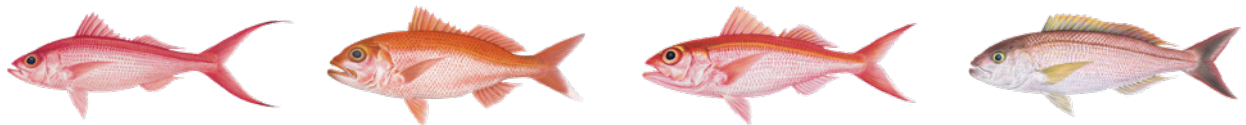


Towards improved governance, management and sustainability of the demersal line fishery in Tonga

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In September 2023, the New Zealand Ministry of Foreign Affairs and Trade funded project 'Improved governance, management and sustainability of the demersal line fishery in Tonga' will wrap up. In this article, we provide an outline of the project, summarising key highlights achieved and some of the key challenges experienced during the project's eight-year lifespan.



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History and context

Deepwater demersal fish species are an important fisheries resource in many Pacific Island countries and territories (PICTs). In Tonga, a fishery for deepwater demersal fish species has operated since the early 1980s following surveys by the Food and Agriculture Organization of the United Nations (FAO) and the Pacific Community (SPC; then the South Pacific Commission) that showed commercial quantities of fish existed in Tongan waters. The fishery exploits a multi-species assemblage of deepwater snappers (Lutjanidae), emperors (Lethrinidae) and groupers (Serranidae) for export and domestic consumption. The fishery is a valuable source of income, livelihood and social well-being to the people of Tonga.

The snapper, emperor and grouper species harvested in the fishery have moderate to high vulnerabilities to fishing as they are fairly long lived (with several species capable of living for over 40 years and as high as 56 years in the case of giant ruby snapper), slow growing, and mature late in life (Halafihia 2015; Wakefield et al. 2015, 2020). As such, they need careful management to avoid overexploitation. However, the fishery has been characterised by cycles of 'boom-and-bust', where periods of large catches and intense exploitation are followed by periods of low catches and stock recovery. Since its inception, the fishery expanded rapidly to over 600 tonnes (t) in 1987, but subsequently declined to about 100 t during the 1990s. A second smaller expansion occurred, peaking at 250 t in 2002. Since 2005, annual landings have fluctuated between 100–200 t (Figure 1, left).

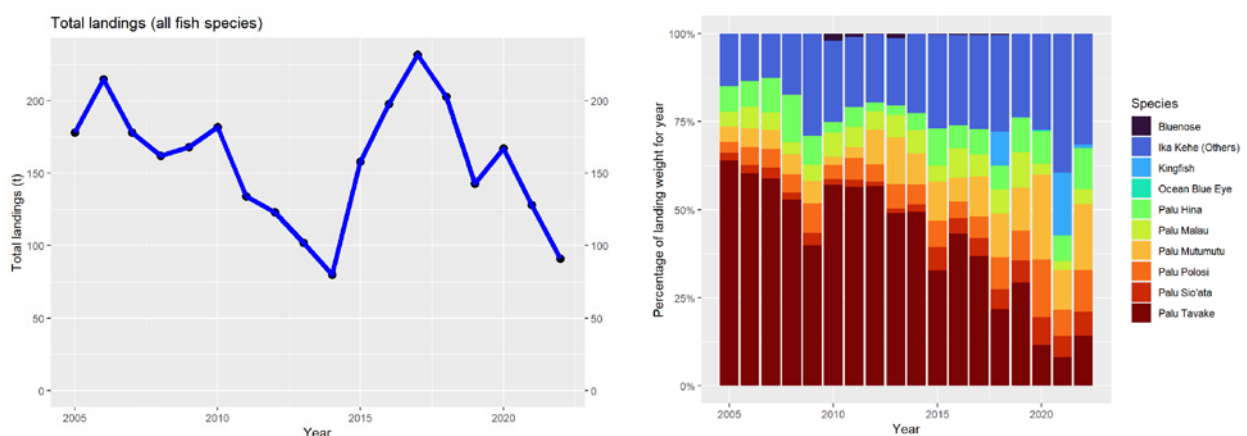


Figure 1. Left: Total landings (all species) of the Tonga deepwater demersal fishery, 2005–2022. Right: Catches of key species by proportion, 2005–2022.

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Changes in species composition over time are also evident. In the early years of the fishery, catches were dominated by eight-bar grouper (*Hyporthodus octofasciatus*; Mohuafi) and crimson jobfish (*Pristipomoides filamentosus*; Palu hina), but the proportion of these species in the catch has since declined (Halafih 2015). Catches of flametail snapper (*Etelis coruscans*; Palu tavake), the main target species for export, generally exceeded 50% of total landings between 2005–2014 but have steadily declined since 2010 and comprised just 10–15% of total landings between 2020–2022 (Figure 1, right). These declines were in part due to a decrease in flametail snapper biomass, changes in market preferences, and a lack of investment and confidence in the fishing sector. In parallel, fishers have avoided catching flametail snapper due to the closure of the export fishery from 2020 onwards resulting from the COVID-19 pandemic. There has also been a reliance on a single export market (Hawaii), underscoring the need for diversification of target species and improved marketing.

Project initialisation

In 2015, with funding from New Zealand's Ministry of Foreign Affairs and Trade (MFAT), the Tongan Ministry of Fisheries (MoF) and New Zealand's National Institute of

Water and Atmospheric Research Ltd (NIWA), along with the Tongan National Fisheries Council (NFC) and SPC, implemented the 'Improved governance, management and sustainability of the demersal line fishery in Tonga' project (hereafter the Project). The Project had three long-term outcomes designed to facilitate an ongoing, well-managed and sustainable line fishery for deepwater fish species in Tonga:

- Increased revenue and business confidence.
- Improved governance and robust decision-making.
- Biologically sustainable fishery established.

Project structure and governance

The Project was initially implemented in 2015 as a five-year, two-phase activity. However, due to the impacts associated with COVID-19 and the Hunga-Tonga Hunga-Ha'apai (HTHH) eruption in 2022, the Project was extended to June 2023. Phase 1 (2015–2016) of the project was dedicated to understanding the fishery; identifying entry points for change; and developing, agreeing on and embedding key management measures designed to limit the over-exploitation of flametail snapper and other species in the deepwater fish assemblage. Phase 2 (2017–2023) was dedicated to implementation.



The Project was overseen by a Project Management Group (PMG), which comprised representatives from each of the four partner organisations (MoF, NIWA, NFC and SPC) as well as representatives from key stakeholder groups, including Tongan deepwater line fishers, the Fafine Tonga 'o Ngatai Women in Fisheries Group and New Zealand's Ministry of Primary Industries (MPI). The PMG met multiple times in each year throughout the Project, either in-person or online via MS Teams, to discuss project progress, review activities and outputs, and prioritise next steps. MFAT staff based at the New Zealand High Commission, Nuku'alofa, also regularly attended PMG meetings, greatly strengthening the links between the donor and implementing agencies.

Increasing revenue and business confidence

To increase revenue and business confidence the Project has:

- Conducted preliminary bioeconomic analyses of the deepwater fishery in Phase 1 to provide baseline information at the start of the Project (James 2016). In Phase 2, revised bioeconomic analyses were completed with updated cost information to evaluate the effect of diversifying the fishery (Mardle 2021). Results from these analyses stressed the importance of conservative catch limits, suggested the fishery can sustain a maximum fleet size of around 15 vessels, and highlighted the need for diversification of species caught in the fishery and markets.
- Increased diversity of catches through training fishers in deepwater squid, loligo squid, small pelagic and mini longline fishing gears, and provided sets of these gears to NFC (see boxed text on 'Fishery diversification'). In addition, the Project explored diversifying the fishery to fish for bluenose (*Hyperoglyphe antarctica*) following the observation of good catches in the south of Tonga's exclusive economic zone (EEZ) during surveys conducted under the AusAID-funded, SPC-implemented 'Pacific Fisheries for Food Security' programme. Fisheries-dependent surveys recorded low catch rates around Tongatapu and Ha'apai, suggesting the majority of fish biomass was in the south, and thus only accessible to the largest vessels that could travel the furthest. As such, bluenose was not considered to be an equitable diversification option for the fleet.
- Provided a one-off payment to licensed deepwater fishers to allow for vessel repairs/improvements to enhance the efficiency of their business operations and maintain consistent product supply for markets.
- Provided training to fish processors and vendors in fish handling and processing to improve marketability of catch, reduce product wastage and maximise economic return.
- Provided training in accounting and business practices to increase revenue and business confidence.

- Invested in the development of a local market for deep-water squid through marketing campaigns, promotions and competitions, and public tastings.

An original objective of the Project was to develop alternative export markets for deepwater fish species to reduce the reliance on the single Hawaiian export market. Alternative markets were initially canvassed in Australia and New Zealand. However, with the onset of COVID-19, the maintenance of domestic food security became a priority, and thus this objective was not pursued further.

Improving governance and robust decision-making

To improve governance of the fishery and ensure robust decision-making, the Project:

- Convened regular meetings between stakeholders to facilitate collegiality among stakeholder groups and to improve understanding of the needs and desires of the different stakeholders. In-person meetings were held approximately quarterly, with meetings held more regularly with the shift to online meetings during COVID-19.
- Supported the development of the NFC Strategic Plan 2021–2025 (NFC 2021).
- Developed harvest control rules and embedded these within the Deepwater Fishery Management Plan (DFMP) to ensure transparent decision-making. The most significant of these include adoption of a total allowable catch (TAC) of 200 t for the deepwater demersal fish assemblage, adoption of a species-specific TAC of 86 t for flametail snapper and adoption of a minimum size limit of 48 cm fork length (FL) for flametail snapper. The minimum size limit can be considered a 'move-on' rule in that it mandates that undersized flametail should comprise no more than 20% of total flametail catch per trip (effectively encouraging fishers to fish elsewhere if they are catching undersized flametail snapper).
- Developed and provided training in the tongafish R package, which allows for the generation of semi-automated reports from logbook and port sampling data via SPC's Tuna Fisheries Data Management System (TUFMAN 2) to enable regular monitoring of fishery performance against DFMP objectives.
- Provided scientific and bioeconomic advice and assisted with the development of monitoring and evaluation criteria for the 2017–2019 and 2020–2023 DFMPs.
- Supported mid- and full-term reviews of the 2017–2019 and 2020–2023 DFMPs, in collaboration with New Zealand's MPI.

Biologically sustainable fishery established

Over the course of the Project, a number of initiatives were undertaken to improve biological sustainability of the fishery. These included:

- ◆ Supporting monitoring of catch volumes and the size of landed fish, as well as the collection of otoliths from target species for estimating fish age and exploring the effects of climate cycles on growth (in collaboration with the University of Adelaide).
- ◆ Undertaking regular descriptive analyses to understand recent trends in the fishery, such as changes associated with COVID-19 (McKenzie 2016, 2020; McKenzie et al. 2023).
- ◆ Undertaking regular stock assessments of flametail snapper. The most recent assessment was conducted in June 2023 using data to the end of 2022. This assessment showed that flametail spawning stock biomass (SSB) had increased from approximately 25% of unfished biomass in 2018 to around 30% and will continue to rebuild should annual catches remain at or below 50 t (McKenzie 2023).
- ◆ Developing a Spatial Population Model of the fishery to determine whether there had been spatial patterns in the flametail snapper depletion. As expected, the model predicted higher levels of depletion around the main fishing ports in Tongatapu, Ha'apai and Vava'u, and lower levels of depletion further south and north.
- ◆ Increasing diversity of catches through training in deepwater squid, loligo squid, small pelagic and mini longline fishing gears, and by providing fishers access to these gears.
- ◆ Investing in the development of a local market for deep-water squid (see boxed text on 'Fishery diversification').



Fishery diversification

Diversification into different target species was a key focus under Phase 2 of the Project. Tongan deepwater fishers were trained in fishing for deepwater squid (including diamondback squid *Thysanoteuthis rhombus* and neon flying squid *Ommastrephes bartramii*) using deepwater dropline techniques (see Figure 2), loligo squid using jigging machines, small pelagics using scoop nets and nearshore pelagic fish such as tunas using mini longlines (deployed either horizontally or vertically). Fishing gears were also provided to NFC to support the long-term viability of the diversification activities. These diversification options have multiple advantages, including reducing operating costs (particularly in the case of squid and small pelagics – prior to the Project fishers were importing frozen arrow squid from New Zealand for use as bait), reducing fishing pressure on deepwater fish populations and creating new economic opportunities for local fishers to increase domestic food security. They give fishers the alternative to engage in other fishing activities when a particular species is in season or in demand, or when conditions do not allow access to deepwater grounds. In particular, the deepwater squid and vertical longline approaches showed great promise – over 4 t of deepwater squid were caught during trials in 2022, while yellowfin tuna and even blue marlin were caught on the vertical longlines!

Significant investment was made in developing a local market for deepwater squid. Notably, the two deepwater squid species targeted did not have a local name, indicating that they were seldom if ever fished for in Tonga previously. To increase public awareness, a naming competition was held and advertised via local radio and Facebook – a popular medium in Tonga. Several food stalls were also established where the public could taste squid cooked in several different ways. To further raise awareness and interest, squid were sold to the public at reduced cost. The result is a fresh, healthy and delicious new seafood product available to consumers. The squid are excellent grilled, as sashimi, boiled in coconut milk or cooked in taro leaves in an umu.



Figure 2. Diversification into deepwater squid was a key focus of the Project. ① Tongan fishers fishing for diamondback squid with SPC's Fisheries Development Officer William Sokimi. ② Dr Tu'ikolongahau Halafihi (MoF) shows off diamondback squid to King Tupou VI. ③ Diamondback squid after a successful fishing trip. ④ Diamondback squid packaged and ready for sale. ⑤ A happy customer at the Tui'matamoana Wharf, Tongatapu. Images ©Ministry of Fisheries.



Figure 3. Some of the capacity building activities undertaken during the project. 1 Skippers and crew following their Master/Engineer Class 6 course. 2 Members of the Fafine Tonga 'o Ngatai Women in Fisheries Group following training in fish handling and processing hygiene, and with new processing equipment. 3 Ministry of Fisheries and NIWA staff at NIWA's Wellington campus for training in data analysis and fish age estimation. 4 MoF and NIWA staff undertaking training in the tongafish R package. Images ©Ministry of Fisheries and Brad Moore.

Capacity building

In addition to the fisheries diversification training described above, several activities were undertaken to improve capacity along the supply chain (Figure 3):

- Training was provided to fishers in the form of Master/Engineer Class 6 courses and three at-sea safety training modules, giving them valuable technical skills, increasing their employability and enhancing at-sea safety. Safety grab bags, including a personal locator beacon, lifejacket, compass, flashlight, mirror and whistle, along with training in their contents, were also provided to fishers to promote safety at sea.
- Members of the Fafine Tonga 'o Ngatai Women in Fisheries Group were provided training in fish handling and processing hygiene to improve marketability of catch, reduce wastage and maximise economic returns, and in accounting and business practices to increase revenue and business confidence. In addition, a range of equipment was provided to further support business development and improve working conditions, such as insulated bins to hold fish, better knives, cutting boards, gloves, boots, aprons and cleaning supplies (Figure 3).

A number of capacity building activities were provided to MoF staff to strengthen their ability to monitor and manage the fishery, including:

- Regular in-country and online training for staff in the R statistical environment and the tongafish R package.
- Attachments to SPC for training in economic analyses.
- Supporting MoF staff attendance at an international deepwater fish-ageing workshop in Hawaii.
- Supporting MoF staff attendance at regional R training courses.
- Secondment of a MoF staff member to NIWA Wellington for a ten-week internship to learn R programming, fisheries analysis and stock assessment principles.
- A combined data analysis and fish age estimation workshop with MoF staff held in NIWA Wellington.

Gender and social inclusion

To inform activities in this area, a social inclusion and gender equality analysis of Tonga's deepwater fishery was commissioned in 2015 and completed in 2016 (Dwyer 2016). This report led to the Fafine Tonga 'o Ngatai Women in Fisheries Group being integrated into the PMG early in the Project to ensure their needs and aspirations were incorporated in decision-making processes. In addition, regular meetings outside of the PMG structure were held with the group to increase engagement and ensure their needs were understood.



Figure 4. Damaged fishing vessels following the Hunga Tonga-Hunga Ha'apai eruption and resulting tsunami, Sopu, Tongatapu, Tonga. Images © Ministry of Fisheries.

The group was instrumental to the developing squid fishery and the associated marketing plan. They organised squid processing infrastructure, including labelling, processing, packaging and distribution. They also led the public tastings of squid, organising food stalls and cooking squid in different ways to help increase public awareness.

COVID-19 and the Hunga-Tonga Hunga-Ha'apai eruption

Over its life, the Project encountered two significant challenges to delivery. The first was COVID-19, which resulted in closure of the export market, reduced food imports and local lockdowns. This highlighted the fragility of the fishery and of the food system in Tonga as a whole. To adapt, fishers stopped targeting flametail snapper and increased targeting of other species for the domestic market such as kingfish (*Seriola* spp.), saddleback snapper (*Paracaesio kusakarii*; Palu mutumutu) and rusty jobfish (*Aphareus rutilans*; Palu polosi). At the time of writing, the export market had not yet resumed, although discussions are ongoing with both the existing market in Hawaii and with new markets in Australia.

On 15 January 2022 HTHH erupted, resulting in a debris field and a plume of ash rising over 50 kilometres into the atmosphere, and a devastating tsunami that severely impacted Ha'apai, Tongatapu and surrounding islands (Figure 4). A damage assessment conducted by MoF in the weeks after HTHH indicated that only four of the 30 licensed deepwater demersal line fishery vessels were seaworthy, with most sustaining damage from the tsunami. To maintain food security after the eruption, MoF supported those deepwater demersal fishers that could go fishing to increase fish production by subsidising ice and bait, purchasing and on-selling demersal fish to the public at reduced costs and subsidising deepwater squid fishing from the Tongan Government's HTHH response fund. With support from the Tongan government and some good old-fashioned Tongan ingenuity, most deepwater vessels are now repaired and back fishing.

Next steps and concluding remarks

Although the Project is wrapping up in September, there is still much to be done. MoF staff are currently working with New Zealand's MPI and Project staff to develop an updated management plan for the fishery incorporating key project findings. Changes in the deepwater demersal fishery towards alternative target species (e.g. saddleback snapper, rusty jobfish) will require additional biological studies to determine their life history characteristics and assess their vulnerability to fishing. Investment will be required to increase the efficiency of fishing and improve the fishery's resilience to climate change. Both the deepwater squid and mini longline diversification activities show great promise and would benefit from further support. With sustained collaboration between science and industry, strong co-management, and continued diversification of catches and markets, the fishery could ultimately be a model for demersal line fisheries throughout the Pacific Island region.

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