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Volume 12

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Historical Perspectives of Fisheries Exploitation in the Indo-Pacific

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Cover picture: Tuna in the freezer of a Longline fishing vessel, Federated States of Micronesia, 2006. By permission of Alex Hofford (http://www.alexhoffordphotography.com).

ISSN 2212-6260 ISSN 2212-6279 (electronic)
ISBN 978-94-017-8726-0 ISBN 978-94-017-8727-7 (eBook)
DOI 10.1007/978-94-017-8727-7
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2014935154

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Chapter 8
History of Industrial Tuna Fishing in the Pacific Islands

Kate Barclay

Abstract The island countries and territories of the Pacific Ocean are relatively sparsely populated so there has historically been less fishing pressure on marine animal populations than in many other parts of the world. Industrial tuna fishing around Pacific Island countries began in the first half of the twentieth century, re-emerged after World War II in the 1950s and developed slowly until the 1980s when new fishing practices and new entrants increased catches steeply and steadily in a curve that continues to the present day. It has been estimated that industrial tuna catches are about ten times the volume and over seven times the value of all other fisheries in the Island Pacific combined – both commercial and artisanal. Furthermore, other fisheries that have been tried commercially in the region have not been resilient to industrial scale fishing pressure. Tuna fisheries may be the only potentially sustainable industrial wild-catch fisheries for the Island Pacific. Thus far fishing does not seem to have harmed the capacity of skipjack and albacore to maintain their populations, but it is having a deleterious effect on the biomass of yellowfin and bigeye. Industrial tuna fishing also incidentally kills other animals, but as yet there is not enough data collected to accurately gauge the ecosystem impacts of industrial tuna fisheries. Various attempts have been made to manage industrial tuna fisheries in the region. The main body responsible is the Western and Central Pacific Fisheries Commission (WCPFC), established in the 2004. Neither the WCPFC nor other bodies have thus far managed to reign in the overfishing of yellowfin and bigeye.

Keywords Industrial tuna fishing · Pacific Islands tuna history · WCPO · WCPFC · Fisheries management history

This chapter is based on existing research about tuna fisheries in the Pacific Islands region. The first part of the paper is based on various histories of tuna fishing in the Pacific and of national fleets within the fishery, and statistical data on changes to the fishery from the 1950s collated by stock assessing scientists at the Secretariat of the Pacific Community in Noumea. The second part of the paper on impacts to marine animal populations is based on scientific papers about fishing effects on stocks in academic publications and in the papers of the Western and Central

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J. Christensen, M. Tull (eds.), *Historical Perspectives of Fisheries Exploitation in the Indo-Pacific*, MARE Publication Series 12, DOI 10.1007/978-94-017-8727-7_8,

Pacific Fisheries Commission. Joe Hamby and Robert Gillett provided helpful information for the development of this chapter. Thanks to Antony Lewis and Thom van Dooren for constructive comments on an earlier version.

The island countries and territories of the Pacific Ocean are relatively sparsely populated so there has historically been less fishing pressure on marine animal populations than in many other parts of the world. Fishing effort has been steadily growing in recent decades, however, as overcapacity and overfishing in other places has sent fleets looking for new fishing grounds. Artisanal fishing has long been an important source of food and livelihoods for Pacific Islanders, but the focus of this chapter is industrial fisheries.[1] It has been estimated that industrial tuna catches are about ten times the volume and over seven times the value of all other fisheries combined in the Island Pacific, including prawn trawling, inshore commercial fisheries, and inshore subsistence fisheries (Gillett and Lightfoot 2002). Furthermore, while various other kinds of fisheries have been tried in a large-scale commercial manner (spearfishing, lobster fishing, live fish collection, giant clam fishing, bottom fishing) these stocks have not been resilient to fishing pressure. At this stage tuna fisheries are the only industrial wild-catch fisheries that may be sustainable in the Pacific Islands (Gillett 2007).

Industrial tuna fishing around Pacific Island countries began in the first half of the twentieth century, and re-emerged after World War II in the 1950s, developing slowly until the 1980s. Then tuna fisheries expanded greatly with new fishing practices and new entrants increasing catches steeply and steadily to the present day. The Japanese fleet was the most active in the region from the 1950s to the 1970s, and used the pole-and-line and longline methods to target fish mostly for the international cannery market. In the 1970s the Japanese fleet started also longlining for sashimi tunas. Taiwanese and Korean longliners also followed this pattern. In the 1980s the new, much more efficient method of purse seining came to be widespread in the fishery, and US purse seiners started operating in significant numbers in the Western Pacific region. Since the 1990s fleets from the Philippines, China, Europe and Pacific Island countries themselves have also come to be significant players, both in longlining and purse seining. The advent of purse seining is largely responsible for steadily rising tuna catches since the 1980s, although innovations in longlining have also led to a smaller increase.

The main tuna species targeted in the Western and Central Pacific Ocean (WCPO) are skipjack (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*) and South Pacific albacore tuna (*T. alalunga*). Fishing does not seem to have harmed the capacity of two of these—skipjack and albacore—to maintain their populations. Fishing is, however, having a deleterious effect on the biomass of the other two species—yellowfin and bigeye—especially in terms of very large fish within populations. Yellowfin and bigeye have been targeted by

[1] There is no clear way to distinguish industrial from artisanal fisheries, especially for smaller scale industrial fisheries, but a working definition of industrial fisheries in the Island Pacific includes criteria such as: vessels greater than 15 m in length; fishing in offshore areas; selling catches for export and/or processing in a factory; and having data on the fishery collected for resource management purposes (Gillett 2007).

sashimi longline fleets, but more damage has been done by the much higher volume purse seine fishery. Purse seiners in the region usually target skipjack, although they may also target yellowfin. One of the main problems is that in some styles of purse seine fishing utilizing fish aggregating devices juvenile yellowfin and bigeye are mixed up in schools of skipjack. Fisheries regulation to date has not managed to significantly limit yellowfin and bigeye catch rates.

Industrial tuna fishing also incidentally kills other animals. Longlining in particular may catch seabirds, turtles and sharks. Because fisheries management has in the past been based on science about the target species in isolation from the rest of the ecosystem, the longitudinal data collected only covers the target species. With the move to ecosystem-based fisheries management the Western and Central Pacific Fisheries Commission (WCPFC) has commenced a more systematic collection of data about the mortality of other species in tuna fisheries, and techniques to minimize this mortality.

History of Industrial Tuna Fishing in the Island Pacific

In 1899 the *Albatross* surveyed the potential for industrial tuna fishing for US fleets around countries from French Polynesia in the southeast Pacific over to Guam in the northwest (Gillett 2007). There was no commercial tuna fishing, however, until after the Treaty of Versailles, when Japan gained control of many German colonial territories in the Pacific, including what is now Palau, the Federated States of Micronesia (FSM), Marshall Islands, and the Northern Mariana Islands. Japan invested substantial effort in developing industries in these islands, in line with its strategy to increase its food production base through colonial territories (Peattie 1984; Gillett 2007). The Japanese government offered subsidies for tuna fishing vessels, fishing gear and processing equipment (Fujinami 1987).

Three commercial fishing and processing operations were established in Palau in the 1920s. Activities accelerated in the 1930s with 116 pole-and-line vessels based in Japanese territories in the Island Pacific. Longline vessels based in southern Japan also fished the area. Most of the catch was processed on the islands into a dried product *katsuobushi*, and there were also two or more canneries processing fish for shipping back to Japan (Gillett 2007).

Japanese fishing in the Island Pacific ceased for some years after defeat in World War II, then recommenced in 1952. As with the pre-war fishing expansion, the Japanese government supported the post-war development of distant water fishing fleets, including large-scale pole-and-line and longline tuna vessels, to boost Japan's food production capacity (Fujinami 1987). Japanese government post-war support for fishing companies operating in the Pacific has included buyback schemes to assist with fleet restructuring, price support schemes, and low interest loans (Bergin and Haward 1996; Barclay and Koh 2008).

Although Japanese fishing vessels returned to Micronesian waters in the early 1950s, the USA had taken over control of most of the former Japanese colonial territories and restricted Japanese economic activity onshore in these places until the

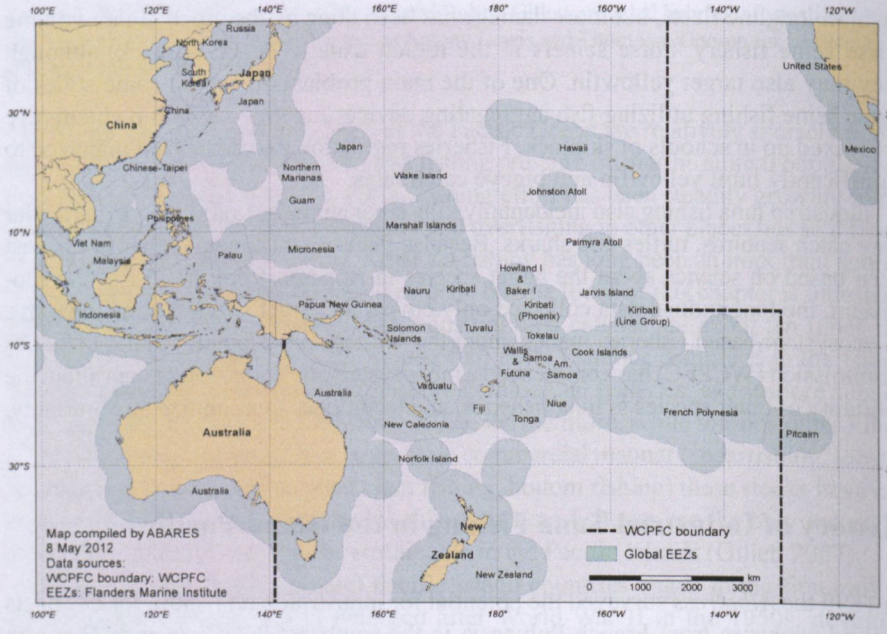


Fig. 8.1 Map of exclusive economic zones in the Western and Central Pacific. (Courtesy ABARES)

mid 1970s (Gillett 2007). The Japanese fleet thus established bases in other parts of the Pacific. From the early 1950s through to the early 1960s Japanese longline bases were established in Fiji, American Samoa, Vanuatu, New Caledonia and French Polynesia. Developments in longline vessel technology improved such that even Japan based longliners increased their range throughout the Pacific to 40° south by the early 1960s (Matsuda 1987). Japanese longline vessels mostly caught albacore, which was exported to canneries in Hawai'i and the USA mainland (Gillett 2007; Fig. 8.2).

The USA government had commandeered California based pole-and-line vessels for service in the Pacific during WWII, and the several hundred fishermen serving on those vessels became aware of the potential of Western Pacific tuna fisheries (Felando 1987). Government and private fisheries surveys were carried out in the 1930s, 1940s and 1950s, but generally tended to concentrate on the Eastern Pacific Ocean (EPO, east of the black line in Fig. 8.1). In 1953 Van Camp Seafood Company bought a tuna cannery in Pago Pago in American Samoa. The cannery had been built to process catch from a Fiji based fishing company in the late 1940s but the fishing venture had failed. Van Camp also established a pole-and-line fishing base with 8–15 vessels and a freezing facility in Palau in 1964. Starkist joined Van Camp in Pago Pago, establishing a cannery in 1963 (Felando 1987; Gillett 2007).

Japanese pole-and-line vessels used live bait, which meant they could not operate far from a shore base, so this method was limited to waters close to Japan until the early 1960s. Then technological improvements allowed them to roam further

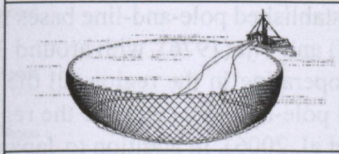
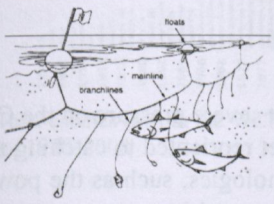
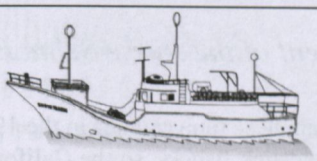
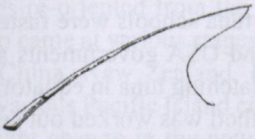
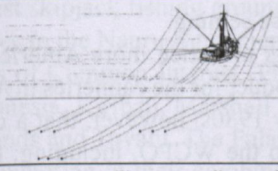
Gear Type	Typical Vessel
Purse seine	
	
Mainly skipjack and small yellowfin are caught by purse seine gear. Most catch is for canning.	About 72% of the tuna catch in the WCPO region is by purse seine gear (about 1.5 million tons in 2006). Most of the purse seine catch is taken within 5^0 of the equator.
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 10% of the tuna catch in the WCPO region is by longline gear (about 229,000 tons in 2006). There are two main types of longliners: (1) relatively large vessels with mechanical freezing equipment (often based outside the Pacific Islands), and (2) smaller vessels that mainly use ice to preserve fish and are typically based 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 10% of the tuna catch in the WCPO region is by pole-and-line gear, about 212,000 tons in 2006. In the 1980s, several Pacific Island countries had fleets of these vessels, but most no longer operate because of competition with the more productive purse seine gear. Most of the catch by this gear is made in Asian waters.
Trolling	
	
Large-scale trolling targets albacore for canning.	Gear types other than the three listed above are responsible for about 10% of tuna catch in the WCPO. Large-scale trolling is an important part of this. It is carried out in the cool water to the south and north of the Pacific Islands region. Trolling in the south results in about 5,000 tons of albacore annually.

Fig. 8.2 Main tuna fishing gear types. (Courtesy Robert Gillett)

afield to the Northern Marianas and Palau in the Japanese off-season. By the 1970s they were also fishing south of the equator in a sweep southeast of Japan as far as Fiji (Gillett 2007). Japanese investors also established pole-and-line bases in Papua New Guinea (1970), Solomon Islands (1971) and Fiji (1976), with around 300 vessels (both distant water and locally based) operating in the region till the peak of this fishery in the 1980s. The highest annual pole-and-line catch for the region was 380,000 metric tons (mt) in 1984 (Langley et al. 2006). In addition to Japanese and Japanese-established pole-and-line fleets in the region, there have been pole-and-line fleets in French Polynesia and Hawai'i.

Development of the Purse Seine Fishery

Expanding Japanese tuna catches in the 1950s put severe pressure on the California based pole-and-line fishery, so the California fleet reoriented to catching tuna with purse seine gear using new techniques and technologies, such as the power block to mechanize hauling the net, and synthetic fibres making nets stronger and less labour intensive to maintain. Like pole-and-line fishing purse seining is a 'surface' fishery—targeting fish on the surface of the water (as opposed to longlining that targets fish further down the water column). Japanese fishers also took up the new method for catching tuna, with 60–70 small purse seine vessels being used in the temperate waters off Japan by the late 1960s (Gillett 2007). New innovations were required, however, before purse seining could be used in the tropical Pacific, because the clear water and deep thermocline meant tuna schools were faster-moving and deeper-diving (Gillett 2007). The Japanese and USA governments sponsored experimental expeditions to develop methods for catching tuna in equatorial waters with purse seines, and eventually a successful method was worked out setting nets around logs (some tunas school underneath things floating on the surface of the water). The mid 1970s saw the development in the Philippines of another technology that facilitated industrial purse seining in equatorial waters—the *payaw* or *payao* fish aggregating device (FAD). FADs for tuna fishing in the Pacific are floating pontoons. They operate on the same principle as the log sets, aggregating the fish so they can be caught with a net. Pole-and-line fisheries also made use of this invention, but it had greatest impact in facilitating purse seining.

From around 1970 there were various efforts to entice more American purse seiners into the WCPO so as to generate more product for the canneries in American Samoa (Felando 1987).[2] It wasn't until the early 1980s, however, that a combination of factors drew more American vessels into the WCPO, including: (1) some American purse seine vessels were demonstrating success fishing around Papua New Guinea and New Zealand; (2) the American fleet was having difficulties getting access to fishing grounds off Mexico and Costa Rica; (3) a new licensing agree-

[2] Other quasi-government support for US tuna fisheries in the Pacific included the Reconstruction Finance Corporation (in the late 1940s), the Pacific Oceanic Fisheries Initiated (1949–1959) and the Pacific Tuna Development Foundation from 1974 (Gillett 2007).

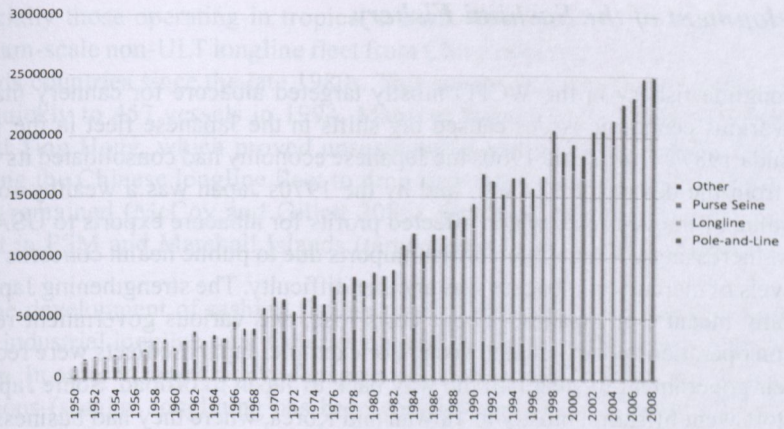


Fig. 8.3 Tuna catches (mt) in the WCPF-CA by Purse Seine, Longline, Pole-and-line and Other Gear Types, 1950–2008

ment was concluded between the American Tunaboat Association with US trust territories in the Pacific; (4) a strong El Niño event in 1982–1983 reduced fish availability in the EPO; and (5) campaigns against dolphin mortality in tuna fishing were encouraging fleets to find new grounds where dolphins do not school with tuna as they do in some parts of the EPO (Felando 1987).

The 1980s also saw the Japanese purse seine fleet grow in the WCPO. Many companies re-oriented from the pole-and-line to the purse seine method. New entrants also came at various stages from South Korea (hereafter referred to as Korea), Taiwan, China, New Zealand, Philippines, Indonesia, and most recently vessels based in various Pacific Island countries. The rise of the purse seine method marked a significant change in the nature of industrial fishing impacts on marine animal populations in the WCPO, with the steep and steady increase in catches from the 1980s attributable to expansion in the purse seine fishery (see Fig. 8.3).

An early attempt to limit purse seining in the region was made with the *Palau Arrangement* for the Management of the Purse Seine Fishery in the Western and Central Pacific in 1995. This agreement was made by a group of governments with the richest skipjack fishing grounds who since 1982 have worked cooperatively as the Parties to the Nauru Agreement Concerning Cooperation in the Management of Fisheries of Common Interest (PNA). Member countries are the Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu. The Palau Arrangement limited the number of purse seine vessels operating in their combined EEZs to 205. The input control measure used for purse seining in the PNA zone was changed in the mid 2000s from the vessel number cap to a Vessel Day Scheme (VDS), to enable flexibility through trading of fishing days across countries within the group and across vessels. As of 2010 around 220 large scale purse seiners operate in the WCPO.

Development of the Sashimi Fishery

The longline fishery in the WCPO mostly targeted albacore for cannery markets until various economic issues caused big shifts in the Japanese fleet in the 1970s (Matsuda 1987). During the 1960s the Japanese economy had consolidated its climb back from the devastation of war, and by the 1970s Japan was a wealthy society. The value of the yen rose, which affected profits for albacore exports to USA canneries. Increasing US regulation of fish imports due to public health concerns about the levels of mercury in albacore was another difficulty. The strengthening Japanese economy meant that Japanese labour costs rose, and various government restrictions on operations contributed to costs. For example, Japanese fleets were required by their government to steam all the way back to Japan to offload. Some Japanese investors went offshore, mostly to Taiwan and Korea, where they had business connections established during the Japanese empire. Costs for fleets also rose due to the oil price shocks in the 1970s, and the oil shocks caused recession in Japan, which also affected the Japanese fleet. Then there was the rollout of 200 nautical mile Exclusive Economic Zones (EEZs) around the coastlines of countries, meaning distant water fleets now had to pay for access to fishing grounds that were previously considered high seas and thus free access. The new fleets from Taiwan and Korea increased competition in longline fisheries, and also increased fish supply, which had a downward effect on prices. Finally, the growing affluence of Japanese consumers in the 1960s, along with supply increases related to Japanese export and import trends, gave rise to an increasing market for high value sashimi tuna (Bergin and Haward 1996, Issenberg 2007).

Japan-based longline fishing companies reacted to this business environment by reorienting their operations away from low value albacore for USA canneries, to high value sashimi tunas (bigeye and yellowfin) to sell in Japan. The Japanese longline fleet adapted new technologies in ultra low temperature (ULT, less than 60 °C) freezing which enabled the preservation of tuna meat in a form suitable for sashimi markets (less cold freezing temperatures allow the flesh to go brown). With ULT vessels could stay fishing out at sea rather than having to steam frequently to the nearest port to airfreight chilled fish. This led to the building of larger longline vessels (>250 GRT) that could go out for months at a time and operate over large areas of the globe.

The Japanese longline fleet's shift to sashimi fishing did not mean that fishing pressure on albacore eased, because Taiwanese and Korean albacore fleets stepped in where Japanese fleets left the field. Taiwan had started distant water longline fishing for albacore in the Pacific in the 1960s, and by the mid 1970s the Taiwanese longline fleet was as significant as Japan's. Korea soon followed Taiwan. Taiwanese and Korean longline companies took over longline bases in the Pacific from the Japanese fleet. Taiwan and Korea also developed ULT vessels.

The development of ULT vessels did not mean the demise of smaller vessels using ice or other chilling methods. A portion of Taiwan's fleet has remained without ULT, and almost all Pacific Islands based longline fleets are non-ULT,

especially those operating in tropical waters. There has also been a significant medium-scale non-ULT longline fleet from China operating in the EEZs of Pacific Islands countries since the late 1980s. This started in 1998 with 7 vessels, growing quickly to 457 vessels in 1994. Many of these vessels supplied a company called Ting Hong, which proved unsustainable and collapsed after a few years, causing the Chinese longline fleet to drop right back to around 120, where it has since remained (McCoy and Gillett 2005). Chinese longline vessels have been based in FSM and Marshall Islands (targeting sashimi) and Fiji (targeting albacore).

The development of sashimi fishing marked a change in the nature of impacts from industrial longline tuna fisheries on marine animal populations in the Pacific Ocean. In order to target bigeye Japanese vessels moved into different geographical locations (sashimi longlining has been concentrated in the tropical WCPO while albacore catches are greater in subtropical areas) and also extended their fishing effort deeper into the water column.[3] To catch bigeye the hooks on longlines are hung deeper in the water (100–300 m below the surface) than for catching albacore (Morgan and Staples 2006). The total number of vessels involved in the longline fishery has stayed relatively stable between 4,000–5,000 since the mid 1970s (Langley et al. 2006). Expansions in fish landings from the longline fleet from the 1970s (see Fig. 8.3), therefore, were due to the introduction of larger vessels and the extension of fishing effort into new species (see Fig. 8.4), new locations and deeper in the water column.

Prior to 1980 yellowfin was the preferred target in the WCPO sashimi fishery, but since 1980 bigeye has been preferred. Bigeye tunas sold on the sashimi market, chilled or frozen, fetch the highest prices of any tropical tuna. Bigeye from the WCPO has an estimated landed value of US$600 million annually, so although longline fishing has only accounted for around 11% of the total catch in recent years, the landed value of the longline catch rivals that of the much larger purse seine catch (Langley et al. 2006).[4]

From the mid-2000s fuel prices once again became a major factor affecting longline fishing. From 2004 to 2008 steady fuel price increases meant some longliners were no longer economical to run, and many Japanese and Taiwanese vessels were tied up in port for long periods. The Global Financial Crisis reduced fuel prices in 2008, but fuel prices have risen again. Whether this results in an overall decrease in fishing effort depends on the balance between production costs (including fuel) and fish prices. This balance, in turn, is affected by factors such as demand for sashimi tunas and the extent to which vessel technology development (usually subsidized) can improve fuel efficiency for longliners. As Japanese seafood cuisine has global-

[3] For information on where in the Pacific the different tuna species are caught, see publications and reports of the Oceanic Fisheries Program (OFP) of the Secretariat of the Pacific Community (SPC) (http://www.spc.int/oceanfish/).

[4] It is worth noting that the highest value sashimi tunas are the bluefins caught in colder waters, fish from the tropical Pacific sit at the lower end of the sashimi price scale.

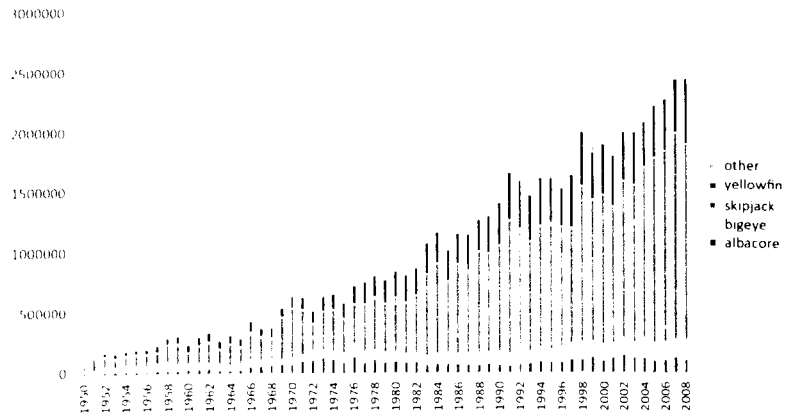


Fig. 8.4 Catches (mt) of yellowfin, skipjack, bigeye, albacore and other species in the WCPF-CA, 1950–2008

ized, demand growth in markets willing to pay high prices for sashimi, including in China, may sustain the industry even in the face of declining stocks and elevated fuel prices.

Development of Locally Based Fisheries

Exclusive Economic Zones of 200 nautical miles became a firm likelihood for the Pacific in the 1960s, and during the late 1970s they came into force. Both US and Japanese fleets resisted paying fishing access fees to Pacific Island countries for some time, although both capitulated in the 1980s (Schurman 1998). Fears that the USSR may gain a foothold in regional fisheries forced the USA government to negotiate access fees, resulting in the USA Multilateral Tuna Treaty in 1988 (Gillett 2007).

Many Japanese fishing companies responded to the advent of EEZs by establishing joint ventures with newly independent Pacific Island states. Support for Japanese tuna industries operating in the Pacific Islands was extended through the quasi-governmental Overseas Fisheries Cooperation Foundation (OFCF), among other avenues. OFCF soft loans could cover up to 70% of the capital costs for joint ventures (Matsuda 1987). Around a dozen such joint ventures between Japanese fishing companies and Pacific Island governments were made from the end of the 1960s, the most significant being Solomon Taiyo in Solomon Islands and Pafco in Fiji, both of which established canneries that are still active today.[5]

[5] Because several import destinations, particularly the EU and USA, have protected domestic canning industries the demand is for frozen 'loins'—tuna meat prepared ready for canning—rather than cans. In recent years the Solomon Taiyo (now called SolTuna) and Pafco factories have exported loins more than cans.

Japanese interests in forming joint ventures coincided with another twist in Pacific Islands tuna fisheries in the 1970s: newly independent Pacific Islands states were interested in tuna as part of their economic development strategies. This was the era when former colonies, seeing the success of the OPEC countries in generating wealth from oil, hoped for a New International Economic Order, whereby wealth could be generated by raw materials (a reversal of the colonial economic order in which trade in primary commodities had benefitted the colonial powers) (Schurman 1998). The 1970s were also an era when government ownership of companies was in vogue, as it was believed that national ownership would guarantee that economic development benefits would be kept within the local economy rather than disappearing overseas. Eighteen state-owned tuna fishing companies were started in the Pacific Islands area in the 1970s, many as joint ventures with Japanese companies (Gillett 2007). During the 1980s and 1990s nearly all of the state-owned fishing ventures failed. None was profitable and some generated huge losses, although some also generated significant benefits for host economies in wealth distribution through employment and human resources development (trained and experienced fishing crews and technical staff have subsequently been used by private sector investors) (Barclay and Cartwright 2007).

Many of these government-owned companies engaged in medium-scale pole-and-line fishing since this method was relatively low-tech and labour-intensive, so it suited Pacific Island economic conditions and aspirations to have locally based and locally crewed vessels. This kind of fishing was carried out in several countries in the Western Pacific during the 1970s and 1980s, but since it required a combination of daily accessible live baitfish from reef and lagoon areas and the right kind of skipjack resources, it was most successful in Papua New Guinea and Solomon Islands, and seasonally in Fiji. Even there, however, competition with cheaper purse seine-caught fish caused problems and there was only one of these fleets still operating by 2000, in the Solomon Islands. The Solomon Taiyo fleet was subsidized, but even then it was only viable while the main buyers in the UK (such as Sainsbury's and Waitrose) were willing to pay a premium above the purse seine price for the positive social and environmental factors associated with the pole-and-line method. In 2000 changing retail conditions in the UK wiped out that premium, which made Solomon Taiyo's business unviable so the Japanese partner withdrew (Nakada 2005). By 2008 By 2008 Solomon Islands' fleet had dwindled to a couple of operable vessels. The increasing importance of Corporate Social Responsibility in food retail in Europe, however, means there is increased demand for environmentally 'friendly' tuna, so the pole-and-line method may yet be revived in Pacific Islands countries (Stone et al. 2009). Any developments in skipjack fisheries, however, need to be able to weather very volatile fish prices. In 1999 the world skipjack price dipped below US$ 400 per tonne, and stayed at record low levels till 2001, which meant some companies tied up their vessels because it was not worth fishing at that price. Prices recovered from 2004 then went the other way to record highs, sitting over US$ 1,500 per tonne for most of 2008 (FAO 2009).

In the 1990s Pacific Islands based small- and medium-scale (< 100 GRT) longlining took off. Pacific Island citizens have been significant players, and Japanese,

Taiwanese, and Chinese investors have been involved. There have been offshore subtropical albacore fisheries based in American Samoa, Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Solomon Islands, Tonga and Vanuatu. There have been tropical offshore sashimi fisheries based in Palau, FSM, Marshall Islands, Guam, PNG, Solomon Islands, Cook Islands, and Fiji. These vessels have used ice or refrigerated sea water, rather than ULT capacity, so needed to return to port regularly to unload their catch for airfreight to market. By the mid 2000s dwindling catches of large yellowfin and bigeye suitable for sashimi markets, fuel price rises and difficulties with airfreight connections rendered some companies unviable and consolidated the rest into the albacore fishery (Barclay and Cartwright 2007). Pacific Island based companies caught 33% of the total south Pacific albacore longline catch in 1998, and over 59% in 2006 (Langley et al. 2006). Expanding domestic longline fleets remains a key aim for fisheries development in Pacific Island countries (Gillett 2008).

Pacific Island governments have often phrased their aspirations regarding the development of tuna fisheries and processing industries as 'domestication'. This overarching term means a range of things including: Pacific Islanders owning, managing and working in fisheries industries, turnover cycling through the domestic economy, and profits being reinvested locally. Purse seine fisheries take the largest portion of the regional tuna catch but purse seine vessels are high tech, large and expensive. PNA countries whose EEZs are used extensively by purse seine fleets have worked to domesticate purse seining. In 1994 the PNA signed the Federated States of Micronesia Arrangement for Regional Fisheries Access (FSMA). The FSMA gives multilateral fisheries access across the combined EEZs to purse seine fleets that meet the criteria for being 'locally based'. Not many purse seine vessels responded by basing themselves in Pacific Island countries, except in Papua New Guinea (PNG). In the mid 1990s the PNG government started using fisheries access to entice foreign fleets to invest in onshore processing (canneries and/or loining facilities). The first company to take up this offer was RD Tuna from the Philippines, with a cannery coming on line in 1997. Following the success of RD another Filipino company Frabelle and a US-Taiwanese venture South Seas Tuna Company established local operations in the mid 2000s. The PNG based purse seine fleet subsequently grew from two vessels before 1994 to around 40 vessels in 2006 (Lawson 2007). The Philippines is a major tuna player in the WCPO with its domestic catch and canning output one of the largest in the region, and with around 45 vessels currently based in PNG the Philippines has become a significant player in the Island Pacific. Growth in the PNG-based fleet accounts for most of the total increase in purse seine vessels operating in the region since the inception of the FSMA – from 147 in 1995 – 175 in 2006 (Langley et al. 2006), and over 200 from the late 2000s.

The PNA and its cooperative agreements the FSMA and Palau Arrangement are not the only instances of collective efforts for fisheries management and development by Pacific Island countries. The Secretariat for the Pacific Community (SPC) has been the umbrella organization for statistical data collection for fisheries management purposes since 1980, and has also long provided technical advice for

development of small-scale commercial tuna fisheries. The Pacific Islands Forum Fisheries Agency (FFA) began in the late 1970s and has housed regional initiatives such as the US Multilateral Treaty, the Vessel Monitoring System for electronic surveillance of fishing vessels, a regional fishing vessel register, and newsletters on tuna trade and market issues.

Pacific Island development of fisheries and onshore facilities for canned tuna has been greatly affected by the international trade regime. 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 et al. 2007). A collapse in regional processing may affect fishing practices, as fleets currently supplying those facilities may shift their fishing grounds.

In sum, the trends in Pacific Islands based tuna fisheries development started with a state-owned model in the 1970s, which led to disillusionment as most of these ventures failed, and the belief that maximizing access fees from distant water fleets was a more sound economic strategy. Then in the 1990s there was success in several countries with locally based longline fleets, and PNG successfully leveraged onshore development from distant water purse seine fleets, so these models of domestic development have been pursued by some countries, while access fees remain economically important for many of the PNA group (Gillett 2008). On the whole, however, Pacific Islands based fisheries have not had as much impact on marine animal populations as the distant water fleets, because distant water fleets have always taken much more fish.[6]

Trends Among Distant Water Fleets

The distant water fleets operating in the region have risen to prominence and declined or changed fishing practices for a range of reasons. The Japanese and USA fleets were the first big fleets and since the 1970s both have had relatively high production costs, in part due to home country regulations and economic conditions affecting their costs. For example, the fisheries sector has been an unpopular em-

[6] For information on catches by national fleets see Lawson (2007).

ployment option since the 1980s in Japan, so has shrunk dramatically. The Japanese and USA fleets have thus been undercut by fleets from Taiwan, Korea and China, which did not significantly innovate in fishing practice but have had lower production costs and 'aggressive' fishing practices (Gillett 2007). There are signs, however, that the Taiwanese and Korean fleets may be declining in the region. Taiwan dominated the albacore fishery from the mid 1980s, but by the mid 2000s Pacific Island fleets and others were taking a far larger proportion of the catch than Taiwan. Like the Japanese fleet before them, Taiwanese longliners have shifted focus to sashimi tunas, but this has not halted their decline. Since trade sanctions were imposed on Taiwanese sashimi imports to Japan in 2005 the Taiwanese government has been regulating its industry more strenuously. Skyrocketing fuel prices also affected longline fleets from 2004. Taiwanese and Korean sashimi catches dropped in the mid 2000s due to drops in active longline vessel numbers; from 133 (Taiwan) and 184 (Korea) vessels in 2002, to 117 (Taiwan) and 130 (Korea) in 2006 (Langley et al. 2006). According to an industry source, longlining is now less economically viable for Taiwanese companies than it was in the past (Wang 2009).

Impacts of Industrial Tuna Fishing on Marine Animal Populations in the Island Pacific

Fisheries have taken out more than 50 million tons of tuna and other predators from the Pacific Ocean since 1950. Some scientists calculate that this has meant there has been a catastrophic reduction in population biomass and collapses in oceanic food chains (Pauly et al. 1998, Myers and Worm 2003). Other scientists assert that those assessments are overly pessimistic, finding that some stocks are greater than 74% of their unexploited potential, and others are 36–49% of their unexploited potential (Sibert et al. 2006).[7] Time series data from 1950 indicates indeed that some stocks have increased, probably because decreasing stocks in other species are reducing competition. It may be that tuna fisheries' removal of slower growing predators from food chains are also causing population bulges in other fast growing predators for which statistics are not collected, such as mahi-mahi (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) (Sibert et al. 2006).

In addition to mahi-mahi and wahoo, other animals such as marlins, swordfish, sharks, turtles and sea birds are also killed by tuna fishing gear, especially longlines. For example, seabirds often try to take the bait from hooks on longlines as they float near the surface before they sink to the intended depth for catching tuna. Non-target fish and turtles may also be caught by longline hooks. Turtles may become entangled in fish aggregating devices used for purse seine fishing. Because fisheries science was conventionally based on single species, no longitudinal statistical information has been collected on mortality in non-target species caused by tuna fisher-

[7] For a refutation of Myers and Worm's (2003) analysis of Pacific tuna populations see Hampton et al. (2005).

ies in the WCPO. As ecosystem based fisheries management has become the norm, however, the WCPFC has for several years had a Working Party on Ecosystem and Bycatch Mitigation. This group is building knowledge about non-target species impacts, developing the basis for deciding which species need to be monitored and how best to collect and analyse data about these species, and investigating the effectiveness of measures such as circular hooks to reduce turtle catches, and 'tori-line' streamers to deter seabirds from attacking longline bait.[8]

Of the four types of tuna targeted by industrial fishing in the Island Pacific, skipjack has not suffered greatly. Skipjack are fast-growing and resilient to fishing. Fishing companies in the southern WCPO have since 2012 claimed that albacore is now showing signs of overfishing. Scientists agree, however, that there are stock conservation problems for bigeye and yellowfin in the WCPO, and fisheries managers have been attempting to decrease catches of these species since 2001.[9]

Impacts on Bigeye and Yellowfin

Yellowfin and bigeye are large fish. By 1970 the biomass of tunas larger than 175 cm from the tip of the snout to the centre of the fork in the tail had decreased by 40% in the Pacific, and currently they are estimated to make up approximately 1% of tuna populations, where they had made up around 5% (Sibert et al. 2006).

The impact of fishing on the total yellowfin biomass in the WCPO was not significant before 1980, but has increased as catches have increased since then. Declines in stocks were first observed in the late 1990s (Hampton and Fournier 2001). Fishing is estimated to have reduced the yellowfin biomass by about 40%, higher in the tropical zone (60%) and lower in the subtropical zone. Most damage has been done by Indonesian and Philippines domestic fisheries and the purse seine fishery in the equatorial region, while the subtropical longline fishery does not appear to have affected stocks (Hampton and Fournier 2001, Langley et al. 2006). Yellowfin tuna is captured at different ages by different gear types – when juvenile it may be captured by purse seiners, when older it is caught by longliners and (under certain conditions) purse seiners. Yellowfin is targeted by longliners supplying sashimi markets. Purse seiners target yellowfin for cannery markets, and they also catch juvenile yellowfin incidentally when targeting skipjack.

Fishing impact on bigeye biomass has increased steadily from the mid 1970s with a sharp increase in the mid 1990s. The impact is highest in the equatorial Pacific, having reduced biomass by up to 80% (which has been somewhat ameliorated by a high level of recruitment in stocks in the mid 2000s) (Langley et al. 2006).

[8] Papers on establishing data about and measures to limit bycatch are available in the Western and Central Pacific Fisheries Commission Scientific Committee meeting files (http://www.wcpfc.int/meetings/2).

[9] Debates about these efforts are in the meeting papers of the Standing Committee on Tuna and Billfish (http://spc.int/OceanFish/Html/SCTB/index.htm), and from 2005 meetings of the Western and Central Pacific Fisheries Commission (http://www.wcpfc.int/meetings/all).

Bigeye is targeted by sashimi longliners, and is also caught as juveniles by purse seiners – unintentionally because bigeye has no particular value as a canning fish.

The WCPO purse seine fishery is largely a skipjack fishery, with skipjack making up 70–85% of the catch, yellowfin 15–30%, bigeye less than 5%, and small amounts of albacore (only in the northern temperate Pacific) (Langley et al. 2006). Purse seiners have caught more or less bigeye and yellowfin depending on the fishing techniques employed. The main techniques are 'unassociated sets' (free-swimming schools of tuna) and 'associated sets'. Associated sets are when the net is set around something floating on the surface of the water that has aggregated tuna underneath: FADs fixed to the bottom of the sea; FADs drifting freely in the ocean; and drifting logs. Associated sets tend to have more juvenile yellowfin and bigeye mixed in with skipjack than do free swimming schools, which tend to be 'pure'— composed of one species.

A variety of factors influence the choice of fishing technique. Fixed FADs can only work in water shallow enough to tie the FAD to the ocean floor but deep enough to attract schools of pelagic fish. This method has been used around PNG and Solomon Islands by locally based fleets supplying canneries in those countries. The percentage of bigeye in catches is highest when drifting FADs are used, especially in eastern areas of the WCPO. Since 2000 the use of drifting FADs has declined and purse seine catches of bigeye have correspondingly declined. The choice to use drifting FADs is based on various factors. Some national fleets use them more than others. Drifting FADs have been used extensively by the USA fleet in the southern and eastern parts of the WCPO, close to the canneries in American Samoa those fleets supply. The Korean purse seine fleet, on the other hand has favoured fishing on free-swimming schools. Oceanographic effects also influence the use of drifting FADs. They are used more during El Niño events when the fish available to surface fisheries concentrate in the eastern part of the WCPO, as there are generally fewer free-swimming schools and logs available for fishing in the eastern than in the western part of the WCPO.[10]

Management of highly migratory tuna species must be done multilaterally so it is organized under intergovernmental Regional Fisheries Management Organizations (RFMOs). The WCPFC came into effect in 2004, after a decade of negotiations. The Parties to the Nauru Agreement (PNA) are the group of countries with the richest fishing grounds for purse seining, in which much of the damage to yellowfin and bigeye stocks is being done. The PNA first made an attempt to limit purse seine fishing effort through a cap on the numbers of distant water purse seiners operating in their combined zone in 1995, which has more recently been converted to the

[10] The majority of the information in this paragraph has been gleaned from Langley et. al. (2006). Notwithstanding the need to use more drifting FADs in the east, during El Niño there are more free-swimming schools available to surface fisheries in the east of the WCPO than there are during other parts of the oceanographic cycle, including free-swimming schools of very large yellowfin. Logs are washed down rivers from the larger land masses, so in the tropical Pacific they have drifted eastwards on the equatorial coun-tercurrent (ECC) from Southeast Asia and Papua New Guinea. They eventually sink, so are not usually available to use for fishing sets any further east than Kiribati. Antony Lewis, personal communication (email), 28 January 2010.

Vessel Day Scheme. As yet government measures, including restrictions on purse seine effort, have been unable to stem the overfishing of bigeye and yellowfin in the Western and Central Pacific Ocean. This mirrors the inability of other RFMOs to tackle overfishing, largely because member states either refuse to agree on effective measures or then fail to implement the agreed measures.

In light of continued overfishing, and because of the economic importance of tuna resources to PNA countries, the PNA group has pursued its own strategy for economic and environmental sustainability. In the 2008 3rd PNA Implementing Agreement it was announced that distant water vessels seeking to fish in PNA EEZs must sign an agreement not to fish on the high seas 'donut holes' between PNA EEZs and to accept 100% observer coverage and a ban on FAD fishing for the third quarter of each year (to relieve pressure on bigeye and yellowfin stocks). Since then the PNA has also entered into assessment of free-swimming skipjack for Marine Stewardship Council (MSC) eco-labelling certification.[11] There is great demand for MSC certified product by the large retailers in Europe and North America, and the PNA fishery includes close to half the world's skipjack stocks, so if successful this strategy could cause a major shift in global canned skipjack markets, and thereby in fishing practices. Improving purse seine fishing practices in the PNA zone, however, is not a total solution to the problem, because it does not address longline fishing, and because a great deal of damage to yellowfin and bigeye stocks is being done in the waters of Indonesia and the Philippines. The WCPFC and related intergovernmental efforts remain the main avenues by which to fix those parts of the problem.

Conclusion

Tuna could be a vital renewable resource for the economies of the Island Pacific, if it is managed well. Most of the fisheries are still showing strong catches despite continual fishing increases since 1950, and accelerated effort from the 1980s, so it is imperative that effective resource management is implemented as soon as possible. It is important to learn more about the ecosystem effects of industrial tuna fisheries in the region and address any damage in bycatch species. Depletion in bigeye and yellowfin stocks is already known, and needs to be more effectively addressed than it has been to date. The Western and Central Pacific Fisheries Commission has been running now for several years so should be prepared to meet these challenges. The most dynamic actor on the scene at present is the PNA – a group of countries with the most productive EEZs in the WCPO. It is to be hoped that the PNA can leverage their position as key coastal states and take the lead in establishing more sustainable fishing practices. The PNA, however, will be unable to fix all of the problems with bigeye and yellowfin stocks, as it has little leverage on longline fisheries or the

[11] The PNA group's collective purse seine fishing ground has been launched as 'Pacifical' (http www.atuna.com/newsletter/pacifical.html).

crucially important fisheries in Indonesia and the Philippines. It will also be necessary for the membership of the WCPFC to move beyond their disparate individual interests and take decisive collective action.

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