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"*Our Tuna, Our Wealth, Our Future*"

Ensuring Sustainability and Social Justice in the Tuna Fisheries of the Western-Central Pacific

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Declaration

I, Ingrid Wester Amundsen, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.......................................

Date..

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Abstract

Several species targeted by global fisheries have suffered declines due to increased fishing efforts and more sophisticated fishing technology since the late 1980s. The Food and Agriculture Organization (FAO) of the United Nations estimates that 30% of global tuna stocks are overexploited or depleted and that 53% are fully exploited. In the Pacific Ocean, one of the last global refuges of healthy tuna stocks remains. More than 70% of the tuna consumed globally is caught here – and for decades, stocks of tuna have seemed inexhaustible. However, certain stocks are under pressure from fishing practices ranging from sustainable and well-governed ones, to fishing methods that are ecologically and ethically harmful, unsustainable and at times illegal. Determining whether a fishery is operating on sustainable terms is challenging. The ability to include multiple variables in assessing the sustainability of a fishery system represents a new school of thought within fisheries sciences. Key challenges in fisheries management today involve issues of overcapacity, perverse subsidies, perverse economics, poor governance, lack of data, climate change, unemployment or the issues of by-catch and discards. The challenges are interlinked and undermine the possibility of achieving sustainability if a holistic, ecosystem-based management is not implemented.

This research has attempted a sustainability assessment of the skipjack and yellowfin tuna fisheries of the Western-Central Pacific Ocean (WCPO), with focus on the fishing methods purse-seine (PS) and pole-and-line (PNL). It illuminated the fishery through a case study of a fishing company in Solomon Islands, with qualitative data collected through semi-structured interviews of fishers and key informants from tuna management agencies performed in Suva, Fiji, Honiara and Noro, Solomon Islands, in April-May 2015. The qualitative data was analysed in a semi-quantitative manner, combined with secondary literature and document analysis using Elinor Ostrom's Social-Ecological Systems (SES) framework as an analytical tool.

The key results of the analysis suggest that the yellowfin tuna stocks of the WCPO are showing slight signs of growth overfishing. It suggests that skipjack stocks in the same area are currently not under overfishing threats, however, their future sustainability will depend on improved policies and implementing more conservational efforts in the stock management. These findings were corroborated by local fishers, who confirmed that current tuna stocks have changed during the past three decades, and that declines of fish stocks have been noticed. In particular, the fishing pressure from Distant-Water Fishing Nations (DWFNs) and increased issuing of fishing licence to PS fishing vessels, were worrying to these informants.

This study concludes that ensuring sustainability in the WCPO could be enhanced by decreasing PS vessels fishing with FADs, and providing benefits to PS fishers shifting to free school fishing. It would seem beneficial to encourage a partial shift to more PNL vessels, as this fishing method secures biological, socioeconomic and employment sustainability. The sustainability issues of the bait fishery are recognized, and further research towards improved management would be advisable to ensure healthy stocks. Finally, the current momentum of Pacific regionalism through the strengthening of the Pacific Islands' solidarity and cooperation are recognised as key factors contributing to social and ecological sustainability, and towards securing their wealth derived from tuna resources.

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List of abbreviations

CMM – Conservation and Management Measure
CPUE – Catch Per Unit Effort
DWFN – Distant Water Fishing Nations
EAFM – Ecosystem-Approach to Fisheries Management
EEZ – Exclusive Economic Zone
ENSO – El Niño-Southern Oscillation
EPO – Eastern Pacific Ocean
ESCAP – Economic and Social Commission for Asia and the Pacific of the United Nations
EU – European Union
FAO – Food and Agriculture Organization of the United Nations
FADs – Fish Aggregating Devices
FFA – Pacific Islands Forum Fisheries Agency
fMSY – the fishing mortality that produces MSY
GDP – Gross Domestic Product
GR – Government Revenue
GRT – Gross Registered Tonnage
ISSF – International Seafood Sustainability Foundation
IUU – Illegal, Unreported, Unregulated
MGA – Main Group Archipelago
MPA – Marine Protected Area
MSC – Marine Stewardship Council
MSY – Maximum Sustainable Yield
MT – Metric Tonnes
NFD – National Fisheries Development
NGO – Non-Governmental Organization
OFP – Oceanic Fisheries Programme
PEQD - Pacific Equatorial Divergence
PICT – Pacific Island Countries and Territories
PNA – Parties to the Nauru Agreement
PNG – Papua New Guinea
PNL – Pole and Line
PS – Purse-Seine
QR code – Quick Response code
RAMSI – Regional Assistance Mission to Solomon Islands
RFMOs – Regional Fishery Management Organizations
SI – Solomon Islands
SPC – Secretariat of the Pacific Community
TAC – Total Allowed Catch
TL – Trophic Level
TRP – Target Reference Point
USA – United States of America
USD – United States Dollar
VDS – Vessel Day Scheme
VMS – Vessel Monitoring Systems
WCPFC – Western and Central Pacific Fisheries Commission
WCPO – Western and Central Pacific Ocean
WWII – World War II
WCP-CA – Convention Area of the Western and Central Pacific Fisheries Commission

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1.0 Chapter 1: Introduction

1.1 Introduction

The most common effect of general fishing practice is that it reduces the abundance of target species. Often the assumption is that this does not impose any direct threat of species extinction as marine fish are generally highly productive and the ocean expanse being so vast. But during the past few decades, it has become apparent that fish can be severely depleted, and also be threatened with extinction through overexploitation. Among commercially important species, those particularly at risk are species that are highly valued, large and slow to mature, have limited geographical range, sporadic recruitment, or exposed to poor governance of species with highly migratory patterns. To further complicate the picture, research has shown that the general assumption of claiming that the most highly fecund marine fish species are less susceptible to overexploitation is not necessarily true; rather it seems that this perception is flawed. Fisheries may not only change the biomass dynamics of stocks; they may also change the characteristics of populations by selectively removing the larger, fast-growing individuals, and as such may induce irreversible changes in the gene pool or change the dynamics of the food web. (Pauly, Christensen, Guénette, Pitcher, Sumaila et al, 2002).

The United Nations Food and Agriculture Organization (FAO) expresses that overexploitation of high seas fisheries is in an acute and growing state, and estimates that:

> In 2005, as in recent years, around one-quarter of the stock groups monitored by FAO were underexploited or moderately exploited and could perhaps produce more, whereas about half of the stocks were fully exploited and therefore producing catches that were at, or close to, their maximum sustainable limits, with no room for further expansion. The remaining stocks were overexploited, depleted or recovering from depletion and thus were yielding less than their maximum potential owing to excess fishing pressure (FAO 2007, p. 7).

Pacific tuna fisheries are no exception, and are facing serious and complex challenges. According to the International Union for Conservation of Nature (IUCN), the situation for tuna species is particularly serious; five of the eight species of tuna are in the threatened or Near Threatened IUCN Red List categories, including Southern Bluefin (*Thunnus maccoyii*), Critically Endangered; Atlantic Bluefin (*T. thynnus*), Endangered; bigeye (*T. obesus*), Vulnerable; yellowfin (*T. albacares*) Near Threatened; albacore (*T. alalunga*) Near Threatened (IUCN, 2015). Tuna resources in these areas are under pressure from increased fishing efforts, particularly from over-seas nationalities, overcapacity in fishing fleets, the impacts of onshore development and population growth, and changes in coastal and oceanic systems, such as the effects of climate change. The combined effects are still not fully mapped or understood by scientists. A 2009 study by the World Bank and FAO, *The Sunken Billions*, estimated that the 'lost wealth' of Pacific Islands' tuna fisheries through overcapacity and open access amounted to US$3.4 billion. To ensure the people of the Pacific benefit from their resource for future generations to come, there is a real and growing need to improve governance, develop a globally competitive private sector, and to enhance Pacific Islands' participation in the value chain (IFC, 2013).

The Secretariat of the Pacific Community (SPC) provides the Western-Central Pacific Fisheries Commision (WCPFC) with scientific advice on how to sustainably manage the tuna stocks in the Western-Central Pacific region, and claims the general trend for annual total catches of all tuna species has increased steadily and steeply upwards since the 1960s. This is particularly due to the expansion of the numbers of purse-seine (PS) fleets in the region. Furthermore, according to SPC, for skipjack tuna in particular, the most recent advice given is:

> Recent catches [for skipjack tuna] are slightly above the estimated MSY [Maximum Sustainable Yield] of 1,532,000 mt. The assessment continues to show that the stock is currently only moderately exploited ($F_{current}/F_{MSY}$ = 0.62) and fishing mortality levels are sustainable. However, the continuing increase in fishing mortality and decline in stock size are recognized. (...) SPC advised the WCPFC that there is concern that high catches in the equatorial region could result in range contractions of the stocks, thus reducing skipjack availability to high latitude fisheries. (...)[The SPC] recommends the commission to take action to avoid further increases in fishing mortality and keep the skipjack stock around the current levels, with tighter purse-seine control rules and advocates for the adoption of target reference points (TRP) and harvest control rules (Harley, Williams, Nicol & Hampton, 2015, p. 3).

For yellowfin tuna, the advice given was as follows:

> Overall fishing mortality [for yellowfin tuna] appears to be below F_{MSY}. It is highly likely that stock is not experiencing overfishing and is not in an overfished state. Latest (2012) catches (612,797 mt) of WCPO yellowfin tuna marginally exceed the MSY (586,400 mt). The Scientific Committee (SC) also noted that levels of fishing mortality and depletion differ between regions, and that fishery impact was highest in the tropical region (...). The WCPFC could consider measures to reduce fishing mortality from fisheries that take juveniles, with the goal to increase to maximum fishery yields and reduce any further impacts on the spawning potential for this stock in the tropical regions. WCPFC could consider a spatial management approach in reducing fishing mortality for yellowfin. The SC recommend that the catch of WCPO yellowfin should not be increased from 2012 levels which exceeds MSY and measures should be implemented to maintain current spawning biomass levels until the Commission can agree an appropriate TRP [Target Reference Point] (Harley et al, 2015, p. 4).

Considering the scientific advice given, neither of the two tuna species is in any acute state of crisis in terms of unsustainable harvest levels. However, agreeing on the sustainable levels of a fishery is a highly complex matter. Sustainability is a somewhat imprecise term; how does one *measure* if a system is sustainable? The nature and extent of the sustainability in a given resource system is becoming increasingly important to assess for natural resource managers, and has been the focus of relevant research over the past few decades. The increasing knowledge of which implications fisheries practices have is pointing to the need for incorporating ecological consideration into fisheries management, research and monitoring. Healthy stocks alone do not determine if a fishery is sustainable; developing a set of criteria to evaluate the degree of sustainability can be done through assessing for instance the ecological, socioeconomic, community and institutional sustainability impacts within a fishery.

The ongoing case of the dramatic decrease in stock size of bluefin tuna is alarming to scientists concerned about the increase of fishing efforts to other tuna species; they are depleting in stock size in every ocean, and their recovery has not been allowed anywhere. The Bluefin tuna case shows that when a fish stock has tremendous monetary worth, politics will go to great lengths to distort scientific advice on limits to fishing harvest (Safina, 2001). Similar concerns have been raised over many of the other tuna species:

> Despite their high fecundity and wide distribution, most tuna stocks are fully exploited, and some are overfished or even depleted. Of the 20 tuna stocks for which the status is known, at least five are 'overfished' (albacore in the North Atlantic, bigeye in the Atlantic, bluefin in the East and West Atlantic, and southern bluefin). Furthermore, western and central Pacific bigeye is approaching an overfished state, and may already be overfished. 'Overfishing' is occurring for at least an additional four stocks (bigeye in the East and western central Pacific, yellowfin in the Indian Ocean, and bluefin in the Pacific). While fishing mortality and biomass were determined to be within MSY-based reference points, the most recent stock assessment for western and central Pacific yellowfin predicted biomass declines in the equatorial subregion of the western central Pacific, where almost all yellowfin is caught in this region. Despite there being skipjack stocks in the Pacific and Indian Oceans, and albacore in the South Atlantic and South Pacific that are only moderately exploited, because these species are caught primarily in purse seine fisheries, it is not presently possible to sustainably increase catches of these stocks without increasing by-catch levels of other tuna species, including small bigeye and yellowfin tunas primarily in purse seine sets on fish aggregating devices (FADs) and other floating objects (Gilman, 2010, p. 591).

Understanding the biological impacts of overfishing or habitat destruction, along with the factors that creates consecutive unsustainable employment environments, or weak governance that enables fishing actors not interested to play by the rules, has led to fisheries managers imposing multi-facetted checklists or criteria to assess a fishery system. Ecological indicators of a sustainable system may include variables like catch levels, current biomass, fish size, diversity, or the amount of protected areas. Socioeconomic or community indicators may include variables like community livelihoods, food supply, or sustainable fleet capacity. Institutional indicators may include variables like management effectiveness, institutional viability, or the amount of capacity building. Any sustainability assessment needs to take into account that the nature of the environment is random and unpredictable, and determining the sustainability is therefore challenging. Assessing the levels of resilience or levels of adaptation capacity in the system are factors that are increasingly being used in research today.

1.2 Overview of the different tuna fisheries of the Western and Central Pacific

The WCPFC formally manage the tuna fisheries in the Western and Central Pacific Ocean (WCPO), however, it is an advisory body that does not have formal jurisdiction over the respective national states in the region. The WCPO section is geographically limited as illustrated in Figure 1:

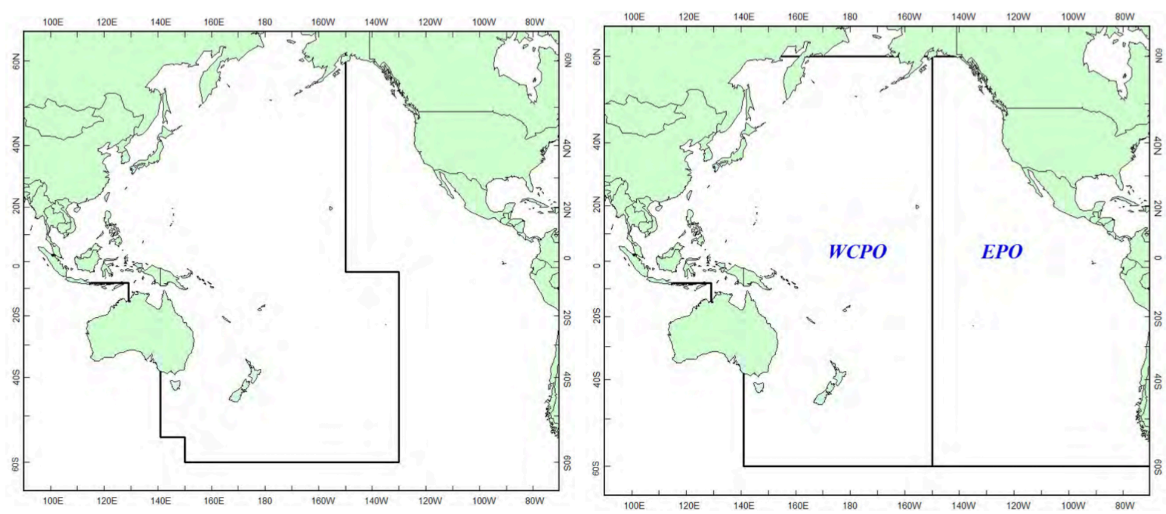
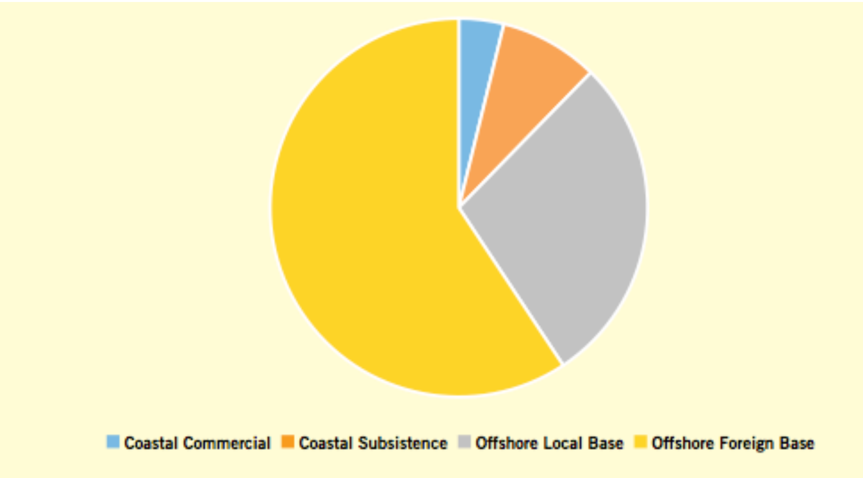


Figure 1 (left): WCPFC Statistical area (WCP-CA). Right: WCPO and Eastern Pacific Ocean (EPO). *Source*: (WCPFC, 2014a, p. 2-3).

The WCPFC was formally established in 2004 by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPF Convention), after ten years of negotiations, and formally manages the fish stocks in the statistical area of the central-western Pacific. The commission has 26 members, including all of the Pacific Island Countries and Territories (PICTs) as well as several foreign states, including United States of America (USA) and the European Union (EU). The Commission "draws on many of the provisions of the UN Fish Stocks Agreement (UNFSA) while, at the same time, reflecting the special political, socioeconomic, geographical and environmental characteristics of the WCPO region"[1]. The commission deals with a number of political and practical management issues of the high seas fisheries, such as unregulated fishing, over-capitalization, unreliable databases and insufficient multilateral cooperation in respect to conservation and management of highly migratory fish stocks. The Commission has three subsidiary bodies; the Scientific Committee, the Technical and Compliance Committee, and the Northern Committee, which each meet once each year, and followed by a full session of the Commission resulting in extensive statistical results and recommendations regarding the fisheries in the WCPO and detailed catch statistics from decades back. Their recommendations are based on the scientific advice given by the SPC.

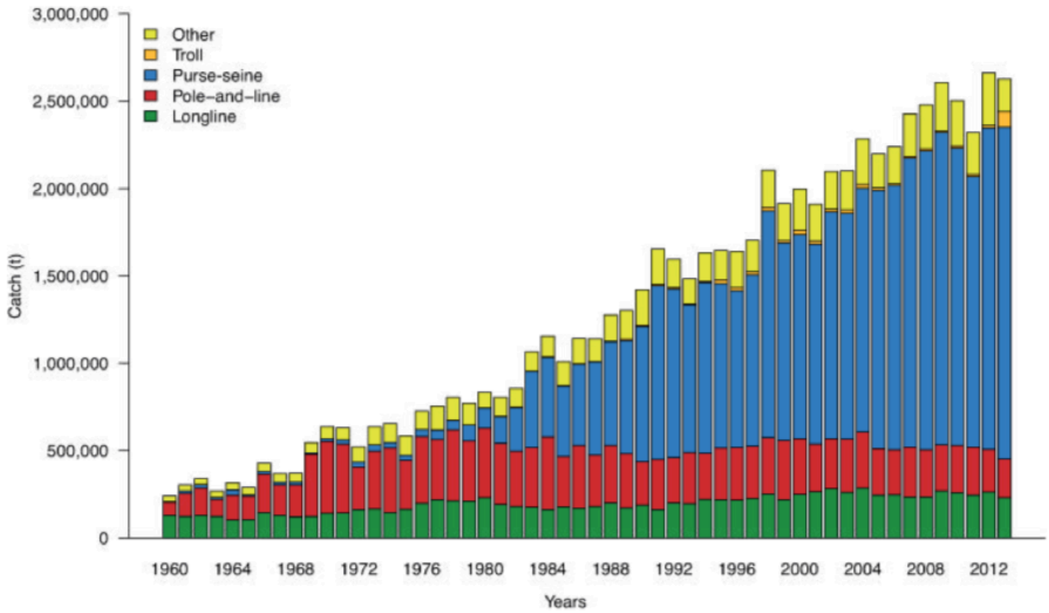
Fisheries have been the most significant renewable resource for PICTs to ensure food security, livelihoods, economic growth and export basis. Historically, there has been less pressure on marine animal populations here than in any other parts of the world due to the mostly sparsely populated land areas here; coupled with vast expanses of ocean (Barclay, 2010). Artisanal and subsistence fisheries has long been, and still is, a significant part of PICTs fisheries, but the past few decades has seen an explosive growth in the industrial-scale tuna fishery sector. An estimation shows that industrial tuna catches makes of about ten times the volume and over seven times the value of all other fisheries combined in the area, and that tuna products dominates the fisheries export of the region in a supreme manner (Gillett & Lightfoot, 2002). Therein; the DWFN fishing efforts makes out a huge portion of the total share of fishery production, as shown in Figure 2:



[1] Extracted from WCPFC's website, see https://www.wcpfc.int/about-wcpfc for more information.

Figure 2: Annual fishery production in the Pacific Islands region. The relative amounts are based in volume, therein mt. *Source*: (ESCAP, 2014, p. 5).

Industrial scale tuna fishing started in the first half of the twentieth century, re-emerged in the 1950s following the end of World War II (WWII), with a steady increase until the 1980s finally expanding greatly with many new DWFN actors entering the WCPO areas combined with a great improvement in fishing technology – increasing catches tremendously (Barclay, 2010), which Figure 3 clearly shows.



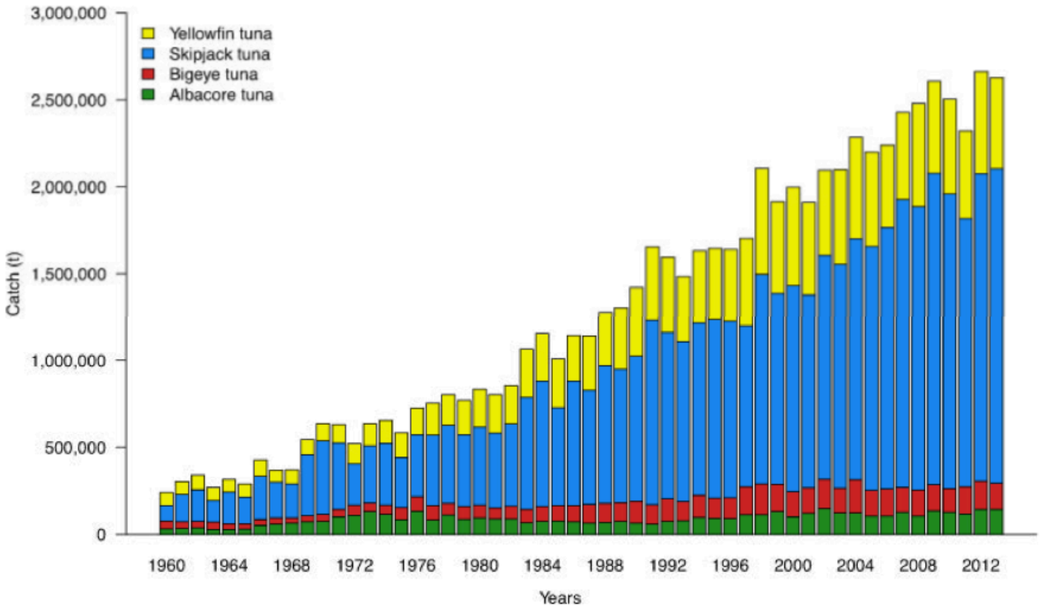


Figure 3 (top): Catch (in mt) by gear for the western and central Pacific region, 1960-2013. Figure 3 (bottom): Catch (in mt) by species for the western and central Pacific region. *Source*: (OFP, 2015, p. 10).

During the 1970s newly independent Pacific Island states started including tuna fisheries as part of their economic development strategies, combined with a firm belief to form companies in national ownership so to guarantee economic benefits be kept in local economies rather than over-seas ones. During this time new players entered the Pacific Island tuna scene – the Japanese were starting to be competed with by Korean and Taiwanese in longlining for albacore. After some time where the Japanese market shifted demand towards high-end sashimi, the Japanese fleet shifted effort towards frozen sashimi by developing ultra-low temperature on-board freezing (Gillett, 2007). This switch involved a shift into longlining in cooler, deeper waters targeting more of bigeye and Bluefin tuna. Several Pacific Island state-owned tuna fishing companies were started during this time, many as joint ventures, however, with Japanese companies (Barclay, 2010).

During the 1980s and 1990s a significant part of these companies failed due to low profitability and huge losses. They were mostly medium-scale pole-and-line (PNL) fleets, which did have huge positive employment benefits as it gave many locals jobs as well as keeping the work force within the local and national economy. During this period many companies therefore re-oriented from the PNL method to the PS method. The competition over the higher profitable which and increasingly numerous PS fleet, combined with locally and seasonally fluctuating levels of baitfish access, made the mostly PNL based tuna fishery unviable. Therefore, during the 1990s, an increasing number of small-and-medium scale longline fleets (<100 Gross

Registered Tonnage (GRT)) dominated (2010). The failures of so many ventures during the previous decades made many Pacific Island governments believe that maximizing fees from DWFN fleets was a more sound economic strategy (2010).

The entrance of DWFN to the fishery has complex reasons; the fishing resources are vast and the ocean habitat so big that exploitation and catches has been highly profitable for centuries; combined with ever increasing human populations demanding food as well as better technology. As Figure 4 indicates, the 2007 total catch numbers for all fish species and fishing gears suggests the scale of DWFN fish catches.

Item	Coastal Commercial	Coastal Subsistence	Offshore		Fresh-water	Aqua-culture	Regional Total
			Offshore Locally Based	Offshore Foreign-Based			
Fishery category totals	165,691,002	200,366,961	596,836,589	1,086,581,587	23,115,025	146,872,423	
Totals adjusted for duplicate offshore fishing	165,691,002	200,366,961	1,513,418,176		23,115,025	146,872,423	2,049,463,587

Figure 4: Total regional fishery and aquaculture production, 2007 numbers. Source: (Gillett, 2009, p. 20).

The ranking of total fisheries and aquaculture production in the PICT region from Figure 4 has been strongly influenced by the level of tuna catches, which is by far the most important fishery both in terms of economic and export values and in terms of food security levels. A general pattern of decreasing total national catches from west to east across the region, and from equatorial to higher latitudes was also found, as well as a relatively large contribution of offshore foreign-based production in Kiribati, Federated States of Micronesia (FSM), Solomon Islands (SI), Nauru and Tuvalu. The total catch in 2007 from international waters accounted for approximately 21% of the catch taken from the entire WCPO, including the WCPO catch of Indonesia, Japan, Phillipines and Taipei, China. Of the 2007 catch, 60% of the total catch and 42% of the total value were made by PS vessels, whereas 23% and 22%, respectively, from PNL vessels (Gillett, 2009). The Figure shows a clear increase in offshore production, but a stagnation or decrease of coastal fishery production; inclining that food and employment has to be spread among a growing number of people.

> With the generally expanding offshore fisheries, the distribution of benefits from fisheries sector in the Pacific islands is already undergoing a profound change. Benefits from employment and nutrition—things that directly affect Pacific islanders, and which disproportionately come from the coastal zone— are stagnating. The less tangible and more abstract benefits (contribution to GDP, exports, and government revenue) tend to come disproportionately from the offshore area, and are expanding (Gillett, 2009, p. 20-21).

The entrance of DWFN to the PICT region has further been coupled with lucrative fishery entrance tax deals with local governments and, many would say, low degree of high sea surveillance, the fishery has had tremendous catches – and that is only accounting for the legal catch. When including Illegal, Unreported, Unregulated (IUU) activities as well as undocumented subsistence coastal fisheries, the catch withdrawal of stocks are truly tremendous. During the 2000s a combination of fluctuating market prices combined with dwindling catches of yellowfin and bigeye suitable for the Sashimi market, fuel price rises and difficulties regarding airfreight connections left some companies unviable. All in all, the Pacific Island development of both fisheries and onshore facilities for canned tuna has been greatly affected by international trade regimes and demands from the western world.

> The largest markets for canned tuna (the EU, Japan, the USA) have all had domestic canning industries, which are no longer competitive due to labour costs, but which have been protected by tariffs on processed fish imports. Some developing countries, especially those with past colonial relationships with importing countries, have had tariff exemptions. The relationship between the EU and former colonies in the Pacific has been particularly influential, contributing to the viability of processing facilities in PNG and Solomon Islands. These countries have higher production costs than competitors such as Thailand, so have survived due to tariff exemption. Pressure from the World Trade Organization to reduce tariffs and make preferential trade agreements WTO-compliant is causing changes in these relationships, possibly undermining the long- term viability of processing in Pacific Island countries (Campling, Havice, Ram-Bidesi & Grynberg, 2007, p. 165).

The WCPO is today the biggest tuna fishery in the world – according to SPC, 51% of the world's tuna catch came from the WCPO area in 2004 (Barclay & Cartwright, 2007b). The fishery is diverse, ranging from small-scale, artisanal operations in the coastal waters of Pacific Island nations, to large-scale industrial PS, PNL and longline operations in the PICTs' Exclusive Economic Zones (EEZs) as well as in international waters (high seas). Today the main targeted species are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and albacore tuna (*T. alalunga*) (Harley et al, 2015). The annual catches of these species has as Figure 3 clearly shows, increased significantly since the 1980s, and the 2013 Convention Area of the Western and Central Pacific (WCP-CA) (see Figure 1) PS catch of skipjack (1,810,166 metric tons (mt) – 69% of total catch) was the highest catch ever recorded, with a 2% increase from the previous catch of 2012 (2015). The same was the case for the PS bigeye tuna catch; the 2013 catch of 73,826 mt was the highest ever recorded. The PS yellowfin catch for 2013 (344,141 mt) was a slight decrease of 5% from 2012, and the longline catch of bigeye (65,587 mt) and yellowfin (65,492 mt) was the lowest in 20 years. Finally, the PNL catch (221,715 mt) were the lowest in 40 years with a 9% decrease from 2012 levels (2015). The WCPFC tuna fisheries assessment report n° 14 with catch data from 2013, edited by Harley et al. (2015), will form the basis of the most recent catch data used for this research. The report was presented during the 9th SPC Heads of Fisheries Meeting in Noumea, New Caledonia 6-12 March 2015.

The demand for tuna has remained stable and high throughout the past three decades with ever increasing catches, however, the increasing public and scientific awareness of the sustainability limits of the fishery has seen a coinciding increase. The increasing interest for and focus on Corporate Social Responsibility (CSR) in food retail in Europe, and increasingly, also in the US, has created bigger demands for 'environmentally friendly' tuna the past few years (Barclay, 2010). This demand has again created a revival for increase of the PNL fleet in the region, therefore; one might expect that the SPC Head of Fisheries Meetings in the near future will present higher PNL catch rates than the low rates from 2013 presented this year. The attention to the ongoing debate of unsustainability in the fishery has brought new insight to the limits of the growth of the fishery, research, consumer awareness campaigns, pressure of tuna companies towards higher sustainability ambitions - and even the inspiration to write this very thesis.

1.3 Research questions

My research has explored the tuna fishery of the WCPO, with specific focus on the yellowfin and skipjack species, fished by PS and PNL fishing techniques. This choice of focus for my research was made due to the fact that these two species constitute the vast majority of the total tuna catch in the region, and the PS and PNL method are the predominant fishing methods used within the commercial tuna fishery. The choice was further made due to the fact that this research was based on a thorough review of secondary literature and on a case study of the fishing company National Fisheries Development, Ltd. (NFD) in SI, where fieldwork were carried out during three weeks in April-May, 2015. Interviews were performed with a total of 30 fishers from PS and PNL vessels owned by NFD, with the ambition of qualitatively surveying a selection of industrial-scale tuna fisher's own perceptions of the tuna fishery and the alleged changes in it over time. Four key informant interviews were carried out as well, with a representative from PNA, one from FFA, and two from NFD. The key informant interviews were carried out in order to get a brief assessment of some of the tuna management agencies' views on the current issues of the tuna fishery, as well as insight to NFD's operation structure. The research, with the above-mentioned focus, attempted to perform a sustainability assessment of the tuna fishery in the region by utilizing Elinor Ostrom's Social-Ecological Systems framework. The overarching research question was formulated in the following manner:

> *A sustainability assessment of a tuna fishery using Ostrom's Social-Ecological Systems (SES) framework: to which degree are yellowfin* (Thunnus albacares) *and skipjack* (Katsuwonus pelamis) *tuna stocks in the Western and Central Pacific Ocean being sustainably fished to ensure their healthy continuation for the future, and to which degree is current management and policy measures contributing to the improved sustainability of the stocks?*

Several sub-objectives linked to the main research question were established along the lines of the SES framework, wishing to assess the sustainability of the fishery system. They were organised along three main objectives; measuring the ecological, socioeconomic and political-institutional sustainability. Some of them can be summed up in the following:

> *What is the perceived sustainability of the fishery from the fishers themselves?*
>
> *How are the catch rates corresponding to current MSY levels?*
>
> *Are there any perceived changes in fish abundance or seasonal catches, compared to before?*
>
> *Which fishing method minimizes the by-catch issue?*
>
> *What is the role of green consumerism in Pacific tuna fisheries?*

How is the management effectiveness, and how viable is the institutional will to act sustainably?

Are the food security and the fight of unemployment rates in PICTs ensured through sustainable tuna fisheries management?

Which measures are taken to ensure occurrences of Illegal, Unreported and Unregulated (IUU) fishing activities are being minimized?

Which measures are taken to improve Pacific regionalism and curb the exploitation pressures from DWFN?

1.4 Justification and outline of thesis

In the general picture, PICTs are not prominent in the sustainable development literature – except from being a prime example of victims from impacts of global environmental changes generated by industrialized nations (Petaia, 2015). The increased evidence that the tuna stocks in this region are suffering from increased fishing pressures by particularly Distant Water Fishing Nations (DWFN), and the possible solutions to these issues, are closely linked to the success of social and economic development within the PICTs since tuna fisheries are such a crucial part of the livelihoods of people in this region.

It was therefore believed that a study of the sustainability levels of a tuna fishery in the WCPO in a holistic manner, would prove both relevant and interesting to write a Master's thesis about. The current ongoing development of the fishery is changing swiftly; the developments of tuna fisheries in the Pacific has received increased attention over the past few years, and has formed the basis of several sustainability concerns and campaigns from Non-Governmental Organisations (NGOs) such as Greenpeace. The international momentum the case is receiving, and the current development of strong Pacific regionalism and ownership of tuna resources, and makes the case even more relevant at this particular point in time. Considerable amount of available research is concerning the tuna species that are struggling the most, particularly the Bluefin and bigeye tuna. For this research, I thought it would be interesting approach would be to have a closer look at two species that are not currently considered to be overfished; namely the yellowfin and skipjack tuna. The current fishing pressure of these species is quite tremendous, and with the increased interest from DWFN having overfished tuna resources in the Atlantic, it is expected that the species will continue to be targeted in the following years. Examining the management measures at this particular point in time is therefore interesting along several variables: what can be done to make sure fishing pressures remains at this level without compromising the PICT's right for economic development? To which degree does current management measures ensure that the two species will not go beyond their current IUCN status, *Near Threatened* and *Least Concern*, respectively? And how is current fishing pressure reflecting the sustainability advice given from fisheries scientists?

The thesis is structured in 8 chapters, structured in the following manner: Chapter 1 introduces the context and background for the research, and briefly outlines the theory that will be used, which will be further explained in Chapter 2, which outlines the theoretical and conceptual framework that illuminates the choices that will be made throughout the research. Chapter 3 outlines the research site, the background information that forms the basis of the analysis, as well as a presentation of the case that forms the case study. Chapter 4 provides insights in which methodological choices that were made during data collection and throughout the interviews, as well as providing a justification for the methodological choices that were made. Chapter 5 outlines the research findings that were collected through fieldwork. The findings from the PNL fishers will be presented first, followed by the PS fishers. Chapter 6 provides extended background information about the case and about the management schemes relevant to the topic, as the selected case is highly comprehensive. Chapter 7 provides an analysis and discussion section, which is structured through the adapted SES framework. And finally; Chapter 8 will provide conclusions and recommendations for future research and policy. The reconmmendations are derived from and based on the findings from the fieldwork as well as from secondary literature.

1.5 Research challenges and limitations

Several challenges were encountered during the course of this research. Becoming acquainted with the right contacts to enable a proper fieldwork was perhaps the most pronounced one. I spent four months in the Pacific region, enrolled as an exchange student at University of South Pacific (USP) in Suva, Fiji, where the sustainable fisheries and marine biology studies I completed helped me in getting in touch with up-to-date research and researchers affiliated with USP. Going to the Pacific region without having ever been there and not knowing a soul beforehand, is not the easiest starting point initiating a fieldwork from. After a long, and sometimes demoralizing, period of research trying to find a fishing enterprise that would allow me to get on-board PNL and PS vessels, I finally went to SI. Beforehand I only had a scarce list of people to contact, without any set agreements with anyone. The persistent knocking on doors in Honiara, SI, combined with the invaluable help of locals, finally enabled me to get in touch with NFD, which provided me with access to their vessels, the fishers on-board them, and the wharfs where fish from numerous vessels were unloaded. Getting to the point of accessing such an establishment was a tremendously overcome challenge; enabled through many months of persistent e-mailing to relevant and not relevant actors, research, sheer luck and Pacific hospitality.

Another challenge when finally nailing the fieldwork site was the language barrier. Communicating with the informants was all in all unfolding unproblematic as most of them spoke English well. However, a great deal of the fisher informants had some English challenges, and misunderstood or misinterpreted the questions asked. It is not possible to draw conclusive remarks, due to the speculative nature; however, I felt some of the informants were somewhat intimidated by the interviewing format, sitting in a room with a stranger answering questions was probably contributing to many of the them answering questions rather briefly and without elaborations. This is considered a research limitation, as it is possible that views, opinions and reflections were held back due to language barriers, the informants not feeling intimate enough with the interviewer to share everything or not understanding the true meaning of some of the questions asked. Despite this, the over-all feeling is that the majority of the fishers felt comfortable, honest and interested in answering the questions. The hospitality and friendliness of people in SI, just like elsewhere in the Pacific, created a highly rewarding environment to perform research in, and the interviews produced all in all several interesting, unique and relevant perspectives on the tuna fisheries.

Another challenge was of a monetary nature – traveling around the Pacific is expensive. Saving up means to carry out the research was challenging and took several months of planning. Lack of money also lead to a direct limitation, as the plan was to travel to Marshall Islands to perform interviews of actors in Parties to the Nauru Agreement (PNA), which has their head office there, as well as with fishers transhipping in the country. Due to it being highly expensive to travel there from Fiji, the plan was eventually written off. However, luckily, through contact via e-mail, an interview with a PNA representative was still enabled, as one of their employees attended a seminar in Fiji during my time there and agreed to do an interview. The decision to go to SI instead proved highly valuable, so the over-all experience of this fieldwork is that everything eventually worked out to the very best in the end.

1.6 Brief literature review

Extensive relevant research has been published on the tuna fisheries of the WCPO. Comprehensive sources of secondary information are from available science-based reports, briefs, conference proceedings or articles published by WCPFC, Pacific Islands Forum Fisheries Agency (FFA), FAO or SPC. There are also a group of fisheries scholars who have published numerous papers based on different aspects of the tuna fisheries in the region; most prominently Robert Gillett, as well as Kate Barclay, Ian Cartwright, Quentin Hanich, Ben Tsamenyi and Peter Williams. Their publishications have been highly relevant as background information sources for the work of this thesis - as many of the publishications are directly or indirectly covering issues relevant to this study and research questions. Their work has been shaping the thesis in a manner that has been inspiring, as the literature is comprehensive, thorough and relevant. Similarities are occurring, however, linking the social-ecological system of the fishery in a comprehensive sustainability assessment has, to my knowledge, not been attempted before. Furthermore, there exists a substantial wealth of peer-reviewed literature regarding sustainability in fishery systems, prevention of fishery collapses, conservation of fish species, loss of marine biodiversity and general approaches to marine conservation. Some of these articles have helped shape the general mindset of the thesis, however, the main focus has been on the factual, scientific reports regarding updated information about tuna stocks in the WCPO. Some NGO reports, mainly from Greenpeace and International Seafood Sustainability Foundation (ISSF), have provided some useful insights, particularly as contributors to examining the extent of IUU activities. The challenge of linking the relevant literature to the research objectives has been to examine it within a theoretical framework, and not in a straightforward article manner. Linking these relevant articles and reports to the theoretical framework of Ostrom's SES model, while embedded in a political ecology discourse, has been highly rewarding and academically challenging; as so many social, political, biological, ecological and economic aspects of the tuna fishery is contributing to its over-all sustainability. The work of Basurto, Gelcich & Ostrom (2013) and Schlüer & Madrigal (2012), has been very relevant as inspiration and assistment in structuring the case within the SES theoretical framework.

2.0 Chapter 2: Theoretical and conceptual framework

2.1 Introduction

The ambition of this thesis is to be able to identify and understand certain sustainability aspects of the skipjack and yellowfin tuna fisheries in the Central-Western Pacific through illuminating a praiseworthy case study of NFD, SI, as well as widespread use of secondary literature. The conceptual framework that this thesis constitutes of will firstly be illuminated by a review of which epistemological and ontological stances it takes. To be able to answer the research questions, which perceptions the researcher holds of the observable world is of theoretical and methodological importance. The thesis is further embedded within a political ecology discourse, and thus an outline of the premises of this academic discipline as well as a definition of its dominant environmental narratives about human-environmental relationships is exemplified. The possibility of scientifically analysing the sustainability of systems that include social and ecological systems, like fisheries, poses significant theoretical challenges. This research will therefore - to a certain extent - seek to balance concepts from a variety of scientific disciplines, however; the theory is founded on an adapted version of Ostrom's Social-Ecological Systems (SES) framework for analysing sustainability, and as such will form the structure of analysis for this research.

2.2 Epistemological and ontological postures

Epistemology is within philosophy defined as the theory of awareness, or rather; of knowledge. Questions like how humans comes to acquire knowledge of the world around us, as well as how we *know* what we know, establishes the philosophical grounds of what may be regarded as 'adequate and legitimate' knowledge (Lewis-Beck, Bryman & Liao, 2004). An epistemological debate thus evaluates how research may define what knowledge really *is*. There are several paradigms within epistemology of how to understand legitimate knowledge. The positivism stance rejects metaphysical speculations in favour of objective, systematic, empirical observation by usage of human senses. Following that premise, a positivistic understanding of the world is based on generalizations following such repeated and consistent observations, resulting in laws of how phenomena coexists (Lewis-Beck, Bryman & Liao, 2004). Interpretivists contests this view and argue that there is a fundamental difference between the subject matters of the natural and social sciences, and thus the methods of the natural sciences may not be applicable to perform social science research (Barbour, 2014). An interpretivist approach requires the scientist to be able to understand the social world that people inhabit, which they have established through the meanings they produce and reproduce through their everyday life (Lewis-Beck, Bryman & Liao, 2004). The notion is that reality is socially constructed and interpreted, and thus knowledge of this reality is available only from the accounts that social actors can give of it (2004).

Ontology, on the other hand, is the study of theories of being, and theories of what makes up reality – the study of underlying reality. In the context of social science it might be said that this implies which methodological positions that makes (implicit or explicit) assumptions of what things can do or can exist, the conditions of their existence, and the way they are in turn related (Lewis-Beck, Bryman & Liao, 2004). Because ontological claims are inevitably linked to epistemological claims, it is challenging to discuss them separately, however, ontology is often contrasted through the two opposing positions of objectivism and constructivism (Barbour, 2014). Objectivism holds that there can be no linear progress in science; rather, there are 'paradigms' of thought and practice that are taken to represent scientific truth at particular times - which in turn may be subject to occasional revolution that can be accounted for by social and psychological factors rather than by objective facts about the world (Lewis-Beck, Bryman & Liao, 2004). This view holds that social phenomena exist independently to that of social actors. Constructivism holds that social phenomena is constructed rather than gained through perception; people are therefore the constructors of their own subjective realities, and thus the creator of their own subjective world (2004).

Following these assumptions, this research will base its conceptual framework within an interpretivist epistemology as well as a constructivist ontology discourse. It aims to understand the sustainability aspects of the fishery, and therefore; studying such a natural resource management scheme means that the actors that composes that scheme are the ones that produces the knowledge of conservation practices and understandings of that fishery. Such a 'soft' constructivism is a tactic many political ecologists makes use of; our concepts of reality are real and have force in the world, but they might reflect incomplete, incorrect, biased and false understandings of the empirical reality (Robbins, 2012). The objective world is thus real and independent of our categorization, but it is inevitably filtered through subjective conceptual systems as well as scientific methods that may be socially constructed (2012). It is particularly suitable to approach an understanding of the inherent logic behind the actions of actors within pelagic fisheries via a constructivist point of view, as many constructivists forms an explicit *normative* approach to legal issues. Ellis (2007) emphasizes:

> One of the prominent uses that can be made of legal rules and systems is persuasive: the primary objective of these rules is seen not as the imposition of costs and rewards, but rather the provision of reasons that can be used to persuade actors to adopt one course of behaviour or another (Ellis, 2007, p. 21).

Since this research also briefly treats resource conservation issues that involve areas beyond state jurisdiction – the high seas – it poses particularly intricate difficulties for international law and cooperation. In such a way, the interrelations between legal and moral frameworks with capacity of legal rules and systems may be understood in a sense of what 'needs to be done'. The impact from IUU fishing in the high seas will only be briefly discussed in the main analysis of this research. However, it poses high relevance to the topic as it plays such influence on pelagic species richness, as well as on the success rate of states' abilities and interest to manage their fisheries of pelagic species within their respective EEZs. As a result, constructivism is a well-suited theoretical tool to highlight the impact of normative developments, such as increasing concern about environmental protection and resource conservation and management, on e.g. high seas fisheries (Ellis, 2007). Particularly law scholars has debated the environmental implications for the inherent 'freedom to fish', and thus an increasing number of regulations to that freedom has been suggested with the results that a states right to fish is consequently coupled with the right to exploit that resource now being teamed with a growing network of obligations (2007).

> (…) However, the fact remains that high seas fisheries presents a difficult case for a constructivist framework focused on legal and political norms relating to conservation and management of high seas resources and to marine ecosystem protection. This is in large measure due to the open-access nature of high seas fisheries, as well as the structure of the fishing industry. Vessels can avoid contact with conservation-minded states and their enforcement machinery, and certain states may feel such a strong incentive to cater those vessels that the pull of political and legal norms is not felt very strongly. As a result, it seems appropriate to consider the ways in which the incentive structure could be changed such that vessels and states alike benefited less from avoiding application of the rules or from violating them, and benefited more from cooperating in conservation and management regimes. The rational choice approach is particularly promising in this regard, focusing as it does on the interests of actors and seeking to identify ways in which policy and legal frameworks operate on those interests (Ellis, 2007, p. 21-22).

When studying the complex matter of fisheries conservation and natural resource management, it is clear that powerful actors produce social customs and norms through discourse, as exemplified through the work of Ellis (2007). Thus, the knowledge that exists about conservation, fisheries practices and fish catches, is all the time adapted and transformed within the discourse of the actors that communicates them. The concept of "fisheries" may therefore be considered a social concept, all the time defined by the actors within it, same goes for the concept of "over-fishing" which may or may not illustrate the actual state of the natural world. However, using the theoretical framework from a constructivist point of view, it may be easier to navigate towards the empirically correct concepts from reality, such as actual fish catches, so that these are unmasked from incomplete, biased or false understandings of the empirical reality out of social, subjective, disclaiming or deceiving perceptions (Robbins, 2012). The research will therefore make use of elements from rational choice theory to meet the challenges similar to that posed from the Ellis quote.

2.3 Defining political ecology

Although the theoretical framework for this research is funded in Ostrom's SES framework, its conceptual framework and the way it deals with and understands the research topics has a lot in common within the school of political ecology.

During the 1970s, a new narrative of perceptions of the planet's natural resources started to receive attention in academic circles. The release of the book "Limits to Growth" (Meadows, Meadows, Randers & Behrens, 1972) was part of a defining moment; the advent of the green political movement. A contemporary new narrative of the environment was starting to form; one that was believed to be much more prone to human interactions and disturbances. Nature was described as a size of finite limits, being subjected to new terms like *ecoscarcity* – all due to the explosive growth of the human race and its adjoining pressure on the earth's ecosystems (Robbins, 2012). The prevailing perceptions of environmental systems such as freshwater access, fisheries, fertile land and forests before regarded as inexhaustible, infinite and everlasting were contested. Political ecology emerged as a subfield of geography, and being a discipline that studied human-environmental relationships, had particular consistent elements; nature can, if its assets are overused, be driven well past the point of self-renewal. The before-told narratives of human-environmental relationships were simply not enough; they were too simplistic and inaccurate to describe the current state of affairs. A special focus was given to underlying political factors, which may in turn further affect environmental change and natural resource degradation (Formo, 2010).

It exists a myriad of definitions to the term political ecology, one of them formulated by Watts (2000): "Political ecology is to understand the complex relations between nature and society through a careful analysis of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods" (2000, p. 257). Watts, among several other political ecologists, attempts to grasp a definition that describes how environmental conflict, especially in terms of struggle over rights to access resources, mixes with political implications of governance, justice and power. Blaikie & Brookfield (1987) advocates a supplementary definition: "The phrase 'political ecology' combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself" (1987, p. 17).

No matter which approach the researcher claims to have, all political ecologists concern themselves with how anthropogenic activities may influence natural ecosystems or environmental resources. Furthermore; how expressed politics surrounding these interactions are mostly weighted by concerns for ecological conservation and perseverance *or* mostly weighted by concerns for human livelihoods, urban expansions or other type of anthropogenic needs deriving from ecosystem services. The assumption, nonetheless, is that ecological conditions are consequently linked to political processes; and central political ecology questions such as: 'what causes regional forest loss? Who benefits from wildlife conservation efforts and who loses? What political movements have grown from local land use transitions?' arises (Robbins, 2012). Political ecology thus arose from a united wish for collective action – a way of facing ecological struggles and documenting livelihood alternatives in the face of change, a change deriving from more evident degradation of natural resources.

2.4 Political ecology discourses

How political ecology is understood and used can also be defined along lines of *discourse*, as political ecology contests the way environmental problems are understood. Conceptualizing what a discourse is can be challenging; Svarstad et al defines discourses to be "constituting systems of knowledge and belief" (Svarstad, Petersen, Rothman, Siepel & Wätzold, 2008, p. 18). Concerns over the degradation of natural resources are interlaced with a range of moral and aesthetic questions about human livelihood, public attitudes as well as relations to other entities on the planet (Dryzek, 2005). Concerns over environmental issues, such as the limits to fisheries resources, thus are home to a range of heated debates and disputes. How then terms and natural systems are *defined* and *understood*, to a far extent defines the level on which they are treated and debated. These levels – the discourse - actively produce knowledge and produces meanings and understandings of different phenomena. Definitions of the word 'nature' can be one example. Defining nature as a place without human activity and thus worthless unless exploited for human usage is something far different than looking at nature as a resource with intrinsic value worth conserving even without exploiting it for human needs. The contests over meaning to concepts then helps understand the way we think and act upon those concepts – for instance how environmental politics and policies are shaped and executed.

Environmental problems tend to be interconnected and multidimensional, and this complexity is often linked to the biophysical world itself – the number and variety of elements and interactions in the environment can be as varied as within a political decision making system. The more complex a situation, the larger is the number of plausible perspectives upon it – because the harder it is to prove any one of them wrong in simple terms (Dryzek, 2005). A discourse, then, is a shared way of comprehending the world and thus acting upon it. Environmental concerns are often acted upon within different discourses, and the policies that are formed within fisheries are no exception. Dryzek (2005) defines environmental discourses along four main basic discourses; the first of them being the *survivalism*, or *limits* discourse, which establishes that the earth's stock of natural resources is limited and thus a wholesale redistribution of power away from perpetual economic growth is needed. Secondly, *environmental problem solving*, which advocates an institutionalization of environmental concerns and other adjustments to operate procedures that helps solve environmental issues somewhat pragmatically. Third, *sustainability* focuses on a redefinition of environmental and economic concepts of growth and thus somehow creating a sustainable axis around which discussions around growth occurs – decision-making that meets the needs of the present without compromising future generations those same needs, and finally *green radicalism* which rejects the way the basic structures of industrial society and the way the environment is conceptualized therein in favour of a variety of different alternative, greener, interpretations of humans and their society (2005).

Within these four categories there are several sub-categories in which environmental problems are understood and solved. This research will be debated and conceptualized within a frame of *environmental problem solving* and *sustainability* discourse. Fisheries and fishing methods are understood as a concept that demands an over-arching institutionalization that again demands pragmatic coordination and cooperation between many different actors. This coordination, however, should be based within a framework of sustainability – not impairing the current fish access so that future generations' access to fisheries are secured.

2.5 Sustainability theories and definition of sustainable development

As this thesis seeks to establish the sustainability levels of a tuna fishery in the WCPO (with emphasis on the skipjack and yellowfin tuna species and the fishing methods of PNL and PS), it is necessary to define the theoretical grounds on which the conceptualization of sustainability rests, within a political ecology context. The publication of the Brundtland report[2] 'Our Common Future' in 1987 marked a shift in public policies covering environmental concerns. The new term 'sustainable development' was launched, defined in Brundtland's words; "humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 8). The concept was not new, as it had been used in the green movement a few decades already, but the report presented a highly ambitious concept seeking human prosperity all the while ensuring *intergenerational equity* – the right for future generations to access the same amount of natural resources this generation gains benefits from. The report debated extensive thematics, including specific concerns about managing natural resources like fisheries.

> Economic growth and development obviously involve changes in the physical ecosystem. Every ecosystem everywhere cannot be preserved intact. A forest may be depleted in one part of a watershed and extended elsewhere, which is not a bad thing if the exploitation has been planned and the effects on soil erosion rates, water regimes, and genetic losses have been taken into account. In general, renewable resources like forests and fish stocks need not be depleted provided the rate of use is within the limits of regeneration and natural growth. But most renewable resources are part of a complex and interlinked ecosystem, and maximum sustainable yield must be defined after taking into account system-wide effects of exploitation (World Commission on Environment and Development, 1987, p. 42).

The report was part of a discourse that can be said to view certain economic growth as an *environmentally* benign growth. Yet economic growth is necessary to accommodate the needs of the worlds poor, which was the essential challenge of the commission: the alleviation of poverty will ameliorate what is one of the basic causes of environmental degradation – as poor

[2] Published formally under the UN World Commission on Environment and Development, welcomed by the General Assembly Resolution 42/187. For more information, see http://www.un-documents.net/wced-ocf.htm

people are often forced to overuse local environments just to survive. Economic growth thus needs to be promoted, but in ways that are environmentally benign and socially just (Dryzek, 2005). The sustainable development theorem further focuses on the integration of social, environmental and economic aspect, and how these three dimensions interrelate to each other and therefore may influence each other in multiple ways.

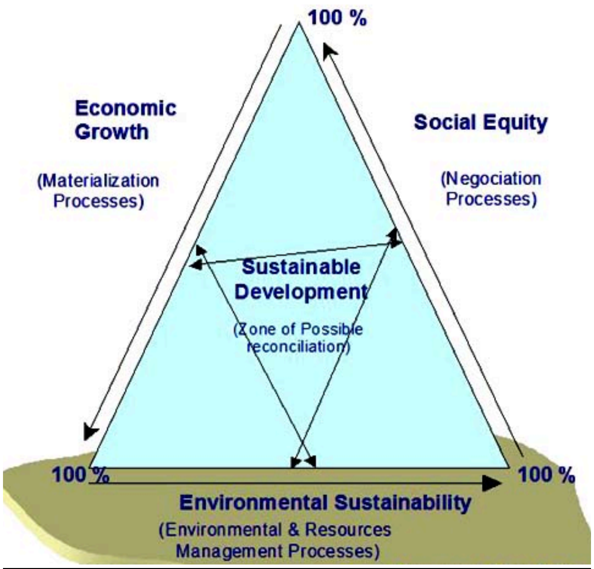


Figure 5: Sustainable development and its three simultaneous objectives. *Source*: (Nijkamp, 1990).

The three 'pillars' in the sustainability triangle in Figure 5 shows how sustainable development policy makers needs to strive for a holistic approach, and to understand the correlations between different systems. Any policy focusing on one of the components may affect the other components, and therefore simultaneous achievements need to be the basis.

2.6 Adapting the SES framework as a tool for analysing sustainability in a fishery

The main idea of sustainability assessment is to evaluate – both quantitatively and qualitatively – the nature and extent of sustainability in a given resource system. For businesses and public managers across sectors it is an increasing need for integration of sustainability into activities. The SES framework can be seen as a tool for engaging people within organisations in sustainable development thinking and to evaluate the sustainability of projects or resources (Cavanagh, Frame & Lennox, 2006). Evaluating the sustainability of an existing fishery system may then be used to predict consequences of a proposed activity such as a new coastal fishery or management approaches. It may involve four steps, which requires the systematic identification of externalities around a particular object of interest. The steps, adjusted to a fishery case, can be defined as 1) deciding on a set of relevant sustainability components for the fishery system, as mentioned in the 'Sustainability theories and definition of sustainable development' section 2.5 in Chapter 2. This step also involves the focus of the cost of the entity. 2) Developing a set of criteria that must be evaluated in assessing each component of sustainability, and the scope or limits of the analysis. 3) Determine set of quantifiable 'sustainability indicators', such as MSY or Total Allowed Catch (TAC), that reflects the status of each criteria. This may also be defined as external impacts to the case. Finally, 4): to formulate indices of sustainability, such as weight or value - the impact of all the externalities associated with the fishery (Cavanagh, Frame & Lennox, 2006, Petaia, 2015). With the steps finalized, the work of addressing some key questions such as 'is the fishery system sustainable?' and 'if not, what needs improvement?' can be concluded by considering the four components of sustainability within a multifaceted checklist framework, or list of criterias.

Ecological sustainability checklist	**Socioeconomic sustainability checklist**	**Political-institutional sustainability checklist**
Are harvest levels sustainable?	Will economic activity provide long-term employment opportunities?	Is the fishery likely to maintain long-term sustainability of communities, regions or countries as a whole?
Are effort levels sustainable?	Will the fishery provide long-term economic viability?	Are people involved in democratic processes, which integrates resource management and development practices?
Are biological impacts well understood to ensure sustainability?	Are pricing systems on inputs and outputs understood?	Will long-term capabilities of institutions be increased?
Are impacts on the ecosystem understood in order to maintain resilience?	Is distribution of benefits to communities fair?	Is financial viability likely in the long term?
Are management measures and strategies effective to ensure resource and environmental sustainability?	Will long-term food security and livelihoods be maintained or increased?	Are management measures effective?

Figure 6: List of ecological, socioeconomic and political-institutional sustainability. *Source*: (Wester Amundsen, 2015).

The checklist is an example of provided guidance and a simple framework to highlight 'trouble spots' in the fishery system – to determine exact criteria for assessing a fishery system; it should incorporate all components of sustainability. Developing sustainability indicators then is the next step as such a quantitative set of indicators creates the *measuring tools* of sustainability in a fishery system. Each sustainability criterion are then quantified appropriately, either through *objective* variables measured in numbers such as biomass or catch levels, or through *subjective* measures evaluated through for instance scales of 1-10. For this research, the sustainability assessment will be performed through both quantitative and qualitative indicators adapted within the SES framework – however, the qualitative component will be much larger than the quantitative one. The checklist model provided is meant as an illustrative example of how to form a sustainability assessment model, however, some of the questions asked formed the basis of the research objectives for this research.

To be able to use sustainability as a model of analysis, it is necessary to both conceptualize what kind of sustainability that is measured, and within which type of ethics the analysis is originating from. Attempts to measure values of a resource may loosely correspond to ecocentric (ecologically centred) and anthropocentric (human centred) positions in environmental ethics (Jenkins, 2009). The ecocentric view traditionally claims that moral decisions needs to rest on the good of inherent ecological integrity for its own sake, opposed to one that holds human need highest. However, these two views needs not necessarily be separated, as a "strong sustainability view could be held from an anthropocentric perspective by arguing that human systems depend on rich biodiversity or that human dignity requires access to natural beauty" (2009, p. 7). Therefore, conceptualizing a theoretical framework to measure a case's level of sustainability is challenging. Understanding the processes that leads to improvements in or deterioration of natural resources is limited, as scientific disciplines makes use of different concepts to describe social-ecological systems (Ostrom, 2009). Seeing how systems like a fishery is composed of several sub-units and internal variables that all interact with each other, scholars like Ostrom argues that the level of analysis needs a better framework to organize findings.

The SES framework incorporates tiers, e.g. in sets of variables that characterizes the ecological dimensions of the system, and as such tries to overcome the limitations done in earlier research in other common-pool resources literature (Schlüter & Madrigal, 2012). For this research, then the tuna fishery in question has been organized into units of analysis, adapted from Ostrom's SES framework; the resource system (commercial fishery), resource units (yellowfin and skipjack tuna), users (fishers) and governance systems (organizations like PNA and FFA as well as country jurisdiction that governs fishing in the central-western Pacific) (Ostrom, 2009). The analysis will then make use of the relationships among multiple levels of these complex systems at different scales. Models for sustainability can be organized into terms of sustainability components, each prioritizing a set of standards that needs to be sustained. This research will make use of such a model, as it distinguishes modes of analysis levels into three research objectives; ecological sustainability, socioeconomic sustainability and political-institutional sustainability – the three pillars is shaped within Ostrom's first-level core subsystems. The integration of ecological, economic and political sustainability thus forms the key sustainability principle, and will form the levels of analysis in Chapter 7. The adapted SES framework model (Figure 7) for this research is to be seen on the following page:

2.7 The adapted SES framework

Figure 7 (following page)

Second-level variables under first-level core subsystems (S, RS, GS, RU, U, I, O and ECO), modified from Ostrom's framework for analysing social-ecological systems (SESs) (Ostrom 2009:421). The variables are not listed in order of importance; this importance varies with the variables. The factors modified specifically for the purpose of this study and for the specific relevance of the yellowfin and skipjack tuna fishery of the WCPO is marked with squared brackets, italic font or starred.

Social, economic and political settings (S)

S1 - Economic development. S2 - Demographic trends. S3 - Political stability. S4 - Government resource policies. S5 - Market incentives. S6 - Media organization.

Resource systems (RS)

RS1 Sector
RS 1.1 Yellowfin and skipjack tuna
RS2 Clarity of system boundaries
RS 2.1 WCP-CA and SI EEZ
RS3 Size of resource system
RS 3.1 WCP-CA
RS4 Human-constructed facilities
RS 4.1 Storage in a human-designed facility
RS5 Productivity of system
RS 5.1 Stock status
RS 5.2 Biophysical factors
RS6 Equilibrium properties
RS 6.1 Landed tonnage in SI and WCP-CA
RS7 Predictability of system dynamics
RS 7.1 MSY/CPUE levels for skipjack and yellowfin
RS8 Location*

Resource units (RU)

RU1 Resource unit mobility
RU 1.1 Yellowfin and skipjack highly migratory patterns
RU2 Growth or replacement rate
RU 2.1 Spawning and reproductive rates
RU 2.2 Perceptions from informants
RU3 Interaction among resource units
RU 3.1 Co-existence in schools
RU4 Economic value
RU5 Number of units
RU 5.1 Perceptions from informants
RU6 Distinctive markings
RU 6.1 Perceptions from informants
RU7 Spatial and temporal distribution
RU 7.1 ENSO and seasonality patterns

Governance systems (GS)

GS1 Government organizations
GS 1.1 Employment in SI
GS2 Non-governmental organizations
GS 2.1 Support enforcement
GS 2.2 Conservation efforts
GS3 Network structure
GS4 Property-rights systems
GS 4.1 Open-access
GS 4.2 The vessel day scheme
GS 4.3 Territorial use privileges
GS5 Operational rules
GS 5.1 Gear limitations
GS6 Collective-choice rules
GS 6.1 Perceptions from informants
GS7 Constitutional rules
GS 7.1 Sustainable fisheries management
GS 7.2 Ecosystem-approach to fisheries management (EAFM)
GS 7.3 Management effectiveness
GS 7.4 Perceptions from informants
GS8 Monitoring and sanctioning processes
GS 8.1 Perceptions from informants
GS 8.2 The VMS scheme
GS 8.3 Social
GS 8.4 Biophysical
GS 8.5 Bans and closures
GS 8.6 By-catch mitigation

Users (U)

U1 Number of {relevant} users
U 1.1 The role of DWFN actors
U2 Socioeconomic attributes of users
U 2.1 Food supply in SI and PICTs
U 2.2 Community livelihoods
U3 History of use
U 3.1 PNL fishery
U 3.2 PS fishery
U4 Location
U5 Leadership/entrepreneurship
U 5.1 FFA, PNA and the role of Regionalism
U 5.2 Tri Marine and NFD
U6 Norms and 'social capital'
U 6.1 Perceptions from informants
U7 Technology used
U 7.1 The 'technology creep'

Interactions (I) → Outcomes (O)

I1 Harvesting levels of diverse users
I2 Information sharing among users
I3 Deliberation processes
I4 Conflicts among users
I5 Investment activities
I6 Lobbying activities
I7 Self-organizing activities
I8 Networking activities
I9 Monitoring activities**

O1 Social performance measures (e. g., efficiency, equity, accountability, sustainability)
O2 Ecological performance measures (e. g., overharvested, resilience, bio-diversity, sustainability)
O3 Externalities to other SESs

Related ecosystems (ECO)

ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.

* The original second-tier variable RS9 'storage characteristics' from Ostrom (2009, p. 421) is removed as it is considered covered in second-tier variable RS 4.1 for this research, and storage characteristics not being a central issue for the purpose of this research.
**Second-tier variable modified from Ostrom (2009, p. 421) and inspired by Basurto, Gelcich and Ostrom (2013).

To be able to answer the sustainability components presented in Figure 7, this research will make use of a mixture of own data collection from fieldwork, as well as secondary cited literature. The structure provides a complex, multivariate analysis format that measures the sustainability levels of the fishery through ecological, socioeconomic and political-institutional factors. The adapted SES framework model in Figure 7 is going to form the structure for the analysis part of this research, in Chapter 7. The SES framework has only recently been proposed as an analytical tool, and therefore there is limited literature where it has been used; although its generally been appraised in the academic world, and in all likeliness more use of this model will be seen in future publications. The SES framework has been used in a marine setting before, for instance in the work of assessing benthic small-scale fisheries by Basurto, Gelcich & Ostrom (2013). From scholars such as Schlüter & Madrigal (2012), the framework has been acclaimed, as it is able to:

> (...) Bridge two important gaps that can exist in research. First, it is able to bridge the gap between different theories and even disciplines. Second, it is able to bridge the gap between a more inductive, empirically driven research approach and a more deductive, theory driven approach. (...) The framework can enhance our understanding of how people use common pool resources (Schlüter & Madrigal, 2012, p. 148-149).

Understanding which school of thought the SES framework derives from is seen as necessary, and as such a short presentation of the tragedy of the commons literature will be presented in the following section.

2.8 The tragedy of the commons and common property theory

The fact that any shared, global, open-access or mutual good are prone to free riding has been known within a wide range of scholars for decades. The common property theory, one of the earliest contributions to the field of political ecology, rests on the understanding that fisheries, forests, rangeland, genes, and other resources, like many of the environmental systems over which struggles occur, are traditionally managed as collective or common property (Robbins, 2012). Many environmental systems that are of extraction or harvesting value to humans can be difficult to divide into individual units of ownership, and are thus vulnerable to overexploitation, degradation, overgrazing, pollution or over-harvesting of fishing resources.

Although many shared resources have been harvested in communities around the planet for centuries without at the same time eradicating it, in the 1970s other ways of foreseeing the possible fate of usage of collective goods emerged among academics. Actors within a shared resource committing self-rational choices to ensure self-sufficiency might lead to a collective collapse of the resource itself. As defined by Ostrom (2009): "The prediction of resource collapse is supported in very large, highly valuable, open-access systems when the resource harvesters are diverse, does not communicate, and fail to develop rules and norms for managing the resource" (p. 419).

At the emerge of the environmentalism movement and political ecology school, the issue was addressed as a "response to the conventional wisdom in the West, wisdom rooted in the premise that private gains might hold social or ecological costs, and which held that collective use of resources tended inherently towards abuse and degradation" (Robbins, 2012, p. 34). The pioneers of political ecology were not the first to address these issues, however. During modern and pre-modern times it has been an assumption that organizations or groups exists to promote the mutual interests of the members within this organization – and that the organization itself is a premise to achieve these interests. It is thus in the rational interest of each individual to support this organizing, because should she not do so, neither will the rest, and she will remain without the benefits the organization could have given her (Hovi, 2009). The understanding of the problematics that may derive from organizational structures were addressed in the 1960s by the political scientist Olson, who wrote about the issues that would later on describe the essence of what challenges the success rates of international climate regimes, fisheries, forestry or any other political and administrative unit coordinating a shared resource:

> It is the essence of an organization that it provides an inseparable, generalized benefit. (...) Any group or organization (...) works for some benefit that by its very nature will benefit all of the members of the group in question. Though all of the members of the group therefore have a common interest in obtaining this collective benefit, they have no common interest in paying the cost of providing that collective good (Olson, 1965, p. 21).

The threat of overfishing a shared fishery resource is a perfectly good example of such a collective good which each actor within that fishery – not to mention; any person consuming that very fish – has an *objective* interest of safeguarding. This is the main point made as the basis of the rational choice theory. However, to refrain from the 'what is rational only for *me*' logic, one is reliant on each actor's combined effort. Garrett Hardin formulated this socioeconomic theory into the renowned allegory of 'The Tragedy of the Commons'. "Picture a pasture, open to all," Hardin begins in his classic statement:

> It will be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal war, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally however comes the day of reckoning, that is the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy (Hardin, 1968, p. 1244).

Because a fishery of a pelagic species like tuna is a common good, transcending country boundaries, it is prone to the logic of this allegory. Providing a shared management plan will likely suffer from the possibility of individuals or fishing companies, assumed to be seeking individual or company benefit, wanting to extract as much as possible from that common good – thinking within a rational choice logic. Say a group of individuals, countries or fishery management organizations forms a management plan of reduction or quota system of TAC. It is then an inherent, following this logic, possibility that one or several actors might freeload to other actors fishing reduction initiatives. If a group of actors follows through an ambitious execution of fishing pressure reductions, other actors that do not follow these ambitions will not necessarily have the incentive to likewise step up their efforts. In fact – they may rather have an incentive to do the exact opposite, *not* to strive for a reduction in fishing pressure and continue 'business as usual' (Hovi, February 6th, 2012) As long as that indifferent actor is leaning on the effort of the ambitious others that *are* implementing measures, it may not be seen as rational or significant to herself being part of the reduction priorities (Hovi, 2009).

The logic is easily transferable to a fisheries situation: since access to marine resources is essentially free, the actions of a single fisher or fishing vessel may not feel, *logically*, like a contribution to the dynamics of an exploited stock. The conservation effort of one individual actor is likely to gain him so little because fish in the water will most likely just be caught by someone else (Jennings, Kaiser & Reynolds, 2001). Lack of access control, a massively improved catch technology on modern vessels, combined with an explosive global population growth demanding food, coupled with a common perception that everyone has a right to fish, are the main logics behind over-exploitation of marine resources (2001).

The big question then remains: when will the users of a resource invest time and energy to avert a 'tragedy of the commons' situation? When will they strive to refrain from what is a rational choice 'only for me, now', to what may be a rational choice 'for us, now, *and* secured into the future'? To avoid the actors to resign into this logic, it is traditionally believed that they need organization in an over-governing body where the resource management is handled. This action is considered needed as that is the only way to achieve aggregate efforts, financing and burden sharing as well as avoiding mutual restraint and coordination (Barrett, 2007). Extensive research has been performed in the topic, and have found that the users of several types of resources has indeed invested in designing and implementing costly governance systems to increase the probability of sustaining that resource (Ostrom, 2009), it does in fact exist evidence of managing schemes wanting to avoid the unsustainable loop of the rational choice logic. It is inconceivable that an international effort to mitigate global tuna overexploitation will succeed, however, without the effort of the 'big players' in the industry. The role of the 'super seiners' and the largest DWFNs will be further investigated in section 7.31.1 in Chapter 7.

3.0 Chapter 3: The research site and research case

3.1 Description of research site

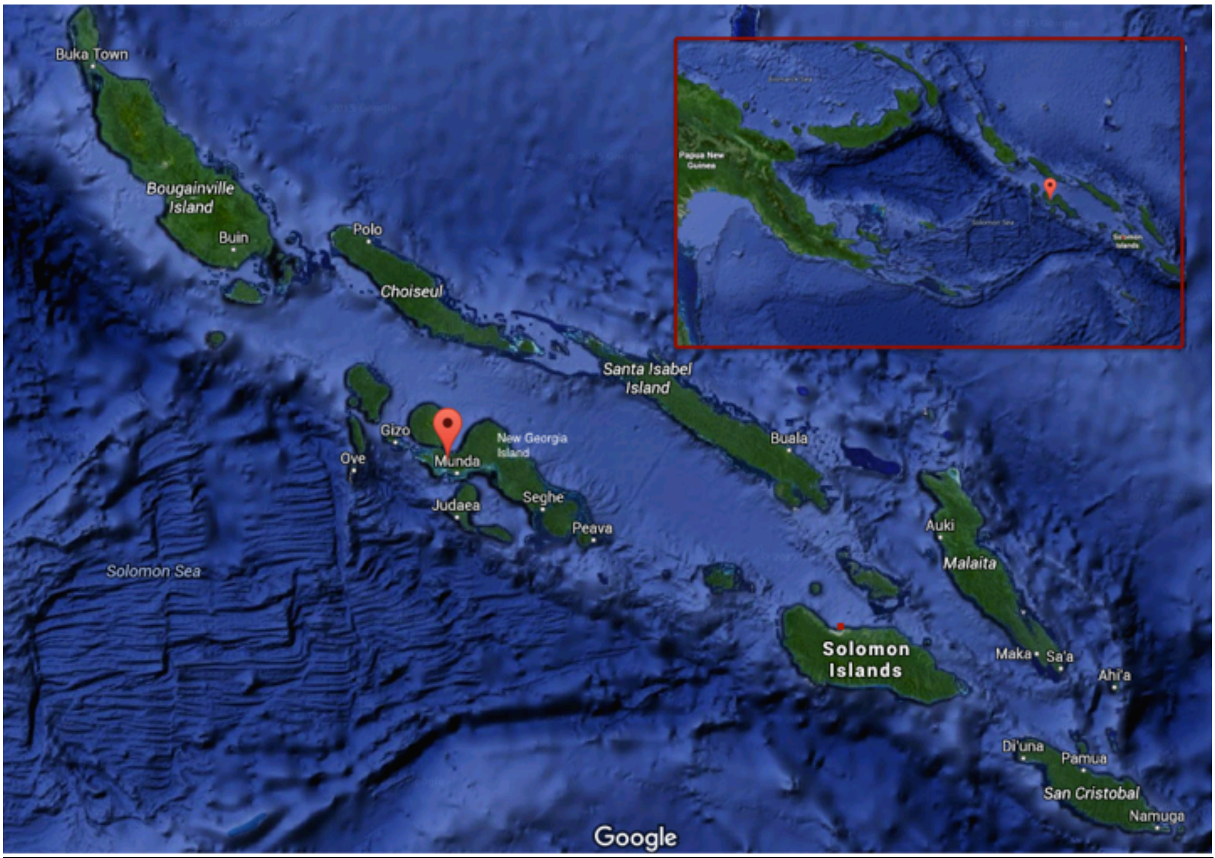


Figure 8: Map of study area. Red and black, angled dot indicates Noro in Western Province. Small, red dot indicates the capital Honiara at the island of Guadalcanal. Inset map indicating SIs location vicinage to PNG. *Source*: (Google Earth, 2015).

Data for this research was collected in the Western Province of SI. SI is an archipelagic state located in the central-western Pacific Ocean, to the east of Papua New Guinea (PNG) and to the north of Vanuatu and New Caledonia. SI is composed of approximately 1,000 islands and other features that are widely scattered over a land area of 27,556 km^2. The port town of Noro, located in the North-Western end of New Georgia Island, was the specific site of which the main portion of the interviews were done – the interviews with the PNL and PS fishers, as well as with the local NFD manager. The key informant interviews from the general manager of NFD were performed in the capital Honiara at the island of Guadalcanal, likewise with the informant from FFA. The Western Province of SI is the largest of the Solomon provinces, and the main destination for the tourism sector in the country. The tourism industry is moderate; according to the World Bank the registered tourists entering the nation were 24,400 in 2013

(World Bank, 2015). The province holds a population of approximately 77,000 inhabitants, the Island of Gizo being the provincial capital as well as the main tourism destination. The waters surrounding this province are internationally renowned as one of the worlds most marine biologically diverse and home to huge areas of coral reef ecosystems. Most tourists, however, travel to the more developed tourism nation of Fiji – making the diving and snorkelling conditions world-class due to its pristine character.

The region is still recovering from the 2007 SI earthquake, striking at 8.1 on Richter's scale causing a subsequent tsunami (Pauku, 2009). The marine habitats around the island of Gizo were severely affected, causing destruction of corals, as well as a small number of human deaths, but many displacements. Reefs around Munda were, however, largely unaffected. The presence of malaria in the country as well as a civil unrest between 1999-2003 has further been considered to cause the tourism industry not to increase despite the indisputable natural beauties of the country and the hospitality and rich cultural history of Solomon Islanders (Barclay & Cartwright, 2007a). The region covers approximately 5,475 km^2 and consists of approximately 40 bigger islands, the biggest of them being New Georgia Island where Noro is situated, as well as hundreds of smaller islands in the shallow waters of the region. According to SPC, SI as a whole covers a land area of 27,556 km^2, an EEZ area of 1,553,444 km^2 (making the land area as % of EEZ only 1.74%), a coastline of 5,313 kilometres and being home to approximately 550,000 inhabitants (Bell, Johnson & Hobday, 2011, p. 211).

<u>3.2 Noro town</u>

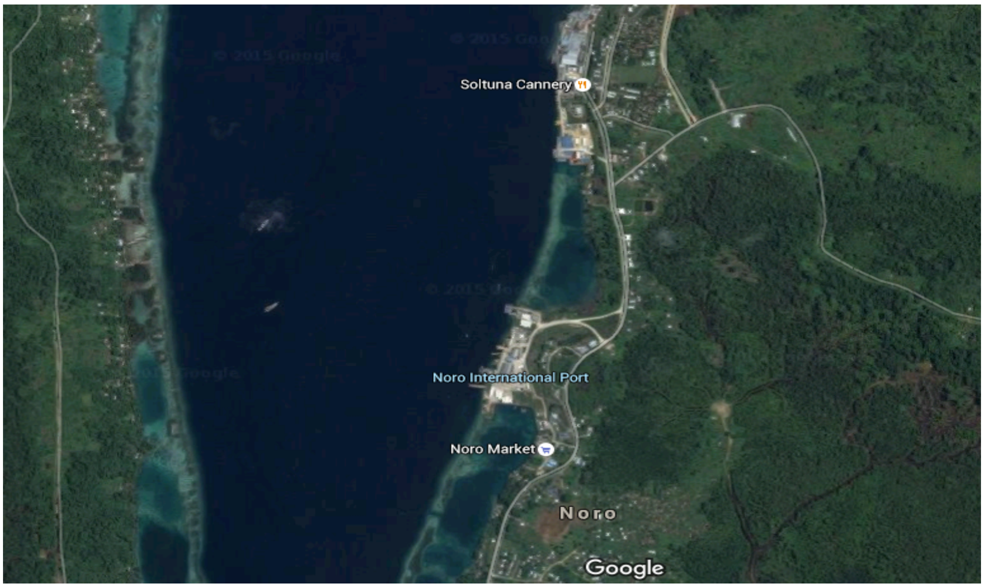


Figure 9: Map of Noro town. *Source*: (Google Earth, 2015)

Noro town is the main fishing port of SI and its coordinates are at 8° 13' 0" South, 157° 13' 0" East and is located approximately 195 nautical miles (nm) North-West from the capital Honiara. The small town has approximately 3,300 inhabitants[3], most of these being employees or families of employees within the Soltuna cannery, at NFDs offices at the port, or with the port authorities handling cargo unloading and loading, as well as passenger ships arriving and departing (IFC, 2013). According to the local NFD manager, approximately 95% of their employees were local, and the total number of crews on their seven vessels is around 180 men. (Five PS vessels with 22 crew members, and two PNL vessels with 35 crew members). The SolTuna cannery's total workforce covering all activities employs approximately 1,500 local workers, and of today is the only domestic tuna processor in the region (2013). The female employment of the cannery is high; approximately 62% of the work force is female, including 15 higher-level professional positions (2013). SolTuna's upgrading and investment in local employment is consistent with the SI government's strategy to increase landing and processing of tuna within their own country boundaries – and as such, being able to capture more value from its tuna resources (2013). SolTuna also has undergone a significant commitment to improve their social responsibility in the community, as their employees are provided with housing or housing subsidies as well as educational subsidies for children, transportation, electricity and a local health clinic service. Their employment size is the by far biggest local employer in the region providing jobs and training opportunities to an otherwise scarce formal employment environment.

[3] Number retrieved from Solomon Islands 2009 Population and Housing census.

The fishing vessels unloading here are both Solomon-registered and international. During the two weeks field trip of this research, for instance, two Taiwanese longline vessels were unloading as well as the NFD Solomon-registered vessels from which interviews were completed. There is a both locally and national strategy of trying to secure a more significant portion of the total albacore catch, as were previously the case, being landed and processed in other countries. Therefore, NFD has been seeking to provide ancillary services in Noro to foreign vessels as a means to attract them to land and unload their catch there. Also, to promote local industry, the SI government has a outspoken policy of restricting DWFN access and fishing effort by providing preferential licencing to domestic fleets and those that lands fish locally for processing (IFC, 2013). A significant traffic of Malaysian cargo vessels passing through the Noro bay or Kula Bay were also observed during the field work for this research, carrying timber, mainly from the Marovo province further east in Western Province. The increased logging activities in the country the recent years have been a source of significant sustainability concerns. Commercial logging has changed the vegetation cover from an approximate 80% in the 1990s to 76% today, with an ever increasing rate of particularly Malaysian logging companies being granted logging licences from the Ministry of Forestry of SI – in 2004, approximately 1 million m^3 of logs were harvested, against the estimated sustainable harvest levels set at only 200,000 m^3. (Pauku, 2009). The role of the logging industry in regards to the abundance levels of baitfish will be further debated in section 6.1.9 in Chapter 6.

3.3 A brief overview of Solomon Islands' current political situation

The civil unrest period from 1999-2003 was a result of long-simmering tension between the *Gwale* people of Guadalcanal and migrants from the neighbouring island of Malaita. After four years of unresolved civil unrest, causing at least 100 deaths and over 30,000 internally displaced Malaitans, a unanimous vote in parliament issued an official request for international help, resulting in the intervention of an international peacekeeping force in August 2003, known as the Regional Assistance Mission to Solomon Islands (RAMSI) (TRC, 2012). Australia was the main contributor of RAMSI security personnel, but also policemen and security forces from New Zealand, Fiji and PNG contributed. As of July 2013, the RAMSI forces have begun a phased redeployment after the security situation in the country has been considered stabilized. The tensions harmed the tuna industry in SI quite significantly. In 1999, SI had the largest domestic-based tuna industry of all PICTs with regards to volume and value – Solomon Taiyo, a Japanese tuna company operating in SI from Noro, employed around 3,000 people as well as 800 women in a cannery. The export value of tuna was 20-46 per cent of total exports. A complete derailing of the formal economy (except the logging industry) was striking the formal economy during the years of the tensions. Prices for frozen skipjack fell from US$980 per mt in 1998 to US$326 in 2000 (Barclay & Cartwright, 2007a). Soon, Solomon Taiyo closed operations, and NFD scaled down. After tuna prices recovered in 2001, however, the domestic industry started its rebuilding and after NFD became taken over by Tri Marine their economical position has strengthened significantly.

Another conflict in SI of recent years has been riots and looting of Chinese businesses in Chinatown in Honiara, following the 2006 general elections (TRC, 2012). Claims were being made of the election being fixed with the aid of money of Chinese businessmen, a culmination of frustration from a general public perception of Chinese enterprises receiving increased power and lucrative business arrangements[4]. Cases of suspected corruption such as this case is not uncommon in Solomon politics, and it is a widespread notion, both nationally and internationally, of the island nation being notoriously corrupt[5]. According to Transparency International SI ranked at an all-time low of being the 120th least corrupt nation out of 175 ranked countries in the world in 2011. They climbed up to a 109th place in 2008, however, hopefully providing an evidence of politicians working towards a future of more accountable politics and governance in the country[6].

3.4 Overview of the tuna fishery in Solomon Islands

SI is a nation, which like most other PICTs has a significant fisheries sector. Their fisheries types includes oceanic fisheries, coastal fisheries, freshwater and estuarine fisheries as well as coastal aquaculture. According to Bell, Johnson & Hobday (2011), SI is a member of several

[4] For more information about the Honiara riots in 2006, see for instance http://www.ipsnews.net/2006/04/south-pacific-fear-of-domination-sparked-anti-chinese-riots/, http://news.bbc.co.uk/2/hi/asia-pacific/4930994.stm or http://www.chinadaily.com.cn/china/2006-04/25/content_575798.htm

[5] For more articles on corruption in Solomon Islands, see for instance https://www.unodc.org/documents/treaties/UNCAC/WorkingGroups/ImplementationReviewGroup/ExecutiveSummaries/V1403922e.pdf, https://freedomhouse.org/report/freedom-world/2012/solomon-islands, http://devpolicy.org/solomon-islands-post-ramsi-falling-down-in-bits-and-pieces-part-2-20131105/, http://www.tradingeconomics.com/solomon-islands/corruption-rank, http://www.solomontimes.com/news/anticorruption-efforts-highlighted/8413, http://www.u4.no/publications/corruption-challenges-in-small-island-developing-states-in-the-pacific-region/, http://www.abc.net.au/news/2015-01-22/solomon-islands-chief-justice-calls-for-action-on-corruption/6036168 or http://www.parliament.gov.sb/index.php?q=node/582.

[6] Numbers retrieved from http://www.tradingeconomics.com/solomon-islands/corruption-rank

regional fisheries management arrangements, including FFA, WCPFC, PNA, South Pacific Tuna and Billfish Subcommittee and Melanesian Spearhead Group. Being situated practically along the equatorial line, SI has a tropical climate throughout the year with an average temperature of 27.4°C. The primary influence on surface climate is therefore not seasonality, but the El Niño-Southern Oscillation (ENSO) effects during the years that occur. Due to its deep thermocline, the waters have low net primary production – however, during ENSO years the primary production rate increases significantly due to a shallower thermocline. Despite this – the equatorial upwelling in the waters surrounding SI creates a highly valuable tuna fishery. Inside SI EEZ the fishery is primarily consisting of PS and PNL fisheries, and increasingly; DWFN longline vessels operating with SI fishing licences. The average annual catches for SI oceanic fisheries is illustrated in Figure 10:

Local oceanic fisheries	Average annual catch (tonnes) 2004–2008	Average annual catch value (USD million)* 2004–2008
Tuna		
Purse-seine	17,870	21.2
Pole-and-line	4540	7.3
Longline	190	1
Other oceanic fish[a]	16	0.02
Total	**22,616**	**29.52**

Figure 10: Recent catch and value of oceanic fisheries in SI. *Calculated using market value per tonne for 2004-2008; a = billfish catch only, valued at USD 1000 per tonne. *Source*: (Bell, Johnson & Hobday, 2011, p. 214).

On top of the numbers appearing in Figure 10, which only includes local fisheries, the average annual catch by foreign PS and PNL vessels between 1999-2008 was approximately 50,000 tons, worth > USD 46.5 million. Foreign longline vessels also landed an average of > 4,000 tons of fish each year in the same period, worth > USD 12 million. Finally, significant catches from foreign PS vessels (averaging at > 65,000 tons a year) are landed in SI for transhipping.

Industrial fishery	Contribution to GDP*		Contribution to GR	
	USD m	GDP (%)	USD m	GR (%)
Surface[a]	14	3.1	11.8	4.4
Longline	1.1	0.2	0	0

Figure 11: Contibution to SI's GDP from industrial fisheries. Surface fisheries includes PS and PNL fishing. GR = government revenue. * Information from 2007, when national GDP was USD 457 million and GR was USD 267 million. a = locally-based PS and PNL fleets. *Source*: (Bell, Johnson & Hobday, 2011, p. 220).

In terms of effects to the national SI economy and government revenue, the fishery sector plays a significant role. The locally-based surface tuna fishery contributed 3.1% and the longline fishery only 0.2% to the Gross Domestic Product (GDP) of SI in 2007. Adding the value of processing tuna to fishing operations, the average combined contribution to GDP increased to 4.6%, with a total worth of USD 22 million. Licence fees combined from DWFN PS and national vessels contributed > 4% of GR in 2007 (Bell, Johnson & Hobday, 2011).

Figure 12 refers to the current contributions from the fishery sector to the livelihoods sector in SI. A large quantity of the numbers presented in the Figure is deriving from the jobs that NFD has created in SI. Large numbers of full-time and part-time employment opportunities has derived from the tuna fishing and processing in SI, even if it is contributing to the total employment rate in the nation to little degree – this is due to the relatively large population. Coastal and subsistence fisheries provide important income for coastal communities, with > 60% of households in representative coastal communities deriving their first or second income from catching and selling fish. Aquaculture only provides approximately 600 jobs in the country, mainly through the seaweed farming industry (Bell, Johnson & Hobday, 2011).

Jobs on tuna vessels			Jobs in shore-based tuna processing			Coastal households earning income from fishing (%)			Jobs in aquaculture*
2002	2006	2008	2002	2006	2008	1st	2nd	Both	2007
464	66	107	422	330	827	29	32	61	610

Figure 12: Contributions from the fishery sector to employment levels in SI. * Ponia (2010); information derived from Chapter 12, table 12.6 and the SPC PROCFish Project. Source: Bell, Johnson & Hobday, 2011, p. 223).

The fishery sector in SI is operating in two different sectors; the archipelagic waters and the EEZ. The area of which the NFD vessels operates is entirely within SI waters, and approximately 95% of the catch caught within the Main Group Archipelago (MGA) waters. Because of its geography, SIs' Baselines Declaration establishes archipelagic baselines around five separate groups of islands, see Figure 13.

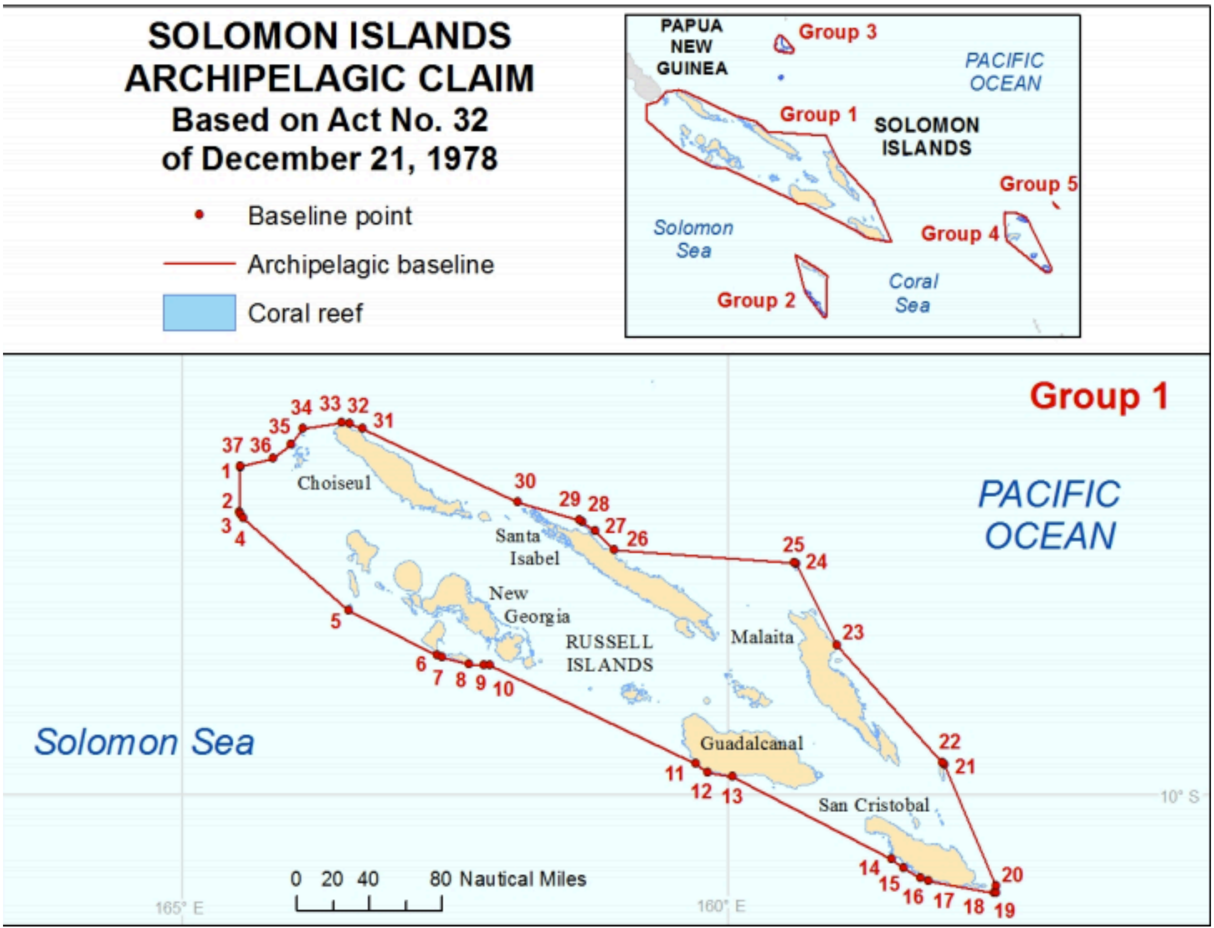


Figure 13: Illustrative map of SIs' Archipelagic Baselines. *Source*: (U.S. Department of State 2014, p. 7).

The MGA, or the Maritime zone under sovereignty of the coastal state of SI, is only accessible by subsistence, artisanal and domestic commercial fishing vessels landing catch for local processing (IFC, 2013, p. 3). As NFD's vessels are almost entirely crewed by Solomon Islanders, that goal is by all estimates reached. The EEZ zone of SI is illustrated in Figure 14:

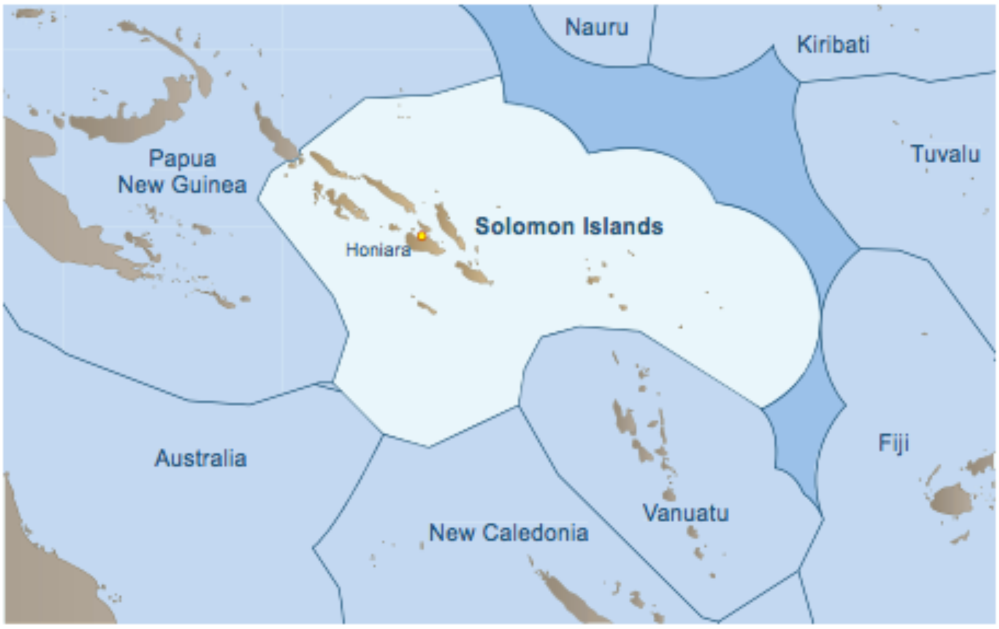


Figure 14: Model of the EEZ of SI. *Source*: (Bell, Johnson & Hobday 2011, p. 211).

In terms of food security, SI is no exemption to other PICT nations: fish is an important portion of the total food consumption and a crucial factor of remaining healthy food security levels. However, SI is among the group of PICTs where "the estimated sustainable production of fish and invertebrates from coral reefs and other coastal habitats will not supply the future population with the 35 kr of fish per person per year recommended for good nutrition" (Bell, Johnson & Hobday, 2011). As Figure 15 shows to, the fish consumption in SI is estimated to 33 kg per person per year. The rural population's protein intake depends almost exclusively to fish; an estimated 94% of the protein intake comes from fish, in urban environments the number is 83%.

Fish consumption per person (kg)			Animal protein from fish (%)		Fish provided by subsistence catch (%)	
National	Rural	Urban	Rural	Urban	Rural	Urban
33	31	45	94	83	73	13

Figure 15: Fish consumption in SI. *Source*: (Bell, Johnson & Hobday, 2011, p. 221).

In the estimated food demands for the future decades, SI will, if the estimations are correct, experience a rapidly increasing total demand for fish for food security due to a significant predicted human population growth. As Figure 16 shows to, the current estimated fish surplus changes to a shortfall of 7 kg per person per year in 2035, and a dramatic increase to 12 kg in 2050 and 21 kg in 2100.

Variable	2010	2035	2050	2100
Population (x 1000)	550	970	1181	1969
Fish available per person (kg/year)[a]	50	28	23	14
Gap (kg/person/year)[b]	(+15)	7	12	21

Figure 16: Effects from fish available for protein intake in future estimations of human population growth. *Source*: (Bell, Johnson & Hobday, 2011, p. 221).

In a recent assessment of effects from global climate change, the oceanic fisheries of SI have been estimated to experience an expansion of its so-called warm pool surface area.

> The greater stratification of the water column in the warm pool due to higher surface temperature, and the increased depth of the nutricline are projected to reduce net primary production within the EEZ of SI. Relocation of the convergence zone between the warm pool and PEQD to the east is also expected to increase the distance between SI's EEZ and the prime feeding grounds for tuna (...). Under B1 and A2 emissions scenarios, catches of skipjack tuna in the EEZ and archipelagic waters of SI are expected to increase slightly in 2035, relative to the 20-year average. Catches of skipjack and bigeye tuna are projected to decrease under A2 in 2050, and under both scenarios in 2100. Modelling for yellowfin and albacore tuna is in progress, but for yellowfin tuna expected to be similar to those of skipjack tuna, whereas albacore are expected to move poleward (Bell, Johnson & Hobday, 2011, p. 214-215).

The excerpt above signals to an important fact: the future of the tuna fisheries of SI and other PICTs does not only depend on levels of fishing effort, vessels or degree of regional cooperation. The role of climate change to the thermophysical features of the oceans will to a highly differing degree affect the development of local and regional tuna fisheries. Figure 17 further adds to the future scenarios of effects to the GDP levels from differentiated climate change scenarios[7] in SI. Figure 17 further draws on potential economic scenarios; 4 out of 6 climate change scenarios estimates that the SI GDP level will decrease due to climate change, further possibly impairing the development and food security levels of the country.

Projected changes to GDP (%)**			Projected changes to GR (%)		
B1/A2 2035	B1 2100*	A2 2100	B1/A2 2035	B1 2100*	A2 2100
+0.1 to +0.2	-0.1 to -0.3	-0.3 to -0.8	0 to +0.2	0 to -0.3	0 to -0.8

Figure 17: projected changes to GDP and GR in SI due to the effects of climate change. * Approximates A2 scenario in 2050, ** information from 2007, when GDP was USD 457 million and GR was USD 267 million. Source: (Bell, Johnson & Hobday, 2011, p. 221).

[7] For definitions of the B1, A2 and B2 climate change scenarios, see Bell, Johnson and Hobday, 2011.

3.5 History and overview of the PNL fishery in the WCPO

This section will briefly describe the developments of the PNL fishery in the WCPO, from its modest start in the 1960s, up until today.

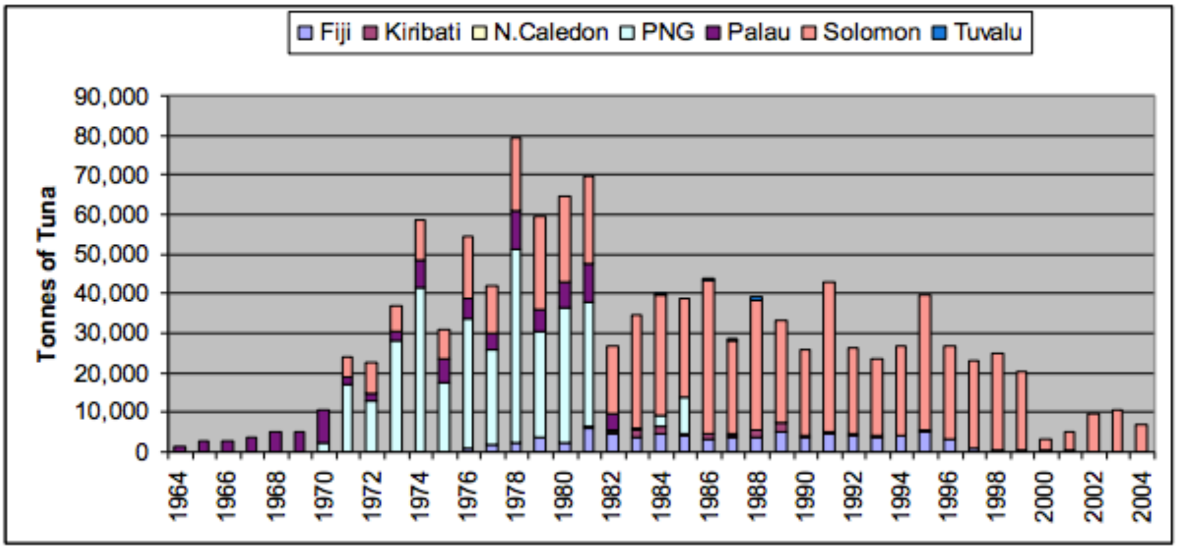


Figure 18: Tuna catches by Pacific Island PNL fleets. Constructed from various SPC yearbooks, especially: Lawson, T. (1998). Tuna Yearbook 1997, SPC, Noumea. *Source*: (Gillett, 2011, p. 10).

Figure 18 illustrates a significant decrease of PNL vessels based in the PICT area starting in the early 80s. That time period was characterized by a period when the number of active PS vessels operating in the PICTs increased rapidly, consequently decreasing the amount of active PNL vessels (Gillett, 2011). Catches from PNL vessels based in PICT reached its maximum in the year of 1978, with PNG as a significant actor within the fishery. Their participation in the fishery then dropped dramatically, and from 1986 disappeared completely. SI, however, can be considered the most stabile actor within the fishery, but also there the amount of active PNL vessels has dropped significantly, with a steady decline starting from the top year of 1991 with 32 active vessels (WCPFC, 2014a). The top catch year peaked in 1986 with 38,000 mt of tuna caught. The decline of the PNL fishery has complex explanations - the lack of ability to compete economically with the more efficient PS vessels being the most important of them. As elaborated in this research, the SI operations are an interesting case, as it represents a cautious re-entry into PNL fishing through the substantial experience of NFD within the fishing method. As the executive from NFD, informant 3, articulated:

> It is a goal for NFD to increase our PNL fleet, because it's valuable in the market as well as from our shareholders point of view – we get a good premium out of PNL caught fish in the EU market. Also, we try our best to practice sustainable fishing, through using PNL as a fishing method. Through the Vessel Day Scheme (VDS), the SPC has adviced us to have the equivalent of 5 purse seiners, which we have now, and the equivalent of 6 PNL vessels, which mean we still can increase to 3 more PNL vessels (Informant 3, April 24th, 2015).

The statement is in accordance to SIs' official view of a strong government support for PNL development (Gillett, 2011). Several PICTs, has, as Figure 18 indicates, had several PNL vessels operating throughout the decades after 1960. However, the by far dominant actors have not traditionally been the PICTs, illustrated in Figure 19.

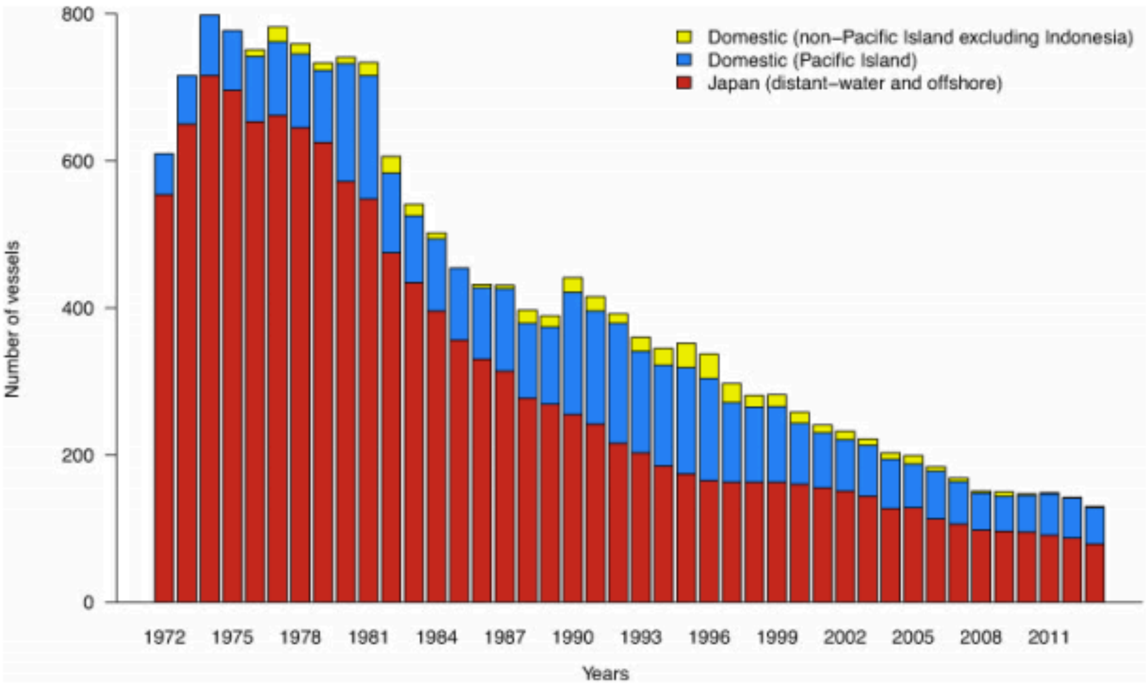
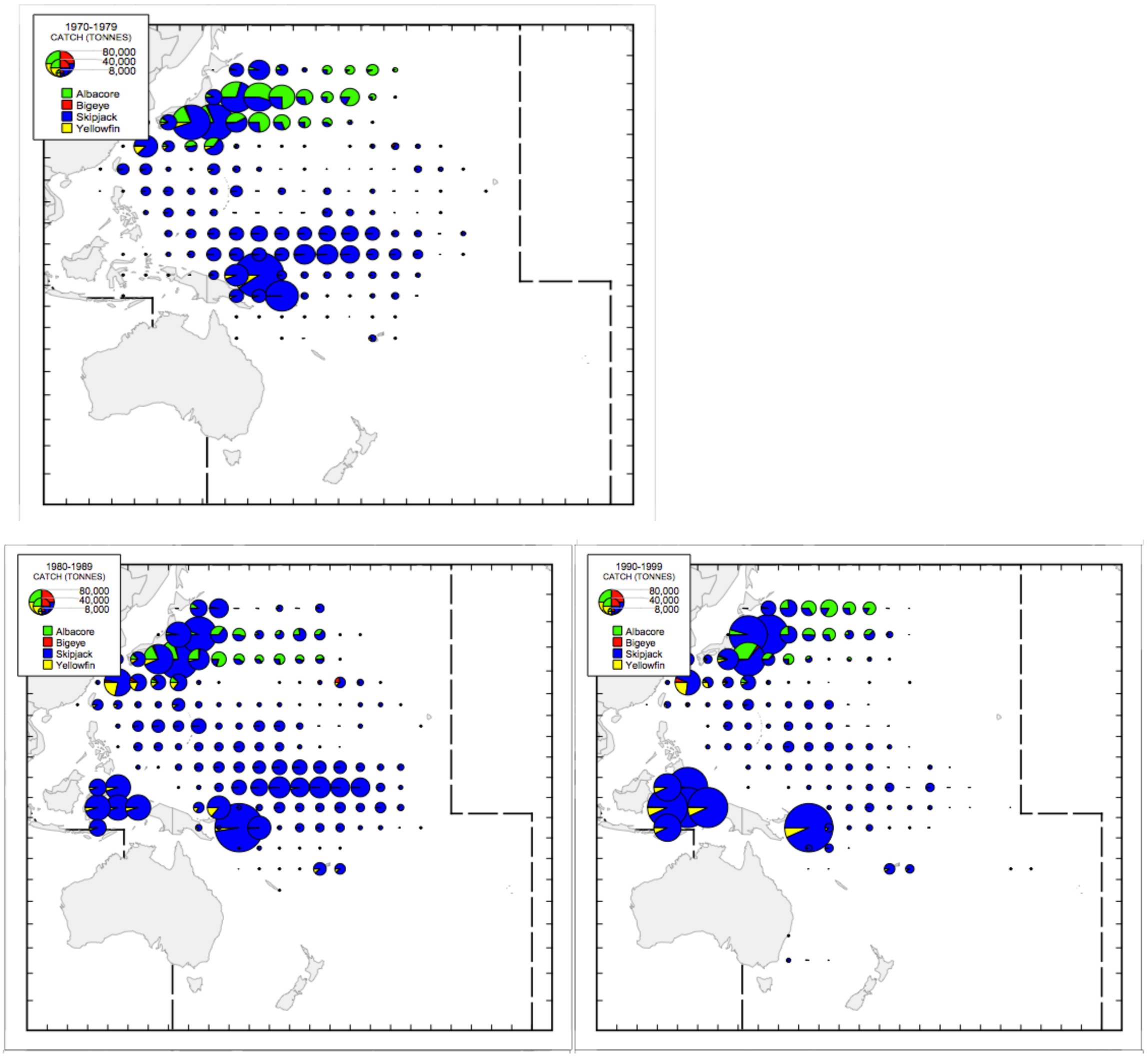


Figure 19: Fleet sizes for the PNL fishery in the WCPO. *Source*: (Harley et al, 2015, p. 13).

As Figure 19 indicates, the numbers of Japanese vessels by far dominated the PNL fishery in the WCPO for over two decades, with a steady decline as the Japanese fishery has to a larger extent shifted vessel types towards the more efficient PS gear. The domestic PICTs vessels have throughout the statistical periods remained outnumbered by the foreign actors, as a testament to the lower degree of economical and technical development made available to the smaller nations in the Pacific throughout the past decades, compared to the more economically stronger nations of for instance Japan.

According to the newest official statistics available by the WCPFCs yearbook of 2013, a total of 49 PNL vessels were actively operating in the Western and Central Pacific – 45 of these within French Polynesian EEZ, 1 in Kiribati and 3 in SI (WCPFC, 2014). French Polynesia is included in the WCPFC statistical area, however, it is generally considered to be situated in the Eastern Pacific Ocean (EPO) sector along the 150°W longitude (see Figure 1). For this research, then, it is most relevant to include the PICTs generally considered to be part of the WCPO sector. As Japan is a central DWFN actor, with 79 registered active PNL vessels operating in the region, it is also highly relevant to include them into the total picture of current PNL vessel activity.



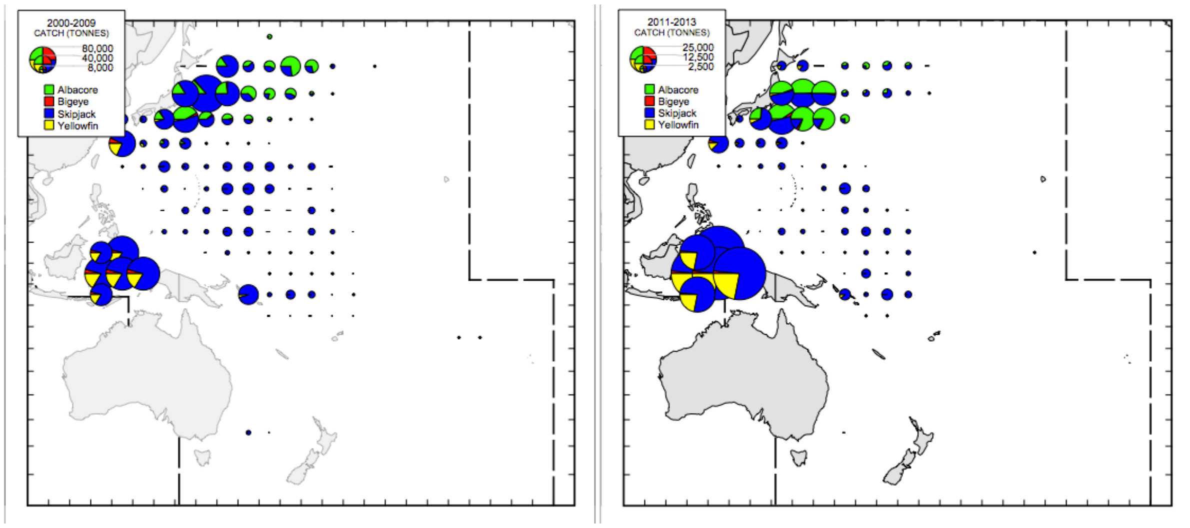


Figure 20: Distribution of PNL catch by species within the WCPFC statistical area, by decade since 1970. *Source*: (WCPFC, 2014a, p. 140).

Figure 20 shows some interesting patterns when it comes to distribution of catches by tuna species. The most stable finding being that the fishery is during all decades presented most profitable along ≈5° north and south of the equatorial line as well as within the Japanese EEZ. What is also stable is that throughout the statistical period, Skipjack Tuna is by far the most common species caught in the PNL fishery. Interestingly, the trend is that Yellowfin Tuna becomes more and more present in the catch statistics towards 2013. Combined with the trend of more DWFN present in the fishery compared to 1970 levels, it correlates to the thesis assumption that more DWFN are indeed present in WCPO waters, increasing the fishing pressure. The total PNL catch in tonnage has fluctuated a bit throughout the decades with available statistics, with the top year of 1984 with a total PNL catch of 415,016 tons, and lowest catch in 2013 with a total of 221,715 tons caught (WCPFC, 2014a), also matching the assumption that PNL is a less common fishing practice than before. The distribution of species has changed a lot during the decades; with Yellowfin amounting to 1% of the total PNL catch in 1970, compared to a level of as high as 14% of the total catch in 2012. Skipjack has by far been the most prevalent species throughout the whole statistical period, amounting to 93% of the catch in 1970, against 70% in 2012 (2014a).

3.6 History and overview of the PS fishery in the WCPO

The PS fishing fleet in the WCPO had its infancy during the late 1960s, a development that was followed by several PNL vessels being converted to purse-seiners the former years. It was not easy performing PS fishing in the clear, tropical waters – the deep thermocline in the equatorial areas formed quite particular biophysical surroundings challenging the pioneering PS actors, primarily from the US and Japan. In the equatorial areas the tuna schools tend to move faster, be smaller in size, and dive deeper than in the EPO or off Japan (Gillett, 2007). The innovations that finally proved successful was discovered by the Japanese by setting nets around logs in the FSM and PNG areas, at pre-dawn times at day. Japanese tuna PS vessels with the range of 50-200 GRT were dominating the fishery in these decades up until the 1980s where the number of PS vessels operating in the PICTs raised rapidly. The strong US presence in the fishery was also due to the fact that potent ENSO occurrences during 1982-83 made fish move westwards, with the fleet following. Combined with pressure to reduce dolphin mortality in their domestic, traditional fishing grounds, it was leading the US fleet to move into the WCPO area quickly (2007). The total tuna catches (including all fishing methods) from US vessels jumped from 75,494 mt in 1982 to 181,593 mt in 1983, and their catch has ever since stayed well above 100 and 200,000 tons a year (except the outlier years of 2004, 2005 and 2006 with catches <100,000 mt) (WCPFC, 2014a).

Since the 1980s the PS fleet in the WCP-CA has expanded every year, with the nationality composition becoming more and more diverse (Gillett, 2007). Following the increase of both PS vessels and nations participating, the first conservation-oriented management move saw daylight during the creation of the Palau Arrangement in 1992, further debated in section 6.3.1 in Chapter 6. Another important feature of the fishery has been the USA multilateral Tuna Treaty[8] signed in 1987. The highly debated - and criticized – treaty has enabled the US fleet ample supply to the fishing grounds in the region. The treaty allowed for a maximum of 40 US PS vessels operating in Parties to the FFA EEZs – in exchange, the US would contribute with a formerly agreed upon development aid, regardless of the amount fished. The treaty has received critique for not distributing assets evenly among the Parties within FFA, and that the US payments has been too low compared to their own profits (2007). The treaty was not renewed, however, in 2013. The high-cost US fleet has also been hit hard by the profitability squeeze the PS fishery has seen in recent years, where a combination of increasing fuel and gear prices with oversupply leading to depressed prices, has caused a reduction of fleet – from 50

[8] The South Pacific Tuna Act signed in Port Moresby, PNG, April 2nd, 1987. For legal paper, see https://legcounsel.house.gov/Comps/South%20Pacific%20Tuna%20Act%20Of%201988.pdf

vessels during the first ratification of the Treaty, to around 20 vessels in 2005, and again up to 40 in 2013 (WCPFC, 2014a, Barclay & Cartwright, 2007a).

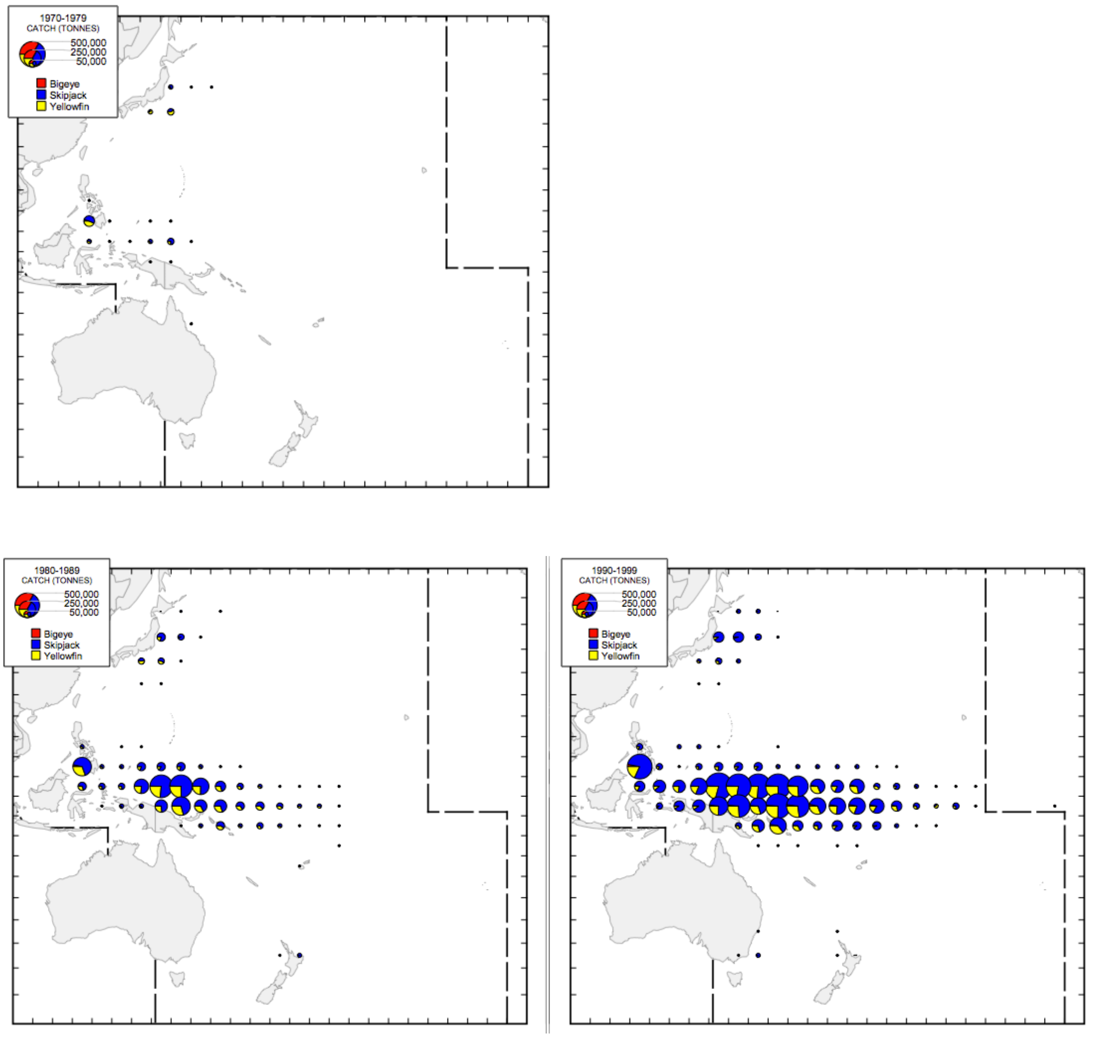
The PS fishery in the Western-Central Pacific has seen an extraordinary growth in terms of caught tonnage of fish (see Figure 3) since the 1970s; from the modest total PS catch (including all tuna species) of 5,224 mt to the remarkable total PS catch of 1,899,015 mt from 2013 (WCPFC, 2014a). The PS fishery today is essentially a skipjack fishery, which accounts for 70-85% of the total catch, followed by 15-30% yellowfin and a small portion of bigeye, the latter mostly targeted by the longline fishery (Hampton, 2010). The PS skipjack catch has remained well above a total of 1,000,000 mt since 2005. The geographical distribution of the PS fishery has remained closely tied to the equatorial line throughout the decades of commercial exploitation. The catches are highest in the zone 5-10° north and south of the equator (Hampton, 2010, WCPFC, 2014a), and this zonation is by all likeliness linked to the equatorial upwelling causing these waters to be favourable in terms of available nutrients (Castro & Huber, 2012). Other oceanographic conditions has notable impacts on the profits in catches, such as the ENSO cycles, which will be discussed in section 7.20.1 RU 7.1, Chapter 7.

The disposal and transshipment of the catch - the *operational patterns* - within the PS fishery is highly differential. Transshipment at sea was a common feature in the fishery until a ban was operationalized by WCPFC in 2005[9]. The ban was an important consideration in the fisheries management due to PICT governments and conservation groups expressing concerns of the previous practice, as it was believed to facilitate higher occurrences of IUU activities. Utilizing at sea-transshipment as a means of circumventing management measures elsewhere – described as "fish laundering", was the situation the ban sought to avoid (McCoy, 2007). Among the legal catch disposal, it ranges between Korean, Taiwanese and Chinese vessels transshipping their catch onto larger vessels – in port in Pacific Island countries, to the Japanese returning all catch to Japan, to offloading catch directly to canneries in the region, such as the case for NFD PS vessels or American vessels offloading in canneries in American Samoa (Gillett, 2007). Other notable events that has affected the PS fishery has been the already mentioned ENSO events, traditionally during El Niño years resulting in good PS fishing in the WCPO (with the opposite

[9] Resolution on Regulating Transhipment by Purse Seine Vessels, recognized by WCPFC December 14th, 2005. For legal document, see https://www.wcpfc.int/system/files/WCPFC2_Records_K.pdf

occurring in the EPO), causing the fishery to move slightly to the east of its typical location between PNG and FSM.

In general, the PS fishery of the WCPO is a highly valuable one, and the single largest tuna fishery in the world. The value is, however, proportionately speaking, declining due to overcapacity. About 200 vessels are operating; dominated by DWFN fleets from Japan, Korea, Taiwan and USA – with a small, but growing, Domestic Island flag fleet. Certain EU vessels also have access to some EEZ, with increasing activities. Especially the Spanish fleet has had a high desire to increase their effort – as they have fished to the limit in other oceans (Barclay & Cartwright, 2007a, McCoy, 2007). The estimated landed value for 2012 was set to about US$ 4,054 million (WCPFC, 2013). Roughly 80 percent of the total tuna catch in the region is currently caught by PS gear (Gillett, 2007).



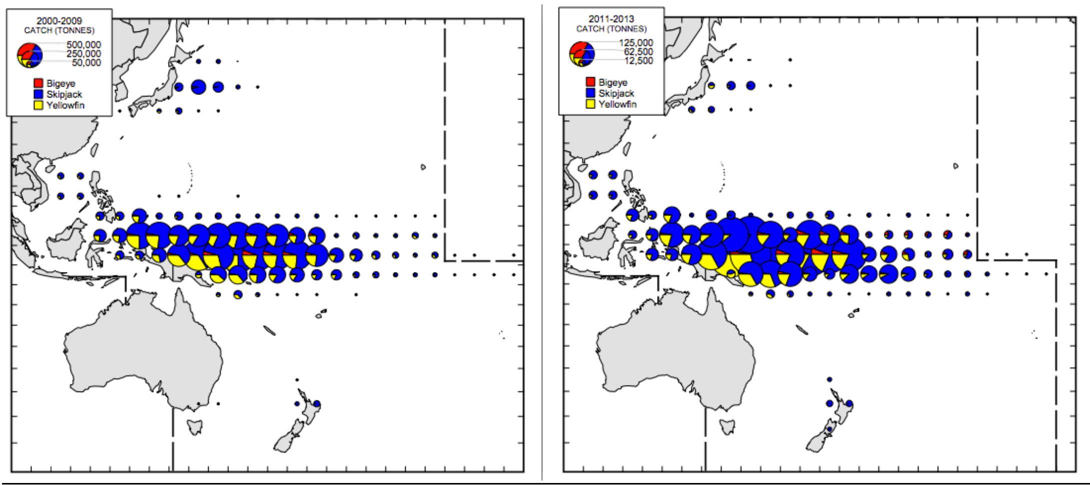


Figure 21: Distribution of PS catch by species within the WCPFC statistical area, by decade since 1970. *Source*: (WCPFC, 2014a, p. 141).

3.7 Fishing methods used in the WCPO

Industrial fishing in the WCPO is generally understood as the utilization of fishing vessels in offshore waters to harvest fish in order to create commercial fishing products to export or processed in canneries. There is a wide range of fishing methods used in the region, the most common ones illustrated in Figure 22:

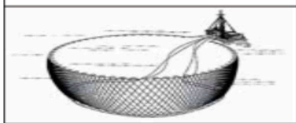
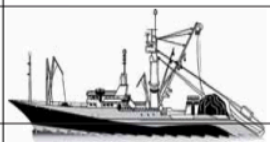
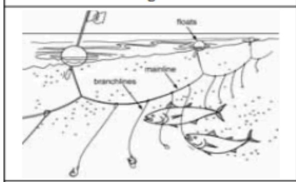
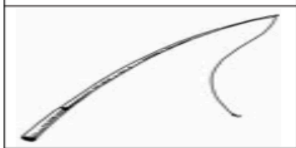
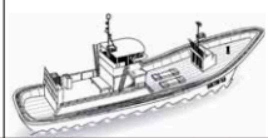
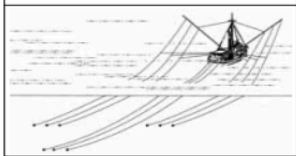
Gear Type	Catch	Typical Vessel that Uses Gear	Notes
Purse seine			
	Mainly skipjack and small yellowfin are caught by purse seine gear. Most catch is for canning.		About 80 percent of the tuna catch in the Pacific Islands region is by purse seine gear. Most of the purse seine catch is taken within 5 degrees of the equator.
Longline			
	Most tuna caught are large size yellowfin, bigeye, and albacore. The prime yellowfin and bigeye often are exported fresh to overseas markets. Most of the albacore is for canning.		About 13 percent of the tuna catch in the Pacific Islands region is by longline gear. There are two major types of longliners: (1) relatively large vessels with mechanical freezing equipment (often based outside the Pacific Islands), and (2) smaller vessels that mostly use ice to preserve fish and are typically based at a port in the Pacific Islands.
Pole-and-line			
	Mainly skipjack and small yellowfin are caught by pole-and-line gear. Most catch is for canning or producing a dried product.		About 7 percent of the tuna catch in the Pacific Islands region is by pole-and-line gear. In the 1980s several Pacific Island countries had fleets of these vessels, but most no longer operate due to competition with the more productive purse seine gear. Most of the catch by this gear is made in Asian waters.
Troll			
	Large-scale trolling targets albacore for canning.		Large-scale tuna trolling is carried out by some vessels based in the Pacific Islands. The actual fishing activity occurs in the cool water to the south of the region.

Figure 22: Main industrial tuna fishing gear presently used in the Pacific Island region. *Source*: (Gillett, 2007, p. 3).

As Figure 22 shows, the WCPO region has a variety of industrial fishing methods; however, for this research the focus will remain on the PNL and PS methods.

3.8 The pole-and-line fishing technique

Figure 23: *Top (left)*: fishers pulling in tuna on an Indonesian PNL vessel. *Bottom*: Photograph of the Soltai No.105 out at sea targeting a school of tuna *Source*: (SPC, 2012[10]). *Top (right)*: fishers from the same vessel unloading tuna in the Noro docks. *Source*: (Wester Amundsen, 2015)

The PNL method is a fishing method where barbless hooks with lures attached to a solid pole (the fishing rod) are used to fish tuna one-by-one. The hook size is customized in a way that prevents undersized fish to get caught, limiting the chance of catching by-catch (IPNLF, 2014). PNL fishing for tuna occurs in a variety of marine environments, from within coastal, archipelagic waters, to within EEZs, to the high seas – all depending on the migration patterns of the targeted species as well as the move of the water layers providing appropriate temperatures. Thus, the method is only used to target schools of fish close to the species – causing most of the catch to consist of skipjack and/or small juveniles of most of the other tuna

[10] For more photos, see http://www.spc.int/tagging/en/medias/gallery/category/12-png-tagging-2012

species that are located in the upper water layers. The PNL operation is in certain areas highly seasonal, according to the target species migrational patters, such as the Japanese PNL fishing season for albacore starting in July (FAOb, 2015).

It used to be a higher seasonality also for PNL operations in the WCPO, also in the NFD PNL operations in SI. The impacts this may have to the sustainability of the fishery will be further addressed in for instance section 7.20.1 RU 7.1, Chapter 7. The method is highly dependent on supply of live baitfish; PNL vessels carry live bait to attract tuna to the boat. Catching live bait in inshore waters with a small lift or seine net commences the fishing operation sequence. This separate fishing operation is usually done at night, with the utilization of lights attracting the fish to the surface of the coastal, often estuarine, waters. The fish then is kept alive in bait wells on-board the boat – a factor that gravely limits the possible time the operation can be out at sea, since the mortality of tropical baitfish species is generally high due to their fragility (Gillett, 2010). The amount of tuna caught is generally much higher than the amount of baitfish, and the amount tuna caught per unit of bait is referred to as the tuna-baitfish ratio. The ratio is highly variable and dependent on the area in question, but in the WCP-CA it is generally around 30 kg of tuna per kilo of bait (2010). The PNL vessels are generally medium-sized, up to 40 meters long and with a GRT of up to 250 tons. The fishermen in the WCPO generally fish from the rear part of the vessel directly from deck – in the EPO and Japanese waters, however, it is common to fish from steel racks mounted on the vessel just above the water or from the stern of the vessel (FAO, 2015b).

Out at sea, the location of tuna school commences, using a mixture of modern radar techniques with the knowledge and skills of the fishing masters on-board, as well as spotting of seabirds, sight of other fishing vessels, or even in some fisheries usage of anchored Fish Aggregating Devices (FADs). Upon location of the school, the skipper positions the boat close to it, and the livebait is scattered into the sea, usually in conjuction with water sprinkling of the surface water. This process is known as the "chumming" – as it creates an illusion of a large school of small fish close to the surface, triggering the tuna into a feeding frenzy causing them to easily bite at any shiny object in the water, even un-baited hooks (IPNLF, 2012). Then, depending on the size of the vessel, 10-20 fishermen fishes simultaneously, sitting on a platform running along the rear of the vessel. In the event of catching particularly large tuna individuals, double or even triple hauling may be necessary to add extra strength (FAOb, 2015).

Once the tuna is hauled on-board the vessel, the speed and height of the fall from the air cause most individuals immediate death as they hit the deck of the boat. The barbless hook is constructed in a manner that causes the fish to release from the hook during the swing radius of the pulling of the fisherman's rod, making the hauling of one and one fish highly efficient – several tons of fish may be caught in an hour. In the Japanese PNL operations there are vessels operating robots to haul the fish instead of fishermen (FAOb, 2015). The pole is composed of a rigid, usually fiberglass material of 2-3 meters long. Due to the low amount of time for the fish to realize what is going on – thus less time to get stressed and obtaining lactic acid in the cells, the meat quality tends to get heightened compared to PS fishing with higher levels of stress before time of death. To prevent spoiling of the meat, the tunas then are stored in a refrigerated hold upon capture on larger vessels or on ice on smaller day boats (IPNLF, 2012). The PNL vessels used as a case study for this research belonged to the former category.

3.9 The purse-seine fishing technique

Figure 24: *Top*: fishers from *Solomon Pearl* unloading tuna in Noro docks. *Source*: (Wester Amundsen, 2015). *Bottom*: Two PS vessels hauling in fish after a set. Both photographs are not from any of the vessels from this research, for illustrative purpose only. *Source*: (Greenpeace, 2010[11]).

The PS fishing technique method is a highly sophisticated mechanical method designed to catch schooling fish. Vessels applying this method are large; but vary considerably. Main targeted species in tropical waters are yellowfin, skipjack and bigeye tuna, and in certain regions, especially coastal ones; smaller tuna or tuna-like fish such as bonito (*Sarda* spp.) or frigate tunas (*Auxis thazard*) (Hall & Roman, 2013). The smaller purse-seiners are often multi-purposed, and may target small pelagic species such as mackerels or sardines (FAOc, 2015). The common

[11] Photograph accessed from http://www.greenpeace.org/international/en/news/Blogs/makingwaves/when-purse-seining-goes-bad/blog/11803/. *Note*: meant strictly for illustrative purpose.

range of PS vessels is between 45 to 85 meters and the common GRT is today between 800-2000 mt. The so-called 'super-seiners', such as the Spanish vessel *Albatun Tres*[12], however, may be up to 120 meters long and with gross tonnages of over 3,000 mt. PS vessels can roam considerable distances of the open oceans to locate schools of fish through utilizing techniques such as radars and drifting and anchored FADs.

The process from beginning of the shooting of the net through the end of hauling is referred to as a "set". When locating schools, the seiners encircle them with a large synthetic net, typically measuring 1,500 to 2,000 m long and 120 to 250 m deep. The big seiners may reach depths of down to 400 m and lengths over 2,200 m. Common mesh sizes are around 120 mm, but vary from 75-250 mm of stretched mesh (Hall & Roman, 2013). The vessel places itself on the starboard side of the school (or the port deck side if facilitated for operating from that side). The skiff – a highly powered annex – then is attached to one extremity of the vessel after being correctly positioned according to the fish school location. The skiff then has the other extremity attached to the purse line cable (whereas the other extremity of this cable is attached to the winch on the purse-seiner), and is released (FAOc, 2015), see Figure 25:

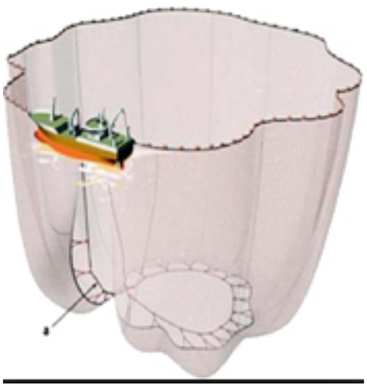


Figure 25: Illustration of a PS set ready to haul in the net. *Source*: (FAOc, 2015).

The PS is made of a long wall of netting framed with a lead and a float line; and is then set from one or two boats to surround the detected school of fish. The top of the net is mounted on a floatline and the bottom of a leadline usually consisting of a steel chain with steel rings, the 'purse rings', attached below the chain (FAOc, 2015). A purse line threaded through purse rings spaced along the bottom of the net is drawn tight – 'pursed' – to stop the school of fish escaping downwards under the net (Hall & Roman, 2013). It is further equipped with a power block in

[12] For more information about the vessel, see https://www.wcpfc.int/node/16245

order to purse the lead line after fish is caught in the net. Currents, its construction material as well as the manoeuvre of the vessel affect the sinking speed of the net. The sinking speed is a variable that may highly affect the success rate of a set, as it may involve the ratio of escape routes for the encircled fish. Before completion of encirclement, there are two escape routes, namely diving under the net or swimming through the open section of the net (Hall & Roman, 2013). The timing of the enclosement of the net is crucial, and should take not more than 10 minutes to avoid tunas escaping. To further avoid escape, it is highly common for big PS vessels to use a smaller rubber boat releasing coloured cartridges into the water as well as spinning in circles around the net opening trying to scare fish away from that direction. For large mammals such as whales, another escape possibility is simply breaking through the netting. As the pursing operation progresses, the bottom of the net encloses, enabling only individuals smaller than the mesh size to escape the net by passing through it.

The whole process from setting to complete pursing can take everything from 30 minutes to two hours depending on the size of the vessel and the weather and wave conditions at the time of hauling. The extremity of the net that stayed attached to the skiff is transferred aboard the purse-seiner and the two extremities of the purse line cable are hauled with the winch (using powerful hydraulics) as quickly as possible in order to close the net at the bottom once the encirclement is finished. During the pursing, to prevent the vessel to drift over the net, the skiff is attached to the starboard side pulling away from the net. Pulling the net then takes up to one hour, before most of the PS has been retrieved on-board again, and the tunas having been grouped within a restricted area along the vessel side. The fish is then harvested using a large scoopnet called the "brailer" (or the brailing operation), scooping the fish several tons at a time (FAOc, 2015). The duration of this final stage in the operation depends on the number of fish in the net. At this stage, the fish has aggregated so much over a good period of time, leading to a large quantity of them being either dead or severely dismembered or disjointed when hauled on-board due to the 'squeeze' from the other frantic fish inside the net.

The handling mode of PS vessels is a crucial part of the operations, as many seiners spend numerours months at sea. Some vessels bulk-freezes the catch, the smaller seiners uses refrigerated brine tanks (brine at 0^{o}C), equipped with batteries of seawater pumps to circulate. The industrialized seiners, however, lets the tuna go towards fish-wells through trays and tubes arranged in the deck, then leading to wells of 20 to 40 mt each to preserve the tunas in, enabled with brine freezing capacities of around -20 ^{o}C (FAOc, 2015). The PS vessels target large and medium-sized pelagic fish that are aggregated around either FADs or free-swimming, and that are not too far from the surface, however, deeper than the schools targeted by PNL operations. The schools targeted are located in the mixing zone above the thermocline, with depths down to maximum 400 m, but usually from 60-150 m. the ability to target species swimming in deeper layers, allows for target species such as Bluefin and bigeye tuna, that thrives in layers deeper than skipjack and yellowfin. The industrial PS fleet worldwide has become highly mobile, with the ability to roam changing oceans in response to changing catch rates, market prices and operating costs – and with higher diversity in DWFN entering the fishery. The 'super seiners' are particularly mobile, changing from successful fishing seasons in one big ocean, in for instance Western Indian Ocean, to then go off to fish in a completely different area such ass the EEZs of PICTs (FAOc, 2015).

4.0 Chapter 4: Methodological approach

4.1 Research design

For this study, a methodological pluralism that combined case study research and qualitative, semi-structured interviews were implemented as method. It even included elements from quantitative research methods, as some of the results from the data collection are presented numerically and graphically. The nature of the situation during fieldwork, however, with limited amounts of available fishers to interview, as well as the limited time scope of the research made the sample group very small in quantitative terms (total sample n=30 and sub-samples n=15 and n=15). This limits the possibilities of performing quantitative tests like regression analysis, as the results would have suffered from low reliability and generalization abilities due to the small sample sizes of respondents. The opportunity of generalizing the findings to a bigger population, was simply not there due to the fact that too few respondents was collected to give a consistent result applicable to the general public. The questions asked to the respondents were not conducted along quantitative variables, nor were possible answers prescribed in strict formats. Therefore, this research does not fill enough criteria to be regarded as quantitative research, but took advantage from a mixed-methods approach.

The population of this research can be defined as 'all PNL and PS tuna fishers in the western-central Pacific'. When choosing a sample from a population, one needs to keep in mind that the size in almost all cases is a small subset of the population in total, as we never have access to the entire population. And thus; the bigger the sample, the more likely it is to reflect the whole population (Field & Field, 2012). The sample in this research being so small, gives it obvious quantitative research quality limitations. However, a quantitative representation of some of the data has been conducted. Methodologically, the thesis will also gain a somewhat normative display as it seeks sustainability solutions that the PNL and PS tuna fishery can be adviced to take into account.

4.2 The case study approach

Although the qualitative interviews created the main fundament for the methodological framework, the case study approach was of notable importance. NFD, SI, formed the *case* structure for this research, and cannot be considered representative to other cases due to the nature of qualitative research. It may, however, share knowledge and insight and even serve as inspiration to similar cases. Yin (2012, p. 6) defines a 'case' as:

> A bound entity (a person, organization, behavioural condition, event or other social phenomenon), but the boundary between the case and its contextual conditions – in both spatial and temporal dimensions – may be blurred (...). The case serves as the main unit of analysis in a case study, while possibly also having nested units within the main unit (Yin, 2012, p. 6).

The entire group of interviewed PNL and PS fishers as well as one of the in-depth interviews were collected from NFD over the time frame of three weeks from April to May, 2015. These interviews served as the main units of analysis in the case studies, while general observations and non-structured conversations served as contextual conditions. NFD were throughout the intense three-week field trip of this research the base from which I lived, observed the everyday operation, such as unloading of fish and meat quality procedures, had an office spot and structured the day-to-day plans with my contacts within the enterprise. As such, NFDs employees and enterprise structure created the vast majority of the primary data entries of this research. As all other case study research, the desire to scrutinize NFDs routines, policies and ethics came from a desire to derive an up-close *understanding* of NFD – the 'case' in the case study – set in their real-world context (Yin, 2012). This approach would presumably provide deeper understanding of one commercial tuna fisheries operation in the Pacific, which again might provide insight that could be applicable to understanding *other* tuna fisheries operations throughout the region as well. As defined by Yin; "case study research assumes that examining the context and other complex conditions related to the case being studied are integral to understanding the case" (2012, p. 55).

The case study approach further allows the study of specifically identified characteristics and their impact on a given phenomenon. As such one may to a larger extent enhance the possibility of making *comparisons* to other similar cases (Barbour, 2014) within the strata, in this case; within the vast diversity of tuna fisheries and/or enterprises. Case study data collection is a research approach that is particularly useful when wanting to respond to the *how* and *why* questions of a contemporary set of events, phenomenons or 'chunk of empirical reality' (Meyer, 2001, Lund, 2014). By emphasizing the study of a case within its real-world context, the case study method favours the collection of data in natural settings, and as such goes beyond the study of isolated variables, or only relying on 'derived' data (Yin, 2012).

For this research, it was a desire to collect information through a wide set of data collection methods. The study of sustainability in fishing methods of such a big fishery as in this research implied usage of interviews, documents, documentaries and observation as sources of information. Using the case study approach, which opens up for usage of a variety of data collection methods in a holistic (Meyer, 2001) manner was thus considered favourable. As such, a case study serves as an analytical or social construct of the researcher in which she communicates the investigated findings (Lund, 2014). However, this urges the researcher to take a clear stance to whether she performs an 'intrinsic' case study, which focuses on studying one instance in its own right, or an 'instrumental' case study – where specific case(s) are selected in order to be able to further investigate similar general principles and phenomena (Barbour, 2014). The latter perspective is most adequately covering the scope of this research; as the case here serves as an instrumental example of a fisheries enterprise presumably striving to achieve sustainability in their operation. The case study setting is also considered appropriate for this research as the method allows for an illumination of particular unusual or admirable features, in this case; how NFD emerges as an enterprise with high regards of social and employment responsibilities as well as ecological limits to fish harvesting growth. Thus, they may serve as a *positive* example to the many less admirable actors in the tuna harvesting community. With the positivistic approach to illuminating NFD as a case study, the 'transferability' and relevance of the findings from this specific case to understanding other similar – or even different contexts in the tuna fisheries may prove valuable methodologically (2014).

Case study research has been criticized for having a low possibility of making any generalizations (Meyer, 2001). A single or small set of cases, like in this research, cannot generalize to larger populations (of other tuna enterprises), nor is it intended to. What its purpose is, however, is to establish an analytical generalization form that uses a theoretical framework to establish a logic that might be applicable to other situations (Yin, 2012). In this context; using NFD as an example of a seemingly successful enterprise, worth taking experience and lessons from for other tuna enterprises wishing to improve their corporate responsibility through for instance increased sustainable *modus operandi* or battling local unemployment rates. Improving the generalizability for this research, could for instance involve applying a multi-case approach, where the findings from this case study were replicated to another case study (Meyer, 2001), and would as such also improve the reliability status for the findings in this research.

TABLE 4
Choices and Steps in Case Study Design

1. Selection of cases	Single or multiple sampling	
	Unit of analysis	
2. Sampling time	Number of data collections	
	When to enter	
3. Selection of data collection procedures	Interviews	Sampling interviewees
		Structured versus unstructured
		Use of tape recorder
	Documents	Sampling documents
		Use of documents
	Observation	Choosing method
		When to enter
		How much
		Which groups

Figure 26. *Source*: (Meyer, 2001, p. 350)

Figure 26 summarizes the operationalization of the case study design for this research. The selection of cases was single, with only fishers from NFD being used as units of analysis, further elaborated by in-depth interviews with informants from PNA, FFA as well as secondary data. The sampling time was limited to convenience – when the respective vessels were at dock and had fishers available for interviews. Time was also the limiting factor when it came to number of data collection – the fishers were only available for interviews while at dock and finished unloading. Within that timeframe for this research, a total of 30 interviews were completed. The selection of data collection procedures will be further emphasized in section 4.3.

4.3 Sampling strategies

The logic behind sampling units while researching is to be able to draw inferences about some larger population from a smaller one – the sample (Berg & Lune, 2013). A probability sampling method would have been favourable in this research, supposing that it were replicated, enlarged in scale, with more time, resources and higher budget. Limited, however, by all these factors, combined with restricted means necessary for a probability sampling procedure not being present, a *nonprobability* sampling method was performed. Nonprobability sampling offers the benefit of not requiring a list of all possible elements in a full population and the ability to access otherwise difficult-to-research study populations (Berg & Lune, 2013). The nonprobability approach was used to get access to informants during the fieldwork of this research. Locating a fisheries enterprise that was willing to receive me and accommodate an open access to their resources and employees was a challenging and time-consuming task. It relied on a mixture of snowball, purposive and quota sampling as well as the power of using contacts as a tool to reach out to the relevant people. The *purposive* sampling was applied due to the narrowed-down perspective of this research. The topic required specific knowledge on fishing methods in tuna fishing, and as thus a significant amount of time was used prior to the fieldwork to ensure that certain types of individuals and enterprises displaying that knowledge were chosen to gather data from. Using such a sampling method, where beforehand-acquired knowledge directs the selection of the informants, may, however, hold certain reliability dangers (2013). As one exercises judgment on the informant's reliability and competency, one may obtain biased results (Tongco, 2007).

This research, like many other qualitative research projects, relied certain parts of its data quality on its key informants. The key informants were chosen on the basis of extensive investigation after suitable persons that had knowledge about the tuna fisheries in the region, in particular individuals that had knowledge about sustainability issues within the fishery. Making sure one holds vigorous overview of ones informant's knowledge and skill levels are of great importance when choosing them. Then, the possibility of holding biased views based on statements from these informants, is a significant danger when performing purposive sampling (Tongco, 2007). The danger of this type of bias was taken into account for this research, however, it is not unlikely that the results and conclusions are somewhat coloured by the statements gathered from the informants.

The *snowball* sampling strategy was also present, as it was a very practical way of achieving and locating the right informants, according to context. One informant in an early research phase referred to NFD in SI as an appropriate place to inquire, and as such helped point out the direction of the research site. Therefore, the research site was not selected based on several specific criteria; it was based on availability and willingness from NFDs local managers to cooperate to this research. The only criterion as such was that the research site had access to fishers working on both PNL and PS vessels. As very few enterprises or private owners perform PNL as fishing method in the Pacific region, it did narrow down the search for a suitable site.

Finally, *quota* sampling therefore is suitable to describe the sampling process; the fishers informants needed to be working at PNL or PS vessels, these 'attributes' were necessary for them to be chosen. These two attributes were then grouped using the same recruitment strategy in order for the resulting groups to be comparable (Berg & Lune, 2013).

Both the PNL fishers and PS fishers made up a group total of 15 fishers, a sample total of 30 fishers. A convenience recruitment sampling method was then used to pick out which individuals within the PNL and PS strata were chosen. It was simply the fishermen that said themselves willing to cooperate and working on the PNL and PS vessels that happened to be at dock in Noro unloading fish during the dates I was present for fieldwork, that were chosen to conduct interviews. The interviews were performed on a *semi-standardized* manner. Berg & Lune defines semi-standardized interviews as a interview format located in the middle of the two extremes forming of the completely standardized and completely unstandardized interview structure continuum of formality (2013). The interview format makes use of predetermined questions forming the basis of the conversation, with the possibility of adding or removing questions from this baseline. The interviews are performed in a systematic and consistent order, but with possibility of digressing and probing beyond the predetermined standardized questions (2013). This format was preferred, as it allows reflecting awareness that individuals understand the questions differently, as well as responding differently to questions phrased in individually adjusted ways. The interview format also opens up for acquiring knowledge the researcher is not aware of before-hand; and indeed many of the interviews in this research resulted in awareness of issues I by no means could anticipate beforehand, further adding meaningful substance to the issues raised under the course of the interviews. This format thus results in a much more textured set of accounts from the participants than would otherwise have occurred if only schedules questions had been asked (2013).

4.4 Triangulation

When choosing a research method during the course of a fieldwork, one may fall into the habit of unwittingly favouring the methodological technique the researcher feels most confident in using. When performing more than one methodological approach, like this research, each method may reveal slightly different facets of the same symbolic reality (Berg & Lune, 2013). Therefore, performing triangulation was a requirement for this research, as it urges the researcher to investigate the findings angled from different perspectives and as such combines several perspectives in a study. Consequently, this study will be framed by not so much one overarching theory, rather by several related theories; a triangulation method referred to as theoretical triangulation (2013). Triangulation is a practical tool to strengthening the validity of a research, by being able to make use of several strategies to investigate the same issue or applying differentiated theoretical approaches during the analysis. To increase the validity of the semi-structured interview format one needs to make use of triangulation strategies so that the questions that are asked are accurate, asked to each informant in the same manner, information before-hand being given in the same way, as well as making sure the questions themselves are formulated in a way that actually investigates what the researcher wants to find out. Making sure the research instruments and the data are valid helps increasing the chance of achieving valid conclusions and findings derived from these data.

During the course of this research triangulation were strived for through including more than one strategy of achieving information. That included observations and photographic documentation of natural settings, meaning; the setting on-board the vessels, the fish caught from the vessels, and the conditions on the docks in Noro. It also included analysis of document and textual analysis to support or disprove findings from the interviews as well as comparing answers to the same questions asked to different stakeholders. It further included watching documentaries debating many of the issues observed during fieldwork, and helped create a picture of tuna fishing techniques elsewhere than SI. The answers that were presented from the PNA official did not necessarily match the perspectives from the NFD representative. As such, interviewing individuals that represented different interests triangulated the answers. Observing the actual fish catch in Noro also helped form a picture of issues like meat quality, fish welfare and helped understanding the sheer, physical scope of tuna catches globally. In the aftermath of the fieldwork, making use of differentiated literature and theory approaches, further enabled triangulation by illuminating the data from various angles.

Some of the arguments stated in this research are supported from empirical material from the performed interviews of both PNL and PS fishers as well as key stakeholders from PNA, FFA and NFD. Other arguments are supported from secondary literature, continually cited.

5.0 Chapter 5: Findings

This Chapter covers the findings that resulted from the fieldwork for this research done in Noro in April-May 2015. The findings are organized in two paragraphs; the first paragraph 'perceptions from the PNL fishers' covers the group of PNL fishers (a total of 15 respondents), and the second paragraph 'perceptions from the PS fishers' covers the group of PS fishers (a total of 15 respondents). The whole respondent group thus is n=30, however, when treating the findings individually, the two groups forms, respectively, n=15. Several respondents have answered multiple answers to the interview questions; this will be referenced accordingly in the section. The abbreviation 'Q' is referring to the word 'Question', and all the questions of the interview guide can be accessed in the appendices section after Chapter 8.

5.1 Perceptions from the pole-and-line fishers[13]

The over-all impression from the PNL fishers interviewed in this research is that they were notably in agreement when answering the questions. The 15 PNL fishers had a total similarity mean of ≈ 71% when adding up all the answers (Q5-Q17 + Q19, n=14) of the questions that directly assessed their perceptions of the fishery. The highest mean similarity, of 100% agreement, was found in Q17 '*How do you view the creation of Marine Protected Areas (MPAs) with fishing restrictions?*' – all answered that they regarded it positively. The lowest mean similarity was found in Q11 *'What do you see as the best option to mitigate IUU activity?'* – where 6 of the recipients agreed that 'more rules and regulations' were the most effective way to mitigate the problem. A wide range of other suggestions to this complex issue was however proposed from the fishers, so this differentiation in opinions is not really a significant finding. 12 of the respondents answered 'PNL' to Q13 *'Which fishing method would you say minimizes the by-catch problem?'*, an answer one may say is biased seeing how the respondents themselves are practicing the PNL fishing method. However, 9 of the PS fishers, also stated the same answer to Q13, further strengthening that PNL might be the preferred fishing method in terms of avoiding by-catch in the opinion of all fishers in the selection. A similar pattern might be said about Q12 *Which fishing method do you think in the highest degree produces best meat quality?*, seeing how 12 stated PNL being the only, or juxtaposed

[13] The percentages stated and total number of selection in this particular section is only referring the PNL fishers interviewed (n=15). When mentioning percentages, they are approximate, and stated as rounded figures, desimals excluded.

with longlining (4 of these 12), fishing method producing high meat quality. Two stated longlining alone to produce highest meat quality, and one preferred PS caught fish in this regard. Also among the PS fishers, when it came to meat quality, PNL was in a surplus position – seven respondents stated PNL was the preferred fishing method, and among those - two juxtaposed with longlining.

5.1.1 PNL background questions (Q1-3)

In terms of years of experience the sample of PNL fishers were highly skilled. The mean years at sea were 14,3 years – ranging from 1 to 26 years. They had worked on their respective vessel on average 3,7 years, ranging from 6 to 1 year. Nine of the fishers had worked only on PNL vessels during their years at sea, and the remaining six had worked on mixed types of vessels, however also these six had worked mainly at PNL vessels during their years at sea. Thus, although the sample size for this research is small, each fisher had multiple years of experience at sea and expertise for their vessel type, making each of their answers highly valuable for the sake of the research validity.

5.1.2 PNL bait fishery reflections (Q15)

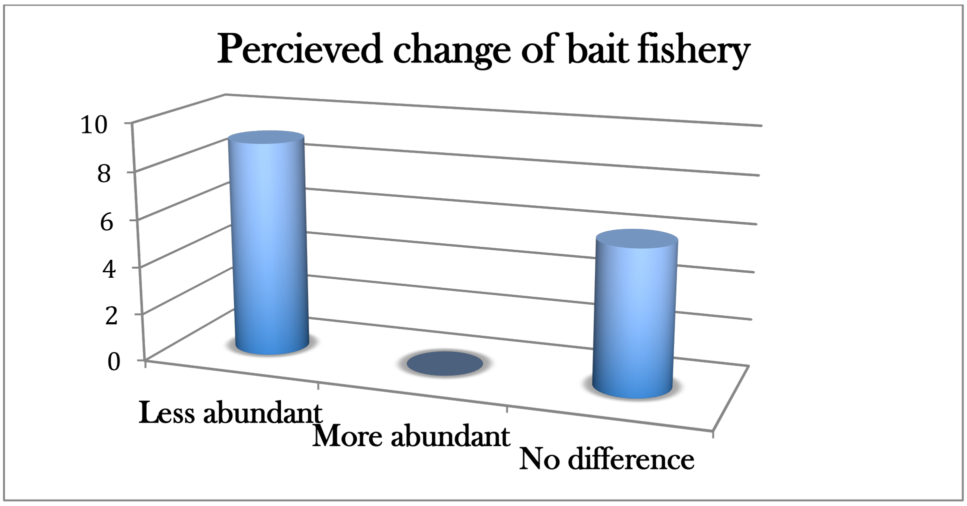


Figure 27 (n=15)

Figure 27 is interesting, as the perceptions of the bait fishery status were rather divergent. None of the fishers asked thought that the bait fishery had increased in abundance, so in that sense they were also here in agreement. However, whether or not the baitfish access has gone down or not changed, is where the fishers' opinions are deviating. Nine of the PNL fishers state that there has been a decrease of the baitfish access, with the remaining six stating the access has remained more or less unchanged. This view is contrasting that of the PNA representative's: that the bait fishery in the region is directly under threat from PNL fishing activities. The baitfish fishery status and threats to its population size is highly unsimilar in the different Pacific island nations, and will be investigated in section 6.1.9, Chapter 6. However, amongst the nine that agreed that the baitfish access had decreased, they were to a large degree in agreement as to why the decrease had occurred.

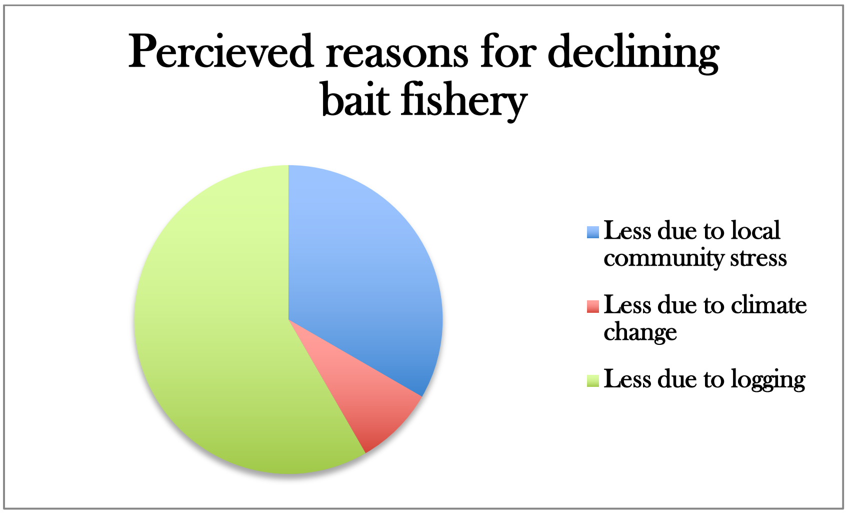


Figure 28 (n=9)

Seven out of nine PNL fishers that viewed the baitfish access as diminished, meant that the increased logging industry were to blame – not the fishing pressure from them or from local communities themselves. The increased logging activities creates freshwater run-off from logging on shore that in turn creates murky and brackish water in the immediate coastline of the islands that has logging activities. This creates less optimal conditions for both baitfish and spawning fish, and may explain the baitfish decrease on those respective locations.

5.1.3 PNL by-catch reflections (Q8, 9 and 13)

The PNL fisher's perceptions of the three by-catch related questions in the questionnaire were also highly similar. In Q8 *'How would you describe by-catch levels on this vessel compared to other vessels you've been working on?'* – nine stated that they believed it to be 'little or no' by-catch on-board the PNL vessel. The remaining six all stated that there was 'somewhat level' of by-catch, and none stated that there was 'high level' of by-catch. Q9 *'What do you do onboard to minimize by-catch?'* – were not asked to nine of the recipients, as this was a follow-up question to those answering 'somewhat level' or 'high level' of by-catch to Q8. The remaining six answered that in the case of other fish species or undersized tuna circling the boat, they would physically see them from the deck, and simply avoiding them by taking up the fishing rod and/or moving on to another fishing location where there was less by-catch: "When we see sharks in the sea, we pull up our rods and wait until it disappears, so we only catch tuna" (Fisher 4, April 27th, 2015), "If we catch a lot of rainbow runners, we go away from that particular spot and search elsewhere for skipjack" (Fisher 10, April 27th, 2015), "During fishing, if we see much other types of fish, we just don't throw the rod down" (Fisher 2, April 27th, 2015). One fisher stated that to mitigate by-catch they would depend solely on the skill and knowledge of the fishing master on-board.

5.1.4 PNL perceived employment opportunities (Q4-5)

When it came to the PNL fishers' entry to the fishery, the results showed no clear pattern. The answers diverged between four stating they got the job through contacts, four through open application, three were headhunted for the job, three were approaching the boat or company themselves, and one recipient stated that he simply had always been out at sea, a natural continuation from his youth occupation. Their perception of availability of jobs in the fishery sector in SI were quite similar – nine described it as being a challenge to even get a job in the first place, not to mention in the popular fishery sector. The remaining six, however, described the possibility of entering the fishery sector in SI for unemployed young as being easy. Thus this finding somewhat matches the official unemployment statistics in SI, which will be further described in section 7.22.1, Chapter 7. The five which describing it as easy getting a job in the fishery sector, however, can somewhat be seen in correlation to the fact that NFD is contributing tremendously to hiring staff locally and thus contributing to the enhancement of employment in SI – a model that might serve as an inspiration to other fishing companies in the region. NFD's role as a positive example to fight unemployment as well as securing national control of the food production chain will be further described in section 6.3.3, Chapter 6.

5.1.5 PNL observed stock variations (Q6, 7 and 14)

Several of the PNL fishers stated that they were deeply concerned about the status of skipjack and yellowfin population sizes, both in terms of individual size and general size of the schools of fish. In Q6 *Would you say that the fishery has changed in any ways during the years you have worked as a fisher?,* a staggering 12 of 15 stated that they thought the available amount of fish at sea had become less than before. However, five of these 12 stated that this change was equal to the fact that a significant increase in the total amount of fishing boats targeting tuna in Solomon waters was the biggest change in the fishery. A quote from the captain of one of the PNL boats illustrates the general impression regarding catch: "the catch is not good, and it keeps going down. I would say it is a dramatic change" (Fisher 8, April 28th, 2015). In Q7 *Do you think that the average fish size has changed during the years you have worked as a fisher?* One recipient stated that increased amount of fishing boats in Solomon waters was alone the biggest perceived change in the fishery. Two stated that the fishery had remained more or less the same throughout their years at sea. When it came to Q14 *Do you, generally speaking, view the general stock abundance/size of schools of tuna as the same, increased, or decreased since you started working as a fisher?*, nine stated that they perceived the tuna stocks as being smaller than before. Several of the fishers elaborated by stating that they spent far more time out at sea searching for fish, compared to before. Fisher 1 stated that in the beginning of his career it was not unusual for them to easily catch 10 tonnes of tuna a day. "Today, if we are *lucky*, we catch 5 or maximum 6 tonnes a day". Fisher 10 stated that "the sizes of the schools has changed dramatically – and it is also very hard to find them. We search for miles after miles, and often we don't see any schools for an entire day. Sometimes it can go as much as two days without seeing schools. This never happened before. Then, I saw school fish every single day". The same fisher further stated "before, in the Solomon Sea, I would see plenty of fish, also near the islands. In three days we would catch 30-40 tonnes of fish. Now it takes up to two weeks before we catch the same amount".

5.1.6 PNL views on IUU mitigation and conservation measures (Q10, 11, 16, 17 and 19)

The PNL fishers in this research expressed a lot of interesting suggestions and views upon their own impact on the fishery as well as recommendations for policy makers in securing future fish stocks. Many issues were addressed when Q10, Q11, Q16, Q17 and Q19 - all questions seeking scrutiny of the fishers' general view on fishing conservation, restriction policies and future safeguarding of stocks - were asked (in respective order: *Do you ever spot IUU activities when out at sea? – If yes, what kind of vessels, and in which areas? What do you see as the best option to mitigate IUU activity?, How do you view seasonal closures of high sea pockets?, How do you view creation of MPAs with fishing restrictions?, What do you, as a fisher, think is the most efficient way to safeguard stocks for the future?*). The first and foremost impression from the PNL fishers were that a significant amount of them were sceptical to the increase of PS vessel activity both locally and regionally, and it was an almost unison agreement that the most important conservation tool for the region is to limit the numbers of PS vessels operating, and setting restrictions to the size and technology that they use. In Q19, 12 of the recipients stated, both as only or as shared, management tool to safeguard future stocks that the amounts of PS vessels needs to go down, or be more strictly regulated. The remaining three stated that a mix of seasonal closures, more rules and regulations and promotion of PNL as fishing methods was the most fitting solution to the complex issue of declining global pelagic fish stocks. Again, one might say that the clear scepticism to PS as a fishing method is biased due to the fact that the recipients are practicing PNL as a fishing method, and would naturally be inclined to favour its own professional practice. However, interestingly enough, section 5.2 shows that five of the PS also proposes the very same as a conservation tool. One might say PS employees would not impose a suggestion that directly undermines their own subsistence. However, an interesting finding of the results of this research shows that the selections of fishers, regardless of practiced fishing methods, generally holds a self-critical and reflected view upon their own effects to the tuna stocks.

Other conservation suggestions to Q19[14] included stricter general rules and regulations (seven responses), seasonal closures of fishing areas (four responses), promoting and increasing the use of PNL as a fishing method (four responses), only allowing nationally owned vessels in each country's EEZ (two responses), less DWFN vessels allowed to fish in the entire Pacific region (one response), only up to the politicians to decide (one response), strengthening of fishing techniques that increases species selectivity (one response) and more control and monitoring of foreign vessel activities in the high seas (one response). Nearly all of the respondents had

[14] 67% of the respondents answered more than one suggestion to this question. Therefore, adding up the stated percentages adds up to >100%.

multiple answers to this question, the numbers provided in parenthesis does therefore not necessarily add up to 15.

Only two of the PNL fishers interviewed had ever personally observed IUU activities at their years at sea. Both were experienced fishermen, with 22 and 17 years, respectively, out at sea. One had, during his years working as a tuna-tagging operator with SPC, observed a foreign vessel in Marshall Islands EEZ fishing without a licence. The other had observed an American PS vessel in 1996 fishing in Solomon EEZ without a licence. The respondents explained how when the vessel observed them, they quickly turned around escaping without getting arrested. Seeing how all the PNL respondents fish at vessels that operates only in Solomon archipelagic water, naturally, spotting IUU activities, that are mostly occurring further out the EEZ or in the high seas, it was to be expected that the vast majority of them had not experienced spotting any such activity. The PNL fishers answers to Q11 were characterized by a myriad of proposals and measures. Seven stated that more general rules and regulations was the most suited way to control IUU activities. Three suggested less PSF activities were the proper IUU mitigation tool; whereas three stated that only allowing nationally registered vessels inside national EEZs were the way to go. Another three restrained from answering as they did not know, two believed more patrolling and strengthening of Vessel Monitoring Systems (VMS) tools were to be preferred, one believed in heavier penalties for IUU felonies, and lastly one believed that authorities should be much more restrictive to issue fishing licences.

The highest level of agreement in the selection of PNL fishers was achieved in Q17, where 100% of the recipients perceived the creation of MPAs with fishing restrictions as a positive conservation tool. Seeing how in most cases MPA creation imposes fishing restrictions, this is an interesting finding as one might expect professional fishers to oppose policies that directly restrict fishing activities. In Q16, 12 respondents viewed seasonal or permanent closures of high sea closures positively, and three viewed it negatively. These three justified this view in two ways: one due to the fact that fishing closures meant less available time for fishers to work and earn money for his livelihood and family. The second view was expressed from fisher 2:

> Lots of fishing activities in the high seas is causing schools of fish that are far out at sea to move closer to our archipelagic waters because they try to escape from fishing pressure further out. Closing the high sea pockets means that this fish stays outside the Salomon EEZ, thus giving us less fish to catch in the archipelagic waters (Fisher 2, April 27th, 2015).

5.2 Perceptions from the purse-seine fishers[15]

The impressions gained from the PS fishers were somewhat different to that of the PNL fishers. It was a slightly bigger divergence in their answers combined with a smaller tendency to favour their own fishing method, as well as retaining perceptions of a fishery under lesser degree of decline or threat than that of the PNL fishers. The 15 fishers had a total similarity mean of ≈57% when adding up all the answers (Q5-Q14 + Q16-Q19, n=14) that directly assessed their perceptions of the fishery. The highest mean similarity, of 100% agreement, was found in Q16 *'How do you view seasonal closures of high sea pockets?'* – all answered that they regarded this positively. The lowest mean similarity was found in Q9 'What do you do on-board to minimize by-catch?' – where seven of the recipients stated that it was 'not possible and/or very hard to avoid' by-catch in their fisheries. Also the PS fishers generally gave the impression that they supported conservation efforts of the fish resources that they depended on for their livelihood – an interesting finding, as most of these conservation efforts would mean less time out at sea, thus less money to earn.

5.2.1 PS background questions (Q1-3)

The mean years at sea for the PS fishers were 15,4 years, so also this respondent group had a significant amount of work experience to derive insight from – ranging from 5 to 26 years at sea. Like the PNL fishers, nine of the PS fishermen had worked only at PS vessels during their career, making their PS-specific skills and knowledge highly relevant. The remaining six that had worked also on other types of vessels, had still mainly worked on PS vessels, as well as a fair amount of them being part of the tuna tagging research project. This further added to their knowledge of the tuna fisheries of their region. They had worked on the respective vessels they were interviewed in on average for 4.9 years, ranging from 0.5 years to 10 years.

5.2.2 PS perceived employment opportunities (Q4-5)

Also amongst the PS fishers, the entry to the fishery showed no clear pattern – a mixture of open applications (four respondents), informal approaches to the company (three respondents), headhunting (three respondents) as well as via contacts (one respondent) was their way of

[15] The percentages stated and total number of selection in this section is only referring to the PS fishers interviewed (n=15). The percentages are approximate, and stated as rounded figures, desimals excluded.

attaining the job. A staggering 12 of 15 described the possibility of getting a formal fisheries job in SI as a challenge, against two, which described it as unchallenging, and one whom did not know. The high level of agreement of entrance to the job market being difficult for Solomon youth, may be seen as a reflection of the fact that getting a job at a PS vessel demands higher formal skills than before.

5.2.3 PS observed stock variations (Q6, 7 and 14)

The impression from the PS fishers regarding fish availability and perceived stock size were somewhat less unambiguous than that of the PNL fishers. In Q6, the answers were highly differentiated. Interestingly, four uttered 'increased amount of paperwork' as the biggest change during their years at sea - none of the PNL fishers interviewed mentioned increased paperwork as being an issue. Another six meant there was no particular change whatsoever, two said more vessels present in the fishery, and five stated the fact that there were less fish than before as the main change. The same tendencies continued in Q7, where eight stated 'no change' in fish size, whereas six stated the individual fish sizes to be smaller compared to before. In Q14 , also eight of the PS fishers perceived the school sizes of tuna to be unchanged compared to before, five thought them to be smaller, and two found the biggest noticeable change to the schools of fish were that the schools to a larger degree than before consisted of mixed species. As fisher 3 stated:

> Before you [could] only see yellowfins in one [separate] school, and only skipjack in [another separate] school, now they are mixed in schools. That is a big change. [It is] maybe 10 years [since] I noticed this change. [That is] when they started to mix (Fisher 3, April 27th, 2015).

5.2.4 PS perceived changes in mesh size (Q18)

When asked about any change in the technical equipment they used at the three PS vessels, in particular mesh sizes in the nets, many of the fishers (three respondents gave as only answer) referred to the recently replaced net system, a Japanese net model with three mesh size chambers – see section 7.26.1, Chapter 7, for more information. As many of the respondents referred to when asked about by-catch mitigation, this net model was described as a particularly effective tool to avoid catching undersized tuna individuals. Eight thought there to be no difference in mesh size during their time at sea, only one respondent described the mesh size to be smaller over the years.

5.2.5 PS by-catch reflections (Q8, 9 and 13)

The PS fisher's perceptions of the by-catch related questions were significantly different to that of the PNL fishers. Eight stated that they had a high amount of by-catch on-board their respective vessels, and the remaining six described the by-catch level as moderate. One respondent stated that the perceived level of by-catch was low. Many fishers balanced these statements, however, by describing how the by-catch mitigation had become much more sophisticated in recent years, many emphasizing the invention of three-layer nets with differentiated mesh sizes as one of these measures. That way of designing nets allows the smaller fish to escape the net before they reach the inner part of the 'purse'. Others emphasized that the knowledge and experience of the fishing master to a large degree also could control the by-catch levels, by visually recognizing schools of fish with a large amount of non-commercial species present and then avoiding these, and/or terminate an already initiated set around a school. Many also emphasized the complete ban of catching predatory species such as sharks, as well as sea mammals like whales, and lastly, avoiding catch of sea turtles. Many of the respondents clearly made the impression that they exerted themselves to great lengths to meet the requirements of avoidance of by-catch by these vulnerable species. Others emphasized the fact that the new legislation of landing everything they harvest, also the non-target species, as being a great initiative in order to mitigate fish discarding.

The legislation, like the NFD policy, gives the Solomon fishers licence to commercially sell everything that they harvest. A large amount of the PS fishers mentioned the most abundant by-catch to be mostly restricted to the Rainbow Runner (*Elagatis bipinnulata*), a species not yet categorized (NE[16]) by the IUCN red list, but generally considered in non-threatened condition by fishers. The Rainbow Runners is a moderately valuable edible species that is sold locally. Most of the fishers emphasized that most of the by-catch consisted of this species. However, fisher 15 illustrated a somewhat different picture: "we are harvesting some things that we don't need (...) every day. It's not a big part of the total catch, but every time we pull the net, there is something other than tuna there. If we pull a tangled shark in while it's still alive, we cut them loose of the net. If they are already dead, we throw them over-board". The statement, together

[16] NE is here defined as the IUCN abbreviation for 'Not Evaluated'. See http://www.iucnredlist.org/search for more information.

with the other eight of the PS fishers stating that by-catch is occurring to a large degree, creates an impression that by-catch is an issue PS vessels deals with to a larger degree than the PNL vessels. But the 15 interviewed fishers also creates an impression of a by-catch mitigation situation much more improved compared to before.

When it came to Q9, seven stated that the by-catch was somewhat or fully not possible to avoid. As fisher 15 stated: “We try to minimize the by-catch, but when you pull the net, what comes up, comes up, it is very hard to correctly observe from the boat what is inside the net”. Two stated that they released the by-catch physically from the net, whereas three stated that the by-catch mitigation depended on the skill and knowledge of the fishing master. Like fisher 22 stated: “we sometimes use glass to observe the fish inside the net. (...) We take in the net again if it’s a lot of undersized fish or by-catch, or we don’t set the net at all”. Many of the fishers emphasized the fact that sharks, dolphins and turtles are prohibited for them to harvest, and gave the impression that this attitude was an unquestioned part of their operation. Fisher 29 elaborated:

> We follow the regulations from the ISSF shark management programme, which minimizes by-catch by putting different types of nets under the FADs so that the sharks don’t get tangled. Our captains and officers goes to ISSF classes and trainings. Our ISSF documentation collected by the observers on-board is used to minimize by-catch. (...) We don’t get as much undersized fish as we used to, due to all the new rules and regulations. We know that we have to create a sustainable fishery. We are only cutting our own necks if we don’t follow these rules (Fisher 29, May 3rd, 2015.

Interestingly, for Q13, nine of 15 PS fishers regarded PNL fishing as the fishing method that predominantly minimizes the by-catch issue, and not their own fishing method. Longliners (four respondents) were secondly favoured, against only two regarding PS fishing as a favourable by-catch mitigation tool. Figure 29 illustrates how the ratio of perceived by-catch levels are decreasing drastically when PNL fishers are asked, a finding that suits the findings from other scientific publications regarding by-catch levels on different fishing vessels.

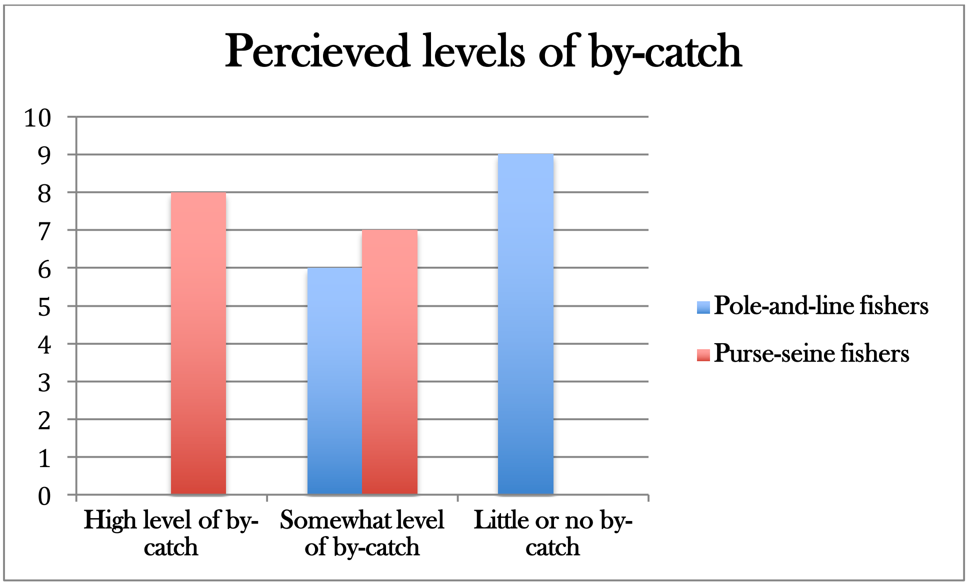


Figure 29 (n=30)

5.2.6 PS views on IUU mitigation and conservation measures (Q10, 11, 16, 17 and 19)

Also the PS fishers in this research drawed reflected thoughts upon their own impact on the fishery, and had many inputs regarding improvements of the current fishery policies. Even though the PS fishers went further out at sea than the PNL fishers, most of them had never spotted IUU activities (seven respondents). Eight had spotted foreign IUU fishing activities, and one had spotted a domestic IUU vessel. Compared to the PNL fishers, where only two had observed IUU activities, it was a moderate increase of spotted IUU activity, strengthening the assumption that IUU fishing activities is mainly an issue at the open ocean, outside sovereign state EEZ's. However, particularly some of the longest experienced fishers expressed some concerns of disheartening character. Fisher 29 (with 26 years of fishing experience) elaborated:

> If we see IUU activities, it's especially concerning longliners – we complain about them all the time. We are not very happy about another SI registered vessel. (...) This vessel[17] has not reported any catch for two years, even though we observe that they are loading fish. (...) When I worked back in the day, when we were not allowed to fish inside the MGA[18], and it took us years and years to negotiate the right to fish there. This other vessel was allowed to fish 4 miles from shore as soon as they came in. They have no established FADs, and are stealing our FADs, and are doing illegal transhipments. This government is very hard on us, I don't know why. They overlook other things like these, I don't know why. As soon as *our* VMS goes, on the other hand, they immediately send a patrol. (...) We send many complaints when we catch them on our FADs, to the company. The company responds with reports sent to the government – they say we have a problem with the other company taking our FADs because they get tangled inside their nets, and can destroy up to 10 FADs in one day with one set. But nothing files

[17] The respondent referred to a neighboring vessel docked up at the port in Noro at the time of the interview

[18] Solomon archipelagic zone, the zone surrounding land within 12 miles. Before, fishers in SI could only fish outside the MGA, meaning from 12-200 miles outside the shoreline.

> through. A few foreign longliners have been impounded and fined. Also foreign PS vessels. We send in lots of complaints, but still see significant IUU (Fisher 29, May 3rd, 2015).

The quote illustrates one individual's opinion, but is certainly a testament to the fact that occurrence of IUU fishing activities; corruption and uneven prosecution may take place both in SI and elsewhere. The effect of politics and suspected corruption within tuna fisheries will be further debated in section 7.22, 7.22.1, 7.24, 7.27.1 and 7.36.1, Chapter 7, or from footnote 5, section 3.3, Chapter 3.

The PS fishers answers to Q11 were, like the PNL fishers, characterized by a variety of suggestions, including; improving VMS on-board vessels (eight respondents), more rules and regulations (three respondents), more observers on-board (three respondents), more protection programmes for vulnerable by-catch species (one respondent). The responds, however, also included a few discouraged sentiments. Two responded that measures to mitigate IUU activities was not possible due to the fact that it is simply too hard to control, two had no suggestions, and three felt that no improvement were necessary on the field. As opposed to the PNL fishers, none of the answers included less PS activities as an IUU mitigation tool. Many of the respondents had multiple answers to this question, the numbers provided in parenthesis does therefore not necessarily add up to 15.

In Q16, 100% of the PS respondents regarded seasonal closures of high sea pockets positively. One may argue that this agreement is achieved due to the fact that it will not personally affect the selection's line of work in any way since they only fish within SI's EEZ. However, it is a significant testament to the general impression from this research; the fishers, both from PNL and PS vessels, are themselves in the frontline to support more rules and regulations of the tuna fisheries. The same positive unanimity was expressed in Q17, where 12 of 15 regarded the creation of MPAs with fishing restrictions as an appropriate conservation tool. Two viewed it negatively, one due to the fact that MPAs imposes fishing restrictions throughout the whole year, he found fishing restrictions to be necessary only during certain months of the year. The other fisher that viewed this negatively was due to the fact that the company would loose revenue they could otherwise collect from the MPA area.

Regarding Q19, suggestions as to how tuna stocks may be safeguarded for future generation, suggestions flourished among the selection of PS fishers. The answers included: less licences should be given to PS fishing vessels (five respondents), less fishing licences given to all types of fishing vessels (four respondents), less foreign vessels allowed in national and regional waters (five respondents), more occurences of seasonal closures in national and regional waters (five respondents), promoting PNL as fishing method (two respondents), more rules and regulations (one respondent), fighting climate change (one respondent), improving regional cooperation (one respondent), creating more MPAs (one respondent), up to politicians to decide (one respondent), and current situation is satisfying (one respondent). Like the PNL fishers, the PS fishers expressed a wish to mitigate fishing activities in general as an important part of safeguarding future stocks. The finding is captivating; as it seems the fishers themselves wishes to be part of the frontline of lessening the fishing pressures on tuna stocks, and seems to a large extent convinced that *less fishing* is part of the solution – although holding such a sentiment involves somewhat compromising their own livelihood. Also here, the respondents do not necessarily add up to 15, as several respondents answered multiple answers to this question.

6.0 Chapter 6: Extended background information and definitions of terms

As the nature of this thesis is comprehensive and complex, with several terms in need of definitions before discussion, an extra section of background information was thought to be necessary. Chapter 6 will further elaborate central fishery science terms, biophysical information and current status on the two tuna species that is elaborated, background information about key tuna management actors relevant for the WCPO, as well as briefly elaborating the role of consumer advocacy in the fishery.

6.1 Central fishery science terms

6.1.1 Defining sustainable fisheries management

> *"The cod fishery, the herring fishery and probably all the great sea fisheries are inexhaustible; that is to say, that nothing we do seriously affects the number of fish"* (Thomas Huxley, biologist and president of the Royal Society at the Great International Fishery Exhibition held in London in 1883[19])

Little did the acclaimed biologist and strong supporter of Darwin's theories know at the time of the fishery exhibition in London in 1883 that in less than a hundred years later, his infamous quote would prove sadly mistaken. His quote was reflective of his time, however, technology not being sophisticated enough to have excerpted most fisheries empty – and also, it reflected a suggestion of the contemporary people's general unawareness of the finite limits to nature. Not many years later came an increasing scientific consensus that research was needed to identify the effects of fishing (Jennings, Kaiser & Reynolds, 2001). Major breakthroughs in the science of fisheries were made early in the twentieth century, such as Norwegian scientist Johan Hjort proving that fluctuations in catch was being linked to changes in survival rate; the abundance of a year class of fish was established within the first few months of life and renewal of fish stocks was not taken place by a constant annual production, as previously assumed, but rather by highly *irregular* annual production with a few fish surviving most years and many fish surviving in only very few years (2001).

[19] Excerpt from Mr. Huxley's Inaugural Address given under the opening of T. H. H. Fisheries Exhibition in London, 1883. See http://aleph0.clarku.edu/huxley/SM5/fish.html for full speech.

During the WWI and WWII years military efforts leading to a drop in fishing efforts created some exceptions to the rule; but for the following decades fisheries were exploding in extent and numbers around the globe, in direct proportionality with the explosive human population growth and rapid improvement of gear and technology. By the 1950s models describing the dynamics of fish populations and their responses to fishing was being developed by scientists, and as such tempted to predict the yields from fisheries were fish were killed at different rates, trying to understand how stocks responded to different human-induced harvesting (Jennings, Kaiser & Reynolds, 2001). Fisheries today are highly unstatic and diverse, and this variety is mirrored in the different means they provide for people - whether it is daily subsistence or super seiners catching 400 tons of skipjack a day to deliver to processing plants for high commercial profits – thus, the objectives of management are just as different.

During the twentieth century there was an explosive growth of fishery development, where new fisheries becoming objects of rapid exploitation. Some fisheries were resilient and sustained a high level of effort, where replenishment of biomass was sufficient to maintain fish production and hence catches. However, many fisheries experienced an over-exploitation face because of too many fishers entering a lucrative fishery. In many cases this face lead to a full collapse of the fishery since many of them suffered from not-controlled fishing efforts due to too many fishers competing for a dwindling resource (Jennings, Kaiser & Reynolds, 2001). Examples of known fishery collapses are the Californian soupfin shark, the Galápagos sea cucumber, the Chilean loco and the Atlantic northwest cod fishery collapse[20]. As many fisheries all over the world has experienced some serious fishery collapses over past decades, the concern over conservation of both stocks and marine ecosystem created the advent for developing sustainable fisheries science. The loss of marine biodiversity and the declines of are illustrated in Figure 30.

[20] For more information about these collapses, see (Jennings, Kaiser & Reynolds, 2001, p. 11-14) or (Hauge, Hiis, Cleeland & Wilson, 2009)

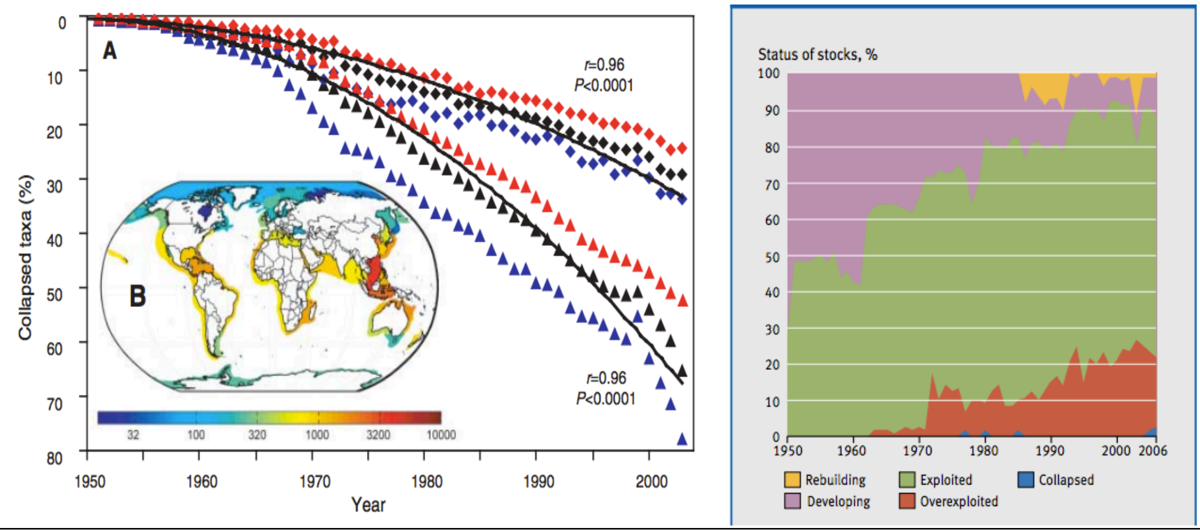


Figure 30 (left): Collapsed marine taxa since 1950. Graph A illustrates the decline in fish stocks, and top curve representing yearly rates of numbers of collapsed taxa and the bottom showing cumulative loss. Inserted figure B shows worldwide distribution of number of species, indicating declining diversity in many regions (red colour indicates biggest loss). *Source*: (Worm et al, 2006, p. 789).

Figure 30 (right): Trends in the state of global fishery stocks, 1950-2006. *Source*: (UNEP, 2012, p. 142).

As Figure 30 illustrates, the concern for fisheries is not unprecedented: numbers from FAO shows that catch records from the open ocean has suffered declines since the 1950s with the rate of decline increasing; in 2008, 32% of global fisheries were overexploited, collapsed, depleted or recovering from depletion. Since the 1800s, the loss of marine biodiversity has been around 40%, and an estimated 60% of today's major marine ecosystems are being used unsustainably (UNESCO, 2015, UNEP, 2012, p. 142, Worm et al, 2006, p. 314).

The management of fish stocks in this grim reality is therefore one that most scientists agree should be based on sustainability efforts. Avoiding the negative outcomes of a tragedy of the commons situation is a consequence of uncontrolled fishing seen as undesirable for most fisheries scientists. The management objectives are thus highly important to define in order to create a sustainable fishery. Without clear objectives it is impossible to judge successes or failures of the management strategy, or, for that matter, conserve non-target species, marine habitat or maintaining maximum biologically sustainable yield (Jennings, Kaiser & Reynolds, 2001, p. 15). *Balancing* objectives is a challenging task; a fishery consists of biological, economic, social and political objectives, all needing to achieve certain goals. Should for instance catches, income and employment be sacrificed to save a species from conservation concern? Different interest groups has different objectives, and a conservation group would in many cases say ‘yes’ to the question, whereas fishers may often say ‘no’ (2001). The challenge, then, is to balance the combination of objectives that each interest group defines as maximized value – a trade-off between objectives. This technique is often referred to as multiple-criteria decision-making. Balancing highly different objectives is highly challenging, and in reality trade-offs between objectives are rarely quantitative. On the contrary, they are more often made on ‘feel’ basis from governments based on a range of consultation, scientific advice and their own political goals (2001).

Creating management that maintains interest of the different actors in the fishery while ensuring future sustainability of the fishery presupposes a management strategy based on scientific advise of biological limits to catch, and fair distribution along fishers depending on the access for livelihood as well as taking market demands into consideration to ensure economic prosperity. The management actions in fishery science is what actions are done to implement the strategy, often divided into *catch control*, *effort control* and *technical measures*.

> **Catch (output) controls** limit the catches of individual fishers or the fleet as a whole, **effort (input) controls** limit the numbers of fishers in the fishery and what they can do, while **technical measures** control the catch that can be made for a given effort (Jennings, Kaiser & Reynolds, 2001, p. 17).

Many management decisions made to obtain sustainability in a fishery is often made by indicators of vulnerability of non-target species and avoiding catch of juvenile fish. Identifying correct indicators of this vulnerability, quantifiable biological reference points and precautionary approaches to deal with uncertainty is further part of that process. Bioeconomic analyses as increasingly important to assess and mange fisheries as well as impacts on seabirds, mammals, rare fishes, habitats and ecosystem processes (Jennings, Kaiser & Reynolds, 2001). Ensuring that the poorest people in the world has continued access to coastal fisheries is also an integrated part of sustainable fisheries. The fact that millions of people depend on fishery resources for protein intake, economic gain and subsistence is crucial factors that need to be fulfilled in order to ensure a successful fishery. Artisanal fisheries has been actively going on for thousands of years without destruction of marine habitat is a reason itself, but modern times with the combination of fast-growing human populations, better fishing tool technology and explosive growth of industrial-scale fishing is the potent mixture that imposes fishing managers to provide strong, sustainable enforcement strategies to ensure sustainable fisheries for the future. Keeping in mind that ensuring human prosperity while keeping marine resources at sustainable levels *is* possible, can be illustrated in this example:

> Empirical evidence from fisheries that were shown to be sustainable suggests that 1 km^2 of actively growing reef, fished for a variety of algal, fish and invertebrate species, can support approximately 320 people if no other protein sources are available. Shallow reef and lagoon areas in general would support about one-fifth of this number. At these human population densities, the fishery is unlikely to collapse if the fishers are catching solely for subsistence (Jennings, Kaiser & Reynolds, 2001, p. 335).

While an objective such as 'maximizing protein intake' may seem desirable, the action needed to meet that objective, needs to not compromise the ability for the long-term users of the same protein source in the future (2001). Balancing objectives in a sustainable fishery is thus highly challenging. The needs of the present generations have to be met without compromising the ability for future generations to meet their own needs from utilization of fisheries resources. This very concept requires that a *balance* between resource uses against protection from that same use is strived for. In defining sustainable fisheries, the following should thus be included; an integrated process that contributes towards maintaining the health and security of marine ecosystems and fish stocks as well as the resource users. It should also take the optimum utilization of resources into account, while ensuring long-term sustainability, maintenance and protection of marine biodiversity. Further it has to involve prevention or elimination of overfishing and excess capacity in a fishery, increase participation and involvement of stakeholders in decision making and fisheries planning, and finally; minimize pollution, wastes and discards in the fishery (Petaia, 2015).

6.1.2 Output (catch) control measures in fisheries management

According to Jennings, Kaiser & Reynolds (2001), catch controls is a way of limiting and controling the output of fishing – the catch. One way to achieve this is to limit the weight of catch that fishers can harvest from the fishery. Such controls traditionally includes Total Allowable Catch (TAC) – the quantity of biomass that is permitted to be caught from a specific stock, as well as Individual Quotas (IQ) and vessel catch limits where the TAC is divided between fishing units. A setting of TAC is set for each specific fish stock or species within a fishery, and is set to meet the target levels of fishing mortality that is in turn determined by the stock assessments. The TAC is used to restrict catch to a predetermined level (such as the MSY), but it often includes significant concealed numbers as catch controls in fact are *landing controls* due to the fact that much catch is discarded or killed due to low quality or undesireable sizes. Catch controls are, however, a widely used fishery management tool. It often leads to competition amongst fishers as they race to maximize their share of the TAC – since once the TAC is equal to the aggregate catch, the fishery closes (2001). The output controls also encourage investments in effective technology competing for higher catches, which may in turn lead to overcapitalization or excess capacity. TACs are then often considered more considerate biologically, but poorer in economic terms. IQs are then a more specific management tool as it limits the catches of individual fishers or boats, and as such creates a limited number of vessels participating in a fishery (2001). Since the fishers are guaranteed a share of the TAC rather than having to compete for it, it creates a more viable fishing operation with more robust economic incentives. The WCPO skipjack and yellowfin fishery is not managed through output controls, but a lot of other fisheries are.

6.1.3 Input (effort) control measures in fisheries management

The basic idea of effort controls in fishery management is to regulate the fishing *effort*. Effort in fisheries science is a measurement of how much fishing that is taking place through the vessels targeting fish stocks and marine ecosystems. Managing and controlling the effort abilities can be done through limiting the number of boats or fishers working in a fishery, the amount, size and type of gear they use, or the time the gear can be left in the water (Jennings, Kaiser & Reynolds, 2001). More specifically it involves calculating the numbers of vessels participating in the fishery, their potential catching power abilities, the intensity in the operation of the vessel, as well as their allowed time at sea targeting the fish. The aim of effort controls is to reduce the catching power of the fishers so that the fishing mortality may be reduced consecutively. Accurately foreseeing and measuring the effects on effort controls to the mortality of the stock is challenging. It involves several variables, including an aspiration to map the fishers' change in behavior in response to the effort control regulations (2001).

Measuring the total effort for the fishing fleet of a fishery may roughly speaking be defined as the number of vessels x catching power x intensity x days at sea (Petaia, 2015). Limiting the entry of the fishery may be done through issuing licenses, permits or concessions to fishers or vessels participating in the fishery. When effort controls are imposed, however, fishers are highly adaptive and quickly respond through improving gears. Using solely entry controls limits the number of vessels, but does not limit the size of the vessel, the range of fishing gear used. Thus, technology investments are also here incentivized, further increasing the effective effort. Therefore, it is common to combine entry controls with *capacity* controls, where limits on vessels size (length, width or GRT) or amount of gear are examples. Using capacity controls is necessary in combination with for instance entry controls are necessary, if not, then effort controls ultimately will not control fishing mortality (Jennings, Kaiser & Reynolds, 2001). Limiting the location of the fishing is another input control, through establishing specific areas set aside or closed for commercial fishing, such as MPAs, spawning grounds, or designated area closures – reserving certain areas for certain usage. The intensity of the fishing operation may be hard to monitor and manage, as it highly depends on unpredictable variables such as weather conditions and the skills and work capacity of the fishers onboard (Petaia, 2015). Limiting the fishing time at sea is therefore a way to apply an effort control that is calibrated to include many of the unpredictable variables, and is the essence of the VDS that PNA has imposed in their waters. The VDS will be comprehensively covered in section 7.25.2, Chapter 7.

Limited licenses issued is another way of controlling the number of boats and fishers operating in the fishery, and can be issued as for instance Individual Effort Quotas (IEQ) or as an individual transferable effort quota, a tradable IEQ (Jennings, Kaiser & Reynolds, 2001). The licenses may be issued as a long-term license or a short-term, depending on the fishery. The skipjack and yellowfin fishery in the WCPO is therefore in effect an input controlled fishery. As discussed in section 6.1.3, chapter 6, input controlled fisheries has significant challenges, as they create incentives for fishers to increase catches through expansions of effort and technology – the technology creep. It further may create economic inefficiencies as they limit choices of fishers (for instance in area closures) – thus, achieving an effective control mechanism is to place controls along a range of inputs. Single control measures such as only limiting the days fished create poorer management objectives, as the continued evolution of more powerful vessels and gear consequently limits the impacts of restrictions (2001).

6.1.4 MSY as a concept and sustainability indicator

In making single-species assessments, the early fisheries scientists in the 1950s tried to equate the concept of sustainability in a fishery with the notion of creating a *maximum sustainable yield* (Pauly et al, 2002). Later on, in fishery science, an important measure that has traditionally been used in discussions of sustainability and conservation is the MSY concept. The MSY levels are set based on complex single-species assessment models, catch-at-age data and interpretation of catch and age-compositions in a fishery. Setting a precise stock assessment number is a complex matter, and has some serious limitations, as well as being technically challenging, with hundreds of parameters to be interpreted for managers (2002). Keeping all the unforeseen numbers in a fishery in mind and also acknowledging that it is difficult to determine the amount of fish in a stock; often results in fishery scientists employing a precautionary principle through setting a conservative MSY number, that if met, still at all likeliness will give the fish stock more than enough room to regenerate. If a fishery at any point in time is exceeding the set MSY levels, the fishery will not be considered sustainable. MSY establishes the largest catches that can be taken over the long-term without causing the population to collapse (Jennings, Kaiser & Reynolds, 2001). MSY is quantifiable through e.g. Total Allowable Catch (TAC) and provides a practical 'bottom line' for fisheries managers, and from a strict biological point of view it makes sense. MSY deals only with single species conservation and does not involve other components of the fishery system, it is thus a simplistic, yet useful way of providing upper catch roofs, and is by no means the only objective of fishery management.

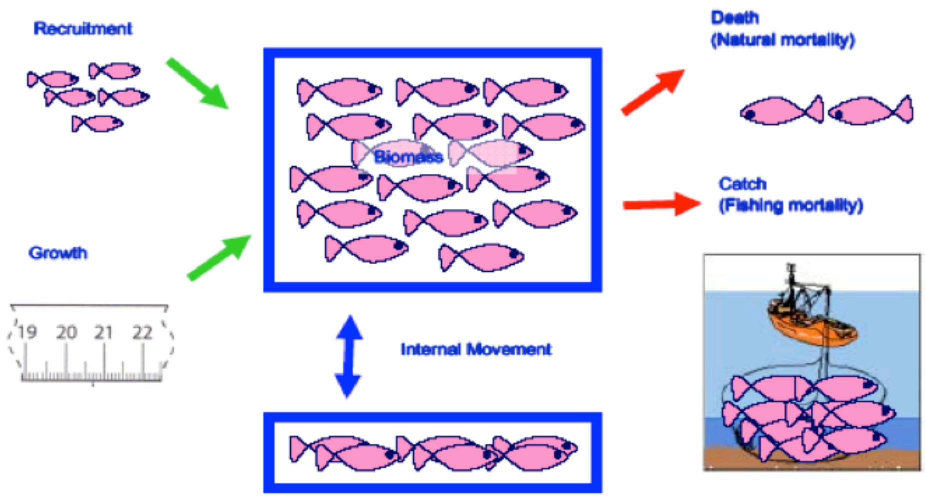


Figure 31: population biomass dynamics of a fish species. *Source*: (Petaia, 2015)

As Figure 31 illustrates, population biomass depends on growth, reproduction, natural mortality and fishing mortality. For a given level of fishing mortality to be sustainable, there must be a balance between the mortality, which reduces population biomass, and reproduction and growth, which increases it (Jennings, Kaiser & Reynolds, 2001). A typical mathematical model to illustrate this dynamic, can be $B_{t+1}=B_t+R+G-M-C$ written as new biomass= old biomass + surplus production – mortality, where surplus production being the difference between production and mortality and production = recruitment + growth (Petaia, 2015). If production >

mortality, the stock biomass will *increase*, and if the production < mortality, the stock biomass will *decrease*. Thus, surplus production refers to the biomass that is produces in excess of that required to replace losses – which is the MSY – which again may be harvested without adversely affecting the stock (Jennings, Kaiser & Reynolds, 2001).

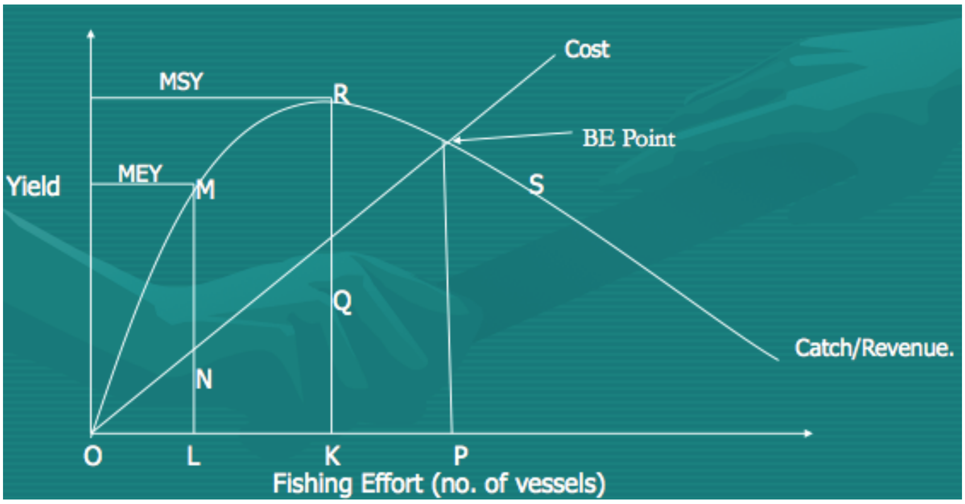


Figure 32: Graphic display of the MSY concept. *Source*: (Petaia, 2015)

Figure 32 illustrates the complex coexistence of different measurement methods for a fishery's threshold points, with fishing revenue at the y axis and costs versus fishing effort along the x axis. At an early stage of development an increase in fishing corresponds to an increase in catch, further encouraging more fishing effort in the fishery. As fishing effort grows, however, the catch and economic yield will decline if fishing efforts are continued beyond the point of MSY, as the fish stock is not able to replenish quickly enough. If the effort is not slowed, then too many boats chasing too few fish will create a collapse in the fishery. The figure refers to several reference points, the MEY (maximum economic yield) considers the economic performance of the fishery and the MSY measuring the biological threshold for the fishery - a surplus production curve for the stock in question with the relationship between the cost of fishing and fishing effort. The BE point (bioeconomic equilibrium) refers to the theoretical equilibrium in an open access fishery, at which point costs and revenues are equal so that there is no incentive for new entrants to join the fishery (FAO, 1999). The determination of the MSY is essential to determine the TAC.

6.1.5 Defining CPUE and fMSY

Determining a stock's abundance levels is crucial for any fishery manager in order to establish effective management strategies for the fishery. Estimating the relative abundance, then, is to find the number of individuals in one area in relation to numbers in another area, or the same area at another time. The Catch Per Unit Effort (CPUE) is a commonly used index of relative abundance, and a tool to provide a general indication of the status of an exploited fish stock. For example;

> If a CPUE is 20 kg in area A and 40 kg in area B, this indicates that there are twice as many fish in area B. The validity of this inference depends on: a) the fisher having used the same skills, same gear; b) equal distribution and vulnerability of fish to fishing gear in both places. If both conditions are met, then 1 unif of effort will catch a constant proportion of that evenly distributed stock. This logic assumes that there is a direct relationship between CPUE and abundance, which may not always be the case. In most cases, the catch-ability of a species is not constant, and may vary in response to behavioural changes associated with time of day, lunar cycle, and season of the year; distribution and density; and efficiency of gear and experiences of the fishers. The basic principle of using CPUE data, then, is that detecting changes in trend of CPUE over time will accurately reflect changes in abundance of a fish stock. (Petaia, 2015).

If efficiency of fishing gears is not taken into account, the CPUE will decrease more slowly than the stock size. The basic principle of using CPUE data is that changes in trend of CPUE over time accurately reflect changes in abundance of a fish stock. Therefore, the apparent CPUE is the reference point that measures just boats, effort and catch, while the adjusted CPUE takes all the latter into account as well as the meaning of technology. Utilizing an adjusted CPUE is relevant for fisheries managers as the role of efficient gear and technology to a far extent determines the total landed catch (FAO, 1999). An overestimate of MSY will occur if the efficiency factor – the adjusted CPUE - is not taken into account, and also: inclusion of adjusted CPUE means a more robust management system with a higher degree of precautionary principles present in the management scheme (Petaia, 2015). When fishing efforts in a newly established fishery is growing, the CPUE and catch (or yield) will decline to the point of MSY at a certain level of fishing effort – the fishing mortality that produces the MSY, the fMSY.

The fMSY is another benchmark used to control a different aspect of the fishery; it is referred to as the fishing mortality rate which again will produce the MSY levels (FAO, 1999). Use of reference points such as the fMSY provides a framework for fishery managers to quantitatively determine the status of the stocks and assessing its exploitation levels. Another way of regarding the fMSY is that it reflects the fishing mortality that occurs at the MSY, and is often used as an indicator of overfishing. Whereas the biomass at the MSY levels, the bMSY, is used as an indicator of an overfished state. Mainly these, alongside with many other, benchmarks are together forming a complex picture of how to assess the stocks correctly to avoid and foresee the state of overfishing.

> It is possible for overfishing to be occurring, but for the stock to not yet be in an overfished state. Conversely, it is possible for the stock to be in an overfished state but for the current level of fishing to be within the overfishing reference point. In this case, the stock has presumably been depressed by past overfishing and would recover to a non-overfished state if the current level of fishing were maintained. It is likely that these reference points, or something similar, will be used for stock status determinations in the new WCPO tuna commission (Langley, Hampton & Ogura, 2005).

As the citation implies: concluding that overfishing is occurring in a stock is a complex matter. Creating benchmarks that together reflects as much as possible of the complex interactions occurring in the natural world is therefore of utter importance to fisheries managers. Combining several of these benchmarks will often create better understanding of the status of the stocks – but often creates headaches for fisheries managers, as many of these indexes forms complex mathematical structures. The different types of overfishing will be briefly explained in the following section.

6.1.6 The by-catch issue

Providing advice to prevent overexploitation or collapse of fish stocks has been the issue of main concern for fisheries scientists since the advent of the discipline of fishery science. However, the ever increasing fishing pressure parallel to the human population growth of the last decades has created severe impacts on the marine ecosystem other than those on targeted species and these impacts are now the main focus of many research and management schemes (Jennings, Kaiser & Reynolds, 2001). Fishing of undersized individuals of the target species or of other non-target species are what often falls under the definition of 'by-catch', however, the concept has been addressed differently by different scholars. Definitions includes issues such as 'trash' fish caught accidentally in some shrimp trawl fisheries, the discards of undersized individuals of the species targeted by the fisher, as well as the incidental mortality of members of the marine megafauna, such as marine mammals, sea turtles or seabirds (FAO, 2013). The species that falls under the by-catch definition can be at risk from fishing, particularly if they are less abundant or more vulnerable than the targeted species. What is often the case is that the target species may be fished at sustainable levels; however, the by-catch species associated with the target species could still be facing overfishing or extinction if it is more vulnerable and/or less abundant than the target species (Petaia, 2015). In defining by-catch, it is necessary to define what falls under the category of 'catch', see Figure 33.

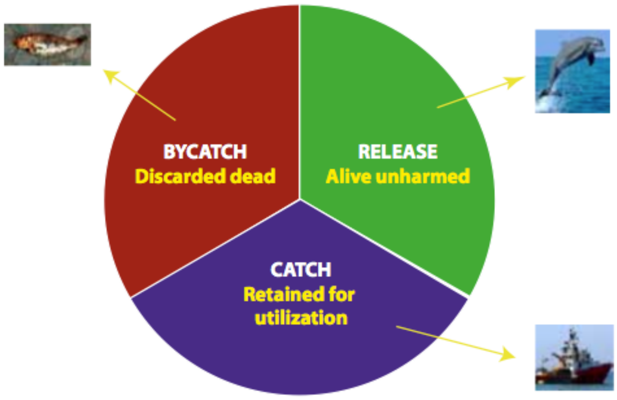


Figure 33: definitions of what falls under the total numbers of biomass included in a catch. *Source*: (FAO, 2013, p. 14).

As Figure 33 illustrates, what falls under the category of *catch* is in fact only what is actually retained from a fishing vessel for utilization, such as consumption, sale or use as bait. This, however, does not necessarily account for all the biomass involved in the capture process at sea; a *release* is the part of the capture that is released alive, such as effort from fishers to cut sea turtles loose from the net before the point of suffocation, and finally: the *by-catch* refers to the part of the capture that is discarded dead at sea, or assumed to die at a later stage as a result of the fishing operation (FAO, 2013). For this research, any catch not targeted by the fishers that is either retained or discarded, as well as undersized, juvenile skipjack and yellowfin tuna (for the WCP-CA meaning individuals <1.3 kg) are considered by-catch.

Slowly-growing species with long maturity periods, bottom-dwelling organisms caught from bottom-trawling as well as numerous species of sharks, turtles, seabirds (albatross caught in the longline fishery in particular) and the general cetaceans group are all well-known examples of species under threat of mortality from by-catch – and forms the basis of numerous conservation campaigns, articles and academic literature[21]. For instance; schools of yellowfin tuna are harder

[21] For more information on the by-catch issue, see for example http://www.fao.org/docrep/003/t4890e/t4890e00.htm or http://iss-foundation.org/wp-content/uploads/downloads/2014/11/ISSF-2014-11-Bycatch-Issues-in-PS-Fisheries-1.pdf or http://wwf.panda.org/about_our_earth/blue_planet/problems/problems_fishing/fisheries_management/bycatch222/bycatch_victims/

to spot due to the fact that they thrive at lower depths than skipjack does, 'skipping' along the surface of the water, easily spotted by fishers. By reasons still unknown by ecologists, the yellowfin tunas of the Eastern Tropical Pacific area are often swimming below schools of dolphins, which allowed the fishers to target schools of tuna by roaming the ocean for easily spotted dolphins. By the 1960s, this was the primary method for fishing yellowfin; to do a PS set around the school of dolphins, simultaneously trapping the yellowfin underneath them (Robbins, Hintz & Moore, 2014). Hauling in the catch also meant the death of millions of dolphins, trapped and suffocated inside the net – usually hauled on-board before being thrown back into the water dead, only a few of them able to breach over the net and escape.

The numbers of deaths of dolphins associated with the fishing method was so substantial, that when the biologist activist Sam LaBudde uncovered the dolphin deaths through undercover filming on the Panamanian tuna fishing boat *Maria Luísa*, it unleashed a public outcry of huge proportions (Robbins, Hintz & Moore, 2014). The outcry led to one of the most successful stories of consumer-advocacy for sustainable harvest practices, which will be further debated in section 6.4, chapter 6. The entanglement or accidental hooking of marine vertebrates with little or no commercial value in nets intended for valuable target species, is a huge problem in fisheries throughout the globe, and particularly so in the trawling and longlining fisheries. By-catch is an alarming issue in the longline fisheries, especially due to the fact of the low observer coverage of around 5%. By-catch figures for the industrial tuna longline fishery are very scarce, and the low observer coverage is not sufficient to draw any conclusive remarks on the true extent of the problem (Hall & Roman, 2013).

6.1.7 Different types of overfishing

If a fish stock is in a state of being overfished, it puts the stock at serious risk of depletion, or ultimately; facing extinction. Loss of biological diversity can have serious consequences for the stability of marine and coastal ecosystems

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http://izt.ciens.ucv.ve/ecologia/Archivos/ECOLOGIA_DE%20_POBLACIONES_Hasta%202004/ECOL_POBLAC_Hasta%202004_(H-N)/Lewison%20et%20al%202004.pdf

Ecosystem overfishing, or “fishing down the food web” refers to the fishing-induced impacts and disturbances on marine ecosystems, which again may alter the structure and function of the ecosystem in question. Setting target reference points (TRPs) such as MSY or TAC, as well as employing ‘monitor, control and surveillance’ (MCS) factors is one way of avoiding ecosystem overfishing. Another is striving for a comprehensive Ecosystem-Approach to Fisheries Management (EAFM) approach to the fishery in question, and a third is establishing the trophic interactions in the ecosystem or food web as indicators of overfishing and sustainability. The ecosystem surroundings of fish can be used as indicators of sustainability through establishing indexes of trophic interactions with other species. Fishing can alter trophic relationships through changing the relative abundance of predators, prey and competitors as well as the genetic make-up of populations (Hauge, Cleeland & Wilson, 2009). In the aftermaths of the Canadian cod fishery collapse a form of ecosystem altering occurred; vast general change in the ecosystem was observed due to what seems to be anthropologically-induced removal of a huge number of fish, resulting in the emergence of a completely different set of dominant species – mainly invertebrates.

Pauly et al (2002) defines the marine ecosystem in terms of ‘trophic level’ (TL), defined as 1+ the mean TL of their prey. Thus, in a marine context, the algae figures at the bottom of the food web with a TL=1, herbivorous zooplankton feeding on the algae with a TL=2, large zooplankton or small fishes, feeding on the herbivorous zooplankton with a TL=3, and large fish such as tuna, cod or groupers whose food tend to be a mixture of low- and high-TL organisms with a TL=3.5-4.5. The mean TL of fisheries landings can then be used as an index of sustainability in exploited marine ecosystems. As fisheries has a tendency of removing large and slower-growing specimen – thus reducing the mean TL of the fishery – can lead to an overall declining trend of TL in the catches. If declines of TL are occurring, it may be an indication of ecosystem overfishing.

Biological overfishing refers to recruitment and growth overfishing. *Recruitment* overfishing can be defined as “depleting the reproductive part of the stock so much that recruitment is impaired” (Diekert & Rouyer, 2011, p. 2). Recruitment overfishing can occur when environmental variability combined with vulnerable state of the resource in question may cause an abrupt recruitment decline and a subsequent parental biomass decline. Overfishing on such low stock sizes often results in collapses, as the case was in the famous collapse of cod in Atlantic Canada (Polacheck, 2002). Overly optimistic predictions of recruitments (survival of juveniles) in a single-stock assessment, or neglect to initiate conservative fishing effort advises from fishery scientists, has often led to biological overfishing. Stock size overestimation is thus a major risk when commercial catch per effort is used as an abundance trend index – as such, for fishery managers to invest in survey indices of abundance trends is crucial in order to avoid overfishing to occur. Uncertainties in stock assessments resulting in poor scientific advice are other examples of the same. It is difficult, but nevertheless possible, to quantify the probability of recruitment overfishing to occur. The longer a stock remains at low levels, the higher the possibility of an abrupt recruitment decline (2002). Estimations of risk requires estimations of the relationship between spawning stock and corresponding recruitment – which becomes harder to establish the smaller the stock is.

In the severely biologically overfished Southern Bluefin tuna stock, Polacheck (2002) defined five factors as crucial in order to avoid further biological overfishing in the future; 1) form of the stock recruitment relationship, 2) establishing natural mortality rates, 3) create a model for estimation of the plus group, 4) interpretation of CPUE as indices of abundance and 5) consideration of a models lack of fit. "Biological extinction from a directed fishery is extremely rare because economic extinction (i.e., the fish becoming too rare to fish profitably) usually happens well before economic extinction" (Hauge et al, 2009, p. 286). If fishing is continued in a fishery system to such an extent that the adult stock is not able to produce enough young fish to maintain the stock, recruitment overfishing is occurring. *Growth* overfishing can be defined as "depleting the young part of the stock before it has reached its full biological and economic potential" (Diekert & Rouyer, 2011, p. 2). Growth and recruitment overfishing are confounded processes, and cannot be strictly isolated – the contribution to recruitment, for instance, may ultimately depend on the levels of growth.

A common perception is that growth overfishing is perhaps the most widespread form of overfishing, particularly in small-scale and coastal fisheries, however, the recruitment overfishing may have more disastrous consequences as it can impede the viability of the stocks (2011). However, growth overfishing is particularly harmful to species that grows significantly in weight and value with age, as well as slowly-maturing fish. Diekert and Rouyer also points to the fact that since fishing gears are so selective making very few fish surviving long enough to grow large and old, it may lead to an effect called 'age truncation' – where old fish, which is better adapted to buffer adverse environmental fluctuations, growth overfishing may lead to magnified fluctuations of abundance and decreased biological stability.

Economic overfishing refers to the point when the revenue generated by a marginal increase in effort is less than the cost of that increase, thus creating an unprofitable fishery system. When redundant inputs are used, leading to depletion of any rents (i.e., total revenues minus total costs), which could be produces, economic fishing may also occur. This form of overfishing does not necessarily imply biological overfishing, however. "Under open-access conditions, a fishery will experience both biological and economic overfishing for as catches decline, the price of fish rises and the cost per unit of catch increases" (FAO, 1989, p. 11).

6.1.8 Defining ecosystem-approach to fisheries management (EAFM)

In traditional fishery science, the sustainability focus was mainly linked to the determination of MSY, forming the basis of management decisions as well as determining how much fishing efforts per year the system could tolerate and still reproduce catch for the future. Determining the MSY was nearly considered the 'Holy Grail' of fisheries science (Jennings, Kaiser & Reynolds, 2001). Thus, the fisheries sciences evolved as a science of sustainability – where the focus of sustainable yield has been a key aspect. However, there are some important shortcomings in only basing the sustainability factors of the fishery on MSY alone. Physical output from the fishery is not the only way to examine its sustainability levels – it is a simplistic view of a highly complex system, with focus on the target species mainly. For instance - the issue of by-catch and how to mitigate these as an integrated part of at the same time not overfishing the target species must be balanced to achieve high levels of sustainability of a fishery. In the more traditional discourse of sustainable fisheries the focus was on physical output and how to sustain fish harvest through circling around the sustainable yield principle. In the more recent understanding of a sustainable discourse it focuses on systems interacting and functioning, such as healthy ecosystems surrounded by healthy human systems. As such, it focuses on *multiple objectives* – a balance of resource conservation and human concerns (Petaia, 2015).

To describe a fishery as sustainable, it is essential to focus on sustaining the processes that are underlying the fishery, such as the health of the marine ecosystem surrounding the fishery in question, integrity of ecological processes and sustaining human and management aspects. Describing an ecosystem can be done in multiple ways – for instance through determining how different species interact in a given system. However, describing an ecosystem can also be done through determining the feeding interactions among component species, through for instance stomach content studies. Extensive generalizations deriving from feeding practices can make useful guidance for ecosystem-based management of fisheries (Pauly et al, 2002). Sustainability discussions are increasingly linked to the concept of 'resilience' – whether a system can absorb and recover from interferences caused by natural and human actions such as harvesting fish. The resilience concept is also applied in human and management systems. Then, to create a modern, sustainable fishery it is essential to strive for a holistic approach, where to achieve sustainability, all decisions should be based on simultaneous achievements of different sustainability components. Achieving sustainability is about integrating economic, environmental and social aspects.

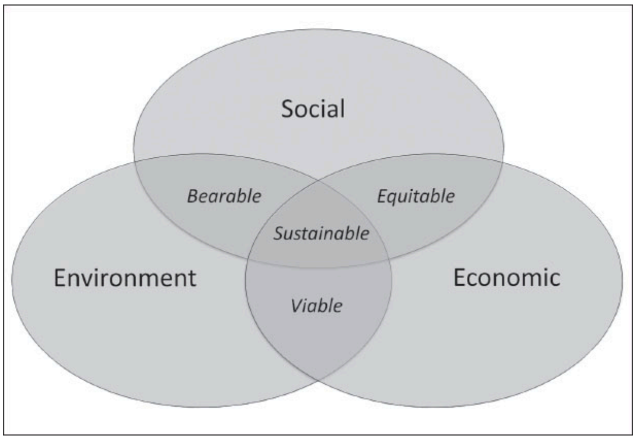


Figure 34: The three pillars concept of sustainable development. *Source*: (Silvius, Brink & Köhler, 2013, p. 185)

The three aspects interrelate and influence each other in multiple ways. In the context of fisheries, and in the context of this research, it is common to operate on 3-4 basic components; 1) ecological sustainability, which focuses on ensuring that fishing efforts or catch levels are at sustainable levels, to avoid depletion of the stock, maintaining resource base and related fish species at all levels, as well as enhancing the resilience and overall health of the adjacent marine ecosystem. 2) Socioeconomic sustainability, which focuses on maintaining or enhancing long-term socioeconomic welfare to the human actors in the fishery, generation of sustainable net benefits, fair and equitable distribution of benefits from the fishery, as well as maintenance of economic viability of the fishery. 3) Community sustainability, which focuses on maintaining and sustaining communities as valuable human systems with emphasis on economic and socio-cultural wellbeing of the community, overall cohesiveness and long-term health of humans in the fishery, as well as integrating sustainable communities with sustainable fisheries. 4) Institutional sustainability which focuses on maintaining suitable financial, administrative and organizational capability over the long terms to support the other three components, setting of management rules by which the fishery is governed, setting bodies and agencies that manage the fishery – where the key requirement to achieve these objectives is the manageability and enforceability of resource-use regulations (Petaia, 2015).

The EAFM scheme is highly acclaimed also within the FAO, and becoming the main reference framework for fisheries management around the globe. Promoting responsible fisheries practices as well as a well-monitored fisheries management, is directly addressed through the FAO Technical Guidelines for Responsible Fisheries on how to translate economic, social and ecological policy goals for EAFM managers into operational objectives and performance measures and indicators[22].

> An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries. A primary implication is the need to cater both for human as well as ecosystem well-being. This implies conservation of ecosystem structures, processes and interactions through sustainable use. Inevitably this will require considering a range of frequently conflicting objectives where the needed consensus may not be readily attained without equitable distribution of benefits. In general, the tools and techniques of EAFM will remain the same as those used in traditional fisheries management, but they will need to be applied in a manner that addresses the wider interactions between fisheries and the whole ecosystem. For example, catch and effort quotas, or gear design and restrictions, will be based not just on sustainable use of the target resources, but on their impacts on and implications for the whole ecosystem (FAOf, 2015).

6.1.9 The baitfish issue

Replacing some parts of the PS fleet in the Pacific with PNL vessels, due to the PNL fleets' low levels of by-catch and generally sustainable catch rates, has been proposed by several environmental NGOs. The momentum for the fishing method is getting stronger each year, as campaigns promoting the fishing method have been increasingly present in Western markets the recent time. More and more tuna canning companies are now branding their tuna with catch method, and subsequently pricing "PNL caught" tuna higher and with higher possibilities of recieveing sustainability branding[23]. The PNL caught tuna is currently certified under the Marine Stewardship Council (MSC) scheme. The suggestions to increase PNL caught tuna are

[22] For the publications from FAO on Technical Guidelines for Responsible Fisheries, see http://www.fao.org/fishery/publications/technical-guidelines/en

[23] For more information, see for instance http://poleandlinecaught.com/about/, http://www.greenpeace.org/australia/en/what-we-do/oceans/Take-action/canned-tuna-guide/, http://www.theguardian.com/sustainable-business/pole-line-fishing-sustainability-tuna-market or https://www.undercurrentnews.com/2014/05/14/more-us-retailers-roll-out-pole-and-line-tuna-products/

also formed on the basis of being a sustainable unemployment mitigation tool as it employs far more people per vessel than the PS vessels does. The fishing method does not initially require formal education, and is thus a more feasible job opportunity for people with less completed formal education. The view that PNL fishing generally has a broad sustainable feature is supported, based on the findings and secondary literature from this research. However, there are a few sustainability issues that need to be addressed also for the PNL fishery. Gillett, Preston and Associates did a study in 2010 where estimates were made for the needed quantity of baitfish in order to partially replace purse seining in the PICT region with PNL fishing. There has been alarms regarding the declines in baitfish grounds for recent years; an assumption, if proven true, that will seriously undermine the sustainability of the PNL fishing method.

The available baitfish in a PNL operation is crucial to its success; the amount of caught tuna during a set is often proportionally equal to its amount of baitfish. The baitfish is captured in a fishing operation that is separated from the tuna fishing operation, and the experience with tropical baitfish, contrary to baitfish in temperate regions, is that it is more vulnerable to stress, and thus has a higher mortality rate after capture. An important indicator of whether the baitfish grounds are being sustainably harvested, are the so-called 'tuna-baitfish ratio'; defined as the amount of tuna captured per amount of bait. Normally, there is caught a great deal more tuna than baitfish, but the ratio can vary due to factors like fishing style and which baitfish species is caught (Gillett, 2010). During the height of the PNL fishery in the Pacific in the late 1970s, the tuna-baitfish ratio was approximately 32:1. As a thought experiment of replacing almost all PS catches with PNL catches, the 2010 article assumed that to catch one million tons of tuna in the region, it would require about 31,250 tons of baitfish annually, given the 32:1-ratio. However, succeeding in catching such amounts of baitfish, which would be equal to 13 times the amount of the 'top year' of the PNL era of 1978 where 2,474 tons (and 79,178 tons of tuna) of baitfish were caught, depends on a number factors; mainly troubling ones.

Firstly, due to natural conditions, the baitfishery grounds are increasingly better towards the west of the region. PNG and SI are well endowed with baitfish resources, whereas nations further east like Palau, Fiji or Kiribati has much less baitfish grounds. Also, the baitfish grounds that do exist in the eastern-wards nations, like Palau, experienced near optimum-levels of their baitfishery. The decline in CPUE in the baitfishery of the country in 1971, indicated that after the optimum fishing intensity for baitfish was reached, the catches dropped sharply (2010).

These figures indicate that there are clear limits to the possible expansion of PNL fleets in the nations, which has much lower optimum levels than PNG and SI. FADs could improve catches of baitfish, however, an increase in the tuna-baitfish ratio is not believed to be substantial. In an expanded PNL fishery, it would be mainly concentrated around PNG and SI, which would leave the nations to the east largely displaced in the tuna fisheries. A substantial amount of current PS catches are made in the EEZ of Marshall Islands, Nauru, Kiribati and Tuvalu, and a decrease in fishing activities, given a shift from PS to PNL, here are not likely to be supported by the western part of the region, as it would harm the economies of those countries. Such a shift could also mean a negative turn to the regional solidarity in the fisheries sector, which is flourishing as of now, and a vital part of PICTs future prosperity (2010).

Another problem with an increase of the PNL fishery is that the usage of baitgrounds that are not fully desirable would have to be considered. During the height of the PNL fishery, locations with attributes such as high catches or proximity to tuna fishing grounds were highly prioritized. An increase of baitfish fishing would mean those locations would be prone to excessive fishing and eventually produce low yields, which again would harm the profitability of the operation. PNL fishing is ultimately restricted to at most a few days away from baitgrounds, consequently leaving the fishery exclusively located in coastal areas. Shifting to less logistically desirable locations could again mean a higher tuna-baitfish ratio, as longer transportation of baitfish leads to higher mortality levels. Examples of local overfishing of baitfish grounds occurred during the height of the PNL era; for instance were the Ysabel Pass, Cape Lambert (both in PNG) and the village of Susui in Fiji places were local communitites reacted on dramatic decreases in local fishing grounds due to heavy fishing on baitfish – two resources that are overlapping, as baitfishing is exclusively done in coastal areas. Restrictions on baitfishing were done on these locations, based on communitites worrying that the food supply of the villages were seriously harmed due to declines in local fish catches derived from baitfishing. A completely other speculation has been that the lights used in nighttime baitfishing may negatively affect turtle nesting activities (Gillett, 2010).

Finally, an issue with expanding the PNL fishery drastically is that it would imply a quite comprehensive baitfish management apparatus. At the height of the PNL era there were minimal management of baitfish activities in regards to the sustainability of the operation; and the restrictions that did arrive were mostly based on compensating villages that were harmed food supply-wise by heavy baitfishing. The ability to carry out effective management schemes and related activities to enforce those, which initially is not necessarily difficult, would be highly different across the PICTs. Given high enough priority by leadership in each respective country, it is possible that sustainable baitfishing management plans are possible to enable. However, as fisheries governance is in certain parts of the region suffering from low effectiveness and quality, it is likely that some of the countries "would have considerable difficulty in establishing and maintaining an effective management regime for baitfisheries" (Gillett, 2010, p. 10).

To meet the significant challenges that a dramatic shift towards a fishery dominated by PNL vessels, several objectives need to be highlighted. Firstly, the protection of flow of marine foods to small-scale communities and local villages adjacent to the baitfishing grounds would have to be of paramount importance for baitfishery managers. Furthermore, it should be emphasized that there are alternatives to baitfishing, such as culture of baitfish or transportation of baitfish into the region. The latter has by former research been deemed unlikely as alternative, as it adds so substantial costs to the PNL operation that it may be unviable, as well as examples of disease introductions from new baitfish species, such as macro-organisms (e.g. snails, worms, larvae) and micro-organisms (parasites, bacteria and viruses). Introduction of such species may be severa and a threat to community livelihoods, food security, poverty alleviation and publich health. The possibilities of growing cultures has seemed more viable, and has been undertaken on locations in Gilbert Group, Kiribati, Fiji, Samoa, American Samoa and the Tuamotu Islands of French Polynesia (Gillett, 2010).

Also, it should be noted that the scenario presented in the 2010 article is operating on *very* high estimates – a 13 times higher production rate than the PNL height year of 1978. Surely, the challenges associated with a 13-fold increase in the fishery may seem unmanageable, but an increase that is not *that* big could prove much more feasible for fishery managers. It also seems that the region producing 31,250 tons of baitfish is an unlikely figure, given the many other threats baitfish grounds are facing without any increase in PNL activities, such as runoff from logging and mining as well as overfishing from increased coastal human populations. As already mentioned in the findings in chapter 5, the PNL fishers largely blamed the increased logging activities in SI for the decline in baitfish, *not* fishing activities from them or local communities. This fact highlights that there are multiple factors affecting a fishery, not only the activities at sea. Such effects need to be adressed in baitfish management plans. There is not a lot of available research on baitfish management, alternatives to baitfish in the PNL fishery and figures estimating the productivity of such ecosystems – more research should be highly promoted to meet the sustainability issues associated with the baitfishery. An increase only half of the size presented in the 2010 paper could prove highly feasible with the right management, and would be a tremendous contributor to the general sustainability of the tuna fisheries of the WCPO. The other features of the fishery are almost exclusively positive, as it creates more employment, has little or no by-catch, produces higher meat quality, higher animal welfare and is very unlikely to produce deprived stocks and situations of over-fishing. Therefore, efforts to increase the PNL fishery while taking serious considerations of the baitfishery issues should be of highest priority to managers interested in increasing sustainability in WCPO tuna fisheries.

6.2 Current status of yellowfin and skipjack stocks

6.2.1 The skipjack and yellowfin tuna species

Both yellowfin and skipjack tuna has a lot of biological similarities, in particular their hunting and swimming strategies. Like other true tuna species, the yellowfin and skipjack tunas are warm-blooded, which is one of the many features enabling them to be highly skilled hunters. They are opportunistic carnivores often swimming in schools of tremendous sizes catching prey like smaller fish, squid and pelagic crustaceans. Feeding activities often peaks in early mornings and late afternoon (FAOe, 2015) With swimming speeds up to 80 km/h their bodies are particularly adapted for high speeds, and the speed levels needs to be maintained in order to keep the high metabolic rate and oxygen uptake at sustainable levels. The research of Bushnell and Brill shows that:

> (...) the two species has oxygen transfer factors that are 10-50 times greater than those of other fish species; their efficiency levels of oxygen transfers from water in tunas (app. 65%) matches that measured in teleosts with ventilation volumes an order of magnitude lower. The high oxygen transfer factors of tunas are made possible, in part, by a large gill surface area; however, this appears to carry a considerable osmoregulatory cost as the metabolic rate of gills may account for up 70% of the total metabolism in spinally blocked (i.e., non-swimming) fish. During hypoxia, skipjack and yellowfin tunas show a decrease in heart rate and increase in ventilation volume (...). In both tuna species, the oxygen consumption eventually must be maintained by drawing on substantial venous oxygen reserves (...). The need to draw on venous oxygen reserves would make it difficult to meet the oxygen demand of increasing swimming speed, which is a common response to hypoxia in both species. Because yellowfin tuna can maintain oxygen consumption at a seawater oxygen tension of 90mmHg without drawing on venous oxygen reserves, they could probably survive for extended periods at this level of hypoxia (Bushnell & Brill, 1991, p. 131).

Their oxygen transport and cardiovascular responses illustrated here explains in turn why the PS method of catching tunas results in a lower meat quality as the fish slowly suffocates due to ever decreasing levels of available oxygen (in effect the fish is exposed to acute hypoxia), as they are dependent on a constant flow of water over their gills (obtained through continuous, high swimming rates) in order to keep up the metabolic rate and oxygen uptake. With the net slowly closing in on the fish, the oxygen uptake diminishes, coupled with the fact that the fish is panicking and stress hormones accumulates - causing lactate acid levels to increase, which further diminishes the meat quality of the fish. As the time of catch followed by the time of death is so small, the meat quality in the PNL method is generally much higher, making PS caught tuna mostly suitable for canning, whereas PNL caught tuna can qualify for tuna steak quality, or even sashimi quality. Being located at a high trophic level; the two species of tuna has few natural enemies after growing to maturity. (Castro & Huber, 2012, Bushnell & Brill, 1991).

6.2.2 Skipjack tuna (*Katsuwonus pelamis*)

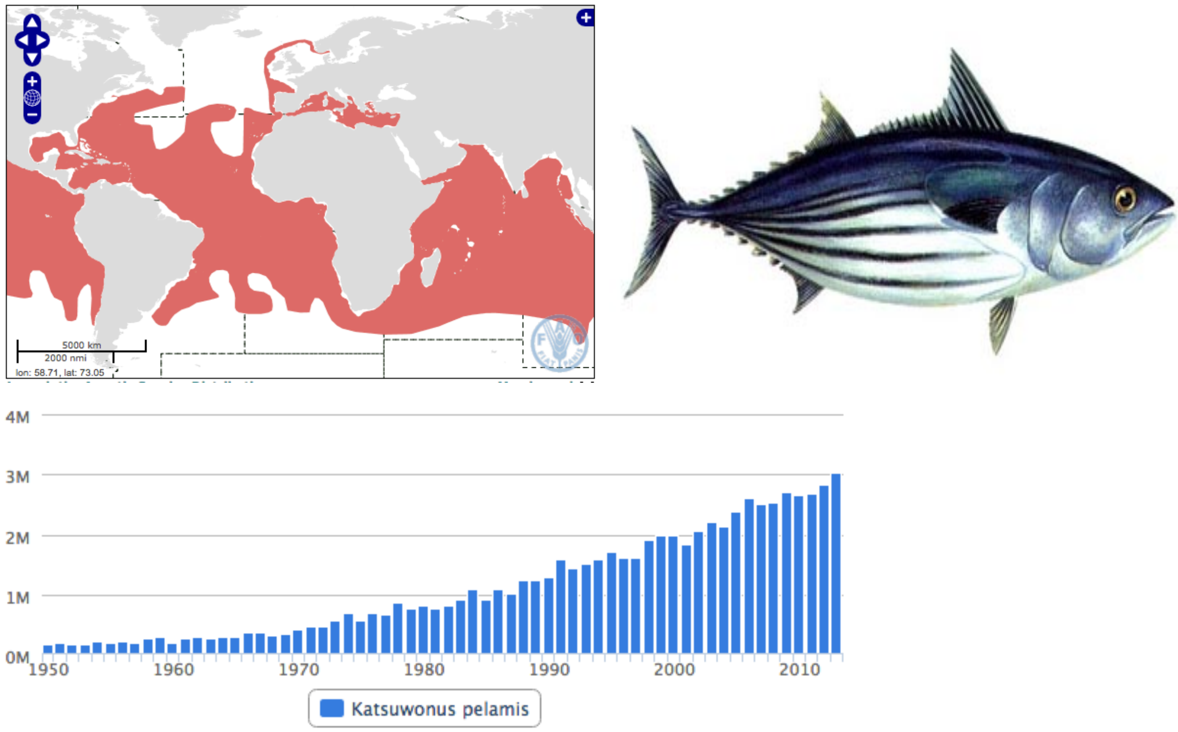


Figure 35: (left) geographical distribution of skipjack tuna; (right) animation of a skipjack tuna and (bottom) global capture production for skipjack tuna in tons since 1950. *Source*: (FAOe, 2015).

Skipjack is a heavily fished, but abundant, very resilient species that is fast growing, short-lived, and highly fecund. The global skipjack resources are not considered overfished, and hold a 'least concern (LC)' status from the IUCN[21]. It is considered a highly robust species not particularly prone to overfishing, but recent WCP-CA catches slightly exceeding MSY levels set by the SPC (SPCb, 2014). The skipjack biomass in the WCPO is considered so large that it exceeds that of the three main targeted other tuna species (yellowfin, bigeye and albacore) combined. It is also assumed that skipjack in the WCPO is a separate population (for stock assessment and management purposes) to the EPO stock, also based on tuna tagging migratory calculations. Except for the Indian Ocean, where the species is fully exploited, there is still room for expansion of the fishing efforts in the skipjack fishery of the Atlantic and Pacific Oceans. The Indian Ocean Tuna Commission (IOTC), the WCPFC and national governments manages skipjack resources. International environment organizations and market controls also have an influence on the governance of skipjack fisheries. Since skipjack tuna still is considered such a resilient species, by most scientific management schemes further increase

[21] See http://www.iucnredlist.org/details/170310/0 for more information.

in fishing effort has not been dissuaded. Figure 36 shows the scale of skipjack biomass present globally.

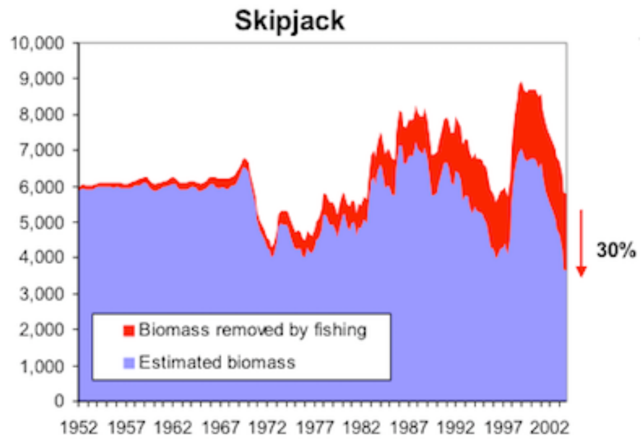


Figure 36: status of skipjack stocks, globally. *Source*: (Petaia, 2015).

The physical features of skipjack tuna includes a fusiform, elongated and rounded body with two dorsal fins separated by a small interspace, the first with 14 to 16 spines, the second followed by 7 to 9 finlets; pectoral fins short, with 26 to 27 rays. A swim bladder is present. The colour is back dark purplish blue, lower sides and belly silvery, with 4 to 6 very conspicuous longitudinal dark bands which in live specimens may appear as discontinuous lines of dark blotches.

	Size (cm)	Weight (kg)	Age (y)
Common	40-80		
Maximum	108	33	6-10
Maturity	43	1.6	1-1.5

Figure 37: Approximate characteristics of skipjack tuna. *Source*: (ISSF, 2014, p. 10).

The species is epipelagic, with larvaes mostly restricted to waters with surface temperatures of at least 25°C. Aggregation of the species tend to be associated with convergences and mixes of cold and warm water masses as well as upwellings. Skipjack tuna exhibits a strong tendency of aggregating at surface waters, but can be distributed at depths down to 260 meters. Schools are often associated with drifting debris, sharks, birds, or other tuna species. Fecundity increases with size, but is highly variable; number of eggs per season in females of 41 to 87 fork length, rages between 80 000 and 2 million eggs per individual. The spawning appears to take place in an opportunistic manner, but during inhabitation of warm water above 24°C with first spawning happening already at around 1 year of age (Fonteneau, 2003). In fact, in the Indian Ocean it has been shown that their spawning activity appears to be happening permanently, with two peaks during the northwest monsoon. Their longevity varies between 8 to 12 years, but reliable age determination methods are yet to be found for the species. Maximum length is around 108 cm corresponding to a weight of 32 to 35 kg; the most common being 80 cm fork length and weight between 8-10 kg. The minimum weight at landing is 1.3 kg for the WCP-CA, any caught tuna under that size is considered undersized juveniles (not having spawned yet) and subject to penalization if uncovered during controls. Sexual maturity occurs at down to 40 cm size (corresponding to 1-2 years of age), however, this is a highly fluctuating figure and the bigger the specimen, the more eggs is she producing. Skipjack tuna spawns year-round in tropical waters, while spawning seasons is limited to the warmest months in temperate regions (FAOe, 2015).

6.2.3 Yellowfin tuna (*Thunnus albacares*)

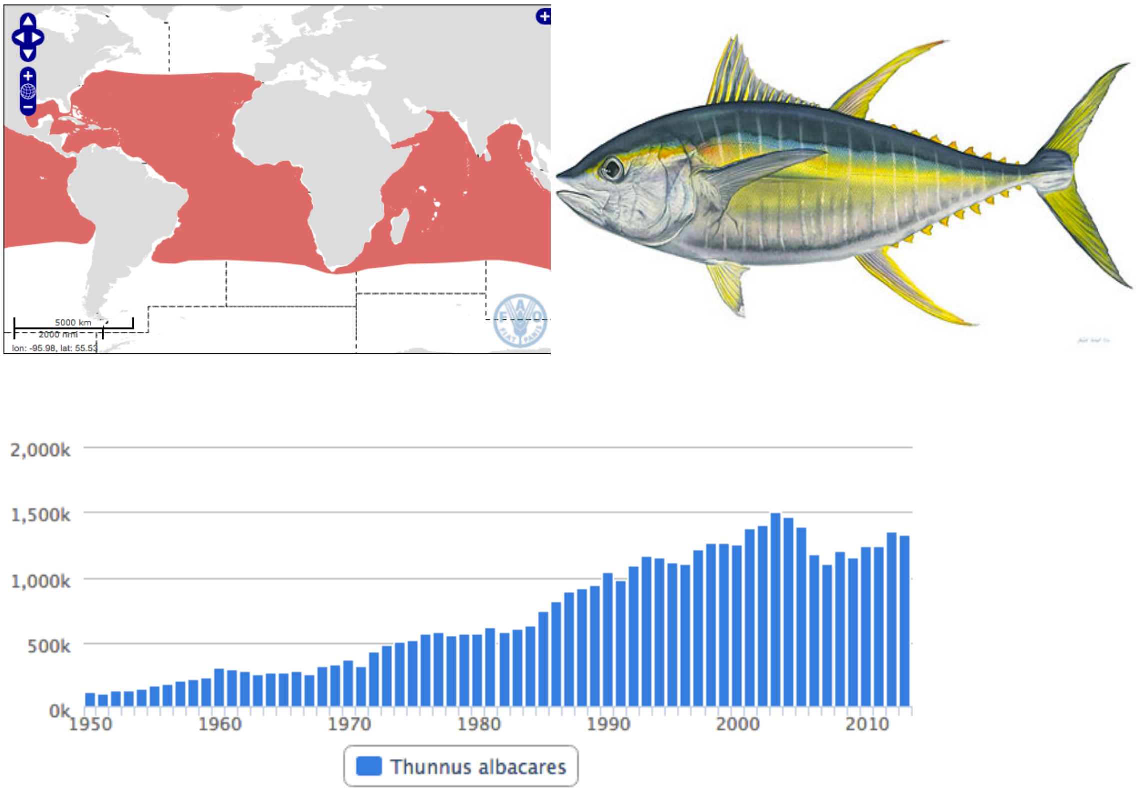


Figure 38: (left) geographical distribution of yellowfin tuna; (right) animation of a yellowfin tuna and (bottom) global capture production for yellowfin tuna in tons since 1950. *Source*: (FAOd, 2015).

Yellowfin tuna (*Thunnus albacares*) is a fast-growing and highly productive species. Although heavily fished from the mid 80s, the yellowfin tuna resources of the WCPO and Indian Ocean are not considered overfished. Scientific assessments, however, indicate concern on the levels of fishing mortality, increasing surface fisheries on juveniles, and on the environmental effects of fishing by certain of the main fishing gears, especially purse seining on floating objects including FADs, longlining and gillnetting (Asia-Pacific Fishwatch, 2015, FAOd, 2015). By the IUCN Red List of Threatened Species yellowfin tuna is considered[25] 'near threatened (NT)', and the yellowfin resources of regions 4 and 8 in the WCP-CA is considered fully exploited (SPCa, 2014); meaning further increase in fishing effort is not advised from the scientific advises provided by the SPC. In some regions the species has been exploited beyond its MSY levels, as Figure 39 indicates.

[25] See http://www.iucnredlist.org/details/21857/0 for more information.

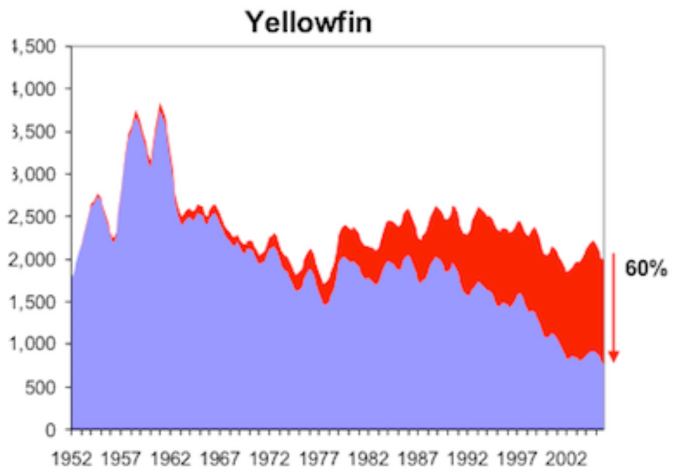


Figure 39: status of yellowfin stocks, globally. *Source*: (Petaia, 2015).

Its physical features includes a back metallic dark blue changing through yellow to silver on belly; its belly frequently crossed by about 20 broken, nearly vertical lines; dorsal and anal fins, and dorsal and anal finlets of bright yellow colour, the finlets with a narrow black border. A swim bladder is present. Maximum fork length is over 200 cm. The most common is up to 150 cm fork length, and smallest maturity sizes is within the range of 50-60 cm fork length at an age of roughly 12 to 15 months, but between 70-100 cm fork length the percentage of mature individuals is much higher, with all individuals over 120 cm attaining sexual maturity (FAO, 2015). The species thrives in the epipelagic layers of the oceans, above and below the thermocline, with thermal boundaries of roughly 18° and 31° C.

	Size (cm)	Weight (kg)	Age (y)
Common	40-170	1.2-100	
Maximum	205	194	8
Maturity	85-108	12-26	2-3

Figure 40: Approximate characteristics of yellowfin tuna. *Source*: (ISSF, 2015, p. 11).

The distribution of the species is spread all over tropical and sub-tropical waters over the globe, however, seasonal changes occur. Larval densities in equatorial waters are transoceanic the year round, but there are seasonal changes in larval density in subtropical waters. Schooling occurs, particularly in near-surface waters often grouped size-wise, either in monospecific or multispecies groups. The schools are often associated with floating debris or other objects. Recent tagging research hints at the existence of subpopulations of yellowfin tuna, although its considered a highly migratory species capable of traveling vast distances across the oceans. This is due to lack of evidence for long-ranging east-west or north-south migrations of adults suggesting little exchange of genes between yellowfin tunas from the EPO with the WCPO (2015).

The Indian Ocean Tuna Commission (IOTC), the WCPFC, the FFA, and national governments manage yellowfin resources. The influence from international environmental organisations and market controls however remains strong towards the governance of yellowfin tuna fisheries (Asia-Pacific fishwatch, 2015).

6.2.4 Stock assessment definitions

A fish stock can be defined as a biological unit of one species forming a group of similar ecological characteristics and, as a unit, is the subject of assessment and management. However, there are many uncertainties in defining spatial and temporal geographical boundaries for such biological units that are 100% compatible with established Regional Fishery Management Organizations (RFMOs) Convention Areas (ISSF, 2015, p. 89). The assessments need therefore to take migrational patterns of the same species to and from adjacent areas into consideration. An imperative feature of any fishery management scheme involves the long-term study of changes in size and properties of a population – the population dynamics. Assessing the dynamics within a species population forms the basis for a stock assessment that in turn leads to an understanding of how fish stocks may react to management actions. Any fish stock is limited, as species are, by sharing the same gene pool, by self-producing new offspring within the stock, sharing a similar pattern of growth as well as to little degree mixing with other stocks. The stock size is increased by *reproduction* of adult fish, which again results in *recruitment* of juvenile fish into the stock. The total weight or biomass is increased by *growth* of individual fish, and is in turn reduced in biomass by *natural* and *fishing mortality* (Petaia, 2015). Any stock abundance will be determined by the levels of mortality, and if this mortality is high enough; the recruitment will be too small to maintain the stock size, further diminishing the number of fish and indicating either overfishing or other natural extraordinary mortality factors.

6.2.5 Stock assessment of yellowfin tuna

According to the Oceanic Fisheries Programme (OFP) within the SPC, the yellowfin tuna fishery had a total 2013 catch of 524,022 mt within the WCPFC statistical area. That corresponded to a total of 11% decrease from the 2012 catch level, with PS catches declining by 5%, and longline catches declining by 18% - the lowest catch in over 20 years (OFP, 2015). Concerns about the current stock status was also expressed during WCPFC's First Regular Scientific Committee Meeting held in august 2005 where the species was showing signs of being at or just beyond the state of full exploitation, although the extent of the overfishing varies greatly across regional areas in the WCPO. The same trend continued in the 10th regular session of 2014, where catches were close to or exceeded MSY by 13% (WCPFC, 2014b). Any increase in fishing mortality could, however, result in moving the stocks to an overfished condition (WCPFC, 2005). The great majority of yellowfin is, like Skipjack, taken in the equatorial areas by large PS vessels, and notably; a large number of undersized yellowfin in the range of 20-50 cm is taken in the domestic surface fisheries of the Philippines and Indonesia (2005). The most recent stock assessment of yellowfin tuna in the WCPO was conducted in 2014, which included data ranging from 1952 to 2012. The SPC made many improvements to the data and the models that structured the stock assessment, including some of the recommendations made during the peer review of the recent bigeye assessment. Some changes involved:

> Increases in the number of spatial regions to better model the tagging and size data; inclusion of catch estimates from Vietnam and other fisheries previously missing; the use of operational longline data for multiple fleets to better address the contraction of the Japanese fleet and general changes over time in targeting practices; improved modelling of recruitment; and a large amount of new tagging data corrected for differential post-release mortality and other tag losses. The results were similar to those from the previous (2011) assessment (ISSF, 2015, p. 29).

The 10th Regular Session (SC10) of WCPFCs Scientific Committee expressed the following as their concerns and recommendations for the management of the Skipjack stocks:

> Fishing mortality has increased in recent years. Current fishing mortality rates for Yellowfin tuna are estimated to be about 0.72 times the level of fishing mortality associated with maximum sustainable yield (fMSY), which indicates that overfishing is not occurring. However, recent catches are close to or exceed the MSY by up to 13%. Both biomass and recruitment have declined gradually over the duration of the fishery, with current spawning biomass estimated to be about 38% of the level predicted in the absence of fishing. Nevertheless, recent spawning biomass levels are estimated to be well above the sbMSY level and the recently adopted limit reference point of 20% of the level predicted in the absence of fishing (...). The WCPO Yellowfin spawning biomass is above the biomass-based LRP WCPFC adopted, 0.2SBF=0, and overall fishing mortality appears to be below fMSY. It is highly likely that stock is not experiencing

> overfishing and is not in an overfished state (...). The WCPFC could consider measures to reduce fishing mortality from fisheries that take juveniles, with the goal to increase to maximum fishery yields and reduce any further impacts on the spawning potential for this stock in the tropical regions (...). The SC recommend that the catch of WCPO Yellowfin should not be increased from 2012 levels which exceeded MSY and measures should be implemented to maintain current spawning biomass levels until the Commission can agree an appropriate TRP (OFP, 2015, p. 4).

The catches of yellowfin tuna has seen a relatively stable increase during the last three centuries with 400,000-450,000 tons annually during the mid-1990's, followed by an average catch of 500,000-590,000 during the 2000's. Consequently, the conclusions generally are that both total and spawning biomass is estimated to be declining with moderate overall fishery impacts. But, for now, fishing mortality and biomass are estimated to be within their MSY-based reference points. The exception is the western equatorial sub-region, which has experienced a more severe biomass decline and fishery impact, where >90% of the WCPO Yellowfin catch is taken (Hampton, 2010). Therefore, the recommendations from SPC from the SC10 were that fishing mortality rates may not be increased beyond the 2012 average levels.

Figure 41 further illustrates the human exploitation levels of yellowfin catches in the WCP-CA since 1960. The increase in catch is indeed quite spectacular, indicating not only a tremendous development within fishing equipment technology, but an increased level of investments in the fishery, an explosive market demand as well as being a testament to the increased human population demanding more and more food since 1960.

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1960	55,020	75	1,872	3	1,438	2	0	0	15,337	21	73,667
1961	53,166	70	3,259	4	2,777	4	0	0	16,236	22	75,438
1962	55,547	66	4,225	5	6,975	8	0	0	17,197	20	83,944
1963	53,185	70	2,071	3	2,277	3	0	0	18,223	24	75,756
1964	45,247	61	5,074	7	3,647	5	0	0	20,186	27	74,154
1965	45,493	62	3,434	5	3,752	5	0	0	20,956	28	73,635
1966	61,654	66	2,192	2	5,844	6	0	0	23,409	25	93,099
1967	36,083	52	3,125	5	3,418	5	0	0	26,303	38	68,929
1968	46,070	56	2,706	3	7,043	9	0	0	26,085	32	81,904
1969	51,627	59	5,166	6	3,873	4	0	0	26,612	30	87,278
1970	55,806	56	4,606	5	7,824	8	0	0	30,933	31	99,169
1971	57,766	55	5,248	5	9,244	9	0	0	32,894	31	105,152
1972	61,175	53	7,465	6	10,064	9	0	0	37,506	32	116,210
1973	62,291	48	7,458	6	14,945	12	0	0	43,828	34	128,522
1974	58,116	44	6,582	5	17,406	13	0	0	49,441	38	131,545
1975	69,462	49	7,801	6	13,099	9	0	0	51,029	36	141,391
1976	77,570	51	17,186	11	15,589	10	0	0	42,766	28	153,111
1977	94,414	51	15,257	8	16,268	9	0	0	58,070	32	184,009
1978	110,202	62	12,767	7	15,275	9	0	0	39,401	22	177,645
1979	108,910	55	11,638	6	29,323	15	0	0	49,565	25	199,436
1980	125,109	57	15,142	7	33,903	16	9	0	43,426	20	217,589
1981	97,110	44	22,044	10	54,277	25	16	0	47,976	22	221,423
1982	86,144	39	17,123	8	75,404	34	54	0	42,800	19	221,525
1983	90,254	33	17,184	6	121,589	44	51	0	48,156	17	277,234
1984	76,982	28	17,633	6	125,371	46	67	0	54,212	20	274,265
1985	79,967	28	22,717	8	115,341	41	69	0	63,329	23	281,423
1986	68,993	26	17,970	7	110,783	42	62	0	65,367	25	263,175
1987	75,400	24	19,044	6	157,025	50	48	0	59,946	19	311,463
1988	88,847	29	20,566	7	125,247	41	76	0	71,578	23	306,314
1989	73,297	21	22,133	6	181,999	52	73	0	75,414	21	352,916
1990	79,289	20	20,769	5	207,910	53	68	0	86,848	22	394,884
1991	63,502	15	19,182	5	242,524	57	51	0	96,916	23	422,175
1992	77,727	18	23,043	5	271,301	62	98	0	62,126	14	434,295
1993	72,044	19	20,486	5	222,884	59	141	0	60,453	16	376,008
1994	82,172	20	21,378	5	235,878	57	101	0	76,877	18	416,406
1995	88,293	22	23,209	6	215,400	52	2,570	1	80,961	20	410,433
1996	91,867	22	30,551	7	190,023	46	2,636	1	98,431	24	413,508
1997	81,050	16	22,845	5	312,847	62	2,838	1	83,755	17	503,335
1998	81,057	13	27,506	5	395,688	65	2,806	0	102,613	17	609,670
1999	71,004	13	26,787	5	323,762	61	3,162	1	102,060	19	526,775
2000	96,831	17	26,957	5	330,283	58	3,343	1	109,665	19	567,079
2001	95,522	18	24,443	5	310,983	58	3,716	1	98,058	18	532,722
2002	95,627	19	24,133	5	266,872	54	3,172	1	100,955	21	490,759
2003	95,694	17	24,304	4	318,423	58	3,101	1	106,270	19	547,792
2004	104,036	18	30,640	5	323,899	56	2,706	0	121,646	21	582,927
2005	82,514	15	27,007	5	364,199	67	2,508	0	66,867	12	543,095
2006	78,000	16	23,653	5	299,234	63	2,607	1	69,608	15	473,102
2007	74,071	15	26,570	5	321,554	64	2,854	1	76,299	15	501,348
2008	75,675	13	22,705	4	414,409	70	2,903	0	76,425	13	592,117
2009	91,202	17	23,918	5	310,081	59	3,027	1	101,374	19	529,602
2010	84,989	16	20,112	4	337,429	62	3,611	1	96,710	18	542,851
2011	83,757	17	36,838	7	294,247	59	3,802	1	83,729	17	502,373
2012	79,741	14	34,705	6	362,565	62	3,935	1	106,246	18	587,192
2013	65,492	12	21,806	4	344,141	66	29,435	6	63,148	12	524,022

Figure 41: Total catches of Yellowfin in the WCPFC statistical area, by gear type, 1960-2013. *Source*: (WCPFC, 2014a, p. 116).

6.2.6 Stock assessment of skipjack tuna

According to OFP within the SPC, the Skipjack fishery saw its highest catch on record so far in 2013 with a total of 1,819,166 mt – an increase of 2% from the year before (OFP, 2015) within the WCPFC statistical area. As has been the case since the 80s, the by far largest amount of Skipjack catch was taken in the PS fishery, a total of 1,476,855 mt in 2013, accounting to 82% of the total catch. The second-highest proportion of the catch was the PNL fishery, with a total of 161,220 mt, accounting to 9% of the total catch. As showed in Figure 20, the vast majority of Skipjack is caught in the equatorial waters, followed by the Japanese EEZ (2015). The most recent stock assessments of Skipjack in the WCPO area was conducted in 2014, which included data ranging from 1972 to 2012. The 10th Regular Session (SC10) of WCPFCs Scientific Committee expressed the following as their concerns and recommendations for the management of the Skipjack stocks:

> "While estimates of fishing mortality for skipjack have increased over time, current fishing mortality rates for skipjack tuna are estimated to be about 0.62 times the level of fishing mortality associated with maximum sustainable yield (F_{MSY}). Therefore, overfishing is not occurring (i.e. $F_{CURRENT} < F_{MSY}$). Estimated recruitment shows an upward trend over time, but estimated biomass is declining over time, to about 52% of the level predicted in the absence of fishing. Nevertheless, recent spawning biomass levels are estimated to be well above the SB_{MSY} level and the recently adopted limit reference point of 20% of the level predicted in the absence of fishing (...). Recent catches are slightly above the estimated MSY of 1,532,000 mt. The assessment continues to show that the stock is currently only moderately exploited ($F_{current}/F_{MSY} = 0.62$) and fishing mortality levels are sustainable. However, the continuing increase in fishing mortality and decline in stock size are recognized (...). SC10 advised the WCPFC that there is concern that high catches in the equatorial region could result in range contractions of the stocks, thus reducing skipjack availability to high latitude fisheries (...). SC10 recommends the commission take action to avoid further increases in fishing mortality and keep the skipjack stock around the current levels, with tighter purse-seine control rules and advocates for the adoption of TRP and harvest control rules" (OFP, 2015, p. 3).

Following the conclusions of the OFP, fishing activities, especially in the western equatorial regions, can be expected to affect catch rates. Oceanographic conditions in concurrence to El Niño and La Niña events also influences the stock distribution, and must be taken into consideration when establishing the stock sizes and fluctuations (OFP, 2015).

Figure 42 further illustrates the human exploitation levels of skipjack catches in the WCP-CA since 1960. Just like yellowfin, the increases in catch is indeed quite spectacular, in the same manner indicating not only a tremendous development within fishing equipment technology, but an increased level of investments in the fishery, an explosive market demand as well as being a testament to the increased human population the world has seen the last decades, demanding more and more food.

YEAR	LONGLINE		POLE-AND-LINE		PURSE SEINE		TROLL		OTHER		TOTAL
	TONNES	%	TONNES	%	TONNES	%	TONNES	%	TONNES	%	
1960	0	0	70,428	78	3,728	4	0	0	15,782	18	89,938
1961	0	0	127,011	81	11,693	7	0	0	18,032	12	156,736
1962	4	0	152,387	84	11,674	6	0	0	17,559	10	181,624
1963	0	0	94,757	77	9,592	8	0	0	18,354	15	122,703
1964	5	0	137,106	75	25,006	14	0	0	20,801	11	182,918
1965	11	0	129,933	84	4,657	3	0	0	20,620	13	155,221
1966	52	0	215,600	86	10,949	4	0	0	22,913	9	249,514
1967	124	0	168,846	82	10,940	5	0	0	24,930	12	204,840
1968	83	0	162,379	83	7,640	4	0	0	24,929	13	195,031
1969	130	0	315,795	90	5,036	1	0	0	30,070	9	351,031
1970	1,608	0	379,074	90	7,501	2	0	0	35,215	8	423,398
1971	1,475	0	333,284	88	13,665	4	0	0	32,429	9	380,853
1972	1,544	1	172,827	73	18,025	8	0	0	45,368	19	237,764
1973	1,861	1	253,217	77	19,235	6	0	0	54,435	17	328,748
1974	2,124	1	289,202	81	10,852	3	0	0	54,022	15	356,200
1975	1,919	1	218,271	76	13,101	5	0	0	55,019	19	288,310
1976	2,096	1	276,582	77	22,422	6	0	0	56,107	16	357,207
1977	3,127	1	294,641	73	34,602	9	0	0	71,240	18	403,610
1978	3,233	1	331,401	74	33,169	7	0	0	81,229	18	449,032
1979	2,179	1	285,859	69	58,371	14	0	0	66,142	16	412,551
1980	632	0	333,597	74	76,186	17	12	0	38,284	9	448,711
1981	756	0	296,065	69	90,090	21	17	0	44,224	10	431,152
1982	972	0	264,726	56	159,337	34	64	0	48,038	10	473,137
1983	2,144	0	298,928	46	293,520	46	154	0	49,506	8	644,252
1984	870	0	366,811	51	304,853	42	284	0	48,124	7	720,942
1985	1,108	0	238,932	42	268,327	48	146	0	53,760	10	562,273
1986	1,439	0	322,665	45	326,464	46	219	0	64,746	9	715,533
1987	2,329	0	252,142	38	342,985	52	168	0	58,534	9	656,158
1988	1,937	0	295,325	37	437,394	55	299	0	58,278	7	793,233
1989	2,507	0	275,088	36	431,492	56	244	0	58,437	8	767,768
1990	363	0	211,573	25	529,158	63	176	0	94,583	11	835,853
1991	885	0	259,778	24	710,880	67	148	0	91,577	9	1,063,268
1992	432	0	218,765	23	647,072	68	168	0	90,889	9	957,326
1993	573	0	255,152	28	585,633	64	175	0	77,882	8	919,415
1994	379	0	209,636	21	703,621	71	228	0	76,964	8	990,828
1995	598	0	247,744	24	689,609	67	12,298	1	78,343	8	1,028,592
1996	3,935	0	242,486	24	664,781	65	6,514	1	99,235	10	1,016,951
1997	4,070	0	236,999	26	589,504	64	9,218	1	86,260	9	926,051
1998	5,030	0	266,772	22	824,926	68	8,316	1	101,686	8	1,206,730
1999	4,208	0	255,330	23	734,216	67	5,660	1	100,578	9	1,099,992
2000	4,559	0	264,407	22	785,313	66	15,005	1	115,573	10	1,184,857
2001	5,059	0	212,668	19	779,857	70	7,536	1	104,415	9	1,109,535
2002	3,450	0	207,488	16	966,999	75	6,796	1	104,811	8	1,289,544
2003	3,824	0	238,179	18	929,809	72	9,721	1	106,759	8	1,288,292
2004	4,051	0	249,936	18	991,114	71	15,118	1	127,364	9	1,387,583
2005	1,084	0	216,715	15	1,055,434	75	6,302	0	123,769	9	1,403,304
2006	1,528	0	208,731	14	1,153,869	77	3,987	0	137,418	9	1,505,533
2007	1,175	0	213,010	13	1,278,316	77	3,598	0	162,190	10	1,658,289
2008	803	0	218,570	13	1,237,748	76	4,572	0	169,763	10	1,631,456
2009	1,219	0	201,323	11	1,415,731	79	4,252	0	170,062	9	1,792,587
2010	1,191	0	223,409	13	1,309,387	77	4,705	0	158,803	9	1,697,495
2011	1,124	0	206,843	13	1,181,457	77	4,214	0	149,843	10	1,543,481
2012	2,004	0	170,538	10	1,409,507	80	6,235	0	182,082	10	1,770,366
2013	1,267	0	161,220	9	1,476,855	82	52,155	3	118,669	7	1,810,166

Figure 42: Total catches of Skipjack in the WCPFC Statistical Area, by gear type, from 1960-2013. *Source*: (WCPFC, 2014a, p. 115).

6.3 Background information about key tuna management actors

6.3.1 About Parties to the Nauru Agreement

> *"We seem to be the biggest game going on in regards to sustainability measures that can be replicated to other oceans"* (Informant 1, April 16th, 2015)

In 1982, the leaders of seven countries in the PICT region with richest tuna (particularly skipjack) fishing grounds got together in Nauru due to the dramatic rise of foreign fishing effort in the region and the concerns over future sustainability of the stocks. Those seven countries were Palau, Federated States of Micronesia (FSN), Marshall Islands, Kiribati, Nauru, PNG and SI. The realisation at the time was that these seven states were in a rather weak position when it came to negotiating terms with DWFNs on their own – in particular was this the case when DWFNs actively sought a 'divide and conquer' tactic, manipulating each state against each other over cheapest possible access fees and conditions (Hanich, Parris and Tsamenyi, 2010). The Parties mutual concerns were particularly regarding the opportunities for local participation in the fishery and the need for higher economic revenue as a result of the higher DWFN activities. Therefore, a strategy of coordinating and harmonising their fisheries management and access conditions proved a much more strategic position when negotiating with DWFNs (p. 4). Later, Tuvalu and Tokelau joined in, making the modern PNA consisting of nine PICTs. The Nauru Agreement formed, amongst others, the following objectives:

- Coordinate and harmonise management of common fish stocks between PNA, without derogating any of their sovereign rights (article 1);
- Give priority consideration for licensing PNA vessels over foreign vessels (article 2a);
- Establish minimum terms and conditions for foreign vessel access (article 2b);
- Cooperate and coordinate fisheries monitoring, control and surveillance (articles 6 and 7) (Nauru Agreement 1982[26]).

Today, the organization provides regional cooperation of the tuna fishery resources; establishes terms and conditions for foreign access to the EEZs of those nine PICTs, as well as mutual in-zone governance plans, and as such controls the world's largest tuna PS fishery (Gilman, 2011). According to the representative from PNA interviewed for this research, they control through

[26] The Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Stocks (as amended April 2010). Ratified in Nauru February 11th, 1982. For legal document, see http://www.pnatuna.com/sites/default/files/Latest%20Nauru%20Agreement_0.pdf

their respective member countries' EEZs, 50% of the global skipjack supply and roughly 25% of the global tuna supply. Figure 43 highlights the scale of the areas that PNA has jurisdiction over.

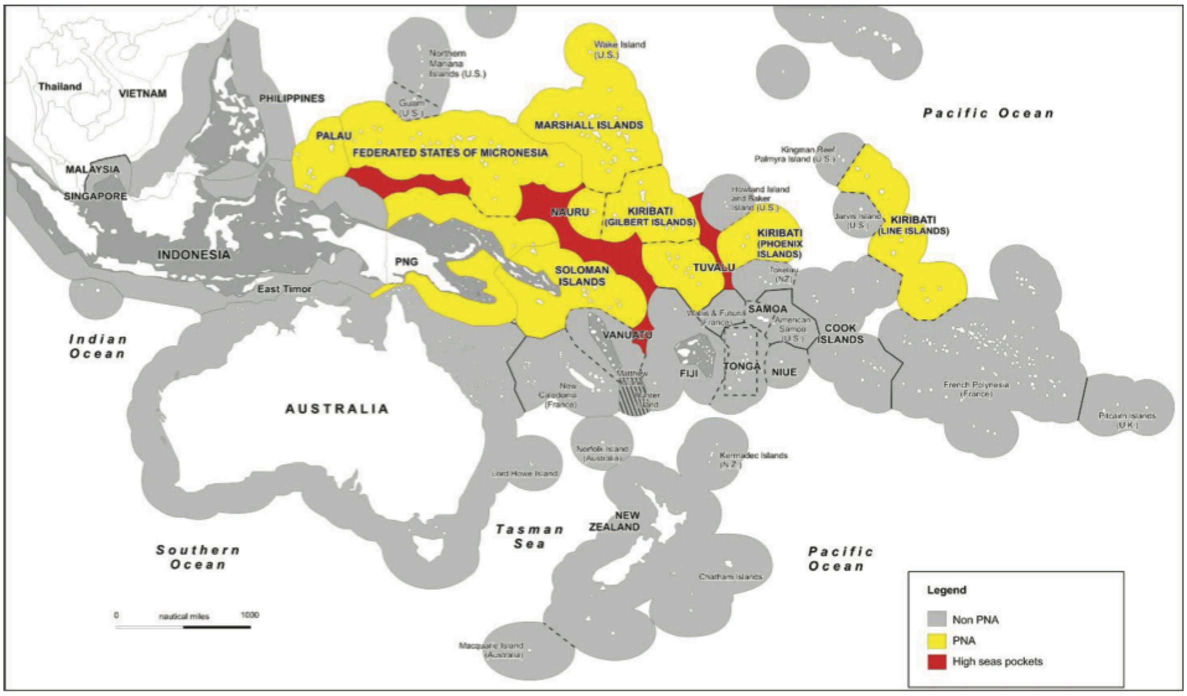


Figure 43: map over the PNA region, defined as the combination of all EEZs of the PNA membership, also including the pockets of high seas (marked red in figure) adjacent to Palau, FSM, PNG, SI, Nauru, Kiribati and Tuvalu. *Source*: (Tamate, 2014, p. 2).

For 28 years, PNA operated without an office and without a secretariat – the officials got together during annual meetings making the decisions. PNA now has five full-time employees, but the values that they are managing are in the multi million-dollar class. They operate and implement regional conservation and sustainability measures such as ship registries, in-port shipment injunctions, tuna retention – meaning all caught tuna needs to be landed, in effect; banning discarding, banning transhipment at sea, seasonal FAD closures, FAD bans, from 2008 a demand of 100% observer coverage on all PS vessels operating in PNA waters[27] and mesh regulations. The same year they closed foreign access to PS fishing by vessels licenced by the Parties two areas of international waters that are enclosed by the Parties' domestic waters, and in 2010 further closed international waters between 10°N and 20°S and 170°E and 140°W (Gilman, 2011, p. 603). All these sustainability efforts may be in sum considered an exemption

[27] Verified during PNA third implementing arrangement in Koror, Palau, May 16th, 2008. For legal document, see https://www.ofdc.org.tw/components/Editor/webs/files/Tuvalu_CMM_PNA_Third_arrangement_Regulations_2009.pdf

to the general trend in the WCPO, where fishing activities has been allowed to increase substantially (Barclay & Cartwright, 2007).

Also, mitigation of by-catch has been an issue within PNA, ensuring 'dolphin safe' caught tuna as well as programs to avoid catches of whale sharks. A recent PNA policy has been one that seeks to gain bigger control of what happens in the high seas and in the 'loopholes' (see Figure 43 red-marked fields, or Figure 53); namely making it a condition of their domestic licences that vessels cannot get a domestic licence, or in-zone licence, if they are fishing in the high seas. Effectively, the incentive to fish in the high sea has been diminished, according to the PNA key informant interviewed for this research. Further PNA policies has included 100% VMS satellite tracking on vessels operating in their waters, as well as the much debated recent introduction of the VDS, which will be discussed in GS 4.2, Chapter 7. The past three decades has seen some significant conflicts over tuna fishery access between the PICTs and the big DWFNs, particularly the US, EU, Korea, Taiwan and Japan. Many PICTs felt their revenue from the vessels fishing in their waters was being justly reflected through received monetary income. The momentum of PNA was thus strong: the need for an organization with the objective of providing necessary regional leadership to ensure regional prosperity and economics benefits was in high demand. Robust rights-based management systems, which increased the economic power and value arising from the PNA area was crucial to ensure that DWFNs did not take unjust advantages of their fishery assets (Gillett & Cartwright, 2010).

Summing up, the PNAs most important conservation measures has included their sets of standards for fisheries management reflected in their 2008 draft measures, the 3rd Implementing Arrangement, which included:

- Fishing vessels are no longer to be allowed to fish in high seas pockets adjacent to the EEZs as a condition of their licenses
- The use of FADs on PS fishing vessels, is banned in the PNA member's EEZs for 3 months of each year (July-September)
- Retention of all bigeye, skipjack and yellowfin tuna catch on-board PS fishing vessels (a measure to stop the catch and dumping of juvenile tuna at sea)

- 100% coverage of PS fishing vessels with observers. (Observers monitor fishing vessel practices to report back to the national governments and FFA in order to monitor and report on implementation of fishing measures). (WCPFC, 2008)

PNA has throughout their operative years had significant successful management measures, being the key to achieve both sustainability and profitability for their Parties. In 2011 the PNA member countries achieved getting an MSC certification for their FAD caught skipjack tuna, creating the world's largest tuna PS fishery with MSC recognition. Their momentum in the future will most likely continue to increase, as any changes in the huge PS fishery (accounting for 74% of the WCPO total tuna catch in 2008) largely will occur in PNA waters. Any increased fishing effort of skipjack, being one of the few large and still underexploited fishery resources in the world, will mostly occur in the PNA countries due to their enormous skipjack grounds (Gillett & Cartwright, 2010). Their efforts to sustain their tuna resources are indeed praiseworthy, however, more actors in the fishery needs to take comparable inspiration to halt the current trend of overfishing and stock declines.

6.3.2 Regarding Pacific Islands Forum Fisheries Agency

The FFA was established in 1977 as a intergovernmental agency aiming to strengthen national capacity and regional solidarity to help its 17 members to manage, control and develop their tuna fisheries. They are a subsidiary body of the Pacific Islands Leaders Forum (FFA 2015). It is a significantly bigger organization than the PNA – and covers countries in the region that has fisheries much further from the equatorial line, which is mainly PNA managed areas. Their role is more policy- and advisory based than PNAs line as a commercial one, with high-level policy making as well as regional cooperation at the heart of their operations. FFA help their member countries sustainably manage fishery resources – with a particular focus on tuna fisheries - within their EEZs, and provides expertise, technical assistance and other support as an advisory service to its members. The management of the tuna fishery is not included in the mandate of FFA, neither do they hold authority to enforce decisions of its governing council (Hanich, Parris & Tsamenyi, 2010). The members then makes their own sovereign decisions about their tuna fishery, usually accompanied by the regional decision making on tuna management through agencies such as the WCPFC, which again bases their scientific advisory from data produced by the SPC. The role of FFA then is of a facilitative nature.

Membership mirrors that of the Forum and includes Australia, New Zealand, Cook Islands, FSM, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, PNG, SI, Tokelau, Tonga, Tuvalu and Vanuatu. The inclusion of Australia and New Zealand to the FFA countries has not been without controversy, as they both are to consider a DWFN when fishing in PICTs, being former colonial powers in the region, as well as having a substantially different starting point being 'developed nations' with high national GDPs, thus placing them in another 'league' of national interests than the rest of the members which are more homogenous in terms of development levels. The two countries have has some 'image' issues in the South Pacific, where both are often considered overbearing, condescending or even hegemonic (Shibuya, 2004). The question as to whether they were to be included in FFA ended with recognition that their presence in the organization would maximize the influence the island states would have on their neighbours. Additionally, Australia and New Zealand would figure as the significant warrant for the funding and budget of the organization (2004). Reluctance from Australia to make ambitious, binding commitment to fight global climate change through the Kyoto Protocol[28] has been another matter shaping the politics of the FFA.

> On the eve of the climate meeting in Kyoto, the Forum had a chance at their meeting in Rarotonga to issue a strong statement on climate change and perhaps build some international sentiment for a strong protocol. However, prime minister John Howard of Australia had already publicly stated that he would not agree to any statement on binding targets for greenhouse-gas reduction for fear that the Australian economy would be damaged. The Forum leader's statement on climate change is a completely uncontroversial document, recognizing 'deep concerns' about the impacts of climate change and 'urged all participants at the forthcoming Kyoto Conference to pursue vigorously an outcome which would produce the highest level of net reduction in global greenhouse emissions'. Tuvalu's prime minister Bikenibeu Paeniu said after the statement was issued, 'Australia dominates us so much in this region. For once, we would have liked to have got some respect'. Howard replied 'there were a range of views, but in the end there was consencus' (Shibuya, 2004, p. 110-111).

The described situation is an illustrative example of the gap that often exists between Australia and its island neighbours and how that gap of interests and perceptions sets a difficult stance to the concencus level of FFA with actors having so divergent goals. The FFA has also suffered from criticism for being so big that benefits are being unequally distributed.

[28] The Kyoto Protocol were signed in 1997, and is ratified by 191 states. The intention was to achieve a reduction of global greenhouse gas emissions, over the period of 1997-2012.

6.3.3 Overview of NFD and Tri Marine

NFD, started off as a domestic PNL company, as a joint venture between Solomon Taiyo and the Solomon government. The PNL catch was then sold through Solomon Taiyo (the canning company now called SolTuna). From the 1990s the company included two longliners under a Japanese aid project, and started a couple of purse-seiners during the same time. They were fully privatized from 1990, and the first owner was British Columbia Packers (Barclay & Cartwright, 2007a). In 1998 NFD became a wholly owned subsidiary of the tuna conglomerate Tri Marine Group, an originally Singaporean enterprise formed in 1972 mainly as a tuna trading company and a base for Albacore and sashimi longliners, as well as a procurement activity for an Italian government-owned group of companies. In 1986 when the Italian government implemented a change in public policy calling for divesture of food sector businesses, Tri Marine became a private company. Since then the company has grown to be one of the largest tuna supply companies in the world, and are now headquartered in Washington, D.C., USA (Tri Marine Group, 2013). The group's contract and owned fleets deliver the catch to processing plants that are located as close to the fishing grounds as possible, as well as within a country that can export duty free to end markets. The enterprise's activities are widespread - it also includes market intelligence, production planning, voyage planning, logistics, trading, quality assurance, financing, consultation and development.

Tri Marine has a vertically integrated business model – meaning that Tri Marine owns and operates its own fleet of fishing boats as well as owns and operates the tuna processing plants in SI and American Samoa. As a result, they manage the fishery practices from catch to the point of purchase. Tri Marine Group owns a PS fleet of 15 ships, under Panaman, American and SI flags. NFD owns and operates five of these - modern, SI flag tuna purse-seiners – *Solomon Jade, Solomon Pearl, Solomon Emerald, Solomon Opal* and *Solomon Ruby,* all with a gross registered tonnage (GRT) of 718,91 tons. The three latter were boats where crewmembers were interviewed for this research; 5 fishers from *Emerald,* 8 from *Opal* and 2 from *Ruby.* The three PNL boats that NFD owns is also the only PNL vessels in the Tri Marine Fleet; *Solomon Venture, Soltai 101* and *Soltai 105.* The two latter of which crewmembers were interviewed for this research; 12 from *Soltai 101* and three from *Soltai 105.* Both vessels have a GRT of 199 tons. Tri Marine is also a licence-holder for 30 longline vessels. SolTuna Tuna Processing and Fishing, Ltd., a factory that employs over 1,200 Solomon Islanders (in total NFD has about

2,500 employees), process the catch from the PNL boats locally. The NFD PNL tuna fishery is therefore a highly unique operation in the PICT area – it is completely domestic, where Solomon Islanders control every step of the production chain, from the fishing operations all the way to processing, canning and sale to the domestic markets (Tri Marine Group 2013). The boats are all based in Noro, Western Province, SI. The NFD SI fleet of purse-seiners supplies the SolTuna tuna cannery in Noro. There is no other tuna canning operation in the Western and Central Pacific that is supplied exclusively by domestic flag fishing boats.

According to Tri Marine themselves, they have ambitious sustainability goals, and mentions the following as part of their sustainable tuna fisheries policy:

> - Pursues full compliance with local and international laws and regulations, and the conservation resolutions of the ISSF
> - Supplies and promotes tuna that comes from abundant, well managed fisheries that have minimal ecosystem impacts
> - Improves the scientific understanding of tuna thorough timely, accurate data collection and submission, and investment in collaborative research
> - Engages with policy makers to promote better tuna fisheries management
> - Incentivizes suppliers to institute by-catch mitigation measures
> - Supports fisheries improvement projects that bring troubled fisheries to a level consistent with internationally recognized sustainability standards.
> - Provides for accountability by making this policy public, reporting on progress, and providing accurate product attribute and traceability information to customers (Tri Marine Group, Owens 2014)

The impression that conservation measures were of importance for NFD was strengthened during fieldwork for this research. The key informant of NFD elaborated further:

> All the conservation and management measures that are proved by the WFCPFC are handed over to us, and we try to implement it into our work, through the ministry of fisheries. One of the challenges we have now are [getting] observers on the longline boats, [it is] practically very difficult - [we are] supposed to be 5% observers on the longliners, but it's very hard. [It is] very crowded, and these agents don't treat our observers well. We piloted an electronic monitoring system with cameras on the boat. It worked ok [but] there are some hiccups. One observer from the ministry that we put on-board, he swore he would never go on-board again. He goes and tells the other observers about his experience, and everybody freaks out. Because there is a lot going on [in terms of] by-catch, I think they want to harass the observers so that when they get to shore they have done enough to leave them alone. On the purse-seiners we have 100%, but at times the ministry does not quickly re-employ. When one gets on-board, we don't always have one quickly replacing him, sometimes 1 trip or 2 trips there is no observer. (...) Our concern with the IUU is the capacity of the ministry to enforce all those rules. (...) Sometimes, in Noro, it's improved now, but sometimes in the past, the fishery officer is not inside when the longliners are there and we've had experience with corrupt fishery officers trying to get money from the captains. I believe that sustainability, if we have good scientific guidance, and [they] provide us with the limit, and we fish within that limit, I think that would be seen as sustainable. With our seiners we now have a by-catch rule – we land all the by-catch. It's a small industry in itself. Lots of women in Honiara go to Noro and then they buy the by-catch and they sell it here in the markets, in the shops. Not sharks, turtles. Our by-catch is archipelagic fish, like

rainbow runners, island bonito, mainly those two. We [also] have catch retention, when we catch it, we land it (Informant 3, April 24th, 2015).

In addition to being a founding member of ISSF, Tri Marine is currently undergoing a large MSC certification process of 10 American Samoa-based tuna purse-seiners, and thus has a group of independent scientists assessing the sustainability of Tri Marine's free school skipjack and yellowfin tuna in the WCPO. The assessment is done in collaboration with PNA to qualify that the fish caught in the PNA waters is also under their current existing certification (Tri Marine 2015a). Tri Marine's North American marketing subsidiary, the Tuna Store, has also launched a MSC certified product under its 'Ocean Naturals' label, Tri Marine's own house brand, from PNL caught skipjack and pole and troll caught albacore. Finally, NFD also is soon to announce its own MSC full assessments for their PS and PNL fleet for skipjack and yellowfin tuna (2015a). The current assessment process is estimated for completion around 02/2016 (MSC 2015). Tri Marine[29] has received attention the past months from environmental NGOs such as Greenpeace due to their ongoing pursuit to become more environmentally friendly; such as introducing full traceability of their 'Ocean Natural' products, where from a Quick Response (QR) code the customer can trace where the tuna was caught, using what kind of fishing method, where it was processed and which species it is. This traceability scheme is also one promoted from PNA, and expressed during one of the interviews done for this research:

> Our chain of custody starts from the net and the observers monitor everything; the segregation of the fish, the species, the species identification, right through the transshipment, and then through to the canning. We collect all that data, and then we run that data backwards. We then have promotional videos linked to the supermarkets where every can has got a code number on. So you can take the code number, plug it into the system, and it will say: 'oh, it's that code number, it's that can. And this is the boat that caught it, this is the part of PNA where it was caught, this is where it was processed, here are the workers, this is the date, and so on' (Informant 1, April 16th, 2015).

The traceability scheme that Tri Marine promotes is thus in line with the traceability ambitions those regional organizations like PNA has. Tri Marine also plans to move the surveillance systems of their boats from manual to electronic logbooks, as well as video surveillance of the vessels. The observer policy is particularly needed in the longline fisheries, which only has a on-board observer coverage of around 5%, against PS vessels under PNAs VDS of 100% observer

[29] For more information about Tri Marine's sustainability policies, see http://www.trimarinegroup.com/activities/sustainability.html

coverage (Greenpeace, 2013, WCPFC, 2015a). All in all, the impression that is given by Tri Marine is one of a company that invests in sustainability efforts through science-based fishery management and education of sustainable seafood programmes, as well as commitment to investing in critical research to improve fishing practices. NFD took for instance part of an extensive tuna tagging research for SPC from 2006-2013, using the *Soltai 105* and *101* as research vessels which tagged and released more than 360,000 tunas, providing science with treasured information about tuna migration patterns as well as knowledge about the rate of exploitation of tuna stocks in the region (SPC 2013). According to Tri Marine, they also provide community efforts in the areas where they operate, by providing medical facilities and school improvements to the local areas. Such a medical facility was indeed observed in Noro during the fieldwork of this research. Renato Curto, the chairman of Tri Marine International, made several statements about his enterprises sustainability ambitions as he chaired the big international tuna industry conference "World Tuna Trade Conference & Exhibition" in Bangkok, Thailand in 2014, for instance:

> As I learn more about the ocean environment, we are discovering that we must do better at managing tunas using tested science-based conservation measures that assure a sustainable resource into the future. Here I see a number of challenges; how do we define sustainability and best industry practices for purse seining, long-lining and PNL, given the differences in each method? Are we effectively working for an accepted, universal standard? How do we address the interests and aspirations of coastal and island states, taking into account the highly competitive nature of global markets and the reality of business risk and reward? What are the responsibilities of established fishing nations, with their historical fishing practices? Are the RFMOs doing as good a job as they should? How can they be improved or strengthened? Is there a uniform commitment to make them work and to enforce agreed-upon measures? How many more newcomers can enter the competition for tuna in the world oceans now that we know of the pressures on Bluefin, yellowfin and bigeye tunas? Can effort be fairly and successfully limited to ease this pressure? How do we effectively deal with IUU fishing that undercuts our efforts at sustainability? Can we improve fishing techniques to avoid by-catch and should we consider reasonable limits on use of FADs? What role should industry groups, such as the ISSF, play in setting market-place best practices to advance sustainability goals? What is the proper role for green labels, and what standard should be applied to qualify for a label? (Curto, 2014).

On the same meeting, Curto criticized his own industry by claiming they ignored the problem of growing tuna fleet capacity and the will to curb that growth. He stated that the number of vessels was exceeding the point of sustainable levels, and that the need for action from the industry was urgent. He was endorsed by WCPFC scientist Glenn Hurry, who addressed the problem of overcapacity as a problem not sufficiently addressed by the industry, and lack of industry attending scientific meeting being part of the problem. "For some of you", said Hurry, addressing an audience of the world's top tuna executives, "selective deafness has become an art-form" (Undercurrent News, 2014). He criticised the industry's short-term gains going on behalf of the long-term future of the fishery, and further stated that the industry took a higher stance towards ecological and socioeconomic sustainability; "Companies in the developing world can go home and do something else [after depleting the tuna resources], leaving those in the Pacific islands with nothing" (2014). The many sustainability issues raised by the Tri Marine chairman is the very same issues that this thesis, and much other relevant research, is pondering. The impression given by Tri Marine, and therefore consequently NFD, is therefore that of a company that asks and acts upon relevant issues concerning the safeguarding of tuna stocks, and a company seemingly striving to achieve an ambitious sustainability profile. Businesses have, after all, fundamental roles to play in delivering sustainable development – the process needed to achieve a sustainable society. However – it may be far from fair intentions into action, and as stated by for instance Greenpeace, the major traders within tuna trade has a significant power to the dynamics of the industry as a whole, a power yet to be fully exploited by themselves to actually ensure sustainability within the global tuna industry.

Tri Marine is part of 'the big three' traders in the canned tuna supply chain, according to FFA (Hamilton, Lewis, McCot, Havice & Campling, 2011), and has a particular, dual function as both a middleman and provider of vessel support services – therefore playing a key role in the global tuna business models. The concentration of power to buy and sell caught tuna, gives them considerable control over parts of the industry that are not necessarily playing by the sustainability rules that companies like Tri Marine strives for (Greenpeace, 2013). Another critical remark worth mentioning is that Tri Marine and the other industry members of ISSF has been criticized for being unbiased in their environmental assessments. The leadership in ISSF has been subject to controversy as they have supported fishing methods regarded as destructive, such as PS fishing on FADs, therefore being acclaimed for prioritizing short-term profit for some of their member companies and not the long-term viability of tuna fisheries (Greenpeace, 2012a). A lot of ambitious sustainability policies have been implemented from efforts of the ISSF. However, their pro-industry stance, such as opposing a ban on destructive FADs in their Environmental Stakeholder Committee (Barclay, 2010) has been criticized by tuna fishery scientists and NGOs like Greenpeace, claiming that the members of the foundation needs to a larger degree to base their tuna fisheries management in formats of unbiased science. Finally, as Tri Marine and NFD during the time of this thesis is undergoing, respectively, MSC assessment and plans to undergo a future MSC assessment, their full sustainability aspirations still remains to be recognized. As described in section 6.3.3, chapter 6, the fishing effort in NFD is organized within the VDS, a scheme that is yet to be proven a sustainable way of managing tuna catches. Should it prove not to, the sustainability level of the company, and of other numerous operators within the VDS, may be given a severe relapse.

6.4 The role of consumer advocacy: introducing the MSC certification scheme

Facilitating a so-called 'green consumerism' has been the focus for many successful, and unsuccessful, campaigns designed to assist consumers in choosing to purchase a product that is fabricated, produced or processed in an environmentally friendly, sustainable way. But to what extent is the consumer's role the determinant of success to any system's sustainability levels? Dryzek (2004) defines the start of 'eco-labeling' goods from Germany in 1977, however, he advocates the "Nordic swan" certification scheme from the Nordic countries since 1989 as an arguably largest and more successful early certification. The idea is to induce a green tax or small certification labeled on a commercial product, designed to induce consumers to make purchases that are less environmentally damaging. That product is often, in effect, more expensive than its equal, non-labeled sister product. An alternative market-based means to the same end is provision of information about the environmental impact of a good, provided through for instance awareness campaigns, as such to facilitate a green consumerism. Eco-labeling is increasing in volume in western markets – from forest products (so-called free from destruction of tropical hardwoods), to organic food, to sustainably harvested fish.

Debates of the actual effects from green certification schemes to damaged or threatened natural habitats the schemes are set up to protect, flourishes. The critics of green consumerism schemes includes the fact that the total quantity of goods consumed by individuals does not necessarily go down although the good is marked, and for being an easy symbolic alternative to confronting the structural causes of ecological destruction – the latter believed to be much more important in order to protect the natural asset in question (Dryzek, 2004). Further, the danger of "greenwashing" a product exists – individual choices of green consumers may be no match to the powers of corporate capitalism pushing for environmentally damaging production practices, if that production scheme is highly economically beneficial.

There has been numerous green or protection of vulnerable marine species consumption campaign throughout the recent decades – the most famous (and perhaps most successful) was the "dolphin safe" labeling of tuna in the aftermaths of the undercover LaBudde documentary from 1988. He filmed how tuna vessels in the EPO targeted schools of dolphins in order to catch the often associated schools of tuna underneath. Millions of dolphins got tangled in the nets, and either dying in the net or being discarded at sea after hauled into the boat. The US congress passed the Marine Mammal Protection Act (MMPA) in 1972, however, the act included several exceptions for dolphins within the EPA tuna fishery. After the LaBudde movie, however, the public outrage over the small amendments of the MMPA agreement still causing millions of dolphin deaths, culminated in a consumer boycott of canned tuna, urging consumers to avoid canned tuna until the producers could show that their products did not result in the deaths of dolphins. The campaign was a massive success resulting in the 1990 "dolphin safe" tuna brand accepted by the companies controling 90% of the canned tuna market in the USA – *StarKist, Chicken of the Sea* and *Bumblebee*. The initiative was soon coupled with the federal government soon passing a law requiring canners to adhere to the "dolphin safe" label – in effect making sure that that label meant a tuna product not involving the pursuit or capture of dolphins (Robbins, Hintz & Moore, 2014).

The story of the 'dolphin safe' canned tuna boxes is an example of a green consumerism great success as the dolphins in the EPA now are facing little threats from being caught in tuna nets after implementing the 'Medina panel'[30] in tuna nets avoiding the entanglement of dolphins. However, the question remains: what was the reasons behind the campaigns tremendous success that other, less successful, green consumerism campaigns, may learn a lesson from? While the dolphin safe campaign rolled on, countless other fisheries around the globe was facing ruthless overexploitation without being offered a shred of the same attention. One way of understanding that paradox is that the success of the dolphin safe tuna campaign and simultaneous failure of ocean fisheries conservation (tuna included) is that victories over animal rights not necessarily mean victories over ecological ethics. Furthermore, it is widely believed that is is much less challenging to get the moral outrage from the public if the campaign in question is proposing efforts to protect so-called 'noble creatures'. Dolphins, being intelligent, highly evolved animals; with cute appearances is an animal that is much more likely to gain the public's sympathy than, say, a vulture, snake or a Bluefin tuna – all the latter being in just as much need for protection in the name of maintaining biodiversity and healthy ecosystems.

However, it seems much more challenging to gather the public in demanding changes for animals that does not sit high in most people's hierarchy of interest (Robbins, Hintz & Moore,

[30] For more information about the Medina panel method, see (Robbins, Hintz and Moore, 2014, p. 231) or http://www.fao.org/fishery/equipment/medinapanels/en

2014). Perhaps that inherent mental attitude among humans, where an animals 'moral value' is measured along the perceived intelligence levels and perceived levels of mainstream outer beauty, is the explanation of why whaling or panda campaigns has also had success stories. These human attitudes is highly relevant to debate in order to determine the success of marine conservation schemes that involves the help from consumers. The environmental ethics from the dolphin safe campaign has shown a controversy involving two types of sometimes-conflicting environmental ethics; animal rights and ecological ethics. Perhaps the case is an indication as to why conservation efforts lag so far behind the marine mammal protection schemes (2014).

In 1997, WWF and the food mega TNC Unilever established the MSC. The marine certification scheme is set to provide market-based incentives to corporations for the production of 'sustainably harvested seafood'. If a fishery meets the extensive requirements from the MSC guidelines, it main gain its seal of approval. The scheme has had a lot of great effects including commercial fishery operations to switch to more sustainable fisheries operations; however, is also may have its downsides:

> From a social justice perspective, the MSC is recieveing troubling reviews from small-scale fishers throughout the global South, who are shut out from MSC certification owing to not having the connections and capital to even begin the certification process. As large companies move into waters previously fished by poorer nations, locals there are locked out of markets in wealthy countries by apparently "green" labels, thus exacerbating the loss of jobs and opportunities in the poorest parts of the world. In this way, producers from poorer nations are bearing a disproportionate share of the "shock" that accompanies the "opening up" of the world to free markets. As such, green labels appear to (somewhat ironically) favor large-scale, corporate, and conglomerated firms over small craft producers (Robbins, Hintz & Moore, 2014, p. 236).

Avoiding such an unfortunate side effect of an otherwise praiseworthy sustainability scheme, urges managers of such schemes to take such side effects sufficiently into consideration. Avoid such scenarios may be done by favoring the smallest actors through for instance economic subsidies, as such enabling them to still participate in the fishery scheme and not being unwillingly shut out.

Gilman (2011), however, holds a cautiously optimistic view of the role of green consumerism within the protection of fisheries.

> RFMO and fishing industry initiatives have generally been insufficient, we can be cautiously optimistic that third party eco-labeling for marine capture fisheries, adoption of scientifically rigorous sustainable seafood sourcing policies by retailers, and other market-based mechanisms are becoming an increasingly effective 'voluntary' incentive to improve fishing practices and governance. However, market penetration of eco-labeled seafood remains nominal: traded Marine Stewardship Council (MSC, the largest global organization for the certification of wild capture fisheries)—labeled seafood has been estimated to represent 0.01% of global trade of edible wild capture marine seafood by volume and 0.3% by value, with limited distribution, primarily in the U.S. and United Kingdom. MSC recently revised its fisheries

> assessment methodology to incorporate a risk-based framework, built on ecological risk assessment methods, for an application in assessing data-deficient fisheries. Unfortunately, MSC has yet to demonstrate substantial ecological gains through improvements in marine capture fishery practices. Major conservation gains resulting from improvements by deficient fisheries have not occurred through the MSC assessment and certification processes because the fisheries that have undergone assessment and made changes in practices to obtain and maintain the certification have generally been data-rich and relatively well-managed fisheries with limited changes required. Implementation of sustainable seafood sourcing by a rapidly increasing number of retailers suggests that growing demand for certified seafood may result in an increased supply and market penetration. Confusion and diminished confidence created by the recent proliferation of competing and often-conflicting certification and eco-labeling programs is one obstacle to the efficacy of the sustainable seafood movement. There is a need for the consolidation of assessment programs, and to harmonize methods for identifying sustainable sources of sea- food. Furthermore, gradual improvements in fishing industry practices and governance can be expected in fisheries that are working with retailers and their suppliers to address identified deficiencies, instead of sourcing only from existing good actors (Gilman, 2011, p. 603).

The role of MSC has, as several scholars points out, significant challenges and points of improvement. However, with continued improved policies as well as expansion of its total coverage in seafood markets, it is cautious hopes for new green consumerism success stories within the many threatened tuna fisheries of the world. Informant 1 from this research also pointed out that the role of consumer advocacy was becoming more and more apparent in the region through NGOs like Greenpeace:

> (...) Another issue with PNL if you're looking at the market situation is Greenpeace had massive campaigns in the UK to promote PNL as opposed to free-school and other things and the volumes of PNL leaves a big question about its origin because the volumes being sold appears to be bigger than the volumes being caught. What I'm saying is perhaps it needs to be better traceability to see who did really catch it, maybe they are just not reporting their catch correctly, or perhaps they are over-reporting their catches, or perhaps they are just very creative on their labelling (Informant 1, April 16th, 2015).

The quote suggests that perhaps loopholes in the current MSC system exist. Should the assertion be true, it would require increased transperancy and control mechanisms in the scheme. It however stands as a useful input for improvements of the legitimacy of all green consumerism schemes.

7.0 Chapter 7: Analysis and discussion section

7.1 Introduction

This section will discuss and analyse the findings from the fieldwork alongside cited, peer-reviewed and other secondary literature and as such provide an interpretative framework for analysis. The discussion will be structured through the first-level core systems (S, RS, GS, RU, U, I, O and ECO) and second-level variables subordinated to those from the adapted SES framework presented on page 28.

7.2 Defining the social, economic and political settings (S)

The social, economic and political setting (S) of this research is defined as the actors within the skipjack and yellowfin tuna fishery in the WCPO, and the same fishery in SI, presented through the case study of NFD in Noro, Western Province. The aim of the study is being able to identify which combinations of SES variables are linked to the interviewed fishers' ability to self-organize and avoid overexploitation of the fishery resource, as well as mapping their perceptions of any change in the fishery towards suggestions for improved management of the stocks. The (S) as well as the (ECO) of the research is intended as a frame for analysis, where interactions with the focal action situations expressed through interactions and outcomes is made, see Figure 44.

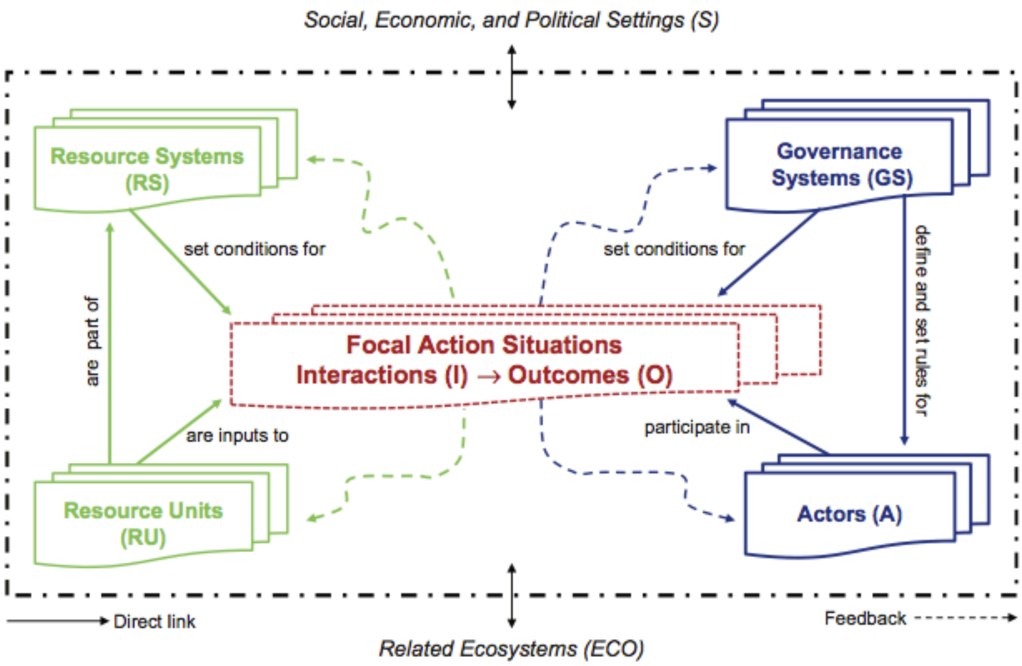


Figure 44: The core subsystems in a framework for analysing social-ecological systems, with multiple first-tier components. *Source*: (Basurto, Gelcich and Ostrom, 2013, p. 1367).

The inaugural mentioned second-level variable under the first-level core subsystem (S) is S1 – Economic development.

7.3 S5 – Market incentives

See section 6.4, chapter 6, for more information on market incentives like the MSC scheme and the role of green consumerism.

7.4 Resource systems (RS)

The first-level core subsystem RS refers to the "biophysical system from which resource units are extracted and through which natural dynamic processes regenerate the levels of the focal resource" (Basurto, Gelcich & Ostrom, 2013, p. 1376). The resource system for this research is defined as the skipjack and yellowfin PS and PNL *fisheries* operating in the WCPO as well as within the SI EEZ.

7.5 RS1 - Sector

The RS1 is understood as "the characteristic(s) of a resource system that distinguishes it from other resource systems" (Basurto, Gelcich & Ostrom, 2013, p. 1375). For this research, the sector is defined as the tuna fishery in the WCPO.

7.5.1 RS 1.1 - Yellowfin and skipjack tuna fisheries

One third-tier variable was added to RS1, since a modification of the sector was needed. Due to the restricted research size, the sector was narrowed down to only being applicable to yellowfin and skipjack tuna. Bigeye, albacore and other species of tropical tuna (that are also being targeted by tuna vessels in the WCPO) are left out of the analysis. This is both due to the fact that they are to a much lesser degree suitable as target species by the fishing gear belonging to the informants interviewed for this research (PS and PNL vessels), as well as being responsible for a much smaller percentage of the total catch (by species) of tuna in the region.

7.6 RS2 - Clarity of system boundaries

RS2 refers to "the biophysical characteristics that make feasible for actors to determine where the resource system starts and ends" (Basurto, Gelcich & Ostrom, 2013, p. 1375). Two resource systems have been presented in this research simultaneously: 1) The tuna fishery in the WCPO, for yellowfin and skipjack tuna and fishing methods of PS and PNL. 2) The case study of NFD in SI, narrowed down to tuna fishing operations within SI's EEZ.

7.6.1 RS 2.1 - WCP-CA and SI's EEZ

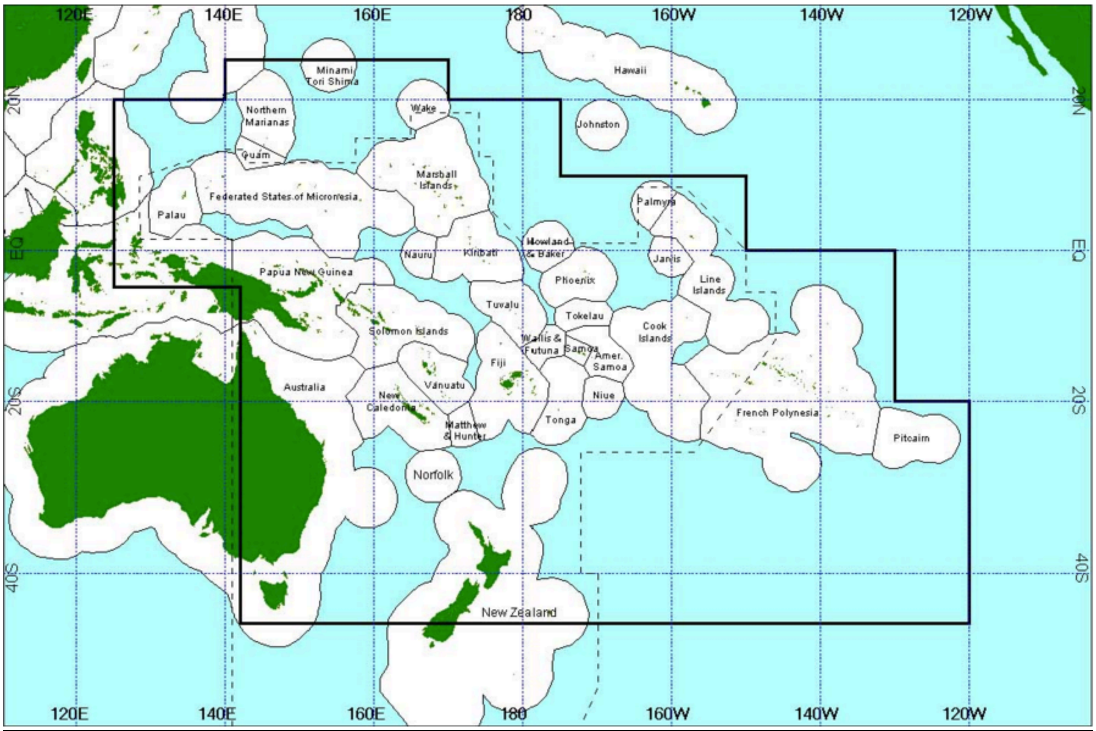


Figure 45: model of the WCP-CA with PICT countries EEZ boundaries and high-sea pockets. *Source*: (SPC, 2010).

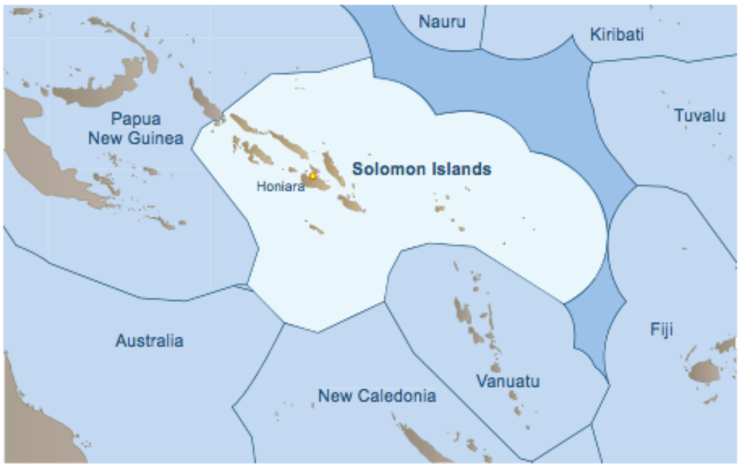


Figure 46: Model of the EEZ of SI. *Source*: (Bell, Johnson and Hobday 2011, p. 211).

Figures 45 and 46 refer to the two system boundaries referred to in this research; the PICTs with respective EEZs that are contributing to the boundaries of the WCP-CA used for the compilation of catch estimates, and a model of the SI EEZ.

7.7 RS3 - Size of resource system

7.7.1 RS 3.1 - WCP-CA and SI EEZ

RS3 refers to "the absolute or relative descriptions of the spatial extent of the two mentioned resource systems" (Basurto, Gelcich & Ostrom, 2013, p. 1375). The WCP-CA is estimated to be approximately 87[31] million km^2 and the SI EEZ, as already illustrated through Figures 14 and 46, is estimated to be 1.34 million km^2. The biophysical carrying capacity for yellowfin and skipjack tuna stocks of the two resource systems are, as the immense size indicates, almost beyond comprehension as the marine habitat is so large, and particularly along the equatorial upwelling, rich in nutrition. Another complicating factor is that, as previously mentioned, uncertainties exist regarding the existence of regional, separate stocks of the two species that are not highly migratory. The stocks principally consists of highly migratory species, further complicating attempts to assess sustainable fishing levels. The Pacific does, however, have large expanses with very low production rates, so the fisheries' productivity is generally higher in colder, more nutritious and higher latitudes as well as along the equator.

[31] See http://www.eoearth.org/view/article/155111/ for more information about the size of the Pacific Ocean

There have been significant disputes and uncertainties in determining the fishing capacity of the PS vessel fleet in the WCPO – the word 'fishing capacity' is defined as the ability of a vessel to catch fish. According to a study done by Gillett & Lewis (2003), the total carrying capacity of PS vessels participating in the WCPO fishery during 1988, 1995 and 2003 was about 140,000, 200,000 and 233,000 cubic meters, respectively. This represents an increase of about 43% during the 1988-1995 period, an increase of about 16% during the 1995-2003 period, and an increase of about 67% during the entire 1988-2003 period. Numbers of PS vessels participating were 136, 175, and 191, respectively. However, statistical errors exists in determining these numbers – and one is fairly certain that the true carrying capacity is in fact approximately 10% higher (2003). The PS catch in the WCPO accounts for over 75% of the total WCPO catch (2003). After 2003 the trend of ever increasing levels of PS vessels in the region has continued, resulting in the fishing capacity of the total number of vessels being even higher at the time of this study compared to the estimates for 2003. This trend combined with constantly improving technology, indicates that perhaps the likelihood of reaching the fishing capacities of even the highly resilient skipjack, may occur in foreseeable future.

7.8 RS4 - Human-constructed facilities

RS4 refers to "the degree to which the resource units can be held stored until final harvest and processing" (Basurto, Gelcich & Ostrom, 2013, p. 1375).

7.8.1 RS 4.1 - Storage in a human-designed facility

RS 4.1 refers to the "degree to which the actors can store (e.g. artificial enclosure in land or cold storage) resource units outside of their natural habitat for later harvesting" (Basurto, Gelcich & Ostrom, 2013, p. 1375). The storage capacities of both the PS and PNL fishery are highly sophisticated, both on-board the vessels and at docks. PS vessels have large freezers below deck, with standard temperatures of around -20°C. Some vessels are equipped to bulk-freeze the catch, however, the standardized method is to keep the catch in refrigerated brine tanks, situated in the lower parts of the hull and equipped with seawater pumps for circulation (FAOc, 2015). As Gillett & Lewis (2003) explain, the tuna storage temperatures were much higher before, which affected the amount of fish that could be carried aboard the seiner since a frozen tuna expands with colder temperatures – just like water. It was indicated that fish expansion, as temperature was lowered from -6 to -10 °C, lead to as much as a 20% decrease in a seiner's tonnage capacity. A 1985 study concluded that the fish quality improved substantially if about 15% less fish are packed into a seiner well, which led to many PS vessels packing lighter. However, the total carrying- and catch capacity of the PS vessels has increased dramatically during the last three decades – all due to the fact that the sheer size of the vessels has increased to such an extent, although the fish is packed slightly less tight.

In regards to NFD, their local storage capacity seems directly linked to their success of local ownership, employment and commodity processing because of their SolTuna cannery in Noro and their storage capacities on-board the NFD vessels. According to the key informant from NFD (Informant 4, May 2nd, 2015), they sometimes experience a storage capacity limitation problem at the cannery, resulting in the occasional export to Thai markets if they have excess fish. NFD vessels do not catch much albacore, but if they do it goes to loining, and is sold to European markets as loins. NFD is also currently processing longline caught tuna into fillets and directly imported to Japan. Their storage capacities are highly modern and meeting the high market demands for ultra-low freezing sashimi quality tuna meat. The sashimi quality tuna is exclusively caught on longline vessels and unloaded from the vessels from under deck freezers holding -40 to -60°C. Such low temperatures keep the natural quality of the meat high due to a very tight time window from death of the fish to placing it in the freezer, as well as low stress levels during catch. According to the PNA informant interviewed for this research, yellowfin does not keep meat quality as well as bigeye and Bluefin tuna do during ultra-low freezing. This may explain the high demands for these two fish in the sashimi market, as well as them thriving below the thermocline, much deeper than the yellowfin, making them more easily targeted by the deep-reaching gears of longliners.

Both PS and PNL is generally not considered to have high enough meat quality to export to the highly selective sashimi markets; although PNL generally holds a higher meat quality than PS caught tuna due to the low accumulation of lactic acid, since the tuna are caught under much less stressful circumstances compared to seiner-caught tuna. However, as the informant from PNA pointed out: the meat quality ultimately depends on the operation of the vessel.

> Poor quality is because of poor handling. If the fish is thrown on the deck and immediately taken away to refrigerated temperatures to take the temperature down, it's better quality because it remains fresh. Because it is fresh as opposed to frozen you are going to get better processing recoveries (Informant 1, April 16th, 2015).

According to the PNA informant, the Solomon PNL operation was commonly perceived within the tuna industry as a high-quality operation, with better meat quality than for instance the Maldivian PNL operation. This allegation has not been further examined in this research; it does however draw to the general positive image of the NFD PNL operation that was gathered during fieldwork for this research as well as from secondary literature (Barclay & Cartwright, 2007a).

7.9 RS5 – Productivity of system

RS5 refers to "the rate of generation of units of biomass determined by production-consumption rates per unit of time, surface or volume" (Basurto, Gelcich & Ostrom, 2013, p. 1376).

7.9.1 RS 5.1 – Stock status

As was established in section 6.2.2, Chapter 6, there is not much concern regarding the maintenance and recruitment status of global skipjack stocks with an estimated 30% of stock biomass currently targeted by fishing operations. When taking into account the fact that skipjack spawns continuously throughout the year in warm waters, and reaches maturity at a small age and size, the fisheries in the WCPO (and elsewhere) are generally exploiting adults (spawners), but seldom the juvenile skipjack. This is is an assuring factor as it in itself is promoting conservation of the spawning stock (Fonteneau, 2003). There are, however, certain locally overfished populations of skipjack. In the EPO skipjack was established as a locally overfished stock has been reported through steadily falling CPUE as well as a drastic decline of average weight in some areas (ISSF, 2015).

For yellowfin tuna, the picture is somewhat gloomier. They are in general not considered overfished in the WCPO, however, in certain areas in the EPO, they are. Increased fishing pressure throughout recent years, increased catch of juveniles, as well as increased levels of by-catch of yellowfin tuna in the PS skipjack fishery are the main sources of concern. The excerpt from OFP (full citation on page 108-109) sums up WCPFCs main concerns for the species:

> Fishing mortality has increased in recent years. Current fishing mortality rates for Yellowfin tuna are estimated to be about 0.72 times the level of fishing mortality associated with maximum sustainable yield

> (fMSY), which indicates that overfishing is not occurring. However, recent catches are close to or exceed the MSY by up to 13%. Both biomass and recruitment have declined gradually over the duration of the fishery, with current spawning biomass estimated to be about 38% of the level predicted in the absence of fishing. (...) The WCPFC could consider measures to reduce fishing mortality from fisheries that take juveniles, with the goal to increase to maximum fishery yields and reduce any further impacts on the spawning potential for this stock in the tropical regions (...). The SC recommends that the catch of WCPO yellowfin should not be increased from 2012 levels, which exceeded MSY (OFP, 2015, p. 4).

The picture given by the fishers interviewed for this research was somewhat in accordance with the stock assessment status given by SPC and WCPFC, however, the impressions particularly from the PNL fishers was that the schools were smaller, catches of particularly big individuals occurred much less, as well as smaller average size of fish. The by-catch rate of juvenile yellowfin both from PS vessels targeting skipjack, as well as PS vessels targeting mixed schools with FADs seems to be the issue causing most concern at this point in time. Figures 57, 62 and 64 show a clear advantage of avoiding catch of juvenile yellowfin from PS vessels targeting free-schools of tuna. Stricter enforcement when vessels violate the minimum requirement of size (1.3 kg) when landing tuna is another measure for managers to consider, particularly in the high seas and for DWFN vessels.

It seems in the context of this research that the skipjack stock status remains at safe levels with recruitment to stock being steady and highly resilient to fishing pressures. Because of its biological characteristics, it is highly difficult to overfish the species. However, measures should be taken to address local overfishing occurrences, such as seen in the EPO. It is not implausible for a similar situation to occur in the WCPO, within regionally separate stocks of skipjack more prone to local overfishing than the highly migratory stocks. Local overfishing with local excessive catches is not, however, considered harmful for the spawning stock as a whole. Further measures to avoid catch of juvenile skipjack are also seen as a necessity for the continued positive recruitment to the stock – in fact, the biggest concern when it comes to skipjack tuna stock control is the accidental catch of other species. By-catch in the form of juvenile yellowfin and bigeye tuna caught by PS vessels targeting skipjack, are a source of significant concern that needs to be integrated in skipjack tuna management schemes. Poor management measures likewise may lead to impoverished status of even resilient species such as the skipjack.

7.9.2 RS 5.2 – Biophysical factors

The biophysical factors are defined as "phenomena like upwelling, biogeographic or geomorphological factors affecting the generation of units of biomass" (Basurto, Gelcich & Ostrom, 2013, p. 1376). A highly important biophysical factor affecting the tuna stocks of the WCPO is the ENSO occurences, which makes the stocks move westwards – creating richer fisheries in the WCPO and poorer fishing conditions in the EPO. This will be further elaborated in RU 7.1, and is a biophysical factor that is not caused or linked to anthropological activities. As previously mentioned, the high productivity rate of tuna along approximately 10^{o} north and south of the equator is linked to the so-called equatorial upwelling. Due to the *coriolis effect*, created by the earth's rotation, and the South Equatorial Current (SEC) in the two hemispheres, the Pacific Equatorial Divergence (PEQD) is generated. Due to these oceanographic phenomena, explained through Eckman spiral processes, nutrients from deeper and denser layers in the ocean creates a divergence that results in a upwelling of new nutrients from below the photic zone, creating a broad line of high phytoplanktonic (chlorophyll *a*) concentration in the photic zone along the equatorial line. The waters of PEQD are also characterized by higher salinity and partial pressure of CO2 (Bell, Johnson & Hobday, 2011). High phytoplanktonic activity fuels the whole ecosystem, and creates favourable conditions for food supplies and diversity of marine life. It has already been mentioned in section 7.32.1, chapter 7, that under different climatic scenarios, variable, but less distribution of available fish both due to climatic changes as well as human population increases may occur. According to Bell, Johnson & Hobday (2011), several other biophysical factors determine the overall fitness of tuna supplies in the tropical Pacific.

> Availability of the nutrients that underpin the food web for tuna, together with suitable water temperature and dissolved oxygen levels, determines the distribution and abundance of tuna and other large fish across the WCPO. It is therefore crucial to understand the responses of phytoplankton, zooplankton and micronekton to changes in the ocean processes that deliver nutrients to the photic zone, and to changes in the physical and chemical properties of the ocean projected to occur as a result of global warming and ocean acidification, are expected to affect all life history stages of large oceanic fish (Bell, Johnson and Hobday, 2011, p. 191).

The report has demonstrated how the food webs underpinning the life support for tuna stocks may change by 2035 and 2100 under low (B1) and high (A2) emission scenarios defined by the Intergovernmental Panel on Climate Change (IPCC). See Figure 47.

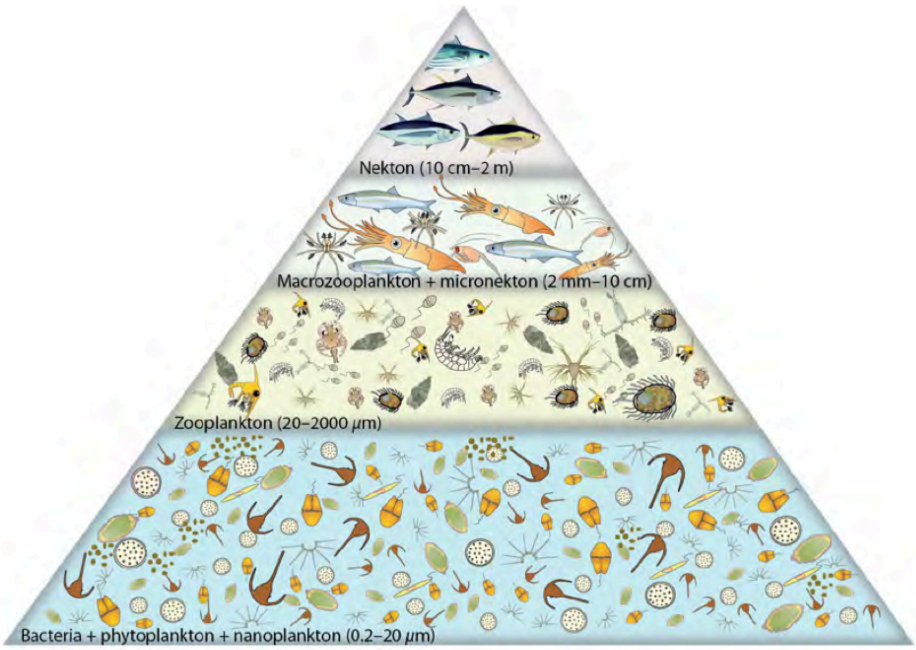


Figure 47: Generalized trophic pyramid for the tropical Pacific. The base of the food web consists of bacteria, small phytoplankton and protists (nanozooplankton), 0.2-20 µm in size. These organisms are ingested by zooplankton, such as crustaceans, molluscs or tuna larvae, up to a size of 2000 µm. In turn, zooplankton is consumed by macrozooplankton, such as jellyfish, and micronekton, such as squid, shrimp and small fish. Micronekton and, to a lesser extent, macrozooplankton are the prey for tuna and other large pelagic fish at the top of the pyramid (Bell, Johnson and Hobday, 2011, p. 192).

Little reliable data exists about the extent of recent changes to the food webs as little long-term observations of oceanic ecosystems in the region exists. However, satellite images from two periods, 1979-1986 and 1997-2000, show that surface chlorophyll *a* concentrations for the oligotrophic oceans of the world decreased by 8% between the early 1980s and the late 1990s. Recent calculations have also shown how ocean gyres with chlorophyll *a* have expanded rapidly, in the southern Pacific by 1.4%. A corresponding, slight increase in sea temperature in the gyres of the Northern and Southern Pacific (of 0.014°C per year and 0.02°C per year, respectively) has been observed. These observations combined has lead scientists to support the hypothesis that increased stratification has lead to lower primary production – correspondingly, perhaps, there has been evidence to suggest that zooplankton productivity in the tropical north Atlantic has declined (Bell, Johnson & Hobday, 2011). This assumed planktonic decrease has not been seen in the WCPO, however; in fact it seems to increase in part due to repetitive ENSO occurrences over the past 20 years. Contrastingly, there has been an increase of chlorophyll *b*, suggesting a shift towards an ecosystem more dominated by cyanobacteria.

> Changes in the extent of low-oxygen zones at intermediate depths have also occurred in the last 50 years in tropical oceans. Although this has obvious implications for micronekton, no comparisons of the vertical

> distributions over time have been made for this important source of prey for tuna (Bell, Johnson & Hobday, 2011, p. 218).

Accordingly, the potential impacts of the projected temperature increases in the food webs for tuna in all provinces, ultimately depends on the capacity of the organisms to adapt to any temperature increases beyond those present today – that is especially the case under the A2 scenario in 2100. As the average mixed layer depths is projected to decrease by <10% for both B1 and A2 scenarios, and the reduction of the area of PEQD as its western border gets displaced westwards, it means a shrinkage of the total productive sections of the province projected to occur. In particular, a decreased mixed layer depth may affect primary production as it can reduce nutrient input to the photic zone – climate change in general is believed to cause visible changes in the near future that can affect the productivity of the tuna stocks as well as the entire food web system (Bell, Johnson & Hobday, 2011). These changes should be well integrated into fisheries management plans on top of the effect on the stocks from fishing activities derived from market demands.

The physical surroundings of skipjack and yellowfin tuna and their ecosystem surroundings can be used as indicators of sustainability through establishing indexes of trophic interactions with other species. Pauly et al (2002) define the marine ecosystem in terms of 'trophic level' (TL), defined as 1+ the mean TL of their prey. As shown in the fishery status reports from SPC for particularly for yellowfin tuna, decrease in size of mean catch may indicate that a reduction of TL is occurring for the species, further indicating that perhaps a "down-fishing of the marine food web" is occurring to a limited extent for the yellowfin tuna fishery. For the skipjack tuna, indications are that the stock is in healthy condition, thus indicating a stable TL level. However, the indications from the informants interviewed from this research, particularly the fishers with 10+ years of experience, indicated that the mean catch size for both species had decreased to a large extent. It is therefore not unlikely that local differences in TL levels of the species are occurring, and that some regions in the WCPO thus are experiencing ecosystem overfishing.

<u>7.10 RS6 – Equilibrium properties</u>

"Equilibrium properties refers to the characterization of the type of attractor of a resource system along a range from one to multiple (chaotic) attractors" (Basurto, Gelcich & Ostrom, 2013). For this research, it is understood as the exchange of extracted harvest from the resource units (the yellowfin and skipjack tuna).

7.10.1 RS 6.1 Landed tonnage in SI and WCP-CA

According to the WCPFC (2014a), the total landed tonnage of tuna (all species) by PS gear was 24,784 mt in 2013, 1,666 mt caught in the PNL fishery – a total of 26,450 mt. In the WCP-CA the according numbers were, in 2013, equal to 1,899,015 mt and 221,715 mt, respectively. There are in all likeliness concealed figures in this estimation, as when IUU fishing occurs, some fishing activities (particularly high seas DWFN fishing) are under-reported, laundered or concealed as well as the fact that somewhat divergent catch statistics exist, depending on the source used.

7.11 RS7 - Predictability of system dynamics

RS7 is defined as the "degree to which actors are to forecast or identify patterns in environmentally driven variability on recruitment" (Basurto, Gelcich & Ostrom, 2013, p. 1376). Hence, the way the MSY, fMSY, CPUE and other benchmark units are understood and used in the fisheries described in order to avoid actors to refrain from actions leading to a tragedy of the commons situation, and avoid of the collapse of the SES system that the tuna fishery of the WCPO is defined as in this research.

7.11.1 RS 7.1 MSY/CPUE levels for skipjack and yellowfin

According to the ISS, the MSY level for WCPO yellowfin tuna is estimated at 586,400 tons, and the recent stock assessment, performed in 2014, indicates that the stock is not in an overfished state. This is due, for instance, to the ratio of $F_{current}/F_{MSY}$ for the period 2008-2011 being estimated at 0.72, indicating that overfishing is not occurring. However, the latest catches have in certain places slightly exceeded or been close to the set MSY levels. The stock is therefore considered fully exploited by most RFMOs in the region, with no further catch expansions advised (ISSF, 2015). This was a view supported by the fishers interviewed for this research – which is an interesting finding: the fishers themselves are in the frontline for safeguarding the conservation of their very subsistence. For skipjack tuna, the MSY is estimated to be 1.619 million tons, with recent catches slightly exceeding MSY levels. The fishing mortality levels were higher during the last decade than for the preceding period of 2004-2007. The current $F_{current}/F_{MSY}$ ratio is estimated to be 0.61, indicating that overfishing is not occurring (ISSF, 2015). Figure 48 illustrates the condition the three main targeted tuna species in the WCPO are considered to be in.

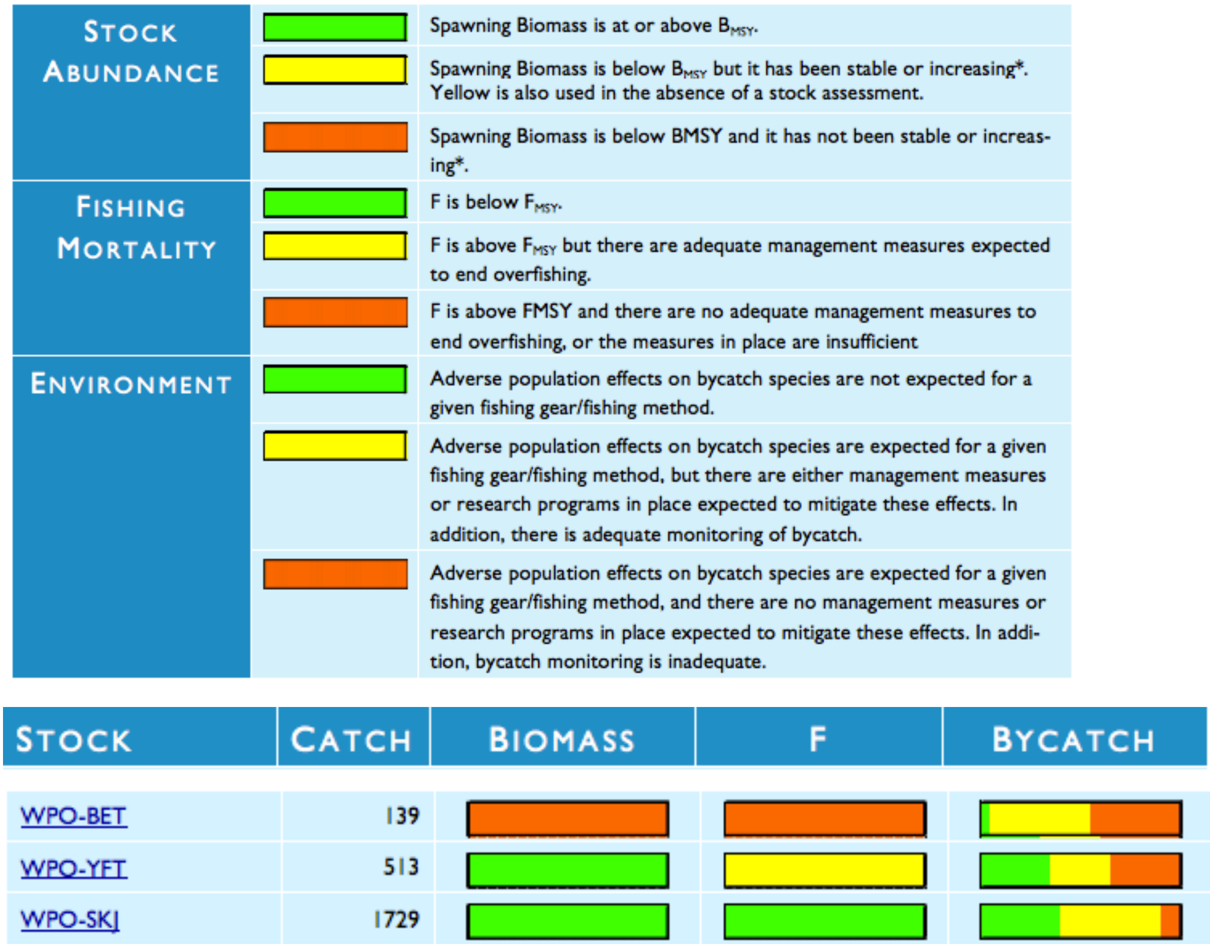


Figure 48: Colour ratings decision table regarding the state of different tuna species, followed by table assessing fishing mortality (F) and environmental impact ratings, sorted by species. Catch is for 2013 in thousands of tonnes. WPO-BET = Western Pacific Ocean Bigeye tuna, WPO-YFT = yellowfin tuna, WPO-SKJ = skipjack tuna. * As determined by the ISSF Scientific Advisory Committee based on the results of the stock assessment. Generally, a stable or increasing trend has to be observed for more than two years. *Source*: (ISSF, 2015, p. 4 and 14).

As the Figure illustrates, the biomass status for both yellowfin and skipjack is considered sustainable, along with the fishing mortality for skipjack. For yellowfin, the fishing mortality is occurring on levels that are worryingly high – slightly above MSY levels for the WCPO, and with a 2013 catch that was 14% higher than 2012 levels. Skipjack levels are, as previously mentioned, within MSY levels (slightly above in certain regions), and there still is room for (cautious) expansions in fishing pressures. By-catch of both other species and juvenile targeted tuna is a significant issue for bigeye and yellowfin, and so far slightly so for skipjack. As the figure illustrates, bigeye is in a severely threatened state, with stocks so heavily targeted that the IUCN considers the species 'vulnerable' (VU)[32], while local estimates are both more and less severe. A summary of the different MSY benchmarks for WCPO yellowfin and skipjack tuna is illustrated in Figure 49:

WCPO SKJ	Estimate	Years	Notes
Recent catch	1729	2013	
5-yr catch	1644	2009-13	
MSY	1619	2008-11	
F/F_{MSY}	0.61	2008-11	
B/B_{MSY}	1.74	2012	
TAC	N/A		

WCPO YFT	Estimate	Years	Notes
Recent catch	513	2013	
5-yr catch	536	2009-13	
MSY	586	2008-11	
F/F_{MSY}	0.72	2008-11	
B/B_{MSY}	1.24	2012	
TAC	N/A		

Figure 49: Illustration of the different benchmark MSY levels for skipjack tuna (left) and yellowfin tuna (right) *Source*: (ISSF, 205, p. 32 and 36).

This research views advice given for the tuna species from agencies like WCPFC, SPC and the ISSF as highly reliable and in accordance with the precautionary principle. Avoiding catch of juvenile yellowfin in particular, the increased control of IUU fishing and high seas laundering of tuna landings, as well as not expanding fishing effort levels from the current levels are the most pressing of them. These efforts may be assisted through schemes like the VDS, which will be further debated in the third-tier variable GS 4.2.

7.12 RS8 – Location

RS8 is defined as the "spatial and temporal extent where resource units are found by actors" (Basurto, Gelcich & Ostrom, 2013, p. 1376). This location has already been illustrated in RS1, and further illustrated by yearly variations of PS vessel locations across the WCPO due to biophysical indicators like ENSO occurences in Figures 20 and 21, Chapter 3.

7.13 Resource units (RU)

[32] For more information about the bigeye tuna species status, see http://www.iucnredlist.org/details/21859/0

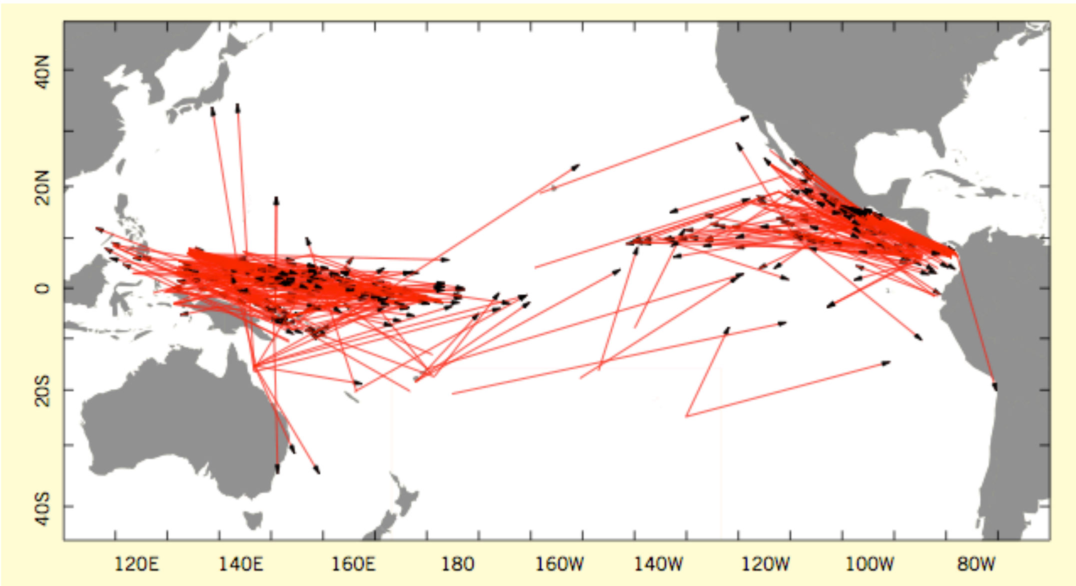
The first-level core subsystem RU is defined as the "characteristics of the units extracted from a resource system that can then be consumed or used as an input in production or exchanged for other foods or services" (Basurto, Gelcich & Ostrom, 2013, p. 1376). The resource units for this research are defined as the yellowfin and skipjack *species*, therein, the two respective stocks of the species existing in the WCPO.

7.14 RU1 – Resource unit mobility

RU1 refers to how the resource units (the tunas) move along their spatial and temporal space, especially how this movement may be interacting and responding to fishers' activities.

7.14.1 RU 1.1 – Yellowfin and skipjack highly migratory patterns

An important feature of the tuna in the offshore fishery resources is that the species are highly mobile. Figure 50 shows the net displacements of tagged yellowfin and skipjack during the "Regional Tuna Tagging Program" years of 1989 and 1992, a tagging project initiated by the SPC.



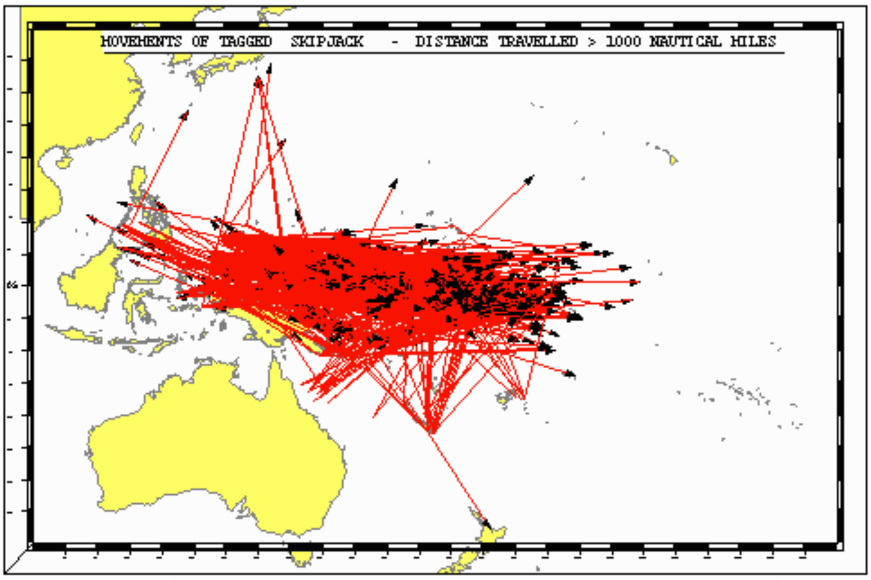


Figure 50 (*upper*): Long-distance movements of tagged yellowfin. *Source*: (ESCAP, 2014, p. 9). Figure 50 (*bottom*): distance travelled by skipjack tuna between the tagging time and the recapture, restriction to fish with distance > 1000 nautical miles. *Source*: (SPC, 2010).

As Figure 50 illustrates, the migratory patterns of the species takes no regard of national states political boundaries. Consequently, many aspects of the management of these species are best undertaken at the regional, rather than only at the national level (ESCAP, 2014). The SPC tuna-tagging project released 98,401 skipjack, 40,075 yellowfin and 8,074 bigeye during the tagging period, with a particular focus on yellowfin, as a response to the increased growth of the PS fishery. The project intended to assess the interactions between different gear types operating on the same fishing grounds, between fisheries of all types operating in adjacent EEZs and between artisanal and industrial fisheries operating in coastal waters, and use the description of tuna movement to predict interactions for projected fishery developments (SPC, 2010). The data derived from the taggings were applied to stock assessments, where at that time the levels of exploitation were moderate (around 20%), and provided information about size-specific natural mortality rates. These tagging projects help commercial actors determine where they are most likely to find abundant levels of schooling tuna, and the fishing activities often correspond to the points in the figure with dense fish activity. To avoid overfishing not only within RFMO convention areas such as the WCP-CA, but also regionally and globally, high levels of regional and global cooperation are required. The impression given in this research is that the regional cooperation levels have a relatively strong position, but the pressure from DWFN wanting to increase their fishing activities is strong – and sometimes of an unscrupulous character. The initiatives of PICTs cooperation are therefore applauded, and in regards to the tuna fisheries; the efforts imposed by the PNA are particularly emphasized. The regional cooperation strengths and points of improvement in regards to tuna fisheries will be elaborated in U 5.1 and GS 4.2.

7.15 RU2 – growth or replacement rates

RU2 is defined as the "absolute or relative descriptions of changes in quantities (*x*) of resource units over time (*t*)" (Basurto, Gelcich & Ostrom, 2013, p.1376).

7.15.1 RU 2.1 – Spawning and reproductive rates

The spawning and reproductive rates of yellowfin and skipjack have been duly covered in sections 6.2.1, 6.2.2, 6.2.3, 6.2.5 and 6.2.6 as well as in RS 5.1 and RS 5.2. Information about the spawning and reproductive rates is therefore referred to in these sections.

7.15.2 RU 2.2 – Perceptions from informants

The impression given from Q7 and Q14 in the interviews of the informants was most relevant for RU 2.2. The PNL fishers unanimously agreed that both the individual and school size of both species had declined during their years at sea. For the PS fishers, the impression was divided, with approximately half finding no change, and half finding fish to be smaller. This may support the observation that secondary literature points to the fact that some occurrences of growth overfishing can be happening at exposed locations, especially for the yellowfin (ISSF, 2015). Many of the fishers stated that the fishing always became poor during the spawning season – for SI that is usually between November-February. Fisher 5, among several others, stated that,

> (...) before, during the Japanese [when SolTuna was owned by the Japanese Solomon Taiyo], they closed the fishing from November-February. [It is] time for [the] skipjack to lay eggs in November. But now we fish all year. The seasonal changes are out of normal. The sea is changing, the environment and logging activities [particularly], when the skipjack lays eggs in [the] Marovo (adjacent geographic area in Western Province) side, the sea are not very clear there because of logging. [There are] so much less eggs than before (Fisher 5, April 27th, 2015).

Fisher 5, amongst some of the other interviewed informants, supported this policy formerly imposed on the fisheries operations. They believed that closing the fishery during the vulnerable spawning months could help improve stocks to rebuild and recruit in healthy manners, and in the long term secure their jobs in the fishery sector, as many perceived the stocks to be shrinking. Another factor entirely is doing so could be to improve the fishers' working conditions. Being a fisher within oceanic fisheries is a hard job with little time on land, and according to the NFD local operations informant, the NFD fishers have an annual leave scheme that entitles them to one month with paid leave each year as well as an entitlement of two days rest leave each month. Many of the fishers are not originally from Western Province, meaning some of them only see their families for one month each year, as the two days leave each month can be too little to be able to travel far away. Their workweeks are scheduled to 40 hours, but depend on the nature of the operation. Since a fishing operation is out 7 days a week, the incentive is overtime payment for documented work on top of these 40 hours (Informant 4, May 2nd, 2015). Returning to 9 months of fishing and 3 months of time-off during spawning season could be considered an improvement to the working conditions for the fishers, to enable to see their families and friends to a greater extent than they do today, with 11 months of fishing and 1 month with time off.

Regarding closing the fishing operations during spawning season, the NFD informant stated that not doing so was a management decision. However, they tried to schedule most of the annual maintenance and repairs of the vessels around that time as fishing operations tend to be less profitable then. NFD rotates work also during spawning seasons, and the downtime depends basically on the cash flow and the budgets at that point in time, not the spawning season in itself. Neither are they required to stop fishing during that time according to their issued fishing licences, meaning that fishing during that time is considered both legal and feasible by the SI fisheries ministry. The NFD informant also referred to their effors to reduce catch of juveniles both in terms of their electronic devices on board where approximate sizes of fish can be indicated through the radars, as well as the aforementioned three-chamber nets to avoid catch of the smallest individuals. These measures are admirable, however, taking the secondary literature of this research into account it seems that closing the fishery during spawning season can be considered to be one of several improvements to the stock status of different tuna species.

However, this not only depends on NFD – regional goals of fishing closures during spawning seasons could be considered for fisheries managers that provides stock sustainability advice on regional levels. Another extenuating factor is that NFD, like other commercial companies, are completely dependent on making continued profits in order to remain cost-effective in a harsh market of many competitive actors. Therefore, for a measure like fishing closures during spawning season not to be unjust and cause disproportionate profit losses to only companies that prioritized such closures for conservation purposes, it would have to be imposed on *all* actors equally. If the law required all commercial actors to cease fishing during spawning seasons, and that closure were enforced, it would mean the monetary loss would be equal for all actors. As such, it would remove the competitive advantage of companies prioritizing fishing also during spawning season.

7.16 RU3 – Interaction among resource units

RU3 is defined as interactions among resource units during different life stages affecting the future structure of the population" (Basurto, Gelcich & Ostrom, 2013, p. 1376).

7.16.1 RU 3.1 – Co-existence in schools

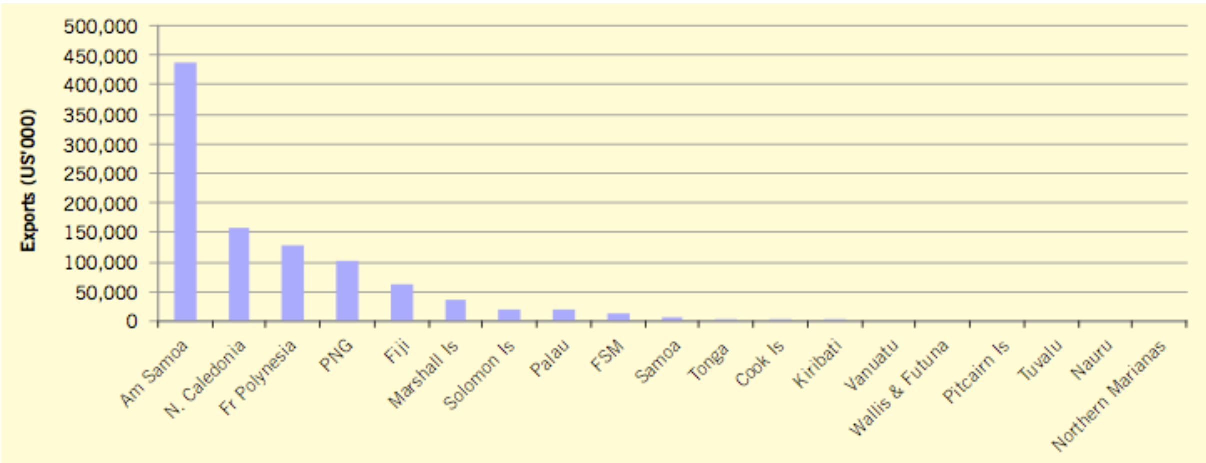
Several of the informants from NFD PS and PNL vessels stated that a strange phenomenon had been observed during recent years. More frequently than in the past, they have seen yellowfin and skipjack schooling together instead of separately, which according to them had usually always been the case. The secondary literature reviewed for this study, supports this claim by stating that schools of tuna usually occur in a mono-specific matter, meaning that yellowfin usually school with yellowfin and skipjack usually school with skipjack, and often in a similar size class (Dagorn & Restrepo, 2011). However, according to Dagorn & Restrepo (2011), the schools associated with FADs are often comprised of more than one tuna species than the free schools that more frequently tend to be mono-specific. This was further explained in section 7.29.6, chapter 7. As the usage of FADs in the PS fishery becomes more widespread, also among the NFD vessels, this may explain how the fishers have observed higher occurrences of multi-specific schools of tuna. When schools of tuna mix, it creates challenges in terms of by-catch. If the school consists of species of tuna that are not in an overfished state, it does not pose particular issues as long as both species have commercial value, are utilized by the fishers and landed at dock. If this mixed species consists of species that are threatened more than the target species, such as bigeye tuna mixing with skipjack, it creates a situation of higher occurrences of by-catch than with mono-specific schools. Shifting fishing operations to increase use of free-schooling tuna would significantly improve this problem. This shift was one that the

PNA informant for this research highly propounded – in fact, the informant claimed that PS vessels shifting to free-school caught tuna was a much more potent means of conservation of tuna species than shifting to more PNL operations; the latter being heavily proposed by conservation NGOs. Secondary literature highly recommends increased use of free-schooling as a means of mitigating by-catch, as shown in sector 7.29.6, Chapter 7, supported by for instance Figure 62 which shows much less frequency of juvenile catches in free-schooling and Figure 57 which shows that the global by-catch numbers from 2012 were 38,551 mt against only 2,691 mt for FADs and free-schooling, respectively. Based on both findings from the fieldwork of this research and the impression given from secondary literature, is seems that promoting the use of free-school caught tuna is a means of conservation which is given little attention in global conservation campaigns. This research supports that free-schooling as a fishing technique by PS vessels should be awarded much more attention by fisheries managers and regional RFMOs, through, for instance, premiering fisheries actors that implement measures to increase the use of free-schooling at the expense of subsequently decreasing the use of FADs.

7.17 RU4 – Economic value

RU4 is defined by Basurto, Gelcich & Ostrom (2013, p. 1376) as the "value of resource units in relation to the portfolio of resources available to actors". For this study, a short assessment of the market value and revenue of NFD as well as the revenue of skipjack and yellowfin tuna fishery will follow.

According to Tri Marine, the export earnings value of SolTuna and NFD are estimated at over US$ 52 million, as well as US$ 8.5 million in payments to the SI government (Tri Marine, 2015b). Having access to foreign markets is a crucial part of their operations and absorbs more than half of SolTuna's production. Especially, having access to the advantageous EU market is an integral part of the business strategy due to its high-income value. This is also the case in many other Pacific Island nations – many rely on preferential trade access to European markets and hefty tax remissions or other kinds of subsidies in order to be economically viable (Barclay & Cartwright, 2007a). Approximately 70% of all SolTuna exports by value go to the EU market (2007a). The SI EEZ is estimated at 1.34 million km^2, an approximate half of the adjacent PNG EEZ. According to Intertek Fisheries Certification (IFC), the mean annual catch of tuna in SI waters was 156,102 tonnes between 2008 and 2011, with an estimated value of US$ 180 million. The last few years have seen bigger catches, however, with a peak in 2010 of 186,260 tons (IFC, 2013). The value of the tuna caught in the WCPO is massive, depending on which areas are defined. Some figures illustrate: according to PNA the negotiated total value of U.S. payments to PNA one-year transitional agreement for VDS is estimated to US$ 89,271,350 for 2016 (PNA, 2015). According to SPC, the total value of the tuna fishery in the WCPFC-CA, when all fishing methods were included, has grown substantially to a net worth of US$ 4-5 billion, and the value of global tuna products accounts for approximately 9% of total global fish trade (SPC, 2010). According to WCPFC, the total value of the PS and PNL fishery in the WCPFC-CA was, respectively, US$ 4,054 million and US$586 million in 2012 (WCPFC, 2013). The last year, however, has been characterized by very low tuna prices due to oversupply of the catch into the market – causing a decline of 41% of ton prices compared to 2014 prices – now down to US$ 1,110/tonne for skipjack and US$ 1,900/tonne. The European skipjack prices are somewhat stable at EUR 900/tonne and yellowfin at EUR 1,950/tonne, according to FAO April 2015 reports (FAOa, 2015). The tuna consumption in 2005 was distributed as follows; 82% of tuna was consumed as canned product, 18% as fresh product (including sashimi) – of this fresh product 78% was consumed by the Japanese market. In 2004 the canned tuna consumption was highest in the EU (734,444 tons,) followed by the US with 445,847 tons (SPC 2010). All in all, the fishery export sector is of significant importance to the PICTs, and makes up a huge portion of both the export value and the portion of the PICTs' GDP, as shown in Figure 51.



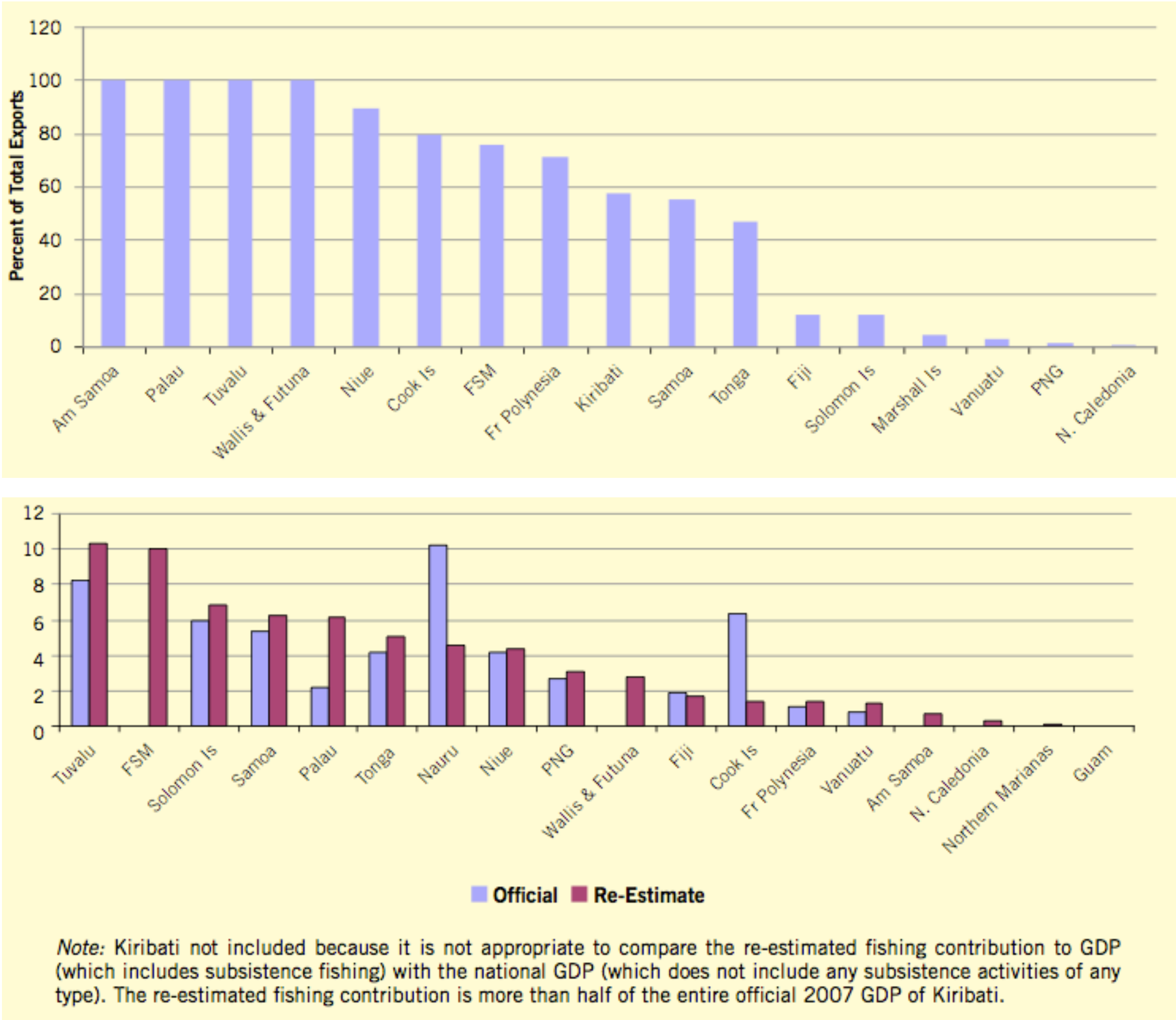


Figure 51: Annual value of fishery exports in PICTs in 2007 (top), relative value of fishery exports in PICTs in 2007 (middle) and official versus re-estimate of fishing contribution to GDP in 2007 (bottom). *Source*: (ESCAP, 2014, p. 10-11).

As Figure 51 shows, in about half of the PICTs, fishery exports are representing over one half of all exports – for four of the PICTs it represents 100% of the exports. It may seem as though fisheries is only a relatively insignificant portion of the PICTs' GDP, with only Nauru and Tuvalu with >10% of its GDP. However, it should be noted that by international convention, the 'sector' is fishing (rather than fisheries) and does not include sectors such as post-harvest activities like tuna canneries, therefore, the overall fisheries contribution to PICTs GDP is likely much larger (ESCAP, 2014). Out of the fishery export values in the region, 64.2% of that total is tuna export; the rest is other types of fisheries (SPC, 2010). It is especially interesting that a few of the countries and territories that hold good tuna fishing grounds, such as Kiribati, Nauru, Tokelau and Tuvalu, export little or no tuna, however, this might be explained by the large amounts of access fees received by the government, as shown in Figure 52:

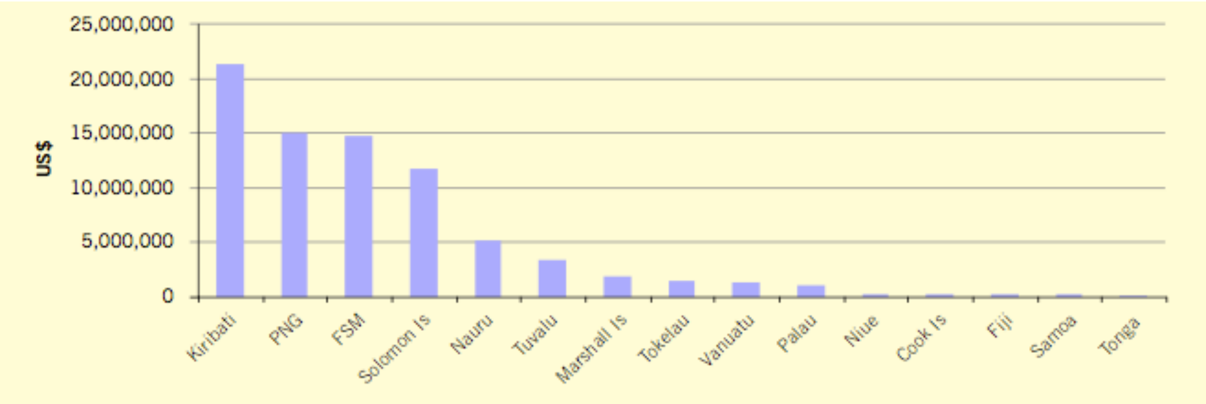


Figure 52: Access fees received for foreign fishing in 2007. *Source*: (ESCAP, 2014, p. 12).

The countries in the region with especially good fishing grounds in particular, receive significant amounts by allowing vessels from DWFNs access to fish in their EEZs. The total access fees received in 2007 were US$ 78.5 million, and FFA reports for access fees of about US$ 135 million in 2011 (ESCAP, 2014). The magnitude of received fees may be due to the introduction of PNAs VDS, which has made a huge impact on the fisheries revenue to the governments in PNA affiliated countries and territories; this will be further covered in section 7.25.2, Chapter 7.

7.18 RU5 – Number of units

RU5 is defined as the "number of resource units harvested or that could be potentially harvested" (Basurto, Gelcich & Ostrom, 2013, p. 1376). The total number of resource units – that is, yellowfin and skipjack tuna in the WCPO, is not only immensely large, but also not known by exact estimates from scientists. The MSY levels are determined from an approximate vindication of the total biomass, and have been thoroughly covered in for instance RS 5.1, RS 7.1 and sections 6.2.2 and 6.2.3, Chapter 6.

7.18.1 RU 5.1 – Perceptions from informants

The impression by the fishers of the perceived existing total biomass and stock sizes of the resource units, with possible changes to it was assessed through Q6 and Q14. In Q6, 12 of 15 PNL fishers stated that they thought the biggest perceived change in the fishery was that the available amount of fish at sea had decreased. Regarding Q14, nine of those 15 PNL fishers thought that the tuna stocks are now smaller. Several of the fishers elaborated by stating that they now spent more time out at sea searching for fish, compared to earlier times. For the PS fishers, the distribution to Q6 was different; five of 15 stated that there were less fish than before as the main change. The distribution of Q14 was also different: eight of 15 perceived the school sizes of tuna to be unchanged compared to before, five thought them to be smaller, and two found the biggest noticeable change to the schools of fish were that the schools consist of more mixed species than before. In total, then (n = 30), 14 of 30 fishers regarded the biomass to have reduced in size, and 18 of 30 found this factor to be the most prominent change in the fishery altogether. These are interesting findings, as the impression given from the workers in the front line of the fishery accurately describes the picture that fishery scientists draws of the fishery status.

7.19 RU6 – Distinctive markings

RU6 can be defined as the "markings and/or behavioural patterns that can be identified in resource units and affect actors' behaviour toward them" (Basurto, Gelcich & Ostrom, 2013, p. 1376).

7.19.1 RU 6.1 – Perceptions from informants

The general impression given from the informants of this research was that all had a much reflected position towards their impacts on the stocks from their fishing pressure. Many stated in an unsolicited manner that they tried as far as possible to avoid by-catch of vulnerable non-target species, that catch of juvenile individual fish was avoided as far as possible and that they themselves proposed more restrictive fishery policies with higher regards to conservation. It is therefore believed, from the SES framework point of view, that physically seeing vulnerable by-catch and/or the presence of undersized tuna, affects the actors' behaviour towards them. The same can be said about the actors at the other end of the scale – the consumers. Being presented with pictures of undersized tuna, by-catch or other emotionally gripping photos by conservation campaigns such as those from Greenpeace, from BBC documentaries or from green consumerism campaigns such as MSC, *is* likely to affect actors' behaviour towards the vulnerability of the species.

7.20 RU7 – Spatial and temporal distribution

RU7 is defined as "allocation patterns of resource units across a geographic area in a particular time period" (Basurto, Gelcich & Ostrom, 2013, p.1376).

7.20.1 RU 7.1 – ENSO and seasonality patterns

As mentioned earlier, the yellowfin and skipjack tuna are uniformly distributed along the 10°N and 10° S ratio of the equator. However, seasonal migration patterns occur, and both species have spawning locations they return to annually. As mentioned before, this is less expressed in skipjack, which exhibit a more opportunistic spawning rate, and are believed to spawn year-round if conditions are favourable. The spawning locations of yellowfin in the WCPO are discussed by Lehodey & Leroy (1999):

> Yellowfin spawning appears to be Pacific-wide and bounded in its northern and southern extremes by the 26°C surface isotherm. While the occurrence of larvae is continuous across the equatorial Pacific within a zone approximately ten degrees north and south of the equator, three areas of higher larval density have been tentatively recognized: 130- 170°E, 180°- 160°W and east of 110°W. Spawning occurs year round, possibly with a peak in the November–April period. Some data also suggest different spawning seasons for areas east (March–September) and west (November–April) of 180°. In the eastern Pacific the smallest female found with mature ovaries was 84 cm, and the estimated length at 50-percent maturity was 95 cm. In the central equatorial Pacific a few yellowfin tuna reach maturity at about 70-80 cm, but recent data collected by the University of Hawaii indicate that the majority do not mature until they reach 100-110 cm. However, the time necessary to attain spawning condition could be linked to food supply (Lehodey & Leroy, 1999, p. 2).

The citation describes how the spatial distribution of the fish changes throughout the year, and that these migrations are linked to spawning locations as well as natural growth patterns. However, another major impact to the species' migration patterns is the physical changes in the temperature of the ocean, for instance, as expressed through the occasional ENSO occurrences. A major El Niño event was building up in the Pacific at the time of writing this research.

Fluctuations in PS yellowfin catches has been linked to this ENSO occurrences. During El Niño years the catch generally increases and whereas it decreases during La Niña years (Hampton, 2010). For instance; in the La Niña years of 1995/96 the catch was, respectively, 215,400 mt and 190,023 whereas the catch in El Niño year of 1998 was 395,688 mt (WCPFC, 2014a). The fish are believed to move westwards during El Niño years, causing the EPO section to suffer significant losses in fish catch. The other 'normal' years, in which no ENSO event occurred, during 1990s and 2000s, the yellowfin PS catch fluctuated at around 300,000 mt. Traditionally, during El Niño years, the PS fishery in the WCPO benefits with bigger catches (with the opposite occurring in the EPO), because the fish move slightly to the east of their typical location between PNG and FSM. As described in RU 2.1, repetitive ENSO incidents have been linked to lower primary production. Lower primary production creates extensive impacts on the whole marine ecosystem. Therefore, ENSO incidents are a factor that cannot be controlled by humans. However, due to their immense impact on particularly EPO fisheries, perhaps they should be expressed and the prognosis for estimated economic and food security losses should be accounted for in fishery management plans to a larger degree than today.

7.21 Governance systems (GS)

The first-level core subsystem GS can be defined as "the prevailing set of processes or institutions through which the rules shaping the behavior of the actors are set and revised" (Basurto, Gelcich & Ostrom, 2013, p. 1377). GS for this research is defined as the governmental, regional, NGO, academic and RFMO governance systems that all influences the tuna fisheries in both the WCPO and in the case study; SI. The GS subsystem is a large one in this research, with modifications added of up to eight third-tier variables to the eight second-tier variables.

7.22 GS1 – Government organizations

GS1 may be defined as "institutions with governmental authority mandated to protect the public trust" (Basurto, Gelcich & Ostrom, 2013, p. 1377). As mentioned earlier, the different governments of the PICTs all mandate sovereign powers to manage their respective EEZ, and the fisheries inside them. Many of them are organized at regional levels, however, in order to manage highly migratory fish species, mitigate IUU activities, form alliances, cooperate on proper VMS tools as well as coordinate mutual standards for terms and conditions for DWFN vessels operating in their EEZs. There have been significant improvements for the region in recent years in terms of increased regionalism, but it seems management from government organizations still has a lot of room for improvement. Corruption such as the issuing too many licenses or excessive quotas, where these are used, are examples of where improvement could be focused.

7.22.1 GS 1.1 – Employment in SI

SI has one of the highest employment levels within the fisheries sector in the PICT region – however, it only accounted for approximately 1000 formal jobs either on shore facilities or local vessels in 2008 (Gillett, 2009). With a population of 523,000 it does not make up a significant part of the formal work force. Unemployment is arguably one of the most serious long-term problems of the PICT region. SI is no exception – only about 10% of the adult population have ever been engaged in formal, taxable employment (Barclay & Cartwright, 2007a). According to a World Bank assessment in 2012, the unemployment rate in SI is high – 39.8%. Unemployment is a particular problem for young people and women. Only 32.8% of the adult female population and 20% of Solomon Islanders aged 15-24 are currently employed. With seven out of ten being under 29 years old, a severe skills deficit exists in the country, with only 18.9% completing secondary education and 1% completing vocational/professional qualifications (The World Bank, 2012). Available evidence points to the fact that lack of functional literacy is a major constraint to creating jobs and furthering economic growth. This lack in formal skills in the work force has led many employers to import work labor – even with an unemployment rate amongst youth in some places of over 80%. According to the World Bank, with statistics given from the SI government, ministry of Education and Human Resource Development, they "identify illiteracy as a major factor in limited socioeconomic development and social problems including poor health and sanitation, lack of economic diversification, poor natural resource management, low employment, and low participation in community and governance" (The World Bank, 2012, p. 2).

The work that NFD is doing locally to fight these rather grim statistics is formidable. Not only is the work force in the company consisting of over 90% Solomon Islanders – these workers also have the opportunity to rise in ranks and achieve positions such as captain, fishing master, or first officer of a vessel. They may also achieve senior positions such as head or assisting production manager. On top of creating formal employment locally, the Central Bank of SI has ranked the fisheries sector as one with the greatest potential to contribute to economic development – in 2005, 18.2% of SI's total exports came from the fisheries sector. SI has a comparative advantage in terms of its resource availability. However, in terms of cost structures SI has not been able to compete with the other major producer countries. Institutional and economic problems have constrained investments in the country and for this growth to continue, SI needs to reduce the cost of operations, requiring taxation and industrial policies that complement the fisheries policies. “One of the main problems is that inconsistent policies undermine investor confidence”, with major obstacles including poor infrastructure, government systems obstructing investment, freight being expensive and difficult to organize, lack of skilled human resources, lack of ancillary services, lack of investment capital, lack of land available reliably and at reasonable prices and taxation structures inhibiting investment (Barclay & Cartwright, 2007a, p. 217). Despite the challenges listed, SI remains one of the most potential success stories of the PICT region, with their rich skipjack fishery and a longline fishery viable for expansion. With a large population and, compared to other nations in the region - a large land area, they have the potential to become a much stronger actor in the regional economies. Up until 1999, SI had strong domestic tuna industry development, which had three locally based tuna operations making profits, and with what was regarded a strong fisheries minister. However, the tensions between 2000 and 2003 created a major breakdown in law and order, little effective government, rampant corruption, escalating costs and lack of confidence in the sector, which caused a huge drawback.

From 2005, the picture has been brighter, with the government in collaboration with RAMSI beginning broad reforms with the ambition of aiding the business section. According to Barclay & Cartwright (2007a), SolTuna has been “less beneficial to the SI economy than Solomon Taiyo was, which provided thousands of jobs and a substantial portion of SI’s exports” (p. 224). According to this study, SolTuna needs better private-sector input, especially in trading, marketing and financial management. This was not the impression given during fieldwork of this research – the management and growth of SolTuna seemed to flourish, with income and positive reputation at increasing levels. However, regardless of the policies at national levels and the potential of growth in the economy: without proper environmental policies the very foundations of lasting, economic prosperity are at risk. Development of tuna resources needs to be carefully managed through precautionary principles and if not, a viable and lasting industry is impossible to achieve. Alongside good environmental governance, good management of social issues arising from commercial developments needs to be taken into consideration to prevent economic collapse. Figures 53 and 54 illustrate the scale of SI domestic tuna production between 1997 and 2004, and catches from domestic and foreign fleets by gear between 2000 and 2004, respectively.

	Total catch (mt)	Frozen tuna exports (mt)	Chilled tuna exports (mt)	Canned tuna total (cartons)	Canned tuna exports (cartons)	Smoke dried tuna (arabushi) (mt)	Fishmeal (mt)	Cooked tuna loins (mt)
1997	37,209	25,910	2,760	1,072,000	7,524	945	70	0
1998	41,158	37,292	2,153	-	1,446	149	118	0
1999	16,865	6,660	1,486	-	6,440	940	1,400	0
2000	4,680	670	804	-	2,349	504	353	0
2001	15,024	13,523	816	78,063	72	563	50	0
2002	11,283	7,750	1,385	254,224	72	1,480	596	0
2003	22,894	20,592	882	173,312	90	1,145	185	0
2004	27,496	23,331	1,116	262,144	215	574	225	2,035

Figure 53: SI domestic tuna production, 1997-2004. Note: According to NFD interviewees, NFD sold 5,282 mt of its catch to Soltai in 2004 for processing as loins. The difference between the amount of tuna exported as frozen and the total catch is less than this, so there is a discrepancy between NFD and Fisheries Department figures. *Source*: (Barclay & Cartwright, 2007a, p. 224).

	Domestic PL	Foreign PL	Domestic LL	Foreign LL	Domestic PS	Foreign PS	Total
2000	2,777	0	1,197	835	2,365	3,885	11,059
2001	6,534	0	434	500	7,670	10,883	26,021
2002	9,787	0	907	1,267	6,783	10,883	29,627
2003	10,793	0	1,439	1,474	15,191	31,751	60,648
2004	6,882	0	1,174	619	16,094	70,184	94,953

Figure 54: Tuna catches from domestic and foreign fleets by gear, 2000-2004. LL = longline. PL = pole-and-line. Licensing records indicate that a Japanese PNL fleet was operating in SI during this period, but the Statistics Section could not provide figures on the catch of this fleet since 1997. The fact that the 2002 and 2001 figures for 'Foreign PS' are exactly the same as the year before seems to indicate an error in the data provided by the Statistics Section for one of these years. NFD figures differ from the Fisheries Department figures for 'Domestic PS' for 2004; NFD interviewees reported their 2004 catch to be about 20,000 mt, as did the 2004 Annual Report of the Central Bank of SI, whereas the total domestic PS catch recorded by the Fisheries Department figures is just less than 17,000 mt. *Source*: (Barclay & Cartwright, 2007a, p. 225).

Finally, as a general comment; the number of total crewmembers is much smaller on PS vessels compared to PNL; for the NFD vessels it is 22 vs 35 crewmembers, respectively. The fact that PNL is a highly labour-intensive fishing method has been used as a prime example of its superiority in terms of unemployment mitigation. The number of crewmembers on PS vessels is closely related to both the cost of labour and the frequency of transhipping, as the latter is a labour-intensive process. The crew costs are highest in the US and Japanese fleets, and therefore the average crew numbers are also lowest on these vessels (Gillett & Lewis, 2003).

7.23 GS2 – Non-governmental organizations

GS2 can be defined as "institutions without governmental authority mandated to protect the public trust" (Basurto, Gelcich & Ostrom, 2013, p. 1377). For this research, several NGOs and RFMOs either have influence or real power in managing and conserving the fishery resources. Some NGOs, like Greenpeace, focuses more on activism on extreme-sized PS vessels[33], exposing offenses and IUU activities in the open ocean, as well as awareness campaigns targeted at consumers who buy canned or fresh tuna in the global markets. The focus of this research, however, is on regionalism, exemplified through the FFA and PNA, further explained in GS3 and U 5.1.

7.23.1 GS 2.1 – Support enforcement

GS 2.1 can be defined as "institutions with a mandate for monitoring and enforcement of rules to access and use the resource" (Basurto, Gelcich & Ostrom, 2013, p. 1377). These institutions includes the sovereign states of the PICTs with their accompanying EEZs, as well as regional organizations cooperating on IUU mitigation and VMS schemes, which will be further elaborated in GS 8.2. Such enforcement exists in the region not only to tackle the difficult task of IUU mitigation in the open sea, but also to prevent members of smaller-scaled fisheries to have incentives to maintain operational community rules. Enforcement officials from fisheries authorities in the respective PICTs are the ones conducting any prosecutions of that matter, and it is believed that improved management in the support enforcement sector is a key element of safeguarding future healthy fish stocks.

7.23.2 GS 2.2 – Conservation efforts

GS 2.2 can be defined as the efforts with a mandate to address conservation problems to maintain healthy fish stocks in the natural population (own definition). The conservation efforts that are made in the WCPO region are immense and differentiated, and it also depends on the PICT in question. Generally speaking, the main conservation issues are focused on high seas IUU mitigation – especially of the DWFN vessels, by-catch mitigation schemes, and the

[33] For more information about Greenpeace's confrontation of large PS vessels in the Pacific, see for instance their encounter with the Spanish super seiner *Albatun Tres*, at http://www.greenpeace.org/international/en/news/features/albatuna-tres-062708/

ongoing debate concerning whether an effort-based or catch-based control measure in managing the fisheries is best suited in terms of conservation. The proposed conservation efforts are mentioned several places in this research, for instance in GS 8.7, GS 8.8, GS 7.1 or U 5.1.

The WCPFC has, on their annual meetings, drafted up Conservation and Management Measures (CMM), which has been defined as binding rules that apply to all its members. A 2015 ISSF report summed up yellowfin tuna conservation measures implemented from RFMOs in the region, previously put forward by FFA members in the Commission:

> Limit reference point: 20% of the equilibrium spawning biomass that would be expected in the absence of fishing under current (most recent 10 years of the current assessment, excluding the last year) environmental conditions (20%SBcurrent, F=0). The yellowfin stock is estimated to be above this limit. Target reference point: Not defined. CMM-2014-06 calls for WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules and other elements. At its 2015 meeting, the WCPFC is to establish a workplan for doing so. Harvest control rule: Not defined. CMM-2014-06 calls for WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules and other elements. At its 2015 meeting, the WCPFC is to establish a workplan for doing so. The main binding conservation measure for yellowfin established by the WCPFC is CMM 2014-01. The measures call for the following in 2014-2017: 1. A 3-month closure (July through September) of fishing on FADs in EEZ waters and on the High Seas between 20°N and 20°S. VMS polling frequency is increased to 30 minutes during the closure; 2. In 2015 and 2016, in addition to (1), each member shall choose between extending the FAD closure for a total of 5 months (January, February, July, August and September), or limiting the number of FAD sets to be less than the number of sets made by its vessels in a reference period specified in the CMM. In 2017, a prohibition on FAD sets on the high seas will apply, except for vessels purse seine flagged to Kiribati. 3. A limitation in the number of vessel days: For PNA members, the limit in their EEZs is the 2010 level. For other coastal states with effort in their EEZs exceeding 1,500 days annually over (2006- WCPO-YFT ISSF Status of Tuna Stocks - 2015 31 2010), the limit is either the 2001-2004 average or the 2010 level. For non-SIDS members, purse seine effort on the high seas will be limited to levels specified in the CMM. 4. Each member shall not allow the number of fishing days in the high seas to increase above limits specified in the CMM; 5. Each member shall not allow its catch of yellowfin to increase; 6. A requirement to submit FAD management plans, including information on strategies used to implement the closure and other measures for reducing small bigeye mortality; 7. A full-retention requirement for all purse seine vessels regarding bigeye, skipjack and yellowfin tunas between 20°N and 20°S; 8. 100% Regional observer coverage for all purse seine vessels fishing on the high seas, on the high seas and in waters under the jurisdiction of one or more coastal States, or vessels fishing in waters under the jurisdiction of two or more coastal States during the same trip; all purse seiners fishing between 20N and 20S must have an observer onboard, unless they fish exclusively in their EEZ. 9. A limit between 20N and 20S in the number of purse seine and longline vessels with freezing capacity at the current level for most countries; In addition, CMM 2009-02 provides more guidance on the FAD closure and full retention requirements. CMM-2014-01 requires members to adopt measures so that their catch of yellowfin tuna does not increase (ISSF, 2015, p. 30-31).

The same report summed up the proposed skipjack tuna conservation measures:

> Limit reference point: 20% of the equilibrium spawning biomass that would be expected in the absence of fishing under current (most recent 10 years of the current assessment, excluding the last year) environmental conditions (20%SBcurrent, F=0). The skipjack stock is above the limit. Target reference point: Not defined. However, TRPs of 40%, 50% and 60% of unfished spawning stock biomass are being considered for skipjack by WCPFC. Current levels of spawning biomass are within this range. CMM-2014-06 calls for WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules and other elements. At its 2015 meeting, the WCPFC is to

establish a workplan for doing so. Harvest control rule: Not defined. CMM-2014-06 calls for WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules and other elements. At its 2015 meeting, the WCPFC is to establish a workplan for doing so. The main binding conservation measure for skipjack established by the WCPFC is CMM 2014-01. The measures call for the following in 2014-2017: 1. A 3-month closure (July through September) of fishing on FADs in EEZ waters and on the High Seas between 20°N and 20°S. VMS polling frequency is increased to 30 minutes during the closure; 2. In 2015 and 2016, in addition to (1), each member shall choose between extending the FAD closure for a total of 5 months (January, February, July, August and September), or limiting the number of FAD sets to be less than the number of sets made by its vessels in a reference period WCPO-SKJ ISSF Status of Tuna Stocks - 2015 35 specified in the CMM. In 2017, a prohibition on FAD sets on the high seas will apply, except for vessels purse seine flagged to Kiribati. 3. A limitation in the number of vessel days: For PNA members, the limit in their EEZs is the 2010 level. For other coastal states with effort in their EEZs exceeding 1,500 days annually over (2006- 2010), the limit is either the 2001-2004 average or the 2010 level. For non-SIDS members, purse seine effort on the high seas will be limited to levels specified in the CMM. 4. Each member shall not allow the number of fishing days in the high seas to increase above limits specified in the CMM; 5. A requirement to submit FAD management plans, including information on strategies used to implement the closure and other measures for reducing small bigeye mortality; 6. A full-retention requirement for all purse seine vessels regarding bigeye, skipjack and yellowfin tunas between 20°N and 20°S; 7. 100% Regional observer coverage for all purse seine vessels fishing on the high seas, on the high seas and in waters under the jurisdiction of one or more coastal States, or vessels fishing in waters under the jurisdiction of two or more coastal States during the same trip; all purse seiners fishing between 20N and 20S must have an observer onboard, unless they fish exclusively in their EEZ. 8. A limit between 20N and 20S in the number of purse seine and longline vessels with freezing capacity at the current level for most countries. In addition, CMM 2009-02 provides more guidance on the FAD closure and full retention requirements (ISSF, 2015, p. 34-35).

Many of the actions that are drafted in the CMM meetings, have already been imposed and implemented by PICTs, especially those that are members of the PNA. If implemented completely in the high seas, the measures will apply the same standards to fishing across the region. These are actions that are highly consistent with the findings of this research. However, the right of PICTs to explore options for development such as building local tuna industries, should not be deprived while implementing the CMM measures. Previous bigeye and yellowfin tuna catch and effort limits have generally not restricted rights to development to the small island states, and similar strategies should be further emphasized. The measures proposed were designed in a manner that aimed to reduce fishing by DWFN vessels in PICTs waters; and in the VDS case - make fishing more costly for the foreign actor, and consequently much more profitable for the PICTs owning that tuna resource, which again can be expected to increase price and value of Pacific tuna.

7.24 GS3 – Network structure

GS3 can be defined as "the connections among the rule-making organizations and the population subject to these rules" (Basurto, Gelcich & Ostrom, 2013, p. 1377). The positive role that regionalism has played in the PICTs throughout recent years, has been a network structure considered to be a large determiner of future governance success. Vertical relationships between governments, fishery enterprises, smaller-scaled fisheries and conservation RMFOs have contributed to a positive trend towards higher enforcement controls, access to new markets and support conservation efforts, which ultimately can help facilitate successful collective action for resource sustainability. The collective-action arrangements of the common-pool resources that tuna fisheries are, as implemented by the PNA, are good examples of this. In only a few years, they managed to 'turn the table' in favour of PICTs in securing higher economic benefits from their foreign fishery licence sales, while setting strict access rules in terms of conservation. Another good example is the vertical structure of NFD, which has secured them economic prosperity as well as providing highly valuable local employment opportunities. The way that the influence from RFMOs such as PNA is increasing the regionalism solidarity and group affiliation in the PICTs, a region long suffering from a state of subordinacy from the bigger economies, post-colonialism issues and exploitation of their natural resources, is highly interesting for future research. Including new tiers within the SES framework variable set and doing policy analysis of the fisheries in the PICT region could shed insightful knowledge on how the existing policies are emerging and evolving.

With that said, the network structures of the fisheries management sector have some severe threats; perhaps most importantly; corruption and weak management or policy schemes. Making sure that research-based biological knowledge forms the base of resource management decisions, all the while ensuring socioeconomic prosperity, is a tremendous task in a region that struggles with high levels of unemployment and low levels of completed higher education. Combined with rather microscopic domestic economies within each small Pacific Island state, when compared to other regions of the world, creates many challenges. However, the impression given from my fieldwork in the region is that, among actors in this region, the sense of entitlement to one's own resources is powerful. Highly skilled, professional regional organizations such as the WCPFC, PNA, SPC and FFA create a science-based environment where creative, potent management schemes have been implemented for many decades already. With the combined strength of many PICTs acting together, creating strong and transparent network structures seems highly achievable, and is already highly prevalent in some sectors. The question then remains; who is really responsible for the decline of many tuna fisheries and other marine species? The answer is complex, but the many violations of the rules and regulations set in Law of the Sea, within national EEZ borders of the region, illegal transhipment at sea and fish catch laundering within initially legally bought fishing licences from DWFN, remains by far the biggest threat to the sustainability of WCPO tuna fisheries – not the fishing pressure from either industrial-scale or artisanal-scale fisheries from any of the PICT nations.

7.25 GS4 – Property-rights systems

GS4 can be defined as the "particular types of rules determining which actors have been authorized to carry out which actions with respect to a specified good or service" (Basurto, Gelcich & Ostrom, 2013, p. 1377). GS4 will briefly examine the different forms of property-rights systems that exist in the WCPO region.

7.25.1 GS 4.1 – Open-access

Having no effective restrictions on the use of resources constitutes an open-access system. The WCPO has four areas that are prone to suffer from open-access related issues – 'loopholes' - that are defined as international waters, not being subject to any sovereign state jurisdiction, but where the UN convention on the Law of the Sea applies[34]. Article 116 states that; "all States have the right for their nationals to engage in fishing on the high seas subject to: (a) their treaty obligations (...) (c) the provisions of this section" (UN, 1982, p. 65). It further states in article 117 that:

> *Duty of States to adopt with respect to their nationals measures for the conservation of the living resources of the high seas.* All States have the duty to take, or to cooperate with other States in taking, such measures for their respective nationals as may be necessary for the conservation of the living resources of the high seas (UN, 1982, p. 65).

In article 118 it is further elaborated that:

> *Cooperation of States in the conservation and management of living resources.* States shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, cooperate to establish subregional or regional fisheries organizations to this end (UN, 1982, p.65-66).

Finally, article 119 states that:

[34] For legal document of the Law of the Sea, see http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf

> *Conservation of the living resources of the high seas.* 1. In determining the allowable catch and establishing other conservation measures for the living resources in the high seas, States shall: (a) take measures which are designed, on the best scientific evidence available to the States concerned, to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the special requirements of developing States, and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether subregional, regional or global; (b) take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened. 2. Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations, whether subregional, regional or global, where appropriate and with participation by all States concerned. 3. States concerned shall ensure that conservation measures and their implementation do not discriminate in form or in fact against the fishermen of any State (UN, 1982, p. 66).

Based on the legal statements in the Law of the Seas, what may appear to be a somewhat lawless area of the Pacific is indeed covered by a wide range of responsibilities that parties to the convention are bound to follow. The range of industrial-scale PS and longline vessels operating in the high seas pockets has increased dramatically throughout recent years, which according to the articles cited above, has to be, avoided by law. The proposed and enforced bans and closures of these areas particularly vulnerable to the open-access problems will be covered in GS 8.6.

7.25.2 GS 4.2 – The vessel day scheme

To achieve a higher level of regional participation and revenue from the fisheries, a presentation during a WCPFC meeting in 2005 turned the tables and recognized an *effort-based* control scheme to manage the fishery, and PNA's much anticipated VDS saw the light of day. The VDS would replace the Palau Agreement for the Management of the PS Fishery in the Western and Central Pacific in 1992. As an attempt to curb, limit and control the steep increase of PS tuna fleets in the PICT region during the 1980s, the Palau Agreement operated as a *licencing regime* based on declared catch, with an initial cap of 164, mostly foreign-owned PS boats, which was progressively raised to 205 vessels. The limit placed a ceiling on the number of PS licences that could be issued by the seven PICs party to the agreement[35] (Gillett, 2007). The scheme was based on landed catch, which then was reported and a 5% premium

[35] The seven countries to sign the Palau Agreement in 1992 was FSM, Marshall Islands, Nauru, Palau, Tuvalu, Kiribati and PNG (the two latter signing the following year). See link for legal paper: http://www.ecolex.org/server2.php/libcat/docs/TRE/Full/En/TRE-001958.pdf

was given to the country that the DWFN vessel bought the licence from. The system was criticised for giving major incentives to its actors to misreport the catch and the location of the catch.

> (...) For example in PNG, we used to see log sheets that would say 'searched PNG waters for two weeks. Never caught a thing. Went into the high sea pockets, caught 500 tonnes, decided to continue search in PNG for another two weeks, still caught nothing, therefore we owe you nothing for licence'. When we changed from that system to an effort-control, there is in essence: 'here is an opportunity. You pay for the opportunity, and don't bother bullshitting us what you caught, we don't care - because we are going to monitor it anyway with a 100% observers and port-transhipments, so we will know what you have caught. So you decide what it is worth for you to come and fish. We are offering the opportunity; you decide what it's worth for you. And if you don't think it's worth enough, well, then you won't get it. Someone else might beat you' (Informant 1, April 16th, 2015).

Following this debate, the wish to modify the Palau Arrangement culminated in the creation of the VDS, a scheme PNA introduced as an answer to try and curb the explosive growth of DWFN fishing as well as trying to ensure economic growth for the PNA countries. The total number of fishing days permitted in the fishery is capped within Total Allowable Effort (TAE) designated on fishing days. The fishing rights in the VDS are sold bilaterally; the right to fish in one respective zone is bought for days at a time – PNA members thus agrees before-hand on a limited number of fishing days for the year, which are based on scientific advice from SPC regarding the biological status of the stocks. Fishing days are subsequently allocated by country and sold to the highest bidder. The control is of the *effort*, not of the *catch*, meaning that the number of tons caught is insignificant; the prior agreed price remains the same. It is, however, implemented adjustments according to the size of the vessel to reflect the highly differential vessel abilities to catch higher or lower tonnage of fish. Vessels of lengths of <50 meters recieve two fishing days for the price of one; vessels with lengths of 50-80 meters pay for one day and recieve one day, whereas vessels of lengths of >80 meters need to buy two fishing days in order to fish for one day.

> The VDS has enabled PNA to account for effort creep by differentiating fishing days based on vessel length and allowing for vessel formulas to be modified over time to account for changes in technology and efficiency. A key objective of the VDS is to create competition between DWFN vessels to purchase fishing days at the maximum price. As the VDS has been introduces, allowances have been made for vessels that fish under an agreement between USA and the PICTs and the FSM Arrangement which was allocated a pooled effort target. (...) The VDS does introduce some innovations include allowing days to be 'traded' between PNA states, and a measure to manage capacity growth by adjusting the value of a 'fishing day' according to the size of the vessel (Hanich, Parris & Tsamenyi, 2010, p. 9).

After the VDS was introduced, the revenue in the region increased significantly; from US$60 million to almost US$300 million over the course of five years (Barclay & Cartwright, 2007a).

The explosive growth in income for the countries in PNA has had a tremendous effect on their economies as well as, according to the opponents of the scheme, to a large extent revealed the true value of the tuna fishery. The VDS has been in the frontline of the region's recent collective approach to establishing new initiatives in regional fisheries cooperation, which has set global precedents in the fisheries sector as well as significantly boosting PICTs' capacity to manage the region's tuna fisheries in a manner consistent with their individual national interest (Hanich, Parris & Tsamenyi, 2010). Like any other political or management issue, the islanders are arguably stronger together due to their individual small economies. This is particularly true when managing tuna, because it is highly migratory. However, the success needs to be further monitored to draw conclusive remarks. It seems that business entities from DWFNs have been actively investing in 'on-shore' facilities in PNA countries in the aftermaths of the VDS. And most significantly perhaps, at least in a sense of building a strong Pacific community voice, the VDS have significantly boosted the collective capacity of PICTs to resist DWFN pressures (2010).

Even if the VDS scheme has received positive attention for being a flexible, potentially tradeable permit scheme, aling with shifting the balance from less revenue options for PICT governments into multiplying much-needed assets from an industry that provides key development opportunities for many of the region's developing island states, concerns have arisen of whether the VDS has yet to prove its worth as a conservation tool. Some significant concerns are linked to the VDS – including technology creep, uncertainty in intensity of fishing operations and lack of imposing technical and catch controls. This was the impression given during the key informant interview from NFD in this research, which stated that:

> I think the VDS have yet to be tested as a conservation tool, and I don't think it will work. As an economic tool, it is very good. It is bringing in more money for the members now than in the past. But I think the DWFN will use the technology to really maximize – a vessel day can mean anything to them. We, as basically small players in the scheme of things, [when] looking at the SI archipelagic water boundary, it is not too far out from the islands, so the big PS vessels can come very close to our archipelagic waters, on the fringes, and set their nets. We are concerned that with the increasing efforts out in the EEZ, maybe the fish in the archipelagic waters will be affected too (Informant 3, April 24th, 2015).

The VDS has been a subject of concern; its worth as a conservation tool has been questioned - whereas its worth as an economic revenue tool for PNA countries has been mostly praised. It does have stated conservation objectives of restraining efforts to 2004 levels, which are levels consistent with broader regional development terms. The effort levels need to stay within 2004 levels, and within the VDS it is increasingly apparent that effort creeps have continued to undermine the conservation objectives of the scheme – it is now at an allocation level of 12% above the 2004 levels (Hanich, Parris & Tsamenyi, 2010). Shifting baselines are further complicating the issue of the absolute TAE – as it increases the number of PS effort days by approximately 30%. Another issue is that the VDS does not apply to archipelagic waters, which already see high PS and FAD activities, as the NFD informants stated. The PS efforts within these zones are entirely at the discretion of the archipelagic coastal state, which therefore may undermine the VDS rationale of decreasing efforts in the PNA zone.

> One of the key barriers to the adoption of tighter conservation targets is the disjunction between those who are deemed 'responsible' for conservation measures in the WCPFC and those who may enjoy the conservation benefits in the future. This is particularly the case for addressing bigeye conservation needs where the PNA states, the primary beneficiaries of the purse seine fishery, are being required to limit the benefits they derive from the fishery for the preservation of benefits accruing to other, non-PNA, longline states. To further complicate matters, bigeye tuna, while not being a primary target for them does nevertheless represent a valuable addition to their small domestic long line fisheries and is an important resource for other FFA states (Hanich, Parris & Tsamenyi, 2010, p. 12).

Despite all these efforts of designing the VDS appropriately, it appears that it is poorly designed to address bigeye conservation – and perhaps also for yellowfin, should the stocks continue to develop into a downward manner. To complicate matters more, the focus on limiting the effort of PS gear is largely ineffective to cap the real issue; gaining control over the tuna *catches*, in particular the bigeye tuna. The catches of valuable and (for now) not biologically threatened, skipjack is unnecessarily affected, and arguably for the PNA members; unfair. They are bearing a disproportionate amount of costs compared to the benefits they gain from bigeye conservation. One option could therefore be to extend the property rights, at least over bigeye tuna or future vulnerable tuna species, as a mechanism for shifting the costs of conservation towards those who may benefit from them. PNA has recently demanded compensation for taking the conservation costs at the price of undermining other valuable tuna catches (Hanich, Parris & Tsamenyi, 2010).

The Scientific Committee meeting under WCPFC in 2005, expressed worry about the VDS, as the cap set under it was viewed as inadequate to address concerns over key bigeye and yellowfin stocks. Suggestions for improvement of the VDS have been formulated by for instance Barclay & Cartwright (2007):

> (…) While the more recent work demonstrates that earlier arguments about reducing purse seine effort for sustainability and profitability were too simplistic, the fact remains that bigeye and yellowfin stock depletion remains a problem for both the purse seine and longline fisheries, and that successful management is the key to both sustainability and profitability. An example of a strategy following this logic would be if the PNA group of countries (which have the power to control purse seine fishing in the region) were to: i) use a sub-regional arrangement to fully 'pool' fisheries access to their combined EEZs; ii) put in place credible measures to prevent overfishing; and iii) use rights-based management approaches to sell long-term rights (as long as ten years), thereby giving fishing companies maximum confidence in their investment (Barclay & Cartwright, 2007, p. 16).

Interestingly, the PNA has recently answered the question of the uncertainty regarding the success of VDS as a conservation tool. They have themselves announced an external assessment in October 2015[36] to advise the Parties to PNA of options to enhance the VDS through a) altering the VDS to a catch-based system; and/or b) maintaining and improving the current VDS.

Summing up, the continued economic success that the VDS has given PICT economies will have to be supplemented through including more potent conservation strategies – particularly for bigeye tuna. Their success in controlling their own tuna resources and reducing the dominance of the DWFNs has been truly admirable. However, overcoming challenges of implementation, baseline and technology creep, protection of archipelagic waters and somehow capping catches, to a larger degree are means seen to achieve higher levels of sustainability within the VDS. As pressures grows from DWFNs in their hunt for ever-decreasing global, open fishing grounds, resolving these issues, while continuing the magnificent precedence of cooperativeness between PICTs, will be critical in order to maintain sustainable control over the WCPO tuna fisheries.

7.25.3 GS 4.3 – Territorial use privileges

GS 4.3 is defined as "area-based permanent or limited property rights granted to a formally or informally organized group of fishers" (Basurto, Gelcich & Ostrom, 2013, p. 1377). For this research, as previously stated, the property rights to fish are issued through the fishery departments within the respective sovereign states. On the regional level, for the high seas, property rights are debated and issued through schemes like the VDS. Formal and informal recognition of de facto property rights in fisheries are important within smaller-scaled fisheries

[36] See the October 2015 job vacancy advertisement here: http://www.pnatuna.com/sites/default/files/ToR%20for%20Review.pdf

as well as within the industrial-scaled ones, and can help to validate, achieve local support and share implementation burdens of establishments of, for instance, MPAs or other conservation issues.

7.26 GS5 – Operational rules

GS5 can be defined as the "implementation of practical decisions by individuals authorized (or allowed) to take these actions" (Basurto, Gelcich & Ostrom, 2013, p. 1377). For this research, there are a wide range of such operational rules meant to limit unsustainable fishing practices, for instance as mentioned in section 7.23, Chapter 7.

7.26.1 GS 5.1 – Gear limitations

Some practical limitations that are meant to increase the sustainability levels of the WCPO fishery exist. Many improvements have been made in designing PS nets with three different sized chambers, as a means to avoid catching undersized fish. The majority of these nets (75%) are made up of much bigger mesh so the smaller fish may get out of the net before the seine is hauled in, to the part of the net with consequently smaller mesh (fisher 29, May 3rd, 2015). With three mesh sizes featured during different stages of hauling, the smallest mesh only covers the net during the last part of the operation, securing mostly bigger fish to stay in the net until brailing. Understanding escape routes and behaviour (such as some fish diving deep when scared, and others not being willing to escape through very tight openings) are crucial as it helps the fishers determine both catch rates of target species and by-catch (Hall & Roman, 2013). Such a limitation of the PS nets has been implemented on all NFD PS vessels. Other limitations specific to gear includes the usage of 'Medina panels' in the EPO to avoid by-catch of dolphins (not applicable for the WCPO).

7.27 GS6 – Collective-choice rules

GS6 can be defined as the "processes through which institutions are constructed and policy decisions made by actors authorized by (or allowed) to do so" (Basurto, Gelcich & Ostrom, 2013, p. 1377). A collective-choice is formed through groups of individuals agreeing to act collectively in order to further their private interests. Making private interests achievable within the group renders the formation of organizations or associations, so that the joint rules may make the members' mutual rights, obligations and interests possible together through creating a contract based on the compromises given.

7.27.1 GS 6.1 - Perceptions from informants

With regards to collective-choice rules, the impression given from the informants interviewed is that a high level of trust and benefit was derived through organization. Groups' proponent of mutual interests - the group-choice apparatus - has been seen through organizations like the FFA, PNA, SPC and WCPFC. The success of conveying their mutual needs seemed satisfying, although some informants complained about organizations not setting ambitious enough conservation goals. Complaints over accusations of corruption or dilatory caseworks were mainly linked to public authorities. Other complaints included how DWFN was included as equal members in FFA and WCPFC, while some of the informants described the needs of PICTs to be diametrically different from those of the DWFNs, like Australia, USA or New Zealand, and therefore perhaps not representing the ultimate composition of members to achieve mutual collective-choice ambitions.

7.28 GS7 – Constitutional rules

GS7 is defined as "the process through which collective-choice procedures are defined and legitimized" (Basurto, Gelcich & Ostrom, 2013, p. 1377). The constitutional rules relevant for this research will be outlined in the following third-tier variables.

7.28.1 GS 7.1 – Sustainable fisheries management

See section 6.1.1, Chapter 6, for description.

7.28.2 GS 7.2 – Ecosystem-approach to fisheries management

For a thorough definition of the EAFM scheme, see section 6.1.8, chapter 6. As mentioned in section 6.1.4, Chapter 6, setting an MSY is determined by establishing a single-species stock assessment. However, scientists have pointed out several issues regarding basing fisheries management solely on the related policies derived from single-species assessments. Pauly et al (2002) point out four main problems:

> First, assessment results, although implying limitation on levels of fishing mortality which would have helped maintain stocks if implemented, have often been ignored, on the excuse that they were not 'precise enough' to use as evidence for economically painful restriction of fishing (the 'burden of proof' problem. Second, the assessment methods have failed badly in a few important cases involving rapid stock declines, and in particular have led us to grossly underestimate the severity of the decline and the increasing ('depensatory') impacts of fishing during the decline. Third, there has been insufficient attention in some cases to regulatory tactics: the assessments and models have provided reasonable overall targets for management (estimates of long-term sustainable harvest), but we have failed to implement and even develop effective short-term regulatory systems for achieving those targets. Fourth, we have seen apparently severe violation of the assumptions usually made about 'compensatory responses' in recruitment to reduction in spawning population size. We have usually assumed that decreasing egg production will result in improving juvenile survival (compensation) so that recruitment (eggs survival) will not fall off rapidly during a stock decline and will hence tend to stop the decline. Some stocks have shown recruitment failure after severe decline, possibly associated with changes in feeding interactions that are becoming known as 'cultivation/depensation' effects. According to this phenomenon, adult predatory fish (such as cod) can control the abundance of potential predators and competitors of their juvenile offspring, but this control lost when these predatory fish become scarce. This may well lead to alternate stable states of ecosystems, which has severe implications for fisheries management (Pauly et al, 2002, p. 690).

The four problems presented urge fishery managers and scientists to strive for a comprehensive ecosystem-based management, with single-species assessments as the core of the management scheme, yet explicitly including trophic level interactions between species, habitat impacts of various fishing gears, a theory for forming an optimum placement as well as emphasizing the urgent need for establishments of more MPAs. Ecosystem-based management will still rely on the lessons learned from single-species assessments – particularly when it comes to limitations of the fish mortality in a stock (Pauly et al., 2002).

7.28.3 GS 7.3 – Management effectiveness

The FFA took initiative to incorporate a more holistic fisheries management approach through implementing EAFM for WCPFC in 2008. Doing this would strive to ensure economic and social prosperity alongside sustainability achievements of tuna stocks for the Pacific region. They assisted the members of WCPFC to incorporate the EAFM initiative through the concepts outlined in Article 5 (g) of the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the WCPO: "take measures to prevent or eliminate over-fishing and excess fishing capacity and to ensure that levels of fishing effort do not exceed those commensurate with the sustainable use of fishery resources"[37]. This process would be implemented in the fisheries in the WCPO following five steps, outlined in the following:

> Step 1 – Determine the scope of the assessment – develop a clear description of what you are trying to manage/assess. This should include identifying the relevant societal values (e.g. species sustainability, food security etc) to be addressed.
> Step 2 – Based on the scope, identify issues across all five EAFM components (target species, non target species, the ecosystem, community outcomes and fishery administration) and determine what objectives are to be achieved for each issue given any treaties, convention, country needs, local requirements and global attitudes. These can, therefore, be based on ecological concerns, economic realities or social attitudes.
> Step 3 – Prioritise issues using some form of risk assessment and the precautionary approach, determine if direct actions are needed.
> Step 4 - Where direct actions are required, a clear management system is developed that includes operational objectives and the ability to assess performance. It also includes the monitoring and review of performance and what actions will be taken if performance is not acceptable.
> Step 5 - Based on the EAFM report, develop an operational plan that outlines the specific activities that will need to be done by all parties to deliver the outcomes needed for EAFM (Fletcher, 2008, p. 5).

The FFA further sees the 5-step implementation process going through a mode of operation, as illustrated in Figure 55.

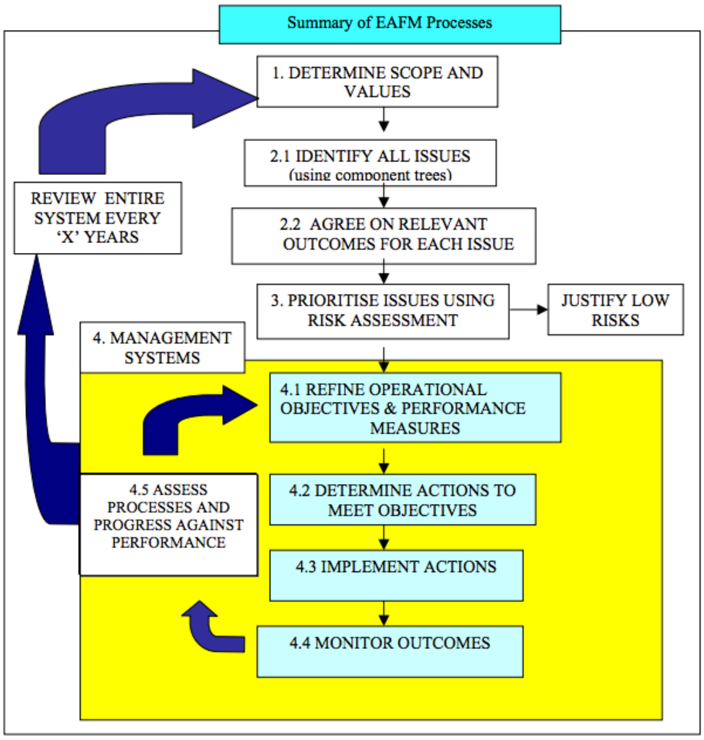


Figure 55: Outline of the EAFM Process. *Source*: (Fletcher, 2008, p.11).

The outlined figures and steps were designed as to emphasize the identification and analysis of social and economic issues, which again is crucial in the decision making process for the

[37] For full Convention document, see: https://www.wcpfc.int/system/files/text.pdf

fisheries in PICTs. If implemented, it is considered a helpful tool in decision-making due to its overarching framework of understanding the implications of management decisions (Fletcher, 2008).

However, the success of any management system is determined by several terms: biological, economic, social and political objectives. Economic and social objectives cannot be met while a stock is in such a depleted state that it threatens its long-term sustainability, and at the same time the biological objectives are unlikely to be achieved without careful consideration of economic and social objectives (Beddington, Agnew & Clark, 2007). Assessing the fishery management process in the WCPO is therefore considered to be possible mainly through looking at the actors within the fishing community as well as the management authorities; in this case, any actors chasing fish, as well as the many different sovereign states' fisheries authorities, as well as RFMOs with tuna fishery management operations imposed through for instance the PNA. The importance of other stakeholders such as NGOs is also worth considering, however, the actors actively fishing or managing the fishery are considered to be more important in terms of sustainability assessments.

The efficient enforcement of sustainable fisheries goals, such as implementing EAFM measures, can be challenging, especially since fishers will only be deterred from breaking fishing regulations if the expected loss from successful prosecution exceeds their expected gain. This is hardly the case in the high seas of the WCPO, where the ability to detect illegal fishing, as well as the penalties for doing so, are perhaps not considered as high enough to act as a disincentive (Beddington, Agnew & Clark, 2007). To create management measures that are *enforceable* is therefore crucial. In the WCPO context, such an enforceable tool can be the VDS – which has seen great successes with less 'loopholes' for rule breakers than the previous system - although it has significant conservation-wise issues, as debated in GS 4.2. It seems, therefore, that an appropriate management tool would be one that can control overcapacity. Fisher 29 (May 3rd, 2015) stated that there is the impression of too many boats chasing ever-fewer fish - "there is complaints of overfishing, but [the real issue] is the issue of over-licencing" in response to Q19 – assessing what the informant viewed as the most efficient ways to safeguard stocks for the future. This problem has not been solved through the VDS. The overcapacity refers to how improved technologies, through the 'technology creep' can undermine the sustainability of the stocks as the system does not, as opposed to the output control system of setting a roof of yearly catches, and then closing the fishery when the year's cumulative catch has reached the TAC.

Setting some restriction of allowable catch as a supplement policy to the already imposed policies in the VDS, is a possible outcome to defeat the technology creep and overcapacity in the fishery. Many of the actors within the fishery can willingly support and adhere to conservative management strategies, as well as avoiding fishing practices that endanger the biological stability of the stocks, as long as long-term rights and advantages are both guaranteed and enforced (Beddington, Agnew & Clark, 2007).

All in all, the Pacific region is not amongst the areas of the world where the most alarming states of overfishing occurring. According to Beddington, Agnew & Clark (2007), only 13% of the WCPO and EPOs major fish stocks suffer from overfishing; the Australian commonwealth fisheries and the federally managed U.S. fisheries show 40%, and 25% respectively. As this research has shown, however, sustaining these positive figures is *not* a given with the hugely magnified fishing effort the region has seen the past three decades, and available statistics are divergent as to the fisheries' real state. Proposing strong fishery management policies, enforcing those, as well as strengthening the regional cooperation will be crucial in a world where the rest of the oceans are heavily fished, and strong DWFN in all probability will target the somewhat healthy WCPO to an ever increasing extent in the future.

Establishing more MPAs is another way of achieving EAFM regulations. It is not a universal solution, however, but an important supplement to otherwise strong fishery management. MPAs can be particularly fruitful if they are established in vulnerable spawning habitats, damaged habitats or areas of particular migratory importance. The findings of this research therefore point to supporting the establishment of prolonged annual closings, or MPAs in some of the four open ocean pockets described in GS 4.1. Establishing such conservation practices, along with strong enforcement practices, could help achieve effective management of the EAFM objectives.

7.28.4 GS 7.4 – Perceptions from informants

The perception of the informants was one of large support for increased and stricter conservation measures. For instance, only 3 out of 30 fishers did not think it necessary to improve current IUU mitigation schemes. The rest, excluding 5 other fishers with invalid answers to this question (Q11), proposed a wide range of improvements and more rigorous policies to fight IUU activities. Similarly, only 1 of the 30 fishers did not propose any policies to secure the future fish stocks, as he regarded the stocks to be in a healthy enough condition, and thus needing no further protection. The rest, excluding 3 fishers with invalid answers to this question (Q19), also proposed a wide range of improvements and conservation policies to secure the stocks, which many of them perceived to be in a threatened position if more rigorous policies were not implemented.

7.29 GS8 – Monitoring and sanctioning processes

GS8 can be defined as the processes, which involve "violations of operational rules that are given a sanction coherent with its seriousness and the times the offense has been committed" (Basurto, Gelcich & Ostrom, 2013, p. 1377). A wide range of monitoring and sanctioning processes exist in the WCPO, and are organized centrally in FFA through VMS schemes. The processes involved in the fisheries will be described in the following 7 third-tier variables.

7.29.1 GS 8.1 – Perceptions from informants

The impression given from the informants was that violation of fishery policies was mainly a problem in the high seas, with DWFN actors or with local actors receiving untimely fishing benefits through corruption, as described in section 5.2.6, Chapter 5. Further, it was clear that the vast majority of them supported increased levels of VMS sanctions and enforcement.

The key informant from FFA also elaborated some of the current VMS policies that FFA is managing:

> We have some excellent new technology and observer reporting and that's the use of all the observer forms on the tablet, so their data entry is electronic, and not by paper. And there's this thing called a Delorme tracking system device. (...) It is a VMS and a personal communication device. And you can send any text message, like twitter, up to 140 characters, and you can have a whole bunch of pre-programmed text messages. You can also treat it like a mobile phone, you can hook it up to your tablet. So observers can now upload data real-time. Let's say a Korean vessel with an observer on-board puts in a claim for a non-fishing day to PNG. PNG can straight away look at the vessels VMS track for the day, where it's been, and then the observer activity report for the day. So the vessel might claim the non-vessel day, but the observer says, 'no, we caught 15 tonnes' (Informant 2, April 23rd, 2015).

The FFA informant was perceived to be fairly positive towards the VMS achievements and improvements in the region over recent years. The informant addressed some issues regarding possible improvements of the current VMS schemes, which will be covered in GS 8.2. The informant from PNA was perceived to be content with the VMS policy of his organization, which rigorously enforces the 100% observer policy on-board PS vessels. The NFD informant was also perceived to be fairly positive in particular toward the same electronic data entry scheme for the on-board observers, however also addressing the challenges with the same technology, as mentioned on page 120-121.

7.29.2 GS 8.2 – The VMS scheme

VMS is defined as the vessel monitoring systems that are used by PICTs to monitor the position and activities of fishing vessels to manage their fisheries, the VMS scheme are centrally managed by the FFA's regional headquarters in Honiara. It was the world's first centralised satellite based VMS, and all foreign licenced vessels in the region are required to report continuously to the headquarters (Hanich, Parris & Tsamenyi, 2010). The satellite-based system monitors the positions, along with the speed and direction of registered fishing vessels and include PS, PNL, longline and support and cargo vessels – in total 1024 vessels. Vessel positions are forwarded from Honiara to national officers in each country for them to further monitor. The legal framework of the scheme is national through FFA VMS legislation, which again is enacted by most of the FFA members. The FFA funds the operational costs of the scheme, but the vessel operators fund equipment purchases and installation. Six staff members work with the VMS scheme centrally at FFA, and in addition, each of the countries involved in the scheme has a designated FFA VMS officer continuously downloading vessel positions and reporting any suspicious activity or responds appropriately to alerts. The programme is anticipated to grow further with up to 1200 vessels over the next five years. Australia, Cook Islands, FSM, Fiji, Marshall Islands, New Zealand, Niue, Palau, PNG, Samoa, SI, Tuvalu, Kiribati, Nauru, Tonga, Tokelau and Vanuatu have ratified the scheme and are actively participating (FAOg, 2015). The WCPFC also has an integrated VMS scheme that closely cooperates with the FFA:

> The contracted system that provides VMS information to the FFA VMS and the WCPFC VMS systems is referred to as the "Pacific VMS". The WCPFC has approximately 1,500 WCPFC-registered vessels that report to the WCPFC VMS through the Pacific VMS. In addition the WCPFC VMS receives, through the Service Level Agreement with FFA, high seas VMS information relating to FFA-registered vessels (WCPFC, 2015b).

The VMS scheme is designed to help ensure that vessel licences conditions are complied with by their crew. VMS activities can also include on-board inspections, patrol vessel activities, inspecting vessel logs or validating catch reports (Fletcher, 2008). Many of the PICTs have meticulously been acting as team players and following their regional fisheries management obligations, such as contributing to scientific data collection, as well as so many of them being part of the VMS scheme. Many of the PICTs are affected by lack of resources to efficiently run their own respective VMSs', and a continued VMS run from the FFA has been considered a success. Cooperating and coordinating the common fisheries' monitoring, control and surveillance within PNA is also a highly outspoken policy of the organization. Even though conditions have improved significantly since VMS was implemented, several PICTs are suffering from lack of capacity to patrol and monitor their massive EEZs – a huge threat to reduce the amount of IUU activities. Some of the informants in this research complained about the SIs fisheries officials weak possibilities of detecting any IUU activity; they only have two patrol vessels to roam their 1,553,444 km^2 large EEZ. The situation is similar in many other PICTs, and is a serious threat to being able to detect vessels not playing by the rules.

Both the informant from NFD and from FFA pointed out that the role of technology was improving at an inspiring rate. One of the many challenges involving enforcement of VMS policies is increasing the amount of observers on-board longliners to the requirement of 5%, and possibly further in the future. This was already covered in section 6.3.3, chapter 6. The impression from the NFD informant was one of hopelessness; it is a tremendously difficult task to recruit observers to work on these types of vessels, and the same impression was given by the FFA informant. However, they both put their trust in how technology could improve the matter.

> [We have introduced an] electronic monitoring camera system on-board [longline vessels]. (...) It is very hard for countries to meet the minimum 5% [observer] requirement [on longline vessels]. It is a very challenging work environment. Can cameras catch the data required by the commission for the minimum data fields of the regional observer programme? Yes, it can, we have proved it. We have done a trial just with two boats, and two trips of 80-day duration, and each boat with a human observer on-board. The camera system alongside with the human system. So then you can verify from the observer reports what you are catching on the camera and what you are not capturing. That trial, we are in the process of running it at the moment, it has been very successful. Not much deviation in the numbers. The only problem was size recognition. Species recognition is easy enough, but size was an issue. Some of the people we are working with is currently working on the software for the size recognition as a component of the system. The other problem is data viewing. Although there is software technology around the data viewing systems we wanted for the purpose of this trial to watch 100% of the data. It took a long time. We got all these fast-forward functions, marks, etc. What we did get to is we have the information from the viewed data able to automatically able to populate and upload the observer management database at SPC. So instead of traditionally the observer writes the data down, then it gets handed to a data entry person who entries the data in country or to SPC, and then it's uploaded to the observer data management system. The electronic reporting [means] no more data entries on the ground required (Informant 2, April 23rd, 2015).

With ever improving technology available to VMS schemes in the region, it seems to be a prevailing atmosphere of tentative optimism. As the VMS is currently both advanced and well-managed, the electronic monitoring systems under development, the will to play by the rules in the PICTs and the huge quantity of foreign vessels obliged to take part in the system, offers hope that this sector will continue to improve over the years. However, the lack of resources in each respective EEZ is recognized, and combined with the truly tremendous spans of ocean in the region, there is still a very long way to go. Another issue is the potential of weakened capacity building within the VMS, as the building block underpinning the VDS and its interplay with other types of monitoring, control and surveillance systems.

> Critical to the success of the VDS is a functional and reliable Vessel Monitoring System that is underpinned by rigorous enforcement mechanisms. Without these two complementary strategies, it is possible that the number of days actually fished by vessels will exceed their allocated amount, and therefore risk generating gradual capacity creep over time. While the monitoring, compliance and surveillance frameworks described above represent an impressive regional infrastructure, their success depends on a strong enforcement capacity at the national level which unfortunately has been an area experiencing significant problems in some PNA states (Hanich, Parris & Tsamenyi, 2010, p. 13).

Socioeconomic development in the PICTs is interlinked to many of the issues covered; maintaining a healthy VMS is one of the most prominent. Lack of enforcement and capacity is directly linked to lack of funding and resources within each territory. Investing in increased socioeconomic development is therefore an indirect investment to many of the difficult issues that need solved in order to maintain healthy tuna fisheries, through making sure IUU activity is curbed as well as keeping local and DWFN actors playing by the rules.

7.29.3 GS 8.3 – Social

Many levels in society and organizations are involved in the monitoring and sanctioning processes in the tuna fisheries. A social monitoring and sanctioning actor can be defined as "local actors, or outsiders legitimized by them, observe that other actors comply with agreed-upon behaviour in the use of the resource system and units" (Basurto, Gelcich & Ostrom, 2013, p. 1377). For the purpose of this research, the impression is generally that local actors are likely to adhere to conservation policies that are inflicted upon them, if, but only if, they are conceived to be fair, just and secure their livelihood. Several examples were seen of this; such as the establishments of many smaller and bigger MPAs across the region – often established through the initiatives of local actors. Also, several of the interviewed fishers explained how it was considered plain obvious for them to report any observed malpractices or violations of rules and regulations to official authorities, as well as their general positive attitude towards conservation practices.

Another important social actor is the role of conservation NGOs such as Greenpeace and WWF, among others. Several fishing violations have been uncovered in the Pacific region through Greenpeace's expeditions with their fishing-monitoring vessel *M/V Esperanza*; the most recent was their 'Defending Our Pacific' expedition in 2011. Their mission was to uncover IUU practices in the high sea, and as such trying to contribute to the little that is known of the factual extent of IUU fishing in the high seas of the WCPO. The three-month expedition which began in September 2011, coincided with the regional ban on the use of FADs with PS vessels from July 1^{st} – September 30^{th}, as well as with the closure of area 1 and 2 of the high sea pockets (see Figure 56) by the WCPFC to PS fishing. At the time, PNA was also enforcing a ban on PS fishing in areas 3 and 4, which also included an entry-exit reporting requirement for all types of vessels (Greenpeace, 2012b). The Esperanza encountered 63 vessels during their 14,100 nautical mile expedition, which included several suspicious encounters, indicating that certain actors do not respect the existing conservation and management measures. One of their encounters was of an "overt, illegal, stateless and unmarked PS vessel operating with six other support vessels in what appeared to be a group operation" (Greenpeace, 2012b, p. 4). The Indonesian *Lapu Lapu*, a freezer reefer vessel, was spotted alongside the unmarked vessel, aiding them in transhipping their catch at sea, which was documented by photographers on-board the *Esperanza*. Transhipment at sea is strictly forbidden in both the WCP-CA and PNA waters.

Another example was the encounter of the Mainland Chinese longliner *Jing Lu Yuan 005*. Documentation by helicopter showed that shark fins were drying on the upper deck, and while they were approached by the Esperanza, the crew "appeared to panic, and removed the shark fins as the photographer and videographer recorded. Upon boarding with consent, the captain conceded they were targeting both sharks and tuna" (Greenpeace, 2012b, p. 14). Finally, the Chinese Taipei-registered vessel *Sheng Chi Hui No 7* was discovered in Palauan waters. A Palauan patrol boat (currently the only patrol boat of the nation) was with the Esperanza in a joint enforcement. The vessel was fishing with a licence inside Palau's EEZ, however, they were not reporting via VMS, which in itself is a violation of fishing regulations and therefore made them subject to IUU fishing prosecution. Upon inspection, both the Palauan officer and the

Greenpeace photographer documented allegedly finned shark carcasses. This is a particularly serious violation within Palau's EEZ – as it is a designated shark sanctuary, where retaining, finning or even storing or possessing sharks caught outside Palau's EEZ is banned. The vessel was escorted back to port in Koror, Palau, and subsequently fined to the sum of $65,000 USD as well as a one-year ban from fishing in Palauan waters (Greenpeace, 2012b).

The findings from the 2011 expedition show that particularly longline fishing in the open ocean pockets, with a significant number of vessels not holding any PICT licences, poses such a great number of vessels that continued closures of the high sea pockets should be considered. It also shows that by-catch, and in particular targeting of sharks for shark finning, is an extensive problem in the high seas. It also showed that bans from fishing in the high sea pockets did not necessarily create less fishing – as so many of the vessels recieved a licence to fish inside PICT's EEZs, creating a rise in total fishing effort during the period of closure. Documented FADs in the high seas during the three-month FAD ban as well as the high prevalence of FAD fishing within EEZs were also a finding of concern. However, and perhaps most importantly, the expedition showed how the substansial role NGOs could play in certain parts of conservation efforts. In particular, this is the case when helping to map the true extent of IUU fishing. There is a serious lack of enforcement resources in the high seas, even if the regulations within the EEZs are stronger. The assistance of NGOs like Greenpeace can be a highly valuable source of assistance in terms of documenting IUU fishing information.

7.29.4 GS 8.4 – Biophysical

GS 8.4 can be defined as "local actors, or outsiders legitimized by them observe the condition of the resource systems and units" (Basurto, Gelcich & Ostrom, 2013, p. 1377). As mentioned earlier, the informants percieved fish stocks to be smaller than before, with more mixed species schools, smaller mean size of individual fish and more time spent finding fish than before. In particular, this was the impression given by the PNL fishers, but to a lesser degree from the PS fishers. This impression also comes from secondary literature, especially with differences in species and juvenile composition in FAD fishing vs free-school fishing by PS vessels. This will be covered in GS 8.7.

7.29.5 GS 8.5 – Bans and closures

As mentioned before, the decision to close the high sea pockets was taken in 2008 by a binding measure at the WCPFC annual meeting, and was convened in 2012-2013. This was done in particular to meeting stock management objectives for bigeye stocks, currently being overfished, and preventing healthy tuna stocks from becoming overexploited (Gilman, 2012). The closure also meant a positive income possibility for PICTs – as the closure of the high seas meant that DWFN were forced to shift fishing operations to their coastal waters instead, providing socioeconomic benefits. The high seas closure did not, however, reduce total fishing efforts, as it displaced fishing from the high seas into PNA areas – as much as a 10% increase of PS vessel activity in the EEZs adjacent to the closed pockets (2012). In general, roughly 57% of all tuna catches in the WCPO are already taken from the PICT's EEZs (Hanich, Parris & Tsamenyi, 2010). For some time now, Greenpeace has promoted the permanent closure of all four pockets, and to turn them into a combined MPA, see Figure 56.

Figure 56: Location of high sea pockets (area 1 and 2) previously closed to PS fishing by WCPFC and currently closed via some FFA foreign licence agreements. Areas 3 and 4 are two additional high seas pockets that FFA (and Greeneace) has proposed to also close for commercial PS fishing. *Source*: (Gilman, 2012, p. 2).

The proposal comes from these oceanic areas being considered to "meet the criteria for the identification of ecologically or biologically significant open-ocean and deep-sea marine areas in need of protection, developed by the Convention on Biological Diversity" (Greenpeace, 2009, p. 5). The human impacts from fishing pressure in this area has not been the only source of concern and from which establishing MPAs has been emphasized; by-catch is also a main concern, particularly for the oceanic whitetip shark *Carcharihinus longimanus* and several species of sea turtle. Also, the general changes to the oceanic ecosystem deriving from the anthropogenically imposed climate change, are a source of concern as it may include shifts in the distribution and abundance of prey and predator species, including the commercially important tuna species (Greenpeace, 2009). Greenpeace stated to Atuna, a tuna fisheries news agency, in 2009[38] that:

> Pacific Island Countries have agreed to support the closure of four large areas of international waters that lie in between the Pacific Island Countries. These areas act as a loophole for pirate fishing and are also rich in biodiversity. These areas are especially vulnerable to plundering by large longline fleets originating from Taiwan, Korea and Japan, and evidence that they contribute to regional pirate fishing activities keeps piling up. Urgent action to halt overfishing and stop the decline of Pacific bigeye and yellowfin tuna is needed (Lagi Toribau of Greenpeace Australia Pacific, 2009).

The closure of the two biggest high seas pockets can be regarded as a conservation-wise success in terms of allowing time for the marine ecosystem to 'recover' from fishing practices, however, the fishing effort still *increased* during the time of the closure in the adjacent areas of the pockets. For restrictions to contribute to meeting stock management objectives for highly migratory fish stocks, Gilman (2012) emphasizes that it should be:

> Combined with other management tools to maintain fishing mortality within biological limit reference points. Consideration of the complex allocation consequences between distant water and coastal States, and between gear types, of maintaining, expanding, or eliminating the high seas closed areas and other control measures on fishing for WCPO tropical tuna is warranted in considering alternative management measures to meet ecological objectives (Gilman, 2012, p. 4).

One of the informants of this research pointed to the fact that the PNA-imposed FAD bans (see section 6.3.1, Chapter 6) had some, perhaps unforeseen weaknesses:

> The FAD ban that [PNA] applies, from August [through] October, [I'm not sure] how effective [it] is. Because during the time of the ban the fish aggregates and all the DWFN boats have satellite buoys on those FADs. So as soon as the ban is lifted, they come in and they flock around it (Informant 3, April 24th, 2015).

The exact same point was made in the 'Defending Our Pacific' Greenpeace report from 2012. As the FAD bans on one hand are a great conservation measure, the loopholes described do exist and should be dealt with. Fishing activities remain high within the EEZ during the high sea closures, and the FADs are not necessarily being removed during FAD bans. So, although the

[38] See http://www.atuna.com/NewsArchive/ViewArticle.asp?ID=7792 for full article

PS fishing remains subject to heavy restrictions through a combination of measures enacted by the WCPFC and PNA, the overall PS fishing pressure seems to currently be above sustainable levels.

7.29.6 GS 8.6 – By-catch mitigation

In the context of PS fishing methods, the main by-catch concern is the level of by-catch primarily in PS sets on FADs and other floating objects. The FADs and other floating objects or debris attract fish, including schools of tropical tuna species – although this fishing method has existed for decades, the commercial use of both anchored and free-floating FADs has became more and more commercially important since the 1990s (Dagorn & Restrepo, 2011). PS sets on anchored and drifting FADs and natural floating objects such as logs or decaying large marine animals, has generally widespread by-catch rates. About half of the tropical tuna catches are from FAD sets, usually with high catch rates of small and juvenile tuna species as well as unmarketable species and sizes of other fish (Gilman, 2011). The FAD sets are usually highly commercially valuable, as one set usually results in a higher tonnage than in a free-swimming tuna school. The catch composition of target tuna species in FAD and free-school PS fisheries is a topic of lively debate among tuna managers, and there is a wide range of relevant statistics available.

Bycatch Footprint - Skipjack*		FADs			Free Schools		
Ocean	Catch (MT)	% of Catch	Bycatch Rate	Bycatch Total (MT)	% of Catch	Bycatch Rate	Bycatch Total (MT)
Eastern Pacific	271,000	0.63	0.024	4098	0.35	0.008	759
Western and Central Pacific	1,647,000	0.56	0.017	15679	0.3	0.003	1482
Eastern Atlantic	208,000	0.81	0.089	14995	0.06	0.028	349
Western Atlantic	33,000	0.09	0.089	264	0	0.028	0
Indian	315,000	0.31	0.036	3515	0.04	0.008	101
* 2012	2,474,000			38,551			2,691

Figure 57: By-catch footprint of skipjack in FAD sets compared with free-school sets. *Source*: (Owens, for Tri Marine Group, 2014)

As Figure 57 indicates, the by-catch rates from free schools are significantly smaller than those from free schools. This correlates with the expressions from one of the key informants from this research – informant 1 from PNA, as well as widespread other literature regarding by-catch. The number of turtles dying in PS fishing operations are relatively small, and often it is easy to release them from the net, which is the main mitigation method utilized by fishers. This was also unsolicited, stated by several of the fishers interviewed in Noro. Sharks are trickier to release from the net and can swim at the depths of the net where it is impossible for the fishers to spot them – thus, death from entanglement is a significant problem for the FAD PS fishing operations, particularly for oceanic white tip and silky sharks. Seabirds entangled in PS nets are not a problem in the PS fishery, mainly for longlining operations. Other finfish, however, is where the vast majority of the by-catch in FAD sets occur (ISSF, 2015); particularly the dolphinfish ("mahi-mahi", *Coryphaena hippurus*), and as frequently mentioned by the fishers interviewed for this research; the rainbow runner (*Elagatis bipinnulata*). Interestingly, however;

> Currently, it appears that these catches do not adversely impact the abundance of these species, which are very productive and resilient to fishing. Rather, the main problem with these by-catches is one of utilization (waste), since the majority of these are discarded at sea so that the fish holding tanks can be reserved for the more valuable tunas (ISSF, 2015, p. 92).

As ISSF indicates, the main problem globally with the by-catches of other finfish in tuna fisheries is the discarding. All discarding is strictly forbidden in all of the WCP-CA, as well as enforced through both the 100% observer coverage on-board PS vessels from the PNA and an out-spoken Tri Marine policy. Hence, all the fish caught on boats interviewed for this research, was landed, utilized or sold at local or commercial markets.

Breaking down the actual species composition of target tuna species in FAD and free school PS fisheries forms the basis for many management decisions to achieve higher sustainability in the fishery, and according to Dagorn & Restrepo (2011), the schools associated with FADs are often comprised of more than one tuna species than the free schools, which more often tends to be mono-specific. This was also unsolicitedly stated by several of the fishers interviewed in Noro. Combining the numbers for all oceans, the tuna catch composition in FAD sets is made up of 75% skipjack, 16% yellowfin and 9% bigeye, see Figure 58.

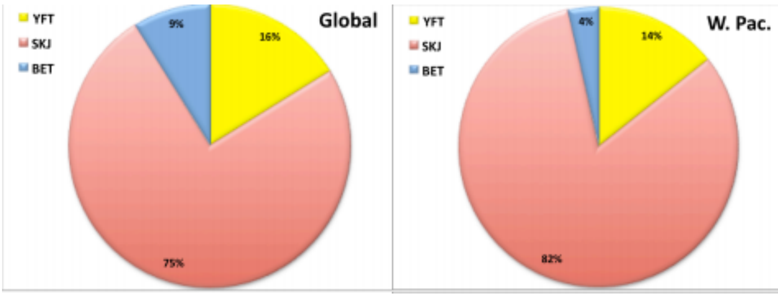


Figure 58: Composition of tropical tuna species in FAD sets, globally and in the WCPO. Data derived from tuna RFMOs for the period 2000-2009. *Source*: (Dagorn & Restrepo, 2011, p. 4). Abbreviations: YFT = yellowfin tuna, SKJ = skipjack tuna, BET = bigeye tuna.

For free school sets, the numbers are quite different; for all oceans combined are 63% skipjack, 35% yellowfin and 2% bigeye, see Figure 59.

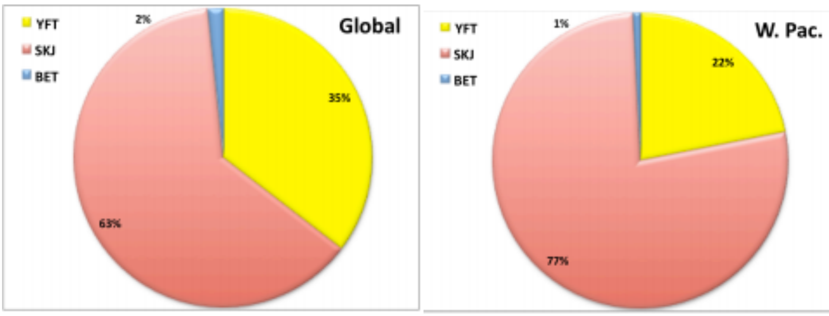


Figure 59: Composition of tropical tuna species in free-school sets, globally and in the WCPO. *Source*: (Dagorn & Restrepo, 2011, p. 5).

Generally, the catch composition does not only occur according to gear type. Factors such as the ocean region that is fished in, as well as oceanographic conditions such as ENSO years, will always make the catch composition variable. FADs account for 23-46% of the catches of skipjack, yellowfin and bigeye combined, whereas freeschool sets accounts for 24% and 39% from a variety of other gear types (Dagorn & Restrepo, 2011). As the by-catch rates tend to be larger in the FAD sets, it is estimated that they account for 3 to 4 times the amount of by-catch than free-swimming school sets. In the WCPO, however, this number is bigger: up to 6.6 times higher – the accuracy of the data does however depend on the coverage and scrutiny levels of the observers programmes in each ocean, so deviating numbers surely exist to a large extent as many high sea fisheries do not have 100% neutral observer coverage. In the Indian and Atlantic Ocean, for example, the observer coverage is less than 10% (2011).

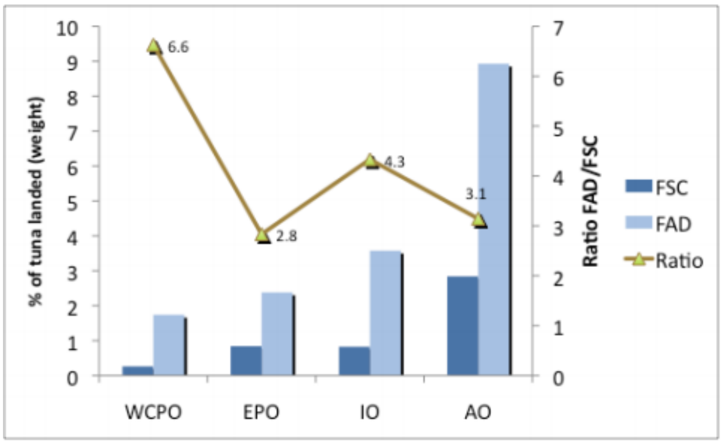


Figure 60: Amount of non-target species by-catch as a percentage of the landings of target species (tropical tunas), with information on the ratio of by-catch between FAD and free-school sets, for Atlantic using EU observers data 2003-2007, and using IATTC (2000-2009) and WCPFC (2005-2010) for Eastern and Western Pacific, respectively. *Source*: (Dagorn & Restrepo, 2011, p. 8). Abbreviations: EPO = Eastern Pacific Ocean, IO = Indian Ocean, AO = Atlantic Ocean.

Figure 60 shows how divergent the percentage of by-catch is according to ocean, and clearly indicating how higher observer coverage should be a priority, particularly for fisheries managers operating in the Indian and Atlantic Ocean.

The species composition amongst the by-catch is another interesting feature of the by-catch issue, and is also highly different according to ocean and gear type. For the FAD fisheries in the four main ocean areas, the picture is as illustrated in Figure 61:

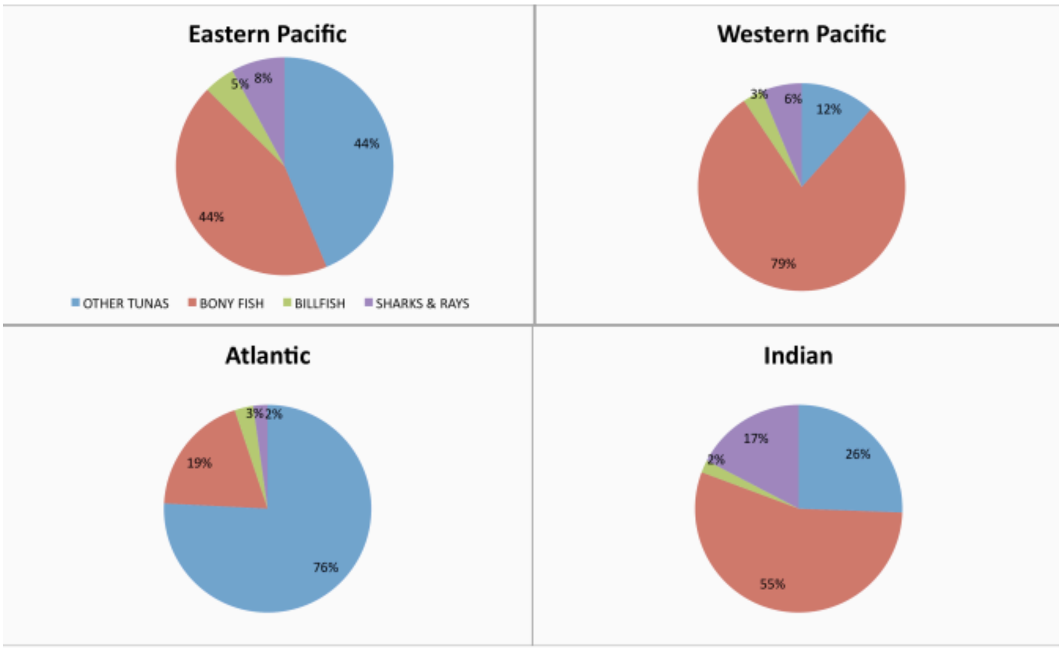


Figure 61: Composition of non-target species by-catch in FAD fisheries, by Ocean region, for Atlantic using EU observers data 2003-2007, and using IATTC (2000-2009) and WCPFC (2005-2010) for Eastern and Western Pacific, respectively. *Source*: (Dagorn & Restrepo, 2011, p. 9).

As Figure 61 illustrates, the main by-catch species composition in FAD sets in the WCPO consists of other bony fish, and is the opposite of the composition in the Atlantic Ocean. Sharks and rays are less common than in the Indian Ocean, and the Eastern Pacific has a bigger challenge with catching other species of tuna as by-catch. This is in accordance with the impression given by the interviewed fishers from this research.

As full retention of all fish caught is a strict rule in the PNA and WCPFC areas, unless the fish is unfit for human consumption, it creates a more comprehensive and rightful picture of catch composition, as well as the ethical side of it; utilizing all that is caught for something. Measuring how many of the released species that actually survive is a challenging issue. Several RFMO measures require the release of sea turtles and most sharks, but knowing which portion of these survive is largely unknown. "The ISSF by-catch mitigation research program includes deploying pop-up archival tags to estimate post-release survival" (Dagorn & Restrepo, 2011, p. 10).

Juvenile tuna are also an important part of the by-catch levels, and are generally an issue of concern in the PS tuna fishery. Innovative solutions such as using nets with differentiated mesh sizes, with biggest mesh allowing the smallest fish to swim away before hauling in, is one of them – and a method practiced by all the NFD PS vessels interviewed for this research, which according to the fishers interviewed, significantly decreased the numbers of landed, undersized tuna.

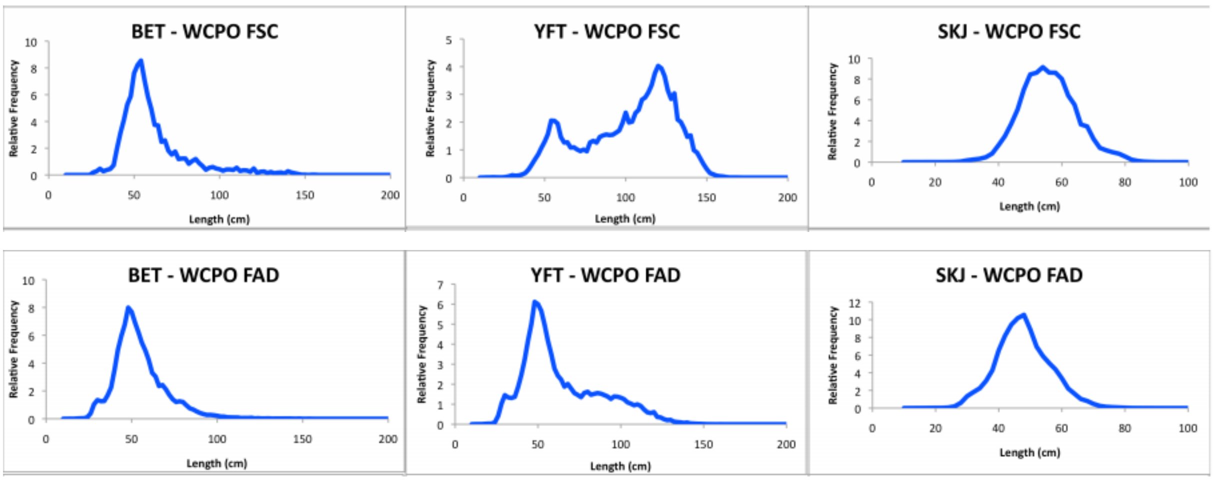


Figure 62: Size composition, in numbers, of bigeye (BET), yellowfin (YFT) and skipjack (SKJ) caught in FAD sets in the WCPO. Data from the SPC. *Source*: (Dagorn & Restrepo, 2011, p. 12-13).

As Figure 62 illustrates, the vast majority of the catch is within the maturity sizes of the fish; therein within the sustainable catch ratio – ensuring that the individual fish are able to spawn and reproduce at least once before being caught in the net. Interestingly, however, a quite significant number of undersized yellowfin tuna is caught in both the FAD and free-school sets targeted by PS vessels in the WCPO. For the skipjack, the trend of little catch of undersized individuals is prevailing in both free-school and FADs, however, the favourable fishing method in this regard is the free-school, as most of the catch is within the targeted, sustainable size scale.

When it comes to the PNL fishing method, the by-catch rates are practically not an issue, which was further confirmed by the interviewed PNL fishers. As by-catch is usually occurring in all fisheries, it certainly occurs on PNL vessels too, however, the gear type is so selective due to the fact that a fisher can physically see what he wants to haul in from the boat, making the method highly favourable in terms of avoidance of by-catch. The rates of discards (thus, consequently; the by-catch levels) of different fisheries globally are illustrated in Figure 63.

Fishery	Landings	Discards[1]	Weighted average discard rate (%)	Range of discard rates (%)
Shrimp trawl	1 126 267	1 865 064	62.3	0-96
Demersal finfish trawl	16 050 978	1 704 107	9.6	0.5-83
Tuna and HMS longline	1 403 591	560 481	28.5	0-40
Midwater (pelagic) trawl	4 133 203	147 126	3.4	0-56
Tuna purse seine	2 673 378	144 152	5.1	0.4-10
Multigear and multispecies	6 023 146	85 436	1.4	n.a.
Mobile trap/pot	240 551	72 472	23.2	0-61
Dredge	165 660	65 373	28.3	9-60
Small pelagics purse seine	3 882 885	48 852	1.2	0-27
Demersal longline	581 560	47 257	7.5	0.5-57
Gillnet (surface/bottom/trammel)[2]	3 350 299	29 004	0.5	0-66
Handline	155 211	3 149	2.0	0-7
Tuna pole and line	818 505	3 121	0.4	0-1
Hand collection	1 134 432	1 671	0.1	0-1
Squid jig	960 432	1 601	0.1	0-1

Figure 63: Discards according to fishing method in the world's fisheries. *Source*: (Dagorn & Restrepo, 2011, p. 11).

Finally, the composition of undersized tuna is highly differentiated according to fishing methods. As shown in Figure 63, the by-catch levels in the PNL fisheries are extremely low. According to Gilman (2011), increased PS catches of certain moderately exploited tuna stocks might have been sustainable, had they been restricted to the unassociated (free-swimming) schools of tuna, as well as increased use of longline and PNL catches of moderately exploited tuna stocks, such as the albacore fishery. When by-catch does occasionally occur within the PNL fishery, it is mainly other bony fish such as kawakawa tuna (*Euthynnus affinis*), frigate mackerel (*Auxis rochei*) as well as the previously mentioned mahimahi and rainbow runner (Gilman, 2011). Figure 64 shows some significant differences within the percentages of undersized tunas in different fishing methods. Only 5% of the skipjack catch in the PNL fishery in the WCPO against 14% in the PS is undersized, for yellowfin the numbers are N/A for PNL and 88% for the PS fishery. It is therefore in accordance with the somewhat worried notion from the WCPFC annual meetings in 2014, already stated in the introduction section of this research, where official stock assessments of the tuna species were presented: "(...) The WCPFC could consider measures to reduce fishing mortality from fisheries that take juveniles (...) WCPFC could consider a spatial management approach in reducing fishing mortality for yellowfin" (Harley et al, 2015, p. 4). From the numbers presented in the following table, it seems such a spatial management plan for avoidance of catch of undersized yellowfin tuna should be considered for the WCPO area.

BET	(percent in numbers below 100 cm)			
	PS FAD	PS FSC	Pole&Line	Longline
EPO	93	85	100	N/A
WPO	99	93	N/A	21
ATL	99	95	95	14
IO	99	57	100	6
SKJ	(percent in numbers below 40 cm)			
EPO	19	7	24	N/A
WPO	14	2	5	N/A
ATL	14	6	6	6
IO	7	1	11	11
YFT	(percent in numbers below 100 cm)			
EPO	96	92	97	N/A
WPO	88	40	N/A	16
ATL	96	52	98	26
IO	94	23	98	5

BET	(percent in weight* below 100 cm)			
	PS FAD	PS FSC	Pole&Line	Longline
EPO	65	48	100	N/A
WPO	89	65	N/A	8
ATL	90	51	69	4
IO	89	12	100	2
SKJ	(percent in weight* below 40 cm)			
EPO	8	3	11	N/A
WPO	5	1	2	N/A
ATL	7	3	3	1
IO	3	0	3	2
YFT	(percent in weight* below 100 cm)			
EPO	69	66	84	N/A
WPO	56	13	N/A	7
ATL	61	5	80	7
IO	62	5	84	2

Figure 64: Percentage of the catch of bigeye, skipjack and yellowfin composed of fish below 100 cm, 40 cm and 100 cm (approximate sizes at maturity for the three species, respectively) in different fisheries. Top table is in numbers; bottom table is in weight. Data are from IATTC (EPO), SPC (WCPO), ICCAT (ATL) and IOTC (IO); years are 2000-2009, except for ICCAT (2000-2005) and IO Pole and Line (1995-1997, the only available data). Source: (Dagorn & Restrepo, 2011, p. 14).

Figure 64 shows quite dramatic numbers – the by-catch rate in FAD fishing is drastically higher than those estimated for the free-schooling technique. According to the informant from PNA, this fishing method was what he considered to be most sustainable altogether – even more than the PNL method, due to the latter's extensive usage of baitfish. The baitfish issue is debated in section 6.1.9, Chapter 6.

Local landing of longline catch in the field work site in SI was believed to provide opportunity to improve integrity of catch data and as such mitigate by-catch rates; NFD is seeking to provide ancillary services to longline vessels (bunkering, supplies etc) as a way of attracting vessels to land and unload all their catch at Noro.

> Given the current low levels of observer coverage (< 5 percent), under-reporting of catch and by-catch is believed to be widespread across longline fleets. Increasing the landing of longline catch in country will enable improved catch estimates and assessment of impacts. It also potentially provides greater leverage for improvements in practices such as by-catch mitigation through gear modification and improved handling and release (IFC, 2013, p. 3).

7.30 Users (U)

The first-level core subsystem GS can be defined as the "characteristics of the individual or corporate users of the common-pool resource" (Basurto, Gelcich & Ostrom, 2013, p. 1378). For this research, the U sector will thus include the characteristics of the fishers, the consumers and the managers of the tuna fishery – again with a particular emphasis on the PNL and PS method, as well as yellowfin and skipjack tuna.

7.31 U1 – Number of [relevant] users

U1 can be defined as the "number of actors affecting decision-making processes related to harvesting in the fishery" (Basurto, Gelcich & Ostrom, 2013, p. 1378). This number is currently not known in exact figures, however, it is *large*. It would include for instance the relevant staff and representatives within FFA, WCPFC, SPC, PNA, UN's FAO, a wide range of NGOs such as the regional offices of Greenpeace and WWF, as well as for instance Locally-Managed Marine Area Network (LMMA), the International Pole & Line Foundation (IPNLF) or the ISSF. These mentioned actors come on top of the government authorities that manage the fish stocks in each respective country that either has their own national tuna fishery, or draws benefits from one as a DWFN. The latter often affects decision-making processes related to the management of tuna species. On top of this comes the thousands of artisanal and industrial fishers involved in tuna fisheries in the WCPO, which, although often limited, has variable degrees of influence on the management of the fisheries. The breadth and sheer scale of this research is reflected in just that; the high numbers of relevant users and their consecutive views and opinions, which therefore make the tuna fisheries in the WCPO such a comprehensive and complex matter.

7.31.1 U 1.1 – The role of DWFN actors

Access fees, transhipping fees, export duties and taxes or port fees from DWFN to fish in PICTs EEZs are no doubt a huge contributor to economic growth in the region. According to Bell, Johnson & Hobday (2011), access fees are currently contributing approximately USD 80 million to the region annually. For nations like FSM, Nauru, Tuvalu and Kiribati those fees provide between 10-40% of annual governmental revenue. Vessels from DWFN by far dominate the tuna fisheries in the WCPO (approximately 75% of the PS catch according to Barclay & Cartwright, 2010, p. 6), although an increase in domestic based fleets has occurred in recent years. So although the presence of DWFN actors is positive in regards to governmental income, their role has historically been problematic; repeated attempts of fishing exploitation with little benefit for the PICTs, evasion and lobbying for proposed restrictive fisheries policies, or lobbying bilaterally for advantageous fishing access deals are examples of the long and dual role DWFN has played in the region. Although agencies like FFA has provided policy advice and technical support to assist their PICT members and manage fishing efforts from DWFNs, the fact remains that the biggest sustainability issues deriving from the tuna fishery in the region are due to excess fishing from DWFN actors failure to comply with regulations, as well as cases of direct violations of fishing rules, vessel retentions and fines. As compliance to fishery policies in the high seas is particularly poor, the possibility of DWFNs to take advantage has historically been high. According to Gillett & Cartwright (2010), "DWFNs continue to dictate terms and continue in expanding 'divide and conquer' tactics. (...) Failure of PICTs to adequately present a united front with respect to licence fees allows DWFNs solidarity and forces access fees down" (p. 23).

Changes in property rights have been a source of many disagreements. Viewing tuna rights as property rights has often been attempted to be as undermined as possible from DWFN negotiatiors towards PICTs representatives. Not until the VDS arose, were the property rights over tuna more or less respected by certain DWFN actors (Asian Development Bank, 2005, Barclay & Cartwright, 2007a). Several cases of DWFN vessels being retained or claims of law violations has occurred in the past three decades; such as the South Korean fishing company *Dongwon*[39], the Spanish *Albacora* fleet[40], or the fact that the WCPFC received 55 reports from FFA members notifying them about allegations of illegal activity - where 13 of those detected had committed serious violations[41]. Taking the role of DWFNs into consideration when implementing fishery management schemes is therefore particularly important in the WCPO. The huge economic disparity between DWFNs towards individual PICTs are huge. Regional bodies such as PNA and FFA should be further strengthened to ensure improvements in

[39] See http://www.cookislandsnews.com/item/54264-korean-fishing-venture-in-hot-water/54264-korean-fishing-venture-in-hot-water for more information.
[40] See https://www.greenpeace.org.au/blog/real-pirates-plunder-and-steal/ for more information
[41] See https://www.wcpfc.int/system/files/WCPFC-TCC10-2014-OP03%20WWF%20Emerging%20technologies%20initial%20cost%20benefit%20analysis%20study.pdf or http://pacific.scoop.co.nz/2010/11/operation-kurukuru-clamps-down-on-illegal-fishing/ for more information

policies are based on benefits for PICT development, sustainable resource harvest practices, and such that the negotiations are done from equitable basis with DWFNs (Asian Development Bank, 2005). Ensuring future prosperity from DWFN access fees implies that PICTs' strategies revolve around negotiating with DWFNs to pay as much as they can for access, negotiating with DWFN governments to supply industry payments with aid packages, or attract DWFNs to tranship, take on supplies and undertake repairs in Pacific Island ports. As poor tuna sustainability management may lead to falling CPUE and revenue streams, good governance will ultimately improve the profitability of the tuna fishery, which again may increase the capacity and willingness of DWFNs to pay more for fishing opportunities (Barclay & Cartwright, 2007a). Consideration of alternative models derived from the revenue from access fees could be a rights-based management scheme, based on fishing rights.

> (…) It is a basic economic principle that by restricting rights their value increases. To introduce rights-based management of fisheries means establishing rights and empowering the individuals and locally registered companies holding the rights, who are in turn obligated to pay fees and are expected to meet certain standards in terms of investment, job creation and so forth. (…) Through this approach the role of distant water access agreements is reduced or eliminated because vessels from outside the region are allowed to operate only under charter to or in joint ventures with domestic rights holders. PNG has been successful in pursuing a strong domestication policy by providing preferential access to fishing opportunities to those companies prepared to make onshore investment, particularly in the area of processing. Having one of the most productive EEZs in the region has strengthened PNG's capacity to implement these policies (Barclay & Cartwright, 2007a, p. 36).

The role of rights-based approaches to fully or partially replace access agreements is an interesting contribution to the ability of PICTs to capture more wealth from their tuna through DWFNs. It seems that the biggest contributor to unsustainable fishing practices in the region derives from DWFN's activities, and less so from the domestic fleets of the PICTs. Therefore more research and knowledge of rights-based management and other tools to enhance PICTs' control over tuna resources is welcomed as a contribution to the other current positive trends in the Pacific regionalism, through for instance the VDS.

7.32 U2 – Socioeconomic attributes of users

U2 can be defined as the "characteristics of actors related to social and economic dimensions affecting fishing dynamics" (Basurto, Gelcich & Ostrom, 2013, p. 1378).

7.32.1 U 2.1 – Food supply in SI and PICTs

Without any doubt, the access to fishing is essential to the food security of the PICTs. However, particularly in Melanesia, the dependence on fisheries is not as strong as before. In PNG especially, the dependence has shifted towards forestry, agriculture and mining. And for other island nations, tourism has taken over as the main source of income. Apart from the exceptions, however, the dependency on fisheries remains strong – and is a vital part of the livelihoods and food security for residents of the region. The average annual consumption of fish (including shellfish) in coastal communities in the region ranges from 30-118 kg per person in Melanesia, 62-115 kg in Micronesia and 50-146 kg in Polynesia (Bell, Johnson & Hobday, 2011). The global average is 16-18 kg per person annually, so even including urban areas of PICTs, the consumption of seafood is particularly high. With approximately 48% of total tuna catch being targeted within the EEZs of PICTs, and with most of the fish caught for food being from subsistence fishing in coastal waters around coral reefs, adequate means of conservation is needed in order to maintain healthy food security levels (2011).

The capacity of coastal fisheries to supply enough fish to maintain this food security has been a rising concern in recent years. The region's rapidly growing population will demand an approximate 47% increase in fish catch to continue to provide a nutritious baseline for the estimated population in 2030. According to analysis done, the 2030 coastal fisheries will only supply nutritional demand to a minority of the 22 PICTs, due to overexploitation and failure of coral reef production rates which are down due to climate change and destructive fishing practices. The estimated forecasts of future needed fish in rural and urban areas are illustrated in Figure 65.

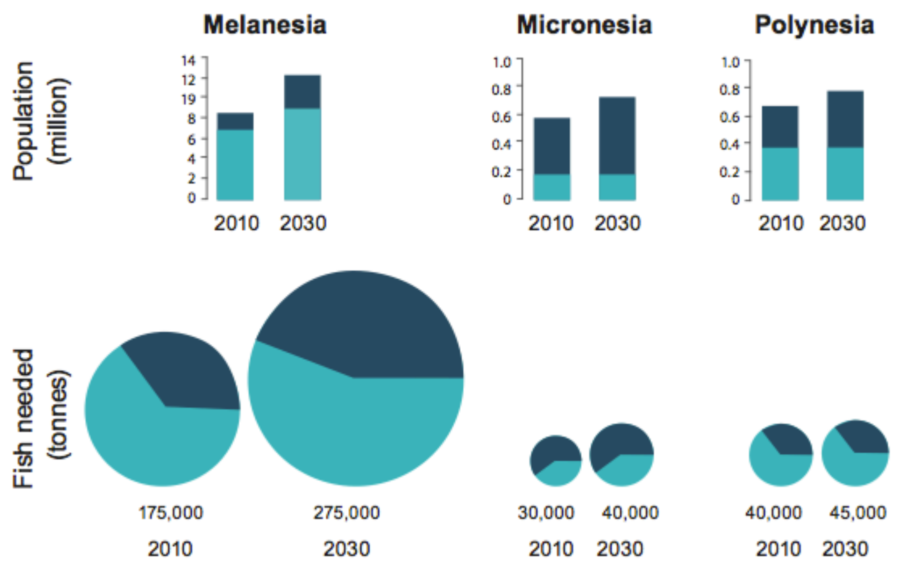


Figure 65: Forecasts of population growth, and the fish needed for food security in rural (light blue) and urban (dark blue) areas of Melanesia, Micronesia and Polynesia in 2030. *Source*: (Bell, Johnson & Hobday, 2011, p. 18).

As Figure 65 shows, the fish needed to supply future generations will increase rapidly, particularly within the most densely populated Melanesia. The productivity of respective sites are highly variable, and improving the fisheries management, particularly of coastal fisheries, will be vital to meet food security demands for the future in a reality where fishing pressure from DWFN keeps on increasing. This may be done through allocating a small fraction of the industrially caught tuna, and as such:

> Would go a long way to filling the emerging gap between the amount of fish required for food security and the fish available from coastal fisheries, (...) and then distribute this proportion of the tuna resources among coastal communities and the urban poor (Bell, Johnson & Hobday, 2011, p. 18).

Furthermore, extending the small portion of aquacultures in the region could prove highly valuable to improve food security. Yield from tilapia small ponds in Fiji has for instance proved highly productive, with production of up to 500 kg of fish every 4-5 months (2011). The successful structure of aquaculture would depend, however, on the sustainable use of feeds, reducing possible influences on freshwater biodiversity, as well as the training of fishpond farmers.

Maximizing the sustainable benefits of the region's fisheries is therefore vital to keep its inhabitants healthy and supplied with food. The cooperative regional management arrangements posed through SPC, FFA and PNA are therefore vital to keep strengthening the investment in regional cooperation and the control over their own resources.

7.32.2 U 2.2 – Community livelihoods

The term 'livelihoods' are loosely defined through describing any activities that jointly determine the living gained by individuals, households, or small communities, to make income. An immense number of individuals in the PICTs are involved in fisheries through part- or full-time employment, and hence directly and indirectly are involved in the chain, supplying fish and aquaculture commodities to local and export markets. These include over 12,000 people employed in canneries or other tuna processing operations in American Samoa, Fiji, Marshall Islands, PNG and SI, as well as crewing on foreign and local boats along with employment in ports or other transhipping operations. Shrimp farming, aquaculture or culture of black pearls in French Polynesia and Cook Islands are other existing livelihood opportunities. An economic survey done by SPC's Coastal Fisheries Program showed that 47% of coastal households, across 17 PICTs, earned their first or second income from selling fish or shellfish that they caught – which would include selling surplus subsistence catch to local markets or urban centers, exporting high-value marine invertebrates or tropical fish, as well as industrial-scale supply of wild- or high seas-caught fish to the global market (Bell, Johnson & Hobday, 2011).

Although the governments of PICTs are proposing increased investment in fisheries and aquaculture as a means to provide livelihood opportunities in the future, the challenges are many; the tuna processing plants face competition from less costly operations in Asia, many local sites in the coastal fisheries are both limited and/or already facing overfishing, as well as the small economies and the remoteness of PICTs limiting the potential of developing big-scale, economically competitive aquaculture or fisheries operations (Bell, Johnson & Hobday, 2011).

7.33 U3 – History of use

The history of use is defined as the way the different fisheries investigated in this research has developed over the years, and how those past interactions and developments may have affected the current fisheries dynamics.

7.33.1 U 3.1 – PNL fishery

See section 3.5 in Chapter 3 for description.

7.33.2 U 3.2 – PS fishery

See section 3.6 in Chapter 3 for description.

7.34 U4 – Location

U4 is defined as the "physical place where the users are in relation to the resource itself and the market" (Basurto, Gelcich & Ostrom, 2013, p. 1378). Those locations relevant for this research were defined in RS2 and RS 2.1.

7.35 U5 – Leadership/entrepreneurship

U5 is defined as "actors who have skills useful to organize collective action and are followed by their peers" (Basurto, Gelcich & Ostrom, 2013, p. 1378). Such actors are believed to be particularly present through the recent positive developments originating from the strengthened regionalism work in FFA, PNA or SPC, as well as positive developments within commercial fisheries companies like NFD.

7.35.1 U 5.1 – FFA, PNA and the role of Regionalism

The positive role that regional organizations like the PNA plays for PICT's prosperity, has already been discussed in GS3, as well as in the background (Chapter 6), where as descriptions of the organizations were described in section 6.3.

Several PICT scholars agree that the way PNA has established new measures affecting tuna fishery dynamics, has in fact changed the very way the 'game' in tuna fisheries is played. Maintaining the solidarity that has characterized the organization will need further efforts. The ideals that shaped the establishment of the organization have changed, as some of the members have become flag states, while others prefers bilateral access agreements. Tamate (2014) proposes that establishing a compensation mechanism should be considered to maintain the positive regionalism momentum that is currently prevailing. Under such a mechanism, "any state that is adversely impacted as result of implementing PNA established measures/instruments is compensated by the group for any loss or burden experienced" (2014, p. 2). Enforcing such a mechanism could help ensure that PNA measures be maintained, and their control continued to keep up with their anticipated effectiveness.

According to a report published by Asian Development Bank in 2005, poor governance in PNG, Fiji, SI and Nauru has resulted in nearly 75 billion USD in forgone income since independence. Considering sustainable development objectives, prioritizing improved governance policies as well as increased amounts of decisions taken on the regional level could help maintain the Pacific Regionalism momentum. Such measures are believed to be strengthened by working against the problems derived from the PICT's smallness; reinforcing their so-called *effective sovereignty* by increased access to markets, a collective endeavor consisting of groupings that are self-sustained, and together forming a large enough pool of net benefits for each of its members. The success rate of regionalism is thus determined by the benefits of the organization exceeding its costs. As the distances in the Pacific are so immense, the distance costs of transactions - the diseconomies of isolation – will only be considered advantageous by the actors if large-scale benefits are presented as a reward for the high costs of shipping goods, services, information and people. Furthermore, overcoming the "speed bumps" on the road to intergovernmental cooperation requires strong economic momentum to avoid favoring marginalistic, incremental approaches (Asian Development Bank, 2005). There are more examples of regionalism in the Pacific as well as that seen in the fisheries sector – for instance the PICTs regional University of the South Pacific (USP) in Suva, Fiji. Providing a regional provision of services, it has higher level education at lower costs than had a university been established in each PICT, although placing the regional university in one spot requires a lot of moving of students across the region. Another example is from the regional market integration - the free-trade agreement Pacific Island Countries Trade Agreement (PICTA), providing a larger market for Pacific firms.

The continued success of Pacific regionalism depends on, amongst many other matters, directing scarce donor funds into greater regional cooperation so that the net benefit is a huge one for all actors combined. The 2005 Asia Development Bank lists four good governance-points as a guiding tool to continue this trend, namely; a *regional economic and statistical* *technical assistance facility*, for areas like macroeconomics, tax policy and administration, financial sector supervision, microeconomics, and statistics; a *regional capacity* to assist customs officials in collecting revenue; a *regional ombudsman*, with power to assess the merits of citizens' complaints about administrative acts and decisions of government agencies, and finally; a regional panel of auditors, strengthening auditing capacities in national and regional agencies (Asian Development Bank, 2005, p. 20-21). Furthermore, the report supports the establishments of beneficial concepts like a regional sports institute, a regional statistical office and a regional body to protect intellectual property rights.

At the end of the day, it is only Pacific Island governments that can make regional tuna fisheries, just like any other businesses, economically and ecologically sustainable through strengthening their own jurisdictions and governance, and doing so through the existing or new regional cooperative initiatives. This should be done at the initiative of the nations themselves, with the help of local businesses and local industry stakeholders, not through foreign aid or donors. Agencies such as the FFA or SPC will be able to provide ample advice as well as exert influence on the individual governments, however, the governments themselves will play a key role in agreeing to effective fisheries management, which enables them to capture more wealth from tuna (Barclay & Cartwright, 2007a). Strengthening domestic industries, such as NFD in SI, alongside maximizing profits while gaining control over the increasing pressure from DWFN, will continue to prevail as a means to achieve this.

The interest for strengthening collective action to increase benefits for the Pacific region while ensuring sustainability has been high on the agenda the past ten years. During the 5th Conference of the Pacific Community in 2007, the members called upon strategic approaches to fisheries in the region. The science and management activities to optimize outcomes in the future that are under development are summed up in the following Figure:

Regional strategy/Management measure	Responsible agency
Science	
Regular scientific assessments of the status of tuna stocks and their supporting ecosystem[99], and occasional scientific assessments of non-tuna fisheries	SPC
Tuna tagging programme[99]	SPC
Management plans and action	
Regional Tuna Fisheries Management and Development Strategy – a regional agreement on a set of shared principles for the management and development of tuna fisheries by FFA member countries[100]	FFA
Implementation of effort quotas, and other subregionally agreed management measures for tuna, by Parties to the Nauru Agreement (PNA) on vessels fishing within their EEZs[101], and the Te Vaka Moana Arrangement (TVMA) for limits on longline fishing in the EEZs of Polynesian countries	PNA, TVMA
National tuna fishery development plans, incorporating regionally agreed standards, domestication of fisheries operating in their zones, and mechanisms to implement ecosystem approaches to fisheries[102]	FFA
Definition of a Western Tropical Pacific Insular Area (WTPIA) that could form part of the emerging South Pacific Regional Fisheries Management Convention area	FFA
The Apia Policy – regional agreement on best-practice strategies to improve the management of coastal fisheries[103]	SPC
Aquaculture Action Plan[27]	SPC
Monitoring	
Monitoring, Control, Surveillance (MCS) strategy for the tuna fishery[104]	FFA
Regional, subregional and national observer programme for industrial tuna fisheries[105]	FFA/SPC, WCPFC

Figure 66: The science management and monitoring that is currently underway in the tropical Pacific region to help optimize benefits from fisheries resources. *Source*: (Bell, Johnson and Hobday, 2011, p. 23).

All in all, the impression given is that if the highly promising regionalism development continues with maintained momentum, policies and governance will be strengthened alongside ecological and sustainability-wise sound consideration.

7.35.2 U 5.2 – Tri Marine and NFD

See section 6.3.3 in Chapter 6 for description.

7.36 U6 – Norms and 'social capital'

U6 can be defined as the "degree by which one or several individuals can draw upon or rely on others for support or assistance in times of need" (Basurto, Gelcich & Ostrom, 2013, p. 1378).

7.36.1 U 6.1 – Perceptions from informants

The general sense of trust in the informants was regarded satisfactory, however, no questions assessing trust or sense of support and assistance were included in the interview guide, so no conclusion is possible to draw. A couple of informants pointed to the fact that when forwarding concerns of distressing rule violations to the authorities, such as vessels operating in a suspected IUU manner, the impression given was that there was little or no investigation outcome. One of the informants claimed that this was due to weak policies, corruption and briberies from the vessels in question that were given preferential treatment.

If this claim were to be a fact, which is not investigated in this research, it would suggest that the resource regimes are constructed in a shortcoming manner, which as again could mean the regime is prone to political and economic actors able to influence the outcome – meaning, the fish catches. If such weaknesses are true, then strengthening the political institutions that shapes the resource regimes is an appropriate action to aspire to in the fisheries management in question.

Both secondary literature and the impressions from the field work points to the fact that economic actors, particularly those from DWFN, are acting in a manner designed to influence outcomes and resource regimes to their own advantage, or locating weak clauses in existing regimes to maintain a maximizing outcome. The role of ever-improved technology complicates the issue further, and requires current and future managers to create robust, enforcing resource regimes to control the actors wanting to avoid control and restrictions policies.

7.37 U7 – Technology used

U7 refers to the usage of technology in the fishery and how it influences the outcome of the fishing regime. The technology has been described in section 3.7, 3.8 and 3.9 in Chapter 3.

7.37.1 U 7.1 – The 'technology creep'

Technology has played a defining role in the development of all fisheries, and is largely to hold responsible for making the tremendous increases in global catches over the past few decades, possible. In order to sustainably manage fisheries resources, understanding the implications of ‘the technology creep’ is essential. A ‘technology creep’ can be defined as the gradual increase in the efficiency of fishing gears and methods. A fisheries management objective based on controlling fishing effort, rather than catches, will be adversely affected by a creep in technology (Petaia, 2015). Thus, taking the levels of technology into account when framing a resource regime is crucial, as the motivation for actors to adopt new technology is increased catch. Excess capacity like this is often delayed by implementing the correct control measures. Fishers, or the users of the resource, can be expected to engage in fishing activities in the following manner: requiring incentives such as the need for money or food, responding to the size of the incentives by expanding their fishing activities, involving ever more efficient tactics over time by processes of individual learning and competition among themselves, and finally, should the fishery diminish or collapse – responding to declining opportunities by switching to other fisheries and activities.

However, the response to any regulatory measure will often be to seek ways of minimizing the impacts of the regulations, while remaining successful, by adopting new technologies (Petaia, 2015). Understanding the logic behind this reasoning is essential to determine the effects that technology has on the pattern interactions and outcomes in a fishery. The tuna fishery in the WCPO is no exception. The technologies used can be through designing the vessel differently, through handling the gear differently, using synthetic and stronger materials, improving capture techniques, improving communication and navigation systems, improving the preservation of the catch as well as improving the knowledge of how the fish moves and behaves. The rationale behind managing a fishery, keeping the technology creep in mind, is essentially to avoid a fishing overcapacity situation.

> Although discussions on capacity are common, a globally used method of measuring capacity does not exist. The most usual measures of capacity are the number of people fishing, number of vessels in a fleet or the GT of that fleet, but this does not adequately measure the fishing power, nor does it account for that fact that as technology increases, so does the ability and efficiency to catch fish. (...) That increase, the technology creep, may increase effective fishing power by 2-5% per year. This means that even if the number of vessels GR remain the same, vessels can become more efficient and catch more fish year on year (MRAG, 2010, p. 18).

To correctly understand the implications of the technology creep on, for example, the MSY, a definition of what the fishing effort implies is necessary. Units of fishing effort can be numbers of meters of gillnets used per hour, numbers of hooks per hour in a hook and line fishery, hours of trawling in a trawl fishery, or number of boats per day in for instance a PS fishery. Then, when estimates of the total catch combined with the total fishing efforts are known, the

CPUE can be calculated. Calculating a correct CPUE is therefore essential in any fishery that strives to operate on sustainable grounds. The consequences of overcapacity through technology creeps may be devastating, due to the capacity exceeding the available resources. Measures that controls capacity should be addressed to a larger extent in the WCPO, and this is especially appearing to be the main weakness in the VDS. Rights-based management through transferable quotas, quota pooling or market demand innovations through schemes like MSC, are examples of capacity controls that worked in the Canadian herring roe fishery, the cod fishery in Iceland or the Pacific halibut fishery in Alaska (MRAG, 2010). The role of technology can be over-arching, as it affects the actors within a fishery, the interactions between them, as well as determining the outcome. This is especially the case if the actors are able to directly adapt their behavior within the fishery scheme without breaking rules, but still increasing catch – determining the outcome – through improving technology. That is, if the outcome is dwindling fish stock sizes.

8.0 Chapter 8: Concluding remarks

The objective of this thesis was to assess the sustainability of the skipjack and yellowfin fishery in the WCPO. This was done through using a multi-facetted adapted version of Ostrom's SES framework, where the model was customised to include my own objectives. As such, a holistic understanding of the sustainability of not only the biological and ecological status of the stocks was sought, but also to assess how the political, institutional and socioeconomic factors contributed to the over-all sustainability. It was believed that framing the analysis in contemporary models within fisheries science, such as the EAFM scheme, would help towards attaining a holistic approach to assessing the sustainability levels of the fishery. A mostly qualitative case study approach was used, utilizing semi-structured interviews as the main data collection method. However, some of the data was presented in a quantitative manner and as such gave the thesis a mixed-methods character. The theoretical framework was based on the principles of sustainable development, as well as having a conceptual framework within the school of political ecology. The research question formed the overarching mandate of the thesis; *A sustainability assessment of a tuna fishery using Ostrom's Social-Ecological Systems (SES) framework: to which degree are yellowfin* (Thunnus albacares) *and skipjack* (Katsuwonus pelamis) *tuna stocks in the Western and Central Pacific Ocean being sustainably fished to ensure their healthy continuation in the future, and to which degree are current management and policy measures contributing to the improved sustainability of the stocks?* In order to answer the research question, the concluding chapter will answer each of the sub-questions presented in the introduction of the thesis.

The perceived sustainability of the fishery from the interviewed fishers drew a somewhat analogous picture. The deviations in the answers were not very large, however, the differences that did occur were interestingly often related to the two groups of fishers; the PNL fishers largely agreed with eachother, and the PS fishers were often of the same impression as other PS fishers. A large portion of the fishers, independent of being PNL or PS fishers, said that they were worried about the current level at which tuna is being exploited, and particularly, those fishers who have worked at sea for a long time claimed the sizes of the schools and the individual sizes of the fish was observed to be smaller. Furthermore, they stated that considerably more time was spent at sea searching for fish than before. Finally, an interesting finding was that the vast majority of the fishers proposed widespread and extensive regulatory fishing policies. The fishers themselves were the ones who gave the impression of supporting of much more restrictive fishing policies to ensure sustainability. In particular, the fishers both from PS and PNL vessels, proposed less fishing licences be issued to PS vessels across the region to curb the fishing pressure from DWFN. Interestingly, as one might expect fishers supported policies that enable more fishing. Several of them also suggested that seasonal closures of the fishery during times of spawning should be re-introduced. However, it should also be noted that some of the fishers perceived the current sustainability of the fishery to be of sufficient quality. It is interesting that many of the findings from the interviewed fishers somewhat added up to the picture drawed by scientists by the current fishery status. Replicating this study to a bigger selection could have increased the validity of the findings from the interviewed fishers and help draw an even more comprehensive picture of how the stock dynamics are perceived by WCPO fishers.

Secondary literature from scientific bodies such as the SPC and FAO illuminated the current catches of yellowfin and skipjack tuna is, respectively, slightly exceeding and not exceeding the present MSY levels. However, although the science of reaffirming the total biomass of the species is quite sophisticated, there are still possibilities of significant errors. The full extent of naturally occurring changes within the stock and in the biophysical marine environment are highly complex and can never be fully calculated. The changes occurring in the oceans due to climate change and marine pollution also contribute to an already complex picture. Therefore, the impression given, combined with experiences from fishery collapses in other oceans, is that the precautionary principle should be integrated even more strongly into the current scientific advice and estimations of MSY levels. As such, one can attain a higher degree of likelihood that the tuna stocks may be able to continue to replenish healthily for many decades to come. The current fishing pressure of yellowfin tuna was noted with concern as it was slightly exceeding MSY levels - particularly because the yellowfin fishery was experiencing unsustainable by-catches of juveniles, which is most probably due to the high usage of FADs in the PS fishery. The secondary literature, and claims from the PNA representative, in this research suggest that PS fishing on free schools are much less prone to catching juvenile yellowfin and other types of by-catches. It is therefore recommended that PS fishing on free school fishing should be increasingly encouraged and eventually replace FAD fishing in PS tuna management schemes in the region. The highly resilient skipjack tuna is not experiencing threats of overfishing at this stage, however, even skipjack will be prone to decreases should the fishing pressures continue to rise, as has been seen over the past few decades.

The interviewed fishers in this research, particularly the PNL fishers, claimed there had been significant changes in the fish abundance compared to previous years. Although naturally fluctuating from year to year, the over-all perceived trend was one of declining fish stocks. The secondary literature shows a tremendous increase in catches, however, it was clear that this was due to a large increase of vessels searching for fish and improved technologies. For instance, the yellowfin stock was experiencing more cases of MSY levels being severly exceeded in the EPO than in the WCPO. Furthermore, the bigeye was experiencing more severe levels of overfishing in the WCPO than in the EPO. These regional and local variations have to be taken into consideration when managing highly migratory species like tuna. As the regional tuna stocks are connected through migration, sustainability measures should be integrated across regional management schemes. Therefore, agreements on seasonal fish bans at specific sites during the vulnerable spawning seasons are supported as a means of precautionary principle. Such agreements should take developments of stocks of the same species outside the statistical area into consideration, as the status of the stocks influence each other across the borders of, for instance, WCPO and EPO.

The by-catch issue is a complex matter with tremendous amounts of available research on how it can be mitigated. The fieldwork showed how the fishers from NFD seemed devoted to avoiding occurrences of by-catch, and that the instances of by-catches had been reduced in recent years. The impression from the company was also one of having ambitious by-catch mitigation policies, with catch retentions, discard bans and 100% observer coverage on their PS vessels, as well as widespread contributions to the research community by promoting an 'open door policy' with access to their premises and vessels for research purposes. The role of technological innovations is drawing an optimistic picture for future by-catch mitigation; the development of three-layer nets in the PS has drastically decreased the catches of juvenile tuna. The development of the Medina panel reduced dolphin by-catch drastically, and the ever-increasing investments in VMS schemes and observer coverage on-board vessels in the PICT region, are all contributing to diminish the by-catch issue. Even so, the fact remains that by-catch is still a severe issue in global fisheries and still needs joint efforts to curb; particularly for the PS fishery in the WCPO, is to curb the use of FADs and in general to strengthen VMS.

Furthermore, increasing the observer coverage on longliners, which are contributing far more prominently to global by-catch rates, is crucial. The longliners are catching many more birds, sharks and vulnerable tuna species such as bigeye, compared to PS vessels. Longlining is therefore a fishing method that needs to be monitored more intensely than it is today, requiring only 5% observer coverage. The by-catch rates of PNL vessels are believed to be close to zero, and are therefore considered an exemplary fishing method in terms of avoiding by-catch. The impression given from the interviewed PNL fishers supports this assumption. However, the representative from PNA, along with a limited amount of secondary literature and some of the interviewed fishers, state that the sustainability of the consecutive bait fishery is not necessarily satisfactory at current rates. To sustain a PNL vessel, continuous supply of baitfish is necessary – and the baitfish grounds in SI and other places in the Pacific with PNL fisheries has experienced declines at certain locations. The declines are not fully surveyed and understood, but are linked to a combination of increased fishing pressures from coastal communities due to increased human populations, decreased prevalence of healthy coral reef ecosystems due to acidification of the oceans, pollution, increased sea temperatures and natural disasters such as typhoons. Polluted freshwater run-off from logging and other polluting industries on land has caused increased eutrophication and murkier waters in coastal areas where baitfish usually thrive. The increase in SI logging was by far what the interviewed PNL fishers believed to be causing the declines in baitfish. The full extent of the baitfish declines, which have huge implications for the over-all sustainability of the PNL fishery, should be of highest priority to researchers and fisheries managers if the PNL fishery will be expanded in the region.

The serious baitfish issues described in section 6.1.9, Chapter 6, are, if not mitigated, seriously harmful to the sustainability of the PNL fishing method. However, the large estimate (31,250 tons of baitfish needed) of the 2010 report described in the section is perceived as somewhat exaggerated and a much smaller estimate in shift of PS to PNL could be feasible, sustainable and manageable. If the challenges in the baitfishery, which are recognised and certainly complicated to overcome, are met, there are highly positive aspects related to an increase in the PNL fishery in the WCPO. The PNL method seems to outcompete the other fishing methods in several other sustainability factors. PNL contributes much more positively to employment rates, since crew on PNL vessels are much more extensive than on PS vessels and require less formal education, thus making PNL fishing an employment method plausible for more people without formal education to participate in. The PNL method produces tuna with higher meat quality as the time window between catch and death is much smaller than PS, which allows less lactic acid to accumulate in the tissue. The PNL method is also believed to employ higher fish welfare due to the method of minimizing the exposed period of stress to the fish, compared to the much longer time taken to haul PS nets. Furthermore, the PNL method is never able to catch a whole school of fish, unlike an effective PS vessel, as the selectivity of the hooks always leaves individuals out of the catch. As such, it leaves individuals to live for another day and thus able to replenish at a higher rate than the much more efficient PS method. The PNL method therefore catches much less tuna, and is for that reason much less likely to overfish the oceans. However, this very factor is also its obstacle for growth; it is simply not economically viable for enough actors to invest in.

The role of green consumerism in the Pacific is therefore believed to be an interesting contributor to achieving more sustainability in the fishery. However, the campaigns need to be based on up-to-date scientific advice and not superficial assumptions on perceived sustainability factors. The increased interest for PNL fished tuna is one green consumer campaign that is perceived positively, because economic stimulation for the fishing method is needed in order for stakeholders to shift their investments from PS to PNL vessels. The demand for 'dolphin safe' tuna in the 1980s created a tremendous international momentum, where consumers demanded that tuna catches were done without harmful by-catches, and showed that consumer campaigns can shift unsustainable fishing practices with the right amount of pressure. Global campaigns demanding less issuing of licences to DWFN, less frequencies of FADs, more sustainable tuna fisheries management practices or promoting PICTs right to their own fish are welcomed as contributors to the increased sustainability of the fishery. It is unlikely for PNL vessels to completely replace the PS fleet in the WCPO, due to its economic viability superiority and ability of higher catches in a future of growing human populations. However, a partial replacement, combined with economic and political incentives to increase the use of free-schooling over FADs in the PS fishery, will greatly enhance sustainability in the fishery.

The management effectiveness and institutional viability across the PICTs' region is experiencing a period of strong will to employ common, more transparent, regional sustainability goals. That is noted with satisfaction and recognition, however, there are still measures to be taken. Amongst these measures worth mentioning, are the continued efforts to develop the nations economically, in order to build stronger management, state legislation, fight poverty and unemployment, and as such being able to build stronger institutions that can manage fisheries even more efficiently; such as increasing the prevalence of observers, VMS actions and patrol boats. Many PICTs are small economies with somewhat weak legal enforcement capabilities. Combined with some of the administrations being prone to give in to pressure from a powerful DWFN with comprehensive lobbying apparatuses seeking to gain advantageous fishery deals, the management effectiveness depends on the PICTs ability and will to stand up and come together for their own fishing resources. The general issues regarding governance in the fisheries sector in the PICT region have been the subjects of a lot of research and some common features of analyses are summed up by scholars such as Gillett (2010, p. 10):

- Low capacity of national fisheries agencies brought about by lack of qualified personnel at all levels, faced with increasing complex issues.
- Poor decision-making: inconsistent, lacking policy objectives.
- Poor leadership/organizational skills by department heads.
- Structures of government fisheries agencies that are not conducive to transparency and stakeholder input.
- Low levels of government funding of government fisheries agencies.
- Few staff incentives for performance in support of good governance.
- A lack of highly competent and appropriately skilled fisheries managers.
- A lack of clear policy directions and planning in all fisheries; continued optimistm (or intertia) that somehow “it will all be fine” in respect of pressure on resources (Gillett, 2010, p. 10).

Despite the outlined challenges from Gillett (2010), which this research is somewhat supportive of, the current development still shows that aggregate efforts such as the VDS are a testament to the Pacific Island groups’ truly impressive ambition to develop their own fisheries and progress to their own economic aspirations. It has enhanced the possibilities of cooperating across PICT governments and strengthened their sometimes weak governance resources. Continuing to build strong cooperative institutions such as the VDS, while addressing its already mentioned conservation weaknesses, will become increasingly critical in an environment where pressures grow and global fishing fleets become more aggressive in their hunt for open fishing grounds (Hanich, Parris & Tsamenyi, 2010). It seems the general increase in the numbers of fishing vessels is the over-arching problem that needs to be further debated. Setting a limit on how many fishing vessels are allowed to target tuna at a given quarter of a year, as an addition to the VDS, could be a start, as well as creating a more comprehensive debate over how many highly technologically efficient DWFN vessels may be issued fishing licences within PICT’s EEZs. If the ever-increasing fishing effort is not addressed, there is evidence to suggest that the yellowfin tuna, like the Bluefin, will continue beyond its ‘NT’ status with the IUCN in the foreseeable future.

Securing food supply and fighting unemployment will most certainly become a more pressing issue in the Pacific in the years to come as the human population rises and the effects from global climate change become more apparent. PICTs' dependency on fisheries for food security has been demonstrated in section 7.32.1 in Chapter 7 as well as section 3.4 in Chapter 3, and seafood provides a much more significant portion of protein intake than in other regions of the world. Improving fishery policies in an ever more sustainable direction is therefore of utter importance in this particular region, and a key element in securing food supply. Fighting unemployment can be a successful effect of more sustainability in the fisheries through following holistic sustainability business models such as the one NFD in SI is employing. Their policy of almost exclusively employing local labour has resulted in them being able to provide livelihoods for a great portion of the local community, and further strengthen the profitability of SI's national economy through tuna export value. Promoting labour-intensive fishing methods such as PNL is a sustainable way to ensure gentler harvesting of tuna while employing more people at the same time, and their planned expansion of their PNL fleet is recognised positively. Keeping up to date with current scientific advice, particularly about the sustainability of baitfish levels, will be equally important when performing that expansion.

Ensuring IUU activities are curbed and controlled is certainly one of the most challenging sustainability variables to overcome. The full extent of IUU fishing in the Pacific is not known, and significant dark numbers, fish laundering and transhipment at sea is most likely taking place in big scales, particularly in the high sea pockets. Continuing IUU activities severely undermine effective management measures and stock assessments. The PNA-imposed closure of the pockets is encouraged, and should be continuously enforced. The suggestion from the NGO Greenpeace to make some or all of the high sea pockets into MPAs is interesting, and closures should be considered regularly, at least during parts of each year. Based on Greenpeace's mission in the high seas pockets in 2012, it seems the waters of the Pacific high sea pockets are still vulnerable to destructive fishing practices and unregulated fishing activities. Many vessels without fishing licences in PICTs were encountered. Retaining the closures of high seas pockets 1 and 2 to PS fishing as well as rejecting calls to weaken or add exemptions to these measures under WCPFCs annual meetings should be considered by policy makers. The pressure from DWFNs seeking to weaken conservation and management measures, while not complying with those that are already in place, is noted with concern. Documenting illegal fishing operations should therefore be considered, and involve NGOs that operate on documented trustworthy and reliable terms, in order to submit IUU information to regional bodies such as WCPFC.

> While stronger regulations do exist in the EEZs of PICTs, IUU fishing continues because of the inadequate enforcement resources available to them. Of further concern is the apparent lack of consistent noncompliance procedures enacted by EEZ and flag-state members, cooperating non-members and participating territories within the WCPFC's adopted measures (Greenpeace, 2012b, p. 17).

Strengthening IUU mitigation will depend on further enhancing economic development in the PICT region, as it will enable nations to invest in more sophisticated monitoring mechanisms. It is interesting that also the fishers themselves that were interviewed in this research found IUU mitigation to be of the utmost importance in order to improve sustainability in the region. Strengthening longline observer coverage should also be of high priority, along with the current innovations from FFA, where electronic logsheets and surveillance on-board is acclaimed. The PS observer coverage is at this stage considered sufficiently high enough to draw conclusive remarks on by-catch rates and correct target species catch rates.

When it comes to strengthening of Pacific regionalism, the recent efforts from PNA show some truly promising developments in terms of stronger fisheries legislation. Their strategic advantage has been to form a unified regional process based on perceived common interests in the PS fishery. By keeping a common *modus operandi* within the agreement, with agreements on common position grounds along with joint decision-making, has made them into a strong, recognisable identity within regional tuna politics. These common grounds have tremendously increased their power over tuna resources since many small PICT states stand weaker alone, but cannot be neglected when standing together. Gradually, the strategic advantage has been a gradual shift of the power relationships between PNA countries and major DWFNs. By encoding such 'resource regionalism' into international treaties, the DWFN has been forced to recognise the legitimacy of the views PNA are imposing, and shift their perspective of FFA states from "being merely 'sellers' of a low value natural resource to being 'partners' in the future development of the industry" (Hanich, Parris & Tsamenyi, 2010, p. 14).

The work of PNA is admirable and no doubt bears hope for the future aspirations of PICTs' development. However, implementing the VDS as a conservation tool is yet to be proven. It will be necessary to combine a significant number more input controls if the VDS can be further considered sustainable and as a fisheries management or conservation tool. Its economic success for the member Parties of PNA is outstanding, but in order for the fishery to remain sustainable, a combination of a wide range of input controls should be imposed. Using only a few controls such as limiting the days fished does not seem sufficient in order to meet the ecological management goals. To avoid a situation of technology creep, further strengthening managing controls such as the already imposed vessel capacity controls (issuing only half a fishing day for vessels >80 meters) seems appropriate to further strength the management schemes' conservation goals. Recent achievements of improved yellowfin and bigeye conservation efforts are recognised, and have demonstrated the strength of FFA and PNA groups when negotiating collectively – they are acclaimed, and further strengthening of these vulnerable species should be prioritized.

Tuna fishing resources is crucial for the PICT population and for the fishers of the region. This importance goes both along economic and cultural dependency curves; the resource of tuna fisheries constitutes a source of cultural values and services, plays a major role in sustaining countless livelihoods across the region and sustains a source of monetary income on both the individual and community level, as well as on the nation state's level with their ability to create stronger economies. The findings from this research can certainly back the claim that tuna fisheries play a significant role in the economies of the PICTs, and their sustainable development is crucial for the PICTs to prosper the future. Adaptations to maintain the benefits in fisheries are needed for the PICTs to promote further domestification of the tuna industry, mixed with controlled access for DWFN to their EEZs based on sustainable principles. It should be a priority for fishery managers to reduce the access for DWFNs to their EEZs to provide more fish for national vessels, and for those DWFN operating in the EEZs, to make it a requirement to land a proportion of tuna catches for local canneries to derive employment benefits from. Failure in the past to arrive at mutually beneficial arrangements between DWFNs and PICTs, are demanding high levels of dedication to provide sustainable management efforts with development aspirations, while strengthening regional solidarity over solidarity to DWFNs.

However, it is not sufficient to address the problem of depleted fish stocks by only reducing fishing efforts, restricting catches and imposing size limits if the key threats to their recovery are degraded ecosystems, due to, for example, pollution or climate change. The effect on the fisheries is certainly also affected by variations in natural systems, and these variations need to be further understood in order to provide robust scientific advice. As assessments are only able to provide advice on the impact of a limited range of species, ecosystem considerations and holistic approaches need to be implemented in future fishery management plans. Continuing large-scale tuna tagging operations should be prioritized on a regular basis in order to provide correct tuna stock assessments that sustainability advice should be based on. Furthermore, a policy that promotes the use of free school fishing in the PS fishery over FAD fishing is believed to strengthen the sustainability in the fishery.

Given the high level of uncertainty facing the management of fisheries, which is highlighted by several collapses having occurred in the past in other fisheries, the continued establishments of new MPAs in the Pacific region could assist policy makers in ensuring the sustainability of highly migratory species. This would aid the rebuilding of ecosystem complexity and decrease the mortality rates of juveniles. Using the SES framework as an indicator of sustainability has drawn a somewhat conclusive remark on the status of the skipjack and yellowfin tuna fishery in the WCPO. Given the slight excess of MSY in yellowfin catches, combined with the high catches of juveniles, increased fishing pressure from DWFNs, perceived decrease in stock size from informants and uncertainty in the natural system, the yellowfin fishery is currently not considered sufficiently sustainable. Given the highly resilient nature of the skipjack tuna, and with its current catch levels not indicating any occurrence of overfishing, the fishery is considered sustainable for the present time. However, given the fact that schemes like the VDS are not enforcing output controls, a move towards more catch-based approaches should be considered in order to maintain the current catch rates of skipjack, which should not be increased much further. A greater proportion of tuna value has been accrued to PICTs under the VDS than before, but the sustainability of the stocks seems remain the same, perhaps even decreased. As DWFN continue to exert pressure to undermine efforts from regional management schemes in order to achieve ever-expanding access to the fish resources, the future of WCPO tuna will ultimately depend on the continued admirable work of regional RFMOs of the region wishing to strengthen the Pacific ownership of tuna through sustainable management. The increased fishing pressures in the region will call for even more resolute dedication towards sustainability, and the impression given is that there is both enough will and commitment to overcome these challenges if the Pacific Island nations continue to build strong alliances together.

List of references

Asian Development Bank. (2005). *Toward a New Pacific Regionalism – An Asian Development Bank-Commonwealth Secretariat Joint Report to the Pacific Islands Forum Secretariat.* Pacific Studies Series. Publication No. 081105.

Barbour, R. S. (2014). *Introducing Qualitative Research: A Student's Guide.* London: Sage Publications ltd.

Barclay, K. (2010). *History of Industrial Tuna Fishing in the Pacific Islands: A HMAP Asia Project Paper.* Working Paper No. 169, December 2010. Asia Research Centre; National Library of Australia, Murdoch University, Perth, Australia.

Barclay, K. & Cartwright, I. (2007a). *Capturing Wealth from Tuna – Case Studies from the Pacific.* Canberra: Asia Pacific Press, The Australian National University, Australia.

Barclay, K. & Cartwright, I. (2007b). *Governance of Tuna Industries: The Key to Economic Viability and Sustainability in the Western and Central Pacific Ocean.* Institute for International Studies, University of Technology Sydney and Australian Government Agency for International Development (AusAID).

Barrett, S. (2007). *Why cooperate? The Incentive of Supply Global Public Goods.* Oxford University Press, USA.

Basurto, X., Gelcich, S. & Ostrom, E. (2013). The social-ecological system framework as a knowledge classificatory system for benthic small-scale fisheries. *Journal of Global Environmental Change* 23, 1366-1380.

Beddington, J. R., Agnew, D. J., & Clark, C. W. (2007). Current Problems in the Management of Marine Fisheries. *Science* 316(5832), 1713-1716. DOI: 10.1126/science.1137362

Bell, J. D., Johnson J. E., Hobday, A. J. (2011). *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change: Summary for Pacific Island Countries and Territories.* Secretariat of the Pacific Community (SPC), Noumea, New Caledonia.

Berg, B. L., and Lune, H. (2013). *Qualitative Research Methods for the Social Sciences – Eighth Edition.* Pearson Education Limited. ISBN 10: 1-292-02249-3

Bushnell, P. G. and Brill, R. W. (1992). Oxygen transport and cardiovascular responses in skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) exposed to acute hypoxia. *Journal of Comparative Physiology B, Springer-Verlag,* 162, 131-143.

Campling, L., Havice, E., Ram-Bidesi, V., and Grynberg, R. (2007). *Pacific Islands Countries, The Global Tuna Industry and the International Trade Regime – A Guidebook.* DEVFISH Project, Forum Fisheries Agency, Honiara.

Castro, P. & Huber, M. (2012). *Marine Biology- ninth edition.* Published by McGraw-Hill Companies, Inc., New York.

Cavanagh, J. A. E., Frame, B., & Lennox, J. (2006). The Sustainability Assessment Model (SAM): Measuring Sustainable Development Performance. *Australian Journal of Environmental Management,* (13), 142-145.

Curto, R. (2014). Retrieved October 4th, 2015, from: http://www.undercurrentnews.com/2014/03/25/tri-marine-chairman-sees-sustainability-customer-focus-as-big-themes-of-tuna-2014/

Dagorn, L. & Restrepo, V. R. (2011). *Questions and Answers About FADs and By-catch*, International Seafood Sustainability Foundation (ISSF) Technical Report 2011-03. Institut de Recherche pour le Développement (IRD), Victoria, Seychelles.

Diekert, F. & Rouyer, T. (2011). *Managing growth-overfishing is more important than managing recruitment-overfishing.* January 26, 2011, University of Oslo (UiO), Centre for Ecological and Evolutionary Synthesis (CEES), Dept. of Biology. Oslo, Norway.

Dryzek, J. (2005). *The Politics of the Earth*, 2nd edition. Oxford University Press, London, UK.

Economic and Social Commission for Asia and the Pacific of the United Nations (ESCAP) (2014). *Pacific Perspectives on Fisheries and Sustainable Development*, publication manufactured in Fiji, August 2014. ISBN 978-982-91410-2-6.

Ellis, J. (2007). Fisheries Conservation in an Anarchical System: A Comparison of Rational Choice and Constructivist Perceptives. *Journal of International Law and International Relations*, (3), 2, 1-40.

Field, A., Field, Z., & Miles, J. (2012). *Discovering statistics using R*, 1st edition. Sage publications, Ltd. ISBN 978-1-4462-0045-2

Fletcher, W. J. (2008). *A Guide to Implementing an Ecosystem Approach to Fisheries Management (EAFM) for the tuna fisheries in the Western and Central Pacific Region.* Forum Fisheries Agency (FFA), Honiara, Solomon Islands. Version 5 March 2008. 70pp.

Food and Agriculture Organization of the United Nations (FAO). (1989). *Management of Fish Stocks and Fisheries of Deep and Shallow Lakes of Eastern/Central/Southern Africa.* RAF/87/099-WP/02/89 (EN), December 1989. United Nations Development Programme (UNDP).

Food and Agriculture Organization of the United Nations (FAO). (1999). Chapter 5: The use of scientific information in the design of management strategies. Retrieved November 3rd, 2015, from: http://www.fao.org/docrep/005/y3427e/y3427e07.htm

Food and Agricultural Organization of the United Nations (FAO). (2007). *World Review of Fisheries and Aquaculture* in The State of World Fisheries and Aquaculture 2006, Rome, Italy.

Food and Agriculture Organization of the United Nations (FAO). (2013). *By-catch and non-tuna catch in the tropical tuna purse seine fisheries of the world.* FAO Technical Paper 568 by Hall, M. and Roman, M., Inter-American Tropical Tuna Commission, La Jolla, USA. FAO of the United Nations, Rome, 2013.

Food and Agriculture Organization of the United Nations (FAOa). (2015). Globefish market reports, April 2015. Retrieved October 5th, 2015, from: http://www.globefish.org/tuna-march-2015.html

Food and Agriculture Organization of the United Nations (FAOb). (2015). Tuna Pole and Line Fishing, retrieved October 13th, 2015, from: http://www.fao.org/fishery/fishtech/30/en

Food and Agriculture Organization of the United Nations (FAOc). (2015). Tuna Purse Seining, retrieved October 13th, 2015, from: http://www.fao.org/fishery/fishtech/40/en

Food and Agriculture Organization of the United Nations (FAOd). (2015). Species Fact Sheet: *Thunnus albacares*. Retrieved November 9th, 2015, from: http://www.fao.org/fishery/species/2497/en

Food and Agriculture Organization of the United Nations (FAOe). (2015). Species Fact Sheet: *Katsuwonus pelamis*. Retrieved November 9th, 2015, from: http://www.fao.org/fishery/species/2494/en

Food and Agriculture Organization of the United Nations (FAOf). (2015). The ecosystem approach to fisheries management. Retrieved November 19th, 2015, from: http://www.fao.org/fishery/topic/13261/en

Food and Agriculture Organization of the United Nations (FAOg). (2015). South Pacific Forum Fisheries Agency (FFA) – VMS programme. Retrieved November 19th, 2015, from: http://www.fao.org/fishery/topic/18074/en

Formo, R. K. (2010). *Power and Subjectivation: The Political Ecology of Tanzania's Wildlife Management Areas*. (Master thesis, Norwegian University of Life Sciences (NMBU), Institute of International Environment and Development Studies (Noragric)). Retrieved November 1st, 2015, from http://brage.bibsys.no/xmlui/bitstream/handle/11250/187699/formo_thesis.pdf?sequence=1

Forum Fisheries Agency (FFA). (2015). Retrieved October 7th, 2015, from: http://ffa.int/about

Fonteneau, A. (2003). *A comparative overview of skipjack fisheries and stocks world wide*. WPTT-03-02. IOTC Proceedings no. 6 (2003), p. 008-021.

Gillett, R. & Lewis, A. (2003). *A Survey of Purse Seine Fishing Capacity in the Western and Central Pacific Ocean, 1988 to 2003*. Gillett, Preston and Associates, September 2003.

Gillett, R. (2007). *A short history of industrial fishing in the Pacific Islands*. RAP Publication 2007/22. Asia-Pacific Fishery Commission, Food and Agriculture Organization (FAO) of the United Nations. Regional Office for Asia and the Pacific, Bangkok, 2007.

Gillett, R. (2009). *Fisheries in the economies of the Pacific Island countries and territories*. Mandaluyong City, Philippines: Asian Development Bank, 2009.

Gillett, R. (2011). *The Promotion of Pole-and-Line tuna fishing in the Pacific Islands: Emerging issues and lessons learned.* ISSF Technical report 2011-08. International Seafood Sustainability Foundation (ISSF), McLean, Virginia, USA.

Gillett, R. (2010). *Replacing Purse Seining with Pole-and-Line Fishing in the Western Pacific: Some Aspects of the Baitfish Requirements.* Published by Gillett, Preston and Associates, Inc., for International Seafood Sustainability Foundation (ISSF). Washington, D. C, USA.

Gillett, R. & Cartwright, I. (2010). *The future of Pacific Island Fisheries.* Secretariat of the Pacific Community (SPC), Noumea, New Caledonia and Pacific Islands Forum Fisheries Agency (FFA), Honiara, Solomon Islands. ISBN: 978-982-00-0422-1.

Gillett, R. & C. Lightfoot. (2002). *Contribution of Fisheries to the Economies of Pacific* Island Countries, *Pacific Studies Series.* Manila: Asian Development Bank.

Gilman, E. L. (2011). By-catch governance and best practice mitigation technology in global tuna fisheries. *Marine Policy* 35, 590-609.

Gilman, E. L. (2012). *Western and Central Pacific High Seas (ABNJ) Closures for the Purse Seine Skipjack Tuna Fishery.* December 2012.

Greenpeace International. (2009). *High Seas Pacific Marine Reserves: a case study for the high seas enclaves.* A briefing to the CBD's Expert workshop in scientific and technical guidance on the use of biogeographic classification systems and identification of marine areas beyond national jurisdiction in need of protection. Ottawa, 29 September – 2 October 2009, A report for Greenpeace International by Eleanor Partridge.

Greenpeace International. (2012a). Link retrieved October 6th, 2015, from: http://www.greenpeace.org/international/en/news/Blogs/makingwaves/transforming-the-tuna-industry/blog/39194/

Greenpeace International. (2012b). *Defending Our Pacific: Summary of findings from the* Esperanza's *expedition, September – December 2011.* Edited by Smith, S. and Erwood, S. March 2012, Amsterdam, The Netherlands.

Greenpeace International. (2013). *Out of Line: The failure of the global tuna longline fisheries*, edited by Dawe, A., Leal, I. and Partridge, E. Amsterdam, The Netherlands, November 2013.

Hall, M. & Roman, M. (2013). *By-catch and non-tuna catch in the tropical tuna purse seine fisheries of the world.* Food and Agriculture Organization of the United Nations (FAO); Technical Paper No. 568. Rome, FAO. 249 pp.

Hamilton, A., Lewis, A., McCoy, M., Havice, E. & Campling, L. (2011). *Market and Industry Dynamics in the Global Tuna Supply Chain.* Forum Fisheries Agency (FFA), Honiara, June 2011. Accessed December 4th, 2015, from: https://www.ffa.int/system/files/Global%20Tuna%20Market%20%2526%20Industry%20Dynamics_ Part%201a.pdf

Hampton, J. (2010). *Tuna Fisheries Status and Management in the Western and Central Pacific Ocean.* Oceanic Fisheries Programme (OFP), Secretariat of the Pacific Community (SPC), New Caledonia. Accessed December 4th, 2015, from:

http://awsassets.panda.org/downloads/background_paper___status_and_management_of_tuna_in_the_wcpfc.pdf

Hanich, Q. A., Parris, H., & Tsamenyi, B. M. (2010). Sovereignty and cooperation in regional Pacific tuna fisheries management: Politics, economics, conservation and the vessel day scheme. *Australian Journal of Maritime and Ocean Affairs*, 2 (1), 2-15.

Hardin, G. (1968). The Tragedy of the Commons. *Science*, 162, 1243-1248.

Harley, S., Williams, P., Nicol, S. & Hampton, J. (2015). *The Western and Central Pacific Tuna Fishery: 2013 Overview and Status of Stocks*, Secretariat of the Pacific Community (SPC), Oceanic Fisheries Programme (OFP), Tuna Fisheries Assessment Report No. 14. ISSN: 1562-5206.

Hauge, K. Hiis, Cleeland, B. & Wilson, D. C. (2009). *Fisheries Depletion and Collapse*. International Risk Governance Council (IRGC), Geneva, Switzerland.

Hovi, J. (February 6th, 2012). [Personal communication].

Hovi, J. & CICERO. (2009). *Towards a Better Compliance System for the Climate Regime?*, in Christophe P. Vasser (ed.), *The Kyoto Protocol: Economic Assessments, Implementation Mechanisms, and Policy Implications*, chapter 5. Nova Science Publishers, Inc. ISBN 978-1-60456-983-4.

Informant 1. Brownjohn, M. (2015, April 16th). [Personal communication].

Informant 2. Wickham, F. (2015, April 23rd). [Personal communication].

Informant 3. Walton, H. (2015, April 24th). [Personal communication].

Informant 4. Petanoe, L. (2015, May 2nd). [Personal communication].

International Pole-and-Line Foundation (IPNLF). (2012). *Ensuring Sustainability of Livebait Fish*. International Pole-and-Line Foundation, London, United Kingdom.

International Pole-and-Line Foundation (IPNLF). (2014). How to Fish by Pole and *Line*. Retrieved October 13th, 2015, from: http://ipnlf.org/about-pole-and-line/how-to-fish-pole-line/

Intertek Fisheries Certification (IFC). (2013). Link retrieved October 5th, 2015, from: http://ifcextapps.ifc.org/ifcext/spiwebsite1.nsf/0/EF45494EE2FAAF3385257B410065BB9F/$File/Soltuna%20Project%20_update%20to%20stakeholders%20Feb%202013_FINAL.pdf

International Seafood Sustainability Foundation (ISSF). (2015). *Tuna Stock Status Update, 2015: Status of the world fisheries for tuna*. ISSF Technical Report 2015-03. International Seafood Sustainability Foundation, Washington, D.C., USA.

International Union of Conservation of Nature (IUCN). (2015). Increased protection urgently needed for tunas. Retrieved November 30th, 2015, from: http://www.iucn.org/knowledge/news/?7820

Jennings, S., Kaiser, M. J., & Reynolds, J. D. (2001). *Marine Fisheries Ecology*. Blackwell Publishing, Oxford, United Kingdom.

Langley, A., Hampton, J. & Ogura, M. (2005). *Stock assessment of skipjack tuna in the western and central Pacific ocean*. Western and Central Pacific Fisheries Commission (WCPFC) 1st Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission WCPFC-SC1, Noumea, New Caledonia, 8-19 August, 2005. WCPFC-SC1 SA WP-4.

Lehodey, P. & Leroy, B. (1999). *Age and growth of yellowfin tuna (*Thunnus albacares*) from the western and central pacific ocean as indicated by daily growth increments and tagging data*. Working paper YFT-2, Oceanic Fisheries Programme, Secretariat of the Pacific Community (SPC), Noumea, New Caledonia.

Lewis-Beck, M. S., Bryman, A., & Liao, T. F. (ed.). (2004). *The SAGE Encyclopedia of Social Science Research Methods*. SAGE publications, Thousand Oaks, California, USA.

Lund, C. (2014). Of What is a Case?: Analytical Movements in Qualitative Social Science Research. *Human Organization*, 73(3), 224-234.

Marine Resources Assessment Group (MRAG). (2010). *Towards sustainable fisheries management: international examples of innovation*. MRAG Ltd., London, United Kingdom. 93 pages.

Marine Stewardship Council (MSC). (2015). Link retrieved October 3rd, 2015, from: https://www.msc.org/track-a-fishery/fisheries-in-the-program/in-assessment/pacific/tri-marine-western-and-central-pacific-skipjack-and-yellowfin-tuna

McCoy, M. A. (2007). *Regulation of Transshipment by the Western and Central Pacific Fisheries Commission: Issues and Considerations for FFA Member Countries*. FFA Report #2007/26. Published by Gillett, Preston and Associates, Inc.

Meadows, D. H., Meadows, D. L., Randers, J. & Behrens, W. W. I. (1972). *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. New York, Universe Books, USA.

Meyer, C. B. (2001). *A Case in Case Study Methodology*. Published in *Field Methods*, vol. 13, No. 4, November 2001, pp 329-352, Sage Publications ltd.

Nijkamp, P. (1990). *Regional Sustainable Development and Natural Resource Use*. In World Bank Annual Conference on Development Economics, Washington, D. C., USA.

Olson, M. (1965). *The Logic of Collective Action*. Harvard University Press, USA.

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science* (325), 419. DOI: 10.1126/science.1172133.

Parties to the Nauru Agreement (PNA). (2015). Retrieved October 5th, 2015, from: http://www.pnatuna.com/node/279

Pauku, R. L. (2009). *Solomon Islands Forestry Outlook Study*. Working Paper No. APFSOS II/WP/2009/31. Food and Agriculture Organization (FAO) of the United Nations Regional Office for Asia and the Pacific, Bangkok, 2009.

Pauly, D., Christensen, V., Guénette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., Watson, R. & Zeller, D. (2002): Towards sustainability in world fisheries. *Nature*, (418), 689-695.

Petaia, S. (2015). *Sustainable fisheries* (MS305) at University of South Pacific (USP), spring semester 2015, Fiji. [Powerpoint presentations]. Published on *Fronter*.

Polacheck, T. (2002). Experimental catches and the precautionary approach: the Southern Bluefin Tuna dispute. *Marine Policy* 26, 283-294, Elsevier Science Ltd.

Robbins, P. (2012). *Political Ecology, A Critical Introduction*, 2nd edition. Wiley-Blackwell Publications, Ltd, Oxford, United Kingdom.

Robbins, P., Hintz, J. & Moore, S. A. (2014). *Environment and society – A Critical Introduction*, 2nd edition. Wiley-Blackwell Publications, Ltd, Oxford, United Kingdom.

Safina, C. (2001). Tuna Conservation. *Fish Physiology*, (19), 413-459.

Schlüter, A. & Madrigal, R. (2012). The SES framework in a Marine Setting: Methodological Lessons. *RMM journal*, (3), 148-167.

Secretariat of the Pacific Community (SPC). (2010). Regional Tuna Tagging Program – RTTP. Retrieved November 14th, 2015, from: http://www.spc.int/tagging/en/programs/rttp

Secretariat of the Pacific Community (SPC). (2013). PNG Tagging Project, retrieved October 4th, 2015, from: http://www.spc.int/tagging/en/programs/png-tp

Secretariat of the Pacific Community (SPCa). (2014). *Stock assessment of yellowfin tuna in the western and central pacific ocean*, WCPFC-SC10-2014/SA-WP-2014. Scientific Committee, tenth regular session, Majuro, Republic of the Marshall Islands 6-14 August 2014.

Secretariat of the Pacific Community (SPCb). (2014). *Stock assessment of skipjack tuna in the western and central pacific ocean*, WCPFC-SC10-2014/SA-WP-05. Scientific Committee, tenth regular session, Majuro, Republic of the Marshall Islands 6-14 August 2014.

Secretariat of the Pacific Community (SPC). (2015). Retrieved October 5th, 2015, from: http://www.spc.int/oceanfish/en/tuna-fisheries/171-total-catches

Shibuya, E. (2004). *The Problems and Potential of the Pacific Islands Forum*. Published in The Asia-Pacific: A region in transition, Asia-Pacific Center for Security Studies, pp 102-115.

Silvius, G., Brink, J. V. D., & Köhler, A. (2013). *The impact of sustainability on project management*, published in The Project as a Social System: Asia-Pacific Perspectives on Project Management, pp 183-200. Monash University Publishing.

Solomon Islands Truth and Reconciliation Commission (TRC). (2012). *Confronting the Truth for a better Solomon Islands: Final Report.* Truth and Reconciliation Commission, Honiara, Solomon Islands, February 2012.

Svarstad, H., Petersen, L. K., Rothman, D., Siepel, H., & Wätzold, F. (2008). Discursive Biases of the Environmental Research Framework DPSIR. *Land Use Policy,* (25), 116-125.

Tamate, J. (2014). *Regionalism: The Experience of the Parties to the Nauru Agreement.* In Brief 2014/31, Australian National University.

The World Bank. (2012). *Skills for Solomon Islands: Opening new opportunities.* October 2012.

The World Bank. (2015). *International tourism, number of arrivals.* Retrieved October 28th, from: http://data.worldbank.org/indicator/ST.INT.ARVL

Tongco, M. D. C. (2007). Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research & Applications* (5), 147-158.

Tri Marine Group. (2013). Retrieved September 30th, 2015, from: http://www.trimarinegroup.com/operations/index.html

Tri Marine Group, Owens, M. (2014). Tri Marine and Responsibly Caught Tuna, power point presentation April 23rd, 2014. Retrieved October 1st, 2015, from: http://cmsdevelopment.sustainablefish.org.s3.amazonaws.com/2014/05/13/2014_EUFF_SFP%20Europe%20Forum%20-%20Tri%20Marine-a242c616.pdf

Tri Marine Group. (2015a). Retrieved October 3rd, 2015, from: http://www.trimarinegroup.com/news/press/Trimarine_MSC_Announcement_010615.html

Tri Marine Group. (2015b). Retrieved October 5th, 2015, from: http://www.trimarinegroup.com/news/press/Trimarine_Announcement_020315.html

Undercurrent News. (2014). Retrieved October 4th, 2015, from: http://www.undercurrentnews.com/2014/05/21/tri-marine-ceo-top-tuna-scientist-call-for-action-on-tuna-overcapacity/

United Nations. (1982). *United Nations Convention of the Law of the Sea.* United Nations – Office of Legal Affairs, December 10th, 1982, Montego Bay, Jamaica.

United Nations World Commission on Environment and Development. (1987). *Our Common Future.* Oxford: Oxford University Press.

United Nations Environment Programme (UNEP). (2012). *Global Environmental Outlook (GEO5) – Environment for the future we want.* Chapter 5 Biodiversity, pp 134-166.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2015). Retrieved October 9th, 2015, from: http://www.unesco.org/new/en/natural-sciences/iococeans/priority-areas/rio-20-ocean/blueprint-for-the-future-we-want/marine-biodiversity/facts-and-figures-on-marine-biodiversity/

United States Department of State. (2014). *Limits in the Seas, No 136 Solomon Islands: Archipelagic and other Maritime Claims and Boundaries*. Office of Ocean and Polar Affairs, Bureau of Oceans and International Environmental and Scientific Affairs. March 28th, 2014.

Western and Central Pacific Fisheries Commission (WCPFC). (2005). *Report of the First Regular Session of the Scientific Committee of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean*. Noumea, New Caledonia: Western and Central Pacific Fisheries Commission (WCPFC).

Western and Central Pacific Fisheries Commission (WCPFC). (2008). *Bigeye and yellowfin tuna management measure*. 2-minute briefs, Pacific Islands Forum Fisheries Agency (FFA), Honiara, Solomon Islands.

Western and Central Pacific Fisheries Commission (WCPFC). (2013). *Overview of Tuna Fisheries in the Western and Central Pacific Ocean, Including Economic Conditions – 2012*. WCPFC-SC9-2013/GN WP-1.

Western and Central Pacific Fisheries Commission (WCPFC). (2014a). *Tuna Fishery Yearbook 2013*, Oceanic Fisheries Programme, Secretariat of the Pacific Community. Noumea, New Caledonia. Access: https://www.wcpfc.int/system/files/WCPFC_YB_2013.pdf

Western and Central Pacific Fisheries Commission (WCPFC). (2014b). *Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean*. Scientific Committee, 10th Regular Session, Majuro, Republic of the Marshall Islands 6-14 August 2014.

Western and Central Pacific Fisheries Commission (WCPFC). (2015a). *Review of Guidelines for Long Line Oberver Coverage*. WCPFC-2015-IWGROP4-08, June 19th, 2015.

Western and Central Pacific Fisheries Commission (WCPFC). (2015b). Vessel Monitoring System. Retrieved November 19th, 2015, from: https://www.wcpfc.int/vessel-monitoring-system

Worm, B., Barbier, E. B., Beaumont, N., Emmett Duffy, J., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowics, J. J., & Watson, R. (2006): Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science* (314), 787-790.

Yin, R. K. (2012). *Applications of Case Study Research*, 3rd edition. Sage Publications ltd, California, USA.

Appendices

List of interviews

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2. Key informant (Informant 2) from FFA, H. Walton. Honiara, Solomon Islands, April 23rd, 2015.
3. Key informant (Informant 3) from NFD, F. Wickham. Honiara, Solomon Islands, April 24th, 2015.
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31. Fisher 28 (PS) from M/V *Solomon Opal.* Noro, Solomon Islands, May 1st, 2015
32. Key informant (Informant 4), local Noro manager for NFD, L. Petanoe. Noro, Solomon Islands, May 2nd, 2015
33. Fisher 29 (PS) from M/V *Solomon Ruby.* Noro, Solomon Islands, May 3rd, 2015
34. Fisher 30 (PS) from M/V *Solomon Ruby.* Noro, Solomon Islands, May 3rd, 2015

Interview guide for PNL and PS fishers

Purpose: getting an impression of which perceptions the fishers held over the tuna fishery they took part of, with specific focus on sustainability issues.

Q1 How long have you been working as a fisher?

Q2 Which types of vessels have you worked on?

Q3 How long have you worked on this particular vessel?

Q4 How were you initially employed as a fisher?

Q5 Would you describe it as easy or as a challenge to get employed at industrial-scale fishing vessels in Solomon Islands?

Q6 Would you say that the fishery has changed in any ways during the years you've worked as a fisher?

Q7 Do you think the average fish size has changed during the years you've worked as a fisher?

Q8 How would you describe by-catch levels on this vessel compared to other vessels you've been on?

Q9 What do you do onboard to minimize by-catch?

Q10 Do you ever spot IUU activities when out at sea? – If yes, what kind of boats, which areas?

Q11 What do you see as the best option to mitigate IUU activity?

Q12 Which fishing method do you think in the highest deegree produces best meat quality?

Q13 Which fishing method would you say minimizes the by-catch problem?

Q14 Do you, in general, view the general stock abundance of tuna as the same since you started, increased, or decreased?

Q15 (PNL ONLY) Have you noticed any changes in the bait fishery since you started?

Q16 How do you view seasonal closures of high sea pockets?

Q17 How do you view creation of MPAs with fishing restrictions?

Q18 (PSV ONLY) Have there been any differences in average mesh size in the tuna fishery since you started working?

Q19 What do you, as a fisher, think is the most efficient way to safeguard stocks for the future?

Interview guide for key informant from PNA (Informant 1)

Purpose: getting an overview of the PNAs' organization structure and objectives, and their views on certain sustainability issues in the WCPO tuna fishery. Additional questions and/or follow-up questions were asked spontaniously in addition to those lined up here, as the interview had a semi-structurized format.

1. General introduction – what are the main objectives of the work of PNA?

2. What is the main difference between FFA and PNA?

3. How does one obtain a PNA license?

4. What are done to minimize variability in catch levels – how well managed are the total days of allowed fishing?

5. Capacity building – how much is invested in fishery capacity, knowledge, research?

6. How is the catch rate of yellowfin tuna in regards to the MSY and/or the TAC?

7. What is the fleet capacity of the two different fishing methods?

8. How has the implementation of the vessel day scheme changed the fishery system?

9. Can you describe the level of compliance to the rules and regulations imposed on vessels by authorities of local, regional fishing vessels?

10. Can you describe the level of compliance to the rules and regulations imposed on vessels by authorities of foreign states fishing vessels?

11. Which fishing method minimizes the by-catch problem in PNAs opinion?

12. According to PNA, which measures can ensure that overfishing are avoided in the areas of open sea?

13. What are the biggest challenges to these measures?

14. What is PNAs view on increased consumer advocacy such as MSC? Can such efforts support a better management of tuna fisheries?

15. What are the biggest challenges in ensuring a transparent, traceable and robust catch documentation system?

16. What measures are done in PNA to ensure that the MSY requirements are met?

17. Is the current biomass (relative to average) below or above critical level?

18. Is the fish size (relative to average) – average size at capture lower than optimal size?

19. Regarding catch levels – does the catch exceed the MSY? Are the catch-limits in your opinion truly science-based or somewhat market-based?

20. Protected areas – is there an increase or decrease in % of areas protected?

21. Discarding – reduced or increased over the past few years?

22. Can you explain a bit further what PNA is doing in regards to rebuilding of overexploited stock areas – seasonal bans on use of Fish Aggregating Devices (FADs), seasonal closure of spawning grounds, seasonal or regular fishing ban days?

23. Prevention of mortality of rare species/bycatch – which measures are taken to measure mortality rate and abundance of rare species?

24. Prevention of ecosystem shifts – which measures are taken to understand the diversity of indicator species?

25. Market demand – how is the yellowfin tuna market fluctuating?

26. Export level – what is the value and volume of the export of yellowfin tuna?

27. How is the regional/local employment in the (yellowfin) tuna sector?

28. Numbers of complaints recieved – from fishers, distant water fleets, regional water fleets etc?

Interview guide for key informant from FFA (Informant 2)

Purpose: getting an overview of the FFAs' organization structure and objectives, and their views on certain sustainability issues in the WCPO tuna fishery. Additional questions and/or follow-up questions were asked spontaniously in addition to those lined up here, as the interview had a semi-structurized format.

1. General introduction – what is the main objective of the work of FFA?

2. What are the main objectives of your specific work in the FFA?

3. What would you address as FFA and PNAs major differences in terms of views of management of tuna?

4. The FFA member countries consists of countries with very different political and economic situations – how is the work balanced to meet the different interests and needs of the member group?

5. What is FFAs view on how to minimize variability in catch levels?

6. How does the FFA view the VDS scheme compared to purse-seine vessel limits?

7. What is FFAs view of how well managed the VDS scheme is?

8. In general - is there active efforts being done to limit the fishing effort in the region? Or is the goal to increase the fishing effort?

9. How does the FFA view the fishing efforts of distant water nations in the Pacific region?

10. Does FFA actively promote measures to mitigate or slow the increase of distant water nation fishing in the nation?

11. What policies does FFA promote do to mitigate IUU activities in the region, and particularly in the loopholes?

12. How is capacity building work organized in the FFA? (Fishery capacity knowledge, research etc)

13. How does the FFA view the current catch rates of tuna species in the region compared to their respective MSY and/or TAC?

14. How has the implementation of VDS changed the fishery system?

15. How do you view the compliance levels towards the rules and regulations imposed on vessels by authorities of local, regional fishing vessels?

16. How do you view the compliance levels towards the rules and regulations imposed on vessels by authorities of foreign states fishing vessels?

17. Which fishing method minimizes the by-catch problem in FFAs opinion?

18. According to FFA, which measures can ensure that overfishing is avoided in the areas of open sea?

19. What are the biggest challenges to these measures?

20. What is, according to FFA, the most sustainable fishing method to harvest yellowfin tuna? And the other tuna species?

21. Pole-and-line has been accused for seriously degrading coastal/artisanal fisheries because of using live bait. What is FFAs view on this?

22. What are FFAs views on increased consumer advocacy such as MSC? Can such efforts support a better management of tuna fisheries?

23. What measures are promoted in FFA to ensure that the MSY requirements are met?

24. Protected areas – is FFA promoting an increase or decrease in % of areas protected in the region?

25. Can you explain a bit further what FFA is recommending in regards to rebuilding of overexploited stock areas – seasonal bans on use of FADs, seasonal closure of spawning grounds, seasonal or regular fishing ban days?

26. Prevention of mortality of rare species/bycatch – which measures are advised to measure mortality rate and abundance of rare species?

27. How is the regional/local employment in the tuna sector?

28. What are the numbers of complaints received to the agency – from fishers, distant water fleets, regional-water fleets etc?

29. Is the current fleet capacity meeting or exceeding the MSY requirements in FFAs opinion?

30. All in all – how effective do you view the policies that are currently implemented?

31. Reducing conflicts – how is the management schemes safeguarding and balancing the interests of fishers, lobbyists and conservationists interest?

32. How is the fleet capacity in the FFA countries in pole-and-line?

33. How is the fleet capacity in the FFA countries in purse seine?

34. How is the fleet capacity in the FFA countries in long-liners?

35. How is the fleet capacity in the FFA countries in free-school?

36. How is the fleet capacity in the FFA countries in other fishing methods?

37. Which fishing method preserves tuna meat quality in the highest deegree, in FFAs opinion?

38. Which actions can ensure a transparent and traceable supply chain for tuna products into local and international markets, including a robust catch documentation system?

Interview guide for key informant from NFD (Informant 3)

Purpose: getting an overview of the NFDs' company structure and objectives, and their views on certain sustainability issues in the WCPO tuna fishery. Additional questions and/or follow-up questions were asked spontaniously in addition to those lined up here, as the interview had a semi-structurized format.

1. Can you describe the work of NFD, its history, and how the company is structurized?

2. Can a government emplpyee issue a fishing licence without consulting scientists?

3. What do NFD see as the most viable fishing method for tuna in these waters?

4. How is your economic viability for NFDs' PNL vessels?

5. The PNL fishery has been critizised for taking out too much baitfish, how do you view this issue?

6. Do you follow the procedures from PNA, with 100% observers on purse seiners? Is it practically hard raising the 5% observer coverage on-board longliners, or is it just hard to find people willing to do it?

7. The observers in Noro – are they employed by the ministry, or by NFD?

8. Is it a goal for NFD to increase the PNL fleet? If yes, is it due to PNL caught tuna being valuable in the market, due to the demand being higher than before, or because of employment?

9. In terms of sustainability, which way does NFD view as the most sustainable way of catching tuna?

10. Do you think a quota system, with a roof of prior given tons would be preferable?

11. Does your fleets only have Solomon employees?

12. On your purse seiners, do you use FADs?

13. Are the FADs anchored or drifting?

14. How do you view the fishing efforts of distant fishing water nations, in general?

15. Which fishing method do you view as preferable for yellowfin?

16. What is the average catch size for the different species?

17. What do you do to avoid fishing juveniles?

18. Will any of your boats get a fine if they bring in too many juveniles?

19. What is the minimum size the fish has to be, and who sets that standard? And is that standard set for the whole region, or specifically for Solomon?

Interview guide for local Noro manager in NFD (Informant 4)

Purpose: getting an overview of some of NFDs' employment rights and benefits, certain company structures, company value and objectives. Additional questions and/or follow-up questions were asked spontaniously in addition to those lined up here, as the interview had a semi-structurized format.

1. What is your general procedure, if any employee notices illegal activity boats, what are the standardized steps issued from NFD?

2. What is your annual revenue for NFDs' PNL fleet vs NFDs' PS fleet?

3. How many fishers are employed in your PNL fleet and in your PS fleet?

4. How often does the fishers have time off annually?

5. What is the maximum amount of days that the fishers can stay out at sea?

6. The previous system Solomon Taiyo performed, closing the fishery in December through February each year due to spawning, 9 months of fishing and 3 months of fishing break. Why is that system no longer operating?

7. How is your salary levels, is it more economically viable working in NFD compared to other work places?

8. Do you conduct maternity and paternity leave?

9. Do you conduct a flat salary rate for the fishers, or is the salary dependent on how much fish they catch?

10. How many applications do you receive, and how is the application distribution towards PS and PNL vessels?

11. Is a full discard ban conducted on-board your boats?

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