Dynamics of a South Tarawa Atoll fisher group, Kiribati

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Introduction

The Republic of Kiribati consists of three main island groups, the Gilbert Islands (or Tungaru Group), Line Islands and Phoenix Islands. While Kiribati's exclusive economic zone encompasses 5 million km^2, its total land area is just slightly more than 810 km^2 (Lovell et al. 2002). Tarawa is the largest of 16 atolls that make up the Gilbert Islands group (Fig. 1).

Tarawa's reef perimeter is approximately 107 km^2 and is open to the west where the reefs are permanently submerged. The lagoon area encompasses 375 km^2 and has many reefs within it, with the shallowest areas being on the eastern and southern margins (Lovell et al. 2002). Inner reef habitats are divided into the atoll rim, lagoon floor, and patch reefs and shoals. Because the western margin of the atoll is submerged, there is a continual exchange of sea water between the lagoon and the ocean. In contrast, the southern and eastern atoll rim consists of a relatively narrow outer reef flat, a series of low islets, and a wide lagoonal sand flat with limited ocean exchange. Causeway construction has further reduced this exchange by obliterating most passages along South Tarawa and several along the eastern rim on North Tarawa. These differences in oceanic to lagoon water exchanges have created a lagoon with marked northwest to southeast gradients in water characteristics, including productivity and composition (Paulay and Kerr 2001).

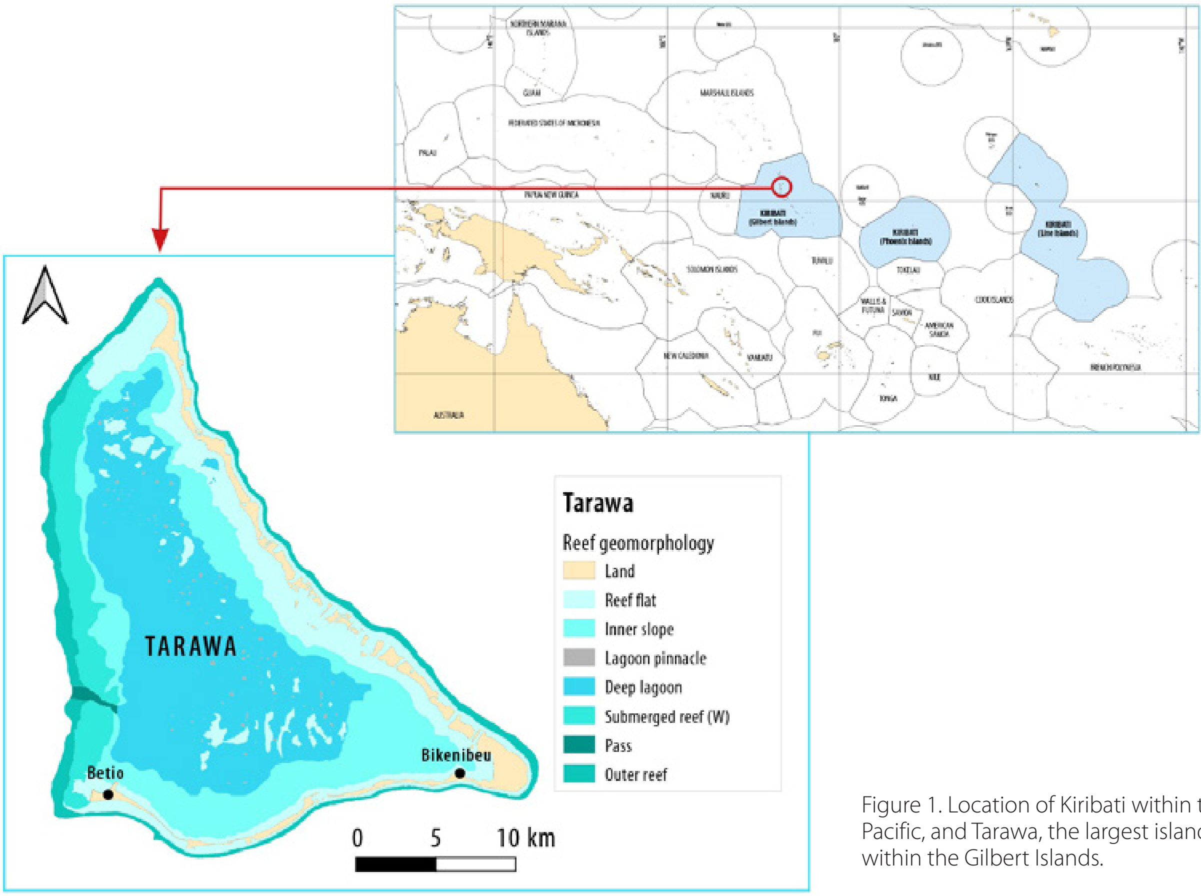

Figure 1. Location of Kiribati within the Pacific, and Tarawa, the largest island within the Gilbert Islands.

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Kiribati is one of the poorest countries in the world and is ranked 134th in the United Nation's Human Development Index (United Nations Development Programme 2021). Its economy was previously dependent on the revenue brought in from phosphate mining on Banaba Island, which ended in 1979. Since then, Kiribati has made up most of its income revenue from fisheries through foreign vessel fishing licenses, most notably for tunas, which are transshipped at Betio on South Tarawa (Barclay and Cartwright 2007; Gillett 2016; Zylich et al. 2014).

South Tarawa is also the main residential area in Kiribati, home to nearly half of Kiribati's total population. South Tarawa's population has grown exponentially in the last century. In 1931, there were 3031 people on South Tarawa. The 2015 census estimated the population on South Tarawa to be 56,338 (National Statistics Office 2016), and the 2020 provisional census data estimated a current population of 63,439 people (National Statistics Office 2021). The people of South Tarawa live on a series of atolls linked by causeways, some 30 km in length, with the widest point being only 300 m, and covering an area of approximately 15.75 km². South Tarawa has a very high population density of 2557 people per km², with some areas, such as Betio, having over 15,000 people per km².

The population increase on South Tarawa is a physical representation of rural–urban migration that dominates interisland movement and reflects the inequalities between rural and urban areas. South Tarawa has many "pull" factors, such as employment and education opportunities, and greater access to goods and services. Because of this huge rural–urban migration, South Tarawa continues to face many development challenges. These challenges include severe overcrowding in both formal and unplanned settlements, increased pressure on freshwater reserves, high levels of pollution in the lagoon as a result of increased solid and human waste, and conflict over land.

The fisheries of South Tarawa have also changed greatly in recent decades as human development and fishing effort have increased to meet the increased demand for food (Beets 2000). Previous assessments have documented declines in abundance and generally negative trends in yield and catch per unit effort (Cross 1978; Yeeting 1986; Mees 1988; Mees et al. 1988).

As part of the Pacific Community's (SPC) assistance to member countries, and in order to gain a better understanding of fisheries dynamics in Kiribati, a number of creel surveys were conducted across three atolls in the Gilbert Islands in 2020: Tarawa, Abemama and Onotoa (see Molai et al. 2020). This article focuses on Tarawa because it is the most densely populated atoll in the group by a factor of 13. During surveys on South Tarawa, we encountered one fisher group in particular at Bikenibeu that was consistently engaged in commercial fishing. During a 14-day period from 25 May to 7 June 2019, the authors sampled their catches daily. This group (referred to as the "study group" hereafter) also kept a detailed logbook of their expenditures and catches of which, copies were made with their permission. The period of the logbook encompassed the period 2 March to 7 December 2019.

Monitoring landings from an artisanal fisher group

For the 14-day sampling period, the study group was visited every morning on their return from fishing the previous night. In total, 10 fishing days were sampled. There were no fishing activities on Sundays, therefore no fish were landed on Monday mornings. In addition, fishing did not occur on two other occasions, once because of inclement weather and the other because there were not enough eskies (portable ice chests or coolers) available because the existing eskies were still full from the previous fishing trip, meaning not all fish from that trip had been sold. This study group targeted reef fish from the outer reef areas at night through handlining. Fishing was conducted at three locations in Tarawa Atoll:

- southwestern end (n = 4);
- northwestern end (n = 4); and the
- northeastern end (n = 2).

Sampling the catch of this study group consisted of short interviews with lead fishers from each fishing event, and sampling the whole landed catch for species identification, length and weight.

Number and weight of fish landed

During the 14-day sampling period, 1322 fish weighing a total of 965 kg were landed with an average of 132 fish ± 16 (SE) or 96.5 ± 14.8 (SE) kg of fish caught per fishing trip. Of note, the amount of fish caught was relatively consistent for most fishing trips but a number of trips showed greater variability (poor or rich days). This could have been influenced by a number of factors, including the location targeted (in this study, comparisons were not made due to the reduced number of fishing trips), tides, moon phase, weather conditions, fisher knowledge and experience. As examples, surveys conducted in late 1985 in Betio, Bairiki-Nankai and the Bikinebeu-Ananau causeway showed that ocean fishing in December declined due to bad weather, with a subsequent shift to reef fishing, which increased during the Christmas and New Year period due to increased demand (Mees and Yeeting 1986). In rough weather, more lagoon fishing is conducted, while in calm weather greater fishing effort is on oceanic species.

During the 14-day period of our survey, catches varied from 32 fish (42.1 kg) to 187 fish (205.8 kg) (Fig. 2).

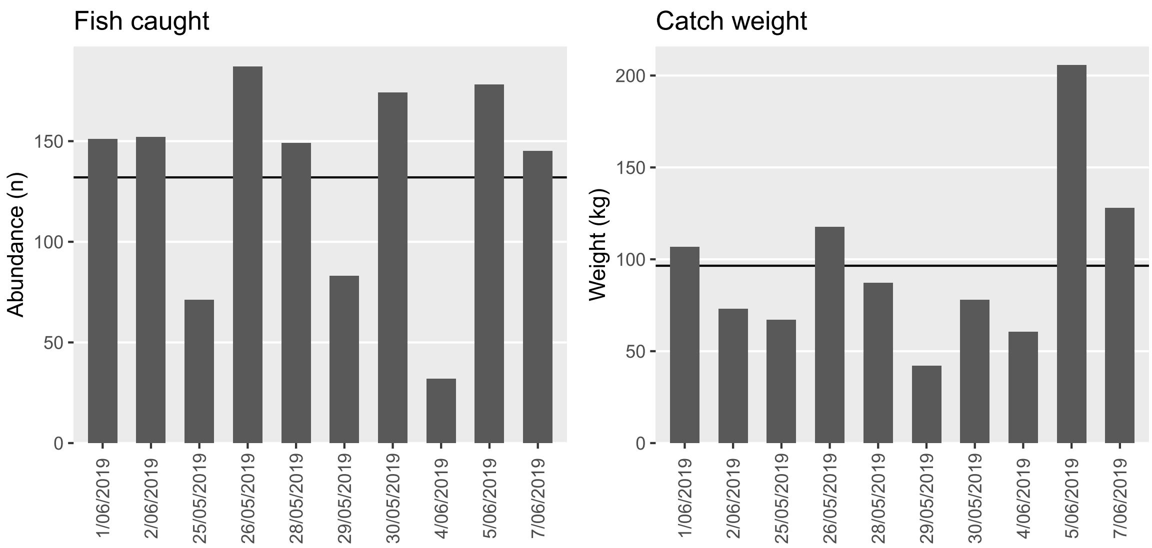


Figure 2. Landed catches across the survey period (May–June 2019).
Left: overall fish catch, right: overall catch weight. Dark horizontal lines correspond to the overall mean.

Fish families represented

Among the nine fish families found in the catches (Table 1), the most common were the families Carangidae, Lethrinidae and Lutjanidae. While these three families were almost equally represented in terms of the number of fish caught (around 30% each), the Lethrinidae family made up more than half of the weight of fish landed (59%) (Fig. 3).

Table 1. Families represented in the catches
(n= number of fish caught)

Family	n
Albulidae – bonefish	3
Balistidae – triggerfish	7
Carangidae – jacks and scads	398
Holocentridae – soldierfish and squirrelfish	28
Lethrinidae – emperors	454
Lutjanidae – snappers	386
Priacanthidae - bigeyes	12
Serranidae – groupers	11
Sphyraenidae – barracudas	23

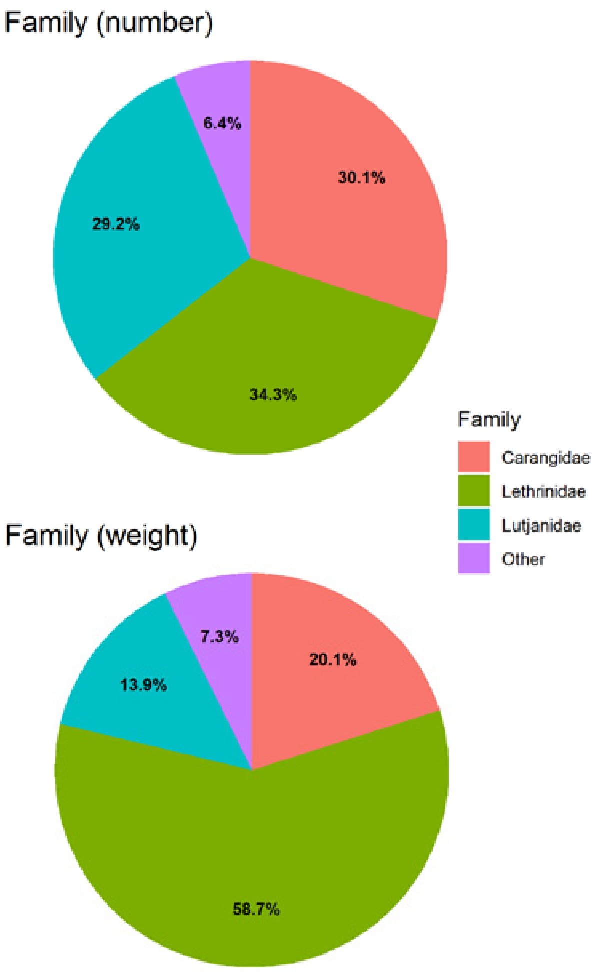


Figure 3. Fish families represented in the catch.
Top: catch in number; bottom: catch in weight.

Dominant fish species

In total, 43 fish species were recorded in the catches, with 17 species represented by at least 10 individuals (Fig. 4). The top five species caught were the spangled emperor (*Lethrinus nebulosus*), scads (*Selar* spp.), paddletail or humpback red snapper (*Lutjanus gibbus*), bigeye trevally (*Caranx sexfasciatus*) and longface emperor (*Lethrinus olivaceus*). These five species had more than 100 individuals landed during the sample period.

Proportion of the catch above size at maturity

To evaluate the status of the populations of species caught by this study group, the proportion of fish caught that were above or under the reported length at maturity (i.e. the length for which 50% of individuals in a given species are mature) was evaluated. This evaluation was done for species that had over 30 measurements. As there are no reported sizes at sexual maturity published for fish in Kiribati, we used sizes at sexual maturity taken from the literature (Table 2). We note however, that because sizes at sexual maturity can vary across locations (Longenecker et al. 2017; Prince et al. 2020), these values should be used with some caution.

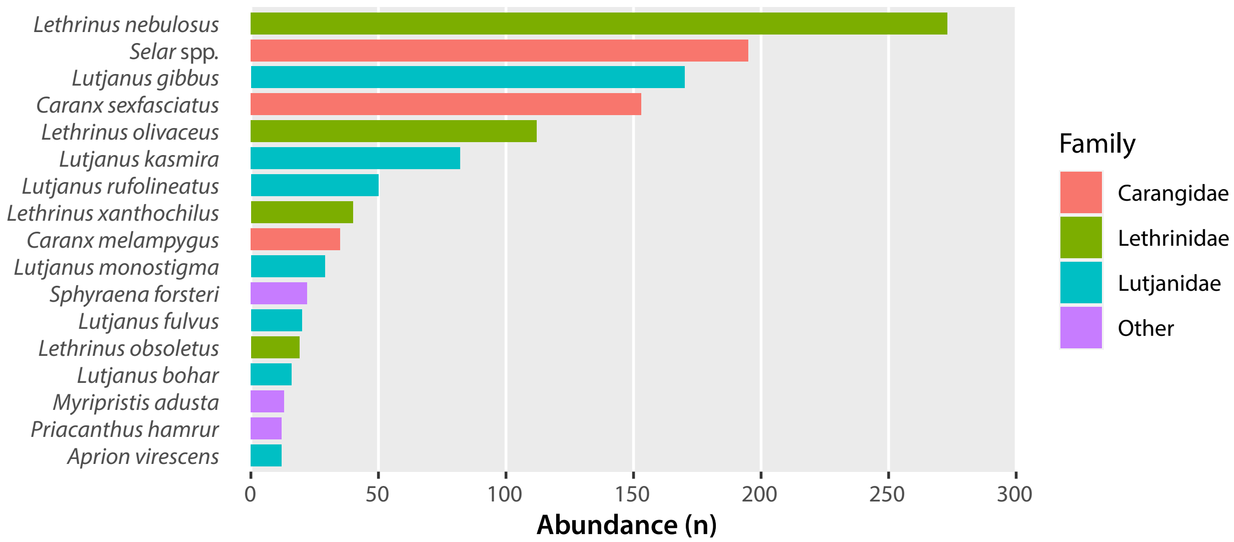
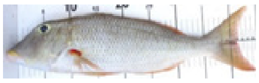
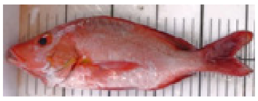
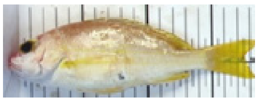


Figure 4. Fish species caught. Abundance corresponds to the total number of individuals encountered in the different catches across the 14-day sample period.

Back from a fishing trip, Tarawa, Kiribati. (image: Jeff Kinch, ©SPC)

Table 2. Species size reference table and associated literature. Sizes are expressed as fork length (FL) or in total length (TL) in centimetres and mean sizes are associated with standard error (SE), the number of individuals measured is also provided (n).

Scientific name Common name	Species photos	Maturity (cm FL)	References used, Location	Legal size (cm FL)	n	Mean size (cm ± SE FL)
Caranx melampygus Bluefin trevally		35 (TL)	(Sudekum et al. 1991) Hawaii		35	32.91 ± 0.85
Caranx sexfasciatus Bigeye trevally		50	(Van Der Elst 1993) South Africa		153	30.99 ± 0.48
Lethrinus nebulosus Spangled emperor		39.5	(Ranatunga and Rathnayaka 2019) Sri Lanka	55	271	40.49 ± 0.23
Lethrinus olivaceus Longface emperor		40.9	(Prince et al. 2015) Palau		112	47.22 ± 0.55
Lethrinus xanthochilus Yellowlip emperor		30	(Prince et al. 2015; Taylor et al. 2018) Palau; American Samoa		40	40.55 ± 0.47
Lutjanus gibbus Paddletail snapper		25	(Moore 2019; Taylor et al. 2018) New Caledonia; American Samoa	25	170	25.37 ± 0.28
Lutjanus kasmira Common blue-stripe snapper		20	(Rangarajan 1971) Andaman Sea	15	82	18.9 ± 0.21
Lutjanus rufolineatus Yellow-lined snapper		16.4	(Taylor et al. 2018) American Samoa		50	17.87 ± 0.10
Selar spp. Scads		21.5	(Roos et al. 2007) Reunion Island		183	25.47 ± 0.11

The nine species considered for their size at sexual maturity (Fig. 5) were:

- four species (longface emperor, yellowlip emperor, yellow-lined snapper, scads) with a high dominance of mature individuals (85–100%);
- two species (spangled emperor, paddletail snapper) with a slight dominance of mature individuals (50–65%);
- one species (common blue-stripe snapper) with a slight dominance of immature individuals (50–65%); and
- two species (bluefin and bigeye trevally) with a high dominance of immature individual (75–99%)

Proportion of the catch above the legal size established in 2020

Of the more than 30 species collected, only three – spangled emperor, paddletail snapper and common blue-stripe snapper – were associated with a minimum harvest size regulation in Kiribati (Ministry of Fisheries and Marine Resources Development 2020) (Fig. 6).

All of the spangled emperors that were caught were under the legal size, while almost all common blue-stripe snappers were above the minimum harvest size. Catches of paddletail snapper were more balanced, with slightly more individuals above or equal to the legal catch size than under it.

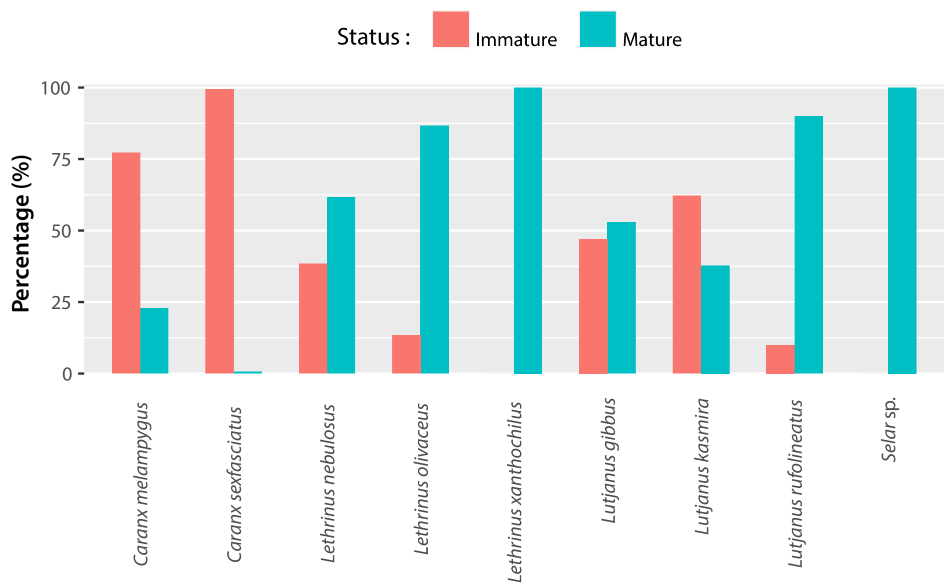


Figure 5. Proportion of estimated mature and immature individuals caught during the two-week sample period.

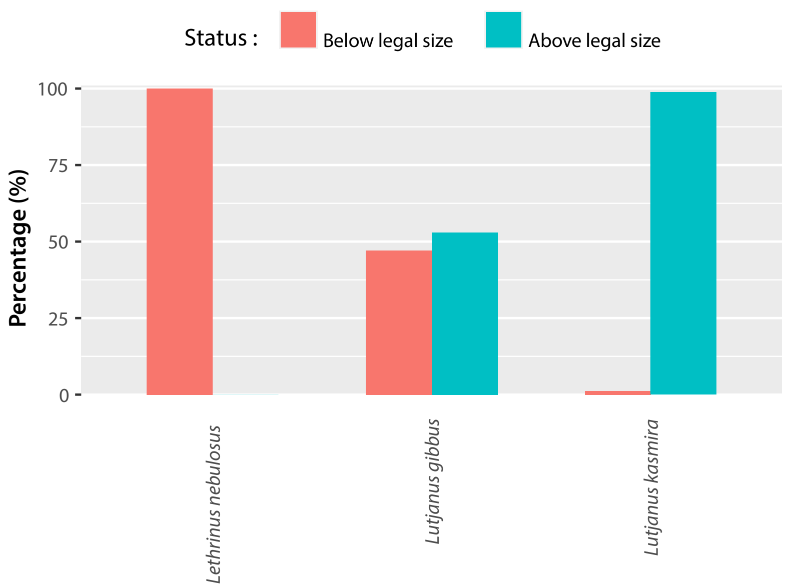


Figure 6. Proportion of individuals above or below legal size caught during the 14-day sample period.

Comparison of study group catches with other 2019 fisher group catches and historical handlining catches in Tarawa

As noted above, target species in South Tarawa have greatly changed over recent decades. The introduction of new technologies, such as monofilament gill nets and boats with outboard engines, also coincided with a significant decline in the use of traditional fishing methods. With high historical incidences of ciguatera from fish caught on the outer reefs of Tarawa Atoll (Cooper 1964; Tebano 1992; Lovell et al. 2002), fishing effort outside the lagoon has primarily targeted tunas or flying fish. Gibson (1976) noted that the most preferred fish species consumed at Bikenibeu in the mid-1970s was, in order of preference, tunas, bonefish, wahoo and mullet. Later catch surveys conducted in early 1981 in Betio, Bairiki-Nanakai, Bikenibeu, Teinainano and Buota showed the most important targeted fish species was bonefish, with an emerging market for the export of spangled emperor. At Bikenibeu, the top five species caught at this time, in order of importance, were bonefish, mullet, paddletail snapper, Pacific silver-biddy and convict surgeonfish (Marriott 1981). During the early 1980s, there was an economic downturn that resulted in increased fishing effort, a growth in entrepreneurism among artisanal fishers, and the acquisition of more efficient gear types (Marriott 1982).

Over time, target fisheries have changed across South Tarawa, with greater specialisation among fisher groups and village localities. Snappers (Lutjanidae), emperors (Lethrinidae) and groupers (Serranidae) dominated handline catches in the early 1990s. A survey conducted from April 1992 to February 1994 recorded 54 species and 1793 individuals caught from 46 fishing trips. Paddletail snapper was reported to be the most abundant species caught (40% of total number of fish caught), followed by orange-striped emperor (18%). Trevallies and squirrelfishes were also an important part of landings. Fishing effort using handlines was significantly greater in the northern and western ends of Tarawa Lagoon than in southern and eastern sites (Beets 2000). Later, Ram-Bidesi and Petaia (2010) noted that fishers on South Tarawa were targeting schools of paddletail snapper prior to their spawning run.

Creel surveys have been conducted in South Tarawa since 2013 by the Research and Monitoring unit of the Coastal Fisheries Division of Kiribati's Ministry of Fisheries and Marine Resources Development (MFMRD). In total, 67 handlining catches were recorded by MFMRD. These records were retrieved from MFMRD's database and compared to the 2019 landings from the study group we monitored (Table 3).

Table 3. Number of historical handlining landings in South Tarawa.

Historical MFMRD landings	
2013	9
2014	19
2015	7
2016	3
2017	12
2018	9
2019	8
Total (past)	67
2019 landings	
Study group 2019	10
Other groups surveyed in 2019	18

A typical handline catch, Tarawa, Kiribati. (image: Jeff Kinch, ©SPC)

Comparison of number and weight landed in the past

The average landing based on the two-week sampling period of the monitored study group tended to be approximately 30% higher than the average landings of other fisher groups monitored during the 2019 survey (Fig. 7). Historical landings recorded by MFMRD in South Tarawa tended to be around 50% lower for the same fisher groups encountered in this study in terms of number of fish landed, landed weight and species diversity. Although MFMRD's historical landing data were lower for the same fisher groups encountered in this study, when all landing were pooled for all fisher group landings recorded by MFMRD, there were some similarities with regards to year. In terms of weight, catches were similar between 2013, 2014 and 2019 while the number of fish caught was closer to those of 2013, 2014 and 2016 (Fig. 7). While this comparison gives some insights into the range of catches through time, the significant disparities in the number of landing surveys completed and/or fisher groups surveyed, as well as seasonal differences, these comparisons cannot be considered definitive or complete.

Comparison of families' representativeness across years

In comparison with the study group, catch composition was well represented across years for the Lutjanidae and Lethrinidae families. The Carangidae family was less represented with the exception of years 2015 and 2019. In 2019, the catch was more diverse with other families well represented in catches (Fig. 8).

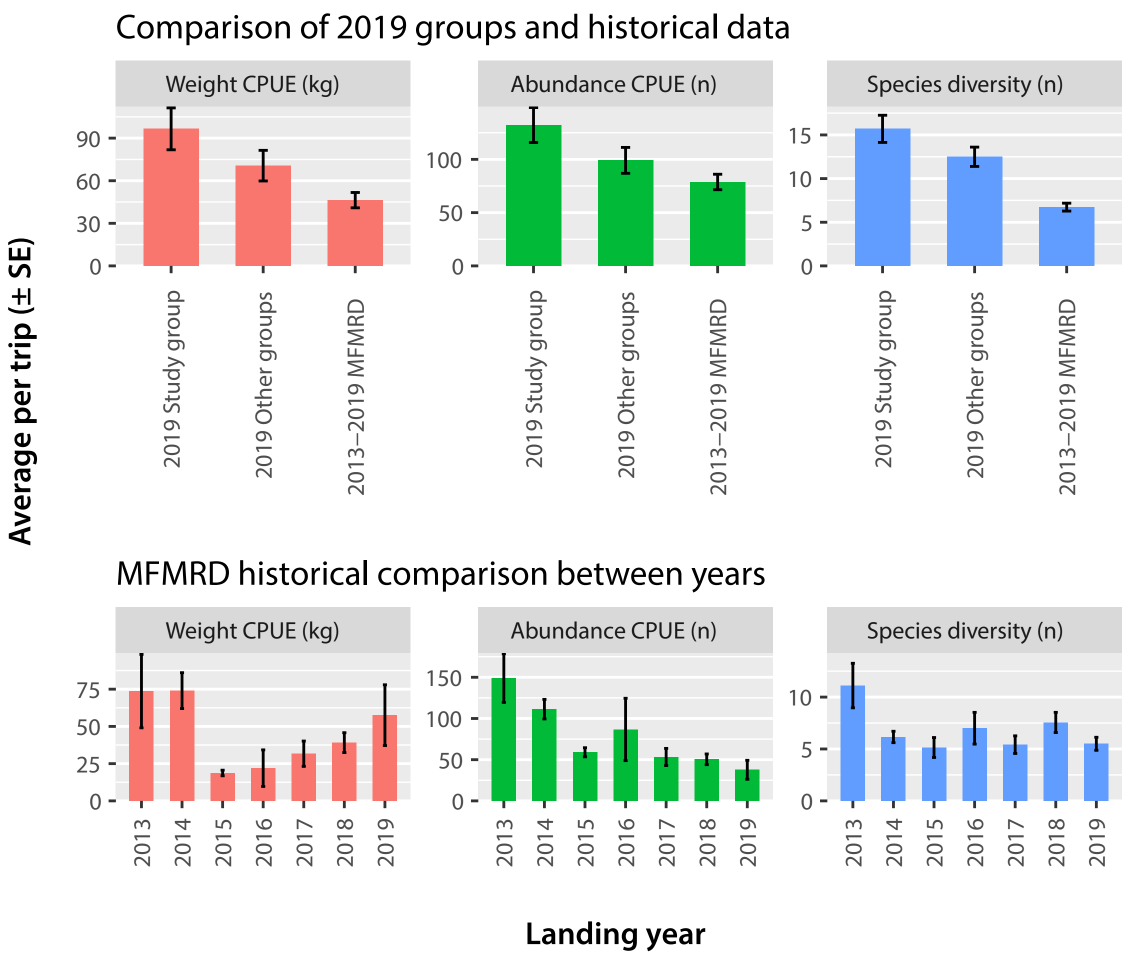


Figure 7. Comparison of catch of study group and historical data (per landing).
Top: The study group against 2019 other groups and MFMRD historical data pooled; Bottom: MFMRD 2013–2019 historical average catch details per year.

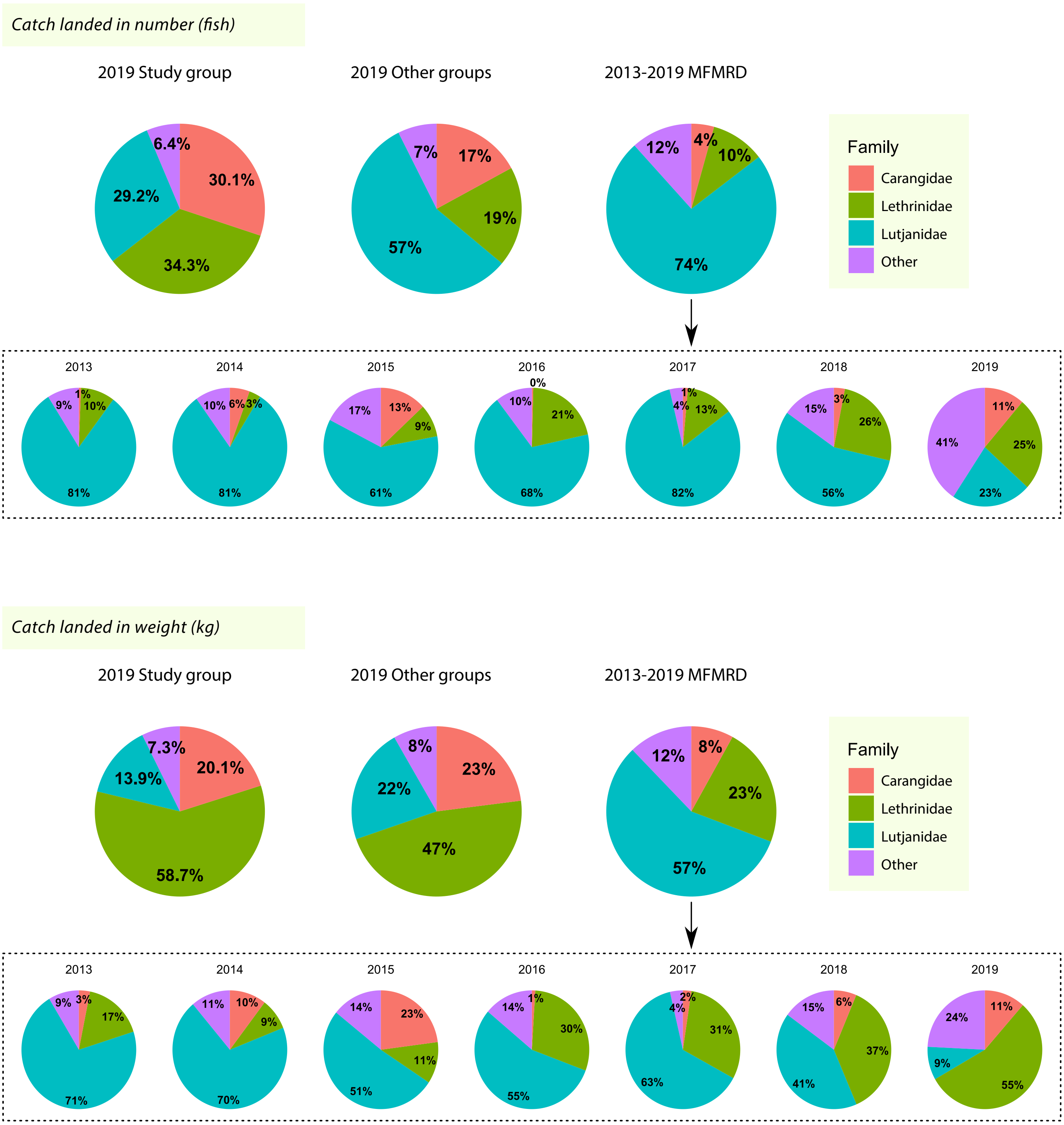


Figure 8. Catch composition, by family, for the study group, the 2019 Other groups and MFMRD historical data (pooled and by years). Top: catch in number; bottom: catch in weight.

On a more general trend, Lutjanidae tended to be dominant in the number of fish landed and overall weight of fish caught. However, the proportion of the Lethrinidae catch by weight was better represented, suggesting larger fish from the Lethrindae family were being caught, as opposed to more fish being caught from that family.

Comparison of mean size of top species

The mean size of fish common to the study group, 2019 other fisher groups, and MFMRD's historical catch data were also compared (Fig. 9). The mean size varied across the different groups studied and the importance of the variability tended to be linked to larger species.

The longfaced snapper displayed the greatest differences between the groups compared. The 2019 study recorded the highest mean size, followed by the study group and the MFMRD historical data. For some species – spangled emperor, blacktail snapper (*Lutjanus fulvus*), paddletail snapper and one-spot snapper (*Lutjanus monostigma*) – MFMRD historical data recorded a slightly greater mean size, which might suggest a possible effect of fishing pressure on these species but, the lack of sufficient data makes it difficult to make accurate comparisons.

Paddletail snapper had the highest number of records in the historical catch data, although there was significant variability in the mean size of this species across years (Fig. 10). In 2016, the lowest mean size recorded was 7.5 cm lower than the highest mean sizes recorded in early 2019.

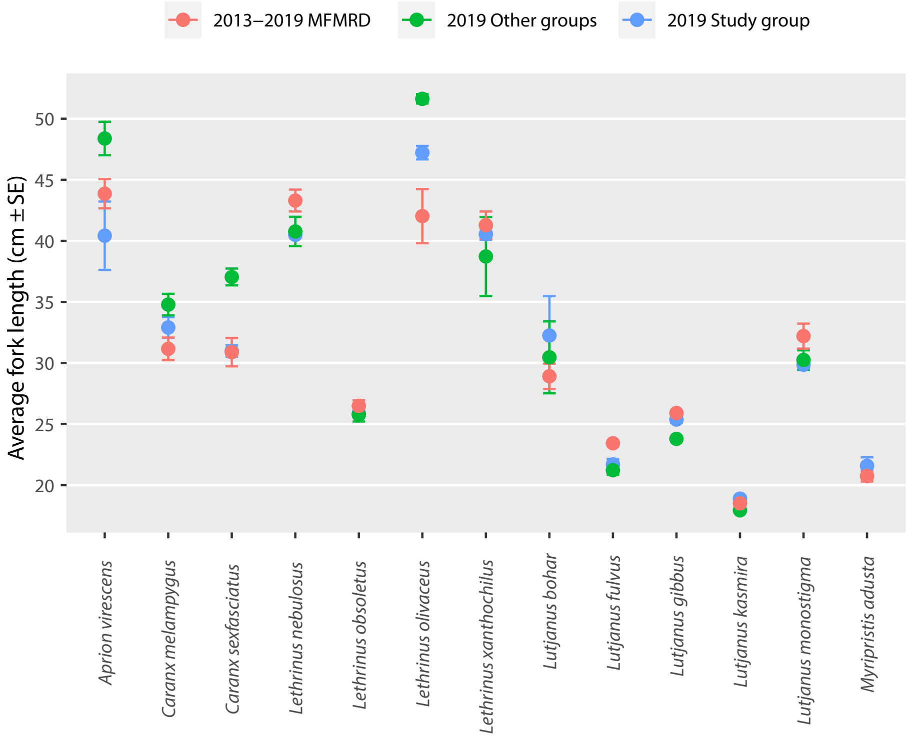


Figure 9. Mean size (±SE) of 13 fish species in the 2013–2019 historical catch data (all years pooled), this study group catch, and the 2019 other fisher groups catch.

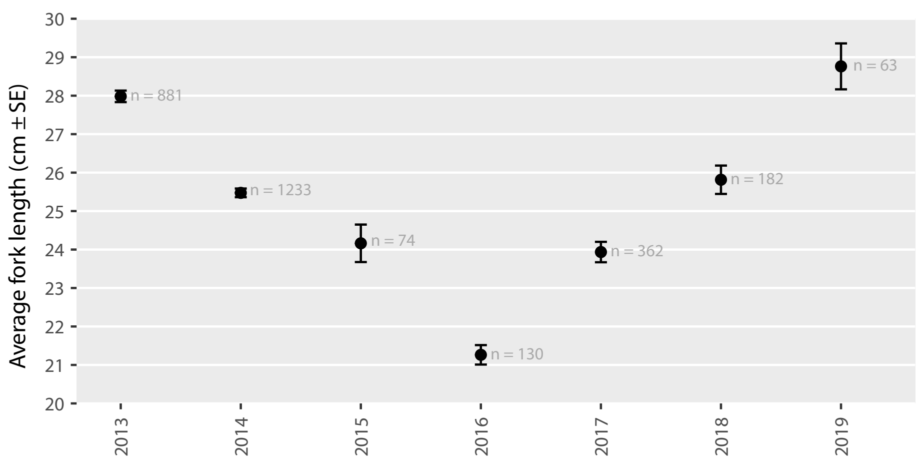


Figure 10. Mean size (± SE) of *Lutjanus gibbus* in the 2013–2019 MFMRD historical catch by years.

Socioeconomics

The artisanal fisheries sector on South Tarawa is divided into full-time commercial, part-time commercial and subsistence fisher groups. In 1982, 130 households were surveyed in Bikenibeu and of these, 72% were fishing households with 14% being full time commercial fishing households, 13% being part-time and 66% subsistence fishing only (Marriott 1982). The study group that we monitored would be regarded as being full-time commercial because fishing is their main income-earning activity and they fish specifically to sell. The leader of this study group was from another island in the Gilbert Group but married to a woman from Bikenibeu. At the time of monitoring, they were running two vessels. Operations of these two vessels were dependent on having working engines and enough fishers to fish. Over the extended period that was recorded in the logbook, 15 fishers were engaged, with 6 of these being considered regular full-time fishers and another 3 being part-time fishers, and the remaining 7 being taught the fishing processes and deciding if they would participate more frequently.

The simplest and most common form of handlining used by the fishers on South Tarawa is a line of a certain length (usually between 20- and 40-lb breaking strength), a sinker (lead, chain or any other weight), a cast snood and at least one hook. The study group described in this paper had a preference for size 7, 8 and 10 hooks, which cost between AUD 0.10 and 0.20 each. Sinkers cost AUD 0.30 each, while a roll of 25-lb fishing line was AUD 4.80, and hand reels were between AUD 4.50 and 5.00, depending on size. Generally, only one baited hook is used for each fishing line, although more than one hook (but not more than three) is also used. Hooks were sometimes rigged with a fluorescent tube over its shanks.

Women's roles in the fishing sector of South Tarawa are mostly limited to gleaning in the lagoon, as well as selling fish on the roadside or in markets (Tekanene 2006). The study group we monitored had two full-time women selling fish. One woman was the wife of the study group leader and the other was her relative. Both women took a portion of the profit from each day's sales.

During the period 2 March to 7 December 2019, 210 fishing trips were recorded (Table 4). In general, three fishers fished each night although on a few occasions only two fishers went. Expenditures were included fuel, bait (mostly tuna or flying fish), provisions (e.g. tobacco, flour balls, coffee and sugar); gear replacement (mostly hooks and sinkers), and ice to keep fish fresh. Batteries were also purchased for torches and a hand-held GPS.

For each fishing trip approximately 70 kg of gutted fish was sold, earning approximately AUD 225.00, which once deducted from operating costs (fuel, ice, bait, provisions and gear) was then shared among the study group as follows:

- the leader took one to two shares: one for the boat and one as a fisher if he went fishing;
- the fishers each received one share; and
- the women marketing the fish also received one share.

Fish usually sold for AUD 1.50/lb, though on some occasions fish were sold for AUD 1.00 to AUD 1.20/lb when it was necessary to sell them quickly for fear of spoilage. On one occasion, high-valued fish were sold for AUD 1.90/lb. The local profit-sharing systems operating among fisher groups on South Tarawa tend to favour those who own the fishing assets and hence command the means of production for themselves and others. Fishers' shares ranged from negative

Table 4. Study group expenditures and income from 2 March to 7 December 2019. Numbers in the table are expressed as average (Av.) ± standard error (SE)

Activity	Boat 1 (n = 131)	Boat 2 (n = 79)	Average (n = 210)
Av. no. fishers	3	3	3
Av. fuel used per trip (L)	39.66 ± 0.89	32.94 ± 0.97	37.13 ± 0.70
Av. fuel cost per trip (AUD)	54.45 ± 1.23	45.10 ± 1.32	50.93 ± 0.96
Av. bait cost per trip (AUD)	8.40 ± 0.27	7.85 ± 0.38	8.19 ± 0.22
Av. ice cost per trip (AUD)	10.00 ± 0.03	10.00 ± 0.25	10.05 ± 0.10
Av. provisions cost per trip (AUD)	9.70 ± 0.09	9.60 ± 0.06	9.69 ± 0.06
Av. gear cost per trip (AUD)	8.00 ± 0.33	6.40 ± 0.39	7.42 ± 0.26
Av. gutted fish weight sold per trip (kg)	74.37 ± 3.13	61.42 ± 2.79	69.49± 2.25
Av. amount earned per trip (AUD)	240.40 ± 9.64	202.25 ± 9.04	226.04 ± 7.01
Av. ice cost for marketing per trip (AUD)	8.00 ± 0.64	9.40 ± 0.65	8.82 ± 0.47
Av. earnings for women marketing fish (AUD)	22.45 ± 0.98	18.60 ± 0.87	21.00 ± 0.70
Av. earnings per fisher (AUD)	23.35 ± 1.47	19.00 ± 1.48	21.72 ± 1.08

Table 5. Study group expenditures and income from 25 May to 7 June 2019. Numbers in the table are expressed as average (Av.) ± standard error (SE).

Activity	Boat 1 (n = 10)
Av. no. fishers	3
Av. fuel used per trip (L)	40.50 ± 2.57
Av. fuel cost per trip (AUD)	55.75 ± 3.45
AV. bait cost per trip (AUD)	5.90 ± 0.67
Av. ice cost per trip (AUD)	10 .00 ± 0.00
Av. provisions cost per trip (AUD)	9.60 ± 0.00
Av. gear cost per trip (AUD)	5.35 ± 1.55
Av. gutted fish weight sold per trip (Kg)	83.23 ± 11.86
Av. amount earnt per trip (AUD)	277.10 ± 38.92
Av. ice cost for marketing per trip (AUD)	7.20 ± 1.93
Av. earnings for marketing woman (AUD)	23.50 ± 2.16
Av. earnings for fisher (AUD)	30.85 ± 6.32

AUD 10.90 to an extreme high of AUD 108.25 but averaged AUD 21.72 across all trips recorded in the logbook. The two women sellers earned, on average, AUD 21 per fishing trip with a range of AUD 3.00 to 77.00.

In the case of the detailed catch monitoring from 25 May to 7 June 2019, only one boat was in operation (Table 5). During this period, the study group's overall catch and profitability was slightly higher than that observed across the average of the logbook period (see Table 4).

Fish selling commences as soon as the fishing boat returns from fishing, which could be between 5.30 and 7.00 am. In general, people on South Tarawa are buying fish for their next meal as many people lack the ability to store fish appropriately. A lack of suitable storage means most fish is cooked the same day that they were bought.

Conclusion

The analysis presented in this study details the importance of understanding better what species fisher groups are targeting, when, why and how. This is particularly important for places such as South Tarawa because if fisheries resources continue to decline, fishers will be left with limited options for income, and there will be an impact on general food security. In South Tarawa, the rate of unemployment is already high with employment opportunities restricted to working in the government public service, the service and retail sector or working on foreign merchant and fishing vessels. South Tarawa's growing population and the associated increasing demand for seafood, changes in fishing technologies, the development of organised fishers' groups, and a lack of alternative livelihood options, means that the fisheries resources of Tarawa Atoll are, and will continue to be, increasingly exploited to sustain growing usage needs. When combined with climate change, South Tarawa is facing multiple and simultaneous threats to its liveability and survival (Donner 2010; Story and Hunter 2012; Campbell and Hanich 2014). It has been predicted that future periodic storm surges caused by increased storm activity associated with climate change could cause up to 25–54 % of South Tarawa to become inundated by 2050 (Campbell 2000). For Bikenibeu, where this study was centred, it has been estimated that a sea-level rise of 0.5 m would cause almost all of the shoreline on the lagoon side, and a small part of the ocean shoreline, to be submerged, resulting in 51% of the total shoreline breached and 71% of the land area of Bikenibeu to be flooded (He 2001)

The Government of Kiribati recognises the importance of the long-term protection of its fisheries resources as detailed in the National Fisheries Policy 2013–2025 (Ministry of Fisheries and Marine Resources Development 2013). The National Roadmap for Coastal Fisheries was also endorsed in 2019 (Ministry of Fisheries and Marine Resources Development 2019) and a set of fishing regulations adopted in 2020 (Ministry of Fisheries and Marine Resources Development 2020). The data presented in this study also highlight the importance of sampling from different fisher groups because having a suitable sampling range allows for the detection of changes to fisheries resources and effort over time. For fish species that are heavily targeted, it is suggested that regular monitoring programmes be conducted that systematically collect the necessary information to inform decisions regarding management in a timely and effective way. Of particular importance are data that allow for better comparison of sizes of fish caught and overall fishing effort. Having this level of information would assist MFMRD to set suitable and relevant size limits as per their Fisheries (Conservation and Management of Coastal Marine Resources) Regulations 2020 (Ministry of Fisheries and Marine Resources Development 2020). For example, the newly implemented size limits imposed for spangled emperor will not have the required purpose of ensuring sustainability as none of the individuals recorded in this study were above the legal size.

Recent efforts to improve the legal frameworks for managing fisheries in Kiribati, raising awareness, strengthening monitoring, control and surveillance are crucial (Teemari et al. 2020). Ongoing monitoring (e.g. Molai et al. 2020; Andrews et al. 2020) is required to help inform management and overall wider fisheries development initiatives for South Tarawa and Kiribati as a whole. Such monitoring programmes, however, remain a great challenge as does the enforcement of regulations.

References

Andrew N., Campbell B., Delisle A., Li O., Neihapi P., Nikiari B., Sami A., Steenbergen D. and Uriam T. 2020. Developing participatory monitoring of community fisheries in Kiribati and Vanuatu 7. SPC Fisheries Newsletter 162:32–38.

Barclay K. and Cartwright I. 2007. Kiribati. p. 117–147. In: Cartwright I. and Barclay K. (eds). Capturing wealth from tuna: Case studies from the Pacific. Canberra, Australia: Asia Pacific Press.

Beets J. 2000. Declines in finfish resources in Tarawa lagoon, Kiribati, emphasize the need for increased conservation efforts. Atoll Research Bulletin, No.: 490. Washington, D.C.: National Museum of Natural History.

Campbell J. 2000. Climate change vulnerability and adaptation assessment for Kiribati. Technical Summary and Synthesis. Report prepared for the World Bank by International Global Change Institute, Waikato University, Hamilton, New Zealand.

Campbell B. and Hanich Q. 2014. Fish for the future: Fisheries development and food security for Kiribati in an era of global climate change. Penang, Malaysia: WorldFish.

Cooper M. 1964. Ciguatera and other marine poisoning in the Gilbert Islands. Pacific Science 18: 411–440.

Cross R. 1978. Fisheries Research Notes (September 1976 to October 1977). Fisheries Division, Ministry of Commerce and Industry, Tanea, Tawara, Republic of Kiribati.

Donner S. 2012. Sea level rise and the ongoing battle of Tarawa. Eos 93(17):169–176.

Gibson D. 1976. Consumer survey (fish): March 1976. Fisheries Division, Ministry of Commerce and Industry, Tanea, Tawara, Republic of Kiribati.

Gillett R. 2016. Fisheries in the economies of Pacific Island countries and territories. Noumea, New Caledonia: Pacific Community.

He C. 2001. Assessment of the vulnerability of Bairiki and Bikenibeu, South Tarawa, Kiribati, to accelerated sea-level rise. SOPAC Technical Report, No.: 322. Suva, Fiji: Pacific Islands Applied GeoScience Commission.

Longenecker K., Langston R., Bollick H., Crane M., Donaldson T., Franklin E., Kelokelo M., Kondio U. and Potuku T. 2017. Rapid reproductive analysis and length-weight relations for five species of coral-reef fishes (Actinopterygii) from Papua New Guinea: *Nemipterus isacanthus, Parupeneus barberinus, Kyphosus cinerascens, Ctenochaetus striatus* (Perciformes), and *Balistapus undulatus* (Tetraodontiformes). Acta Ichthyologica et Piscatoria 47(2):107–124.

Lovell E., Kirata T. and Tekinaiti T. 2002. Status report for Kiribati's coral reefs. p. 163–192. In: Johannes R., Green A. and Adams T. (compilers.). Coral reefs in the Pacific: Status and monitoring, resources and management. Scientifc and Technical Document No.: II 5. Noumea, New Caledonia: Institut de recherche pour le développement.

Marriott S. 1981. South Tarawa artisanal fishery, 1981: Report of a fisheries survey carried out on South Tarawa (19 January to 13 February 1981). Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Marriott S. 1982. The South Tarawa Artisanal Fishery. Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Mees C. 1988. The future of the Resource Assessment and Data Collection Unit of the Fisheries Division following completion of the Baseline Surveys and the departure of the TCO Research/Extension Advisor: A Final Report. Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Mees C. and Yeeting B. 1986. The Fisheries of South Tarawa. Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Mees C., Yeeting B. and Taniera T. 1988. Small-scale fisheries in the Gilbert Group of the Republic of Kiribati. Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Ministry of Fisheries and Marine Resources Development. 2013. Kiribati National Fisheries Policy 2013–2025. Barike, Kiribati: Ministry of Fisheries and Marine Resources Development.

Ministry of Fisheries and Marine Resource Development. 2019. Kiribati National Coastal Fisheries Roadmap 2019–2036. Barike, Kiribati: Ministry of Fisheries and Marine Resource Development.

Ministry of Fisheries and Marine Resources Development. 2020. Fisheries (Conservation and Management of Coastal Marine Resources) Regulations 2020. Barike, Kiribati: Ministry of Fisheries and Marine Resources Development.

Molai C., Bosserelle P., Halford A., Kinch J. and Shedrawi G. 2020. Creel surveys increase understanding of fisher patterns across three atolls (Tarawa, Abemama and Onotoa) of Kiribati. SPC Fisheries Newsletter 160:55–64.

Moore B.R. 2019. Age-based life history of humpback red snapper, *Lutjanus gibbus*, in New Caledonia. Journal of Fish Biology jfb.14142. https://doi.org/10.1111/jfb.14142

Paulay G. and Kerr K. 2001. Patterns of coral reef development on Tarawa Atoll (Kiribati). Bulletin of Marine Science 691:1191–1207.

National Statistics Office. 2016. 2015 population and housing census, Volume 1: Management and housing census. National Statistics Office Ministry of Finance Bairiki, Tarawa, Republic of Kiribati.

National Statistics Office. 2021. https://nso.gov.ki/population/kiribati-2020-population-and-housing-census-provisional-figures/. Accessed on the 27 May 2021.

National Statistics Office 2021. https://nso.gov.ki/statistics/population/. Accessed on the 21st January 2021.

Prince J., Victor S., Kloulchad V. and Hordyk A. 2015. Length based SPR assessment of eleven Indo-Pacific coral reef fish populations in Palau. Fisheries Research 171:42–58. https://doi.org/10.1016/j.fishres.2015.06.008

Prince J., Smith A., Raffe M., Seeto S. and Higgs J. 2020. Spawning potential surveys in Solomon Islands' Western Province. SPC Fisheries Newsletter 162:58–67.

Ram-Bidesi V. and Petaia S. 2010. Socio-economic Assessment of Fishing Practices by North and South Tarawa Fishers in Kiribati. Apia, Samoa: Secretariat of the Pacific Regional Environment Programme.

Ranatunga R. and Rathnayaka S. 2019. Development of gonads and evidence of protogyny in spangled emperor (*Lethrinus nebulosus*) from the coastal waters off Negombo, Sri Lanka. Sri Lanka Journal of Aquatics 24:89. https://doi.org/10.4038/sljas.v24i2.7570

Rangarajan K. 1971. Maturity and spawning of the snapper, *Lutjanus kasmira* (Forskal) from the Andaman Sea. Indian Journal of Fisheries 18:114–125.

Roos D., Roux O. and Conand F. 2007. Notes on the biology of the bigeye scad, *Selar crumenophthalmus* (Carangidae) around Reunion Island, southwest Indian Ocean. Scientia Marina 71:137–144. https://doi.org/10.3989/scimar.2007.71n1137

Storey D. and Hunter S. 2010. Kiribati: An environmental "perfect storm". Australian Geographer 40 (2):167–181.

Sudekum A., Parrish J., Radtke R. and Ralston S. 1991. Life history and ecology of large jacks in undisturbed, shallow, oceanic communities. Fishery Bulletin 89:493–513.

Taylor B., Oyafuso Z., Pardee C., Ochavillo D. and Newman S. 2018. Comparative demography of commercially-harvested snappers and an emperor from American Samoa. PeerJ 6: e5069. https://doi.org/10.7717/peerj.5069

Tebano T. 1992. Ciguatera poisoning and reef disturbance in South Tarawa, Kiribati. SPC Ciguatera Information Bulletin 2:7.

Teemari T., Muron C. and D'Andrea A. 2020. Kiribati takes a major governance step towards sustainable coastal fisheries. SPC Fisheries Newsletter 161:9–13.

Tekanene M. 2006. The women fish traders of Tarawa, Kiribati. p. 115–120. In: Choo P., Hall S. and Williams M. (eds). Global symposium on gender and fisheries. Penang, Malaysia: WorldFish Center.

United Nations Development Programme. 2021. http://hdr.undp.org/en/countries/profiles/KIR. Accessed on the 17 January 2021.

Van Der Elst R. 1993. A guide to the common sea Fishes of Southern Africa. Third edition. Cape Town, South Africa: Struik Publishers.

Yeeting B. 1986. The Fisheries of South Tarawa (for the period February-June 1986). Fisheries Division, Ministry of Natural Resource Development, Tanea, Tarawa, Republic of Kiribati.

Zylich K., Harper S. and Zeller D. 2014. Reconstruction of marine fisheries catches for the Republic of Kiribati (1950–2010). p. 89–106. In: Zylich K., Zeller D., Ang M. and Pauly D. (eds). Fisheries catch reconstructions: Islands, Part IV. Fisheries Centre Research Reports. No.: 22 (2). Vancouver, Canada: University of British Columbia.