of gender condition social interactions:

“we finish the fishing aye ... we on the upper deck yeh ... They [Taiwanese boatman / supervisor] said for us to go down again into the bottom freezer ... you unload and you the job is finished aye ... they pull up the ladder, like this aye ... this is the second time, I was forced two hours ... I was a cold ... they give us gloves but the cotton gloves to make the work easier ... the rest who, the older ones see they have experience in, because ... Vaseline and they drink rum to keep them warm, but we had none ... the other Fijian boy he was a big man aye, he didn’t want to go in the freezer, he was hiding from the boss ... they put the ladder down again and the thing finished. And I start eating I can’t feel my fingers aye so they all numb and it was like someone was banging a hammer ... very painful”

Josaia explained how he and two other Indonesian crew were forced to offload frozen tuna from the vessels’ air blast freezer (~ -40° C) in Japan (Human Rights at Sea, 2019b). He described how crew were not normally asked to work in the freezer, only the ‘iceman’, and that he was given inappropriate protective gear (the ‘iceman’ was given proper gloves but this meant you couldn’t feel the fish), which did not keep his hands warm. This ultimately led to Josaia having all ten of his fingers amputated in Fiji after developing gangrene as a result of severe frostbite. Josaia also reported his contract, a copy of which he never received, stipulated a US\$400 per month income (around FJ\$800) but he only received FJ\$400 per month and he never received his promised bonuses for catching sharks (used for their fins) (Human Rights at Sea, 2019b). These physical injuries had an impact on his ability to support his family (and therefore also impacted upon his family), as well as his perception of his masculinity and status as a man: “because of my disability I cannot help care for my family as a man should, so Virisila [wife] has had to take on that task as well as doing the jobs women do in a family” (Josaia Cama interview, also reported in Human Rights at Sea (2019b)). Women who participated in the focus group and interviews commented on the poor work standards the men had endured including lack of access to clean water, food, and adequate sleep (Focus group, Kalekana Village, 2019). Josaia shared his experience of feeling that his company had taken advantage of him and not paid him properly “because maybe my appearance and my looks, I was discriminated, aye” (Josaia Cama, Waiqanake Village, 2019).

This research reveals that benefits of tuna fishing have no trickle-down effect to the families of injured crew who are left worse off than if their family member had not gone on the boats in the first place. Fishers and their families reported receiving minimal or no pay for work not done when the fisher was unwell (or dead) and unable to work. After injuries or death, these families reported having not received any support for funerals. Families face the burden of losing the income earner of the family and grief associated with losing a loved one or having to care for the injured as well as payments for additional medical care. Women were left behind to provide for the family, often with one or more children to look after, and relying heavily on their local qoliqoli (traditional fishing ground) for food and income. Sons of these men as young as 14 years old were reported to have left school early to take over the father's role. Meanwhile, mothers also explained how tuna fisheries affected their children because of social problems such as drug use and prostitution. In one instance, the whole family of a crewman was ostracised from their village because of their inability to contribute to village activities. Some women expressed their regret that they never knew what had happened to their family members or did not find out the fate of their husbands until they went to the company to pick up their husband's pay cheque. In the case of Fijian Joeli Nailati, a crewman murdered in Solomon Islands while aboard YuhYih no. 12 LL, an investigation by Pacific Dialogue uncovered to his wife that a Chinese man was convicted of his murder and was still serving his sentence.

Some women received government or company compensation of up to FJ\$24,000 (US\$11,000 current value; for example, in the case where a man had been stabbed to death in 2006). In the case of the sunken vessel, Wasawasa, Fiji Fish compensated with tuna fish and FJ\$50 weekly (US\$23 current value) from 1997 until 2000 then after the coups, the court ruled that each family was entitled to FJ\$15,000 (US\$7,000 current value) plus a tuna fish weekly allowance until 2007. No compensation was provided for those families of fishers who had illnesses and died such as loss of wages during the time on board vessels but not working due to illness or death. The women who depended on these men were left unsupported financially and have no alternative but to work harder and longer no matter what the consequence on their bodies, their families, or their qoliqoli.

Gender intersects with other identities such as race and class, which can amplify risks of gender-based violence on board vessels. Recruited women in this research had all lost someone in the tuna fishery or relied on men that had been injured and were unable to

contribute to the household or village income and activities. On board fishing vessels, power-relations are unequal and in favour of fishing companies (owners and captains of vessels). Intersectional subjectivities and a risk-taking culture tied to performances of masculinity on board fishing vessels, often amplified drinking issues and sexual promiscuity, is confirmed in Allison (2013) who explored masculinity in shipside culture. Moreover, while Fijian owned longliners with national crew are family oriented, international vessels with mixed nationality crew are predatory.

The industry was perceived by focus group women and fishers interviewed as hiding behind a corporate veil that blanketed human rights violations. This was evidenced by the lack of labour contracts, forced labour, and misinformation on deaths. Women interviewed were unaware of the causes of death, the outcomes of justice, nor did they receive equitable compensation for impacts on their welfare. For the PNG observer assaulted on the purse-seine vessel, due to lack of evidence, her case was dropped after three years, and she never saw the assailant again. Her boss at work provided support but no counselling was offered to her. She says she has got over it in time and still goes out to sea.

3.5 Gender, policy and governance in Fiji

Pacific regional projects such as those developed by FFA (described further below) show some promising approaches including gender diagnosis through to action (e.g. placing gender/women equality on agendas; policy change; strategies and targets set; action resources, formal reporting and accountability). However, gaps remain in mainstreaming gender in regional and national tuna fisheries policies. The WCPFC currently does not have a gender policy or provisions for the inclusion of gender equality in its conservation and management measures (CMMs). WCPFC's Resolution on Labour Standards for Crew on Fishing Vessels (Resolution 2018-01) includes the minimum labour employment conditions and international human rights standards. A participant who was a former Chair of the WCPFC commented that WCPFC's Harvest Strategy for Key Fisheries and Stocks in the WCP (CMM2014-06) are still economic and science focussed,

“Social and gender issues are just starting to come out in discussions on harvest strategy objectives, management objectives, but I don't think I could say that there are in any way a focus. The focus is still very much on economics and then informed by the science, but yes social issues are getting more attention and gender issues, gender is really in my experience, a focal point, but in the discussion of harvest strategy management objectives it will come out as discussions progress it just hasn't been a

lot of discussion yet on management objectives. Social issues are definitely there, I think that with more women leading delegations and potentially with a lot of women at FFA you might see gender discussions coming up here.” (Former Chair of the WCPFC, Online, 2019).

The comment that gender will ‘come out’ in WCPFC management forums is yet to be seen.

FFA do have gender-focused policies including its 2017 Gender Equity Framework consisting of Pacific Leaders Gender Equality Declaration (2012), The Framework for Pacific Regionalism (2014), and FFA’s Strategic Plan 2014 – 2020, which promotes gender equality and “equitable access to fisheries resources” to “lift the status of women in the Pacific” and “empower them to be active participants in economic, political and social life.” However, while FFA’s Harmonised Minimum Terms and Conditions (revised 2016) includes minimum labour employment and conditions, international human rights standards, and considers ecosystem issues, there is no mention of women or gender (see https://www.ffa.int/system/files/HMTC_as_revised_by_FFC110_May_2019_-_FINAL.pdf).

A local gender expert argued that gender had not been mainstreamed into many policies in the Pacific and while governments are only now waking up to it, they “don’t know how to do it” with a lack of tools and support (Chair of Women in Fisheries Network Interviewee, Fiji, 2019). However, challenges remain in understanding gender-based issues in tuna fisheries. At FFA’s Gender Equality and Social Inclusion (GESI) workshop in 2020, Dr Tupou-Roosen (FFA Director, Online, 2019) stated “We need to make every effort to understand the specific barriers faced by women and other marginalised demographic groups in the fisheries supply chain, so policies and practices are more intentionally inclusive.”

Political (in)stability was identified as a key driver of change of Fiji’s tuna SES, often having flow-on impacts for women. Up until 2000, the industry was development-driven (as opposed to policy-driven). Alongside policy, Fiji saw a proliferation of women’s networks as a key outcome of the United Nations Decade for women (1975-1985). This included groups such as the Women in Fisheries Network (established 1993) and Fiji Women’s Rights Movement (established 1986).

The purpose of these networks is to bring women together across levels of action to share information and resources and to strategise ways to improve gender equality in Fiji. By 2000, there had been some efforts to promote women’s participation in society and the economy including the Equal Employment Opportunity Policy in 1999 providing Ministries with

guidelines and benchmarks from which they could devise their own policies, and the Health and Safety At Work Act 1996 to address women's health issues in tuna industries (Arama & Associates Ltd, 2000). The Government at the time was also reconsidering its minimum wage policy for factory workers (Arama & Associates Ltd, 2000). However, as many participants discussed, the 2000 coup damaged tuna industries for a period, and halted any social policy development the Labour Government had in mind. Moreover, the coups of 2000 presented considerable uncertainty for the country, including the tuna fishing industry. This period was described as "quiet" by one interviewee as the industry was unsure about the political stability of the country until 2006. While tuna fishing continued, Fijians continued to experience gender-based issues and lacked much-needed support from the Government.

After the coups, the Fijian Government became more policy-centric and adopted policy to develop the port to attract distant water fishing nations to Fiji. However, as some participants noted, the development of the port led to an increase in sex work, which has led to associated negative social impacts. Conversely, a major upside of the coups was Government policies encouraging greater participation by indigenous Fijians in ownership of tuna businesses. Over a decade later, gender equality was still off the agenda in fisheries policy. While emphasis was placed on minimising social impacts in the development of the Tuna Management and Development Plan (2014-2018), the first formal mention of gender was not noted until recently in the draft Offshore Fisheries Management and Development Plan (2021-2026). However, the gender policy within this draft Plan remains simplistic and narrow, and focuses on increasing women's participation, improving data collection, and promoting achievements made. Although data collection including sex disaggregated data and increasing women's participation is a step towards gender equality, this is short of a more comprehensive and multi-scalar approach required to achieve gender equality (e.g. multi-level strategies (Lawless et al., 2021); collaborative gender networks (Barclay et al., 2021; Mangubhai et al., 2022)). Gender policies are slowly becoming mainstreamed across Fijian national policy including the 2017 National Development Plan, the 2014 National Gender Policy, and the National Women's Plan of Action (2010-2019) as part of its international obligations.

NGOs (such as World Wildlife Fund (WWF) and Women in Fisheries Network), the tuna fishing industry, and government have worked collaboratively to upskill and increase women's participation in the tuna fishery. Besides national policy, industry and NGOs also

have their own internal gender policies (informal and formal). Industry uses in-house and external training for employees through the Fiji Maritime Academy and The Pacific Community (SPC). Moreover, a NZ Aid programme was reported to require 50% women's participation in Fiji Maritime Academy training. Companies like Solander and Fiji Fish, in collaboration with Fiji Maritime Academy, provide opportunities for women to gain experience for their training towards becoming a captain (STCW-F and national certificates). Other training programmes are facilitated through FFA and other organisations such as Women in Fisheries Network (post-harvest fisheries training). However, there remains a risk of policies aimed to increase women's participation in tuna fisheries to expose women to gender-based violence and human rights violations. An Independent Consultant expressed concern about the movement for increasing women's participation on board tuna vessels, "that's a fight for gender, but for me, I don't totally believe in it because you don't have the safety."

3.6 Culture, a major barrier for gender equality in Fiji

Marine ecosystems are fundamentally important in Fijian culture. The marine ecosystem is described as the "cultural glue that maintains the fabric of how they interact with each other" (Conservation International Interviewee, Fiji, 2019). Fijian people's connection to the ocean and beliefs regarding women's role in fisheries, households, and the village community underpins women's roles and access, control, and ownership of tuna resources for food and for income generating activities. The intersection of culture, technology, and women's biology was discussed by a participant,

"Women don't go on the boats, their supposed to be a taboo, if they go on the boats, there's no fish, so that has carried on up until now and if they have their menstruation then there will be no fish, all this kind of taboo against women fishing that's why they're not really into the big fishing thing." (Independent Consultant Interviewee, Fiji, 2019).

This was confirmed by a Ministry of Marine Resources Cook Islands representative who commented on cultural influences and the importance of women's role in the household and community that ties women to stay 'close' to the home and village,

"I really think that's cos [sic] of the Pacific culture, in particular, women are sort of underpin [sic] a lot of foundation of our communities so their not only mothers and caregivers but they actually ensure the wellbeing of families and extended families which, as you'll know, include the wider or broader communities that they live in and

so there's this continued need or pull for them to be shore-based more so than any other role.”

Interrelations between roles of women in tuna fisheries and their roles in inshore fisheries are complex and are important to consider. The importance of Fijian women’s economic role in communities in fishing have been described in earlier studies (Quinn & Davis, 1997). Focus group women discussed the need to rely on their qoliqoli more as a source of food and income while men were away fishing. Moreover, within the tuna industry, cultural challenges also remain for women to enter the labour market and upskill into higher paid roles from the lower paid processing roles. This has been attributed to women being unable to spend the time advancing their career in their traditionally multitasking household, fishing, and customary roles alongside their waged job (Sullivan and Ram-Bidesi, 2008).

Women interviewed in this research revealed they juggle waged work with fishing, carer, village, and household responsibilities. The connection of women’s economic role, health, culture, fishing, and power relations within villages was made by a representative of Fiji Locally Managed Marine Area Network, who also noted women are in water for long periods of time (sometimes 7 am to 2 pm) during which they are exposed to the sun and cold as well as water “covering their womb”. Reflecting on women’s absence in decision making roles in the village, the interviewee noted that women needed to “discuss with men [these issues] and to get traditional leaders on board to support them” in relation to their health and obtaining fishing licences.

Meanwhile, Fijian men’s household and village roles has allowed them to access offshore pelagic ecosystems. Tuna fisheries are generally capital intensive and in Fiji are generally accessed by industrial fishing vessels, which are male dominated both in terms of crew, captains, and ownership (Parris, 2010). This culture flows throughout the SES. Characterisation of the WCP tuna SES also affirms the technocratic and male-centric culture of the tuna fishery. For example, the fishery’s worker model was described as “masculine” (Independent Consultant Interviewee, Fiji, 2019) and economically focussed. Investors and governments outside of Fiji are complicit in this system because men are identified as economic actors and heads of households. Moreover, science, industry, and policy representatives defined the WCP tuna SES using technocratic approaches to understand its complexity and contextual/socially constructed system and boundaries. Although the tuna fishery is male dominated, men also experience powerlessness (as discussed in section 3.4.3).

3.7 Discussion

The findings of this chapter show that, despite recent attempts to improve gender equality, women directly and indirectly involved in the tuna fishery continue to be affected by gender-based discrimination leading to disadvantage and ongoing inequality (O'Neill et al., 2018; Prieto-Carolino et al., 2021). Moreover, evidence from this research demonstrates unintended outcomes for women because of policy initiatives focussed on addressing inequality and enhancing women's involvement in tuna fisheries, specifically in the form of gender-based violence.

Gender-based stereotyping, discrimination, and violence are outcomes of culture and globalisation, which are antagonistically interlinked with the WCP tuna SES. Firstly, liberalisation of trade and finance, which provide new economic possibilities, have changed the pace, scale, and dynamic by which marine resources are utilised. Secondly, gendered power relations have been fundamental to the functioning of culture, the household, and the natural resources industry in the Pacific Islands, including Fiji (Murray, 2000; Underhill-Sem et al., 2014).

In Fiji, power relations are partly expressed through cultural-power links and can be described as power between cultures (hegemony; (Gramsci, 1971)), but also power within cultures (between individuals or groups of individuals), and its relations to space (Hart, 2002). In Fiji, race is reportedly a dominant social marker when compared to gender (Presterudstuen, 2019). During interviews and focus groups, participants were most forthcoming on where they were from, and where the crew were from throughout the Pacific. There was also a sense of comradery between those who were from other parts of the Pacific Islands compared to those who were considered outsiders such as Taiwanese, Koreans, or Chinese. These two processes (culture and globalisation) have transformed ways in which the marine environment and economy are interlinked with Fijian village life and how women are incorporated. Furthermore, masculinities and femininities in Fijian villages are continually constructed, performed, and negotiated through culture but also, as the research reveals, intersects with wider global and ideological structures of the WCP tuna SES (Presterudstuen, 2019; Underhill-Sem et al., 2014).

Fiji has experienced socio-economic impacts that has shaped traditional culture through two waves of distinct globalisation: the 'colonial wave' (1870s-1914) and the 'neoliberal wave'

(1987-present) (Firth, 2000). Across the two waves of globalisation, the hierarchy of political economic powers ensued between the Pacific Islands and the rest of the world (and in the context of tuna fisheries, with distant water fishing nations) where they have been a resource supplier stripped of power to influence the terms and conditions of trade. Moreover, the impacts of colonialism, modernisation, and Christian conversion has constructed and altered men and women's ideals, practices, and power structures (Desai & Rinaldo, 2016), and, as Presterudstuen (2019) has argued, men's bodily and social capacities. Tuna fisheries' development in Fiji was a way for colonial and economic powers of distant water fishing nations such as America, Taiwan, and Japan to exert their influences on regional and national regulations and economies (Havice & Campling, 2010). Meanwhile, in the 1980s, women were incorporated into the global marine economy predominately as workers in factories processing tuna fish products for expanding global markets such as America, China, and Japan (Bair, 2010). However, gendered power-relations play an important role in shaping patterns of severe labour exploitation within global supply chains such as tuna fisheries. As this research shows, women continue to dominate lower paid and unskilled roles, which is manifested through cultural processes (discussed further below) as well as globalisation that has seen a clashing of the 'Fijian way' with a 'European way' (or 'western way'). This is confirmed in Rodriguez Castro et al. (2016) who argue that women have taken on additional responsibilities without the power of agency where ideas of empowering women into waged work has seen the reinforcement of women as a source of cheap labour.

The interplay between colonial and postcolonial eras, and between different ethnic and cultural groups has shaped the identities of men and women in Fijian villages (Presterudstuen, 2019). These global, historically complex, and political, social, and economic processes have reconfigured Fijian tradition and seen the subordination of women (Murray, 2000; Presterudstuen, 2019). Male domination and masculine-self identities have often been centred on men's assigned roles as 'bread winners' in families and tribal communities, and in modern societies, the ability to make money (Presterudstuen, 2019).

The belief that men are 'strong' heads of the household revealed in this research is identified in other studies that note how cultural values, including strength and humility, are explicitly taught to all Fijian men (Presterudstuen, 2019). Cultural values of the male body tend to contribute to a complex social order and ethos of authority and hierarchy and have been influenced (modified) by Western or modern culture and norms to generate gender-based

stereotypes. Within the WCP tuna SES, these stereotypes can lead to discrimination and violence. For Josaia, his eagerness to support his family by crewing on board a tuna longline vessel was met by forced labour ultimately leading to the loss of his fingers. In this example, alternate conceptions and performances of masculinity that recognise cultural differences and power differentials were not possible or were deemed undesirable because of the persistence of hegemonic masculinity (Cornwall & Lindisfarne, 2006). Elsewhere, Pauwelussen's (2021) exploration of masculinities and especially transformation of masculinities (and men) in fisheries demonstrates masculinities as performative, embodied and affective whereby masculinity in fishing is provisional and changing rather than a fixed identity. This means fisher bodies, and bodily performances of masculinity, have the potential to transform from muscular and strong bodies to impaired and less mobile bodies, which influences social interactions and mediates social relations. Thus, while much fisheries research has tended to focus on macho-type masculinity and male bodies as strong and risk-taking, Pauwelussen (2021, p. 4) argues the need to look “beyond a hegemonic figure of the ‘hard-bodied self-contained man’” to acknowledge other masculinities. Studies into gender and forced labour in global supply chains, such as the tuna fishery, are limited (LeBaron & Gore, 2020). In the case of Josaia, his experience of working in tuna fisheries, a highly (yet narrowly conceived) masculinist and masculinised space, ultimately altered his capacity (as a man) to contribute to the household and village through loss of his wages and an inability to work on village land, which led to his family being ostracised from the village.

The feeling of estrangement articulated by Josaia has also been described in Presterudstuen (2019) with regard to a mining worker who spent time away from the village and who experienced estrangement from village affairs, and loss of respect and connections. For Josaia's wife, Virisila, Josaia's injury burdened her with extra responsibilities that her husband was unable to fulfil, while she also had to continue to negotiate power relations in household, community, and economic activities. This experience mirrored those of the women in the focus group who lost their family members and were left to juggle more than their fair share of roles in their household and in their villages.

While efforts have been made to increase women's involvement in tuna fisheries (administrative, observer, and on board vessel roles), efforts to understand and implement policies to achieve gender equality in tuna fisheries remain in their infancy. Gender equality policy development in Fiji has faced initial international influence from women's social

movements such as the UN Decade for women, giving impetus to establish women's networks such as the Women in Fisheries Network, but then a period of policy backtracking due to significant political change during the coups.

Gender policy relevant to tuna fisheries since then has developed slowly, in part due to the backlash from the coups but most likely due to a lack in priority and political will from regional bodies such as the WCPFC as well as a lack of understanding of how to implement them at the national level. Mainstreaming of gender equality in the Pacific and Fiji has been implemented increasingly across regional and national governance as well as part of donor requirements. Researchers have questioned whether the mainstreaming of gender has led to positive changes in women's lives (Acosta et al., 2019; Syed & Ali, 2019). Gender mainstreaming has been critiqued by development scholars for its universal hegemonic approaches to gender equality representing communities as homogenous (Adusei-Asante et al., 2015; Cornwall & Rivas, 2015; Lawless et al., 2021). Further, rhetorical adoption of 'shopping list' policies are criticised for their inability to be implemented across geographies and contexts to solve complex, diverse, and evolving issues of inequality (Acosta et al., 2019). Thus, researchers have called for gender-sensitive approaches that are context specific and multi-scalar (international, national, local) (Acosta et al., 2019; Syed & Ali, 2019).

3.7.1 Diffusing gender equality into tuna fisheries

Diffusion of gender policies into national offshore fisheries policy in the Pacific has been slow and simplistic (Song et al., 2019) and Fiji is following this trend. This suggests a lack of willingness, interest, and importance placed on gender equality in fisheries. This research has revealed the complex cultural, political, and neoliberal barriers that block diffusion.

However, following Lawless et al (2020) framework for developing buy-in from industry, government, and regional fisheries agencies into gender policy strategies, Fiji and the wider WCP tuna fisheries could be successful in developing a more gender equal WCP tuna SES.

This could include

- 1) 'soft' laws including codes of conduct such as WCPFC's resolutions, advocacy from Fiji's women network NGOs, and encouragement from government and industry; and,
- 2) 'hard' law rules at the national level as well as inclusion of gender equality policy in WCPFC conservation and management measure Harvest Strategy (CMM2014-06).

Fiji could in the first instance leverage regional efforts of FFA as well as learnings from inshore gender programmes such as SPC Pacific Handbook for Gender Equity and Social Inclusion in Coastal Fisheries and Aquaculture (<https://coastfish.spc.int/en/component/content/article/494-gender-equity-and-social-inclusion-handbook>). Other initiatives to promote gender equality policy diffusion could include the development of social ecolabels and application by major markets (including US and Europe) to improve compliance.

3.8 Conclusion

To date, empirical insights of new environment-social linkages have not been met with equal efforts to reconceptualise these linkages. As such, out of date approaches to fisheries issues continue to be employed in policy and management. These externalise society and the environment to economies, and fail to incorporate critical linkages, such as power relations, class, race, and culture. As this research has revealed, women are not included in these analyses, yet they play important and varied roles in tuna fisheries. This research reveals gendered power relations and inequalities shape workers vulnerability to forced labour, while also revealing the challenges confronting traditional Fijian village women and men, who must navigate new and old ways of the economy, culture, and power-relations. Research and policy remain focussed on economics and science. Although there are attempts at gender mainstreaming across the region, this remains universalistic and simplistic. Moreover, this has not filtered down to support women in villages or on board vessels. There are gaps in gender equality policy across regional and national levels requiring further policy development for meaningful implementation.

A new approach to the empowerment of women in fisheries is urgently needed. As well as recognising women as equal economic actors in which they contribute actively in diverse ways across tuna fisheries supply chains and in their family and village lives. To do this, an appropriate and multi-scalar gender policy is required for the tuna fishery, women must hold active participation in decision making and leadership roles across scales of governance to influence policy and practice. This research has shown that educating and getting women opportunities to work on boats, falls short of redressing inequality and injustice that is embedded in the social, political, and economic status quo.

Chapter 4 Collaboration: a solution for Small Island Developing States to address food security and economic development in the face of climate change

This chapter is a peer-review published paper and presents analysis of climate change used as a lens to explore social-ecological linkages in Solomon Island's tuna fisheries SES. Governance is also critically evaluated to mainstream and meaningfully implement measures that seek to build resilience across scales of the tuna fisheries SES. It is worth noting here that the research undertaken in this paper occurred at the precipice of the COVID-19 pandemic and therefore the situation has likely changed since then.

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4.1 Introduction

Climate change is a real threat for marine ecosystems and coastal communities, particularly for Pacific small island developing states (SIDS; (Bell et al., 2011; Duvat et al., 2021; Intergovernmental Panel on Climate Change, 2014a, 2014c)). SIDS are on the frontline of climate change and face major barriers to achieving the Sustainable Development Goals 2050 (Finkbeiner et al., 2018). In Solomon Islands, climate change impacts including ocean warming, ocean acidification, deoxygenation, sea-level rise, and increased severity of storm events threaten the country's economy and communities' food and nutritional security (Bell, Cisneros-Montemayor, et al., 2018; Bell et al., 2013). Tuna provides food security as a critical source of protein, while generating incomes, employment opportunities, and contributing to the nation's economy (Bell, Albert, et al., 2018; Bell, Albert, et al., 2015; Bell, Cisneros-Montemayor, et al., 2018). However, under the Intergovernmental Panel on Climate Change's (IPCC) emission scenario, RCP8.5 (business as usual), tropical fish stocks in some exclusive economic zones (EEZs) are projected to decline up to 40% (Lam et al., 2020). Tuna stocks are also projected to change in abundance and distribution (Bell et al.,

2021; Senina et al., 2018). Pre-existing stressors and major changes such as climate change impact social-ecological systems (SES) resilience in a dynamic and non-linear way. This is compounded by growing human populations (national population increased 30.8% in Solomon Islands to 721,455 in 2019 since the last census in 2009; (Solomon Islands National Statistics Office, 2009, 2020)), natural disasters, political unrest, and a heavy reliance on natural resources (Schwarz et al., 2011). This chapter explores resilience and vulnerability of tuna-based fisheries' SES in Solomon Islands with a focus on examining efforts towards coordination, cooperation and collaboration within both small-scale and industrial-scale tuna fisheries and their governance frameworks to alleviate impacts of climate change.

Vulnerability is a key concept applied to understand impacts of climate change on species or systems (Intergovernmental Panel on Climate Change, 2014c). Vulnerability describes the inability or susceptibility of a system or species to withstand and/or adapt to adverse effects of climate change and includes exposure, sensitivity, and adaptive capacity (Intergovernmental Panel on Climate Change, 2014c). Adaptive capacity is defined in SES research as a system's coping capacity or capacity for response (Adger, 2006; Gallopín, 2006; Hidalgo et al., 2021). Vulnerability is also tied to risk; defined as "the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values" (Intergovernmental Panel on Climate Change, 2014c, p. 5). To understand and define vulnerability, Joakim et al. (2015) identified four categories: 1) a threshold (also known as a tipping point); 2) exposure to hazards or stressors (i.e. physical events); 3) a pre-existing condition (e.g. susceptibility, limitations, incapacities, or deficiencies); and, 4) an outcome (e.g. generated after adaptation). Vulnerability as a concept is also helpful to decision makers examining how communities may be impacted by climate change, for identifying key drivers, and how to respond to minimise impacts and to maximise SES resilience (Johnson et al., 2016). Johnson et al. (2016) identified nine countries (including Solomon Islands) out of 22 Pacific Island states that were expected to experience a fish supply shortage under future climate change. The study identified several options for the countries and their development partners to combat food security issues including nearshore fish-aggregating devices (FADs), protection and restoration of coastal habitats, distribution of bycatch and tuna from industrial fleets, and improving post-harvest methods.

Resilience is also a concept applied in climate change research (Intergovernmental Panel on Climate Change, 2014c). Introduced in the early 1970's and more recently applied to SES

research, resilience is used by researchers from many disciplines to understand a system's capacity to respond to change (Adger et al., 2005; Berkes & Folke, 1998; Deppisch & Hasibovic, 2013; Folke, 2006; Hidalgo et al., 2021; Holling, 1973; Schwarz et al., 2011; Steinberg, 2009). Resilience has been criticised as being many different things, e.g. concept, ideology, normative or ideal concept, strategy of power. It has also been criticised for legitimising action by multiple domains and disciplines to mobilise power to reinforce the status quo, assume equality, and strengthen neoliberalism (Anderson, 2015; Cote & Nightingale, 2012; Derickson, 2016; Simon & Randalls, 2016). Critically, Cote and Nightingale (2012) ask, *resilience for whom, by whom, and at what cost to which others*. Yet the use of resilience, alongside vulnerability (including adaptive capacity), in SES research facilitates the exploration of the complexity of interactions and drivers of change, and the capacity to develop successful adaptation strategies for climate change in SIDS (Hidalgo et al., 2021; Murphy, 2015; Schwarz et al., 2011; Wilby, 2020).

SES research exploring vulnerability and resilience (Hidalgo et al., 2021; McEvoy et al., 2020; Wilby, 2020) has included a focus on social adaptive capacity (human's capacity to manage resilience and reduce exposure; (Walker et al., 2004)) and social resilience (ability to cope with external stresses and disturbances as a result of social, political and environmental change; (Adger, 2000)). In Fiji, Hidalgo et al. (2021) revealed communities' vulnerability was driven by dependency on external support and lack of knowledge about new management programmes responding to rapid environmental change. Resilience was enhanced by access to support and services, high levels of agency, awareness of climate change impacts, inclination to learn, change, and implement, and the capacity to rally community resources and support (ie. adaptive capacity). Similarly, in Solomon Islands, community cohesion, good leadership, and individual support to collective action were identified as critical factors influencing the ability to build resilience and cope with change (Schwarz et al., 2011). For Pacific Island states, understanding SES' resilience and vulnerability requires consideration of contextual factors that influence adaptive capacity (Schwarz et al., 2011). This includes Pacific people's culture that has been shaped by their interactions with the ocean and influences regionalism (refer to Supplementary Material; Appendix D).

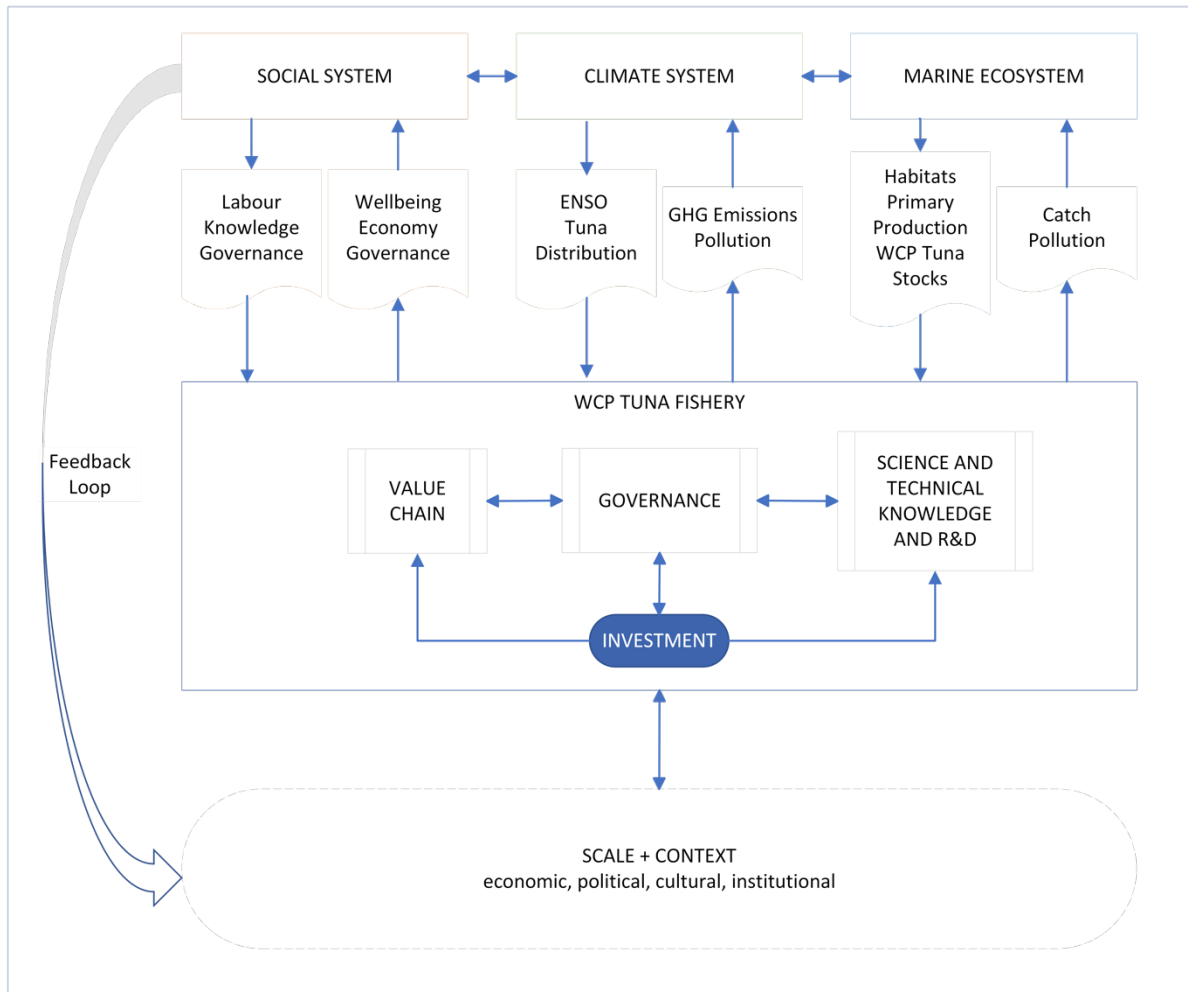


Figure 8. WCP tuna SES showing high level collection of systems.

SES are nested, multi-level systems with interlinkages that occur between three main systems (social, climate, and marine ecosystem) that are interdependent of each other involving system processes such as feedback loops, drivers and facing multiple stressors and cumulative effects. Feedback processes are a critical element of the SES and influence its dynamics (From Syddall et al. (2021))

There have been no empirical studies that examine WCP tuna fisheries' SES across scales (see Supplementary Material Figure 10 in Appendix D for illustration of scales using Cash et al. (2006)). WCP tuna fisheries' SES are defined using Syddall et al. (2021) (Figure 8) and are made up of social, climate and marine ecological multi-level interdependent systems. Furthermore, despite the acknowledgement of risk and vulnerability to climate change, management approaches by the tuna regional fisheries management organisation, the Western and Central Pacific Fisheries Commission (WCPFC) has been described as ad hoc, absent, or uncoordinated (Dey et al., 2016; Engler, 2020; Hanich et al., 2018). Regional and sub-

regional efforts include seeking stock sustainability and revenue maximisation (Barclay & Cartwright, 2007a, 2007b; Parris, 2010). For a recent overview of the WCP tuna fisheries see Williams and Ruaia (2021) and for current regional conservation and management measures in place see <https://www.wcpfc.int/conservation-and-management-measures>. There has also been an increasing focus at the local level by SIDS and the Pacific Community (SPC¹) on improving food security through the use of nearshore FADs (Albert, Beare, et al., 2014; Bell, Albert, et al., 2018; Bell, Albert, et al., 2015; Bell, Allain, et al., 2015; Bell, Cisneros-Montemayor, et al., 2018; Bell et al., 2009). Other interventions include distribution of small tuna and bycatch offloaded by industrial fleets at regional ports and improving access to canned tuna for inland populations (Bell, Allain, et al., 2015). Some efforts have been made to understand SES dynamics of tuna fisheries in a changing environment due to climate change (Duvat et al., 2021; Engler, 2020; Frawley et al., 2021; Godinot & Allain, 2003). These approaches focus on industrial fisheries scales and policy approaches using ecosystem-based approaches to fisheries management. Adaptation options can also be socially based (e.g. education, market diversification), institutional (e.g. programme reviews, adaptation programmes, cross-agency coordination, international agreements), and ecological (e.g. reduction in other stressors; Woods et al. (2021)).

In this chapter, resilience and vulnerability are explored in the WCP tuna fisheries' SES using Gizo and Honiara, Solomon Islands as place-specific studies. Solomon Islands currently has highly productive tuna fishing grounds with established small- and industrial-scale fisheries that are well connected in the WCP region (in terms of governance, supply chains, fishing). However, as a SIDS, the country will be exposed to severe impacts from climate change (Filho et al., 2021; Finkbeiner et al., 2018). Solomon Islands is therefore a relevant and necessary case example of the WCP tuna region to explore resilience and vulnerability across scales of fishing (small- to industrial-scale) and governance. Climate change is used as a lens to identify and reveal the drivers of change, interrelationships, and likely impacts on the wellbeing of coastal communities. Current and future policies, and adaptation strategies are identified and evaluated. This research contributes to understanding climate change impacts in Solomon Islands (and WCP tuna fisheries' SES more broadly) and identifies how climate

¹ The Pacific Community also known as SPC since its name change from Secretariat of the Pacific Community

change intersects with other dimensions to result in fisheries development and policy outcomes (that are sometimes unintended).

4.2 Materials and Methods

Research was conducted using a mixed-method place-specific study approach from 2018 to 2020. This included a two-week visit in December 2019 to Honiara and two villages in Gizo, Titiana and Mbabanga. Using a political ecology approach, the research investigated what changes had been observed in the tuna fisheries' SES, what the perceived impacts of climate change are (if any) and how the SES is prepared for such impacts in terms of adapting and perceived resilience. The overarching questions driving this research are: *How can SIDS best provide for the wellbeing of their people while enhancing value across multiple dimensions including sustainable wealth generated from their tuna resources? How do individual nation states, and states collectively, allocate between their multiple societal values?* To explore these questions, a transdisciplinary SES research approach described by Syddall et al. (2021) was used to assemble diverse theories, knowledge, methods, and analytical techniques to reveal and interpret complicated interactions and connections across WCP tuna fisheries' SES networks (Berkes, 2010; Berkes & Folke, 1998; Bograd et al., 2019; Fischer-Kowalski & Weisz, 2016; Holzer et al., 2018; Huber-Sannwald et al., 2020; Perry et al., 2010; Robbins, 2004).

4.2.1 Data Collection

Fourteen in-depth semi-structured approximately one-hour long interviews were undertaken with representatives of Solomon Islands' tuna fisheries. Representatives were identified using snowballing techniques and existing relationships, and included representatives from industry, independent consultants, regional and national fisheries managers, directors, fisheries officers, and nearshore FAD programme coordinators from the Ministry of Fisheries and Marine Resources (MFMR) Solomon Islands and the Pacific Islands Forum Fisheries Agency (FFA), Maritime Authority, fisheries scientists from SPC, New Zealand High Commission representatives, and non-governmental organisations (NGOs) including World Vision and WorldFish.

Semi-structured focus groups were also undertaken in two villages; Titiana and Mbabanga, located in Gizo, Western Province. These villages were identified as important artisanal tuna fishing villages through the snowballing process. With the help from WorldFish

representatives, focus group discussions were organised with fishers and marketers in the local village meeting house. Focus groups included 17 fishers and marketers in Titiana village (six female, 11 male) and nine fishers and marketers from Mbabanga village (one female, six male). Discussion points included: participants' activities and values linked with the SES (within and between the small- and industrial-scale fisheries); external influences (outside support, political, economic, and environmental influences); SES changes observed and challenges faced in relation to those changes (natural disasters, overfishing, and climate change, loss of traditional knowledge); and, strategies adopted in the face of those changes (norms and informal collaboration, changes to fishing practices). See Appendix B for interview and focus group guides.

Data from informal discussions with Conservation International and independent consultants, and field observations made in fishing villages, Honiara's Central Market and Gizo's market, ports and hotels were also collated. In addition to primary data, secondary sources included country reports, scientific journals and reports from science providers, NGOs, and independent consultants. Ethics approval was obtained from the University of Auckland's Human Participants Ethics Committee.

4.2.2 Data Analysis

Interviews and focus group discussions were transcribed and coded using QSR International nVivo software version 12 to identify key themes. In addition, data were coded for language that suggested relationships such as "dependence" as well as language about impacts. A matrix applying a SES framework was used (developed and outlined in Syddall et al. 2021; see Figure 9) to explore perceived impacts of climate change with particular attention paid to adaptation strategies and unintended outcomes. Using the matrix, a structured approach was used to examine (a) the state of the SES; (b) interlinkages, and (c) changes. Data were cross-referenced with key drivers of the SES identified in Syddall et al. (2021) (Figure 9). Key drivers include scale (geographical space, institutions, networks), power (power relations between fishers located within households, communities, industry, and wider scales), knowledge (e.g. indigenous, technical, scientific), energy (e.g. biophysical, fossil fuel), and equality. The matrix in Figure 9 provided a systematized approach to examine resilience, vulnerability, and identify opportunities to develop adaptive capacity (each overlapping to emphasis the interlinkages) of the tuna fisheries' SES.

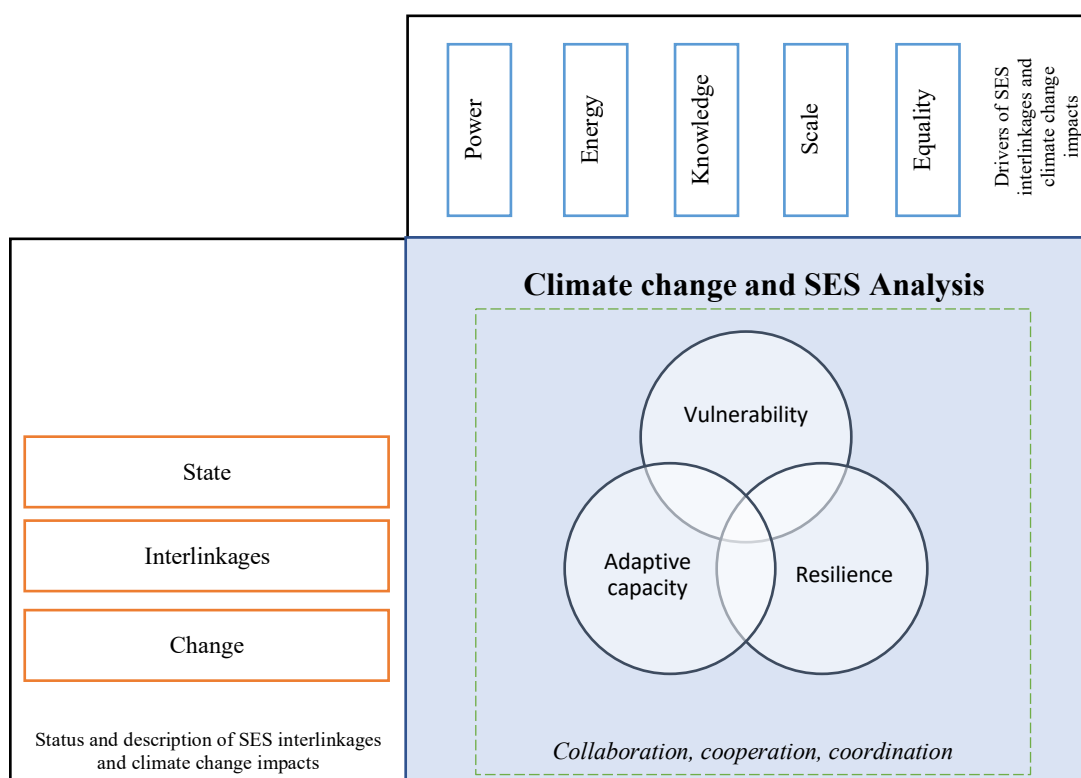


Figure 9. SES Analysis using matrix to explore vulnerability (incl. adaptive capacity) and resilience of Solomon Island’s tuna fishery SES with a focus on collaboration, cooperation, and coordination (adapted from Syddall et al., 2021)

4.3 Results

Findings from the place-specific study in Solomon Islands reveal two SES sub-systems, small- and industrial-scale fisheries' SES. These sub-system SES are characterised by sub-components including tuna and fishing; economy; development and employment; markets; political, social, and cultural; and governance. Small-scale fisheries consist of artisanal fishing using low-technology gear supplying fish to local markets and villages and contributes to food security. MFMR’s FAD programme coordinator reported each village has varying degree of activity fishing for tuna depending on accessibility to FADs and free-school fishing grounds. Industrial-scale fisheries, consisting mainly of purse-seine and longline fisheries, contribute significantly to the economy through, for example, the creation of jobs and access fees (FFA, 2019). Each sub-system exhibits varying degrees of vulnerability, resilience, and adaptive capacity which is described in the following sections.

4.3.1 Solomon Islands' tuna fisheries' SES in the context of change and impacts

Solomon Islands, like other countries in the WCP, have experienced fluctuating tuna stocks over time (Table 13). This is due to several factors including tuna migration and seasonality, fishing activity, tuna population fluctuations (recruitment), inter-annual variability including the Pacific Decadal Oscillation (PDO), and El Niño Southern Oscillation (ENSO) (refer to Supplementary Material, Appendix D). Table 4 provides a summary of interactions organised by sub-components (identified in analysis) during periods of El Niño when tuna distribution moves eastwards out of Solomon Island's EEZ and how this effect is perceived and translated by participants to be impacts of predicted climate change, on a longer-term or extended basis. Cross-scale dynamics (Cash et al., 2006) connect the small- and industrial-scale fisheries (presented in Section 4.3.4). These linkages are far-reaching: through changes to household to national revenues (from fisheries license fees, transshipments, ports entry, export permits, fish processing license fees, observers and service fees and other fisheries related revenues, see FFA, 2019), local and international markets; norms, regulations, policies, and practices; commercial developments; international investment and relations; and, local community access.

Table 4. Adaptive capacity of Solomon Islands' tuna fisheries (small-scale & industrial) SES sub-system showing multi-scalar interactions in the course of change e.g. ENSO and perceived climate change

SES sub-system components	Scale/Level	Change	Outcome	Adaptive capacity
Tuna & Fishing	Local / Near-shore / National / EEZ / WCP	Abundance, diversity, distribution Fewer FAD-free tuna schools Increased bad weather reducing fishing days	↓ catch, size, food security, days sold, transhipment Inefficiencies (↑ time searching, costs e.g. fuel) Compounding existing threats (poverty, biodiversity) Changes to fishing practices (technology, timing)	
Economy	Micro & macro / Local / National / International	↓ efficiencies, stock, profits across supply chain ↓ transhipments	↓ income distribution including ancillary Compounding existing threats (poverty, biodiversity)	
Development & Employment	Local / National	↓ efficiencies, stock, profits across supply chain	Formal employment opportunities (e.g. Noro)	
Markets	Local / National / International	Supply chains and market fluctuations (access, state, geographical isolation, power, refrigeration, infrastructure, fuel, labour capacity) ↓ fish supply, transhipments Changes to 'Least Developed Countries' status	Fluctuations in tuna price EU market access requires new institutional arrangements	
Political, social & cultural	Households / Villages / Organisations / Regional	Youths moving away from villages to urban areas Fishing knowledge not being passed down to generations International relations with China and Taiwan	Disconnection to environment and marine resources corrodes local and indigenous knowledge Foreign direct investments, donor-aid, tuna licenses	
Governance	Local / National / International Soft / Hard laws / Norms	↑ regional fishing allowances WCPFC Climate Change Resolution FAD regulations and programmes National climate change regulations Community-based fisheries management Village-village interactions, norms and practices	Interactive governance to improve access, control and ownership of tuna resources considered not precautionary	

Additional references include: (Bell et al., 2011; Bell et al., 2013; Bell et al., 2021; Lehodey et al., 2013; Ministry of Development Planning and Aid Coordination, 2016; Ministry of Fisheries and Marine Resources, 2019, 2020, 2021; PNA, 2020)

4.3.2 Industrial-scale fisheries' SES adaptation to climate variability

Climate variability impacts fishers, markets, employment, government revenue, number of transshipments, and accessibility to tuna and bycatch into domestic markets (see Table 4; transshipments example background information is also presented in Supplementary Material in Appendix D). As tuna are progressively redistributed to the east by climate change (Bell et al., 2021; Senina et al., 2018), these fluctuations are predicted to reduce government revenue and transshipments, reducing the supply of tuna for urban communities. Representatives reported that these changes were already starting to show in the 2019 season (December-February/March), attributing them to climate change. A few interviewees highlighted the compounding impact this would have on government revenue that was simultaneously affected by other factors (for example, reduced forestry revenue and the flow on impacts on foreign exchange). An independent consultant noted that tuna have been caught more around Kiribati (see Centre of Purse Seine Catch figure in Table 13 in Supplementary Material, Appendix D). It is important to note here, however, that interviewees may not have been aware of the difference between climatic variability (ENSO) and climate change. Low abundance of tuna in Solomon Islands' EEZ in any one recent year (e.g. 2019) is still most likely to be due to the effects of climatic variability on the distribution of skipjack (Clark et al., 2021; Lehodey et al., 1997), not the effects of climate change (see Supplementary Material Table 13 in Appendix D showing indicators developed to track changes due to climate change).

Findings show culture currently enables adaptation to impacts of climate variability and so is likely to be important for climate change (for both sub-groups of fisheries' SES). This can also be expressed as a 'Pacific-way' that characterises Solomon Islands, and other Pacific Island nations, shared histories and principles of faith, capacity, collaboration and community reciprocity, corroborating (see, for example, Rowland (2019) and Schwarz et al. (2011)). Cultural influences on adaptive capacity and resilience is demonstrated further in Solomon Island's sub-regionalism.

Solomon Islands is party to, and dependent on, several collaborative international, regional, and sub-regional forums that provide a range of benefits including, and unintentionally resulting in, different forms of adaptative approaches to combat impacts from climate change on the tuna fisheries' SES (Table 5). Sub-regionally, collaborative forums, such as the PNA that seek to support members in political and economic matters (Hanich et al., 2010), also

build resilience against climate change impacts (Clark et al., 2021; Sills et al., 2018). In particular, the PNAs vessel day scheme (VDS) (see Supplementary Material in Appendix D) has provided a platform for more flexible ways to manage and utilise the fisheries in coordinating with the environmental variability (Hanich et al., 2010). This includes sub-regional pooling (also known as a multilateral pooling arrangement) and roaming (allows VDS days to be used outside of the member's EEZ without needing to transfer or pooling designed primarily to support domestic fleet's development) (Clark et al., 2021). This flexibility builds effective adaptation to climate change for members like Solomon Islands (Clark et al., 2021; FFA, 2019). Although the Chair noted, this was not the objective of designing the current tool, it was to maximise rents, it is therefore a positive unintended outcome.

A critical success factor of the pooling arrangement is the voluntary membership, active participation, and flexibility to fish in any of the five member countries' EEZs (Chair of PNA's sub-regional pooling arrangement, Online, 2019). This is because each country has their different development strategy (for example, processing is a major source of PNG's revenue, whereas in Tokelau, revenue comes 100% from license fees) and their own commitments to their bilateral partners. Together, through this sub-pooling collective action, these smaller countries (in terms of EEZ catch and value, see Supplementary Material Table 14, Appendix D) have banded together to be equivalent to the same value of, for example, Kiribati's EEZ value. Moreover, success was because of the direct involvement of each member in designing the rules and equal sharing of the benefits. One of the main policies is *equal in and equal out* of benefits and costs where each member provides the same number of days and therefore gets the same amount of revenue as the other member. The Chair noted "it's about building consensus, involving people in the design, building together, this is why it has been successful." However, as tuna move eastward due to climate change impacts, the equal in equal out rule will constrain the ability for Solomon Islands to contribute more days. This is because the number of days each country contributes is limited to the country that puts in the least days. The commitments to bilateral partners, and other development strategies also impact this policy. As an MFMR fisheries manager highlighted, it will be interesting to see whether the countries will act collectively to "look after each other" in the face of climate change or whether they will act on their independent nation's interests.

Table 5. Solomon Island's Collaborative Forums

Body/Agreement	Scale	Interactive form of governance	Interdependence, Interests and modes	Benefits	Costs	Adaptation
PNA+Tokelau	Sub-regional	Collaboration	Diverse interests Nine tuna rich countries – fishers, processors, rent seekers Interdependent on strengthening bargaining power VDS Skipjack purse-seine fishery	Economic and political benefits through VDS Sustainability benefits Standardising negotiations with DWFNs Collective bargaining power to increase rents Restricting effort on the high seas	Opportunity cost (bilateral agreements)	Resilient by making efforts to reduce catch
Sub-regional pooling agreement	Sub-regional	Coordination	Diverse interests of 5 SIDS Pooling of VDS days Interdependent on each other to strengthen resilience	Flexibility Higher price gained for those days Certainty of revenue	Sharing of benefits - pooling days	Pooling of VDS days
WCPCF	Regional	Collaboration	UN Fish Stocks Agreement Interdependent on the fact that tuna are transboundary	Development of sustainability measures across WCP – including high seas SIDS capacity building Management of disproportionate burden on SIDS	Politicised by diametrically opposed interests between DWFN and PICs Difficulties getting sustainable measures enacted	Climate Change Resolution 2019-01
FFA	Regional	Collaboration	Sovereignty Interdependent on building capacity, sharing resources, strengthening sovereignty	Regional collaboration, technical and policy support	Balancing sustainability and development between diverse member's development goals. Dependency on support.	Collaborative networks, support, self-determinism

Acronyms: DWFN = Distant water fishing nations; PICs = Pacific island countries; VDS = Vessel Day Scheme

4.3.3 Small-scale fisheries' SES adaptation to climate variability

Perceptions of changes and impacts on Solomon Islands' tuna small-scale fisheries were revealed at the village level too. Interviews with fishers from Gizo perceived climate change impacts to be occurring already in their SES. Participants generally included changes such as sea-level rise and impacts of this to their villages, numbers and/or frequency of tunas schooling in open water, increased time spent fishing on FADs or increased time paddling to get to FAD-free schools (~10 km instead of 1-2 km 10-20 years ago, see Supplementary

Information in Appendix D), loss of transfer of fishing knowledge, and local market changes. Changes can compound other threats and pre-existing conditions such as poverty, remoteness, and socio-economic conditions faced by the small-scale fisheries' SES (Albert, Beare, et al., 2014; Joakim et al., 2015; Schwarz et al., 2011).

The small-scale fisheries SES are also highly adapted to climate variability with culture also being a fundamental driver. Factors contributing to adaptive capacity included learning (FAD technology, fishing techniques, weather), developed networks (supply chain, collaboration, coordination, cooperation), transferring fishing knowledge to “sons”, climate change and sustainability awareness, changing target species (e.g. catch trigger fish if catch of tuna is not good), and collecting stones for fishing from streams rather than buying fishing weights to reduce costs. Moreover, programmes such as MFMR's near-shore FAD programme that seek to improve food security for villages can build social and ecological resilience. Near-shore FADs create diversity of food sources and reduce overfishing stress on the nearshore reef (refer to Supplementary Material for more information on the near-shore FAD programme in Appendix D). Research reveals the importance of building trust, enabling appropriate ownership and control at relevant scales of governance, as well as providing adequate and timely skills, education, and outreach to socialise new innovations and technologies with communities and overcome sabotage and vandalism to FADs (Albert, Beare, et al., 2014; Bell, Albert, et al., 2018; Bell, Albert, et al., 2015; Campbell et al., 2016).

Findings also reveal small-scale fisheries' SES vulnerability, where it may not necessarily have high *adaptability* to strong perturbations that would occur due to climate change. For example, loss of tuna due to climate change will put pressure on food security, networks, and knowledge sharing (Bell, Cisneros-Montemayor, et al., 2018). Moreover, drivers of vulnerability include dependency on external support, degradation of reef ecosystems, and economic changes. For example, in Gizo, villages visited are reliant on aid for disaster relief, including near-shore FADs, redevelopment of the village including homes and meeting houses, and the redevelopment of the Gizo market (Australian Government programme 2016-2019, \$3.5 million²) due to tsunami damage and to manage climate change risk. Other drivers include the overfishing which degrades reef ecosystems and diminish availability of fish for

² <https://www.dfat.gov.au/about-us/publications/Pages/empowering-womens-economic-development-in-solomon-islands>

food security and changes to the price of fuel and other economic goods. How Solomon Islands government, industry, and villagers respond to perceived and impending climate change impacts will be critical to the future success of both sub-system SES's, particularly, the economy, and people's wellbeing.

Cooperation within the artisanal tuna fisheries and with MFMR has been a key success factor for access and allocation, adaptive co-management, and developing supply chains across remote locations of Solomon Islands. In terms of access and allocation, the two Gilbertese fishing villages cooperate by sharing the Gizo market by fishing every other day. This is an example of reciprocity. Allocating the market and thus fishing days is necessary to moderate market prices and without adequate refrigeration facilities to store fish overnight. The villages also coordinate days the other village may fish on a non-fishing day if they have an emergency (e.g. funeral or wedding). Moderating prices at market through cooperation has been seen to be successful by fishers of these villages. Cooperation has also been part of how MFMR allocates resources to villages and builds networks in terms of deploying FADs and arranging opportunities for donor funding. An MFMR provincial fisheries officer noted the importance for villages to communicate with the MFMR, NGOs, and donors to develop relationships providing opportunities for them to gain funding, deployment of FADs, and community-based marine management support.

4.3.4 Cross-scale linkages between SES sub-systems

Climate variability also impacts cross-scale linkages between small- and industrial-scale fisheries' SES. This included economic, access, and social (e.g. gender impacts) interlinkages. In addition to the allocation in Gizo, another example of allocation reported by Gilbertese fishers is where an NFD vessel operator shares some of the catch when they are close to the Gilbertese village. Fishers reported NFD vessel operators to phone the village to coordinate offloading bycatch. This action was described as being respectful of their food and income needs and is important to the villagers who find the catch per unit effort (CPUE) is decreased for a period of time after NFD has fished there. One fisher noted that other NFD vessel operators do not share the catch, noting it was "rude" (Gilbertese fisher, Gizo, 2019).

Reduced transshipment due to less tuna in Solomon Islands' EEZ influenced by climate variability (see Supplementary Material in Appendix D) leads to reduced access to tuna for local villagers in Honiara who buy via bartering (using vegetables and beer) (Deputy Director of Inshore Fisheries Division at MFMR; MFMR compliance officer, Honiara, 2019). This

decline in access reduces the supply of lower grade tuna and bycatch into domestic markets and leads to an increase in prices for fish. High prices, while advantageous to sellers of fish to the Honiara markets (villages across Solomon Islands including Gizo), conversely increases the price paid for tuna by families and restaurants (see Box 10.3 in Keen et al. (2017)).

Gender equality and impacts in tuna fisheries is another important factor yet is not understood (Barclay et al., 2021). Research has identified women play critical roles across tuna supply chains within small- and industrial-tuna fisheries (Chapter 3, also see Barclay et al. (2021)). The current Chapter does not present findings on gender because they are described in Barclay et al. (2021) and in Chapter 3. Nevertheless, it is important to identify the importance of women's role and impacts that tuna fisheries development and governance has through cross-scale linkages across both the small- and industrial tuna fisheries' SES (i.e. roles of women occupy multiple SES scales and levels, see Figure 10 in Supplementary Material, Appendix D). For example, in Gizo villages visited, women held fisher as well as market roles in the small-scale fishery. Fishers (including male) in the village noted how 'everybody is a fisher' and this mentality was carried through to national scales of governance. For example, a FAD programme coordinator also acknowledged that women fish. However, this is not translated across national processes of fisheries management. Policy and management interviewees argued that women do not fish, that their roles were restricted to the more well-known roles as tuna cannery workers in Noro, observers onboard industrial vessels, or as marketers, selling in domestic markets. Such a blanket belief can be detrimental to progressing gender equality across small- and industrial-scale supply chains. Invisibility of women's roles can impact women's adaptive capacity and resilience (Eastin, 2018). This area of research in tuna fisheries requires further work.

4.3.5 Existing national climate change governance framework

Solomon Islands has several policies and strategies to manage impacts from climate change that link into an informal multi-scalar framework comprising of national, regional, and international levels of governance. The National Climate Change Policy 2012-2017 (administered by Ministry of Environment, Climate Change, Disaster Management and Meteorology) outlines Solomon Islands government policy and strategies for climate change mitigation and highlights fisheries as a key area of vulnerability. Moreover, Solomon Islands National Ocean Policy (2018) identifies climate change as a key threat that will compound existing threats upon the "fragile and vulnerable" ocean environment and people reliant upon

it. The Policy sets the direction to combat these threats including mitigate or reduce risks, strengthening resilience of people and communities, mechanisms to address liability, loss, and damages, foster social responsibility to reduce negative impacts, and to promote research. Solomon Islands Tuna Management Development Plan also identifies climate change as a challenge to the tuna fisheries that requires addressing and sets out several goals and strategies to ensure the tuna fisheries are managed, sustainably used, and maximise economic and social benefits. However, there are gaps and a concerted effort is lacking in tuna fisheries governance and practice to implement these directions as recognised by Keen and Masu (2019). Table 6 maps out relevant tuna fisheries policy, strategy, legislative, and operational documents, and outlines which of these have identified climate change impacts and adaptation strategies. Although directed, the incorporation of climate change policy and development of adaptation strategies and their implementation remain either high level or absent, in particular in MFMR’s principal planning documents (Table 6). Furthermore, policies and strategies are focused on *technical* approaches to adaptation in the fisheries sector. This research reveals, however, a grassroots Pacific culture-led, and *social* approach to adaptation in the form of collective action such as collaboration, cooperation, and coordination within and across governance scales.

Table 6. Mapping of Solomon Islands Relevant Governance Framework and Inclusion of Climate Change Adaptation Policy (shaded identifies relevant documents to tuna fisheries)

Type of document	Document Name	Responsibility	Climate change Identified and Included in Policy	Technical / Social
Policy documents	The Solomon Islands National Development Strategy 2016-2035	Ministry of Development Planning and Aid Coordination	Yes, although not directly linked to fisheries	Social & technical management of environment Social resilience (awareness, research, strategies & policies)
	Solomon Islands Government Policy (DCGA ¹ Policy Statement)	National Government	Yes, although not directly linked to policy on fisheries	Social and technical (review legislation, resettlement, sanitation)
	Solomon Islands National Climate Change Policy 2012-2017 ²	Ministry of Environment, Climate Change, Disaster Management and Meteorology	Yes, fisheries highlighted as a main vulnerable sector	Social and technical through a yet to be developed National Adaptation Program of Action
	National Ocean’s Policy 2018	Oceans12 (made up of 12 ministries)	Yes	Social (research to understand impacts and responses to address threats from climate change)
	National Fisheries Policy 2019-2029 <i>MFMR Principal Planning Document</i>	MFMR	Yes	Technical (zone-based management tools)

Strategy Documents	Corporate Plan 2020-23 <i>MFMR Principal Planning Document</i>	MFMR	Yes	Technical (“mechanisms to address threats due to climate change on tuna fisheries” by applying management tools to ensure ecological sustainability of offshore tuna resources)
	MFMR Strategy 2017-2019 ² <i>MFMR Principal Planning Document</i>	MFMR	No	-
	Business Plan 2018-2023	MFMR	No	-
	Solomon Islands Tuna Management and Development Plan	MFMR	Yes	Social and technical strategies with no particular reference to climate change
Legislation	Fisheries Management Act 2015 <i>Principle legislative framework that gives MFMR its regulatory and management powers.</i>	MFMR	No	-
Operational documents	Regulations National Plans of Action Development Plans Annual Work Plans National Fisheries Management Plans	MFMR	Some have incorporated e.g. Operational Plan 2020. Others like the Provincial Fisheries Division Activity Plan do not.	Social (research into climate change threats on tuna fisheries)

¹ Democratic Coalition Government for Advancement (DCGA)

² A more recent version was not available online

4.4 Discussion

This study revealed collaboration builds resilience in both small- and industrial-scale fisheries’ SES across all scales and levels of governance. Modes of governance (see Treib et al. (2007) or Bednar and Henstra (2018) for descriptions ranging from state intervention to societal autonomy) have the ability to influence and change SES resilience to projected (Bell et al. 2021; Senina et al., 2018) and perceived impacts from climate change (Ojea et al., 2017; Sills et al., 2018). Collaboration in Solomon Islands’ tuna fisheries’ SES is borne from a ‘Pacific-way’ culture based on shared histories and principles of faith, capacity, collaboration, and community reciprocity that paves an adaptive pathway for a resilient tuna fisheries’ SES (Schwarz et al., 2011).

This current research reports on several adaptive capacity strategies of small- and industrial-scale fisheries’ SES and supports Cinner et al. (2018) who argue for a widening of scope when designing strategies that seek to build adaptive capacity. They include availability of

assets; flexibility; ability to organize and act collectively; learning; and agency. The small-scale fisheries assets included, for example, FAD technology and financial support received from collaborative networks. Flexibility was illustrated in the example of Gizo fishers who applied different fishing techniques or searched different fishing grounds depending on time and availability of fish. In the industrial-scale fisheries' SES, PNA have developed flexible strategies such as the VDS and its sub-regional pooling arrangement. Flexibility in collaborative governance networks is also noted in the governance literature to be essential for successful cooperation and fisheries regionalism in PNA's VDS and for increasing resilience (local to regional) to climate change (Clark et al., 2021; Folke et al., 2005; Hahn, 2011; Luthe et al., 2012; Sills et al., 2018; Yeeting et al., 2018). Organisation and acting collectively was shown by the way Gizo villages allocate market days as well as PNA's regionalism approach which has strengthened collective bargaining with distant water fishing nations (DWFNs). Cultural factors promoted collaborative and cooperative approaches corroborating Snyder et al. (2022) who also identify culturally important factors in adaptive capacity. Learning has also been identified in both the small- and industrial-scale in the passing down of fishing knowledge, as well as the science that props the industry and region to predict and plan for future climate change impacts on tuna biomass and distribution. Agency is also part of these illustrations that is connected to the 'Pacific-way' and self-determinism through sub-regionalism but also at the village level through cooperative decision-making networks (as shown in Gizo villages, for example, changes to fishing days when there is an emergency). Overall, adaptive capacity in the small-scale fisheries enhances their resilience through access to financial and technical support, learning, networks (social, supply chains), and daily routines.

4.4.1 FADs build networks and leverage existing cooperative forms of adaptive governance

Wider research shows that ecological resilience, while providing benefits for livelihoods for those dependent on the resources from the ecosystem, does not necessarily translate to social resilience or greater capability to respond to major SES changes such as that predicted for climate change (Adger, 2000; Folke, 2006; Woods et al., 2021). Solomon Islands' tuna fisheries' SES seems to follow this trend; however, because of the seasonal nature, resilience has evolved across scales of governance through social networks of interactive governance (e.g. sub-regional pooling). An example of this is seen through the FAD programme. The deployment of near-shore FADs has developed new human-environment linkages of use and knowledge of the SES (new fishing techniques, markets and food security, income

generation), and power and competing value systems (sabotage and vandalism and politics of placement of FADs) that are argued by Cote and Nightingale (2012) to be integral to the development and functioning of SES. In the context of placement of FADs, situating resilience is a political rather than ecological matter (Cote & Nightingale, 2012; Simon & Randalls, 2016). Situating resilience is described in (Fisher, 2016, p. 33): “resilience is found, made or situated within people, communities (human and non-human), cities and economies and has roots in ecology, psychology and engineering”. For example, village access to donor funding in villages for community-based resource management was noted to be based on communication and developing the necessary cross-scale relationships (MFMR provincial fisheries officer, Honiara, 2019). Moreover, collaboration in Gizo did not emerge from specific rules based on environmental knowledge, but through relations of power and historical relationships between these two villages (both Gilbertese islanders and from the same village from their home in Kiribati) and the intersection with the economy and specifically the markets. This example highlights the processes by which individuals and groups develop understandings of their actions and feedbacks in response to SES change (Cote & Nightingale, 2012). Interactive adaptive governance in Solomon Islands’ tuna fisheries’ SES provides flexibility, leadership and relationships, learning, empowerment, and opportunities for building trust. Furthermore, findings here reveal the nation’s near-shore FAD programme fostered social resilience at the local scale when matched with education and outreach and leveraging existing grass-roots adaptation strategies.

Key factors determining a household’s and village’s resilience have been studied in Solomon Islands in several communities in Schwarz et al. (2011) and include: intra-inter-community cooperation, coordination, and collaboration (e.g. participation in voluntary work, cooperation between community members); community based fisheries management of fisheries providing fisheries opportunities; and, external assistance (e.g. external post-disaster help). The FAD programme has built on this by introducing new knowledge and technical fishing capability, creating a new source of income, food and nutrition, and trust across and between scales of governance with villagers. Trust is an important component of social capital that enables effective collaboration. Once fishers understood the usefulness of FADs, they could see the value in them and developed supply chain networks and management to support and maintain FAD use. For example, existing collaborative networks in Gizo, between villages and NGOs and between the two villages, Mbabanga and Titiana successfully allocated the FADs and market.

4.4.2 Cultural influences on resilience: The Pacific-way, grassroots, and self-determinism

The ‘Pacific-way’ and its influences on collaboration is not new and has been driving successes for SIDS in the WCP tuna fisheries’ SES regionally for decades (Bernadett, 2014). PNA and their VDS is an example of adaptive governance engineering new futures for tuna-rich SIDS and has enhanced sustainability measures in the WCP tuna fisheries (Bell et al., 2021; Yeeting et al., 2018). As described by the Chair of the sub-regional pooling arrangement, PNA members are not directly angling towards ‘being resilient’, they are trying to shape their economic and environmental futures through sub-regional collaboration (Derickson, 2016). SIDS and individual fishers want self-determination and resourcefulness. For those in small-scale fisheries, for example in Gizo, fishers wanted market sales, GPS location devices, allocation of catch for domestic food security within the fishery, and access to refrigeration and storage. SIDS have a Pacific-way of responding to outside threats, for example to disasters, to COVID-19 pandemic, and to political pressures from DWFNs (Farran & Smith, 2021), as well as to climate change. This is validated in Cote and Nightingale (2012, p. 479) that adaptive governance is “embedded in historic and place-specific cultural and political contingencies.”

4.4.3 A need for multi-scalar concerted efforts

Current climate change adaptation approaches in Solomon Islands’ tuna fisheries are top-down and mainly technical that focus on ecological resilience (e.g. use of MFMR near-shore FADs, marine protected areas, and conservation management measures such as harvest control rules). This corroborates findings of Woods et al. (2021) from 21 nations/regions spanning North America, Europe, and the South Pacific which highlights ecological and institutional adaptation options for SES’ dependent on fisheries are predominately managed by centralised government institutions. Top-down approaches involve policies and agreements set at international, regional or national ‘top’ levels of government to be implemented locally as opposed to bottom-up voluntary initiatives local to the village and fishing activity. While a Pacific-way and collaboration plays a key role in building resilience in Solomon Islands’ tuna fisheries’ SES, social, institutional, and ecological efforts are fragmented, with benefits and costs distributed unevenly. Top-down approaches applied by several organisations across scales and levels of governance (WCPFC, FFA, PNA, MFMR) have led to the unevenness of benefits and costs (Anderson, 2015; Cote & Nightingale, 2012; Derickson, 2016; Fisher, 2016; Simon & Randalls, 2016). For example, the political nature of

FAD placement influenced where adaptation and subsequent outcome occurs. Therefore, there is a need for a multi-scalar climate change adaptation framework deliberately designed to manage, untangle and depoliticise future negotiations that are fraught with a nation's interests when managing trade-offs and synergies between economic, environmental, and social objectives.

Decision makers across local to Pacific-wide regional institutions should work together to apply a multi-scalar climate change adaptation framework to support and promote sustainable livelihoods. Applying adaptive governance across different scales and levels provides flexibility and a structural framework for fusing diverse top down, technical approaches with Pacific-way and grass roots, location-specific approaches (Dey et al., 2016; Lomonico et al., 2021; Ojea et al., 2017; Poulain et al., 2018; Wilson et al., 2018; Woods et al., 2021). My research identifies the importance of ensuring that social approaches are incorporated into an adaptive governance framework including attributes of flexibility, diversity, and cross-scale connectivity (Cote & Nightingale, 2012). It also confirms the importance of social capital and social memory for building adaptive capacity in SES (Folke et al., 2005). This approach should also include attention to gender issues (Eastin, 2018).

At the national level, this framework needs to apply cross-sectoral approaches. Moreover, regional and national management could acquire unique and timely information about climate change impacts on the tuna fisheries' SES through previously overlooked indigenous knowledge of social and environmental interactions (Cote & Nightingale, 2012). Technical development in the fisheries that are translated into social resilience could be strengthened by making government and regional organisations as places for knowledge accumulation on climate change impacts and environmental changes.

In the long-run, PNA SIDS face climate-driven tuna redistribution that will eventually shift a substantial proportion of the tuna outside combined EEZs of PNA members, forcing Pacific SIDS to depend on other pathways beyond their direct control to adapt (Bell et al., 2021). As part of the concerted multi-scalar approach, PNA SIDS will need to extend their collaborative approaches further afield and think innovatively, as they did with the VDS, to secure their economic futures and to continue to positively influence sustainability measures. This should include PNA placing pressure on WCPFC to ensure equality by recognising climate-driven tuna redistribution and sustainable management of WCPO high seas areas (Bell et al., 2021).

Cultural influences raise the importance of how grass-roots approaches to resilience and adaptation are critical for self-determination and sovereignty of SIDS. While resilience can develop through collaboration, it can also cement unequal social relations (as was the case where deployed FADs disrupted village-to-village relations). Answers to questions in particular *resilience of what and for whom* must also be made transparent. Resilience, argued here, is inherent in the individuals and SES and is tied to culture and a Pacific-way. Collaboration directs outcomes of culture. A multi-scalar framework must be cognisant of the political tendencies that resilience is often critiqued for to avoid maintaining status quos, further entrenching neo-liberal agendas (Anderson, 2015; Cote & Nightingale, 2012; Derickson, 2016; Simon & Randalls, 2016; Swyngedouw, 2010b). Furthermore, such an approach would benefit by taking care of the Oceanic regionalism critique to avoid reinforcing neoliberal and status quo approaches that oppress cultural or traditional values (Leslie & Wild, 2018; Teaiwa, 2018). Challenges to do so may include the need for transformative changes of values and practices. In Solomon Islands, logging is a key sector for the national economy; however, the impacts this has on the marine environment (runoff, physical damage) and also socially on nearby villages needs to be considered when developing adaptation strategies (Minter et al., 2018). In a review of marine governance, Kelly et al. (2018) report that incorporating holistic transformative changes is often overlooked by many of the academics, policymakers, and environmental groups where issues of incumbency, path dependency, policy layering, and other pragmatic strategies are missed. They argue that there is a need to understand the institutional dynamics that act as barriers to effective implementation of integration and holistic approaches to governance (Kelly et al., 2018). Moreover, revealing local context to understand how society will be impacted and to understand vulnerabilities, resilience, and adaptation opportunities is critical (Schwarz et al., 2011).

Solomon Islands' tuna fisheries' SES has provided examples of where multi-scalar governance has started to pave a resilient pathway in the face of climate change. While nearshore-FADs are likely to remain relevant for providing access by local people to fish (Bell, Albert, et al., 2018), collaboration (e.g. in the PNA VDS) is a longer term strategy with which tools (e.g. pooling) may be adapted to changing contexts. The learnings in this research can be transferred to other regional tuna fisheries and SES with transboundary resources. Other Pacific island countries within the WCP tuna SES could also apply the methods described in this Chapter (and in Chapter 2) as a first step to coordinating and

collaborating a multi-scalar climate change adaptive framework. By doing so, barriers and opportunities for building resilience could be identified and strategies could be incorporated into the framework's operational plans.

4.5 Conclusion

Collaboration, cooperation, and coordination is critical to build resilience within and across levels of governance. As this research has shown, grassroots and top-down adaptation approaches facilitate the development of networks (e.g. supply chain through donor-funded Gizo market development, village-village in Gizo) or the leveraging of interactive forms of governance to provide social and ecological resilience outcomes. While the SES shows some progress towards building resilience, there is need to orchestrate a multi-scalar climate change adaptation framework for tuna fisheries. These learnings can be applied to the WCP region, particularly to PNA member countries as it is relevant to their sub-regionalism approach and similar fisheries, however, because SES are context and place-specific, additional analysis would be required. This is critical for those livelihoods that depend on tuna, for countries' income, and for the future of the fisheries.

Chapter 5 Synthesis



5.1 Introduction

This chapter synthesizes key findings, demonstrates how the research objectives and questions have been addressed, reflects on limitations of the research, and identifies future research opportunities. The purpose of the chapter is to thread the conceptual and theoretical together with the place-specific research findings from Fiji and Solomon Islands and reflect on how these have contributed to an understanding of the WCP tuna SES.

5.2 Reflections on research objectives and questions

This thesis sought to explore how SES thinking in conjunction with political ecology can be used to consider how to balance trade-offs in decision making to combine a more holistic and ‘political’ approach to governance of WCP tuna fisheries. The following reflections provide details for how this was (and was not) achieved including through SECO’s development and testing.

A note on answering the ‘real world’ questions

Communities and decision makers of social-ecological ocean systems in the Pacific are at a cross-road. Faced with critical decisions about future climate change impacts while at the same time allocating costs and benefits across multiple social, economic, and environmental values within the WCP tuna SESs is no easy feat. This thesis provides a more nuanced conceptualisation of WCP fisheries that considers the broader social, economic, and environmental contexts. It therefore identifies ways, broader than fisheries management tools, in which to support decision makers achieve their societal goals through the WCP SES (e.g., gender equality, SES multi-scalar resilience) that are a step towards enhancing societal wellbeing and value from SIDS’ tuna resources.

Objective 1: To contribute to the development of a transdisciplinary social-ecological framework for analysis of pelagic tuna fisheries.

Question 1: How can transdisciplinary and mixed-method research approaches be integrated to examine complex ocean SES and unintended outcomes of fisheries development and governance?

Question 2: How can transdisciplinary research be tailored to provide strategies for achieving multi-dimensional goals across the different levels of governance?

To answer question one, critical ways to integrate methodologies and methods and facilitate understanding of SES networks included: co-development of research questions, the use of political ecology and SES thinking, and empirical research. To answer question two, SECO was tailored by exploring gender issues within Fiji's tuna fisheries' SES and climate change impacts on Solomon Islands fisheries' SES. The research contributed a nuanced approach to propose action and solutions for multi-scalar WCP tuna fisheries management to address sustainability and wellbeing concerns.

Identifying ways to integrate methodologies and methods for understanding SES networks

Co-development of research questions: Fundamentally, the co-developing of research questions with fisheries and ocean science and management specialists supported engagement in the research and opened up different perspectives on the problems being researched. As the research proceeded, communities became an important focus of the research, and therefore it would have been beneficial to engage at this level during the development of research questions to identify issues of relevance.

Use of political ecology and SES thinking: By integrating political ecology and SES thinking into gender and climate change issues I was able to expose and tease out interlinkages and unintended outcomes. Whereas political ecology focuses on the subjects that drive environmental change and explores power and politics in human-environmental relationships, it pays less attention to ecological systems and processes. SES research, however, is suitable for drawing attention to ecological systems and how they interact with social systems, yet the social dynamics and power-relations are given less attention. These approaches have been used together in other studies who also find them complementary (Fabinyi et al., 2014; Ingalls & Stedman, 2016; Michon, 2011). Using both SES and political

ecology concepts provides a multi-faceted (ecosystems, political, cultural) and multi-scalar (local to global scales) approach to explore and contribute to better understanding of complex SES such as the WCP tuna SES (Ingalls & Stedman, 2016). Bringing these two bodies of knowledge together to analyse gender and tuna enabled critical insight into inequality and injustice issues that are embedded in social, political, and economic status quo. For example, examination of gender equality initiatives in tuna fisheries that seek to redress inequality by increasing women's participation in fact increased their vulnerability, and in some cases led, to gender-based violence. This supports the findings in Barclay et al. (2021) O'Neill et al. (2018), and Prieto-Carolino et al. (2021).

Given the different conceptual backgrounds, there are challenges in reconciling these two approaches. While this thesis did not seek to merge the two concepts to seek one truth or one grand narrative, one challenge was how to apply the research alongside themselves so that they co-existed in the research. For example, while SES resilience research is great for its emphasis on nonlinearity, feedbacks, and systems dynamism, it lacks attention to power and culture and tends to treat, for example, communities as homogenous. I overcame these conceptual differences by first designing SECO that would first identify the SES as structures and interlinkages (SES characterisation) and then applied a separate analysis to draw out social differences, cultural and political relationships to understand the differences in people's experiences of the tuna fishery.

Empirical research: A critical aspect of transdisciplinary research, and of political ecology is the use of empirical research at the individual, household, and community level. Systems complexity creates multi-dimensional phenomena that people experience at different temporal and spatial scales. Understanding this multi-scalar experience requires mixed methods, both qualitative and quantitative. Moreover, political ecology enabled me to attend to power, culture, gender at different scales and to elucidate cross-scale interactions while SES makes explicit the interlinkages between social and ecological systems. As noted above, bringing these two concepts together provided a way to see the relationships and processes.

Key learnings from carrying out transdisciplinary research in the WCP tuna fishery included the need to talk to a diverse range of people (including those involved in the tuna supply chain, the families of the fishers, people involved in the governance across national, regional, sub-regional levels) that offered different types of researcher-participant relationships. Some participants offered different types of relationships including acting as:

- Informants or networkers who provided local information, identification of the right type of individuals, fishing communities, organisations to speak with, sources of other information, organisations/villages to approach.
- Gatekeepers (both informal and formal) to villages/individuals/organisations who sought to protect their rights and interests but also acted as facilitators of access.

Gatekeepers were naturally cautious of me as an outsider and my research intentions. For example, one gatekeeper, a consultant to MFMR, heralded the process for undertaking research in Solomon Islands and developing trusting and win-win researcher-village relationships. This included the importance of developing trust, credibility, and rapport with fishers and the wider community within fishing villages for several months before beginning research. This process is also discussed in studies who explore the researcher-participant relationship in vulnerable hard to reach communities (Emmel et al., 2007). Due to limited time and resources, I was unable to spend this time immersing myself in fishing villages, I found this particularly challenging, and therefore I felt uneasy as an outsider going into villages without having developed these integral relationships. To overcome this, I leaned on relationships I had developed with WorldFish in Gizo prior to visiting Solomon Islands (via zoom and emails) who would grant me access, escort me, and translate visits to the villages and acted as conduits for the credibility, trust, and rapport required. I also used focus group discussions rather than individual interviews to create an environment where participants might feel more open to sharing their stories with me. These meetings were critical for the research, and I learnt so much from such a very short time. In the future, however, I would seek to source funding and plan the time to allow me to establish relationships. Overall, the establishing relationships with diverse participants helped practically in the research design, logistics, navigating ethics and village practices and was extremely valuable and the research would not have continued without these people (as discussed further in Chapter 2).

Furthermore, to strengthen the research, it would have been beneficial to meet with more villages, fisheries offices, and ministries in both Fiji and Solomon Islands. It would also been helpful to seek out more women involved in invisible roles such as sex workers and to have conducted the gender work in Solomon Islands as well. The additional information could have identified additional unintended outcomes connected to gender and climate change. However, due to my own time constraints and capacity constraints of those identified to interview who were unable to participate, I was unable to interview everyone involved in the

tuna fishery in these locations or carry out additional place-specific studies. Nevertheless, I was able to speak with enough people with a diversity of interests and involvement in the fishery.

Given the time spent in villages was short, it in no way replaces anthropological or other in-depth studies that are lengthier and where the researcher observes and interacts with fishers to provide richer account of their practices. On the other hand, while fisheries researchers focus on quantitative research of the fishery, they may not be interested or have the capabilities to undertake in-depth interviews or other qualitative methods to explore social aspects of the fishery. This research therefore exists somewhere in between these two approaches. SECO sought to apply a 'rapid' approach to transdisciplinary empirical research that applied several strategies to add depth to a 'lighter' empirical touch (e.g. including focus group discussions, triangulation with secondary data, gatekeeper relationships). Qualitative data from interviews and focus group discussions were considered alongside a raft of social and ecological factors across multiple scales and levels of governance, sectors, disciplines, as well as fisheries science and economics. Interviews and focus group discussions enabled me to identify critical interlinkages (e.g. perceptions of climate and environmental change, equality and allocation issues, cultural processes, gender and power-relations) that could be further interrogated in SECO's matrix of drivers to reveal unintended outcomes of development and governance and their underlying causes.

A common criticism of transdisciplinary research is that it requires significant time to develop and undertake research, and is challenging across large spatial scales such as oceans (Moffitt et al., 2016). In this context, and reflecting on question one, it is unsurprising that transdisciplinary research is slow to be implemented in an ocean context. While, SECO provided a framework to facilitate a rapid form of transdisciplinary research across large geographies, adapting it could provide better research outcomes while not significantly adding to time and effort. For example, a possible approach could be to start from the local level first, before conducting a characterisation of the fishery. A challenge, however, is the process of identifying which villages and which lenses. This could be done through scanning for hotspots of fishing activities, ports, or other forms of physical supply chain linkages that villages may have. Or if in a different sector or natural resource (e.g. logging, water, agriculture) it could be where these resources are harvested or processed. In the WCP tuna fishery, there are many villages across the WCP that fish for tuna although only few ports,

and processing facilities. Randomised selection of countries with resource hotspots and then snowballing through initial inquiries in countries' ministries involved in the natural resource could facilitate identification of villages. Although it is important to recognise the bias involved in choosing villages through ministries or other formal gatekeepers such as NGO's that work with fishing villages. In terms of tuna, village access (based on marine topography, location in respect to the coast, the use of FADs, history of fishing) and their fishing activity, while obvious, can determine its relevance for research. Although, highland countries could be also connected to tuna fisheries if they are fishers on industrial vessels, so these villages may also be relevant and could potentially be picked up through snowballing or later on in the research. All these factors start to identify which villages are relevant to be chosen.

Starting the research at the fishing village / local level and planning initial visits early on could provide the opportunity to establish relationships to build rapport, credibility, and trust earlier on. It could also identify possible issues that require more exploring than what was allowed when visits were planned at the end. Although these visits were part of testing SECO, those planning to use SECO could develop their research questions alongside people who do the fishing (or other natural resources of interest). A characterisation could then be conducted, and a second visit could be planned to go back and carry out interviews and focus group discussions. This approach is more aligned also to participatory research by including minority groups to develop research questions and to be brought along with the research.

Tailoring to provide strategies – the use of lenses and responding to real-world problems

SECO was tailored by identifying lenses, place-specific study locations, and social drivers that were deemed important to participants in Step 1 (section 2.4.1 in Chapter 2). Using Binder et al.'s (2013) criteria, SECO's approach conceptualises social and ecological system's relationships as bidirectional, taking an anthropocentric perspective on the ecological system but also appreciating that ecosystems are an end in and of themselves rather than a means to some anthropocentric end. Finally, SECO is both an analysis- and action-oriented framework to draw out understandings of the SES as well as provide tools to achieving and answering a certain 'real world' goal and/or question (like those identified in Weeks and Adams (2018)). SECO is similar to Ostrom's (2007, 2009) SES framework and was iteratively developed in the context of pelagic transboundary fisheries involving SIDS. However, using political ecology differentiates SECO from other SES frameworks. Firstly, it goes a step further and allows for a wider analysis of the SES by allowing for the

investigation of those indirectly involved in the fishery. Secondly, it allows a focus on the subjects that create the change within the SES while acknowledging the benefits and costs of change are distributed unevenly. This contrasts to analysis using a SES framework approach, which engages with the system's dynamics of that change. 'Borrowing' from social sciences, as Ban et al. (2013) argues, benefits SES analysis' efforts to understand and govern complex SES. Equally, Folke et al. (2005) also extend SES analysis to examine further the social dimension of the SES with a focus on social sources that adapt to and respond to change. With both political and ecological theoretical gearing, SECO thus sits between science and policy issues to unveil both issues of scale and feedbacks as well as how the complexities of power and culture distribute benefits and costs unevenly. Although these perspectives are incompatible, they may co-exist and be complementary. In this respect, those interested in understanding and governing use of resources embedded within complex SES in the context of marine environment may be drawn to this framework. Equally, those interested in power relations, gender, climate change may benefit in using SECO to understand other types of SES networks. However, the framework would need to be adapted to the context of the SES as part of the characterisation phase.

Chapter 2 shows how SECO was developed to navigate SES networks and provide strategies for holistic management of the WCP tuna SES. With a focus on interlinkages, the use of place-specific studies revealed issues of allocation and equality in development and governance. Specifically, SECO provided insights into where collaboration is occurring and where collaboration is needed or could offer a solution to specific problems. Collaboration answers the *how* while applying SECO answers the *what* in terms of understanding the WCP tuna SES, trade-offs, unique win-win solutions, and which dimensions and values are critical for its success.

Lenses: An important principle of transdisciplinary research is that it must respond to a real-world problem. Using lenses, identified as the research progressed, this research responds to critical and timely research gaps. In doing so, exploration of multiple dimensions of the SES reveals how fisheries management issues are connected (yet overlooked) to social aspects of the WCP tuna SES. This in turn offers opportunities and solutions for action that are much wider than fisheries' business-as-usual. It is important to note, however, that there is a politics in selecting lenses. During the SES characterisation interviews, several issues were discussed that could have been used as lenses to further interrogate the SES (e.g. pollution

from micro-plastics, technology). Gender and climate change were chosen because of interviewees' interests and agendas but also because of my own research connections in the region, which enabled better access to resources and people. In addition, limited time and resources also drove the choice of places to explore lenses. Climate change, for example is a well-studied area, especially in Solomon Islands, which receives a lot of attention in resources management; however, the Solomon Islands receives less attention in regards to the WCP tuna fishery, particularly as it impacts social systems. It was my own want and wider researcher needs to fill this gap. Researchers must be mindful of these politics, and may wish to consider a more unbiased approach when choosing lenses.

Place-specific locations: Interviews and focus discussion groups identified or emphasised issues for further interrogation. For example, identifying the group of women in Kalekana Village in Suva and Josaia Cama in Waiqanake helped reveal and locate critical interlinkages. Gendered power-relations and Fijian culture within villages were found to 'clash' with western and tuna fisheries cultures. Compared to a narrow single disciplined fisheries management research approach that tends to focus on resource use and economics, the multi-dimensional nature of SECO allowed the research to 'hear' in new contexts all the different stories whether economic, social, political, or ecologically relevant. From these stories, issues and interlinkages could be identified further examined, and themes framed using a matrix.

Examination of social drivers: A political ecology meant SECO could be tailored to incorporate identified themes or social drivers such as power, energy, scale, equality, and could draw on different knowledge in a methodological way (using a matrix) to explore the multi-scalar dynamics that cause unintended outcomes. Using this matrix, with social drivers against SES structures and processes (e.g. globalisation, markets and supply chains, poverty, and employment), enabled me to explicate the intersections with culture and tradition, gender, climate change to explain and demonstrate unintended outcomes of fisheries development. Having applied SECO, and at the centre of these intersections held multiple and contested rights and values of which groups formed alliances. Many note the difficulties of designing and implementing projects, policies, and regulation that addresses economic, environmental and equity objectives; however, these difficulties should not be the reason not to try and design or implement solutions. As a next step, it would be useful to examine these alliances, rights, and values as additional lenses and applying approaches such as substantive

equality Fredman (2016) and meta-norms Lawless et al. (2020) to complement equality, law, and justice research of transboundary fisheries.

Objective 2: To understand WCP tuna SES.

Question 3 *How is the WCP tuna SES characterised and how does this characterisation (and other challenges identified) influence the implementing of holistic approaches to governance?*

Objective 2 was achieved in two ways. Firstly, a preliminary step completed prior to the development of SECO was to characterise the SES to identify important drivers and potential areas of inquiry (or lenses) to be explored in more depth as part of the research. Interviews with key fisheries managers, fisheries scientists, fisheries climate experts, NGOs, local peoples, and gender expert representatives along with applying the political ecology frameworks and relevant background literature to the WCP tuna fishery provided the necessary information to understand how the SES is generally defined and characterised. Table 7 provides a snapshot of how the WCP tuna SES was characterised by regional fisheries management representatives, scientists, and NGOs and how this characterisation (or discourse) is played out on the ground. Key learnings for governance are also provided in the table. As this thesis has shown, characterisations that contribute to fisheries governance (e.g. siloed, technocratic, simplified) are in tensions with lived experiences due to social and political SES complexities.

Table 7. How respondents defined the SES

Role	Theme / Discipline Used to Define SES
Scientist	Bio-geographic-centric (e.g., an oligotrophic ecosystem, the productivity of which is influenced by upwelling involving a short food chain with keystone species).
Biological scientists with social science interests	Holistic descriptions with no hierarchy, including habitat, animals, bycatch, social, government and economics.
Industry	Socio-economic-centric (e.g., focus on jobs, communities, economies' dependency).
Advocacy	Interrelationships focussed (e.g., finding harmony between marine and human systems, relationships).
Fisheries management – FFA, Independent Consultant, Australia	Collection of hierarchically organised ecosystems, defined using species, oceanography, and biogeography, and influenced by funding sources (e.g., 'large marine ecosystem' is a term used by GEF).
Fisheries Management - Pacific Island Country / PNA	Biological and humans separate but part of the system emphasis on management and political dimensions. Highlighted the importance of sovereignty and included EEZs as part of the ecosystem.
Technical management	Large marine ecosystem based on western Pacific warm pool.

Table 8. Characterisation, translation in place-based studies, and relevant learnings

Characterisation	Place-Based Studies	Relevant learnings
Defined differently by different respondents. No consistent agreed definition of the WCP tuna ecosystem.	WPWP is commonly used, however omits multiple complex SES relationships. Moreover, social systems which rely heavily on tuna in the Pacific, are omitted when defining ecosystems.	Importance of including humans and social systems in the ecosystem.
Lack of knowledge about the social-ecological system within which the tuna fisheries operate.	Knowledge is based on interactions with the fishery, technocratic and 'expert' regionally / international centred approaches.	Importance of gathering knowledge from different levels of governance as well as from indigenous / local fishers.
Acknowledgement that ecosystems are highly interlinked yet governance and management decisions seek to put boundaries around them (species, areas).	Governance and management is severely siloed, excluding social factors such as gender. Climate change has only recently made the policy and decision-making agenda.	The need for a more holistic governance and management approach to the WCP tuna fishery.
Social and ecological dimensions are segregated as separate and homogeneous.	Social and ecological dimensions are intricately linked and difficult to separate.	The need to conceptualise SES as a single dimension.
Major threats include climate change, plastic pollution, overfishing.	WCP tuna fishery is a threat to some individuals and villages experiencing negative social impacts.	The social feedback revealed in this research highlight the critical need for understanding the tuna fishery as a SES

Teasing out the different ways in which the SES was defined, and by whom, and reflecting on the different interests and rights of individuals, communities, and organisations in the context of power-relations revealed nuances in how threats and barriers to livelihoods and governance of WCP tuna SES are perceived across scale. Importantly, threats can be viewed differently within a country and across the Pacific. For example, research reveals diverse perceptions of the WCP tuna fishery, as a threat, or benefit to society. In the Solomon Islands, while there were also reports of prostitution by respondents this was not demonised as it was in Fiji. It is important to note, however, that this exercise was conceptual and heuristic, based on only a proportion of key representatives in a snapshot in time across the scales of the fishery. This exercise could be expanded to be conducted over time, including a larger group of people within scales of the fishery.

Overall, the tuna fishery was more seen as a benefit to society in Solomon Islands (compared to in Fiji). Direct and indirect benefits included overflows of tuna bycatch into the markets, food security solutions, access through nearshore FADs, employment opportunities, and contribution to national income. However, as an independent consultant described, the story is different for the southern longline albacore fishery due to the failure of southern Pacific island countries to collaborate. The key issue is the inability to manage the fishery across

EEZ / high seas boundaries because any measures made for sustainability in EEZ's lead to "fishing vessels go[ing] to the high seas, and this is frustrating" (Independent Consultant, Online, 2019). The outcome of which is that the southern longline albacore fishery is eroding resilience of communities in Fiji.

A key learning that answered Question 3 was that gaming is used by industry and PICs to manage individual and collective perceived threats and barriers by leveraging upon collaboration, geopolitical, sociocultural, and ecological diversity factors. Gaming is a critical constraint to more holistic governance and influences the *how* and *what*. Understanding *what* it is that is being governed is necessary, but more critical is *how* it is governed. Science is politicised, and decisions made at the regional and national level are constantly being negotiated and navigated by Pacific island countries often with high priority to bilateral relations, as well as individual aspirations of sovereignty and economic independence.

Ecosystem-based management, for example, is dismissed and excused as being difficult to implement by leaders of delegations. This research has revealed that these challenges are far more systemic than can be explained by institutional, cultural processes - such as path dependency (Fulton, 2021). Shifts towards regional scale governance (e.g., forming the WCPO under the UN Fish Stocks Agreement) was advocated for strengthening institutional capacity and governing the transboundary resource within the bounds of its ecological niche. However, regional governance has shifted the balance of power beyond nation states (Jones & Hameiri, 2020) and influenced the equitable sharing of benefits and costs of conservation efforts.

Objective 3: *To explore unintended consequences of fisheries development and governance processes on SES networks.*

Question 5: *What are the impacts on gender, the roles of women, and exposures women and men have to unintended outcomes of fisheries governance and development?*

Question 6: *What are the impacts and perceived impacts of climate change on the WCP tuna SES and its resilience and how does this relate to unintended outcomes of fisheries development and governance?*

Objective 3 was achieved by carrying out place-based studies and exploring the two lenses, gender (in Chapter Three) to answer Question 5 and climate change (in Chapter Four) to answer Question 6.

There were challenges to designing a research project that sought to analyse unintended consequences. Unintended outcomes are unpredictable outcomes of development or governance interventions and occur directly or indirectly because of them. I was interested in how they form through fisheries governance and development in the WCP tuna fishery with a goal to avoiding outcomes that negatively impact society and the environment. Outcomes of fisheries development and governance have been the focus of many scholars who examine the human-environment nexus (Chapter 3 and Chapter 4). However, much of this research focuses on the economic efficiency or overfishing issues, for example, rather than the whole SES network. I argue a SES approach is key to understanding how social, political, cultural, environmental, climatic, and governance factors combine to produce new trajectories with implications for society and the environment. Once lenses were identified, these were framed to identify unintended outcomes of development and governance - gender (in)equality and impacts from climate change. Design elements I had to think about to analyse them was, how to investigate them in a complex system, questions involved answering how these issues manifested throughout the system and what were the systemic causes. For gender, this was difficult to identify through interviews and the rapid research approach without immersing myself into the daily lives of fishers and families of those fishers, and the day-to-day running's of fishing industry including trips out at sea. This therefore required using the matrix, undertaking secondary research, and speaking with gender experts in the tuna fishery and in Fiji. I found that, through this secondary research, I could better understand what the systemic causes could be. Overlaying these possible systemic causes with focus group discussions and interviews data enabled the identification of trends for further interrogation (e.g. Fijian culture and the marine activities of villages). Research on unintended outcomes that impact social first needs to be adopted into a formalised research plan across a multi-scalar governance framework (WCPFC, SPC, national authorities). Difficulties will lie where such outcomes are unpredictable and include the unknown unknowns and therefore difficult to identify before policies and plans are implemented. However, knowledge accumulated from the application of SECO, for example, to understand the SES network across scale can provide information for more adaptive fisheries governance.

SECO offers an approach to identifying or giving a voice to previously marginalised peoples that are part of a regionally governed resource SES. This is not to say that only marginalised peoples bear the brunt of unintended outcomes; however, by focussing in on unintended outcomes, groups of individuals that were not considered in the policy and development process can be identified. SECO contributes to other SES, gender, climate change, and transboundary resources research by providing strategies and tools to help identify what (potentially mainstreaming) policy initiatives might be required to help with the development of more holistic policies where the unintended outcomes may be better understood and therefore, transparently and adaptively planned (and prioritised) for. Applying SECO in Chapter 3 and Chapter 4 shows that tuna fisheries in the Pacific are embedded in social, environmental, economic, and political structures and non-linear processes; described as ‘oceanscapes’ by Pacific scholars. Exploring ‘embeddedness’ by focussing on interlinkages, this research uncovered the multi-dimensional, socially constructed, politically powered, and inextricably linked nature of human-environmental relationships and reinforced that society, economy and environment should not be considered separate from each other (but usually are) (Nightingale, 2017).

Although the research did not seek to compare the two place-specific studies, analysis suggests that negative unintended outcomes occur in less collaborative, less ecologically productive WCP tuna SES networks (e.g. Fiji tuna fishery SES) while positive unintended outcomes occur in more resilient, ecologically productive, and collaborative WCP tuna SES networks (e.g. Solomon Islands tuna fisheries SES). Both countries have experienced recent political unrest and have similar economies comprised of diverse activities, suggesting that these characteristics are not necessarily the key drivers of unintended outcomes although they most certainly do contribute to them. However, because this study did not seek to compare, more studies would be required to test this hypothesis as it may be that different types of negative unintended outcomes occur across different contexts.

Moreover, this research demonstrates the important contribution that local artisanal fishers can make to decision making regarding issues such as climate change. As explained in Chapter’s 3 and 4, fisher and fishing villages’ knowledge and practices of the SES reveals important information about SES change, perceived climate change, gender equality issues, and how this impacts their livelihoods and resilience to shocks. In this way, fishers unique relationships link them to multiple sites of the SES such that they are uniquely positioned to

fill the SES knowledge gap and provide better informed strategies for adaptation and building resilience across the SES. Similarly, those who are governing must consider capacity issues in gender and climate change within Ministries. For example, a key learning was the difficulties the Ministries, the regional fisheries managers, and industry had with gender equality as a concept and as a policy to implement. As one interviewee noted, although MFMR had a gender focal point to implement the nation's gender mainstreaming strategy and deal with gender issues, that person did not have adequate training nor experience and may speak to wider capacity issues of the organisation or to the tokenistic adoption of mainstreamed policy (Lawless et al., 2020).

Objective 4: To assess the adequacy of current tuna fisheries management regimes in the Pacific and identify opportunities to strengthen governance.

Question 7: To what extent do fisheries management take into consideration unintended outcomes of fisheries development and governance processes?

Question 8: How might governance processes be strengthened to better reflect the whole system?

Objective 4 was achieved in both Chapters 3 and 4 by assessing tuna fisheries management within Fiji and Solomon Islands in relation to gender-based issues and climate change, respectively. Key unintended outcomes of fisheries development identified were assessed against existing fisheries management regimes and presented in Chapter's 3 and 4, answering Question 7. Gaps were identified in governance processes and opportunities to strengthen these were identified.

Question 7 was answered firstly by revealing how tuna fisheries management are currently siloed, simplified due to cultural and political processes (Objective 2). Secondly, place-based studies revealed barriers to consideration of wider SES issues that would therefore fall short of management of unintended outcomes (Objective 3). Gaps in fisheries management to manage gender-based issues and climate change, as this thesis has revealed, leaves government and regional fisheries managers legless in terms of being able to manage unintended outcomes, because it is not within their purview nor in the mandate to do so. There is a need to design new regional governance arrangements to allow the WCPFC to be more nimble or adaptive and integrative as unintended outcomes arise or to avoid them

entirely. Such arrangement could be integrated with scales of governance including international organisations that deal with wider issues (e.g. International Labour Organisation) as well as local level governance (e.g. representatives of fishing villages such as). However, it is important to consider how these are designed in terms of power-relations (who gets access to participation).

Chapters 3 and 4 answer Question 8 by providing strategies for tuna fisheries governance. Multi-scalar and adaptive governance frameworks must navigate the multiple sites of tensions that cannot be navigated at science or management scales. This includes navigating the politicisation of science, the inclusion of indigenous knowledge, gender equality issues, and finding sites to form or leverage upon SES adaptive capacity.

5.3 Limitations of Research

This research faced numerous logistical, cultural, and financial limitations that are discussed above as well as strategies that were used to overcome them. A key learning was the cross-cultural researcher-researched tension that can limit access to fishing villages and information. As described earlier, as a white female New Zealand researcher, I was met with cautious gatekeepers. This has been documented in Teaiwa (2006) who draws on the effects of westernization and colonialism from ‘outsider’ researchers. This emphasized to me the question, do we need indigenous researchers, or do we need to live in a place for a lengthy period before we can carry out research. As noted, there are strategies used in SECO to overcome these barriers, or adaptations that should be taken to ensure better relationships with those the research is intending to approach. In my experience in the Solomon Islands, in terms of marine research, it would be beneficial to work within an already established network of researchers. There are pockets of this already including the research undertaken at WorldFish Research Centre in Gizo; however, there are capacity and funding constraints. For example, a place-based transdisciplinary research institute to allow for individual local and non-local researchers to contribute towards, while achieving their own, research objectives could enable such a network. It would be important to have objectives including sustainable funding sources (through for example blended finance), local staff, and devising ways that would build capacity of local researchers through developing external researcher-local researcher projects. Benefits for the researchers and research could include, for example, the input of multiple perspectives from researchers from different backgrounds (local, indigenous, external, western but also different fields of research including physical and

social sciences, law, economics, etc), to offer unique ideas for solutions for big and complex SES issues (this is also argued in post-normal science for complex issues (Funtowicz & Ravetz, 2009)).

While the research uses two place-specific studies, additional place-specific studies would have added insights to other interlinkages not assessed. Although the use of Fiji and Solomon Islands was interesting, both have diverse economies and are therefore not solely reliant on the tuna fishery. Analysis of countries including Tokelau and Kiribati where tuna fisheries contribute significantly to the nation's economy would be interesting see any similarities or differences in terms of unintended outcomes. Whilst carrying out a region-wide study would provide a 'whole of WCP tuna SES' perspective to enable comparisons, this could also reduce the depth of analysis of the SECO.

Due to COVID-19, I was unable to revisit the villages in Suva and Gizo to share and discuss key learnings of the research and to follow up with further questions the villages may have had, or equally if I had had any. While some of this follow up information was available via scientific reports and Ministry officials, none of this information included the social and cultural information that applying SECO reveals. Summary reports nevertheless were sent to participants via the NGO connections I had made.

In Fiji, there were difficulties in obtaining interviews with the Ministry of Fisheries. This is a major limitation and may impact conclusions as there was a lack of voice on the Ministry's position on gender and fisheries development as well as the lack of verification of statements made by other Fijian interviewees. Furthermore, any projects, policies, and context in development but not available online or known to the other interviewees are also missing from analysis. In contrast, in the Solomons I was able to speak with multiple MFMR representatives and gained vital information on their nearshore-FAD programmes, further people to interview in Gizo, and context around policies. For example, a key insight was the emphasis on how climate change is not a priority issues as they are dealing with so many other confronting issues such as poverty, food security, and disasters.

After the research in Fiji, it was impossible to ignore the role of gender in tuna fisheries in the Solomon Islands, including how gender interacts with climate change.

5.4 Future Research Suggestions

SECO has provided a framework for future transdisciplinary research into understand complex marine social-ecological challenges. This research could be expanded by returning to the villages visited and undertaking additional place-specific studies in PNA and non-PNA countries. Furthermore, an analysis of gender and climate change in the WCP tuna fishery is also warranted to understand how climate change will impact women and men differently in WCP tuna SES and how gender plays a part in this. The SECO platform and the issues revealed could also be mainstreamed into WCP tuna multi-scalar governance as a step towards more holistic governance.

More gender research is urgently required on the WCP tuna SES because women and men continue to experience gender-based violence and discrimination and there seems to be a lack of willingness within state and regional governance to attend to these matters. This includes the need to more thoroughly and systematically explore women's roles in sex work as well as understanding the impacts of the tuna industry on race, age, and gender. Finally, while focus group discussions were done, a next step would be to workshop these findings with regional fisheries managers in the WCPFC to identify ways in which to bring gender and climate change more meaningfully into governance and management decisions so that CMMs are better understood in terms of their ability to perform equitably. This could include workshopping new programmes such as gender and climate change that incorporate social aspects and how these learnings may be incorporated into the development of CMMs.

Appendices



Appendix A: Supplementary Information to Chapter 2

This Supplementary Information is published in Syddall et al. (2021).

1. Overview of the Western and Central Pacific Tuna Fishery

The WCP tuna fishery is diverse, ranging from artisanal fisheries to the large-scale industrial multi-species, multi-gear, transboundary fisheries that constitute 81% of Pacific Ocean tuna catch (Williams & Reid, 2019). Associated ecological, economic, cultural, and political landscape are intricately linked in a complex multi-scalar, social-ecological system (SES) network. This complexity, combined with the uncertainty and dynamic nature of marine ecosystems is acknowledged by many who study, manage and use ecosystems (Clements et al., 2019; Holling, 1973).

The Western and Central Pacific Convention Area (WCP-CA) encapsulates a collection of pelagic ecosystems connecting 41 Pacific Island nation states and distant water fishing nations (which are members of the Western and Central Pacific Fisheries Commission, WCPFC). Tuna are apex pelagic predators, and four species represent the main commercial harvest that inhabit the Western Pacific Warm Pool (a collection of water 10 degrees north and south of the equator with sea surface temperatures greater than 29 degrees Celsius), tropical and subtropical pelagic waters, and archipelagic waters. The fishery within this area is incredibly productive with a provisional estimate catch of 2018 of 2,716,396 metric tonnes consisting mainly of purse seine, longline, and pole and line vessels (Williams & Ruaia, 2020).

The unique relationship of tuna to its oceanic environment (for example its evolution, life-stages, form, function, diet, distribution and movement/migration) underpins the complexity of pelagic social-ecological systems in the Pacific. Dynamic and complex oceanography drive fish and the ecosystems to which they belong (Bell J.D., Johnson J.E., & Hobday A.J.,

2011). Oceanographic circulation patterns at both small and large scales influence a range of properties including: larval dispersal; species migration patterns; water temperature, salinity, nutrient availability, dissolved oxygen concentration and pH affecting biological activity; and oceanic currents, waves and sea level that shape coastal habitats (Bell J.D. et al., 2011). These properties together influence the productivity and location of Pacific tuna fisheries.

Pacific tuna fisheries have provided many economic and social benefits to Pacific Island nation states. The greatest benefits are resource license and access fees (US\$535 million in 2018) and harvesting (more than US\$400 million in 2018) (FFA, 2019). The next greatest benefit is employment provided through tuna industries particularly from tuna processing facilities such as canneries and loining plants (Barclay, 2010). In some countries, employment from tuna fishing industries is the main source of income for communities (Barclay, 2010), although for others, employment is negligible. Overall, the WCP tuna value chains employ 22,500 workers which is less than 0.5% of the total WCP workforce (FFA, 2019). Furthermore, over the last two decades, fisheries governance reforms have paved the way for maximising income from fisheries access agreements, development of locally based industries, and provided opportunities for development in the private sector (Barclay & Cartwright, 2007).

While development of tuna industries through fisheries access agreements have been championed for their contribution to Pacific Island states' economies, they are viewed in many other ways as being economically, politically and socially destructive (Barclay, 2010; Barclay & Cartwright, 2007; Siaoosi, Huang, & Chuang, 2012). Several Pacific Island countries have attempted to develop their own fishing industry with little success (Hanich & Tsamenyi, 2009; Siaoosi et al., 2012). Government subsidies from fishing nations are believed to have caused the significant depletion of resources, increased fishing opportunities and the export of excess resources from the developing to the developed world (Sumaila, Dyck, & Baske, 2014). Moreover, access through investment deals are said to be uneconomical (Barclay & Cartwright, 2007; Hanich & Tsamenyi, 2009). For example, in 2003 it was reported that if access fees were maximised, rather than provided cheaply in return for aid, the full potential for the access fees, the tuna fishery, and more widely, the Pacific's natural and capital resources could be realised (Petersen, 2003).

With relatively new regional and sub-regional governance (WCPFC, FFA, PNA) the WCP tuna fishery is recognised as having nuanced multi-scalar governance arrangements that have

successfully brought about positive sustainable changes to stock abundance (Jollands, 2011; Jollands & Fisher, 2018). The four main tuna stocks; albacore, bigeye, skipjack, and yellowfin, have been assessed as not being subject to overfishing, and not overfished (Juan-Jordá, Murua, Arrizabalaga, Dulvy, & Restrepo, 2018; Miller, Bush, & Van Zwieten, 2014; Parris, 2010; WCPFC, 2018; Williams & Reid, 2018).

The fishery is however replete with challenges across various economic, social, and ecological dimensions. For example, bluefin tuna stocks are designated as endangered (Wakamatsu & Managi, 2019); the southern longline fishery’s economic returns have declined, requiring management intervention (Skirtun, Pilling, Reid, & Hampton, 2019); the Commission has failed to make long-term strategic decisions on complex issues (Abolhassani, 2018); and, the Commission has been unable to design equitable conservation and management measures that do not place a disproportionate burden on SIDs (Azmi, Davis, Hanich, & Vrahnos, 2016). Facing these and other challenges has led to unintended outcomes tied to conservation and management measures on Pacific tuna socio-ecological systems; however, these are not well understood. These include human rights issues, bycatch of vulnerable species such as sharks, coastal resource overuse, illegal, unreported, and unregulated activities. Despite being considered one of the best-managed fisheries in the world, problems are still apparent and come into sharper focus when shifting from a fisheries’ specific to SES perspectives.

2. Political Ecology Arguments Used

Political ecology arguments from Robbins (Robbins et al., 2012) applied are provided in Table 9 and bring together relevant biological, chemical, geological, and physical oceanographic reference data through the multidisciplinary marine sciences field of study.

Table 9. Political ecology key arguments

Topic	Political Ecology Argument
Degradation and marginalisation	Explaining environmental conditions and the reasons for their change. Environmental degradation, long blamed on the poor, is shown in its larger political and economic context.
Conservation and control	Explaining conservation outcomes – usually viewed as benign. Efforts at environmental conservation are shown to have pernicious effects, and sometimes fail as a result.
Environmental conflict and exclusion	Explains access to the environment and conflicts over exclusion from it. Environmental conflicts are shown to be part of larger gendered, classed and race-based struggles (and vice versa).

Topic	Political Ecology Argument
Environmental subjects and identity	Identities of people and social groups. Political identities and social struggles are shown to be linked to basic issues of livelihood and environmental activity.
Political objects and actors	Socio-political conditions. Political and economic systems are shown to be underpinned and affected by the non-human actors with which they are intertwined.

Adapted from Robbins (2012)

3. Research Methods and Ethics

Table 10. Research Methods

SECO Step	Method	Location	Month/Year	Method details
Step 2	Observations	Bali, Indonesia	December 2015	Attended Twelfth Regular Session of the WCPFC as an observer
	Interviews	Online	April 2018	18 in-depth semi-structured interviews (45 min – 1.5 hour)
Step 3	Interviews and observations	Suva, Fiji	May 2019	15 in-depth semi-structured interviews (45 min – 1.5 hour) Participant observer and field visit observation (including visits to processing factories, local fish markets, ports, and other supply chain sites)
	Focus group discussions	Waiqanake village and Kalekana village, in the province of Rewa and adjacent to Suva	May 2019	1-2 hour semi-structured focus group discussions with 6 women in Kalekana Village and a family in Waiqanake Village.
	Interviews and observations	Solomon Islands in Honiara, Guadalcanal and Gizo, Western Province	December 2019	13 in-depth semi-structured interviews (45 min – 1.5 hour) Participant observer and field visit observation (including visits to processing factories, local fish markets, ports, and other supply chain sites)
	Focus group discussions	Titiana village, Gizo Island and Mbabanga village, Mbabanga Island	December 2019	1-2 hour semi-structured focus group discussions (17 fishers and marketers participated from Titiana village, Gizo; 9 fishers and marketers participated from Mbabanga village, Gizo)

The research ethics approach followed that approved by The University of Auckland Human Participants Ethics Committee. Interviewees and focus group participants gave written consent and were provided Participant Information Sheets in advance of interviews or focus groups. A research permit was also obtained through the Solomon Islands Government Ministry of Education and Human Resources Development in accordance with the *Research*

Act 1982 (no.9 of 1982). Participants were provided the option to participate, to be anonymous, and to withdraw information once completed. Each participant consented to either a one-hour interview or three-hour focus group, to information being stored for six years, to allow (or not) discussions in interviews being recorded, to edit transcriptions, and to not disclose information discussed during discussions. A summary document was provided to participants that wished to receive a summary, and all were able to provide comment within one month of its receipt.

4. Place-based Study Characteristics

Table 11. Characteristics of place-based studies

	Fiji	Solomon Islands
Location and EEZ	South-central Pacific ~800 islands and islets. EEZ is 1.29 million km ² .	South-western Pacific ~1,000 islands. EEZ is 1,589,477 km ² .
Marine environment	Complex geology (depths ranging from intertidal reefs to 4,500). Variety of marine habitats including of coral reefs, mangrove forests, seagrass beds.	Marine environment makes up over 98% in the south-western Pacific Ocean ⁷ and one of the most biodiverse areas in the world with nearly 500 species of coral and over 1,000 species of reef fish ⁸ . Large range of ocean depths of shallow coastal marine habitats to up to 7,500 m providing a wide range of marine habitats ^{7,8} including mangroves, seagrasses, coral reefs, and seamounts.
Population	880,000 in 2017 inhabiting just over 100 islands, mostly (about three-quarters) located in Suva, Nadi, and Lautoka ¹ .	Over 600,000 with around 19% residing in urban areas and the remainder in rural areas ⁹ .
Tuna Fishery Development	Established in the 1970s. Mid-2000's the Fijian Government developed infrastructure and logistics networks that supported Suva as a hub for tuna vessels in the region ² .	Established in the 1970s. Locally based Solomon-Taiyo (joint-venture) had a pole-and-line fleet that targeted skipjack and a processing plant, both of which employed Solomon Islanders from the outset.
Large-scale fishery (as at 2019)	National longline fleet (93 vessels including 7 charter vessels ³).	National fleet, National Fisheries Development (NFD), (68 vessels - 11 domestic purse seiners, 53 chartered longliners, and 4 pole-and-line vessels) and foreign fleet (226 vessels - 119 purse seine vessels, 37 longliners, 1 pole-and-line, 13 bunker vessels, 56 carriers) ¹⁰ .
Small-scale fishery	Spearfishing, trolling, longlining, and handline fishing on anchored FADs ⁴ .	Handline, longline, trolling and trawl fishery throughout the country fishing on FADs and non-FAD fishing areas ¹⁰ .
Tuna and tuna-like species catch and markets (2019)	15,188 metric tonnes ³ of albacore and yellowfin for the sashimi and canning markets. In Levuka, on Ovalau Island, the PAFCO factory produces canned tuna for the local market, and cooked and frozen loins for canneries in the US. In Suva, several processors can tuna for local and export markets, provide cannery raw material to Thailand, American Samoa, Taiwan and Vietnam, and sashimi to Japan. Tuna (fresh, frozen, canned) as well as bycatch and reject fish are also sold or cooked and sold	110,968 metric tonnes ¹⁰ ; export markets include loined skipjack, yellowfin, and albacore for canning in European markets. Also, a small amount of fresh longline yellowfin and bigeye is exported to sashimi markets. Tuna (fresh, frozen, canned) as well as bycatch and reject fish are also sold or cooked and sold domestically to local markets, larger supermarket chains, restaurants, and the hospitality sector. Some tuna is bought off boats in Honiara port by locals who barter using vegetables, cigarettes and other means to gain access

	Fiji	Solomon Islands
	domestically to local markets, larger supermarket chains, restaurants, and the hospitality sector.	to the freshly caught fish and are either on sold in the local market or provided to the village.
Value (average 2016-2018)	USD 48 million ⁵	USD 306 million ⁵
Employment (average 2016-2018)	4,212 jobs ⁶	3,009 jobs ⁶
Villages Visited	Waiqanake Village, approximately 20 kilometres west of Suva, forms part of the <i>Vanua</i> Navakavu of which approximately 900 people reside (Marine and Coastal Biodiversity Management in Pacific Islands Countries, 2017). Kalekana Village is on the outskirts of Suva in Lami Town and has approximately 50-70 families in the village (Orcherton, 2016).	Gilbertese villages, Mbabanga and Titiana located in Gizo, Western Province. They are relocated villages from Phoenix Islands from the late 1950's during the British colonial times ¹¹

¹ (Fiji Bureau of Statistics, 2018)

² (Barclay & Cartwright, 2007a)

³ (Ministry of Fisheries Fiji, 2020)

⁴ (Gillet, 2018).

⁵ (FFA, 2019)

⁶ (Pacific Islands Forum Fisheries Agency, 2019)

⁷ (Gillet, 2018; Jupiter et al., 2019)

⁸ (Green et al., 2006)

⁹ (Solomon Islands National Statistics Office, 2015).

¹⁰ (Ministry of Fisheries and Marine Resources Solomon Islands, 2020)

¹¹ (Albert, Beare, et al., 2014).

Appendix B: Interview and Focus Group Guides

The following provides interview and focus group guides used in the place-specific case studies. As noted, the sample frame was identified using snowballing techniques starting with existing contacts to identify those relevant to gender and climate change to:

- Clarify issues identified during the first round of interviews to characterise the SES,
- Deepen initial understandings about gender and climate change, and
- Reveal any stories that aligned with the PE arguments from Robbins (2012).

A few points on the snowballing approach used is warranted:

- The number of research participants was not pre-determined and recruitment was designed to be flexible in the absence of pre-existing knowledge of likely participants/population of the study area. It wasn't until the research had come to a point where a) there were no more available / willing participants left to interview, and b) stories were starting to be repeated amongst participants and no new information was being gained.
- The iterative approach to the study allowed for new participants to be gradually included in interviews if identified as being relevant to the study – e.g. the nature of the fishery and its regional network meant interviews included people outside Fiji connected to the women in fisheries network through training or consultancy on gender issues.
- Although snowballing is considered a non-biased approach, managing bias in qualitative research using non-random sampling procedure can be subjective. To ensure balance of representation I made sure that representatives within the supply chain / SES were approached.

1. Interview Guides

Interviews held in Fiji and Solomon Islands were semi-structured and open ended.

Interviewees were provided with questions prior to interviews scheduled so they could prepare. These questions acted as a guide and were not necessarily asked in the same order as they appeared on the document provided. This allowed the interview to progress in a more fluid and conversational manner. Interviews were held in places of the participant's choosing

and involved being at, for example, their workplace in meeting rooms or their own office, at cafés, or at the hotel lobby I was staying at.

The following prompts were used to develop questions for the guide:

- Questions were broad enough to leave no stone unturned. Each relevant story/event/action was discussed in more specific detail.
- Questions were structured using scale and characteristics of the SES (e.g. touching on policy/governance local to regional, tuna ecosystem and social/cultural/economic interactions from subsistence to industrial levels).

Interviewee participants in Fiji were asked questions about:

- Their role and background to gain a sense of their involvement in the tuna industry and to ease participants into the interview. This also helped to identify any connections / similarities upon which I could build rapport.
- Their life to gain a sense of their family and work life, educational status, country of origin, and places they had lived.
- Tuna and women:
 - Interviewees were asked to identify what roles women play in tuna fisheries and to expand on any relevant topics e.g. links between nodes of the supply chain, women's movements or demonstrations.
 - How they thought the tuna fishery had impacted women.
 - How they thought current local and regional policies and practices took into consideration gender issues in tuna fisheries. Interviewees were asked to discuss challenges. Interviewees were then asked to discuss challenges for incorporating a gender focus into policy.
 - Interviewees were asked to provide any knowledge and experience they had with gender mainstreaming in the fisheries sector and its governance.
 - Interviewees were also asked to provide an example of where a conservation or management measure had impacted women and to discuss how it impacted women.
 - Interviewees were asked to discuss the impact of tuna fisheries on local artisanal fisheries.

- A final discussion point was to provide interviewees the chance to discuss any points they thought relevant to the research.

Interview questions for participants in Solomon Islands included the following discussion points:

- The fishery, the ecosystem upon which tuna depend, and fisheries management:
 - Describing their ecosystem, tuna ecosystems within Solomon Islands (the term ecosystems was generally understood by interview participants).
 - Describing the fishery, including targeted and non-targeted species, and obtaining most up to date statistics if relevant.
 - Discussions around information used to manage the fishery (both ecologic, fisheries, social, and economic).
 - Discussions about how the fishery and the ecosystem it depends on is managed.
 - Discussing challenges faced to achieve sustainable development of the fishery (including discussing trade-offs between the economy and well-being).
- Their perceptions of environmental change:
 - Observed changes in their coastal and marine environment, if so, why. (e.g. overfishing and why they think it is occurring).
 - Observed changes in the fishery, what kind of changes (catch volumes, areas fished, gear types used, markets, countries / domestic, inshore / offshore).
 - What do they believe the change is attributed to?
- Climate change and fisheries:
 - General questions about climate change and the Solomon Islands.
 - Available research, monitoring, or reports on climate change.
 - Mitigation / adaptation strategies.
 - Hypothetical scenario posed: if tuna was not there anymore or had a 50% reduction: discussion could include: implications to fishing practices, target species; adaptation strategies required; cultural, environmental, or regulatory barriers to fishing different species.
- Economy, social / cultural and governance aspects of the tuna fishery.
 - Discuss changes and their impacts and subsequent responses (informal and formal through governance strategies or policies).
 - Challenges, tensions, opportunities and benefits of changes.

All interviewees were thanked for their time and any follow up questions were emailed through.

Table 12 provides an example of what data interviewees contributed to the research and to answering the overall research questions.

Table 12. Example of the contribution of interviews to answering research questions

Role/Representation	Purpose	Attribution
NGO	Village access, policy, local knowledge of village life/culture and fishery, referrals	Roles of women in tuna fisheries Social and cultural issues/barriers, incl. gender-based issues within villages and tuna fisheries History and development of tuna industry and policy Wide networks within fishery, policy, and villages Tuna FAD fishing and gender training
Academic	Training	Fisheries and maritime training Tuna regional fisheries policy (esp. EBM) Gender policy mainstreaming
Tuna fisher	Industry experiences	Stories of forced labour, GBV, flow on impacts
Independent consultants	Fisheries expert	Gender training the in the fisheries industry Gender issues on-board vessels Wide networks Policy development Livelihood impacts from the industry
Industry	Industry perspective	Provided gender dis-aggregated data Background info of operating in Policy and development changes Gender and social issues
Recreational fisher	Rec fisher perspective	Sustainability concerns, concerns towards industry.
Policy – WCPFC	Policy and management	Experiences working in policy as a woman in the tuna fishery. Regional tuna fisheries policy and operationalisation at national level.
Subsistence marketing	Suva markets	Observing women and men selling fish at Suva markets
Village women	Village scale	Village life and roles they play Women’s experience of family member working in tuna fishery. Referral to focus group women
Village women	Women who had lost family members to tuna fishing	Women’s experience of family member working in tuna fishery

2. Focus Group Guides

The following provides a guide to structure focus groups.

Those who attended included:

- NGO representatives who acted as gatekeepers, provided access to villages, and assisted as language and cultural interpreters.
- Village leaders and priests (in the case of Gizo, Solomon Islands).

- In Solomon Islands: Fishers, their wives (who could also be fishers), and their children.
- In Fiji: Women who had stories to tell about their husbands, sons, or brothers being impacted by the tuna fishery.
- The researcher.

The following prompts were used to develop questions:

- Questions were broad enough to leave no stone unturned. Each relevant story/event/action was discussed in more specific detail.
- Questions were structured using scale and characteristics of the SES (e.g. touching on policy/governance local to regional, tuna ecosystem and social/cultural/economic interactions from subsistence to industrial levels).

In the Solomon Islands, the focus groups were opened with a prayer. In Fiji, the meeting was opened by the NGO representative who thanked participants for coming, introduced the researcher and the research. They explained the aims and focus of the research and focus group and how the focus group's discussion was to be used.

The researcher elaborated on these points and the NGO representative translated this and further described what an ecosystem was, what climate change was, and any other terms used in the research that villagers may have known but not necessarily have been familiar with the terms in English.

Focus group participants were then invited to share their stories about how they were connected to the tuna fishery (this helped to cleanse or to get on the same page).

For the focus group in Fiji, each woman in the room shared (in no certain order):

- Who they were, where they were from, where they lived, their occupation.
- How the tuna fishery had impacted them, including stories of their family member's experience of injuries/illness/murder on board tuna fishing vessels.
- Their connection to tuna (besides through their family members) e.g. eating, fishing, and to the wider marine environment – their qoliqoli.
- Messages to government / decision makers of tuna fisheries.

The focus group then were asked to imagine their role / connection in the tuna fishery, and this was drawn on a large white A2 paper. This started with a picture of the tuna fish, fishing

vessels and crew, SSF (spearfishers, FAD fishing), markets and distribution, fishing villages linked through supply of crew and tuna received for food. This drawing did not become part of the results explicitly but was developed further to become Figure 6 in Chapter 3. This was a useful task to do because it confirmed their roles in the tuna fishery.

For the focus groups in Gizo, participants were asked to share (in no certain order):

- What they valued their marine environment for – e.g food and income.
- Other villages in the area and their types of fishing e.g. nusu baruku (sweepers – coastal reef night divers).
- Historical events that have significance to the village (e.g. relocation from Kiribati to Gizo; tsunamis).
- External assistance and the need for it – money, technology (e.g. GPS, refrigeration).
- Fishing techniques and practices including discussion on the use of FAD's and their importance, the FAD programme.
- Changes to the marine environment over time.
- Women's and men's roles – fishing and village roles (this was added after having done gender in Fiji).
- Marketing practices.
- Management – informal and formal.
- Challenges to fishing, marketing, environmental changes.
- Social issues.

The focus group was then provided with questionnaires that were discussed as a group. These helped to ensure no stone was left unturned and to cover further the management and SES points that were briefly discussed above. Topics included:

- Connection and culture: fishing practices (including navigation, reading the weather); transfer of knowledge.
- Formal and informal management: NGO and government assistance – awareness and training of FAD programme and markets (price setting); sharing the market and thus days fishing; fishing rules (e.g. catch what you keep).
- SES changes: fish abundance and diversity; seasonality; adaptation.

Focus group discussions in Gizo were closed with prayers. All participants were thanked for their time and follow up information / summary of learnings were forwarded via emails to the NGO representatives.

Appendix C: Interview and Focus Group Reference List

Step (2=Characterisation; 3=Place-specific study - (a)Fiji(b)Solomon Islands)	Interview (I)/ Focus Group (FG)	Role	Location of interview	Organisation
2	I	Chief Scientist	Online	SPC
2	I	Director	Online	SPC
2	I	Senior Fisheries Scientist	Online	SPC
2	I	Senior Fisheries Program Officer	Online	WWF
2	I	Director of Fisheries Management	Online	FFA
2	I	Scientist and independent consultant	Online	Independent consultant
2	I	Former Deputy Director-General FFA	Online	Independent consultant
2	I	Former Chief Scientist at SPC	Online	Independent consultant
2	I	Chair (Former Deputy Director FFA)	Online	Independent consultant
2	I	Researcher and independent consultant	Online	Independent consultant
2	I	PNA Chairman	Online	PNA / Nauru
2	I	Chief Operating Officer	Online	TriMarine
2	I	Senior Director Tuna Fisheries	Online	Conservation International
2	I	Scientist and researcher	Online	Retired
3a	I	Secretary, Head of Ministry	Online	Ministry of Marine Resources, Cook Islands
3a	I	Fisher and crew	Village - Waiqanake	ex crew longline industry, Fiji
3a	I	Academic researcher	USP	Lecturer, University of South Pacific (USP)
3a	I	Fisheries consultant	Café - Auckland, NZ	Fisheries consultant, New Zealand
3a	I	Lecturer at USP and member of WIF	USP	USP and Women in Fisheries Network-Fiji
3a	I	Group Business Manager	Fiji Fish	The Fiji Fish Marketing Group Limited
3a	I	Fisher	Suva Yacht Club	Recreational fisherman
3a	I	Chair (ex Chair to WCPFC)	Online	National Nuclear Commission, Marshall Islands
3a	I	General Manager	Golden Ocean	Golden Ocean Fish Limited

3a	I	Independent consultant; researcher and member of WIF	Café - Fiji	Women in Fisheries Network-Fiji
3a	I	Principal Consultant and member of WIF	Café - Fiji	Women in Fisheries Network-Fiji
3a	I	Coordinator	Office, Suva, Fiji	Local Marine Areas Network
3a	I	Independent consultant	Café - Fiji	Independent Consultant
3a	I	Compliance Manager	Online	WCPFC
3a	I	Senior Program Manager	Office, Suva, Fiji	Conservation International
3a	I	Local wife of tuna longline crew	Office, Suva, Fiji	Wailekutu Road, Kalekana Village
3a	I	Local wife of tuna longline crew	Wailekutu Road, Kalekana Village	Wailekutu Road, Kalekana Village
3a	I	Mayor	Online	Marshall Islands
3a	I	Industry	Phone	Solander
3a	FG	Local wives, mothers, sisters of tuna longline crew	Wailekutu Road, Kalekana Village	Wailekutu Road, Kalekana Village
3b	I	Fisheries Officer	Office, Honiara, SI	MFMR
3b	I	Programme Specialist	Office, Honiara, SI	World Vision
3b	I	Livelihood sector portfolio manager	Office, Honiara, SI	World Vision
3b	I	Deputy Director, Inshore Fisheries Division	Café, Honiara, SI	MFMR
3b	I	Scientist	Online	SPC
3b	I	Fisheries Officer	Office, Honiara, SI	MFMR
3b	I	First Secretary (Development)	Office, Honiara, SI	NZ High Commission
3b	I	Fisheries Officer	Office, Honiara, SI	MFMR
3b	I	Fisheries Officer	Office, Honiara, SI	MFMR
3b	I	Economic Development Policy Advisor	Office, Honiara, SI	FFA
3b	I	Independent Consultant	Online	Independent Consultant
3b	I	Manager	Office, Honiara, SI	Maritime Safety
3b	I	Fisheries Officer	Hotel Lobby	MFMR
3b	FG	Fishers, villager	Mbabanga Village	Mbabanga Village
3b	FG	Fishers, villager	Titiana Village	Titiana Village

Appendix D: Supplementary Information to Chapter 4

This Supplementary Information is published in (Syddall et al., 2022).

3. Cultural Context Focus

“The ocean in us” emotively written by Epeli Hau’ofa (1998), advocates for unity through regional solidarity along with scholars such as Teresia Teaiwa (2006). However, they assert, unity is not to do away with diversity or lead to homogeneity of cultures, language, economies, and political status. In the context of fisheries, this ‘regional’ discourse has shaped Pacific governance institutions and the policies created to accumulate power within for the sustainable governance of their fisheries. Pacific Island countries have shared histories in colonisations, economic development, isolation, aid profiles and relations to donor countries and institutions, and environmental disasters which have also contributed to regionalism (Farran & Smith, 2021). Strengths of values and principles including faith, capacity, collaboration and community are also revealed in studies of the Pacific, for example, in recent research examining acceptance of draconian measures in responding to the COVID-19 pandemic (Farran & Smith, 2021).

4. Example of Scale in WCP tuna fishery

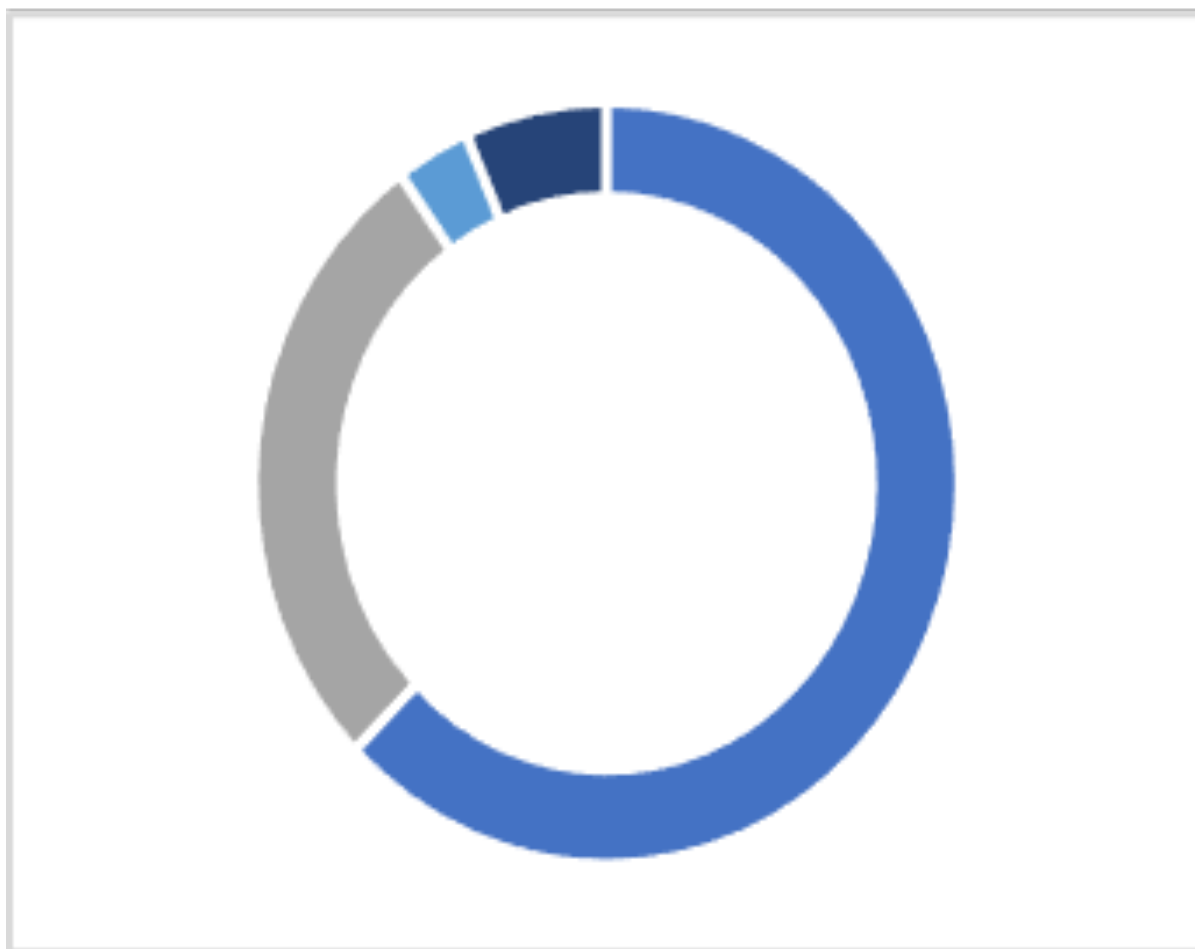


Figure 10. Schematic illustration of scales and levels of a tuna FAD fishery in the WCP (adapted from Cash et al (2006))

5. Western and Central Pacific Ocean Climate Variability due to ENSO

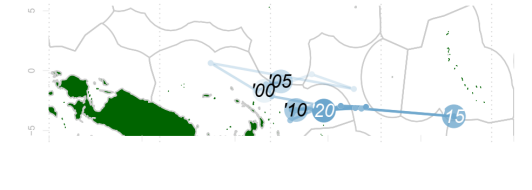
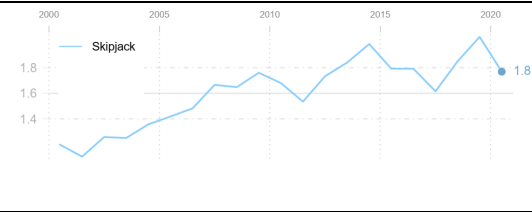
Climate variability includes changes to a convergence zone location where the warm pool butts up to the Pacific Equatorial Divergence Province (cold tongue) and moves according to ENSO across the WCP, changing abundance and distribution of tuna in Pacific island countries' EEZs (Table 13). During an El Niño, the westerly trade winds weaken, the thermocline shallows, the western Pacific warm pool expands eastward therefore the WCP experiences warmer waters, and the tuna move eastward toward more the central and east Pacific (Lehodey et al., 1997). During La Niña, tuna populations are found more in the western Pacific.

Transshipment example of variability impacting economic and social factors:

Interviewees from MFMR, New Zealand High Commission, FFA, and fishers from Gizo noted that, the tuna had not “come back” for the beginning of the season in December 2019. Moreover, interviewees reported an inability for Solomon Islands to sell all their vessel days resulting in lost revenue. A compliance officer interviewed from the MFMR also noted that, at the start of the season, the port at Honiara was usually busy with many fishing vessels for inspection (approximately ten boats per day between November and January); however, in December there was only one vessel present (a South Seas Investment vessel at Point Cruz, Honiara). They highlighted that the number of purse seine vessels entering Honiara’s port in the Second Quarter Report for Fish Accountancy 2019 was considerably lower than expected (five purse seine vessels in the three months ended 30 June 2019). The MFMR compliance officer also attributed this to climate change. During 2019, catch value within Solomon Islands’ EEZ was US\$306 million (FFA, 2019). Seventy percent of this is contributed from licenses issued to overseas vessels (Ministry of Fisheries and Marine Resources, 2018). During 2012-2016, transshipment was the lowest in 2015 and 2016 during an el Niño event.

Table 13. Indicators of climate change: Climate indices, warm-pool indices, target species catch and distribution for skipjack tuna (excerpt taken with permission from SPC-OFP (2021))

Indicator	Description	Notes	Time-series
Oceanic Niño (ONI) and Interdecadal Pacific Oscillation (IPO) Index	<p>ONI indicates SST anomalies in the Niño 3.4 region during Nov-Jan each year</p> <p>IPO represents long-term oscillation between El Niño favourable and La Niña favourable phases</p>	<ul style="list-style-type: none"> ▪ ONI values > 0.5 indicative of El Niño events, values < -0.5 indicative of La Niña ▪ IPO values > 0 indicative of more El Niño events, < 0 indicative of more La Niña events ▪ Long-term IPO changes only calculable to 2016 	
Mean Size of Warm-pool	<p>Approximate size of warm-pool in millions of km²</p>	<ul style="list-style-type: none"> ▪ Derived from ocean models ▪ Warm-pool defined by mean Nov-Apr temperature > 29°C 	

Centre of Purse Seine Catch	Annual centre of gravity for associated purse seine catch of Skipjack tuna, with every fifth year highlighted with a point (2000-2020)																																														
Annual Tuna Catch	Total Skipjack catch for entire WCPFC-CA, in millions of tonnes	<ul style="list-style-type: none"> ▪ Data from all fishing gears combined ▪ See Hare et al. (2021) [SC17-SA-IP-15] for a compilation of all fishery indicators for skipjack 	 <table border="1"> <caption>Approximate Annual Skipjack Catch (Millions of Tonnes)</caption> <thead> <tr> <th>Year</th> <th>Catch (Millions of Tonnes)</th> </tr> </thead> <tbody> <tr><td>2000</td><td>1.35</td></tr> <tr><td>2001</td><td>1.38</td></tr> <tr><td>2002</td><td>1.40</td></tr> <tr><td>2003</td><td>1.42</td></tr> <tr><td>2004</td><td>1.45</td></tr> <tr><td>2005</td><td>1.48</td></tr> <tr><td>2006</td><td>1.50</td></tr> <tr><td>2007</td><td>1.52</td></tr> <tr><td>2008</td><td>1.55</td></tr> <tr><td>2009</td><td>1.58</td></tr> <tr><td>2010</td><td>1.55</td></tr> <tr><td>2011</td><td>1.50</td></tr> <tr><td>2012</td><td>1.55</td></tr> <tr><td>2013</td><td>1.60</td></tr> <tr><td>2014</td><td>1.65</td></tr> <tr><td>2015</td><td>1.60</td></tr> <tr><td>2016</td><td>1.55</td></tr> <tr><td>2017</td><td>1.50</td></tr> <tr><td>2018</td><td>1.55</td></tr> <tr><td>2019</td><td>1.65</td></tr> <tr><td>2020</td><td>1.80</td></tr> </tbody> </table>	Year	Catch (Millions of Tonnes)	2000	1.35	2001	1.38	2002	1.40	2003	1.42	2004	1.45	2005	1.48	2006	1.50	2007	1.52	2008	1.55	2009	1.58	2010	1.55	2011	1.50	2012	1.55	2013	1.60	2014	1.65	2015	1.60	2016	1.55	2017	1.50	2018	1.55	2019	1.65	2020	1.80
Year	Catch (Millions of Tonnes)																																														
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6. Background to PNA’s VDS and Sub-Regional Pooling Mechanisms

Established in 2007, the VDS seeks “to support collaboration between Parties to enable them to maximize their net economic returns from the sustainable use of tuna resources by purse seine vessels” (PNA 2016). Through the VDS, PNA members seek to constrain and reduce targeted tuna catches to implement the WCPFC’s Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the WCP (CMM2018-01) (Hanich et al., 2010). Since 2010, purse seine catches within PNA waters have fluctuated around 1.5 million tonnes while purse seine catches outside these waters but within the WCP come around 400-450,000 tonnes (PNA, 2020). In 2019, total allowable effort under the VDS was agreed upon at 45,033 days for the PNA + Tokelau. This followed scientific advice that notes catches should not be increased if the target reference point is to be met (PNA, 2020). Since the inception of VDS, member’s revenues have skyrocketed, delivering better and more equitable returns for their fishery. For example, in Solomon Islands, access fees have more than doubled to USD 42 million in 2019 (USD 18.3 million in 2008; (FFA, 2017, 2019)).

PNA’s sub-regional pooling arrangement, established in 2016, was described by the Chair of PNA’s sub-regional pooling as incredibly successful in generating higher revenues for a sub-group of the smaller PNA member countries (Parties to the Nauru Agreement Office, 2021)). The Chair listed the members to this sub-regional pooling arrangement to include five of the nine eligible PNA countries to participate including Solomon Islands, Nauru, Tokelau, Tuvalu, Marshall Islands (and in 2021 Palau will also join) (see Table 2 below). The Chair described, each year, members meet to agree on the terms and conditions including how many days they will contribute and the minimum benchmark price for the following year. A

tender is then distributed to all owners of purse seine vessels registered on the PNA registry of PNA members then determine which ones to accept. The Chair noted that the pool has been generally made up of about 300 days from each country (maximum of 500 days) and bids range from 25-30% higher than a bilateral day and has been “enormously successful”. For example, in 2019 Tokelau averaged US \$9,500 for a bilateral day, but through the pool, they earned US \$12,600. Industry pays the extra premium for these days because of the flexibility the arrangement provides in that they can choose to fish in any of the five (soon to be six) EEZs, therefore they can follow the fish (Chair of sub-regional pooling, also Tokelau’s fisheries advisor; (Hanich et al., 2021)). For example, during El Niño purchasers would be expected to fish in Tokelau and during La Niña, they would fish in Nauru and Solomon Islands. These countries are the smaller of the PNA countries. The remaining PNA members including PNG, FSM, Kiribati which have relatively large EEZs’ with different development strategies that they could get just as much value in other ways.

Table 14. PNA member states catch and value av. 2016-2018 in ascending order

<i>PNA Member (sub-pooling member bolded)</i>	<i>Catch EEZ (t)¹</i>	<i>Value EEZ (US\$m)¹</i>
Palau	12	58
Tokelau	27	51
Marshall Islands	53	111
Tuvalu	90	165
Nauru	125	208
Solomon Islands	142	306
Federated States of Micronesia	229	421
Papua New Guinea	368	675
Kiribati	400	702

1 data from FFA (2019)

7. Small-scale fishery SES changes example in Gizo

During focus group discussions, fishers from Mbabanga and Titiana villages in Gizo shared their knowledge of the ecosystem, how it has changed, and how these changes impact their fishing. A fisher mentioned how 10-20 years ago, they did not have to use FADs, which are now a major source of daily tuna catch, because there were many tunas schooling in open water. No studies exist to confirm the perceived changes described by fishers interviewed in Gizo from 10-20 years ago. However, in a more recent study exploring the contribution of FAD fishing to food security and livelihoods in Gizo, Solomon Islands, fishers reported spending an average 5.1 hours fishing per day (n=8 fishers, 6 month study; (Albert, Beare, et al., 2014)). In this study, interviews with fishers in 2019 corroborates the data presented in Albert et al. (2014) by not being markedly different but there may be a suggestion of a reduced CPUE (6 hours per day and 5.75 kg fisher hour⁻¹ in 2019 versus 13.5 kg fisher hour⁻¹ in 2014; n=14). Caution should be taken when examining these results as, while the studies compare the same villages across years, this study used one off interviews and discussion groups to obtain data, compared with the Albert et al. (2014) quantitative study, which undertook the study over six months.

8. Background to MFMR's near-shore FAD programme

In 2009, MFMR's nearshore FAD programme was developed through a New Zealand Mekem Strong Solomon Island Fisheries (MSSIF) programme funded initiative to be implemented by WorldFish in partnership with MFMR to "develop a Solomon Island National Inshore FAD Programme". As part of this programme, FADs were deployed in Gizo in 2009 and later rolled out across the country in 2014 (Albert et al., 2015). In 2011-2012 21 FADs were deployed at 13 locations across Solomon Islands, now there are over 100 nearshore FADs accessible from several constituencies (including communities discussed with participants in Tiaro in Western Guadalcanal, Langalanga Lagoon in Malaita Province, and those visited in Titiana and Mbabanga, Gizo) (FAD-programme manager, 2019).

Successes of FAD-fishing reported by interviewees in Gizo and MFMR, Fisheries Officers, and FAD-programme managers included increased access to fish sources where otherwise the reef had been overfished, increased catch-per-unit-effort (CPUE), better time management, and a source of revenue for the household and village. Gilbertese fishers interviewed described how beneficial it has been to their fishing as they have seen free schools have diminished due to perceived overfishing and climate change. One fisher from Titiana village

reported on adapting to these changes in abundance through adopting different fishing methods from fishing on free-school tuna 1-2 kms, which now they must paddle up to 10 km offshore to access these. A leader of the Mbabanga village described how fishing techniques have changed over the day by trolling early morning for “big yellowfin” then swapping to fishing on FADs using trolling, then using the stones to sink ~ 400 yards with the coconut leaf to catch the yellowfin that dive at daybreak. The near-shore FAD programme also developed cross-scale networks, alongside other marine programmes such as developing community-based management plans, which can be useful for building social resilience at the local level.

Key challenges of the FAD programme were reported by fishers and programme managers to include sabotage and vandalism (Albert, Beare, et al., 2014; Bell, Albert, et al., 2018; Bell, Albert, et al., 2015; Campbell et al., 2016). Reasons given included misinformation on FADs in some villages and teaching approaches of new fishing techniques across varied cultural fisheries practices in the different villages. Reports were given by MFMR representatives of villages, and nearby villages who did not have the access to FADs, who would cut FADs off because they believed that the neighbouring FAD was taking pelagic fish away from their fishing grounds. Villagers were also reported to cut them off for political reasons, as one key MFMR representative explained, for example, if they did not support the Minister or member of parliament who deployed the FAD. The FAD programme coordinator highlighted that over 50% of the FADs deployed have been either sabotaged or vandalised. In the Solomon Islands case example, an outreach programme has been used since 2014 to educate village fishers on the use of FADs for fishing. Alongside this, MFMR have adapted FADs to deploy submerged or sub-surface FADs (approximately 20 m below the surface) to avoid these issues. As highlighted by the programme coordinator, incidentally, being submerged also makes them more resistant to cyclones, a hazard that will increase with climate change. Other challenges included the need to adapt the FAD programme according to village, for example, when teaching fishers new fishing techniques different strategies were required. This is because there are multiple cultural groups in Solomon Islands, with different applied marine management approaches, as well as the different fishing practices and techniques applied on different fishing grounds, and so a one size doesn't fit all (Cohen et al., 2015; Hviding & Baines, 1994; Lauer & Aswani, 2009). For other fishers, fishing on FADs is not that new. The villages in Gizo, Mbabanga and Titiana, have been fishing for tuna using FADs since the 1980s when NFD established their FAD fishery. Originally from the Gilbertese Islands, but

relocated to Gizo during the 1950s, fishers in Titiana and Mbabanga paddled for hours to reach a free school of tuna many kilometres offshore past the reef in dugout canoes made from local hard wood trees. Fishers, however, noted they had to get used to FADs, using the NFD FAD initially then later the nearshore FADs deployed as part of the post-tsunami (in 2007) work (Prange et al., 2009). Gilbertese fishers reported that they would fish on the FAD then cut the float. The Mbabanga fishermen explained that it took a year until fishers realised that if you don't cut the FAD, there will be fish tomorrow.

Appendix E: Summary of Coding and Analysis

The following provides a summary for how data were coded in the characterisation phase, how the data were then summarised, and how the matrix was used to examine state, interlinkages, and changes of the SES (Holzer et al., 2018) against drivers of the SES identified in characterisation. The Fiji place-specific study is used to show this as an example.

1. Coding Interviews

Coding involved several steps each set of interviews in Step 2 and 3 (as outlined in Chapter 2):

- Coding the first set of interviews in Step 2 (characterising the system – Table 15)
- Recoding these from grouping of questions to groupings of a set of themes (Table 16)
- ReCoding into the matrix (Table 18) using the themes / typologies into 1) describing the SES state (GBV stories); 2) interlinkages between parts of the SES (economic and fisheries); or, 3) the changes of the system e.g. political reforms (Table 17).

Table 15. Example of coding SES characterisation interviews

QUESTIONS	DESCRIPTION	CODE	QUOTES / COMMENT
Defining ecosystem	Different ways of defining ecosystem	E (Ecosystem) KP (Key players) PFF (Processes, Functions, Feedbacks) WPWP (Western Pacific Warm Pool) LME (Large Marine Ecosystem) U (Uses)	Complex Multi-scaled Stock structure Includes humans Context and scale specific Biogeophysical Labour mobility Benefits e.g. economy, remittances

Managing ecosystem	EAFM vs EBM Governance processes	EAFM (Ecosystem Approach to Fisheries Management) Ecosystem-based Management SES (Social-ecological system approach) T (threats) C (challenges)	Politics Science-Management interface Regionalism vs nationalism Climate change Plastics Overfishing Ocean acidification Aid / Trade Uncertainty / Precautionary / Enforceability
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Coded Step One interviews were further coded into five sets of themes or ideas and renamed as “SES interlinkage typologies” (Table 16). Table 16 shows how these SES interlinkage typologies acted as drivers of the WCP SES and how these are explained using the political ecology lens.

Table 16. SES interlinkage typologies

SES INTERLINKAGE TYPOLOGY	CHARACTERISTIC	POLITICAL ECOLOGY ISSUES EXAMPLE
Energy	Key driver of: Oceans ecosystems (e.g. food chains) Supply chain (e.g. fuel, labour, transportation, consumers) Science (research vessels)	Climate change, FADs, productivity and PNA
Knowledge	Different types of knowledges: R&D: Biological, oceanographic, ecological science, economic, social from tagging and trawl surveys, fisheries monitoring (catch and effort forms, observer forms – ROP), electronic monitoring and reporting, tissue and otolith bank, unloading and port sampling data – species composition and length-frequency of the landed catch Local/Indigenous: Limited at the regional scale – food security, fishing, fishing methods / gear Institutional knowledge: e.g. industry knowledge: Catch, fishing practices	Technocratic approaches to understanding the fisheries. Lack of social science to inform policy (e.g. gender) The ways in which we understand the system determines the modus operandi for governance
Scale	Leveraged by other typologies e.g. power and knowledge Scales are nested, SES is multi-scalar	Geopolitics - scale and linkages to politics – WCPFC boundaries for example
Power	Defined as a “social relation built on an asymmetrical distribution of resources and risks” (Paulson et al., 2003, p 209)	Ways in which power is enacted through the system was discussed in terms of access, control, relationships, and sustainability
Equality	Power, knowledge, scale used in the quest for equality Questions include who should bare the conservation burden? And, Are SIDS exclusions fair?	Power and equality are central to concerns of development with the SES. SIDS sovereignty and development aspirations vs. conservation is as the heart of these issues.

Coding interviews and data from place-specific case studies involved identifying whether the participant or the data were describing the state, an interlinkage, or changes in the SES (Table 17)

Table 17. Description of the State, Interlinkage, Changes of the SES

QUESTIONS	
State	<p><i>Define and characterise the social-ecological system</i></p> <p>Indicators and inquiries include:</p> <p>- lists of countries, societies, cultures, communities; description of culture; govt rev & exp; poverty and health indexes; international relations; history - political, economic, social, cultural, environmental; tuna biology, ecology, population dynamics; fisheries statistics;-defining ecosystem and its health; biohistory and future scenarios; societies biophysical structures (energy and society, landuse and food production and social metabolism)</p>
Interlinkages	<p><i>Define and characterise the interlinkages between and within social and ecological dimensions</i></p> <p>Indicators and Inquiries:</p> <p>Description of social-ecological interlinkages; identification of key relationships to provide a typology e.g. directional, unidirectional, coevolutionary, productive (direct communication, boundary objects, financial interactions)</p> <p>Systems complexity, resilience, and adaptability characteristics</p>
Changes	<p><i>Understanding changes in human activities, attitudes, beliefs, knowledge, relationships, interactions and cultures in response to tuna fisheries; understandings changes in response to changes made in policy and practice.</i></p> <p>Indicators and inquiries</p> <p>Changes in: level of trust, legitimacy of ideas, policy or practice; size or strength of social capital; distribution of ideas.</p> <p>Changes to fisheries and ocean management, policy and practices; restoration or habitat improvement projects perceptions of change in environmental quality; changes in tuna and fishery related species catches.</p>

An example of analysis using the matrix is provided in Table 18 below. Applying the matrix highlighted issues to further interrogate and cross-reference with primary and secondary data (literature, reports, fisheries data etc).

Table 18. Example of analysis using matrix using Fiji place-specific study

	POWER	KNOWLEDGE	SCALE	ENERGY	EQUITY
State	<p>Gendered access to fish due to cultural norms</p> <ul style="list-style-type: none"> - Technology: Physical access - Authority / Rights - Participation <p>Power across supply chain - held centrally according to status, power, money and impacts lower paid, less power within those supply chains</p> <ul style="list-style-type: none"> - Power over crew on boats - Death of crew - Power in the household: patriarchal society: - Industry power in Fiji: China have the "bigger piece of the pie" <p>International legal instruments to protect women</p> <ul style="list-style-type: none"> - Not all ratified by all states. - Francisco on EBM and ethical choices 	<p>Education</p> <ul style="list-style-type: none"> - women at school increased <p>Fishing knowledge and development</p> <ul style="list-style-type: none"> - Local knowledge on coastal fishing - Crew knowledge - FAD fishing knowledge nascent <p>Industry training</p> <ul style="list-style-type: none"> - Training health and safety HCCAP, skills on processing, hygiene. 	<p>Access is multi-scalar:</p> <ul style="list-style-type: none"> - Fish access space and time - Access to markets - Management at regional and national scale <p>Volume scale - small scale to larger scale fishery</p> <ul style="list-style-type: none"> - Chinese and Taiwanese boats to prop up the processing requirements. 	<p>Tuna biology / Ecological:</p> <ul style="list-style-type: none"> - Fiji's tuna fishing grounds aren't as rich as their Pacific counterparts. <p>Human Energy / Body:</p> <ul style="list-style-type: none"> - Increased time to get fish = overfishing; impacts on the body - Food security - Further to boat / paddle out to FAD; same for industry - go for longer <p>Economic output and efficiency:</p> <ol style="list-style-type: none"> 1) south Pacific ALB situation; 2) international markets - EU, USA, Japan, California, NZ, Bangkok, Taiwan 3) Local economy: 1) Industry and local village development; 2) Local markets in Fiji 4) HH income - supplemented with fishing 	<p>Equality Issues:</p> <ul style="list-style-type: none"> - Stigma, participation, disadvantage - Gendered Roles of women - low pay, low skilled - Cultural barriers to women's involvement <p>Stigma, participation and violence:</p> <ul style="list-style-type: none"> - Gendered roles - of men onboard vessels: human rights issues - Conditions on board, food etc - see WCPFC Phil's proposal. Women want to work on boats but conditions prohibit, especially on longliners - "no bathrooms on the smaller boats" - Not sure if this is an equality but payments for crewman deaths

Interlinkage	<p>Tourism and development: - lead to UI e.g. Attracting fishing vessels to Fiji</p> <p>Political Coup - 2000-2006 a lot of uncertainty Coup - stopped the judicial system</p> <p>Scale and access: National rights for access to fisheries and sovereignty</p>	<p>Knowledge and scale - Environmental knowledge - women knowledge only of inshore fisheries - Centralised knowledge - at regional scale - Knowledge of social impacts on fishery - unknown and unmanaged in the WCPFC</p>	<p>Scale and access - transboundary tuna, offshore, FAD to attract for near-shore small scale fisheries in some trialled villages</p>	<p>Food security and economy - Women and value added work and gender issues</p> <p>Social and ecological Sustainability and Energy (economic efficiency) - Human rights issues connected to IUU - sustainability issues - International market demand for quality or quantity (cheaper) and interlinkage with sustainability practices of tuna boats - e.g. pole and line versus pole and line - Fishing and sustainability: Overfishing, over capacity</p>	<p>Equality and Economic development - Equity issues with subsidies for SIDS profitability with increased competition Sustainability and Equality - IUU fishing is often associated with human trafficking Scale and equality - Industry and equality: Chines fleet subsidised, operating ok, but domestic fleets are not making money to meet their costs - human interaction with the biological ecosystem</p>
Changes	<p>No changes in the access: - Hasn't improved for women - Due to cultural norms - women do not fish for tuna - Access to safe work - Women involvement increasing - Government interventions, post-2006 coups, policy driven changes in the tuna fishery International / national / regional legal instruments:</p>	<p>Knowledge over gender issues - SPC Gender and training - 5 modules released by SPC</p>	<p>Inshore to offshore fisheries Scale and access - climate change</p>	<p>Industry adaptation to changes in energy - Industry adapting to less fish, targeting mahi mahi (Fiji Fish); markets development Market demands & MSC certification - demands for EBM - Fiji's Fisheries Plan - low cost LL fishery - Changes to fish products sold, use of energy to value add products,</p>	<p>Mainstreaming gender Balancing equality and safety push for gender equality onboard vessels is not necessarily equality</p>

- Locally in Fiji its progressed -
awareness

changes women's participation -
automation, number of jobs
available,

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