Fisheries New Zealand
Tini a Tangaroa

Fishery characterisation and age composition of tarakihi in TAR 1, 2, 3, 5, 7, and 8, for 2018–19 and 2019–20

New Zealand Fisheries Assessment Report 2021/79

J.R. McKenzie, M. Beentjes, H. Armiger, A. Bradley, K. Spong, C. Walsh, D. Buckthought, M. Stevenson, R. Taylor, O. Evans, R. Bian, D. Parsons, C. Sutton, A. Hart, C. Ó Maolagáin, S. Patke, A. Langley, D. Kater, J. Sykes, M. O'Driscoll, Y. Qureshi, A. Miller, C. Bodie, M. Smith, B. Hartill, D. Toman, J. Maggs, N. Bagley

ISSN 1179-5352 (online)
ISBN 978-1-99-102611-8 (online)

December 2021

New Zealand Government

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz
Telephone: 0800 00 83 33
Facsimile: 04-894 0300

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-and-resources/publications
http://fs.fish.govt.nz go to Document library/Research reports

TABLE OF CONTENTS

EXECUTIVE SUMMARY

McKenzie, J.R.; Beentjes, M.; Armiger, H.; Bradley, A.; Spong, K.; Walsh, C.; Buckthought, D.; Stevenson, M.; Taylor, R.; Evans, O.; Bian, R.; Parsons, D.; Sutton, C.; Hart, A.; Ó Maolagáin, C.; Patke, S.; Langley, A.; Kater, D.; Sykes, J.; O'Driscoll, M.; Qureshi, Y.; Miller, A.; Bodie, C.; Smith, M.; Hartill, B.; Toman, D.; Maggs, J.; Bagley, N. (2021.) Fishery characterisation and age composition of tarakihi in TAR 1, 2, 3, 5, 7, and 8, for 2018–19 and 2019–20.

***New Zealand Fisheries Assessment Report 2021/79*. 118 p.**

Catch-at-age sampling of the TAR 1, 2, 3, 5, 7, and 8 bottom trawl catches during the 2018–19 and 2019–20 fishing years provided evidence that tarakihi off the east coast of New Zealand comprise a single stock, confirming results of the previous sampling in 2013–14 and 2014–15. The sampling also provided strong evidence of a second tarakihi biological stock comprising all west coast tarakihi QMAs (i.e., TAR 7, 8, and western TAR 1).

Patterns in year class strength suggest that tarakihi recruitment to the east coast stock largely occurs south of Banks Peninsula. Recruits then progressively move northwards up the east coast such that the destination of the majority of the older tarakihi age classes is east Northland. Recruitment to the west coast stock appears to occur centrally (TAR 8) with fish progressively moving north and south as they age. Evidence from trawl surveys suggest that Tasman Bay/Golden Bay is a major contributary region of west coast juvenile tarakihi.

Sampling achieved good spatio-temporal representative coverage in seven of the nine regional tarakihi sampling areas. Poorer sampling representativeness in two of the regions (Cook Strait and TAR 5), however, did not weaken the overall stock structure conclusions from this study. Ageing precision on the tarakihi otolith readings were amongst the highest achieved in any New Zealand ageing programme with IAPE of, and CVs for, all ten paired readers being all less than 3.5%.

1. INTRODUCTION

1.1 General biology, distribution, and depth range

Tarakihi (*Nemadactylus macropterus, N. rex*) belong to the family Cheilodactylidae, which are also commonly known as morwongs (and include several species of moki in New Zealand). *N. macropterus* are found throughout New Zealand waters including around the Snares, Chatham, and Three Kings islands and are mostly found on the continental shelf (Ayling & Cox 1982). *Nemadactylus rex* (king tarakihi) is known from Southeast Australia, Lord Howe Island, and Norfolk Island. In New Zealand, *N. rex* occurs mostly around the top of the North Island, Three Kings Island, and East Cape region (Roberts et al. 2015). Both tarakihi species are taken commercially in New Zealand with catches managed under the Quota Management System (QMS) controlled by individual quota. Fishers are not required to differentiate the two species in their catch reporting, so the relative catch of each species is unknown. Difficulties is differentiating the two species in catches have meant that it was impractical to monitor the two species separately (it is reasonable to assume, given the limited New Zealand geographic distribution of *N. rex,* that this species is likely to make up a relatively small component of the annual reported tarakihi catch). For these reasons, stock assessment and monitoring of New Zealand tarakihi is largely assumed to apply to *N. macropterus*.

The mean depth at which tarakihi have been caught during research trawl surveys throughout New Zealand is 182 m (range 11–486 m), although this mean is biased by the large amount of survey effort directed towards deepwater fisheries (Anderson et al. 1998). The median catch depth for commercial bottom trawlers landing tarakihi from the east coasts of the North Island and South Island is about 80 to 100 m (Beentjes 2011, Parker & Fu 2011, Beentjes et al. 2012, Beentjes et al 2017, McKenzie et al. 2017), although capture depths vary by statistical area, gear type, and target species.

1.2 Age and growth

Several studies assessing the age of tarakihi catch have been conducted over the years. Although estimates of maximum age vary substantially by area (from 18 to 44 years), all of these studies suggest that tarakihi are relatively long-lived, and populations can comprise many cohorts (Vooren & Tong 1973, Beentjes et al. 2012, McKenzie et al 2017).

1.3 Reproductive biology

Tarakihi are serial spawners that aggregate to spawn in summer-autumn, when final maturation and gonad ripening coincides with the drop in seawater temperature in April-May (Tong & Vooren 1972). Spawning is thought to occur on the outer continental shelf in areas such as the western Bay of Plenty, East Cape area (between Lottin Point and Hicks Bay and towards Mahia Peninsula), west coast South Island, and Pegasus Bay (including Conway Ridge and Cape Campbell) (Tong & Vooren 1972, Vooren & Tong 1973, Vooren 1975, Morrison et al. 2012). The seasonality of the trawl fisheries that catch tarakihi along the east coast of New Zealand roughly coincides with spawning related migrations into these areas (Langley & Starr 2012). Tarakihi have a long pelagic larval phase of 7–12 months.

Size at 50% maturity has been estimated at near 27 cm and 28 cm fork length (FL) for males and females respectively (Tong & Vooren 1972) and more recently by Parker & Fu (2011) at 32 and 33 cm from the East Cape area. These lengths correspond to an age at 50% maturity of between five and seven years.

1.4 Nursery areas

The location of tarakihi nursery grounds has been inferred from commercial catch sampling and trawl surveys conducted in the 1960s and 70s (Vooren 1972, 1975, Beentjes 2011, Beentjes et al. 2012). The two main areas where tarakihi smaller than 20 cm were caught were Tasman Bay and Golden Bay (TAR 7) and off the South Canterbury Bight (TAR 3). Smaller numbers of under 20 cm tarakihi were occasionally caught in the eastern Bay of Plenty, Hawke Bay, along the southern Wairarapa coast, off Kapiti coast, and

off Kaikōura (Vooren 1975). Except for the Kapiti coast, very few juvenile tarakihi were caught off the west coast of the North Island, and many areas have not yet been sampled with fishing gear that would select small tarakihi. Juvenile tarakihi were only rarely caught off the east coast of the North Island, between East Cape and the western Bay of Plenty (Vooren 1975).

Inshore trawl surveys off both the east coast South Island and Tasman Bay/Golden Bay, indicate that juvenile tarakihi are consistently abundant in these areas (MacGibbon 2019, MacGibbon et al. 2019).

1.5 Stock structure and status

Tagging studies conducted in the Bay of Plenty in the 1970s revealed that tagged tarakihi only moved short distances within the first year, but some fish were recaptured up to 200 km from the tagging site after a longer period at liberty (Crossland 1976). Tarakihi were subsequently tagged off the Kaikōura coast between 1986 and 1988, but relatively few of these fish were recaptured (Annala 1988). Of those recaptured, seventeen were caught off the east coast North Island, three were caught off the west coast North Island, and another three were recaptured south of Kaikōura. These tag recoveries suggest a stock linkage between the South Island and North Island Quota Management Areas, with a predominant northward migration of tarakihi from TAR 3 to TAR 2 and TAR 1. Small numbers of tarakihi have also been tagged during biennial west coast South Island trawl surveys in Tasman Bay, but there have been no reported recaptures of these fish to date.

Year class strength patterns seen in 2013–14 and 2014–15 TAR 1, 2, and 3 catch sampling data (McKenzie et al. 2017) suggest that tarakihi recruitment to the east coast New Zealand fisheries largely occurs south of Banks Peninsula. Recruits then progressively move northwards up the coast such that the destination of the majority of the older tarakihi age classes is east Northland. Apart from extensive movements of adults described above, the long pelagic larval phase of 7–12 months suggests that larvae will also be widely dispersed.

Prior to 2017, the absence of an accepted definition around the spatial extent of biological stocks had led to the management of New Zealand tarakihi fisheries within eight administrative Quota Management Areas (QMA) boundaries, corresponding to Fisheries Management Areas (FMA), as illustrated in Figure 1. New Zealand tarakihi stock structure assumptions were revised in 2017, in the light of 2013–14 and 2014–15 TAR 1, 2, and 3 catch sampling data and updated CPUE analyses (McKenzie et al. 2017, Langley 2018), indicating that tarakihi off the eastern coast of New Zealand North and South islands are thought to belong to a single contiguous biological stock. There was also evidence in the 2014–16 TAR 1 catch sampling data that tarakihi off the western coast of the North Island are part of a separate west New Zealand biological stock (McKenzie et al. 2017).

A 2017 assessment of east coast New Zealand tarakihi by Langley (2018) estimated this stock complex was below the soft limit of 20% SSB_0 and, on that basis, the Harvest Strategy Standard specifies that a strategy is required to rebuild the stock to the target biomass level (Ministry of Fisheries 2020). The 2017 assessment results led to quota cuts being implemented across all east coast tarakihi QMAs in October 2017.

1.6 Tarakihi commercial fisheries

The major tarakihi fishing grounds are: off the west and east coasts of Northland in TAR 1; between the western Bay of Plenty and Cape Turnagain in TAR 1 and 2; from the Cook Strait to the Canterbury Bight, which mostly falls in TAR 3; and between Jackson Head and Cape Foulwind in TAR 7 (Figure 1). About 70–80% of the tarakihi taken off the North Island is targeted, mostly by bottom trawlers (McKenzie et al. 2017).

Only about 30% of the trawl catch of tarakihi taken off the South Island is currently targeted, with much of the remainder taken as incidental catch by bottom trawlers targeting barracouta (*Thyrsites atun*) and red cod (*Pseudophycis bachus*). In addition, there is a small target tarakihi set net fishery off Kaikōura.

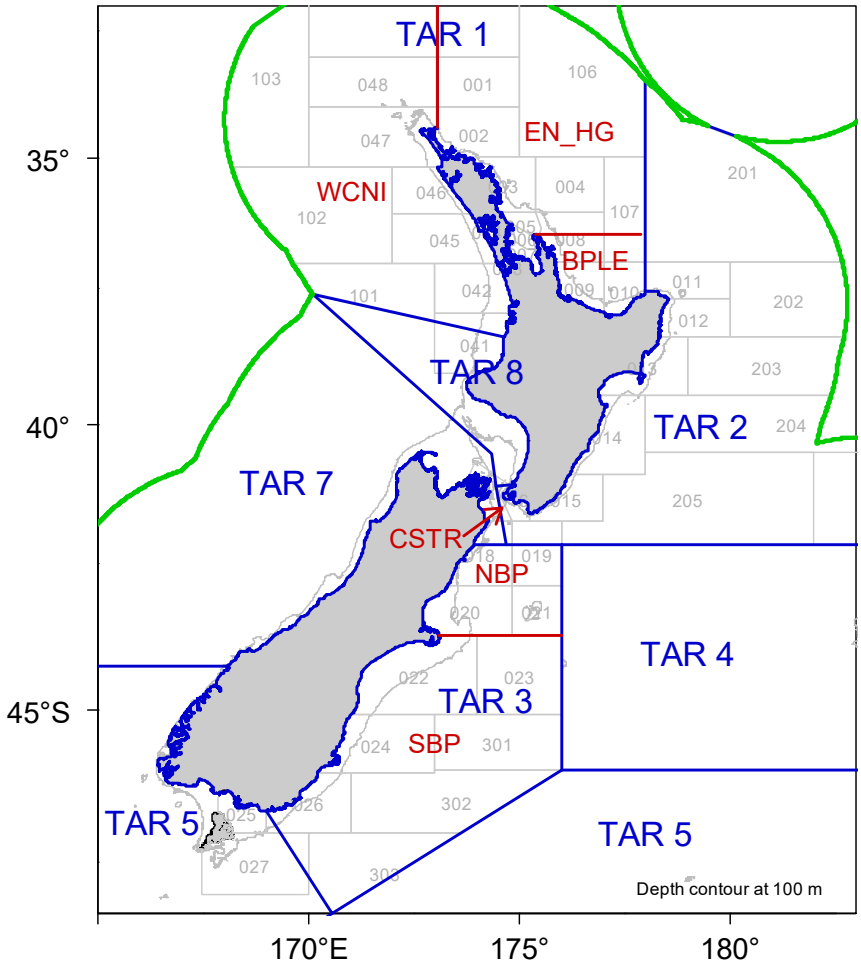


Figure 1: **Map of tarakihi Quota Management Areas (in blue), and statistical reporting areas (in grey) around New Zealand. Sampling took place in QMAs 1, 2, 3, 5, 7, and 8 in 2018–19 and 2019–20. The red areas indicate the QMA sub-divisions used for sampling: WCNI is West coast North Island; EN_HG is east Northland–Hauraki Gulf; BPLE is Bay of Plenty; CSTR is Cook Strait; NBP is North Banks Peninsula; and SBP is South Banks Peninsula.**

1.7 Monitoring of TAR stocks

Since 1990, the trends in status of most tarakihi QMAs have been inferred from standardised commercial catch per unit effort (CPUE) indices and trawl survey indices of relative abundance. Commercial trawl CPUE data are available for all the main tarakihi QMAs (1, 2, 3, 7, & 8), as continuous series since 1990. Research trawl survey time series are only available for two tarakihi fish stocks; TAR 7 (west coast South Island and Tasman Bay/Golden Bay surveys (MacGibbon 2019)) and TAR 3 (MacGibbon et al. 2019). Both trawl survey programmes were initiated in 1991. In 2019, an analysis of the TAR 3 trawl survey series suggested there had been no trend in relative tarakihi biomass (MacGibbon et al. 2019). Although tarakihi have been caught during trawl surveys conducted in other parts of the country, in our opinion, none of these surveys are optimally designed to monitor tarakihi abundance, because they have been intermittent and occurred at suboptimal times of year, and/or over inappropriate depth ranges.

Catch-at-age sampling of east coast New Zealand commercial trawl and set-net fisheries was undertaken in various fishing years and areas between 2007 and 2015. Good spatial sampling coverage of TAR 1, 2, & 3 trawl fisheries and the TAR 3 set-net fishery was achieved in the 2009–10 and 2010–11 fishing years (Beentjes 2011, Parker & Fu 2011, Beentjes et al. 2012). Catch sampling of TAR 1 trawl fisheries was undertaken in the 2007–08 and 2010–11 fishing years, but, in each year, full spatial coverage of TAR 1 was not achieved (McKenzie et al. 2015). Subsequently, catch sampling across all TAR 1, 2, & 3 stocks

was undertaken concurrently in 2013–14 and 2014–15 (McKenzie et al. 2017), achieving good spatial sampling and leading to the conclusion that tarakihi in all east New Zealand tarakihi QMAs belong to one contiguous stock.

1.8 TAR201801 project objectives

The results presented in this report are based on data collected under Fisheries New Zealand commercial tarakihi catch sampling project TAR201801. The specific objectives for this project were:

1. To characterise the TAR 1, 2, 3, 5, 7, & 8 fisheries.

2, 3, 4. To conduct representative sampling to determine the length, sex, and age structure of the commercial catch of tarakihi in TAR 1, 2, 3, 5, 7, & 8 during the 2018/19 and 2019/20 fishing years.

5. To age tarakihi otoliths collected during the above sampling programme.

6. To age tarakihi otoliths collected during previous trawl surveys conducted of the east and west coasts of both North and South islands.

This report covers results pursuant to objectives 1 through 5 above.

Sampling under TAR201801 represents the first time all the main New Zealand tarakihi stock management areas (TAR 1, 2, 3, 5, 7, and 8) and core commercial trawl fisheries have all been sampled in the same fishing years.

2. FISHERY CHARACTERISATION AND CATCH SAMPLING DESIGN

2.1 Overview

Trawling is the predominant commercial tarakihi catching method in TAR 1, 2, 3, 5, 7, & 8. The objectives of the TAR201801 sampling programme required year-round sampling of tarakihi target trawl fisheries in each of the six main tarakihi QMAs in each of two fishing years (2018–19 and 2019–20) to describe the age, sex, and maturity composition of the catches. The design also included additional stratification within some of the QMAs (Figure 1). The sampling goal was to achieve a mean weighted coefficient of variation (CV) on the at-age estimates in each tarakihi QMA region of 0.3 or lower for both sexes combined. To achieve representative sampling throughout each fishing year, the years were divided into seasonal strata with an allocated number of landings to sample in each season. However, no formal seasonal stratification was incorporated in the final analysis. Because of the need to conduct sampling throughout the year, a random age sampling approach was used. This approach required the random collection 60 otolith pairs from each sampled landing. The number of target landings to be sampled from each tarakihi region/stratum varied across the three QMAs, being largely in accordance with previous tarakihi sampling programmes (Beentjes 2011, Parker & Fu 2011, Beentjes et al. 2012, McKenzie et al. 2017).

Sampling designs used in this programme were based on a characterisation of recently reported fishing activity in TAR 1, 2, 3, 5, 7, & 8, by fishing year, fishing method, month, and fish processing facility. Commercial catch effort data were extracted from the Fisheries New Zealand catch effort database for the period October 2012 to September 2017 (hereafter referred to as the 2013–2017 fishing years). This extract included all reported effort data and associated catch weights (for all species including tarakihi) from all trips landing tarakihi from TAR 1, 2, 3, 5, 7, & 8. All requested data were reported on Trawl Catch Effort Processing Return/Trawl Catch Effort Return/Net Catch Effort Returns (TCP/TCE/NCER) forms, and individual records were at the fishing event level.

This dataset was initially groomed so that estimates of the species catch per tow were linked to their associated effort variables, by fishing event (such as fishing location, fishing method, target species, tow

speed). Individual fishing events were then linked to landed catch weights for each trip, to prorate the landed weight for each species across events, given event-based catch weight estimates. The link between the event-based estimated effort and trip-based landed catch weight tables was a common trip number field (trip_key). This allowed the catch weight from individual fishing events to be assigned to particular stocks and regions of interest (based on stock structure reviews (Annala 1987, Annala 1988, Hanchet & Field 2001, Langley & Starr 2012) and recommendations from the Northern Inshore Working Group (NIWG)).

2.2 Revised spatial sampling design stratification

The previous commercial tarakihi catch sampling programme took place during the 2013–14 and 2014–15 fishing years (Fisheries New Zealand project TAR201301), sampling TAR 1, 2, & 3 target bottom trawl fisheries and the TAR 3 set net target fishery. The tarakihi QMAs were divided into seven regions for sampling purposes: West coast North Island (WCNI TAR1); East Northland–Hauraki Gulf (EN_HG TAR1); TAR 2; Cook Strait (CSTR TAR 2/7); North Banks Peninsula (NBP TAR 3); South Banks Peninsula (SBP TAR 3) (Figure 1). The area divisions were specifically chosen to enable potential spatial differences in age structure to be identified (McKenzie et al. 2017).

Cook Strait region sampling included portions of Statistical Areas 017 and northern 018. The purpose of sampling Cook Strait statistical areas was to describe the length and age structure of a potential spawning aggregation (Robertson 1978, Annala 1987). The catch from this area is targeted by a bottom trawl fishery that specifically targets large, aggregated, pre-spawning fish. The catches occur typically over the summer months, the period when tarakihi are in spawning condition.

In addition to bottom trawl regional sampling, a Kaikōura seasonal tarakihi target set net fishery (TAR 3) was also sampled during the 2013–14 and 2014–15 fishing years.

As discussed above, the TAR201301 spatial results provided strong evidence for a single east coast New Zealand tarakihi stock having ontogenetic movement from south to north, and for the western region TAR 1 as likely being part of a separate west coast tarakihi stock (McKenzie et al. 2017). The spatial stratification for sampling east New Zealand tarakihi in the 2018–19 and 2019–20 fishing years was revised considering the observed TAR201301 spatial age structures with the intent of gaining better insight into New Zealand tarakihi stock-related spatial age distributions. The revised east coast tarakihi sampling design recognised six areas: East Northland–Hauraki Gulf; Bay of Plenty–East Cape; Cook Strait; North Banks Peninsula; South Banks Peninsula; Southland–Stewart Island (Figure 2). To better understand the potential for latitudinal differences in east coast tarakihi age structure, bottom trawl trips fishing between the northern TAR 3 boundary and the latitude corresponding to Cape Turnagain in TAR 2 were not initially sampled (eastern shaded area given in Figure 2). Due to the high similarity in age structure between the North Banks Peninsula TAR 3 trawl fishery and the Kaikōura tarakihi set net fishery (McKenzie et al. 2017) the TAR 3 set net fishery was also not sampled in 2018–19 and 2019–20.

In addition to sampling the west coast region of TAR 1, as was done in the TAR201301 programme, TAR 7 & 8 west coast bottom trawl fisheries were also sampled. To better understand the potential for latitudinal differences in west coast tarakihi age structure between TAR 7 & 8, bottom trawl fishing trips in TAR 7 & 8 Statistical Areas 036–039 and 701–703 were not sampled (western shaded area given in Figure 2). West coast tarakihi sampling recognised three areas: west coast North Island (TAR 1); New Plymouth (TAR 8); west coast South Island (TAR 7) (Figure 2). Note: the alternative option to sample the exclusion areas as designated spatial areas would have required the addition of two strata which was not feasible within the budget constraints of the project.

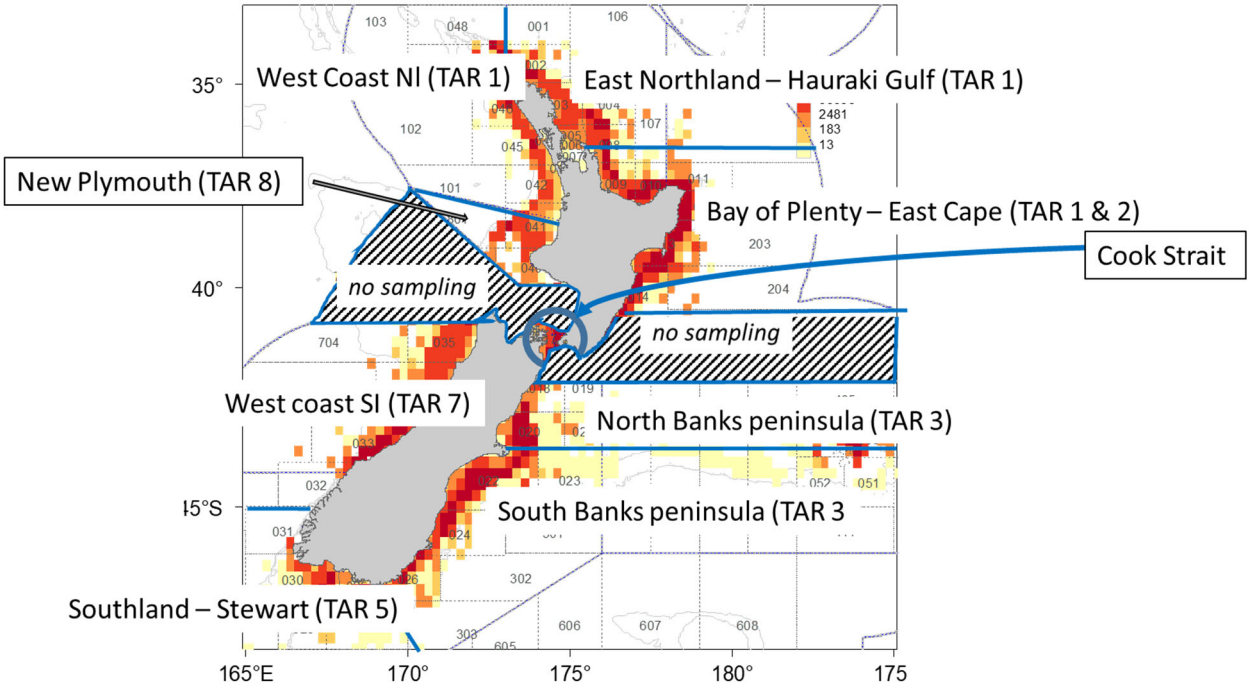


Figure 2: Initial TAR 1, 2, 3, 5, 7, & 8 sampling areas proposed for 2018–19 and 2019–20. Deeper red square colours represent higher relative fishing intensity as based on combined 2013–2017 fishing period data.

Annual sample landing and ageing targets (Table 1) were set with due regard to mean weighted CVs achieved in previous New Zealand tarakihi sampling programmes (Beentjes 2011, Parker & Fu 2011, Beentjes et al. 2012, McKenzie et al. 2017) and reflect both the anticipated level of annual catch from each stratum and the expected number of age classes in the samples.

Table 1: Target number of annual (fishing-year) sampled trawl landings and annual aged otoliths across designated tarakihi region strata for 2018–19 and 2019–20, using the BT method (including MHS) in some areas.

QMA	Area	No. landings	No. otoliths aged
TAR 1	*West Coast North Island	20	600
	*East Northland–Hauraki Gulf	20	600
TAR 1 & 2	Bay of Plenty–East Cape	30	900
MIX	Cook Strait	10	450
TAR 3	North Banks Peninsula	20	600
	South Banks Peninsula	10	300
TAR 5	Southland–Stewart Island	10	450
TAR 7	West Coast South Island	20	600
TAR 8	New Plymouth	10	450

* Areas where the modular harvest system (MHS) method would also be sampled.

2.3 East Coast tarakihi sampling areas

2.3.1 East Northland–Hauraki Gulf commercial fishery profile 2012–13 to 2016–17

The majority of tarakihi taken from East Northland–Hauraki Gulf (EN_HG) region between 2013 and 2017 were caught by bottom trawling (Figure 3). Significant quantities of tarakihi were also taken by bottom longline method largely as bycatch of the target snapper (*Chrysophrys auratus*) fishery (Figure 3). Frequent use of the new Precision Seafood Harvesting Ltd modular harvest system (MHS) trawl net was evident in the 2016–17 fishing year (Figure 3).

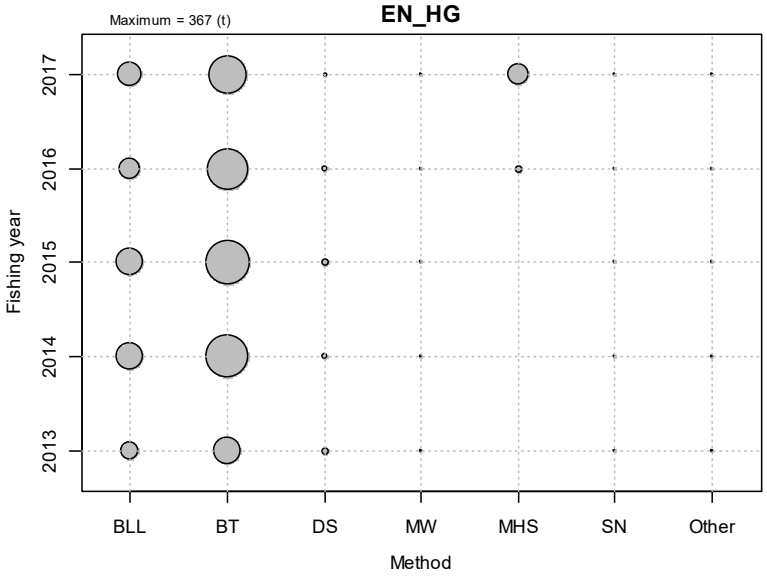


Figure 3: Tonnages of tarakihi landed annually by different EN_HG fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, DS = Danish seine, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

The potential for significant use of the MHS trawl method over the sampling period was problematic to developing the sampling design. It was not feasible to exclude this method from the sampling nor was it feasible to include the method as a specific design stratum. The decision was made to lump MHS with bottom trawl for sampling purposes and to sample it approximately in proportion to its relative use by the EN_HG bottom trawl fishery (Table 1). Note that MHS catches have been combined with bottom trawl catches in the trawl characterisations that follow. The majority of the annual EN_HG bottom trawl tarakihi catch was taken whilst targeting tarakihi (Figure 4).

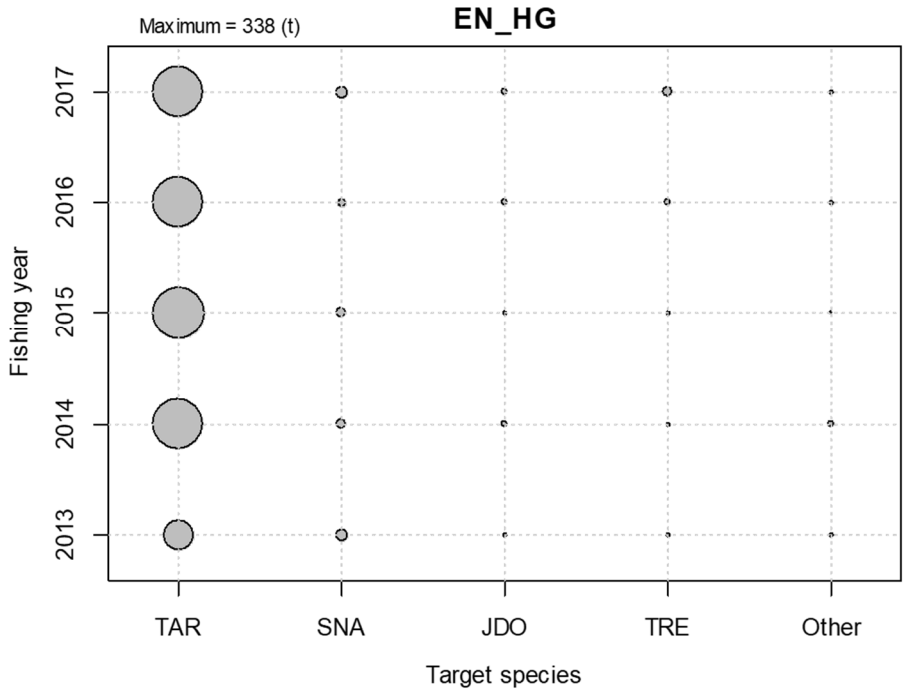


Figure 4: Tonnages of tarakihi landed by EN_HG trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, SNA = snapper, JDO = John dory, and TRE = trevally.

The seasonal profile of the EN_HG tarakihi trawl fishery changed between the 2012–13 to 2016–17 fishing years, from being a predominately winter fishery in the early years to year-round in the most recent years (Figure 5).

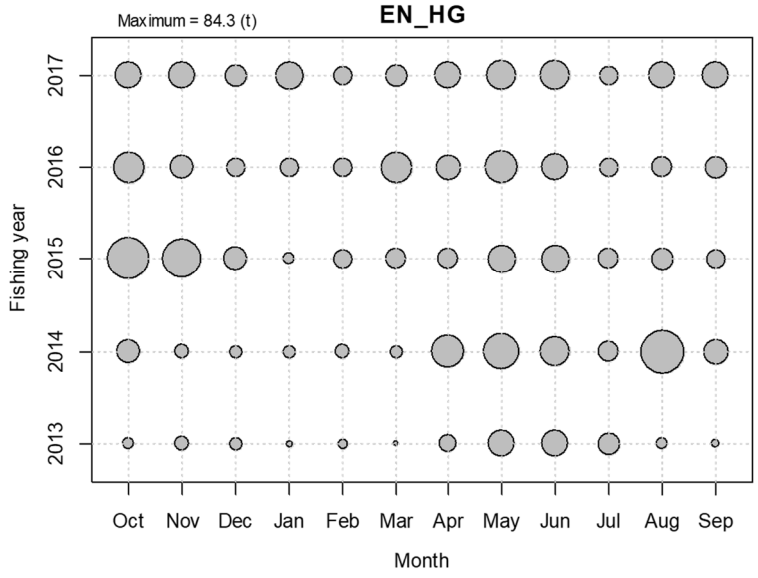


Figure 5: Monthly tonnages of tarakihi landed by EN_HG trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

There were consistent patterns in the relative contribution of landings from each EN_HG statistical area across all five fishing years (Figure 6). Most of the annual EN_HG bottom trawl tarakihi catch was taken

from Statistical Areas 002, 003, and 004 (most recent years). A significant amount of tarakihi was also taken from the EN_HG border region with the Bay of Plenty (Statistical Area 008, Figure 6).

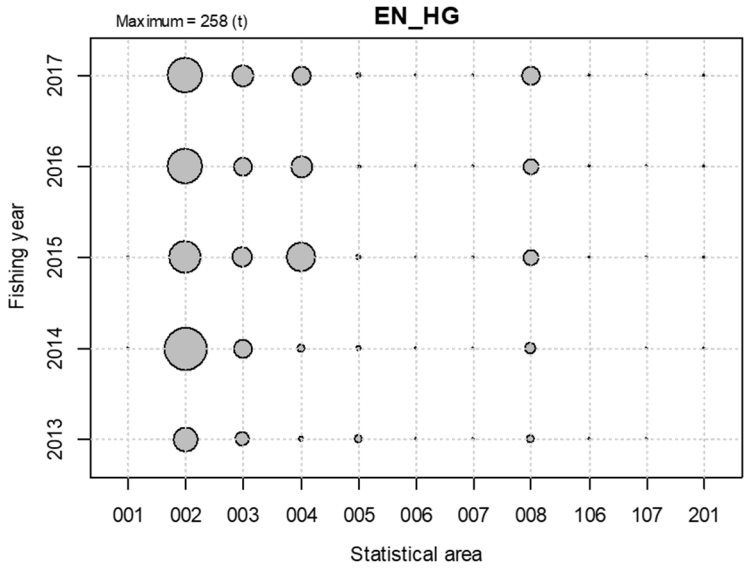


Figure 6: Statistical area tonnages of tarakihi landed by EN_HG trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within EN_HG, based on the reported latitude and longitude of individual trawl shots, suggests that tarakihi are caught on the outer shelf (about 100 m depth) throughout this region (Figure 7).

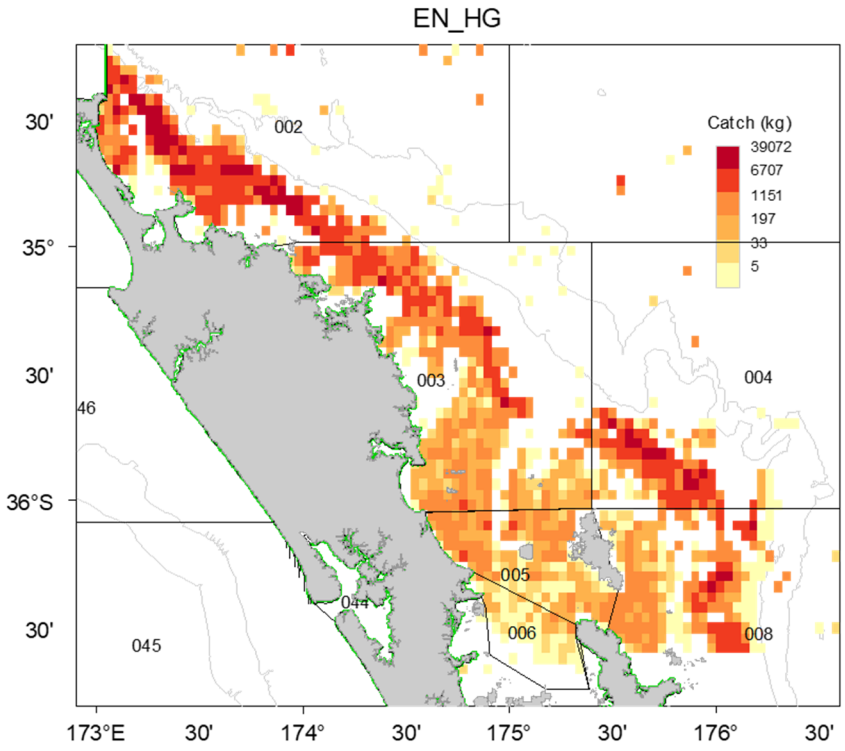


Figure 7: Spatial distribution of the EN_HG region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.3.2 East Northland–Hauraki Gulf region sample design

Several considerations were needed to ensure that sampling was undertaken in a way that represented the EN_HG bottom trawl fishery. A total of 20 sampling events were allocated to EN_HG bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). Landings from trips that had fished across multiple stocks/areas were not sampled because it was not possible to identify fish from each area. To ensure representative temporal coverage within each fishery, the seasonal trend of catches from past years was assessed, and sampled landings were distributed in accordance to these patterns. For sample allocation purposes the fishing year was divided into four season/strata: October to November, December to February, March to May, and June to August. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 500 kg would have resulted in about 90% of the EN_HG tarakihi landed catch by weight and 40% of tarakihi landings being eligible for sampling (Figure 8).

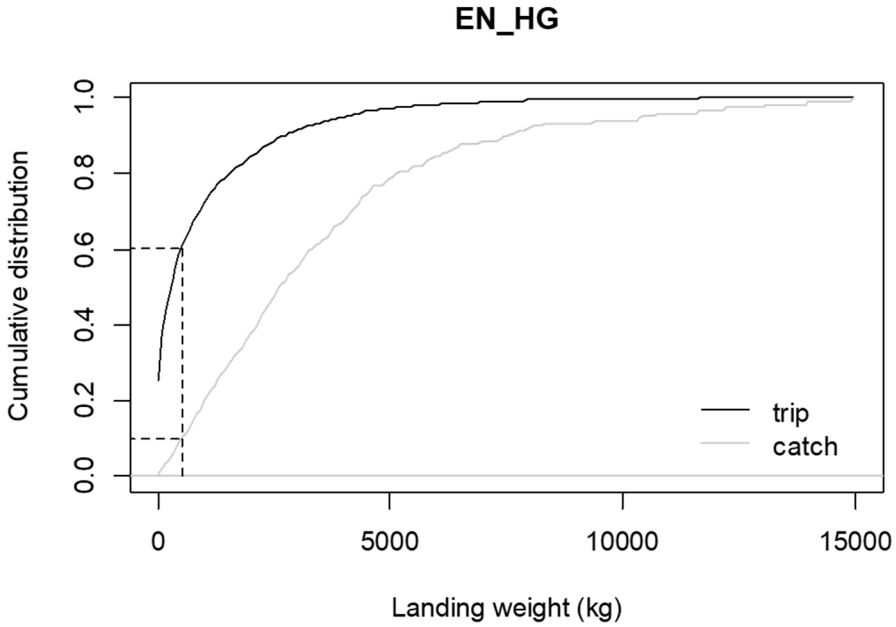


Figure 8: Cumulative distribution of landings from the East Northland–Hauraki Gulf (EN_HG) region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 500 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 40% of the number of available trips.

Landings from the East Northland–Hauraki Gulf (EN_HG) region were predominantly processed by two Licensed Fish Receivers (LFRs) (Figure 9), the 20 sampling events were allocated to these processors proportional to the relative weight of annual catch processed.

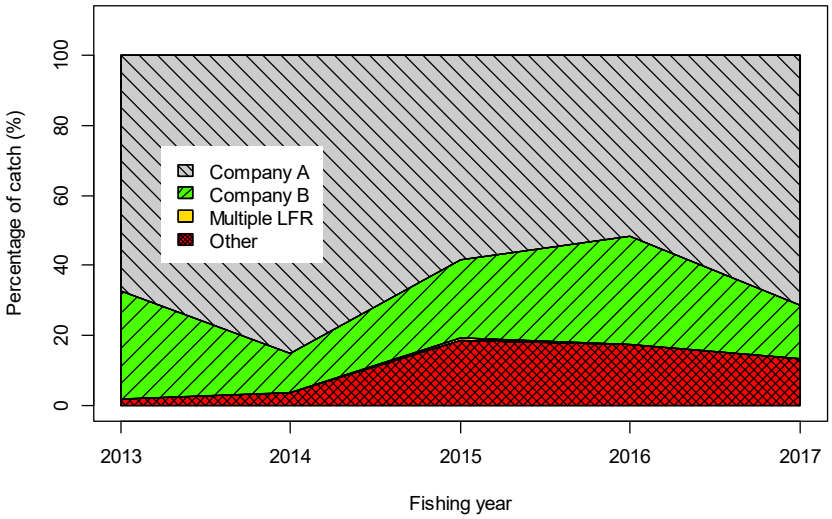


Figure 9: Percentage of the bottom trawl tarakihi catch from the East Northland/ Hauraki Gulf region processed annually by the main LFRs between the 2012–13 and 2016–17 fishing years.

2.3.3 Bay of Plenty–East Cape commercial fishery profile 2012–13 to 2016–17

The majority of tarakihi taken from Bay of Plenty–East Cape (BP_EC) region between 2013 and 2017 was caught by bottom trawling (Figure 10).

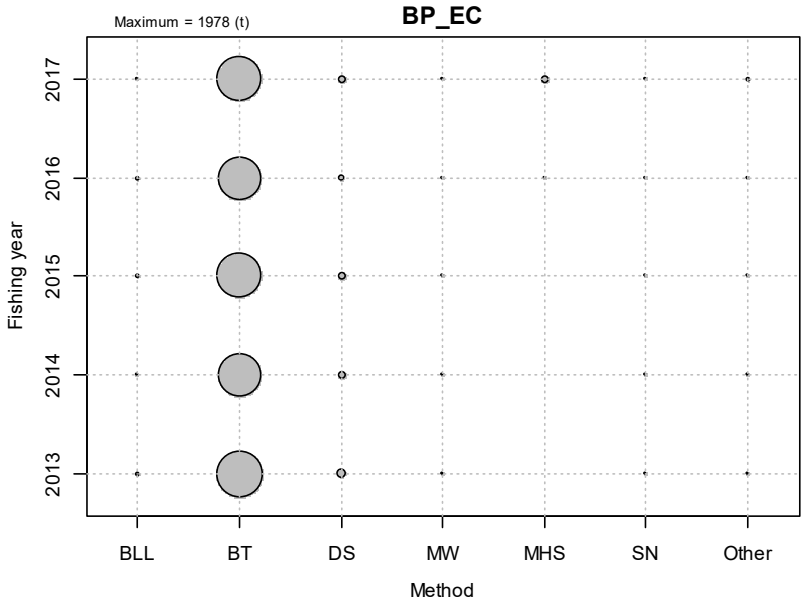


Figure 10: Tonnages of tarakihi landed annually by different BP_EC fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, DS = Danish seine, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual BP_EC bottom trawl tarakihi catch was taken whilst targeting tarakihi (Figure 11).

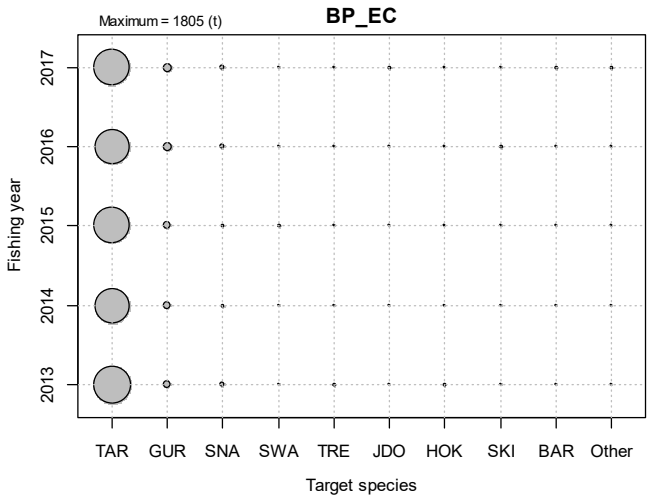


Figure 11: Tonnages of tarakihi landed by BP_EC trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, GUR = red gurnard, SNA = snapper, SWA = silver warehou, TRE = trevally, JDO = John dory, HOK = hoki, SKI = gemfish, and BAR = barracouta.

The BP_EC tarakihi trawl fishery was relatively consistent over the course of the 2012–13 to 2016–17 fishing years, with no clear seasonal patterns evident (Figure 12).

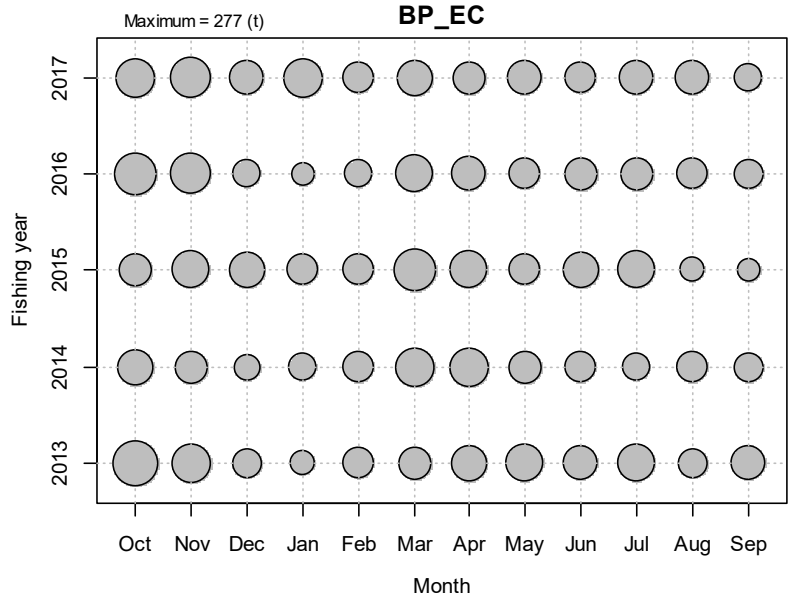


Figure 12: Monthly tonnages of tarakihi landed by BP_EC trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

The spatial distribution of the BP_EC tarakihi trawl fishery was relatively consistent between 2012–13 and 2016–17 with a high proportion of the annual regional catch coming from the East Cape (TAR 2) Statistical Areas 011, 012, 013, and 014 (Figure 13).

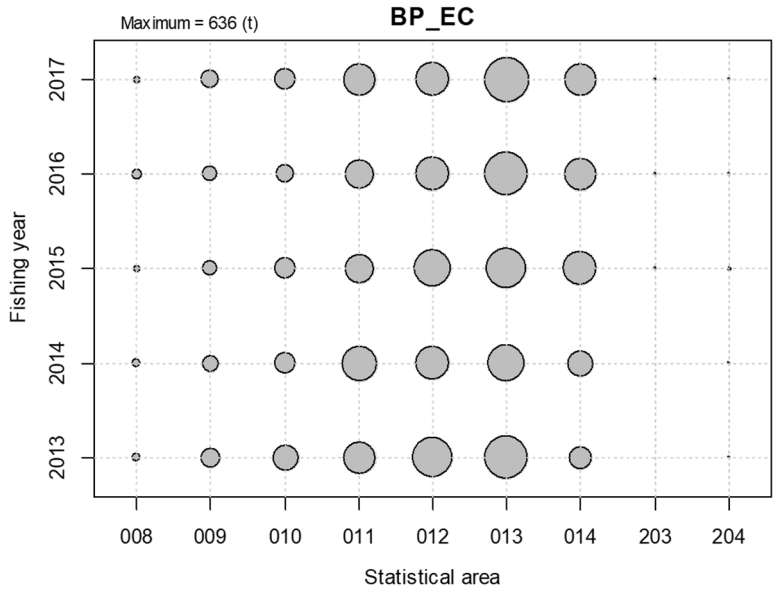


Figure 13: Statistical area tonnages of tarakihi landed by BP_EC trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within BP_EC, based on the reported latitude and longitude of individual trawl shots, shows that the area where tarakihi are predominantly caught is between East Cape and Mahia Peninsula (Figure 14).

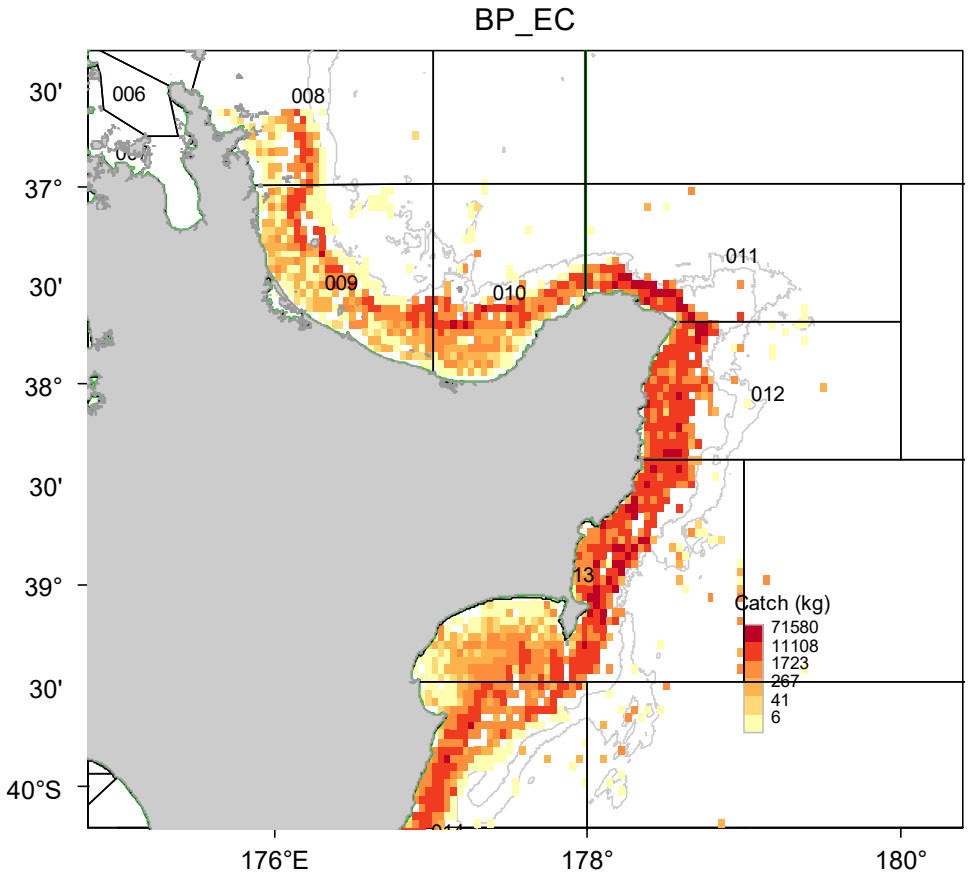


Figure 14: Spatial distribution of the BP_EC region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.3.4 Bay of Plenty–East Cape region sample design

A total of 30 sampling events were allocated to BP_EC bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 to 2016–17 fishing years were used to allocate sampled landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 1500 kg would have resulted in about 90% of the BP_EC tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 15).

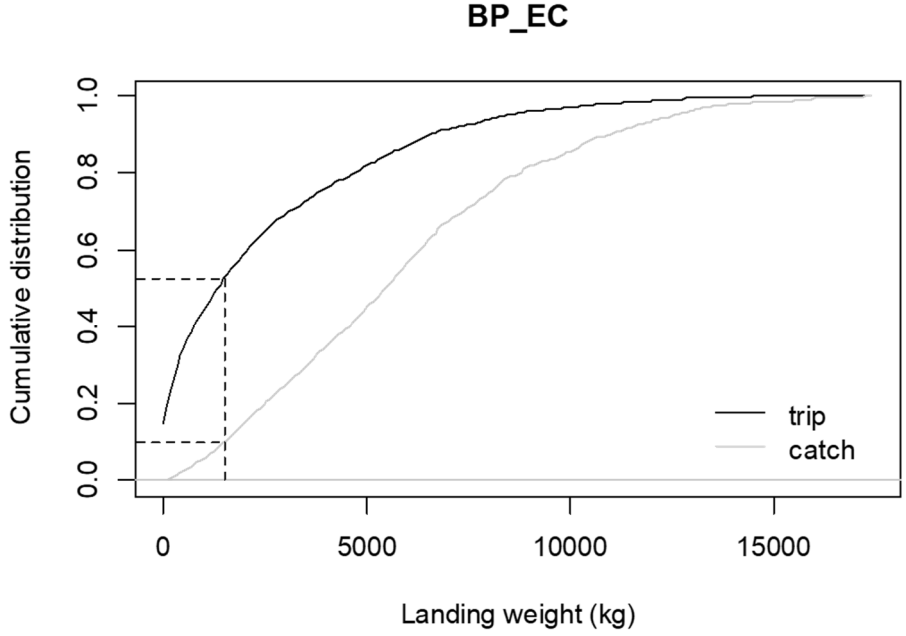


Figure 15: Cumulative distribution of landings from the Bay of Plenty-East Cape (BP_EC) region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 1500 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 45% of the number of available trips.

Landings from the Bay of Plenty–East Cape (BP_EC) region were predominantly processed by three LFRs (Figure 16), so the 30 sampling events were allocated to these processors based on the relative weight of annual catch they processed.

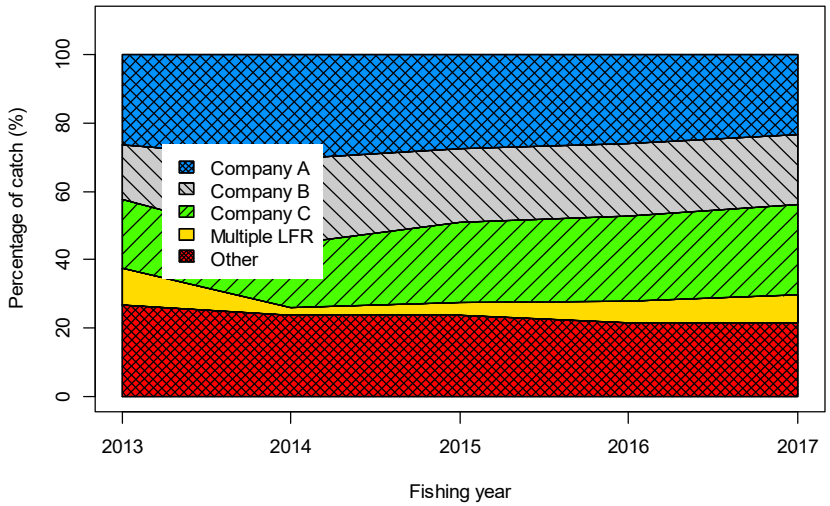


Figure 16: Percentage of the bottom trawl tarakihi catch from the Bay of Plenty-East Cape region processed annually by the main LFRs between the 2012–13 and 2016–17 fishing years.

2.3.5 Cook Strait region sample design

The Cook Strait (CSTR) sampling region included portions of Statistical Areas 017 and northern 018. The purpose of sampling Cook Strait was to describe the length and age structure of a potential spawning aggregation. The catch from this area is targeted by a bottom trawl fishery and specifically targets large, aggregated, pre-spawning fish during the period January to May.

A total of 10 sampling events were allocated to CSTR bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The designated sampling period included the months January to May. Fishing company catch patterns during the 2016 and 2017 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 2000 kg would have resulted in about 84% of the CSTR tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 17).

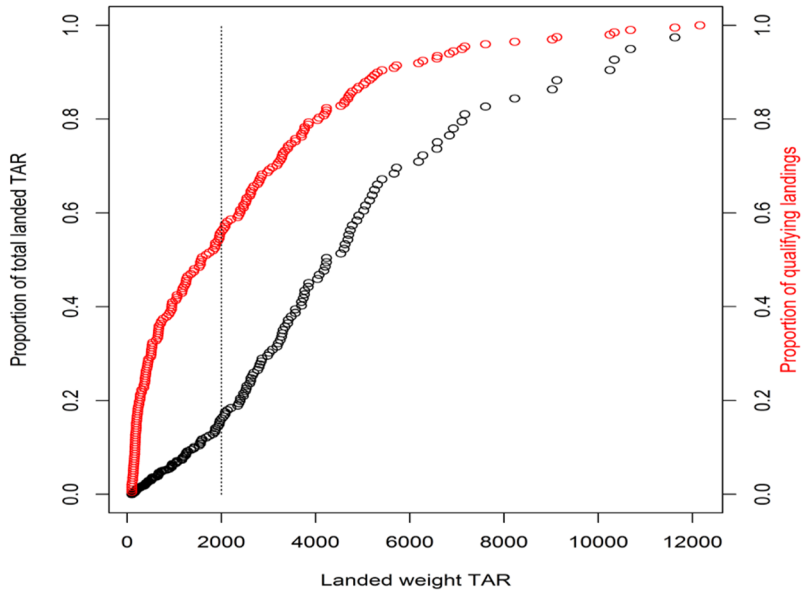


Figure 17: Cumulative distribution of landings from the Cook Strait (CSTR) region (by weight and number of trips) for the 2015–16 to 2016–17 fishing years. The vertical line denotes the 2000 kg minimum size limit for landings deemed eligible for sampling which accounted for about 90% of the catch by weight, and about 45% of the number of available trips.

Most of the qualifying landings (> 2000 kg) occurred during January-June. However, the monthly distribution was variable between the two years (Figure 18). The number of qualifying landings in 2015–16 and 2016–17 was 45 and 38, respectively, which suggested that the 10-landing sample target was achievable.

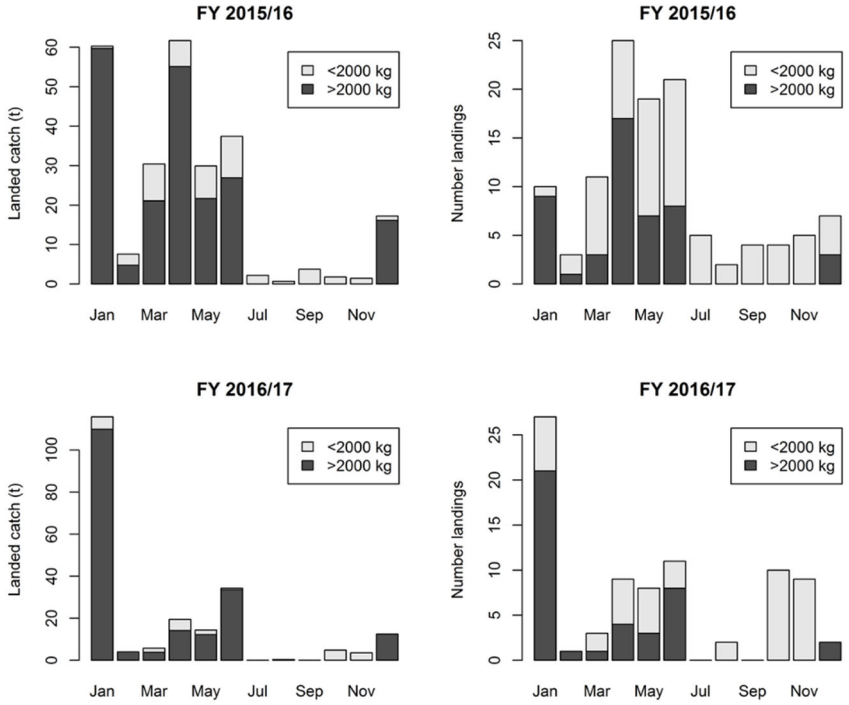


Figure 18: Cook Strait monthly landed catch and number of qualifying trips based on 2015–16 and 2016–17 reported landing data.

2.3.6 North Banks Peninsula commercial fishery profile 2012–13 to 2016–17

The majority of tarakihi taken from the North Banks Peninsula (NBP) region between 2012–13 and 2016–17 was caught by bottom trawl and set net methods (Figure 19).

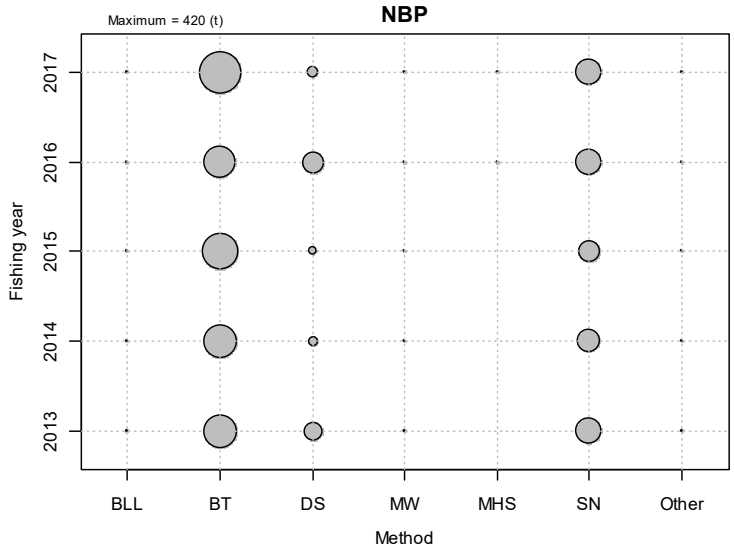


Figure 19: Tonnages of tarakihi landed annually by different NBP fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, DS = Danish seine, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual NBP bottom trawl tarakihi catch was taken whilst targeting tarakihi (Figure 20).

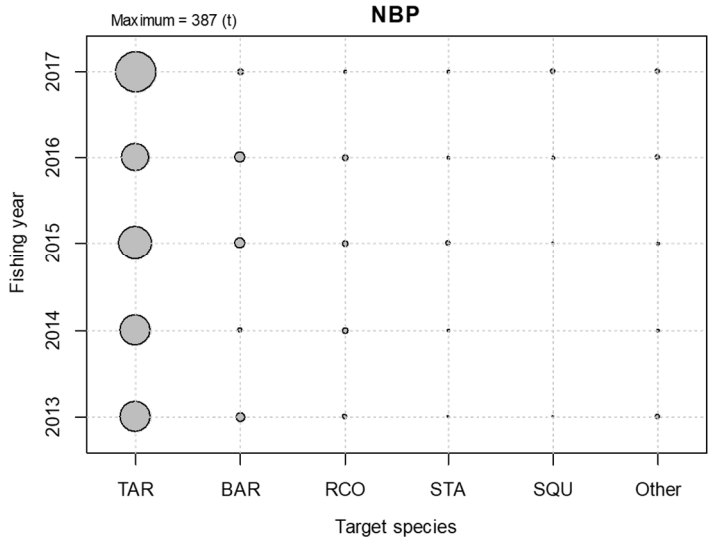


Figure 20: Tonnages of tarakihi landed by NBP trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, BAR = barracouta, RCO = red cod, STA = stargazer, and SQU = squid.

The NBP tarakihi trawl fishery showed high monthly variation over the 2012–13 to 2016–17 fishing years, with no clear seasonal patterns evident (Figure 21).

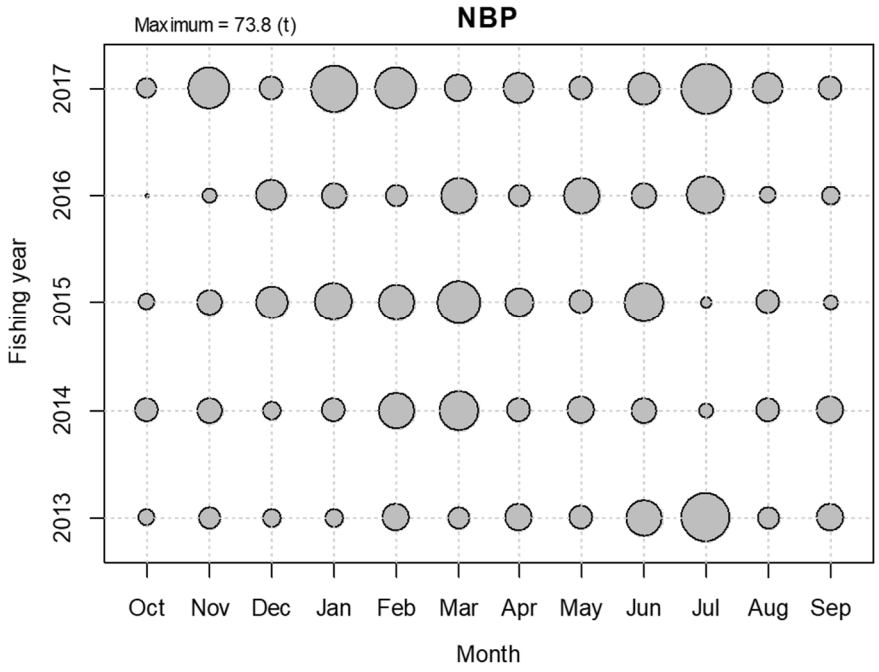


Figure 21: Monthly tonnages of tarakihi landed by NBP trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

The spatial distribution of the NBP tarakihi trawl fishery was relatively consistent between 2012–13 and 2016–17 with most of the catch coming from Statistical Areas 018 and 020 (Figure 22).

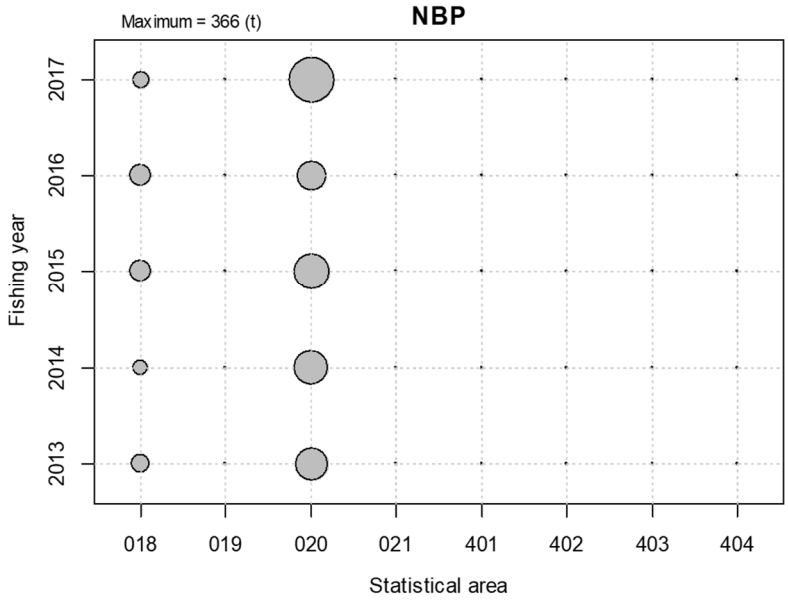


Figure 22: Statistical area tonnages of tarakihi landed by NBP trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within NBP, based on the reported latitude and longitude of individual trawl shots, shows the predominant tarakihi catching area between 2012–13 and 2016–17 covered a relatively large area immediately north of Banks Peninsula (Figure 23).

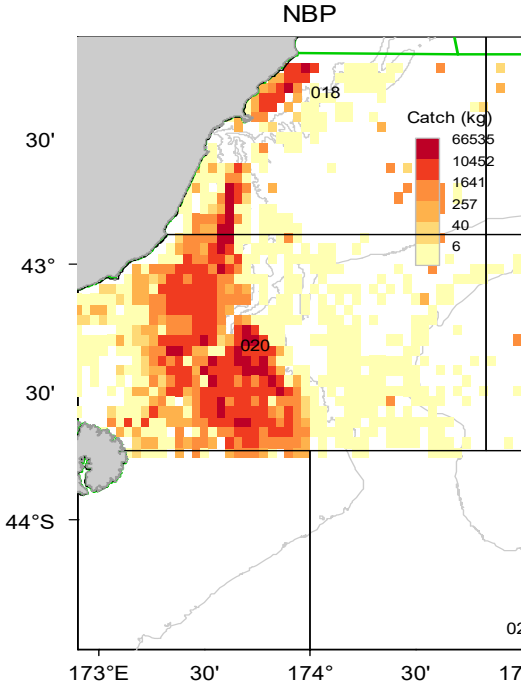


Figure 23: Spatial distribution of the NBP region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.3.7 North Banks Peninsula region sample design

A total of 20 sampling events were allocated to NBP bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 500 kg would have resulted in about 90% of the NBP tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 24).

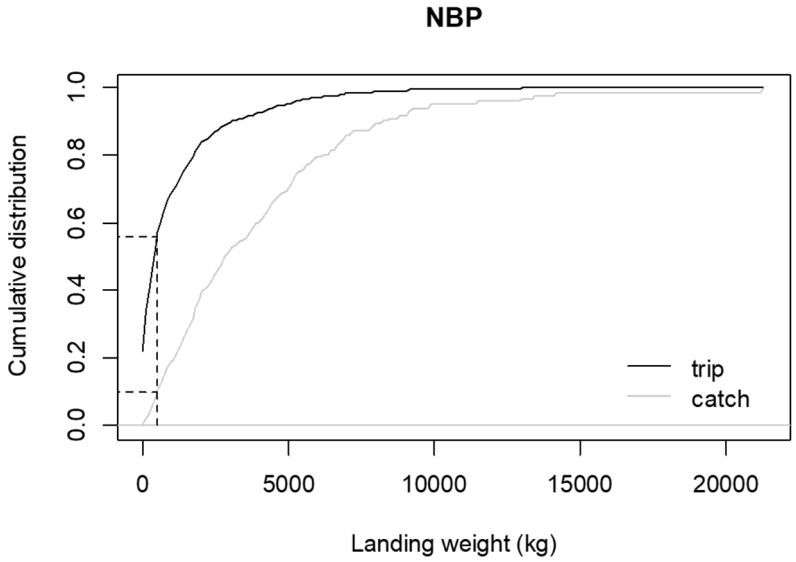


Figure 24: Cumulative distribution of landings from the NBP region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 500 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 45% of the number of available trips.

Landings from the North Banks Peninsula region were predominantly processed by one LFR (Figure 25) and all annual 20 target landings were allocated to that company.

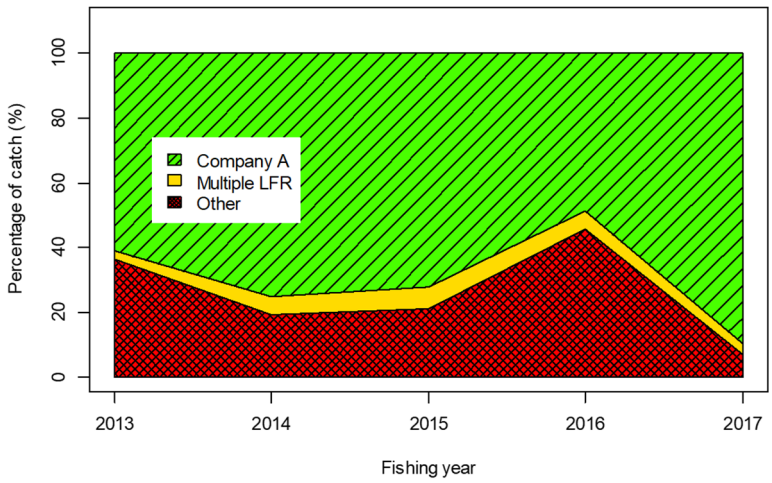


Figure 25: Percentage of the bottom trawl tarakihi catch from the NBP region processed annually by the main LFR between the 2012–13 and 2016–17 fishing years.

2.3.8 South Banks Peninsula commercial fishery profile 2012–13 to 2016–17

The majority of tarakihi taken from South Banks Peninsula (SBP) region between 2013 and 2017 was caught by bottom trawl (Figure 26).

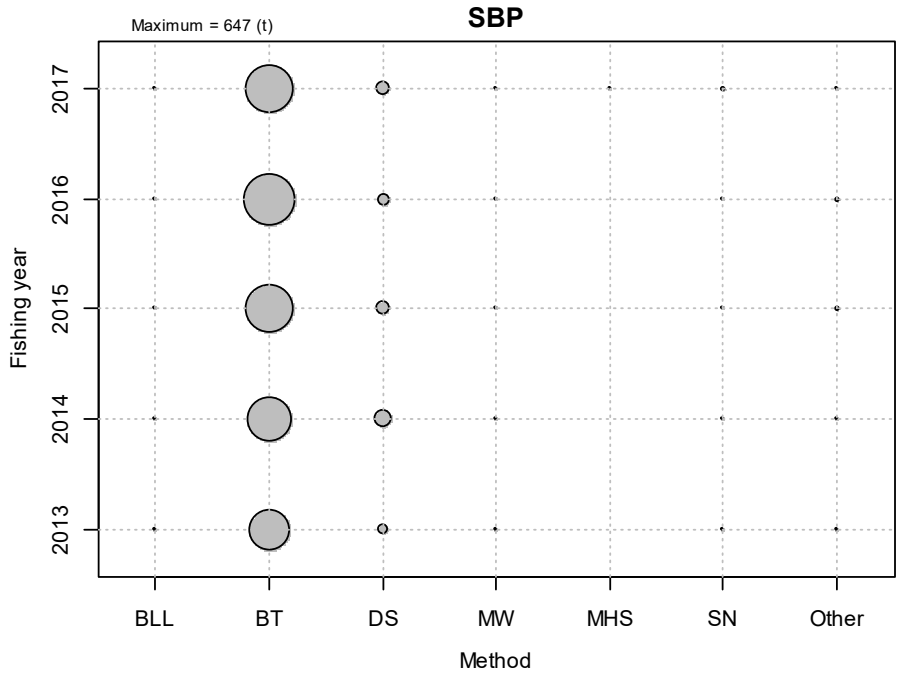


Figure 26: Tonnages of tarakihi landed annually by different SBP fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, DS = Danish seine, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual SBP bottom trawl tarakihi catch was taken whilst targeting tarakihi (Figure 27). But moderate quantities of tarakihi were also taken targeting barracouta, sea perch, red cod, and flatfish).

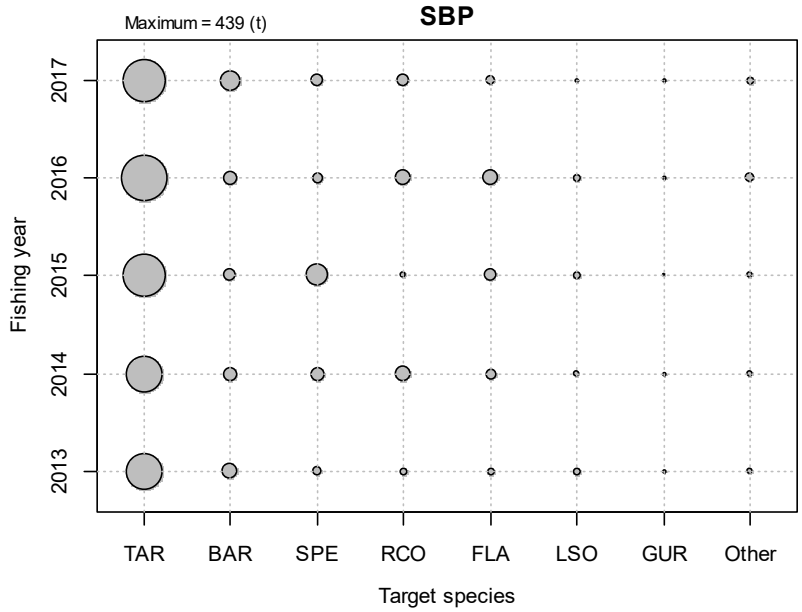


Figure 27: Tonnages of tarakihi landed by SBP trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, BAR = barracouta, SPE = sea perch, RCO = red cod, FLA = flatfish, LSO = lemon sole, and GUR = red gurnard.

The SBP tarakihi trawl fishery exhibited a distinct and consistent seasonal pattern over the 2013–2017 fishing years with most of the catches occurring over the months of January to June (Figure 28).

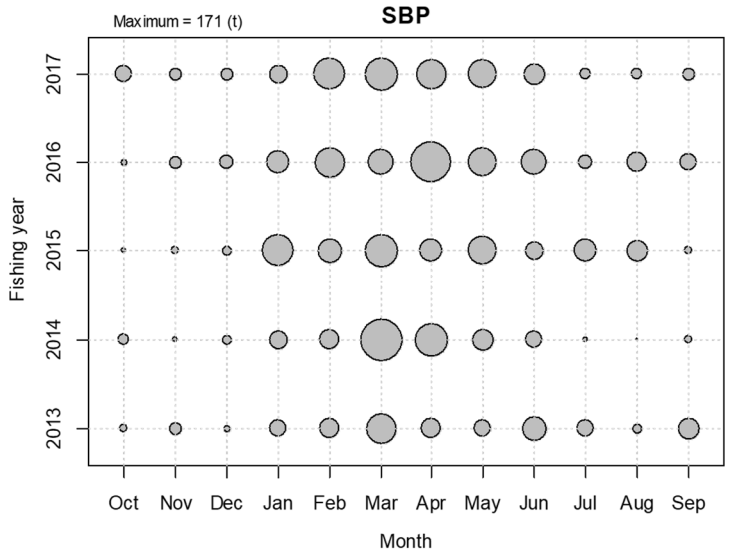


Figure 28: Monthly tonnages of tarakihi landed by SBP trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

The spatial distribution of the SBP tarakihi trawl fishery was relatively consistent between 2012–13 and 2016–17 with most of the catch coming from Statistical Areas 022, 024, and 026 (Figure 29).

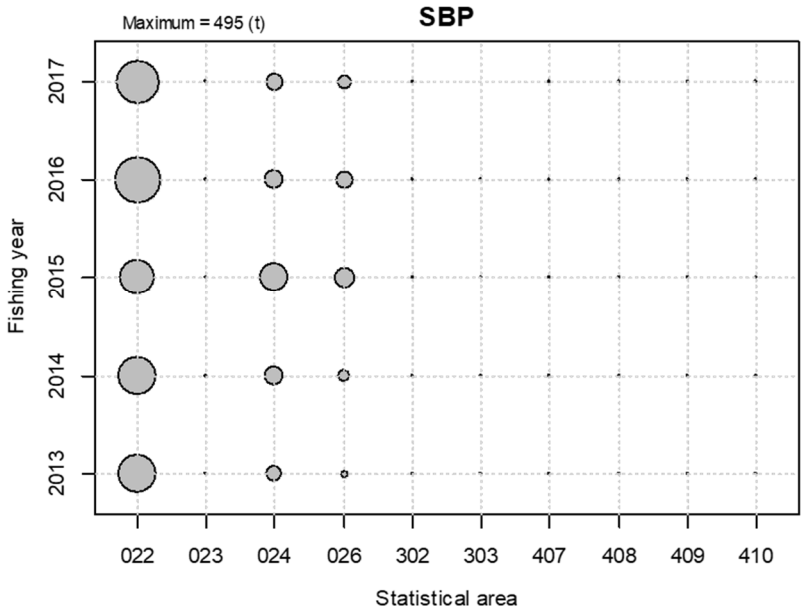


Figure 29: Statistical area tonnages of tarakihi landed by SBP trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within SBP, based on the reported latitude and longitude of individual trawl shots, shows tarakihi are caught over the entire latitudinal range predominately at a depth of 50 to 120 m (Figure 30).

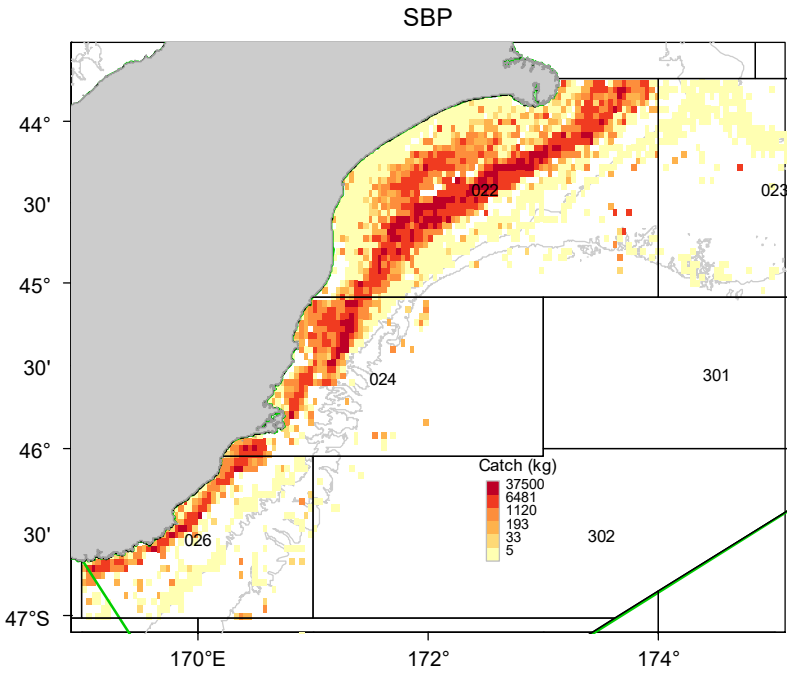


Figure 30: Spatial distribution of the SBP region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.3.9 South Banks Peninsula region sample design

A total of 10 sampling events were allocated to SBP bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2016 and 2017 fishing years were used to allocate sample landings across seasons and for setting the minimum sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 300 kg would have resulted in about 90% of the SBP tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 31).

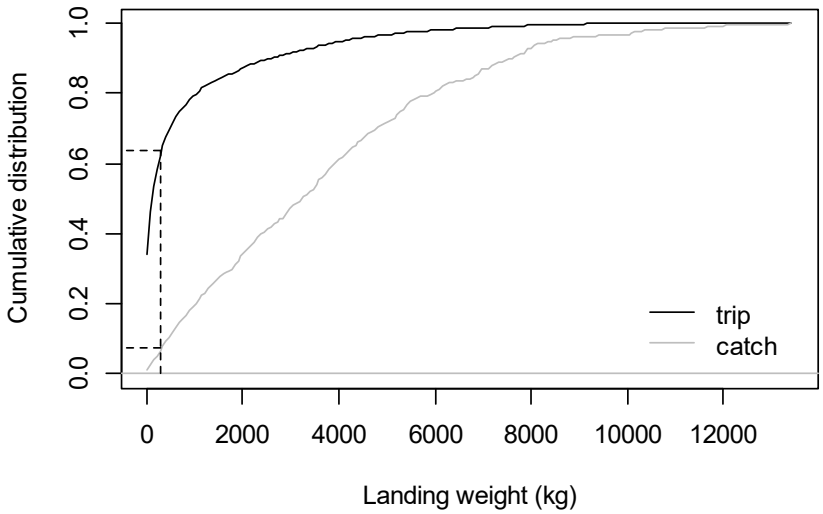


Figure 31: Cumulative distribution of landings from the SBP region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 300 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 35% of the number of available trips.

Landings from the SBP region were predominantly processed by two LFRs (Figure 32) so the 10 sampling events were allocated to these two processors based on the relative weight of annual catch processed.

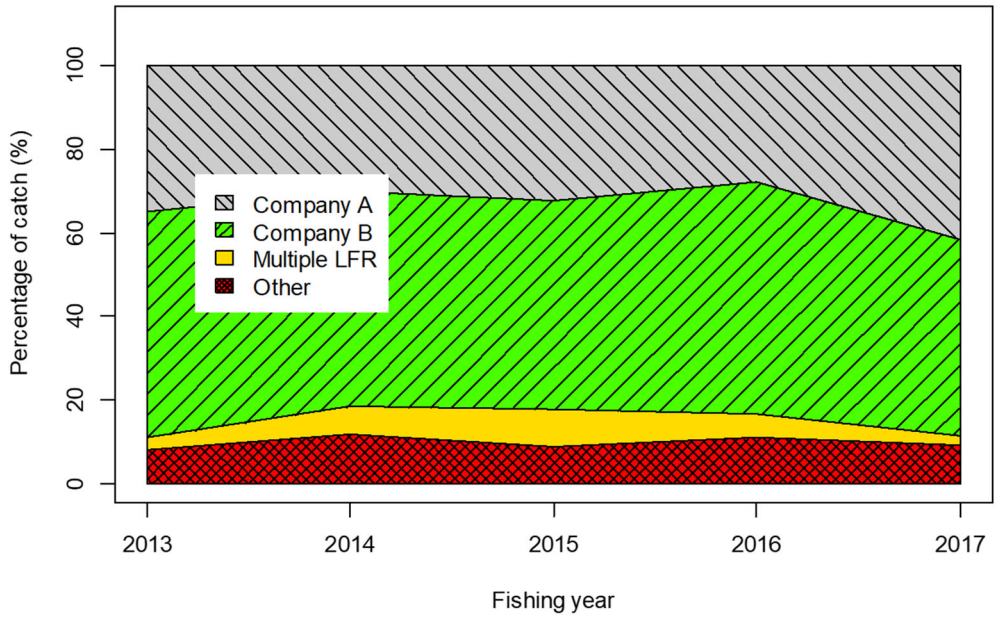


Figure 32: Percentage of the bottom trawl tarakihi catch from the SBP region processed annually by the two main LFRs between the 2012–13 to 2016–17 fishing years.

2.3.10 Southland–Stewart Island (TAR 5) fishery profile 2012–13 to 2016–17

Almost all of TAR 5 catch taken between 2012–13 and 2016–17 was caught by bottom trawl (Figure 33).

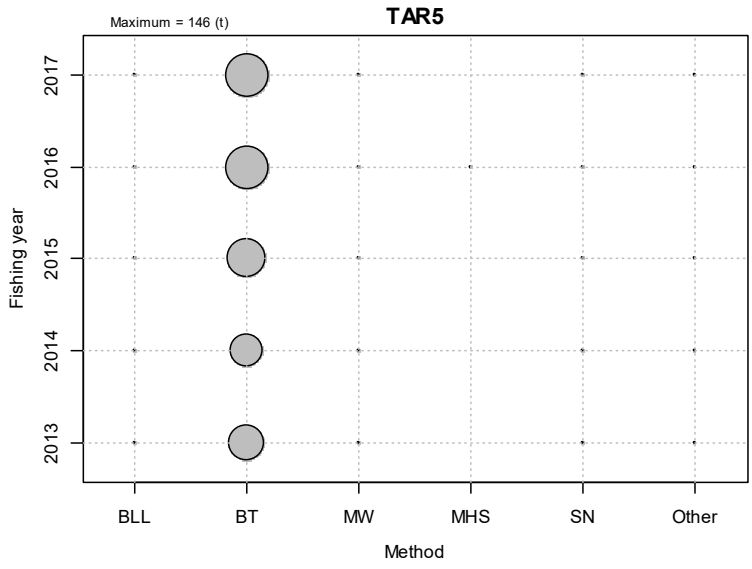


Figure 33: Tonnages of tarakihi landed annually by different TAR 5 fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual TAR 5 bottom trawl tarakihi catch was taken whilst targeting stargazer (Figure 34) although tarakihi, flatfish, and blue warehou targeting also accounted for moderate amounts of the TAR 5 landed catch (Figure 34).

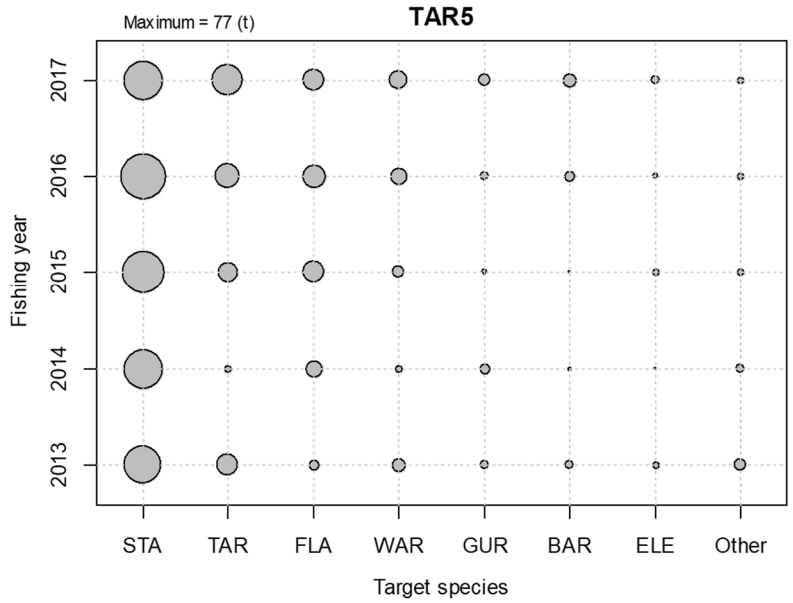


Figure 34: Tonnages of tarakihi landed by TAR 5 trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: STA = stargazer, TAR = tarakihi, FLA = flatfish, WAR = blue warehou, GUR = red gurnard, BAR = barracouta, and ELE = elephantfish.

Although tarakihi were taken throughout the year by the TAR 5 trawl fishery, a seasonal pattern to the catches was evident with higher catches occurring over the first four months of the fishing year with a distinct drop in catch during May, June, and July (Figure 35).

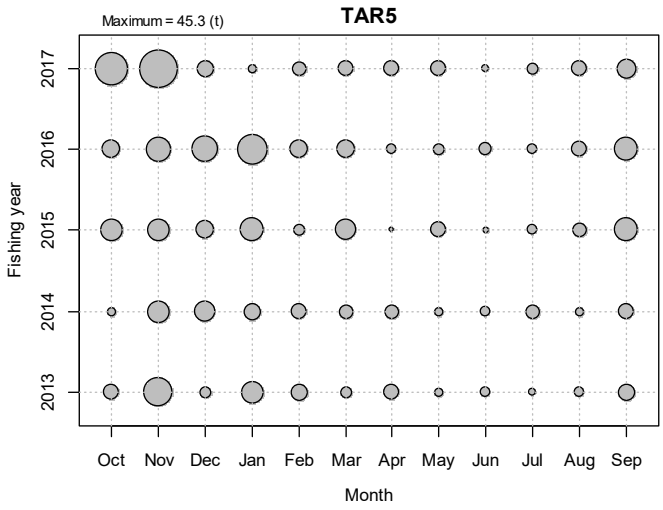


Figure 35: Monthly tonnages of tarakihi landed by TAR 5 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

Most of the TAR 5 trawl tarakihi catch was taken consistently from Statistical Areas 030 and 025 (Figure 36).

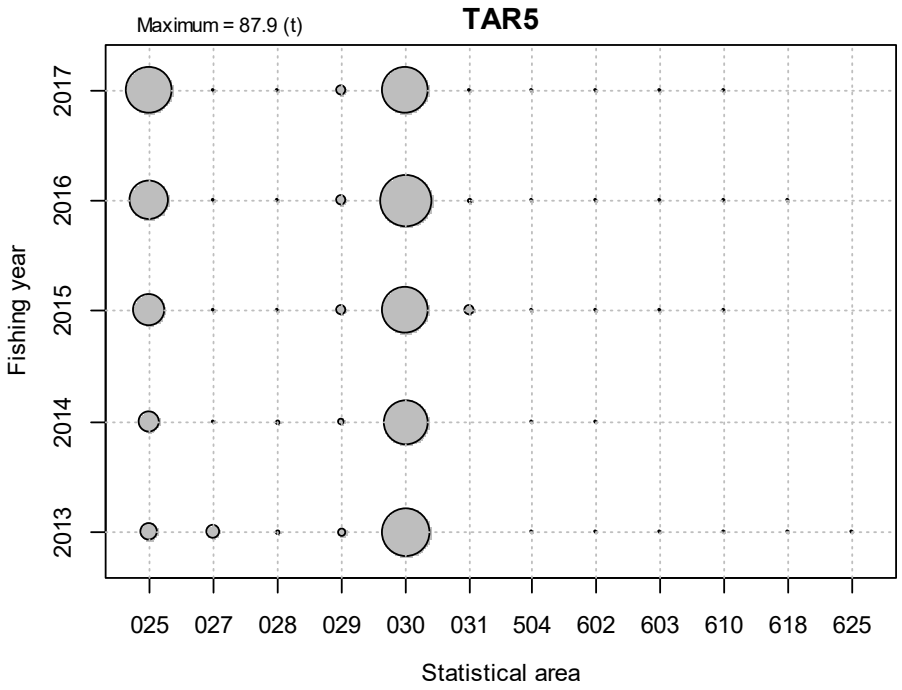


Figure 36: Statistical area tonnages of tarakihi landed by TAR 5 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within TAR 5, based on the reported latitude and longitude of individual trawl shots, shows tarakihi were caught predominantly from areas west and north-east of Stewart Island and from the Te Waewae Bay region of Southland (Figure 37).

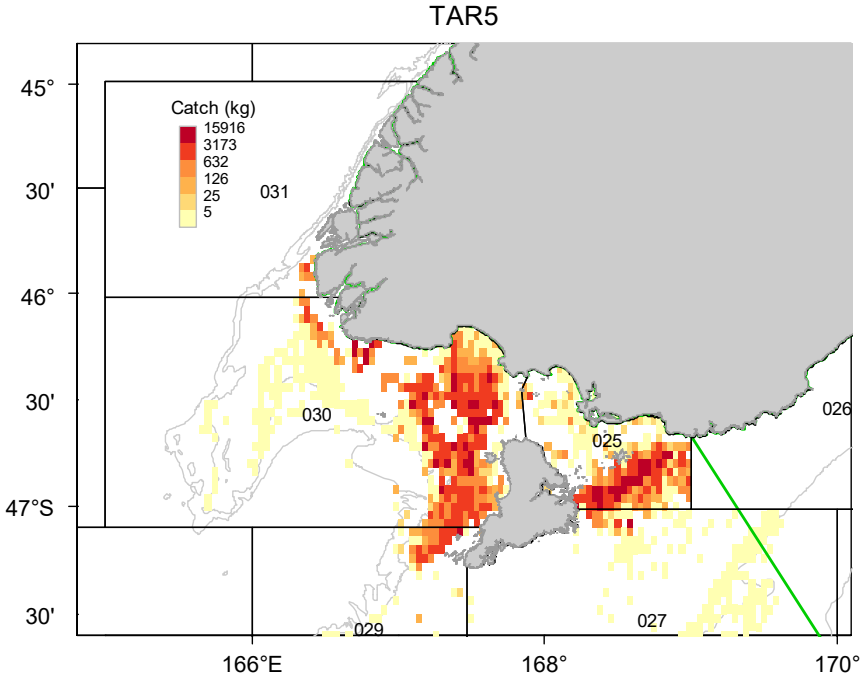


Figure 37: Spatial distribution of the TAR 5 region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.3.11 Southland–Stewart Island (TAR 5) region sample design

A total of 10 sampling events were allocated to TAR 5 bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 200 kg would have resulted in about 90% of the TAR 5 tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 38).

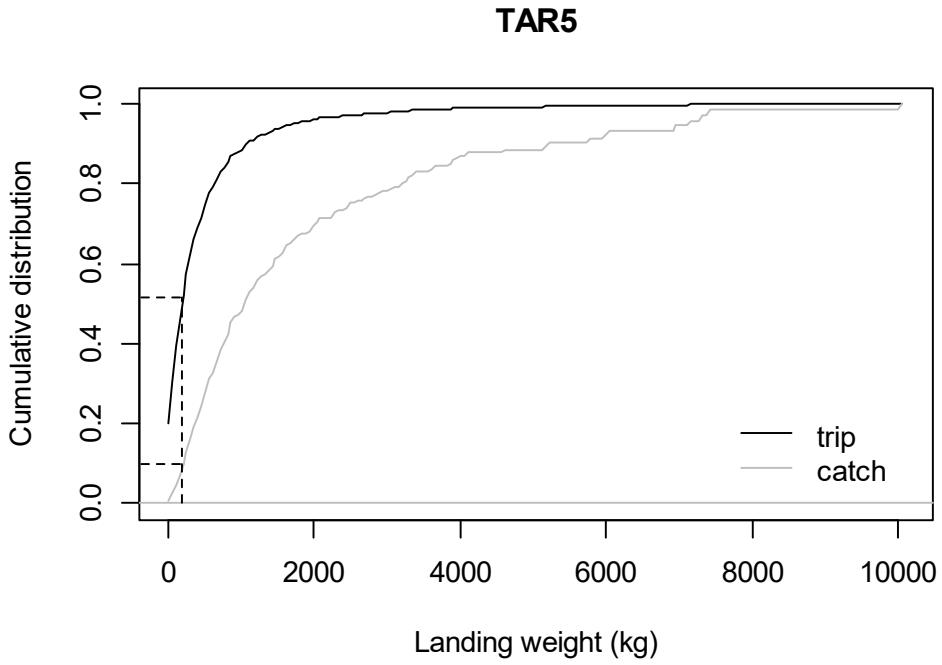


Figure 38: Cumulative distribution of landings from the TAR 5 region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 200 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 45% of the number of available trips.

TAR 5 tarakihi landings were processed by multiple LFRs and only the one main LFR could feasibly be sampled (Figure 39) so all 10 sample landings were allocated to this LFR.

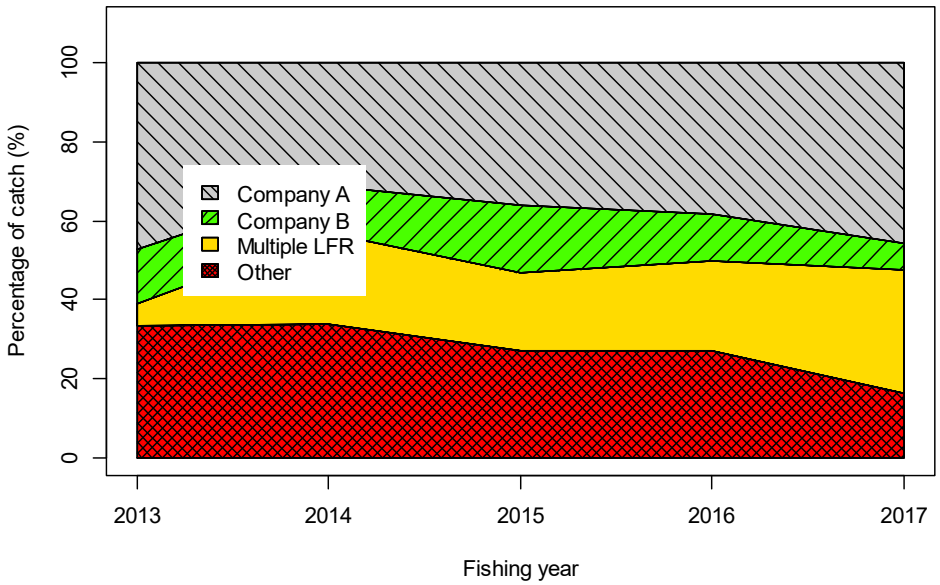


Figure 39: Percentage of the bottom trawl tarakihi catch from the TAR 5 region processed annually by the two main LFRs between the 2012–13 and 2016–17 fishing years.

2.4 West Coast tarakihi sampling areas

2.4.1 West Coast South Island (TAR 7) fishery profile 2012–13 to 2016–17

Almost all of TAR 7 catch taken between 2012–13 and 2016–17 was caught by bottom trawl (Figure 40).

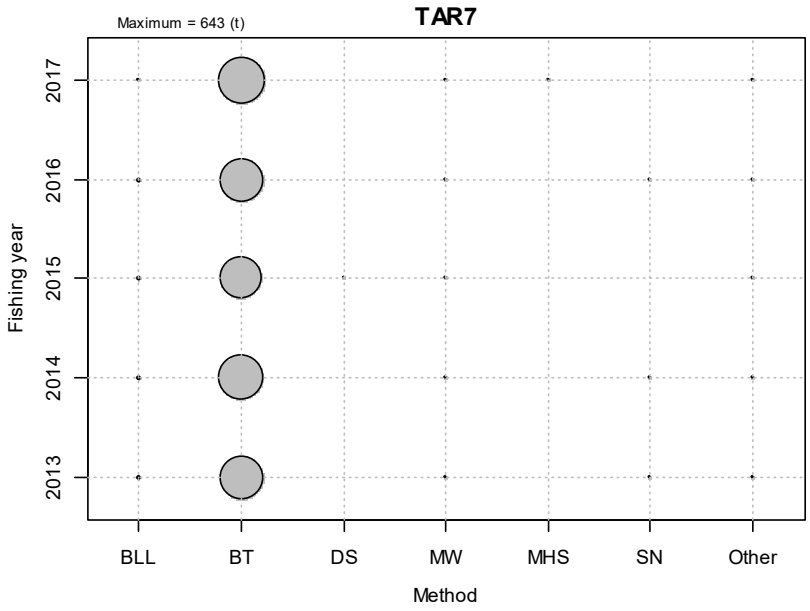


Figure 40: Tonnages of tarakihi landed annually by different TAR 7 fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual TAR 7 bottom trawl tarakihi catch was taken whilst targeting tarakihi (Figure 41), but moderate quantities of tarakihi were also taken targeting barracouta, stargazer, blue warehou, and red cod (Figure 41).

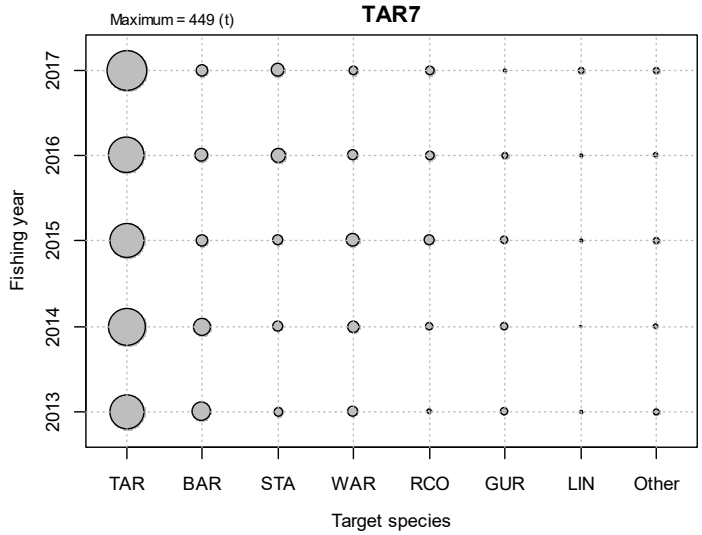


Figure 41: Tonnages of tarakihi landed by TAR 7 trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, BAR = barracouta, STA = stargazer, WAR = blue warehou, RCO = red cod, GUR = red gurnard, and LIN = ling.

Tarakihi were taken throughout the year by the TAR 7 trawl fishery with only a slight drop in catches over autumn-winter months (Figure 42).

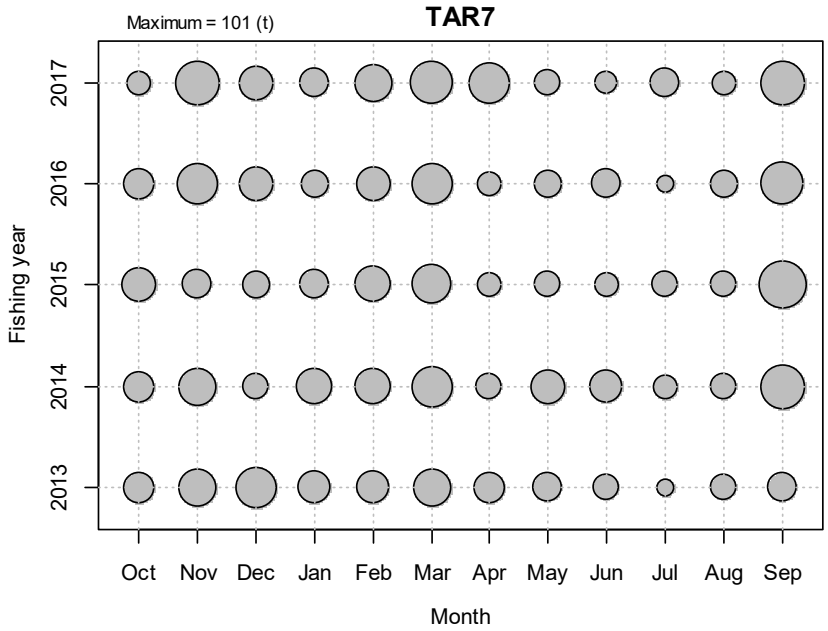


Figure 42: Monthly tonnages of tarakihi landed by TAR 7 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

Virtually all the TAR 7 trawl tarakihi catch was from the coastal Statistical Areas 032, 033, 034, and 035 (Figure 43). Significant quantities of TAR 7 catch were also taken from statistical areas in the sampling exclusion area (not shown, refer to section 2.2 for explanation of why there was no sampling of TAR 7 trawl trips fishing in these statistical areas).

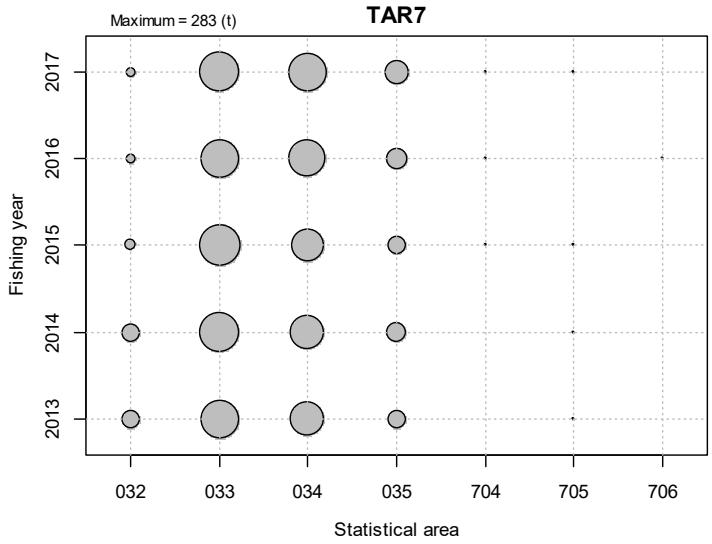


Figure 43: Statistical area tonnages of tarakihi landed by TAR 7 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within TAR 7, based on the reported latitude and longitude of individual trawl shots, shows that tarakihi were consistently caught across the whole of the TAR 7 QMA latitudinal range (Figure 44), with higher catches coming from the 70–200 m depth range.

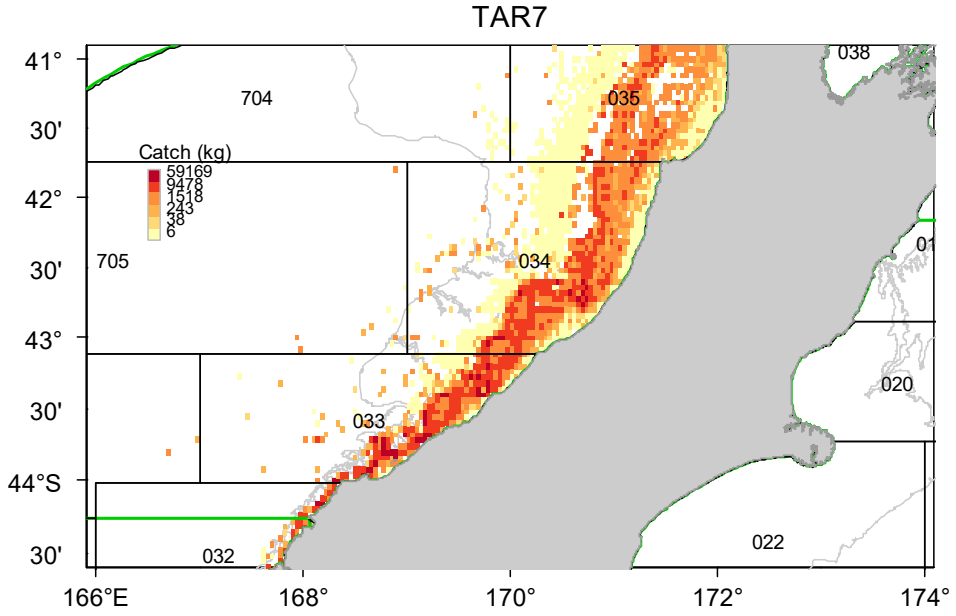


Figure 44: Spatial distribution of the TAR 7 region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.4.2 West Coast South Island (TAR 7) region sample design

A total of 20 sampling events were allocated to TAR 7 bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 750 kg would have resulted in about 90% of the TAR 7 tarakihi landed catch by weight and 55% of tarakihi landings being eligible for sampling (Figure 45).

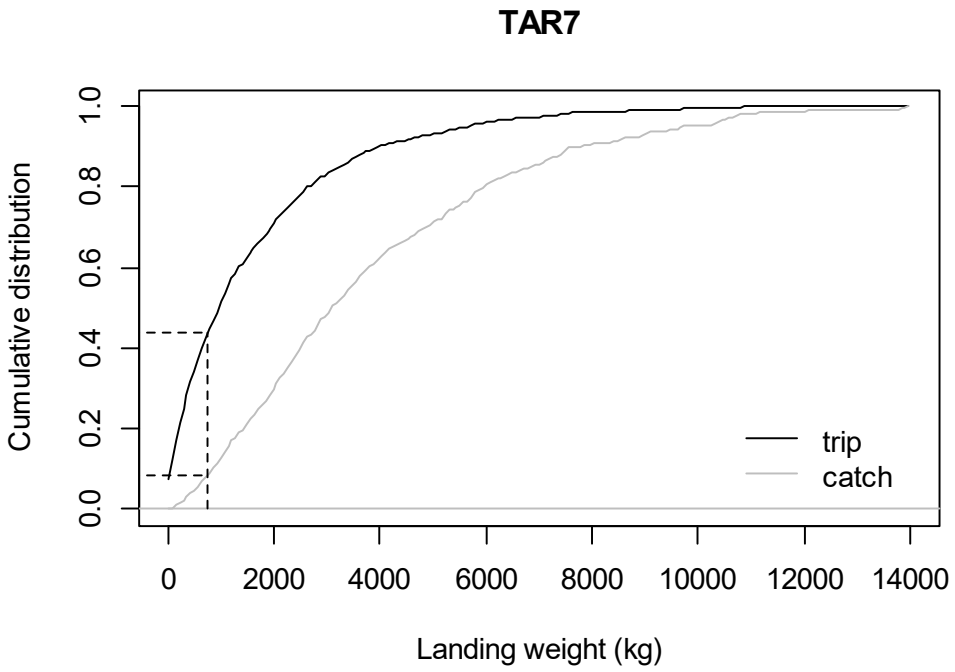


Figure 45: Cumulative distribution of landings from the TAR 7 region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 750 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 55% of the number of available trips.

TAR 7 tarakihi landings were largely processed by two main LFRs (Figure 46) so the 20 sampling events were allocated to these two processors based on the relative weight of annual catch processed.

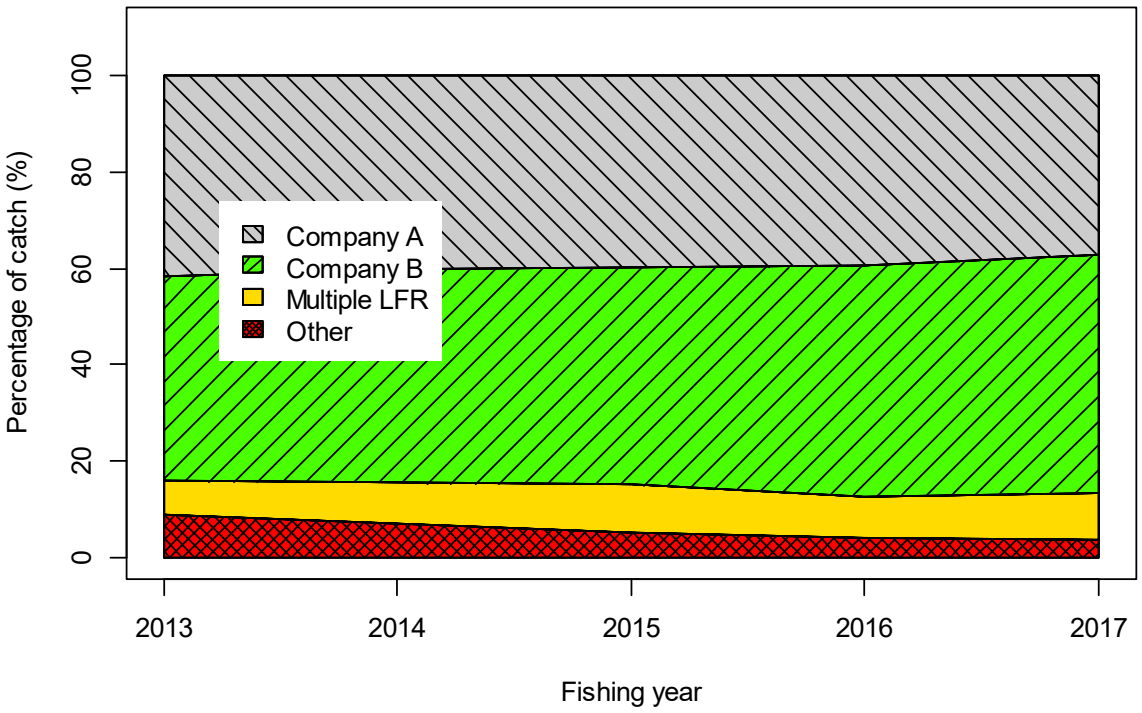


Figure 46: Percentage of the bottom trawl tarakihi catch from the TAR 7 region processed annually by the two main LFRs between the 2012–13 and 2016–17 fishing years.

2.4.3 New Plymouth (TAR 8) fishery profile 2012–13 to 2016–17

Almost all of TAR 8 catch taken between 2012–13 and 2016–17 was caught by bottom trawl (Figure 47).

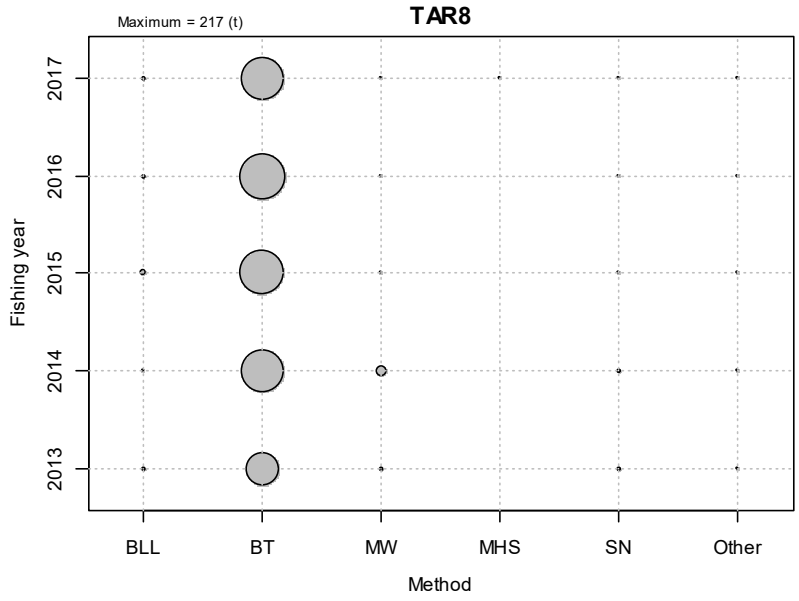


Figure 47: Tonnages of tarakihi landed annually by different TAR 8 fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

Most of the annual TAR 8 bottom trawl tarakihi catch was taken whilst targeting tarakihi, with John dory and red gurnard targeting of minor importance (Figure 48).

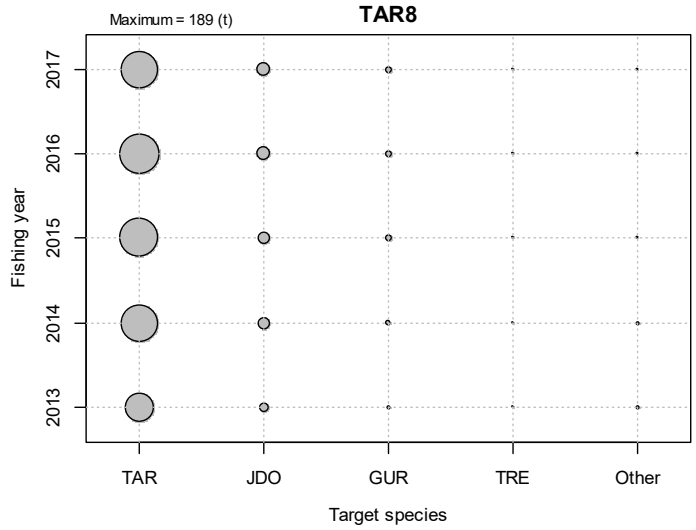


Figure 48: Tonnages of tarakihi landed by TAR 8 trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, JDO = John dory, GUR = red gurnard, and TRE = trevally.

The TAR 8 trawl fishery showed distinct seasonal patterns with consistently higher catches occurring from February to April and a noticeable drop in catches over winter months (Figure 49).

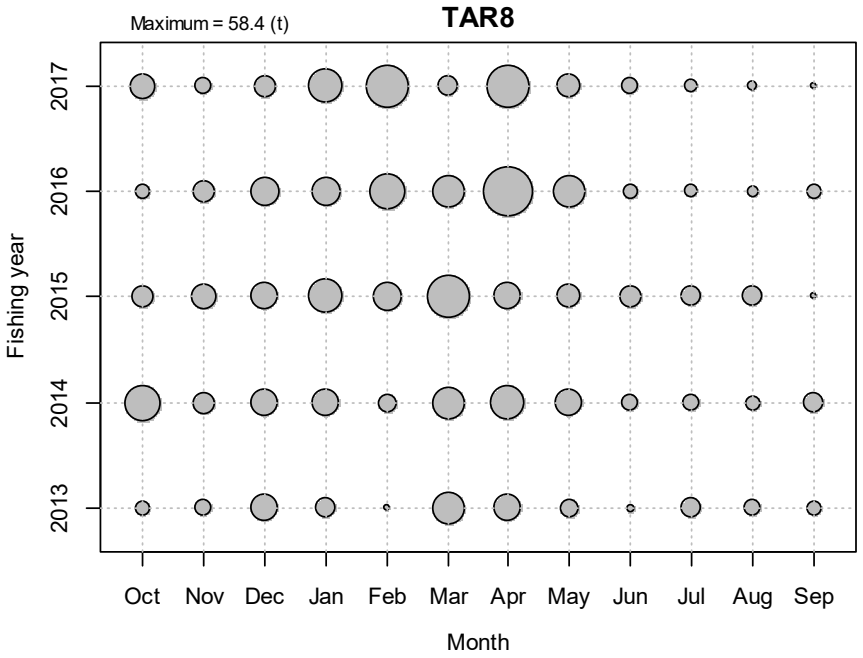


Figure 49: Monthly tonnages of tarakihi landed by TAR 8 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

A significant amount of the TAR 8 catch was taken in each of the component statistical areas (Figure 50), including the exclusion area within Statistical Area 041 (not shown; refer to section 2.2 for explanation), with the majority of the catch coming from Statistical Area 041.

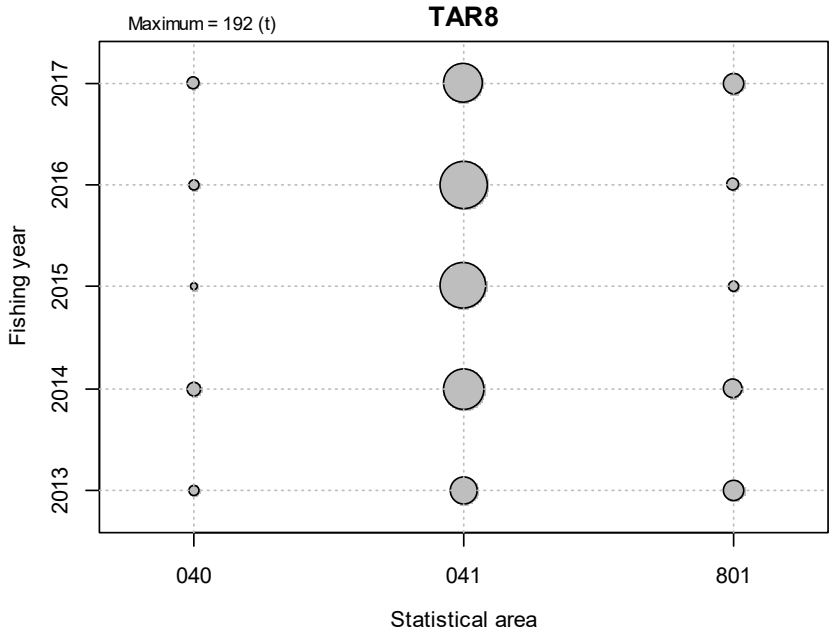


Figure 50 Statistical area tonnages of tarakihi landed by TAR 8 trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area.

A fine scale plot of the spatial distribution of tarakihi catches within TAR 8, based on the reported latitude and longitude of individual trawl shots, shows tarakihi were predominately taken north of New Plymouth with marked higher catches occurring along the 150 m contour (Figure 51).

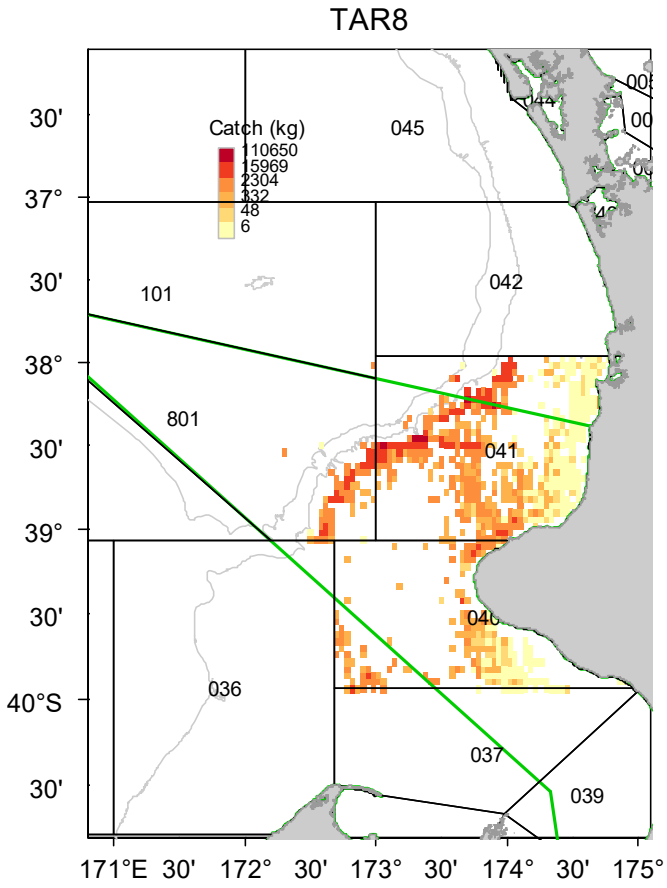


Figure 51: Spatial distribution of the TAR 8 region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.4.4 New Plymouth (TAR 8) fishery profile region sample design

A total of 10 sampling events were allocated to TAR 8 bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons/strata: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 1000 kg would have resulted in about 90% of the TAR 8 tarakihi landed catch by weight and 45% of tarakihi landings being eligible for sampling (Figure 52).

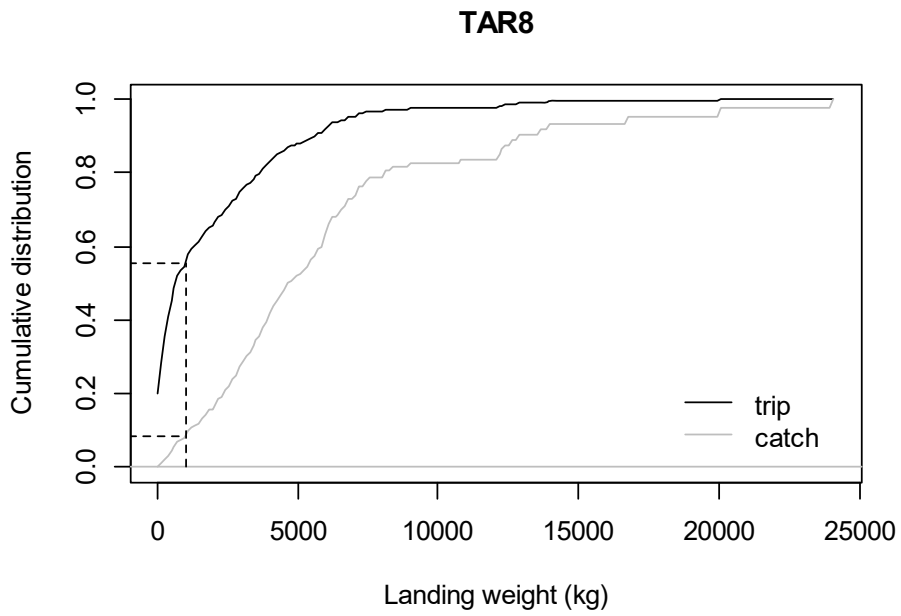


Figure 52: Cumulative distribution of landings from the TAR 8 region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 1000 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 45% of the number of available trips.

The majority of TAR 8 tarakihi trawl landings were processed by two LFRs (Figure 53) so the 10 sampling events were allocated to these two processors based on the relative weight of annual catch they processed.

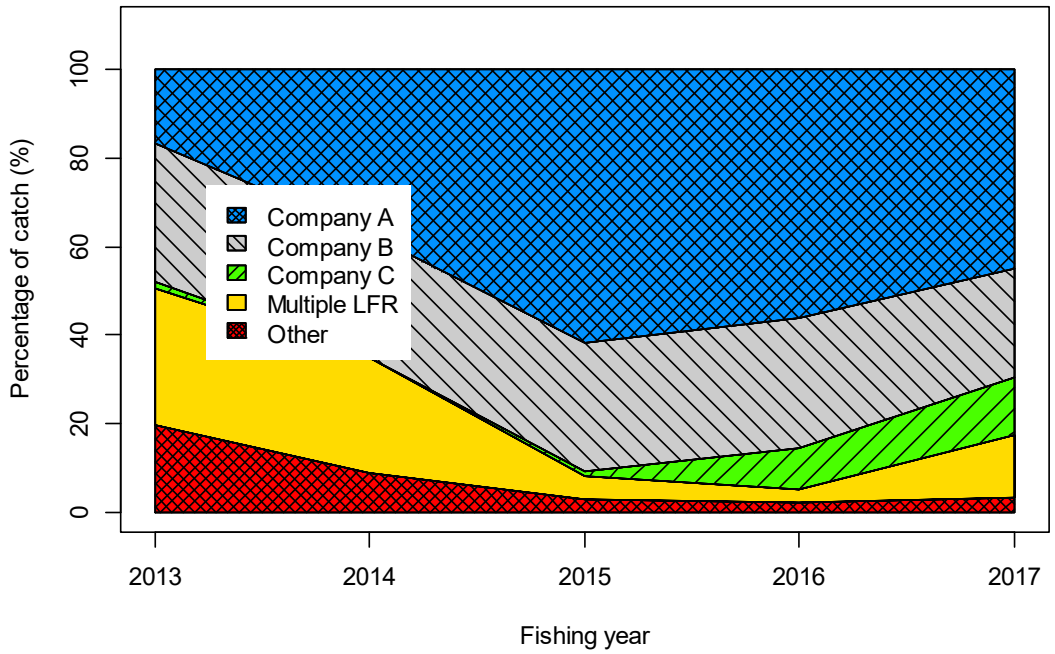


Figure 53: Percentage of the bottom trawl tarakihi catch from the TAR 8 region processed annually by the two main LFRs between the 2012–13 and 2016–17 fishing years.

2.4.5 West Coast North Island commercial fishery profile 2012–13 to 2016–17

The majority of tarakihi taken from the West Coast North Island (WCNI) region between 2012–13 and 2016–17 were caught by bottom trawl (Figure 54). Significant quantities of tarakihi were also taken by bottom longline method largely as bycatch to the target snapper fishery (Figure 54). Use of the new Precision Seafood Harvesting Ltd modular harvest system (MHS) trawl net was evident in the 2016–17 fishing year (Figure 54).

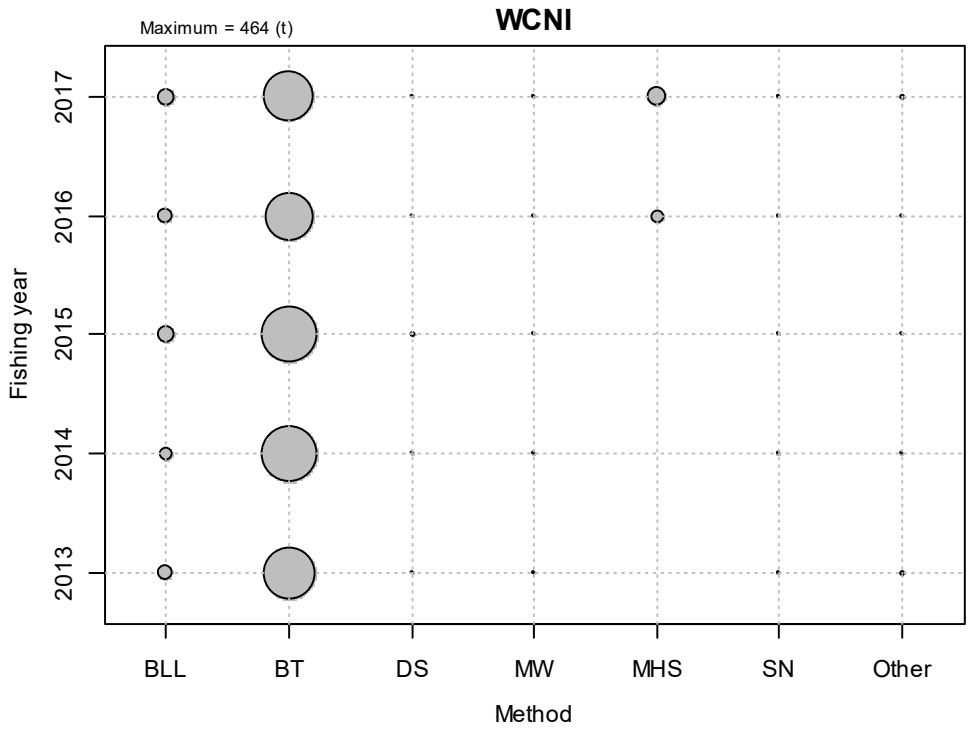


Figure 54: Tonnages of tarakihi landed annually by different WCNI fishing methods, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken by each method: BLL = bottom longline, BT = bottom trawl, DS = Danish seine, MW = mid-water trawl, MHS = modular harvest system trawl net, and SN = set net.

The potential for significant use of the MHS trawl method over the sampling period was problematic to developing the sampling design. As mentioned above, it was not feasible to exclude this method from the sampling nor was it feasible to include the method as a specific design stratum. The decision was made to lump MSH with bottom trawl for sampling purposes and to sample it approximately in proportion to its relative use by the WCNI bottom trawl fishery (Table 1). Note: MHS catches have been combined with bottom trawl catches in the trawl characterisations that follow.

The majority of the annual WCNI bottom trawl tarakihi catch was taken whilst targeting tarakihi with minor catch while targeting trevally (Figure 55).

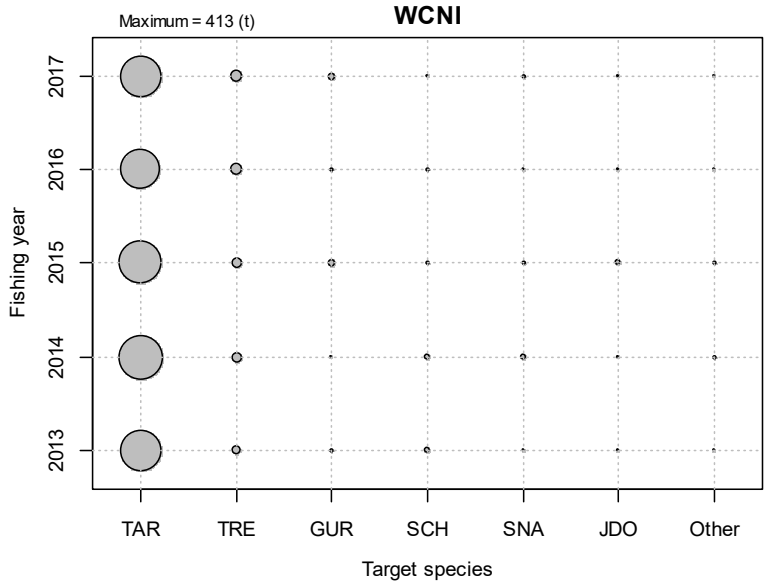


Figure 55: Tonnages of tarakihi landed by WCNI trawlers when targeting different species, from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual catch tonnage taken when targeting each species: TAR = tarakihi, TRE = trevally, GUR = red gurnard, SCH = school shark, SNA = snapper, and JDO = John dory.

Although tarakihi were taken throughout the year by the WCNI trawl fishery, a noticeable peak in catches occurred between March and May (Figure 56).

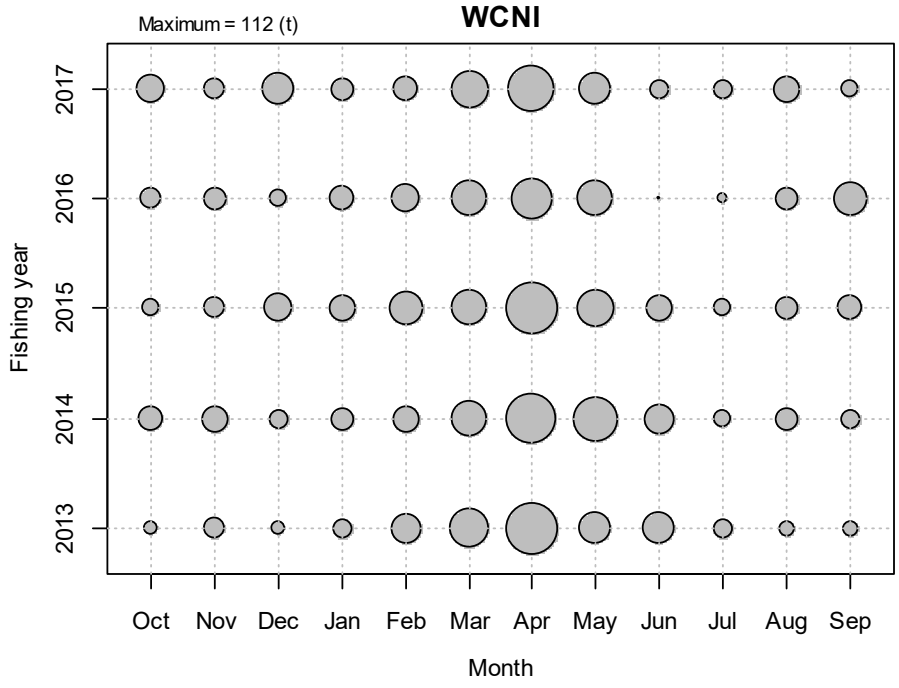


Figure 56: Monthly tonnages of tarakihi landed by WCNI trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the monthly catch (t).

Significant quantities of tarakihi were taken by trawlers from all WCNI coastal statistical areas with the majority of the catch coming from Statistical Area 047 (Ninety Mile beach region) (Figure 57).

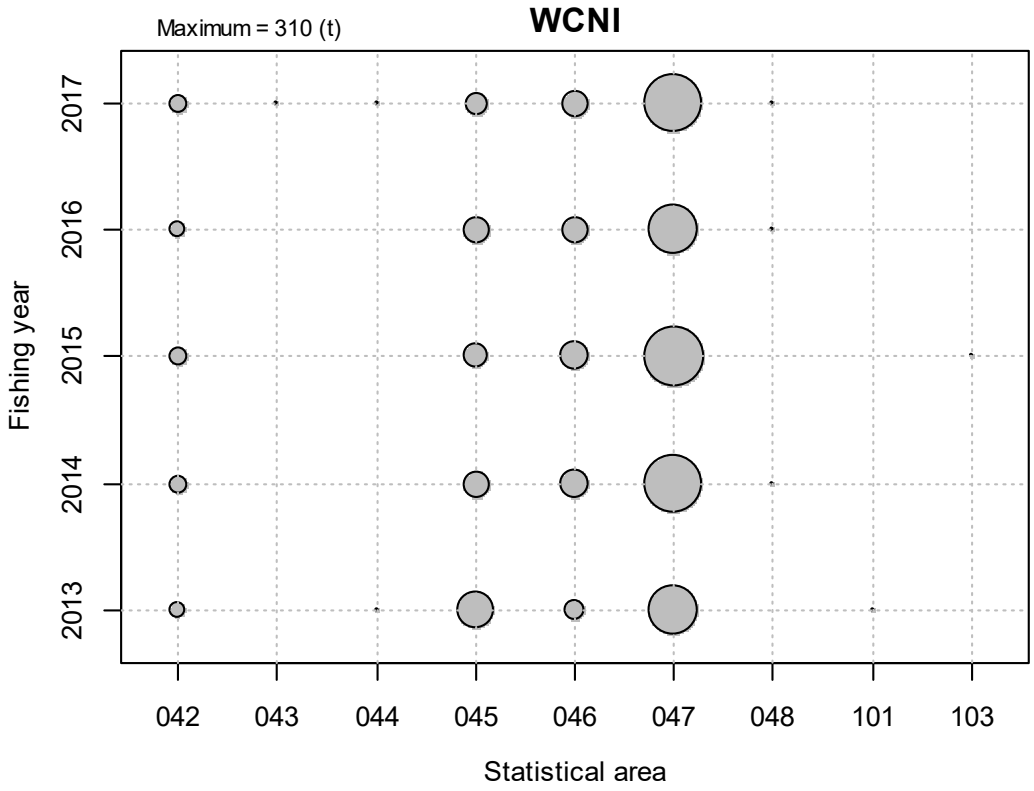


Figure 57: Statistical area tonnages of tarakihi landed by WCNI trawlers from the 2012–13 to 2016–17 fishing years. The area of each bubble is proportional to the annual tonnage landed in each statistical area (note: Statistical Areas 043 and 044 are, respectively, the Manukau and Kaipara harbours where trawling is banned).

A fine scale plot of the spatial distribution of tarakihi catches within WCNI, based on the reported latitude and longitude of individual trawl shots, shows significant tarakihi catches occurred over the entire WCNI latitudinal range, predominantly in the depth range 100–200 m (Figure 58).

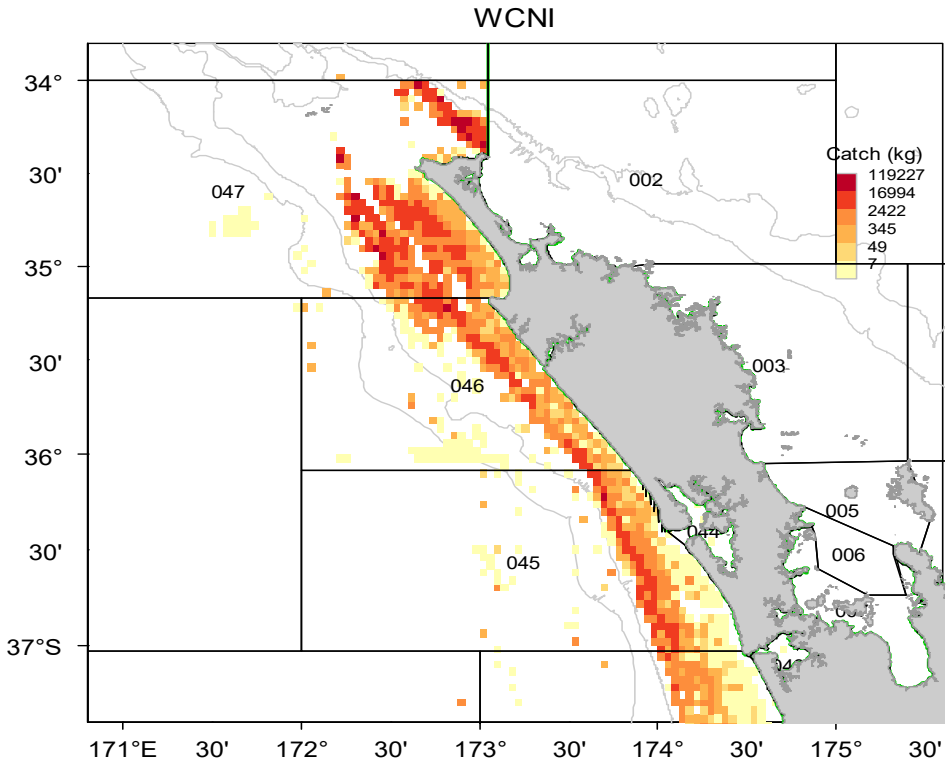


Figure 58: Spatial distribution of the WCNI region bottom trawl tarakihi catch from the 2012–13 to 2016–17 fishing years. The colour within each cell (0.08 of a degree of latitude) represents the total catch caught over this five-year period.

2.4.6 West Coast North Island commercial fishery region sample design

A total of 20 sampling events were allocated to WCNI bottom trawl tarakihi landings in each of the 2018–19 and 2019–20 fishing years (Table 1). The fishing year was divided into four seasons: October to November, December to February, March to May, and June to August for sample allocation purposes. Fishing company catch patterns during the 2015–16 and 2016–17 fishing years were used to allocate sample landings across seasons and for setting the minimum tarakihi sample landing weight threshold. Based on these trip data a minimum tarakihi landing weight of 1000 kg would have resulted in about 90% of the WCNI tarakihi landed catch by weight and 50% of tarakihi landings being eligible for sampling (Figure 59).

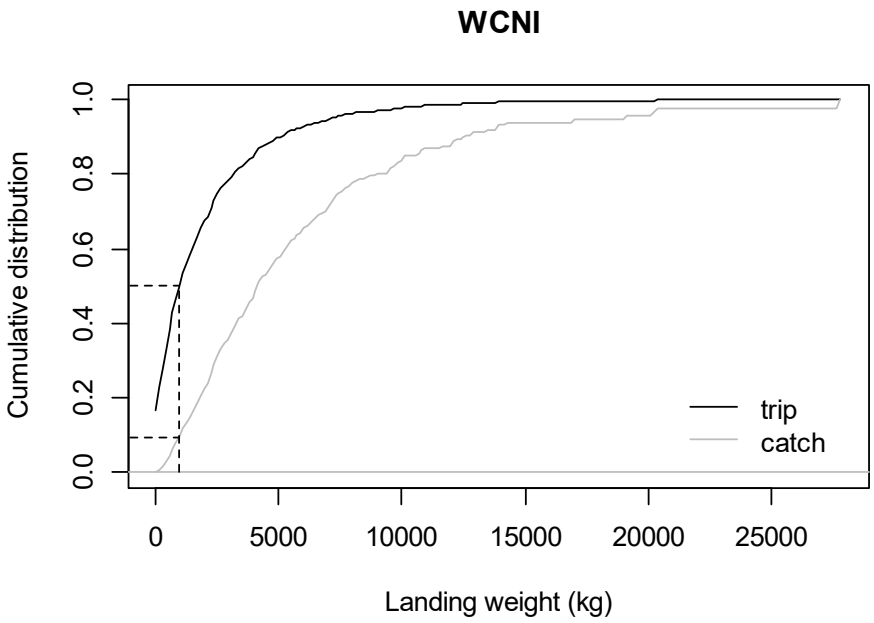


Figure 59: Cumulative distribution of landings from the West Coast North Island (WCNI) region (by weight and number of trips) for the 2015–16 and 2016–17 fishing years. The dashed vertical line denotes the 1000 kg minimum size limit for landings deemed eligible for sampling. The horizontal dashed lines denote the corresponding proportions of landings smaller than this minimum size limit, which accounted for about 90% of the catch by weight, and about 50% of the number of available trips.

Landings from the WCNI region were predominantly processed by two Licensed Fish Receivers (LFRs) (Figure 60), so the 20 sampling events were allocated to these processors based on the relative weight of annual catch they processed.

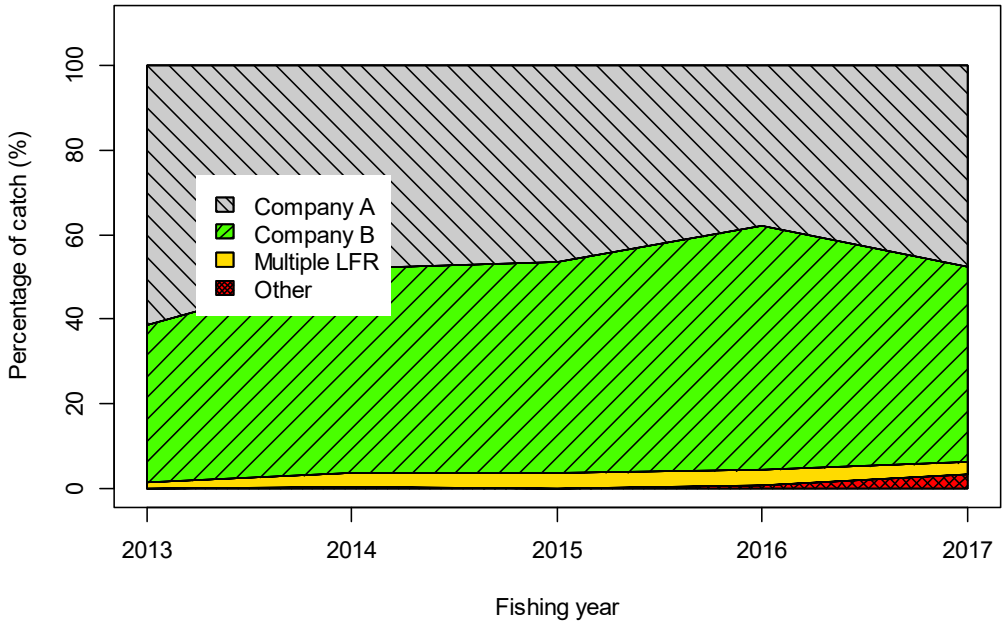


Figure 60: Percentage of the bottom trawl tarakihi catch from the West Coast North Island region processed annually by the main LFRs between the 2012–13 and 2016–17 fishing years.

3. METHODS

3.1 Random Age Frequency (RAF) sampling methods

The random age frequency (RAF) approach requires randomly selecting a small number (typically 30–60) of fish from the sampled landing for subsequent ageing using otoliths (Davies et al. 2003). The number of otoliths collected from a fishery using the RAF approach is usually higher than that required under the age-length key (ALK) approach for the same target precision (Davies et al. 2003). Because fewer fish are typically measured for length under the RAF approach, the precision on the length frequency estimates are typically less than with ALK methods. RAF is primarily used when samples are to be collected over a protracted period of time (e.g., one year) such that fish growth during the sampling period is likely to introduce bias (Davies et al. 2003).

Otolith ageing targets were defined for each tarakihi QMA region on the basis of previous catch sampling programmes (Beentjes 2011, Parker & Fu 2011, Beentjes et al. 2012, McKenzie et al. 2017) with the intention of achieving a mean weighted CV of 0.3 or lower on the region proportion-at-age estimates for both sexes combined (Table 1).

The main challenge with collecting a small number of fish (about 60) from a trawl landing of several thousand fish (i.e., 1–6 tonnes) is in ensuring that the fish sample is 'random', i.e., representative of the age composition of the landing. The sampling process relied on the fact that most New Zealand trawl tarakihi catches are packed into standard 35-kg fish bins at some stage during the catch unloading process. Samplers were instructed to collect a quasi-random sample of 12 × 35-kg bins of tarakihi from throughout the total unloaded catch. A sample of 60 fish were removed from the 12 sample bins using a specially designed random selection form. The form designated which fish from the first 300 fish sequentially taken from the bins were to be retained for ageing. Each sampling form identified a unique sequence of random draws so the sampler could not anticipate which fish were to be selected. Two people were required to undertake the random sampling process: one to draw 300 fish sequentially from the bins, the other to track the form and alert the sampler when a fish was to be retained (note: the sampler did not know immediately prior to selecting the fish if it was to be retained). Audit length frequencies of the 300 bin selected fish were obtained from approximately 10% of sampled landings to enable a length frequency comparison with the 60 fish sample length frequency. Note: if the selection of the 300th fish occurred part way through a sample bin, additional length measurements were collected until the bin was completed; hence the number of fish in the full length frequency (LF) sample comparisons varied. Audit length frequency comparisons were undertaken using a Kernel Density Estimation (KDE) non-parametric test (Anderson et al. 1994). The KDE analysis tested for differences in the shape and central location of the two LF distributions; the null hypotheses being that each of these two statistics came from the same distribution.

The RAF selection process resulted in the collection of more otoliths than required from each region (Table 1). An initial random sample of 15 otoliths was selected from each sampled landing. The remaining required number of otoliths (Table 1) were then randomly drawn from across all the landings in proportion to the landed weight for the landing.

For one LFR in TAR 3 the landings were sometimes landed into the LFR in a size-graded state with some bins containing small and others large tarakihi. To deal with this, ten bins for sampling the 300 fish were selected randomly as they were unloaded from the truck into the factory, with knowledge of the total number of bins in the landing. Fish selection then began, as described above, from the first random bin and continued until all 300 fish were sampled.

3.2 Ageing methods

A standardised procedure for the preparation and reading of tarakihi otoliths was previously documented in an age determination protocol for tarakihi (Walsh et al. 2016). In short, up to five tarakihi otoliths are embedded in epoxy resin and sectioned along a dorsal-ventral line directly through the core using a

Struers Secotom-10 digital sectioning machine to a thickness of approximately 350 μm. Section wafers were cleaned and embedded on microscope slides under a few drops of epoxy resin with a coverslip and oven cured at 50 ºC. Otoliths were viewed with a compound microscope under transmitted light and the number of opaque zones were counted.

A total of ten readers were used in ageing tarakihi otolith samples collected from the nine regional strata (sub-stocks within TAR 1, 2, 3, 5, 7, & 8) in 2018–19 and 2019–20. Each sub-stock otolith set was assigned two readers; each of these reading the set independently having no prior knowledge of the zone count of other readers or of the fish length. For otoliths where both readers agreed on the zone count, the age was determined from this count. When readers disagreed, the otolith was re-examined in consultation with a third experienced otolith reader to determine the likely source of disagreement and a final count agreed upon. The forced margin method was implemented to anticipate the otolith margin type (wide, line, narrow) *a priori* based on the month in which the fish was sampled to provide guidance in determining age (Walsh et al. 2016). To determine the 'fishing year age class' of fish using the forced margin, 'wide' readings are increased by 1 year (e.g., 3W is aged as a 4 year old) and 'line' and 'narrow' readings remain the same as the zone count (e.g., 4L or 4N are aged as a 4 year old), meaning that regardless of whether the fish was caught before or after the nominal birth date of 1 May, age remains the same throughout, unlike that which would be used for age groups/age classes or in growth rate estimation (see Walsh et al. 2016).

Otolith reading precision was quantified by carrying out between-reader comparison tests after Campana et al. (1995), including those between each reader and the agreed age. The Index of Average Percentage Error, IAPE (Beamish & Fournier 1981), and mean CV (Chang 1982) were calculated for each test. Of the ten assigned readers, two were highly experienced, and at least one of these experienced readers was assigned to each sub-stock set.

3.3 Age composition

Scaled numbers-at-age by sex and combined were derived for each sub-stock by fishing-year using the NIWA program Catch-at-length-and-age (Francis & Bian 2011). Age data were scaled in the same way as length data, i.e., by landed weights of tarakihi from the sampled vessels, and by the annual commercial catch from the sampled region. The mean-weighted coefficients of variation (MWCV) were estimated by sex and overall using a bootstrapping routine (500 bootstraps).

4. RESULTS

4.1 Otolith reader comparison tests by sub-stock and fishing year

Between-reader tests, based on statistical comparisons, show that, although some inconsistency exists between readers, the overall percentage agreement between readers on the independent reads was very high (ranging between ~70–90% across the region sets; Table 2). Based on meta-analysis, Campana (2001) showed a typical range for IAPE and CV precision was 5–7%, and hence the scores obtained for tarakihi indicate high (above average) reader precision (Table 2).

Table 2: Sub-stock otolith set reader comparative statistics.

Sub-stock	Sample year	Number of otoliths	% reader agreement	IAPE between reader	CV between reader
EN_HG	2018–19	610	79%	1.45%	2.05%
	2019–20	600	80%	1.17%	1.66%
BP_EC	2018–19	901	79%	1.61%	1.02%
	2019–20	900	87%	2.28%	1.46%
CSTR	2018–19	450	79%	1.66%	2.34%
	2019–20	180	87%	1.14%	1.61%
NBP	2018–19	600	79%	1.30%	1.83%
	2019–20	600	87%	0.90%	1.27%
SBP	2018–19	300	79%	1.09%	1.54%
	2019–20	300	87%	0.69%	0.98%
TAR 5	2018–19	240	79%	2.04%	2.89%
	2019–20	300	87%	2.39%	3.38%
TAR 7	2018–19	600	79%	1.98%	2.80%
	2019–20	750	87%	2.09%	2.98%
TAR 8	2018–19	450	79%	2.43%	3.44%
	2019–20	450	87%	2.41%	3.40%
WCNI	2018–19	602	79%	1.90%	2.68%
	2019–20	600	87%	2.22%	3.14%

The subsequent conferring process for the discrepant otolith readings was adjudicated by the same independent and experienced reader which likely resulted in the final reading precision relative to the 'true' (best achievable) reading, being very high (> 90%). The level of reader bias against the final conferred reading was minimal across sets and between readers below the age of 20 years and most readers were relatively unbiased across the older age ranges as well (Appendix 1). Again, the conferring process is likely to have reduced the level of reader bias in the final readings.

4.2 Age sample audit length frequency comparison results

Length frequency measurements were obtained from the full 300+ fish subsample on 31 sampling occasions (10% of total programme samples), and these were compared to the 60 fish otolith sample length frequencies using KDE tests. Note: length frequency audits were undertaken on every tarakihi sampler at least once over the two-year sampling programme. None of the 31 KDE tests of difference in central location were significant at the 95% rejection level. Two KDE shape tests were significant at the 95% rejection level—a result still within the expectations of random chance from 31 independent tests. This indicates that there was no bias in the samples collected for RAF.

4.3 East Coast tarakihi sampling results

4.3.1 East Northland–Hauraki Gulf (EN_HG)

Sampling targets and at-age mean-weighted CVs

Logistical challenges associated with Covid-19 were the main reason why fewer EN_HG landings were sampled in 2019–20 (Table 3). However, there were also some loss of sample landings because of subsequent Fisheries New Zealand data validation identifying spatial issues with the landing. Despite the fewer landings sampled, catch-at-age mean-weighted CV targets were achieved in both fishing years (Table 3).

Table 3: Number of EN_HG landings targeted and sampled and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year.

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	20	19	610	0.25
2019–20	20	13	600	0.27

Sampling representativeness

The temporal distribution of sampled landings mostly followed the trend seen for all landings throughout the year, although there were some abrupt jumps in the cumulative weight of the sampled catch when one or more large landings were sampled in a month (Figure 61). Peaks and troughs in the weight of sampled landings and of all landings are also broadly similar when the data are aggregated into seasonal strata (Figure 62).

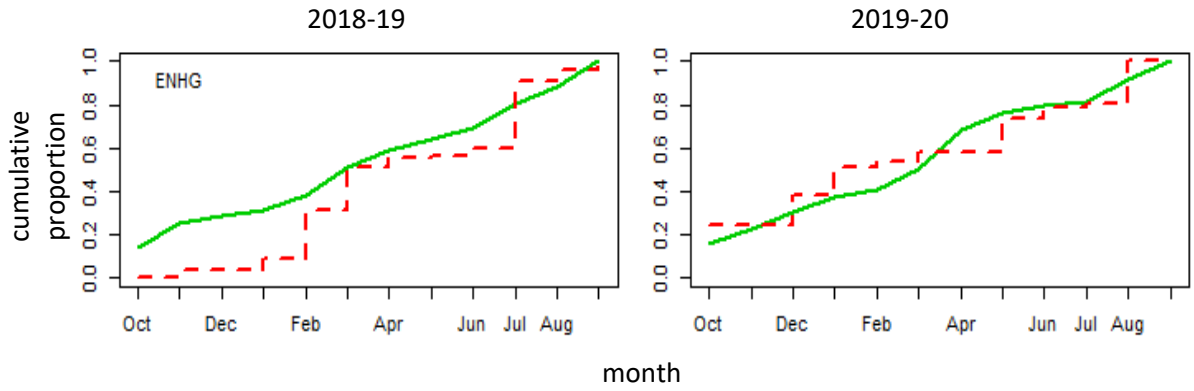


Figure 61: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from EN_HG bottom trawl fisheries in 2018–19 and 2019–20.

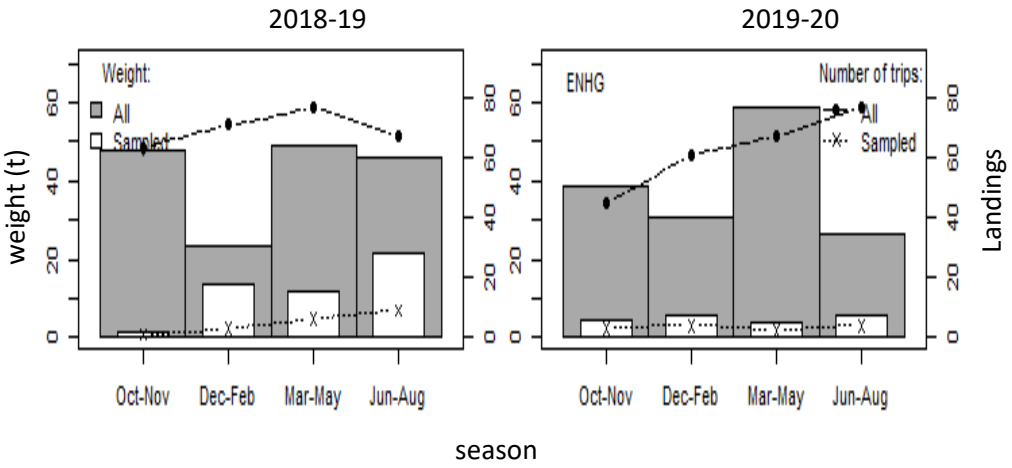


Figure 62: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within EN_HG from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring= October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of sampled catches between statistical areas was also broadly representative of the spatial distribution of all catches landed by EN_HG bottom trawlers in both sample years (Figure 63).

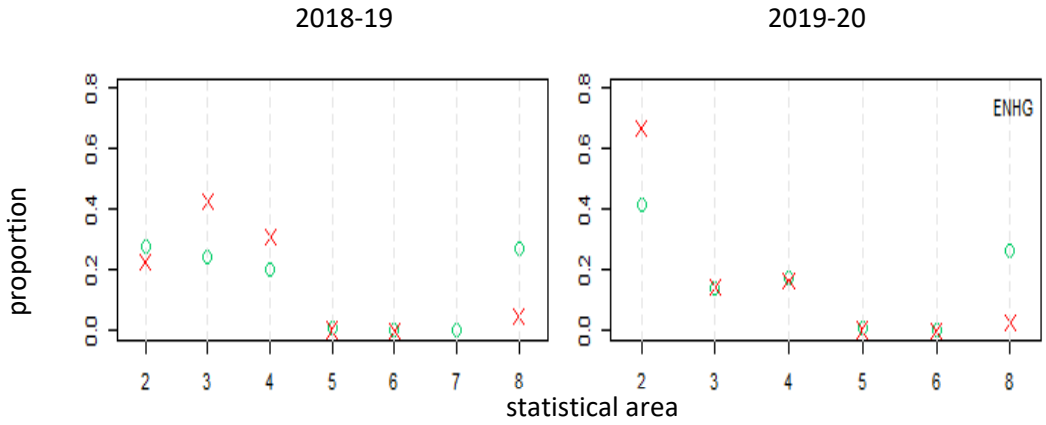


Figure 63: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for EN_HG in 2018–19 and 2019–20 (o = all landings; x=sampled landings). Statistical Area 002 is denoted by '2', Statistical Area 003 by '3', etc.

The distribution of sampled landings by fishing depth was similar to that of the wider EN_HG trawl fishery, with the majority of the catch taken between 50 and 150 m in both fishing years (Figure 64).

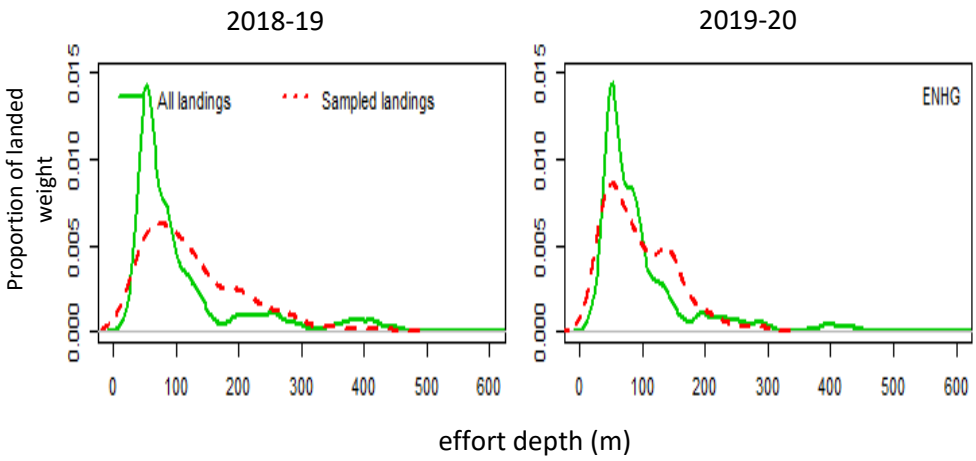


Figure 64: Depth distribution of tarakihi bottom trawl landings and samples for EN_HG during the 2018–19 and 2019–20 fishing years (solid lines represent all-landings, dashed lines represent sample landings).

Length and age frequency distributions

The length frequency distribution of the EN_HG catch in each year was similar and comprised a unimodal distribution with a minimum size of 25 cm, a peak size near 32 cm (both sexes combined), with a small distribution tail in the female length composition extending to about 45 cm (Figure 65). The tarakihi minimum legal size (MLS) is 25 cm and the commercial catch will necessarily be truncated at that length. The sex ratio in EN_HG was roughly equivalent (Figure 65). The MWCVs on the EN_HG length proportions for all fish combined in the two sampling years were 0.26 and 0.28, respectively.

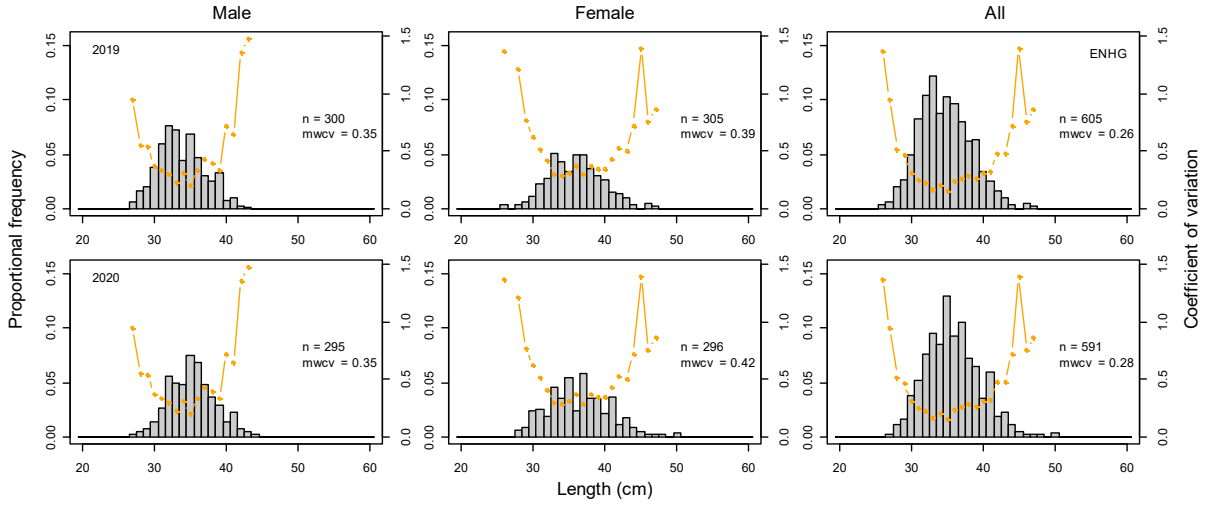


Figure 65: Scaled length frequency distribution and coefficient of variation for each length class for EN_HG bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20.

As was seen in the 2013–14 and 2014–15 sampling programme, a broad range of age classes was evident in the 2018–19 and 2019–20 EN_HG age samples (Figure 66). Colours denote strong age classes and these track between the two sample years (Figure 66); note: these same general patterns of strong and weak cohorts are also seen in east coast regions to the south. The MWCVs on the EN_HG age proportions for all fish combined in the two sampling years were 0.25 and 0.27, respectively (Table 3).

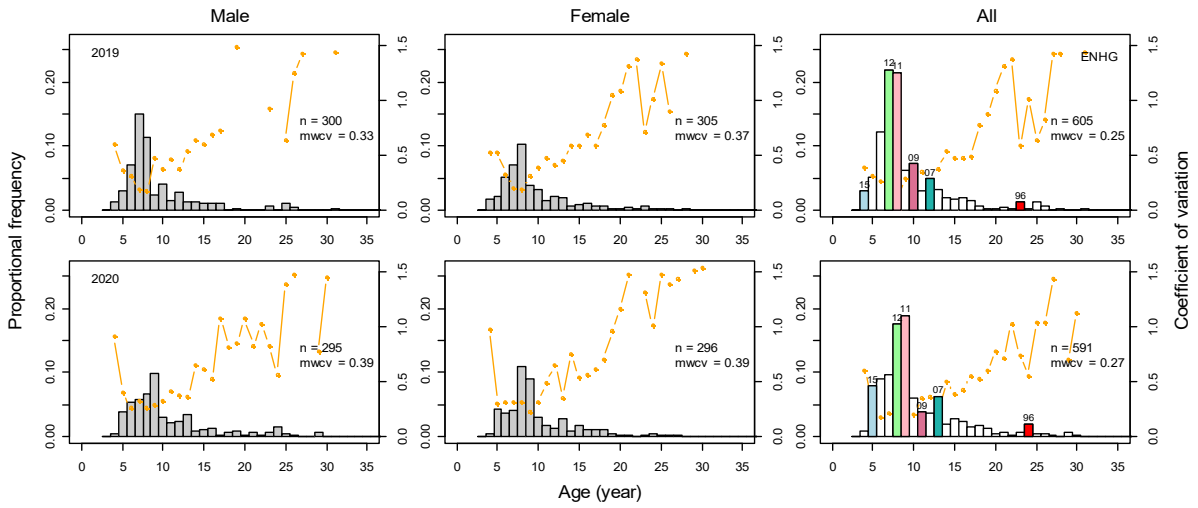


Figure 66: Scaled age frequency distribution and coefficient of variation for each length class for EN_HG bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.3.2 Bay of Plenty–East Cape (BP_EC)

Sampling targets and at-age mean-weighted CVs

Despite Covid-19 logistical challenges the BP_EC sampling target was largely achieved in both sample years (Table 4). Catch-at-age mean weighted CV targets were also well achieved in both fishing years (Table 4).

Table 4: Number of BP_EC landings targeted and sampled and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year.

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	30	26	900	0.14
2019–20	30	30	901	0.18

Sampling representativeness

The temporal distribution of sampled landings closely followed the trend seen for all landings throughout the 2018–19 year (Figure 67). The effect of the 2020 Covid-19 lockdown is seen in sampled landing and fishery tracking profiles for 2019–20 (Figure 67), but sampling still achieved an 'acceptable' coverage of the fishery pooled by season (Figure 68).

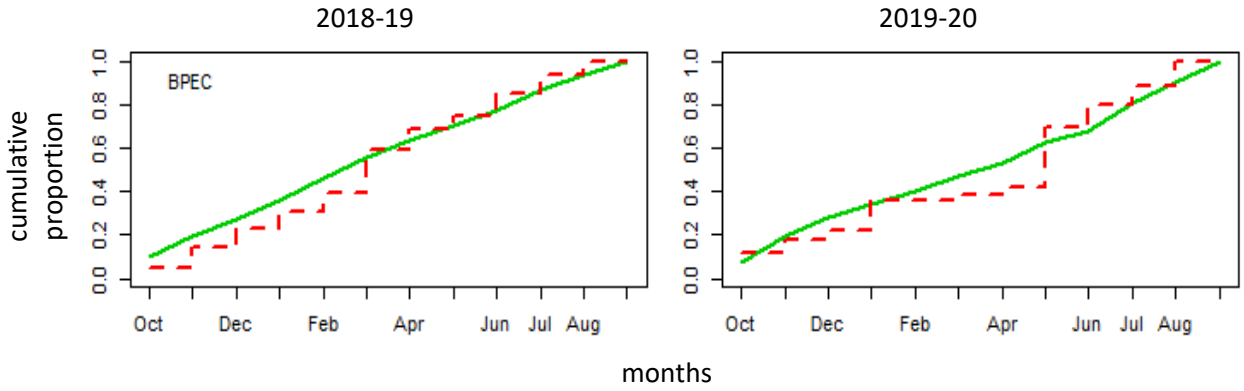


Figure 67: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from BP_EC bottom trawl fisheries in 2018–19 and 2019–20.

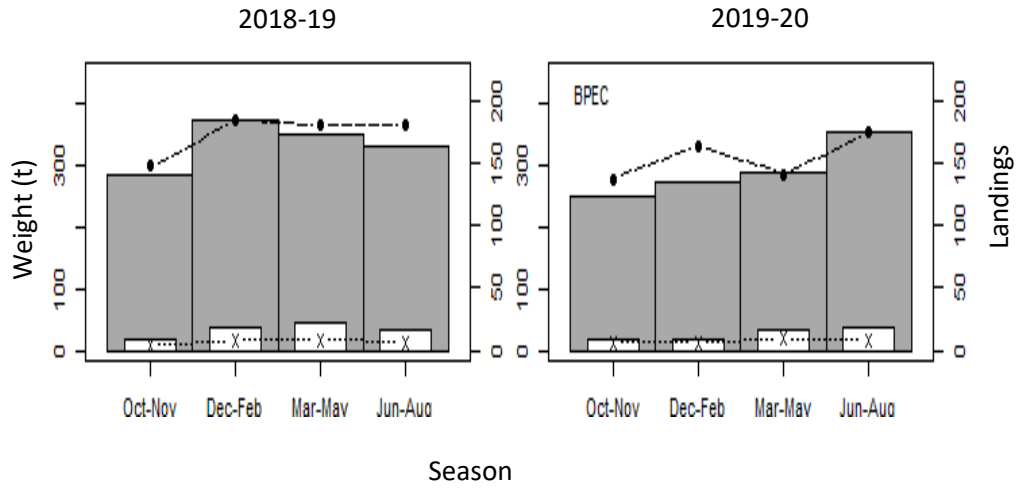


Figure 68 Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within BP_EC from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring = October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of BP_EC sampled catches between statistical areas was also broadly representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 69).

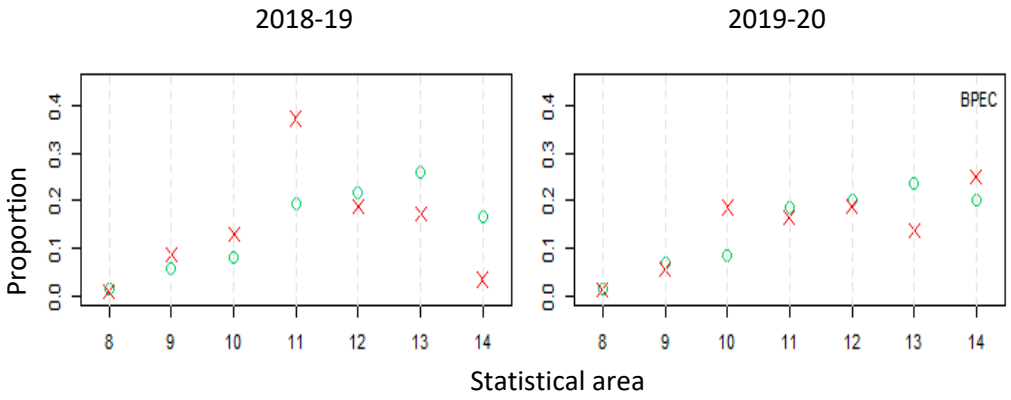


Figure 69: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for BP_EC in 2018–19 and 2019–20 (o = all landings; x=sample landings). Statistical Area 008 is denoted by '8', Statistical Area 009 by '9', etc.

The distribution of sampled landings by fishing depth closely matched that of the wider BP_EC trawl fishery, with the majority of the catch taken between 50 and 150 m and another distinct mode at 400 m in both fishing years (Figure 70).

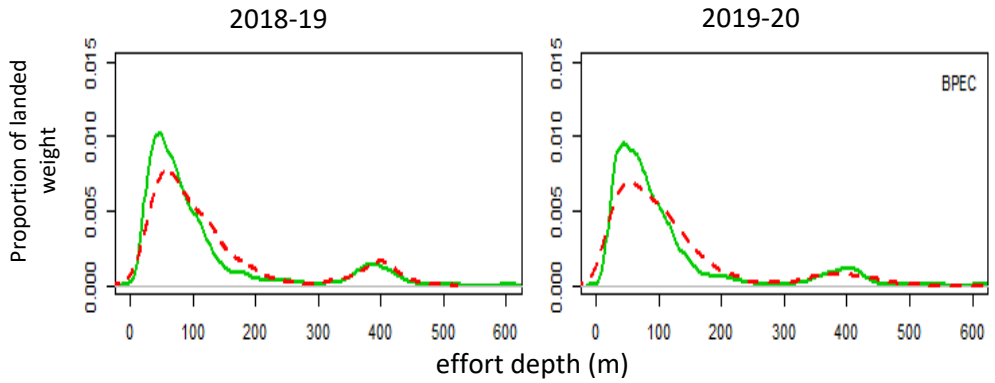


Figure 70: Depth distribution of tarakihi bottom trawl landings and samples for BP_EC during the 2018–19 and 2019–20 fishing years (solid lines represent all-landings, dashed lines represent sample landings).

Length and age frequency distributions

The length frequency distribution of the BP_EC catch in each year was similar and comprised a unimodal distribution with a minimum size of 25 cm and a peak size near 33 cm (both sexes combined) (Figure 71). The male and female length distributions were similar in both sample years (Figure 71) as was the catch sex ratio. The MWCVs on the BP_EC length proportions for all fish combined in each sampling year was 0.19.

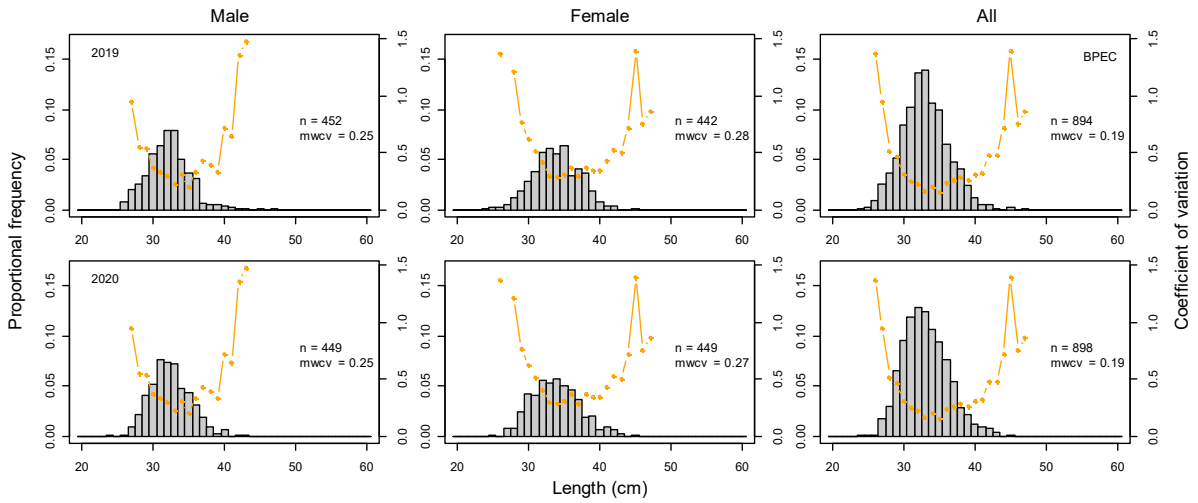


Figure 71: Scaled length frequency distributions and coefficient of variation for each length class for BP_EC bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20.

As was seen in the 2013–14 and 2014–15 sampling programme, the BP_EC region had proportionally fewer fish older than 10 years than in EN_HG (Figure 72). Colours denote strong age classes and these track through between the two sample years (Figure 72). The MWCVs on the BP_EC age proportions for all fish combined in the two sampling years were 0.14 and 0.18, respectively (Table 4).

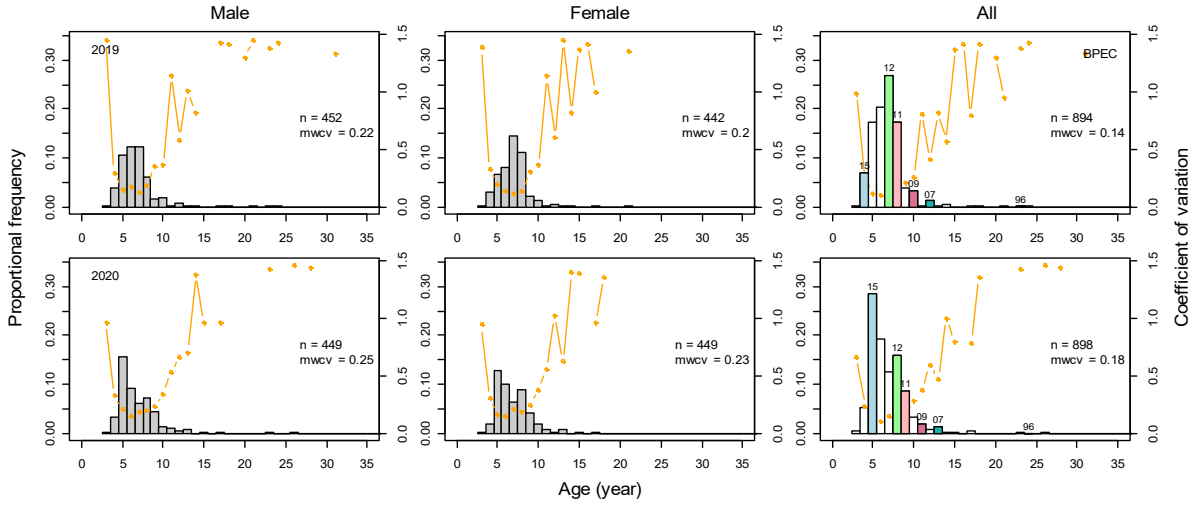


Figure 72: Scaled age frequency distributions and coefficient of variation for each length class for BP_EC bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.3.3 Cook Strait (CSTR)

Revised spatial design

It became apparent early in 2018–19 that the expected Cook Strait spawning target fishery was unlikely to occur. Discussions with the main TAR 2 fishing companies confirmed that the change in Cook Strait tarakihi targeting practice was in response to recent TAR 2 quota cuts and that pre-spawning tarakihi targeting was unlikely to resume in 2019–20. In light of this information, the decision was made to widen the Cook Strait sampling area to include the previously excluded southern TAR 2 statistical area (Figure 2) and to sample throughout the remainder of the 2018–19 fishing year and over the full period of the 2019–20 fishing year. The spatial extent of the widened Cook Strait region sampling area is shown in Figure 73. The minimum sample landing size criterion was also reduced from 2000 kg to 500 kg.

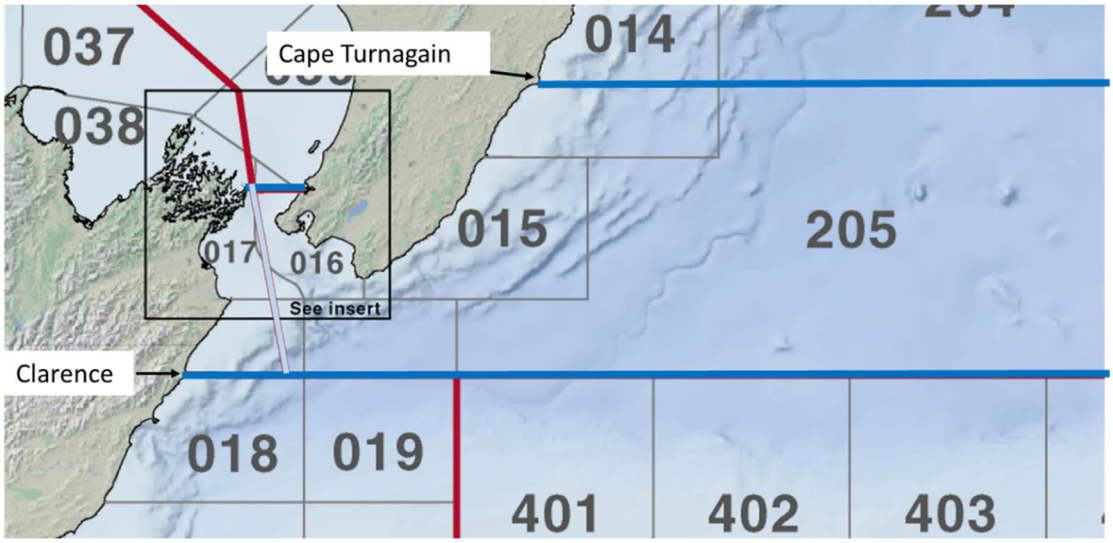


Figure 73: Revised Cook Strait sampling region: encompassed by thick blue lines and includes parts of Statistical Areas 014–019 and Statistical Area 205.

Sampling targets and at-age mean-weighted CVs

The CSTR sampling target was largely achieved in 2018–19, but not achieved in 2019–20 (Table 5). COVID-19 was the main reason sampling was impacted in 2019–20 due to fishing companies denying access to sheds. The 2019–20 MWCV on the age estimates was marginally higher than the minimum target value largely as a result of the sub-optimal number of otoliths collected (Table 5).

Table 5: Number of CSTR landings targeted and sampled and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year.

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	10	9	450	0.25
2019–20	10	3	180	0.34

Sampling representativeness

Despite an 'acceptable' number of CSTR landings being sampled in 2018–19 the temporal distribution of sampled landings was poor. This was largely due to the change in sampling design (Figure 74 & Figure 75). The 2019–20 temporal sampling coverage was poor (Figure 74 & Figure 75).

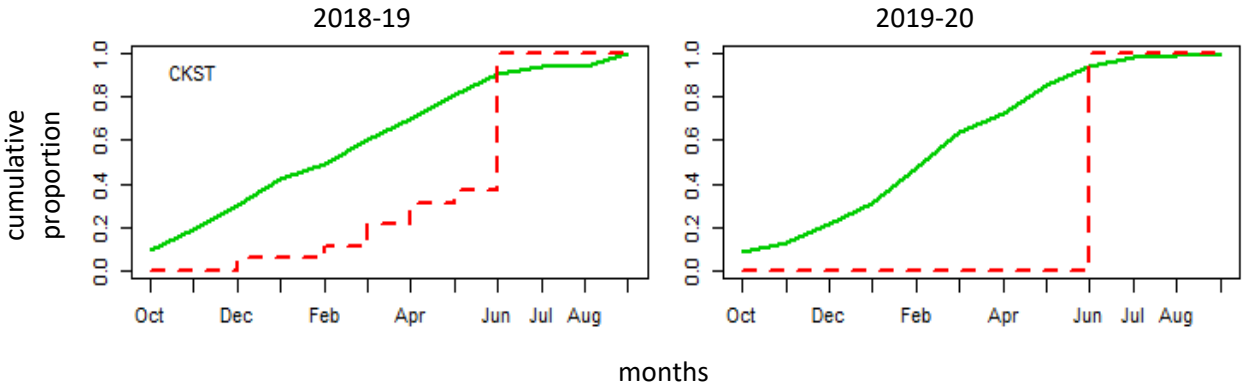


Figure 74: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from CSTR bottom trawl fisheries in 2018–19 and 2019–20.

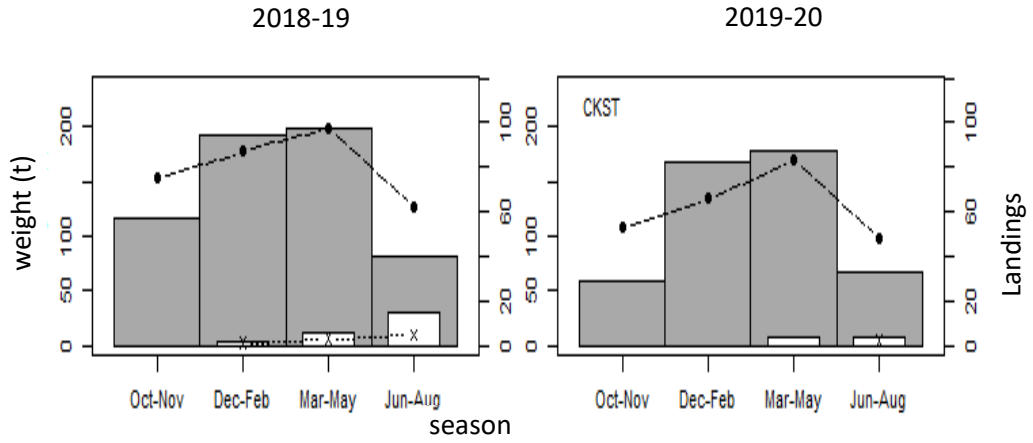


Figure 75: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within CSTR from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring= October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of CSTR sampled catches between statistical areas was also poor in 2018–19 and unrepresentative of the fishery in 2019–20 (Figure 76).

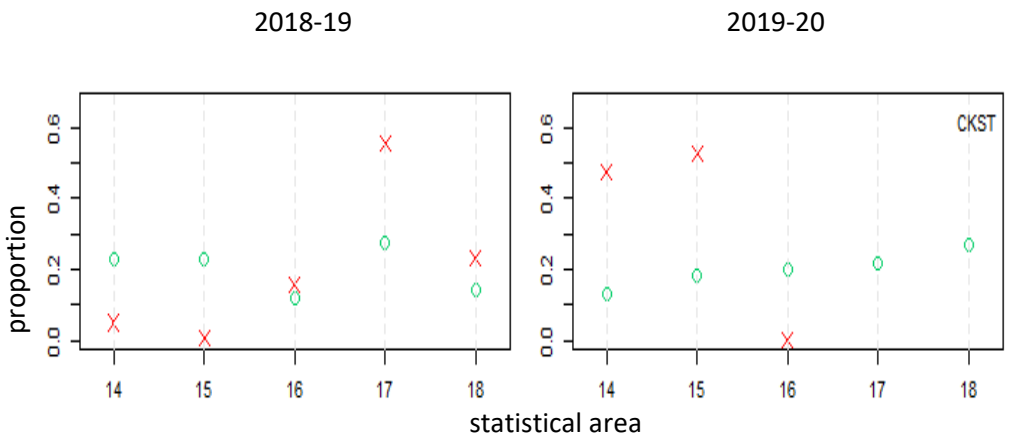


Figure 76: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for CSTR in 2018–19 and 2019–20 (o = all landings; x=sample landings). Statistical Area 014 is denoted by '14', Statistical Area 015 by '15', etc.

However, the distribution of CSTR sampled landings by fishing depth reasonably matched that of the fishery in both sampling years; the majority of the CSTR trawl catch was taken between 50 and 150 m (Figure 77).

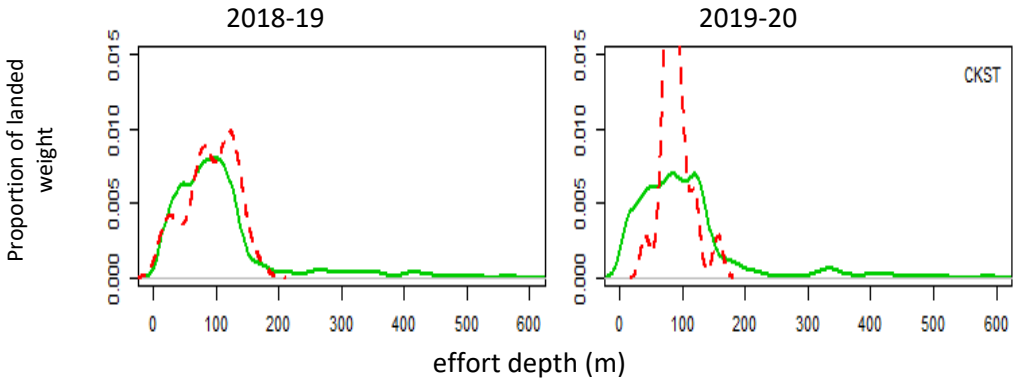


Figure 77: Depth distribution of tarakihi bottom trawl landings and samples for CSTR during the 2018–19 and 2019–20 fishing years (solid lines represent all landings, dashed lines represent sample landings).

Length and age frequency distributions

The length frequency distribution of the CSTR catch for each year were broadly similar in range and dominant mode (Figure 78). As seen in EN_HG, the female length frequency range was broader than the males, with the distributional tail extending out to 45–50 cm in both sample years (c.f. 40 cm for males, Figure 78). The second mode of females at 40 cm seen in 2019–20 is possibly a reflection of the low number of landings sampled (Figure 78). The sex-ratio in sampled CSTR landings was skewed toward females in both sampling years, but, due to the lack of representativeness in the sampling, it is difficult to draw much of a conclusion from this (Figure 78). The MWCVs on the CSTR length proportions for all fish combined in the two sampling years were 0.25 and 0.51, respectively.

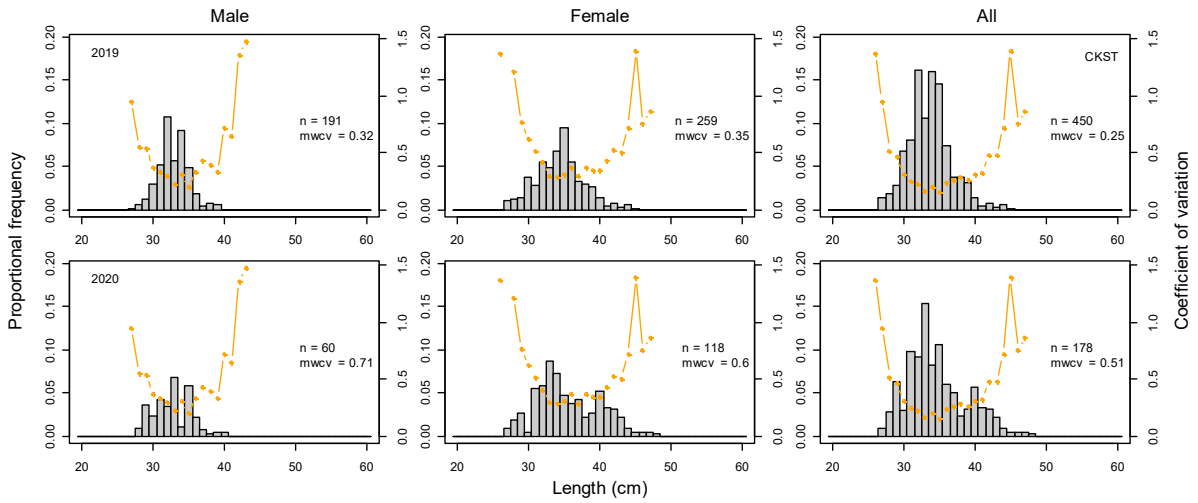


Figure 78: Scaled length frequency distribution and coefficient of variation for each length class for CSTR bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20.

The age distribution of the CSTR sampled catches was very similar to that of the BP_EC region having proportionally fewer fish older than 10 years than seen in EN_HG (Figure 79). Colours denote strong age classes and these track through between the two sample years (Figure 79). The MWCVs on the CSTR age proportions for all fish combined in the two sampling years were 0.25 and 0.34, respectively (Table 5).

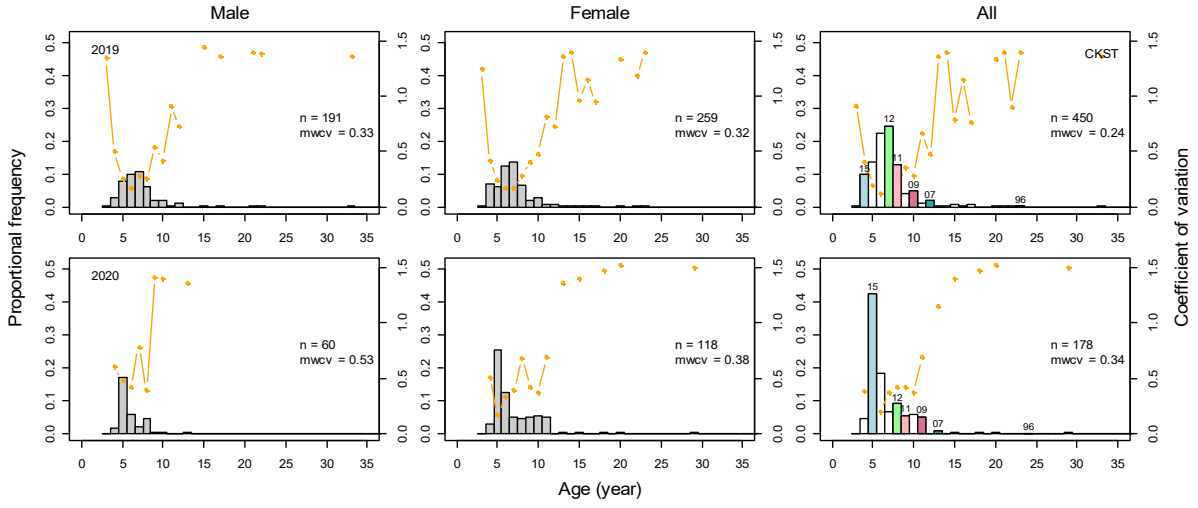


Figure 79: Scaled age frequency distribution and coefficient of variation for each length class for CSTR bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.3.4 North Banks Peninsula (NBP)

Sampling targets and at-age mean-weighted CVs

The level of NBP sampling achieved in both fishing years, although under target, was 'acceptable' (Table 6). Catch-at-age mean weighted CV targets were met in 2018–19, but not in 2019–20, although very close (Table 6).

Table 6: Number of NBP landings targeted and sampled and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	20	15	600	0.26
2019–20	20	15	600	0.31

Sampling representativeness

The temporal distribution of NBP sampled landings reasonably matched the trend seen for all landings in both sampling years despite sampling challenges posed by COVID-19 (Figure 80 & Figure 81).

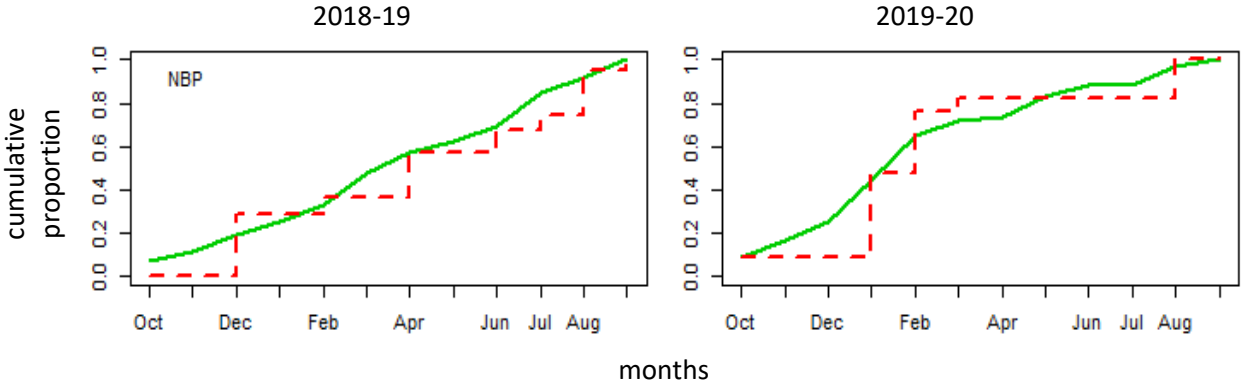


Figure 80: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from NBP bottom trawl fisheries in 2018–19 and 2019–20.

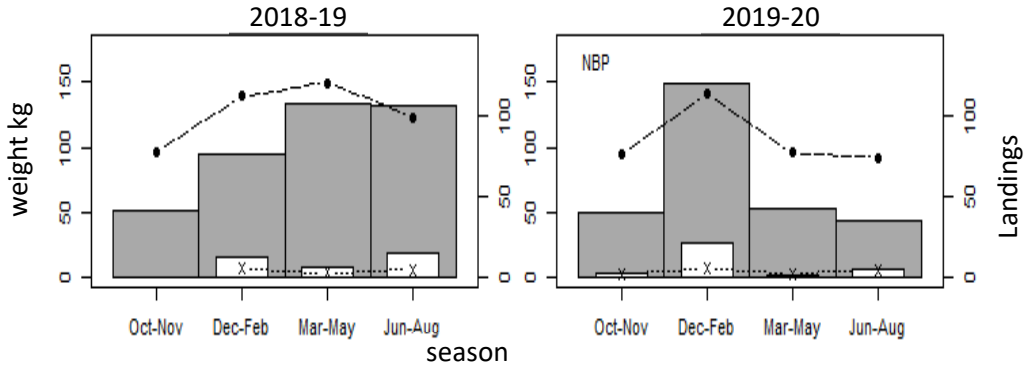


Figure 81: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within NBP from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring= October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of NBP sampled catches between statistical areas was representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 82).

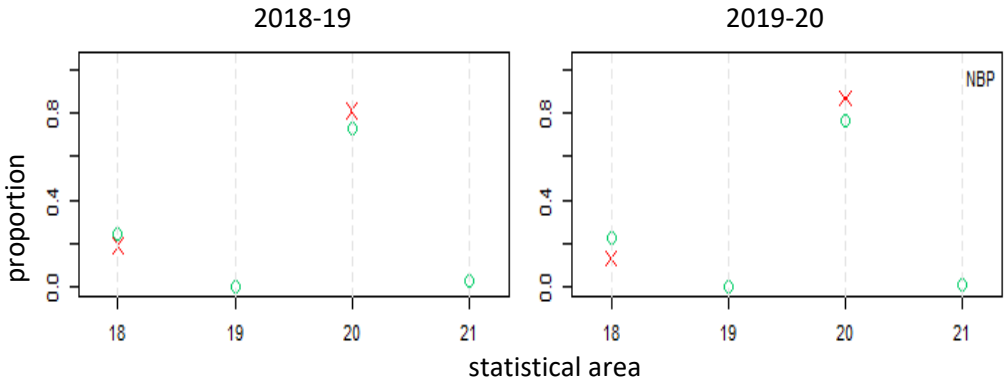


Figure 82: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for NBP in 2018–19 and 2019–20 (o = all landings; x=sample landings).

The distribution of sampled landings by fishing depth was like that of the wider NBP trawl fishery, with most of the catch taken between 50 and 150 m (Figure 83). Another distinct catch mode at 500 m was seen both fishing years (Figure 83), however this deeper mode was not well reflected in the sampling.

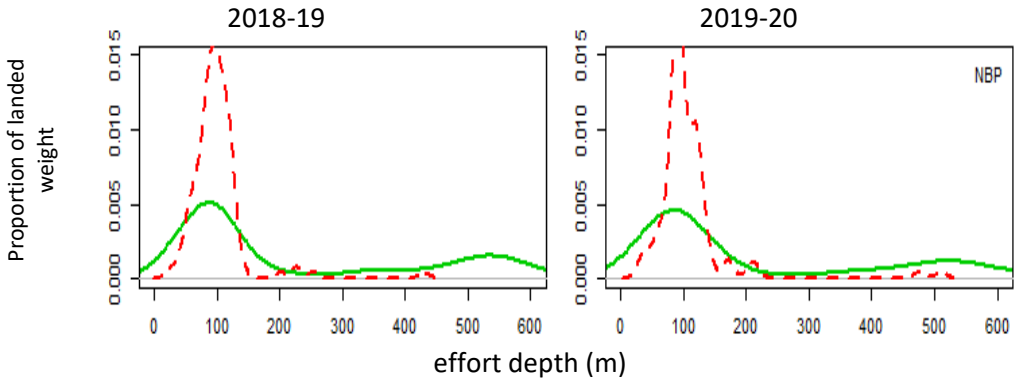


Figure 83: Depth distribution of tarakihi bottom trawl landings and samples for NBP during the 2018–19 and 2019–20 fishing years (solid lines represent all-landings, dashed lines represent sample landings).

Length and age frequency distributions

The majority of male and female tarakihi in the NBP annual catches were between 25 and 40 cm in length (Figure 84). However, nearly all fish in the above 40 cm tail of the distribution were females, this tail being more prominent in the second sampling year (Figure 84). There were more females than males sampled in both annual samples, due to the additional females above 40 cm (Figure 84). The MWCVs on the NBP length proportions for all fish combined in the two sampling years were 0.27 and 0.32 respectively.

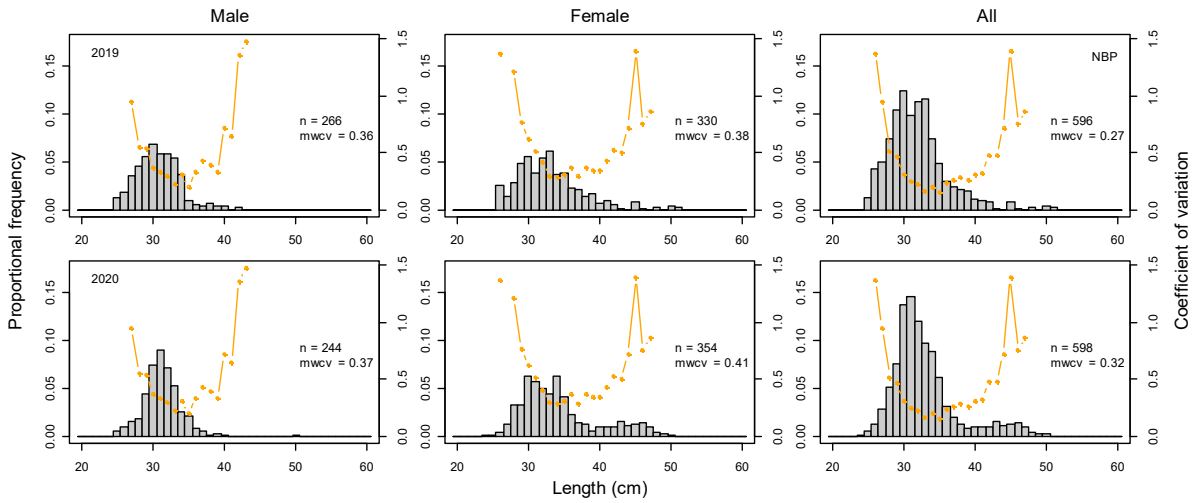


Figure 84: Scaled length frequency distributions and coefficient of variation for each length class for NBP bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20.

The NBP sample age distributions were similar to those seen in the BP_EC and CSTR sampling, having very few fish older than 10 years (Figure 85). As consistent with the length distribution, most fish older than 10 years in the NBP samples were females (Figure 85). Colours denote strong age classes and these track through between the two sample years (Figure 85). The MWCVs on the NBP age proportions for all fish combined in the two sampling years were 0.26 and 0.31 respectively (Table 6).

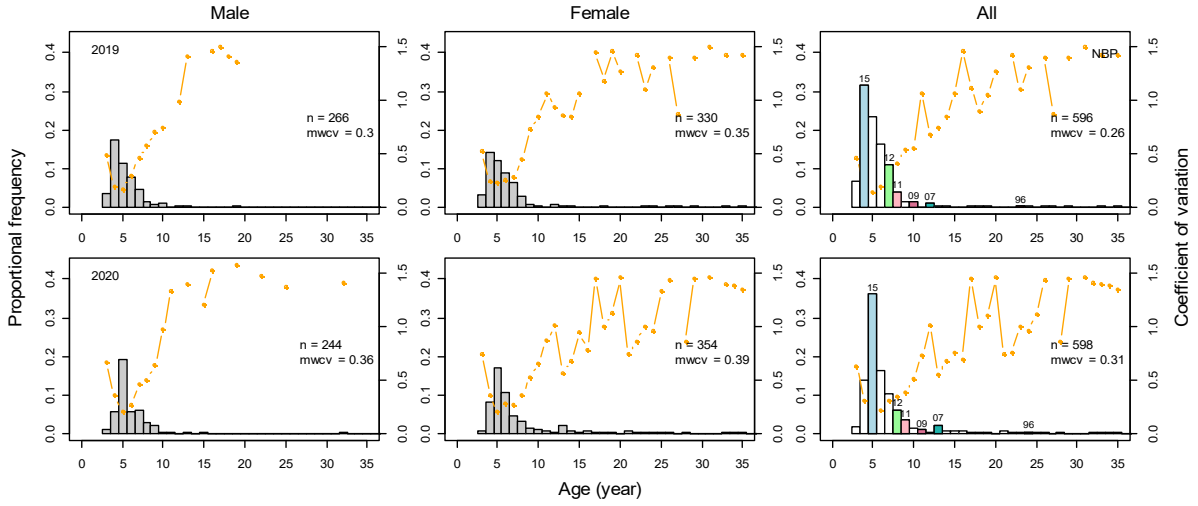


Figure 85: Scaled age frequency distributions and coefficient of variation for each length class for NBP bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.3.5 South Banks Peninsula (SBP)

Sampling targets and at-age mean-weighted CVs

The level of SBP sampling achieved in both fishing years, although under target in 2019–20, was 'acceptable' (Table 7). Catch-at-age mean weighted CV targets were met in 2018–19, but not met in 2019–20, although very close (Table 7).

Table 7: Number of SBP landings targeted and sampled and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	10	9	300	0.14
2019–20	10	7	300	0.31

Sampling representativeness

The temporal distribution of 2018–19 SBP sampled landings generally matched the trend seen for all sample year landings (Figure 86 & Figure 87). The COVID-19 restrictions caused the sampling hiatus in the 2019–20 temporal sampling distribution (Figure 86), which also accounted for the lower number of samples collected. Despite COVID-19 limitations, sample temporal coverage of the 2019–20 SBP fishery was still 'acceptable' (Figure 86 & Figure 87).

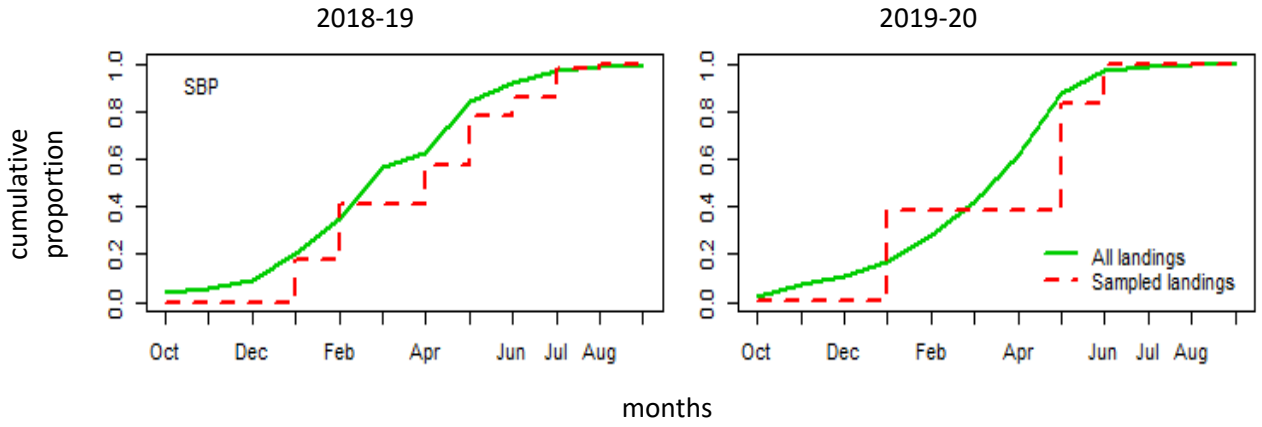


Figure 86: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from SBP bottom trawl fisheries in 2018–19 and 2019–20.

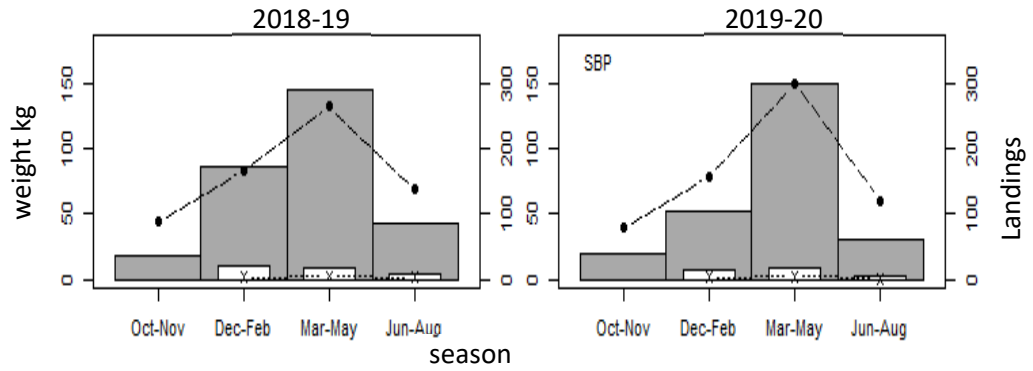


Figure 87: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within SBP from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring = October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of SBP sampled catches between statistical areas in 2019–20 was generally representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 88).

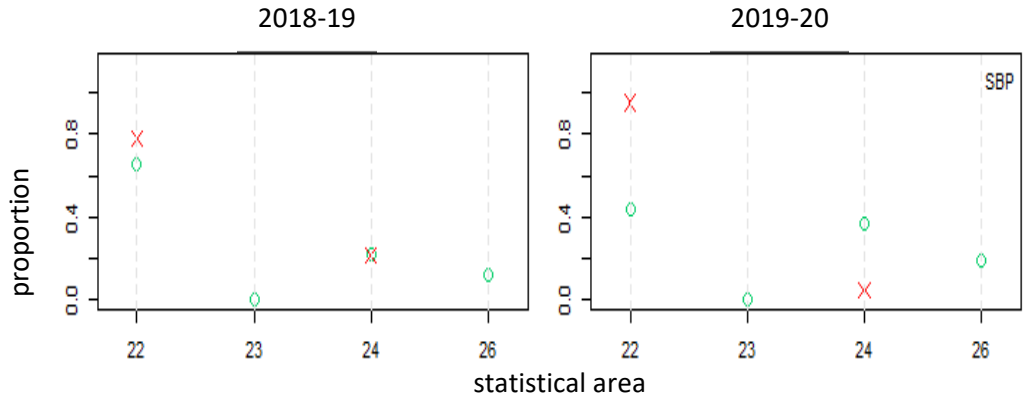


Figure 88: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for SBP in 2018–19 and 2019–20 (o = all landings; x = sample landings).

The distribution of sampled landings by fishing depth was like that of the wider NBP trawl fishery, with most of the catch taken between 50 and 150 m (Figure 89). Another distinct catch mode at 500 m was seen in both fishing years (Figure 89), and this deeper mode was not represented in the sampling.

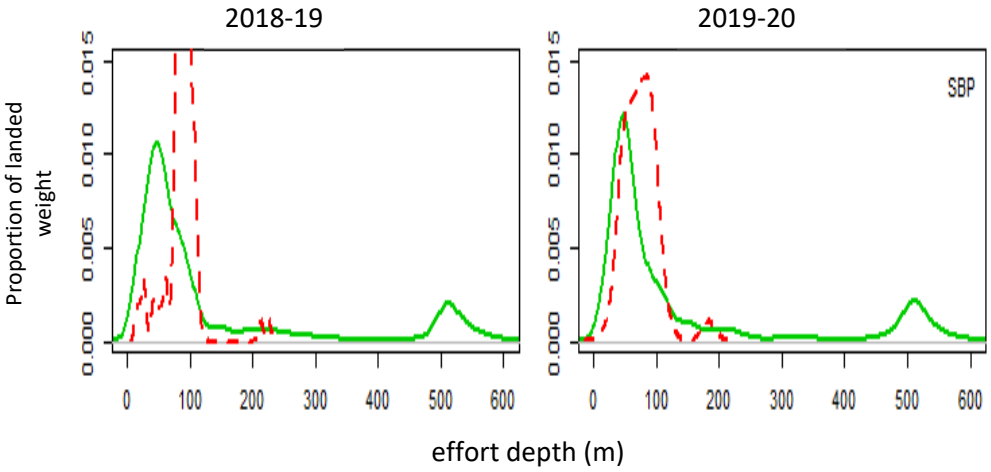


Figure 89: Depth distribution of tarakihi bottom trawl landings and samples for SBP during the 2018–19 and 2019–20 fishing years (solid lines represent all landings, dashed lines represent sample landings).

Length and age frequency distributions

The male and female tarakihi in the SBP annual sampling catches were all largely between 25 and 35 cm in length and small compared with the other east coast sub-stocks (Figure 90). The sample size distributions of male and female SBP tarakihi were similar, as were the sex ratios in the sampled catches (Figure 90). The MWCVs on the SBP length proportions for all fish combined in the two sampling years were 0.34 and 0.35, respectively.

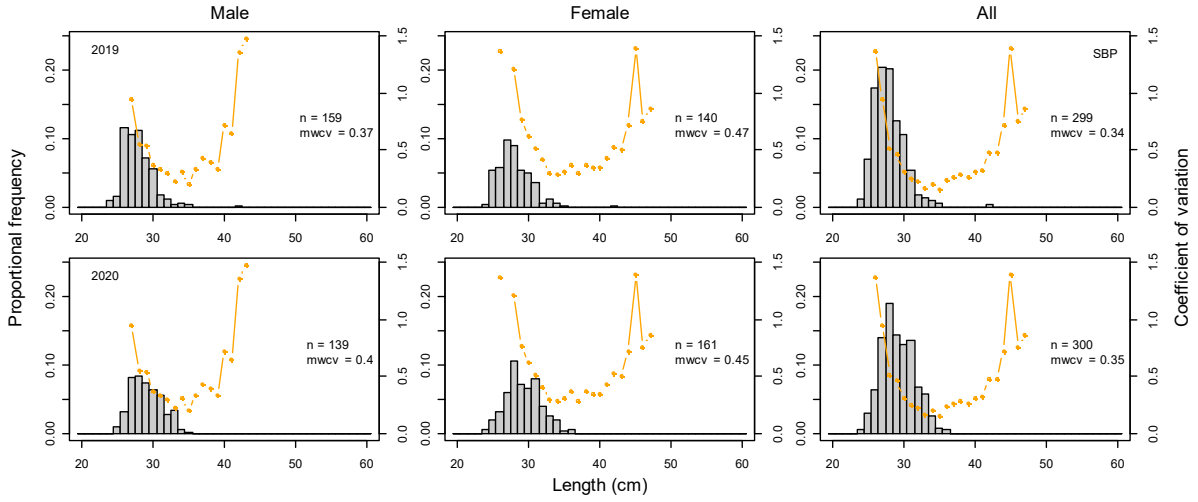


Figure 90: Scaled length frequency distributions and coefficient of variation for each length class for SBP bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20.

The age composition of the SBP annual catches also differed markedly to those in the northern regions. The SBP annual samples were dominated by 4 and 5 year old tarakihi with very few fish older than 7 years (Figure 91). The same younger pattern in SBP age composition was also seen in the 2013–14 and 2014–15 SBP sampling (McKenzie et al. 2017). Colours denote strong age classes and these track through between the two sample years (Figure 91). The 2015 year class (blue) is seen as very strong in both sampling years relative to the 2014 year class that proceeded it (Figure 91). The 2016 year class (green) seen in the 2019–20 samples also appears to be of moderate strength (Figure 91). The MWCVs on the SBP age proportions for all fish combined in the two sampling years were 0.14 and 0.31, respectively (Table 7).

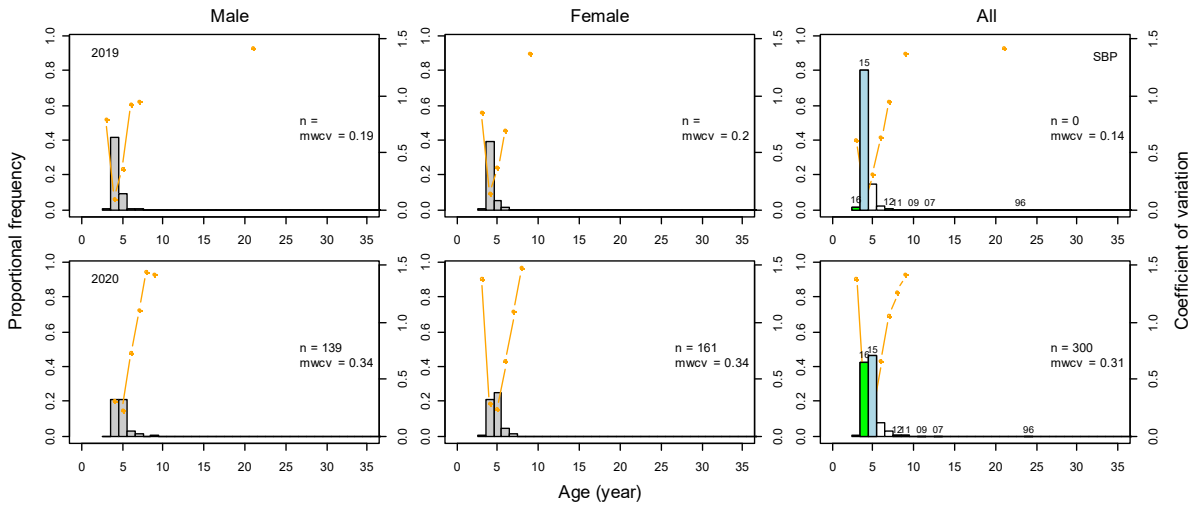


Figure 91: Scaled age frequency distributions and coefficient of variation for each length class for SBP bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.3.6 Southland–Stewart Island (TAR 5)

The level of TAR 5 sampling achieved in both fishing years was low, with just under half the required number of landings sampled (Table 8). Less than the target number of otoliths were collected and aged in 2018–19 which likely contributed to the failure to achieve the required target ageing precision (Table 8). Logistical difficulties accessing TAR 5 trawl landings were the main reason why sampling targets were not achieved. There was a requirement to intercept sample landings at the point of unload, often at very short notice, meaning it was often not feasible to dispatch a sampling team before the catch was on-sold. Further, some of these catches were split after landing and trucked to Timaru or Motueka, further complicating sampling logistics.

Table 8: Number of TAR 5 landings targeted and sampled, number of otoliths aged, and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	10	4	240	0.36
2019–20	10	5	300	0.29

Sampling representativeness

The TAR 5 sampling temporal match with the fishery was poor in both sampling years (Figure 92 & Figure 93).

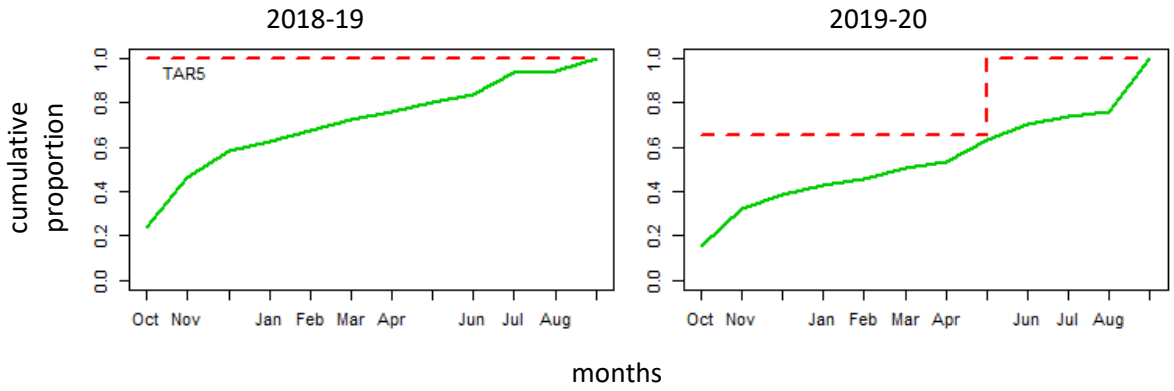


Figure 92: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from TAR 5 bottom trawl fisheries in 2018–19 and 2019–20.

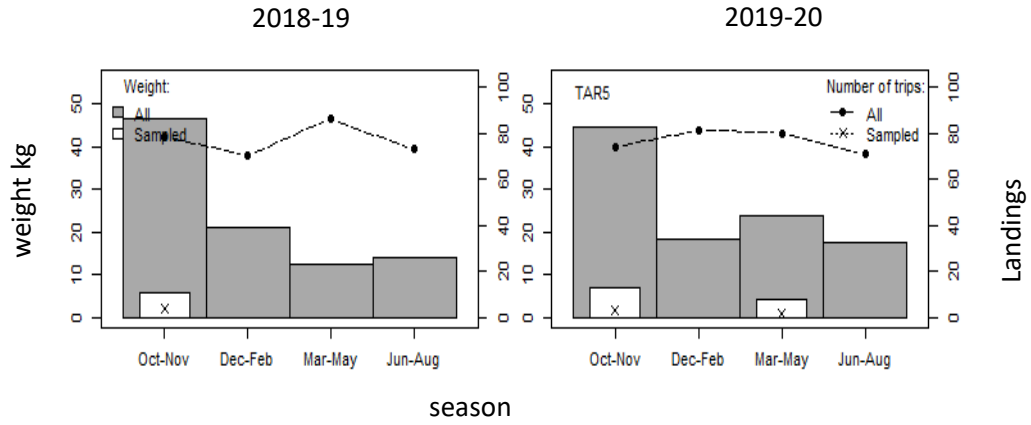


Figure 93: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within TAR 5 from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring= October-November, summer = December-February, autumn = March-May, winter = June-August.)

The distribution of TAR 5 sampled catches between statistical areas was representative of the spatial distribution of fishery in 2019–20, but the important Statistical Area 030 was not sampled in 2018–19 (Figure 94).

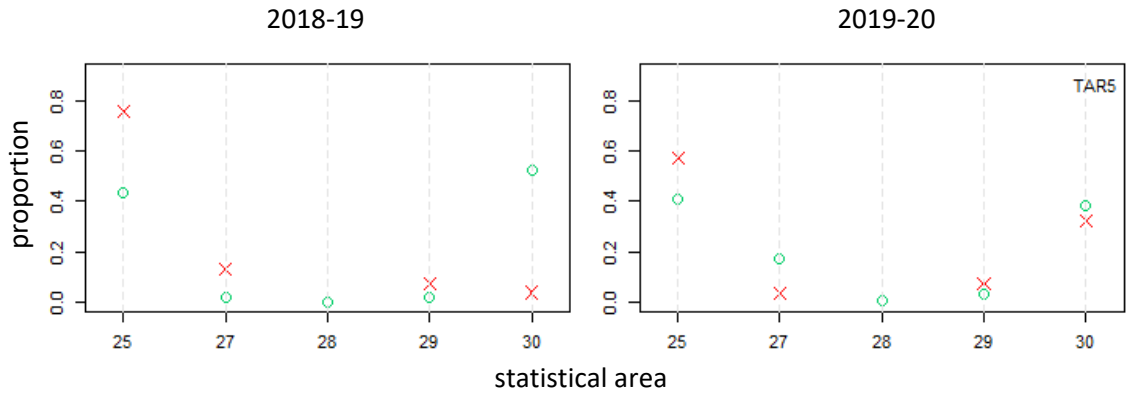


Figure 94: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for TAR 5 in 2018–19 and 2019–20 (o = all landings; x=sample landings). Statistical Area 025 is denoted by '25', Statistical Area 027 by '27', etc.

Bimodality was evident in the depth range of TAR 5 catches in both sample years with peaks at 50 and 150 m, respectively (Figure 95). Sampling did not cover the second deeper mode of the TAR 5 catches in either fishing year (Figure 95).

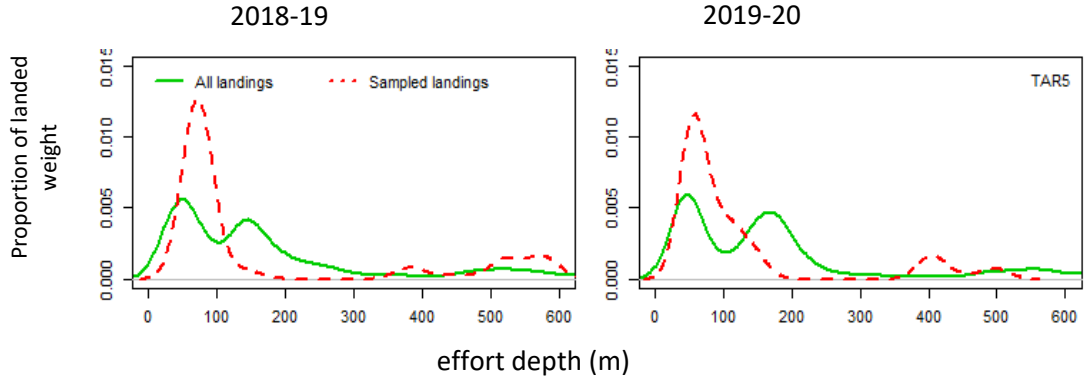


Figure 95: Depth distribution of tarakihi bottom trawl landings and samples for TAR 5 during the 2018–19 and 2019–20 fishing years (solid lines represent all landings, dashed lines represent sample landings).

Length and age frequency distributions

The male and female tarakihi in the TAR 5 annual sampling catches were all largely between 25 and 40 cm in length (Figure 96). The sample size distributions of male and female TAR 5 tarakihi were similar, as were the sex ratios in the sampled catches (Figure 96). The MWCVs on the TAR 5 length proportions for all fish combined in the two sampling years were 0.48 and 0.50, respectively.

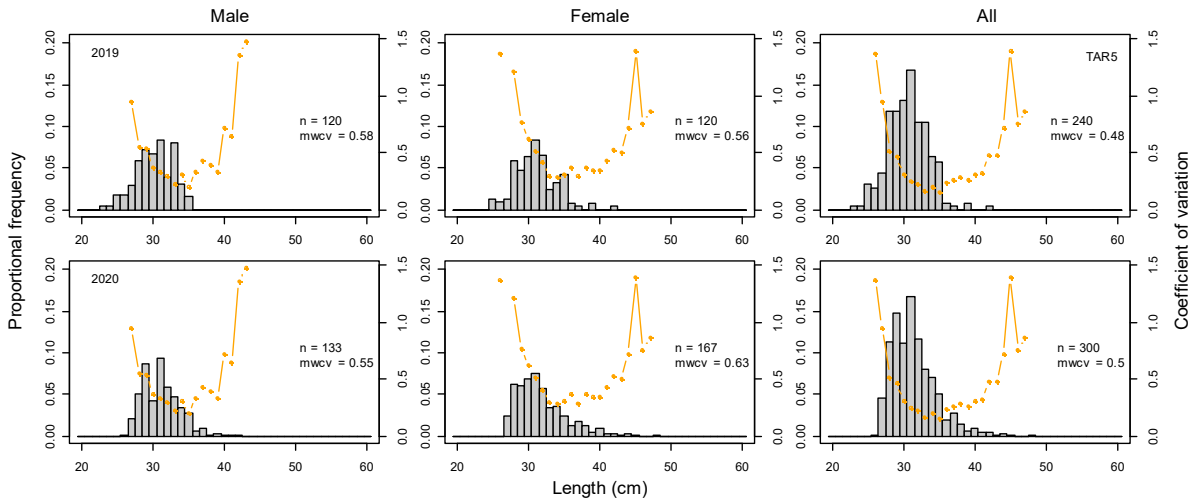


Figure 96: Scaled length frequency distributions and coefficient of variation for each length class for TAR 5 bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20.

The age composition of the TAR 5 annual catches was similar to that seen in SBP, being predominantly made up of fish less than 10 years of age (Figure 97). Colours denote strong age classes and these track through between the two sample years (Figure 97). The 2016 year class is seen as a very strong 4-year-old cohort in the 2019–20 fishing year (Figure 97), and this cohort was also moderately strong in SBP samples (see Figure 91). However, the 2015 year class which was a very strong 4-year-old cohort in the 2018–19 SBP samples (blue cohort, Figure 91) did not appear to be as strong in the 2018–19 TAR 5 samples (blue cohort, Figure 97). The MWCVs on the TAR 5 age proportions for all fish combined in the two sampling years were 0.36 and 0.29, respectively (Table 8).

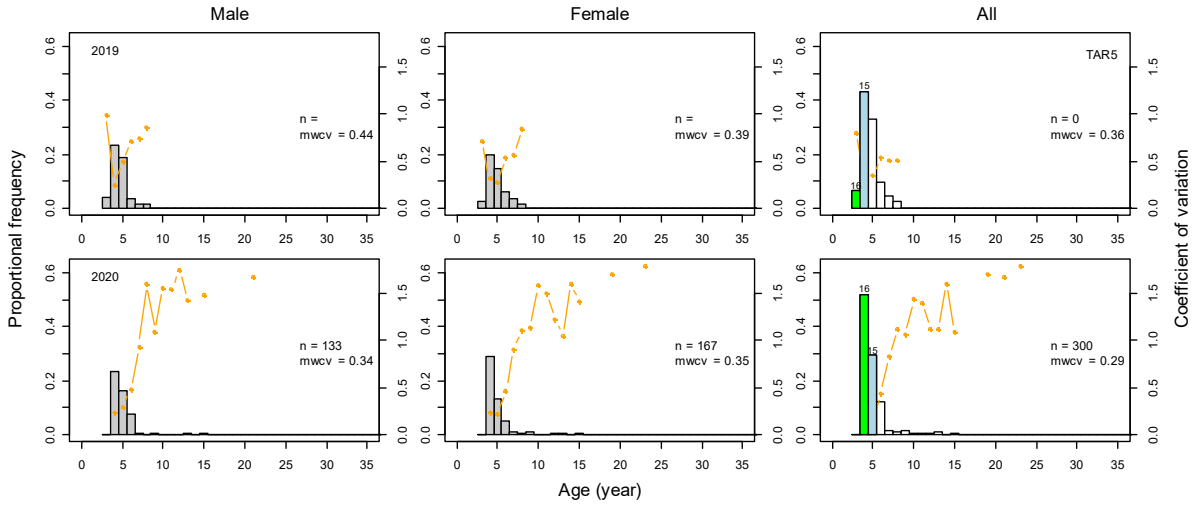


Figure 97: Scaled age frequency distribution and coefficient of variation for each length class for TAR 5 bottom trawl landings by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.4 West Coast tarakihi sampling results

4.4.1 West Coast South Island (TAR 7)

Despite Covid-19 logistical challenges, the TAR 7 sampling target was largely achieved in both sample years (Table 9). Catch-at-age mean weighted CV targets were also well achieved in both fishing years (Table 9).

Table 9: Number of TAR 7 landings targeted and sampled, number of otoliths aged, and mean-weighted CV on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	20	19	600	0.22
2019–20	20	19	750	0.21

Sampling representativeness

The temporal distribution of sampled landings closely followed the trend seen for all landings throughout the 2018–19 year (Figure 98). Sampling largely covered the main catch period of the fishery in both fishing years, but the lower-catch winter quarter was not sampled in the 2019–20 fishing year (Figure 99).

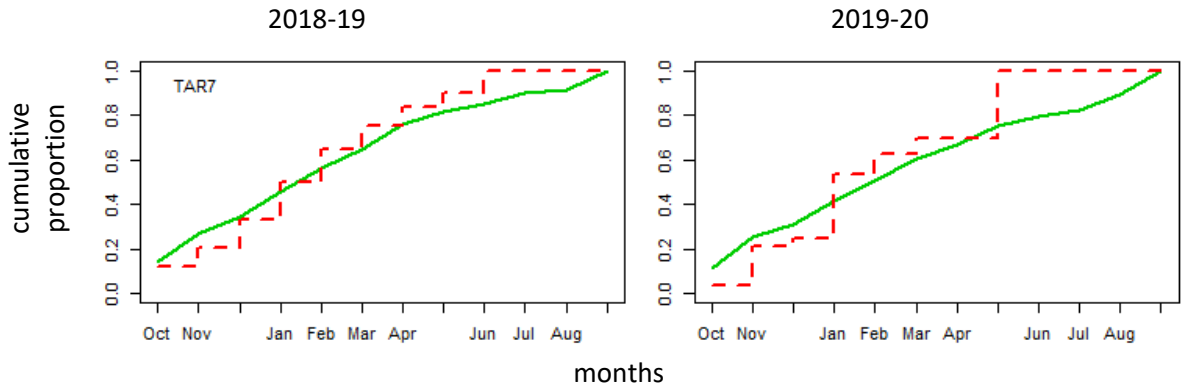


Figure 98: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from TAR 7 bottom trawl fisheries in 2018–19 and 2019–20.

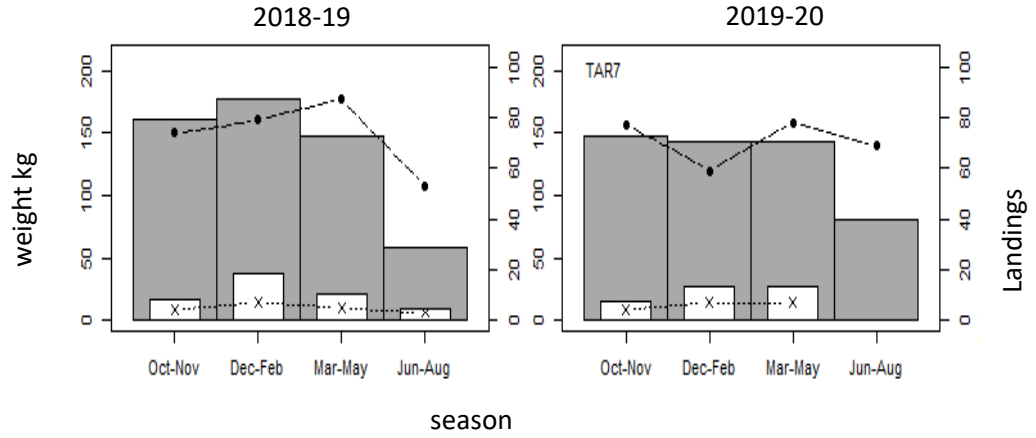


Figure 99: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within TAR 7 from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring = October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of TAR 7 sampled catches between statistical areas was representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 100).

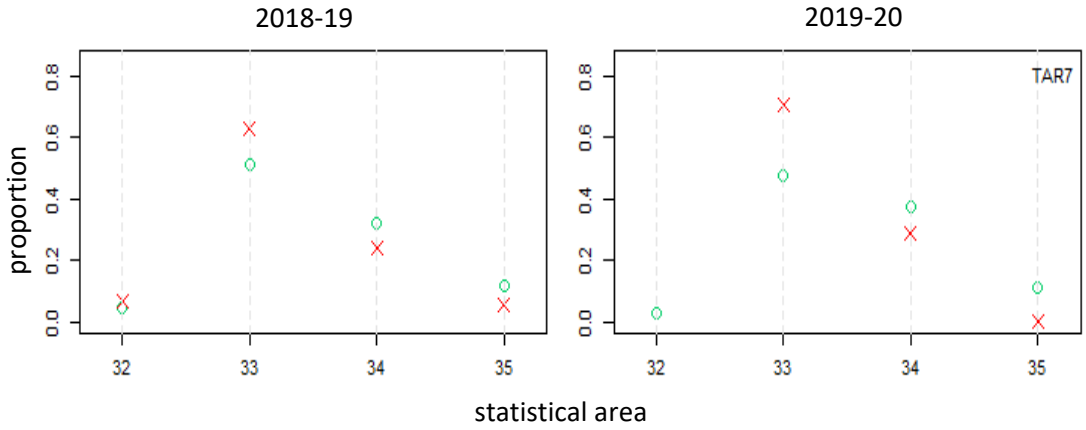


Figure 100: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for TAR 7 in 2018–19 and 2019–20 (o = all landings; x = sample landings).

The distribution of sampled landings by fishing depth closely matched that of the wider TAR 7 trawl fishery, with the majority of the catch taken between 50 and 200 m (Figure 101).

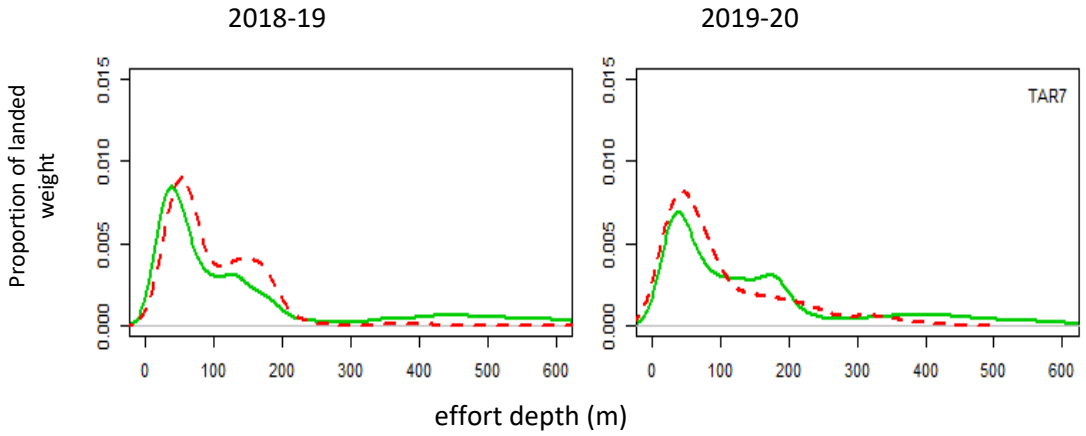


Figure 101: Depth distribution of tarakihi bottom trawl landings and samples for TAR 7 during the 2018–19 and 2019–20 fishing years (solid lines represent all-landings, dashed lines represent sample landings).

Length and age frequency distributions

The male tarakihi in the TAR 7 annual sampling catches were all largely between 25 and 40 cm and females were 25 to 50 cm (Figure 102). The sex ratios in the sampled catches were close to parity (Figure 102). The MWCVs on the TAR 7 length proportions for all fish combined in the two sampling years were both 0.23.

,

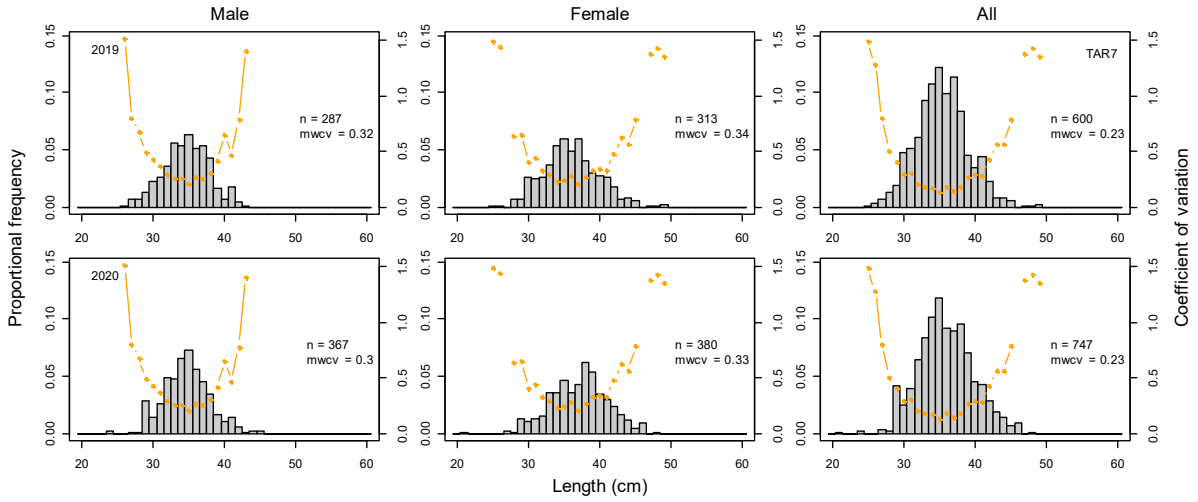


Figure 102: Scaled length frequency distribution and coefficient of variation for each length class for TAR 7 bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20.

A broad range of age classes out to 35 years were present in 2018–19 and 2019–20 TAR 7 trawl catches (Figure 103). There were some marked differences in the TAR 7 year class strength patterns compared to patterns seen across all the east coast tarakihi sample regions: the strong 2014 and 2008 TAR 7 year classes were moderate to weak in all east coast samples; and consistently strong 2012 and 2009 east coast year classes were not strong in the TAR 7 samples (Figure 103). The MWCVs on the TAR 7 age proportions for all fish combined in the two sampling years were 0.22 and 0.21, respectively (Table 9).

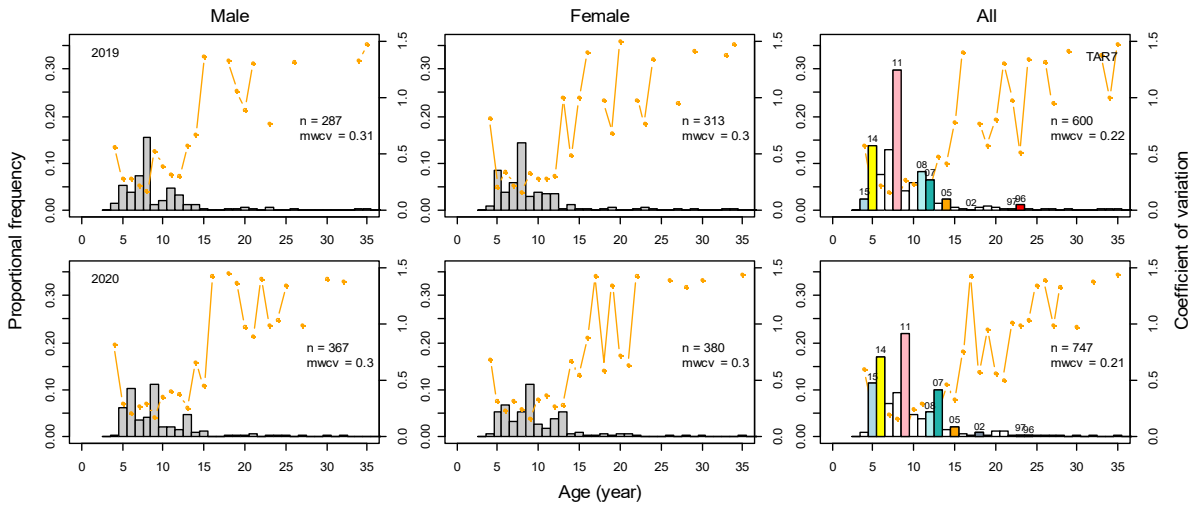


Figure 103: Scaled age frequency distribution and coefficient of variation for each length class for TAR 7 bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.4.2 New Plymouth (TAR 8)

Despite Covid-19 logistical challenges, the TAR 8 sampling target was largely achieved in both sample years (Table 10). Ageing precision targets were not achieved in either sampling year despite the requisite number of otoliths being aged (Table 10), indicating that 450 otoliths were too few to describe the number of age classes present in the catches.

Table 10: Number of TAR 8 landings targeted and sampled, number of otoliths aged, and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	10	8	450	0.36
2019–20	10	8	450	0.33

Sampling representativeness

The temporal distribution of TAR 8 sampled landings closely followed the trend seen for all landings throughout the 2018–19 year (Figure 104 & Figure 105). The COVID-19 restrictions affected temporal sampling in 2019–20; however temporal coverage of TAR 8 was still ‘reasonable’ (Figure 104 & Figure 105).

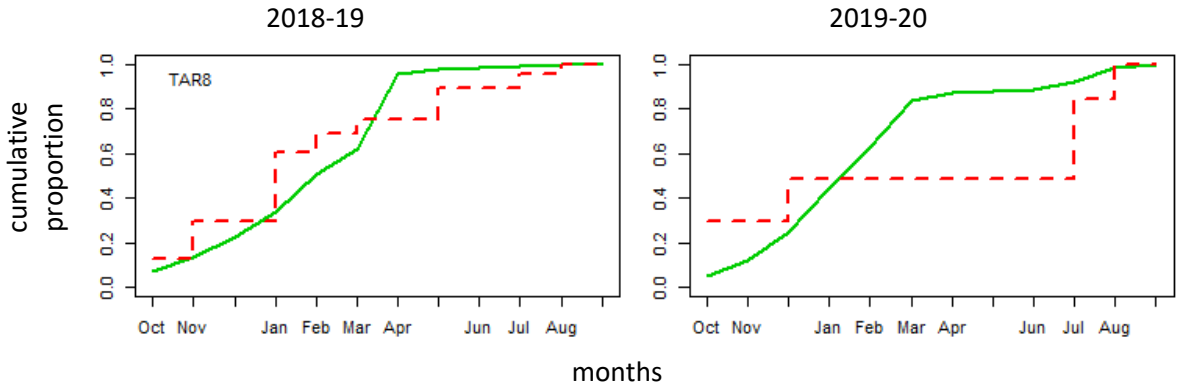


Figure 104: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from TAR 8 bottom trawl fisheries in 2018–19 and 2019–20.

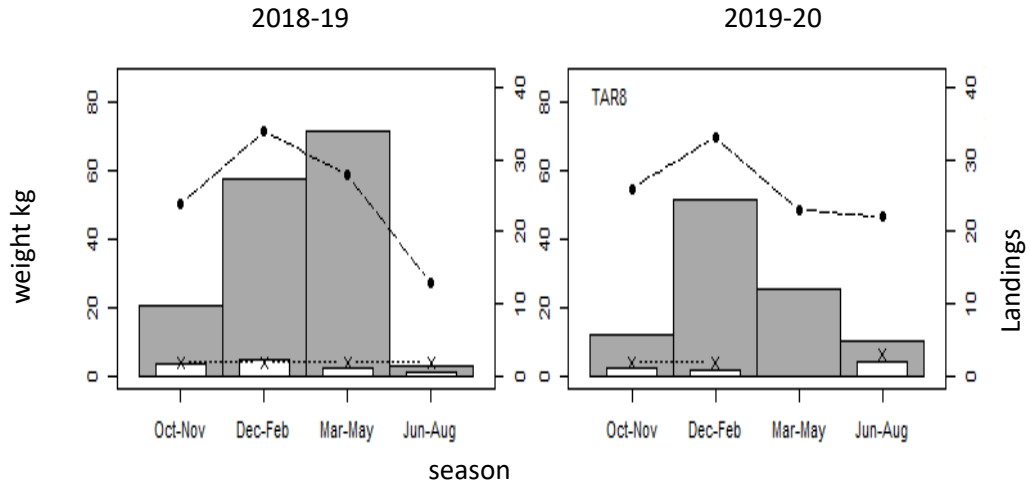


Figure 105: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within TAR 8 from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring = October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of TAR 8 sampled catches between statistical areas was representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 106).

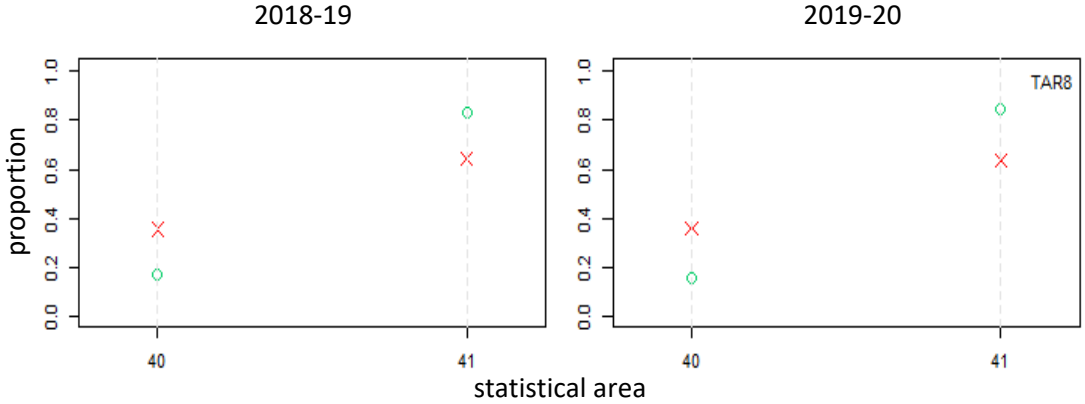


Figure 106: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for TAR 8 in 2018–19 and 2019–20 (o = all landings; x=sample landings). Statistical Area 040 is denoted by '40' and Statistical Area 041 by '41'.

The distribution of sampled landings by fishing depth closely matched the bimodal nature of the wider TAR 8 trawl fishery, with the majority of the catch taken between 50 and 180 m (Figure 107).

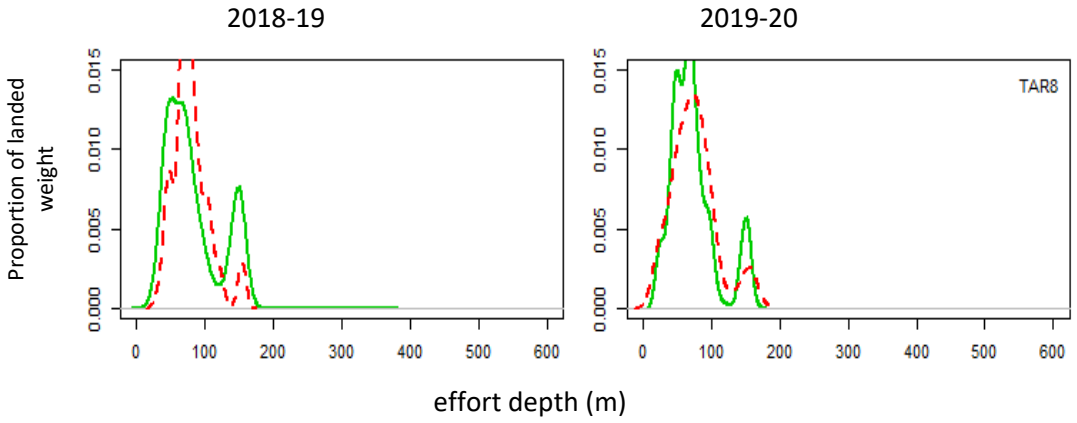


Figure 107: Depth distribution of tarakihi bottom trawl landings and samples for TAR 8 during the 2018–19 and 2019–20 fishing years (solid lines represent all landings, dashed lines represent sample landings).

Length and age frequency distributions

The male tarakihi in the TAR 8 annual sampling catches were all largely between 25 and 40 cm and females were 25 to 50 cm (Figure 108). Females made up a higher proportion of the TAR 8 trawl catches in both sample years (Figure 108). The MWCVs on the TAR 8 length proportions for all fish combined in the two sampling years were 0.38 and 0.37, respectively.

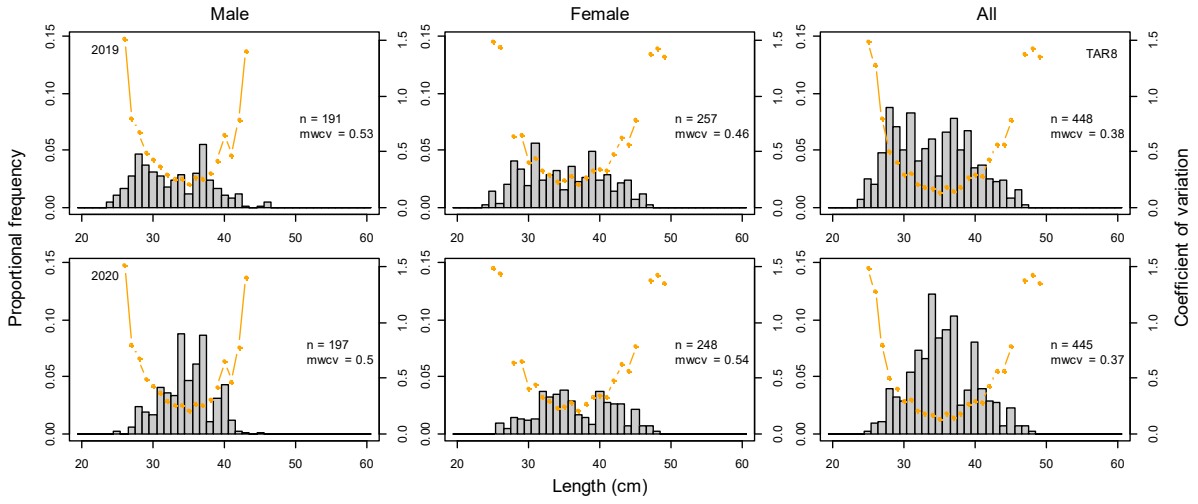


Figure 108: Scaled length frequency distribution and coefficient of variation for each length class for TAR 8 bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20.

As with TAR 7, a broad range of age classes out to 31 years was present in 2018–19 and 2019–20 TAR 8 trawl catches (Figure 109). Year class strength patterns evident in the TAR 8 sampled trawl catches in both sample years closely match those seen in the TAR 7 samples (Figure 103 & Figure 109). The MWCVs on the TAR 7 age proportions for all fish combined in the two sampling years were 0.36 and 0.33, respectively (Table 10).

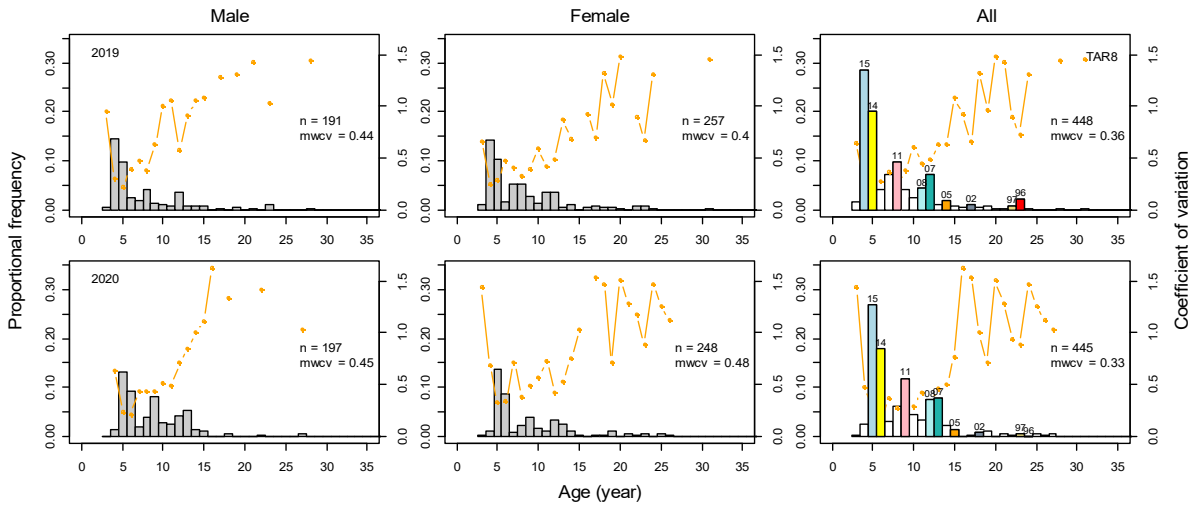


Figure 109: Scaled age frequency distribution and coefficient of variation for each length class for TAR 8 bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

4.4.3 West Coast North Island (WCNI)

Despite Covid-19 logistical challenges, the WCNI sampling and at-age mean weighted CV targets were achieved in both fishing years (Table 11).

Table 11: Number of WCNI landings targeted and sampled, number of otoliths aged, and mean-weighted CV (MWCV) on the combined-sex proportion-at-age estimates by fishing year

Fishing year	Target landings	Sampled landings	Otoliths aged	At-age MWCV
2018–19	20	17	602	0.24
2019–20	20	17	600	0.27

Sampling representativeness

The temporal distribution of WCNI sampled landings largely followed the trend seen for all landings throughout the 2018–19 year (Figure 110 & Figure 111). The COVID-19 restrictions had minimal effect on WCNI temporal sampling in 2019–20 (Figure 110 & Figure 111).

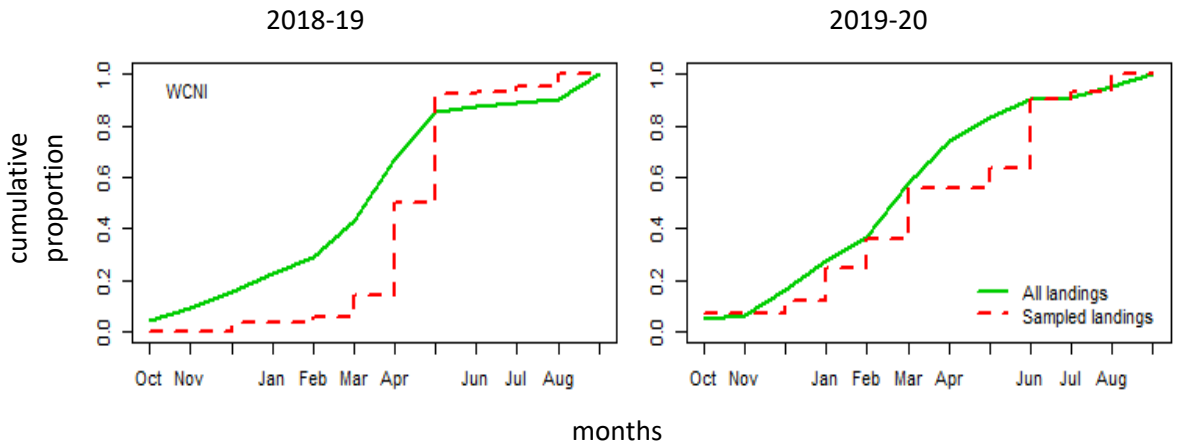


Figure 110: Monthly cumulative proportion of the weight of tarakihi landings (solid line) and samples (dashed line) taken from WCNI bottom trawl fisheries in 2018–19 and 2019–20.

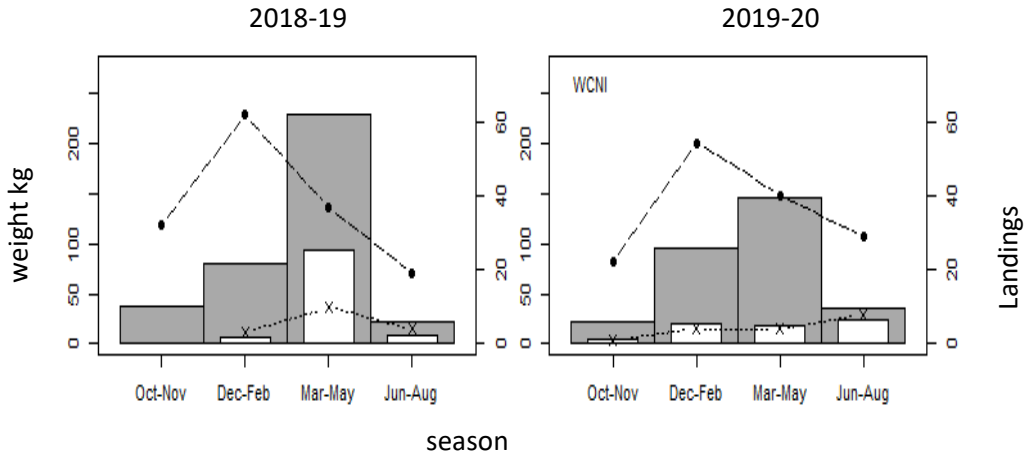


Figure 111: Comparison of the seasonal distribution of landed weight (histograms) and numbers of landings (lines) of tarakihi within WCNI from 2018–19 to 2019–20. (Note: histograms and lines overlaid; spring = October-November; summer = December-February; autumn = March-May; winter = June-August.)

The distribution of WCNI sampled catches between statistical areas was representative of the spatial distribution of all catches landed by bottom trawlers in both sample years (Figure 112).

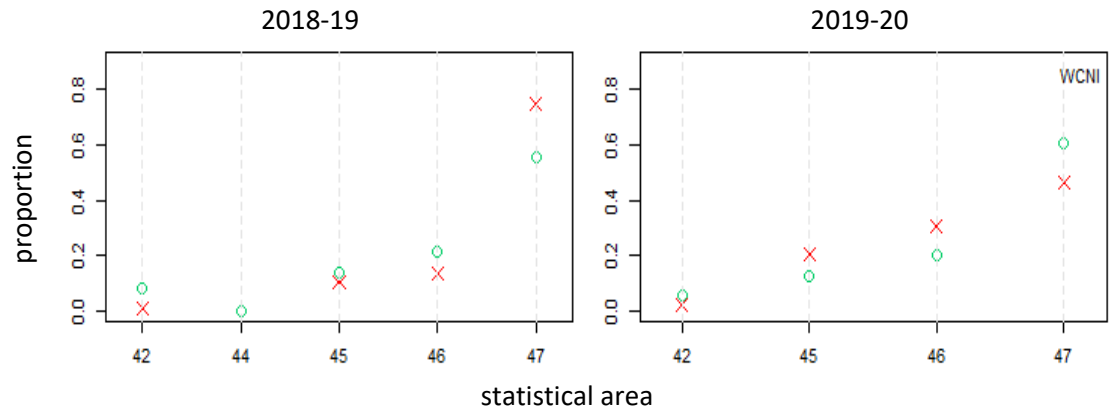


Figure 112: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area for WCNI in 2018–19 and 2019–20 (o = all landings; x = sample landings).

The distribution of sampled landings by fishing depth closely matched that of the wider WCNI trawl fishery, with the majority of the catch taken between 50 and 200 m (Figure 113).

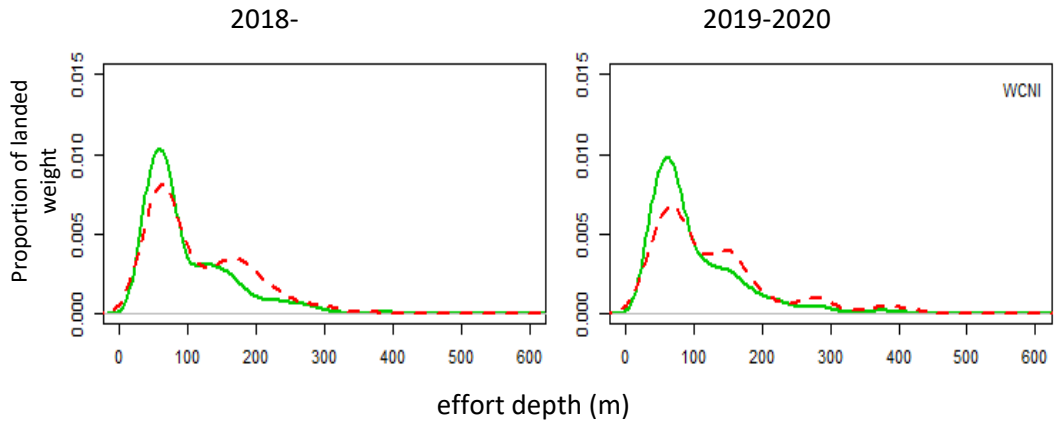


Figure 113: Depth distribution of tarakihi bottom trawl landings and samples for WCNI during the 2018–19 and 2019–20 fishing years (solid lines represent all landings, dashed lines represent sample landings).

Length and age frequency distributions

The male tarakihi in the WCNI annual sampling catches were all largely between 25 and 45 cm and females were 25 to 48 cm (Figure 114). The sex ratio in the WCNI sampled landings in both sampling years were roughly at parity (Figure 114). The MWCVs on the WCNI length proportions for all fish combined in the two sampling years were 0.25 and 0.27, respectively.

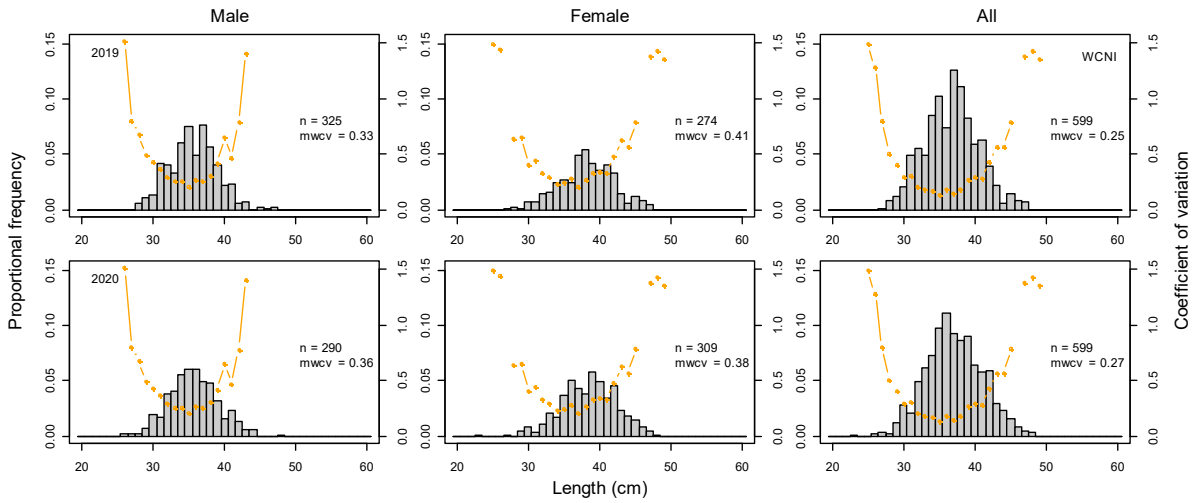


Figure 114: Scaled length frequency distribution and coefficient of variation for each length class for WCNI bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20.

As with TAR 7 & 8, a broad range of age classes out to 32 years was present in 2018–19 and 2019–20 WCNI trawl catches (Figure 115). Year class strength patterns evident in the WCNI sampled trawl catches in both sample years closely match those seen in TAR 7 and TAR 8 samples (Figure 103, Figure 109, & Figure 115). The MWCVs on the TAR 7 age proportions for all fish combined in the two sampling years were 0.24 and 0.27, respectively (Table 11).

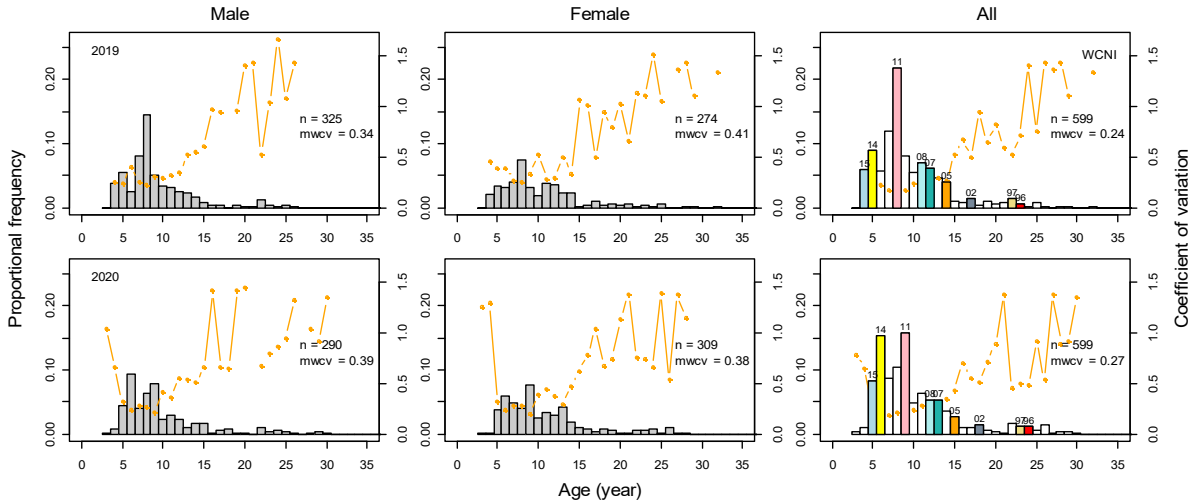


Figure 115: Scaled age frequency distribution and coefficient of variation for each length class for WCNI bottom trawl landings, by sex and combined sexes in 2018–19 and 2019–20. Colours denote strong year classes; numbers above bars denote cohort spawning years.

5. DISCUSSION

This report represents catch sampling of New Zealand-wide tarakihi stocks over two complete fishing years (2018–19 and 2019–20). This is the first time that the length and age structure of tarakihi populations from the entire east and west coast regions of New Zealand have been systematically and comprehensively described at the same time. As such, the results presented here help to concurrently characterise the New Zealand tarakihi stock structure.

Despite sampling logistical challenges posed by COVID-19 lockdowns in the 2019–20 fishing year, sampling achieved good spatio-temporal representative coverage in seven of the nine regional tarakihi sampling areas. Sampling of the Cook Strait pre-spawning tarakihi fishing was compromised because this fishery appeared to no longer operate. The Cook Strait sampling region was increased to include the lower Wairarapa coast area of TAR 2; however, again due to logistical issues, sampling was poorly representative of the wider fishery in both sampling years. Sampling in TAR 5 was also compromised in both fishing years so there is some doubt that the sampling had adequately represented the TAR 5 fishery.

Age patterns seen in the TAR 5 samples were very similar to those observed in the South Banks Peninsula, being predominately composed of fish younger than 10 years and it is likely TAR 5 and the SBP regions are component parts of a wider southern east coast tarakihi stock recruitment area.

Differences in year class strength between the east and west coast regions of TAR 1 in 2013–14 and 2014–15 (McKenzie et al. 2017) suggest that these two regions support separate east and west coast New Zealand tarakihi stocks. Marked differences in year class strength between WCNI and EN_HG were again seen in the most recent sampling (Figure 116) which further strengthens the east-west New Zealand two tarakihi stock hypothesis. Strong 2014 and 2008 WCNI year classes were moderate to weak in EN_HG samples; conversely, strong 2012 and 2009 EN_HG year classes did not appear as strong in the WCNI samples (Figure 116).

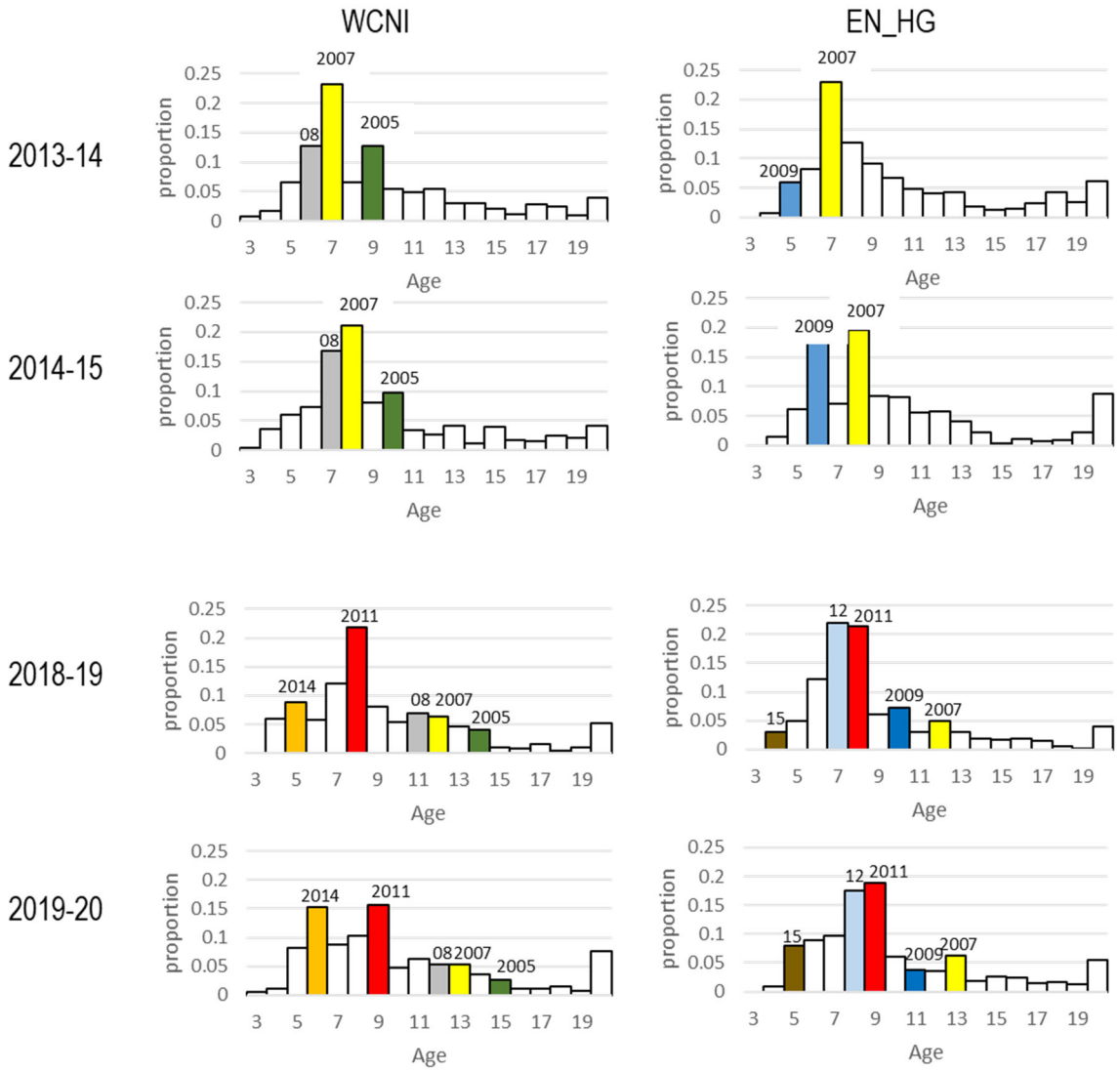


Figure 116: Age frequency compositions of WCNI and EN_HG trawl tarakihi sampled from 2013–14, 2014–15, 2018–19, and 2019–20 fishing years. Coloured cohorts denote those of above-average strength; numbers above bars denote cohort spawning years.

East coast tarakihi stock

Catch-at-age sampling of the TAR 1, 2, & 3 bottom trawl and set net catches during the 2013–14 and 2014–15 fishing years suggests that tarakihi off the east coast of New Zealand comprise a single stock. Patterns in year class strength suggest that tarakihi recruitment to the east coast fishery largely begins south of Banks Peninsula. Juvenile or smaller sized recruits then progressively move northwards up the coast such that the terminal destination of the majority of the older tarakihi age classes is east Northland (McKenzie et al. 2017). The 2018–19 and 2019–20 catch sampling across all east New Zealand coastal regions provided a reaffirmation of the east coast tarakihi single stock hypothesis with the same ontogenetic trends evident (Figure 117).

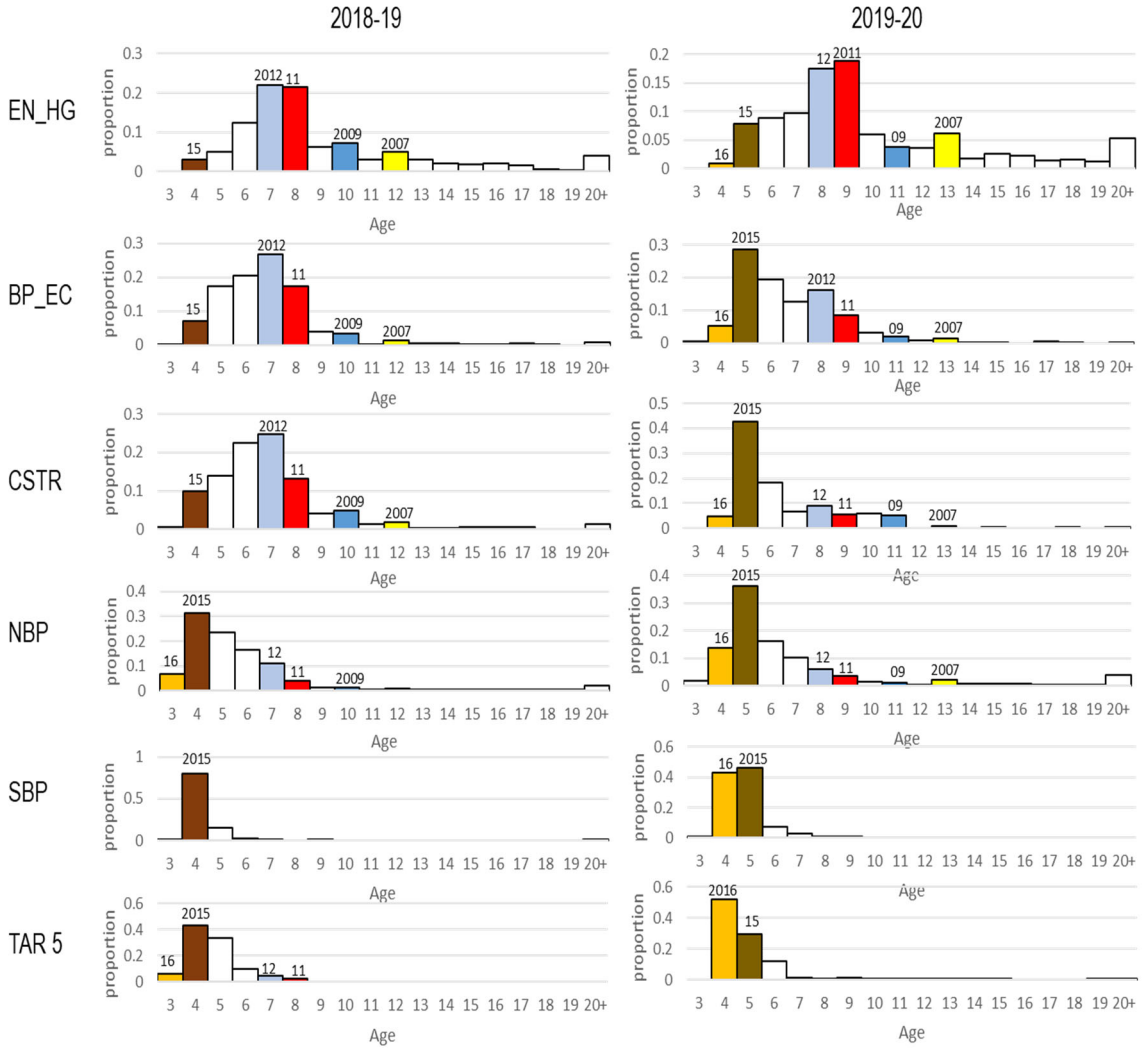


Figure 117: Combined-sex proportions at-age from all east coast tarakihi sample regions. Unique colours denote specific strong year classes; numbers above bars denote cohort spawning years.

Evidence for this conclusion is based on the finding that the 2015 year class, seen as strong in the southern east coast tarakihi regions in the 2018–19 sampling year, appears to become predominantly stronger in the northern regions and weaker in the south in the second sampling year (Figure 117). The 2012 and 2011 year classes, which appear strong in the northernmost EN_HG region in both samples years, have virtually disappeared from the southernmost SPB and TAR 5 regions; these year classes also appear to weaken in prominence in the central region areas between the two sampling years (Figure 117).

West coast tarakihi stock

The WCNI tarakihi age composition signatures in 2018–19 and 2019–20 indicate that this region is likely to be part of a different tarakihi stock than that of the EN_HG region (Figure 116). The same year classes in WCNI were also strong in the TAR 8 and TAR 7 southern west coast regions (Figure 118). These regional similarities in age structure are strong evidence that the WCNI, TAR 8, and TAR 7 regions are all part of the same separate west coast New Zealand tarakihi stock.

Evidence for this conclusion is based on the finding that in 2018–19, 2015 and 2014 were the strongest year classes in TAR 8, whereas these cohorts were weaker in the WCNI and TAR 7 northern and southern regions in the same year (Figure 118). The 2015 and 2014 year classes in the WCNI and TAR 7 regions are both seen to increase in relative strength in the second year of sampling (Figure 118). The 2011 year class, although strong in the TAR 8 samples, is relatively stronger in the northern and southern

regions (WCNI & TAR 7, Figure 118). These spatial ontogenetic patterns in year class strength are evidence that recruitment to the West Coast tarakihi stock occurs centrally with fish increasingly migrating north and south as they age. High abundances of 1+ and 2+ juvenile tarakihi are seen in research trawl surveys conducted in the Tasman Bay and Golden Bay (TBGB) (MacGibbon 2019) pointing to these areas being the likely main source of juvenile recruitment to the west coast tarakihi stock. Furthermore, high years of juvenile tarakihi abundance observed in the TBGB trawl survey time series correspond well to the pattern of strong year classes seen in the recent west coast sampling (Figure 118).

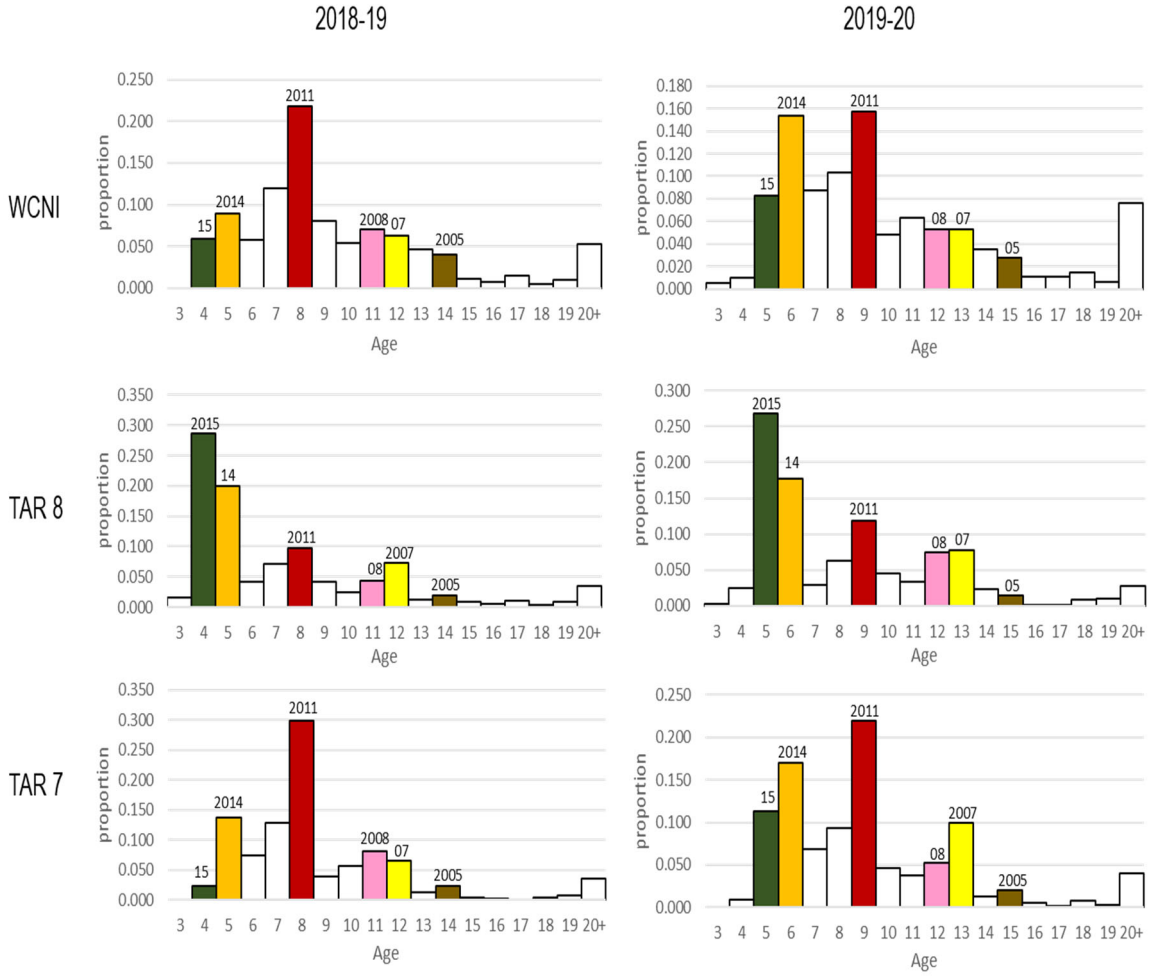


Figure 118: Combined-sex proportions at-age from all west coast tarakihi sample regions. Unique colours denote specific strong year classes; numbers above bars denote cohort spawning years.

Concluding remarks

Overall, the results presented in this report are generally consistent with those of previous studies and suggest: (1) a strong link between east coast stocks/regions with ontogenetic movement from south to north (McKenzie et al. 2017, Langley 2018); (2) separate east and west coast tarakihi stocks (McKenzie et al. 2017). The present study represents the first time that the age composition of all New Zealand tarakihi QMAs has been simultaneously described enabling a better understanding of connectivity and therefore stock linkages along the east and west coasts. These results will inform future catch sampling designs and provide testable hypotheses for stock assessment model configurations.

5.1 Recommendations

- Future catch sampling of the TAR 1, 2, 3, 5, 7, & 8 trawl fisheries should take place concurrently because these QMAs are likely to be part of two New Zealand tarakihi biological stocks (in line with age monitoring of other Fisheries New Zealand tier 1 stocks, the authors recommend sampling should occur over two consecutive years in every five).
- Ageing otoliths collected as part of the recent west coast South Island trawl survey may be a useful interim measure for understanding connectivity between west and east coast tarakihi populations.
- Movement of adult tarakihi, as inferred from the age data, does not in itself constitute definitive proof of the single east coast stock hypothesis. Tarakihi movement patterns should ideally be independently ratified; perhaps using a tagging programme, or with other appropriate biological markers such genetics and otolith microchemistry.
- Future east and west coast tarakihi stock assessments need to account for the spatially disaggregated nature of the tarakihi stocks of New Zealand.
- The annual number of otoliths aged from the TAR 8 region should be increased to 600 in future catch sampling programmes.

6. ACKNOWLEDGEMENTS

This study was funded by the Fisheries New Zealand (project TAR2018-01).

Thanks to the various fishing companies and staff that conducted catch sampling including: Aotearoa Fisheries Limited Auckland (Aroha Belcher, Ross Brown, Denis Cameden, Titi Faamau, John Fakatala and unloading team, Dave Falconer, Villiami Fifita, Ray Kearns, Stephen Lauhingoa, Louise Mangu, Gloria Mau, Tau Nathan, Nathan Reid, Boo Rowley, Salatielu Samuelu, Diane Taka, Elisha Yahel); Sanford Limited Auckland (Jonny Bamford, Katrina Burton, Michael Cronje, Arleen De Verya, Ana Fonua, Louise Franklin, Margaret Hall, Troy Henderson, Jason Hiko, Lana Kimi, Pouha Lotoahea, Jane McWhinnie, Warwick Neame, Alipeti Ofanoa, Patricio Pita, Vincent Stewart, Farao Talamaivao and unloading team, Elisala Toa, Elham Tursun, Paula Vi); Sanford Limited Tauranga (Fay Anderson, Dave Cowdrey, Steve Keeves, Johnathon Makitae, Donnelle McClarnen, Stacy Ngatai, Michaela Pardoe, Jeff Plowman, Corey Rikihana, Pani Te Haara, Kevin Wylie); New Zealand Inshore Fishing Fleet (all the skippers and crew who contributed valuable catch and location information): Gisborne Fisheries Ltd (Nik Askew, Hilton Slement); Takitimu Seafoods (Marcus D'esposito); Egmont Seafoods (Caleb Mawson, Keith Mawson); Talleys Group Motueka (Guy Mannering, Dion Iorns); Westfleet Seafoods (John Brown); Talleys Group Timaru (Leon Moore, Scott Bain); United Fisheries (Emelios Kotzikas, Andrei Kotzikas & commercial fishers Tim Stark and Tony Threadwell); Canterbury Seafoods (Eddy Box); Fisheries Inshore New Zealand (Oliver Wilson, Carol Scott).

Finally, the authors would like to thank Darren Parsons and Marc Griffiths for reviewing the final document; and Suze Baird for editing it.

7. REFERENCES

Anderson, N.H.; Hall, P,; Titterington, D.M. (1994). Two-sample test statistics for measuring discrepancy between two multivariate probability density functions using kernel-based density estimates. *Journal of Multivariate Analysis 50*: 41–54.

Anderson, O.F.; Bagley, N.W.; Hurst, R.J.; Francis, M.P.; Clark, M.R.; McMillan, P.J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. *NIWA Technical Report 42.* 303 p.

Annala, J.H. (1987). The biology and fishery of tarakihi, *Nemadactylus macropterus*, in New Zealand waters. *Fisheries Research Division Occasional Publication No. 51*. 16 p.

Annala, J.H. (1988). Tarakihi. New Zealand Fisheries Assessment Research Document 88/28. 32 p. (Unpublished document held at Ministry for Primary Industries, Wellington.)

Ayling, T.; Cox, G.J. (1982). Collins guide to the sea fishes of New Zealand (revised edition). William Collins Publishers Ltd, Auckland, 343 p.

Beamish, R.J.; Fournier, D.A. (1981). A method for comparing the precision of a set of age determinations. *Canadian Journal of Fisheries and Aquatic Sciences 38:* 982–983.

Beentjes, M.P. (2011). TAR 3 catch sampling in 2009–10 and a characterisation of the commercial fishery (1989–90 to 2009–10). *New Zealand Fisheries Assessment Report 2011/52*. 71 p.

Beentjes, M.P.; Parker, S.; Fu, D. (2012). Characterisation of TAR 2 & TAR 3 fisheries and age composition of landings in 2010/11. *New Zealand Fisheries Assessment Report 2012/25*. 68 p.

Beentjes, M.P.; Walsh, C.; Buckthought, D. (2017). Catch at age of tarakihi from east coast South Island and Bay of Plenty trawl surveys. *New Zealand Fisheries Assessment Report 2017/03*. 39 p.

Campana, S. E. (2001). Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *Journal of Fish Biology 59*, 197–242.

Campana, S.E.; Annand, M.C.; McMillan, J.I. (1995). Graphical and statistical methods for determining the consistency of age determinations. *Transactions of the American Fisheries Society 124*: 131–138.

Chang, W.Y.B. (1982). A statistical method for evaluating the reproducibility of age determination. *Canadian Journal of Fisheries and Aquatic Sciences 39*: 1208–1210.

Crossland, James (1976). Snapper tagging in north-east New Zealand, 1974: analysis of methods, return rates, and movement. N.Z. *Journal of Marine and Freshwater Research 10*: 675-686.

Davies, N.M.; Hartill, B.; Walsh, C. (2003). A review of methods used to estimate snapper catch-at-age and growth in SNA 1 and SNA 8. *New Zealand Fisheries Assessment Report 2003/10*. 63 p.

Francis, R.I.C.C; Bian, R. (2011). Catch-at-length and -age User Manual, CALA (2011) National Institute of Water & Atmospheric Research Ltd. Unpublished report. 83 p.

Hanchet, S.M.; Field, K. (2001). Review of current and historical data for tarakihi (*Nemadactylus macropterus*) Fishstocks 1, 2, 3, and 7, and recommendations for future monitoring. *New Zealand Fisheries Assessment Report 2001/59*. 42 p.

Langley, A.D. (2018). Stock assessment of tarakihi off the east coast of mainland New Zealand. *New Zealand Fisheries Assessment Report 2018/05*. 85 p.

Langley, A.D.; Starr, P. (2012). Stock relationships of tarakihi off the east coast of mainland New Zealand and the feasibility of developing a statistical assessment of the corresponding tarakihi stock(s). *New Zealand Fisheries Assessment Report 2012/30*. 69 p.

MacGibbon, D.J. (2019). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2019 (KAH1902) *New Zealand Fisheries Assessment Report 2019/64*. 87 p.

MacGibbon, D.J.; Beentjes, M.P.; Lyon, W.L.; Ladroit, Y. (2019). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2018 (KAH1803). *New Zealand Fisheries Assessment Report 2019/03*. 136 p.

McKenzie, J.R.; Beentjes, M.P.; Parker, S.; Parsons, D.M.; Armiger, H.; Wilson, O.; Middleton, D.; Langley, A.; Buckthought, D.; Walsh, C.; Bian, R.; Maolagáin, C.Ó.; Stevenson, M.; Sutton, C.; Spong, K.; Rush, N.; Smith, M. (2017). Fishery characterisation and age composition of tarakihi in TAR 1, 2 and 3 for 2013/14 and 2014/15. *New Zealand Fisheries Assessment Report 2017/36*. 80 p.

McKenzie, J.R.; Walsh, C.; Bian, R. (2015). Characterisation of TAR 1 fisheries and age composition of landings in 2010/11 from Industry at-sea catch sampling. *New Zealand Fisheries Assessment Report 2015/74*. 47 p.

Ministry for Primary Industries (2020). Fisheries Assessment Plenary, May 2020: stock assessments and stock status. Compiled by the Fisheries Science Group, Ministry for Primary Industries, Wellington, New Zealand. 1556 p.

Ministry of Fisheries (2008) Harvest Strategy Standard for New Zealand Fisheries Report held by Fisheries New Zealand ISBN 978-0-478-11914-3

Morrison, M.; Jones, E.; Parsons, D.M. (2012). Habitats of particular significance for coastal finfish fisheries management in New Zealand: a review of concepts and current knowledge. (Unpublished report held by Ministry of Primary Industries, Wellington.)

Parker, S.J.; Fu, D. (2011). Age composition of the commercial tarakihi (*Nemadactylus macropterus*) catch in quota management area TAR 2 in fishery year 2009–2010. *New Zealand Fisheries Assessment Report 2011/59*. 35 p.

Roberts, C.; Stewart, A.L.; Struthers, C.D.; Barker, J.; Kortet, S.; Freeborn, M. (2015). The fishes of New Zealand

Robertson, D.A. (1978). Spawning of tarakihi (Pisces: Cheilodactylidae) in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 12*: 277–286.

Tong, L.J.; Vooren, C.M. (1972). The biology of the New Zealand tarakihi (*Cheilodactylus macropterus). Fisheries Research Bulletin, New Zealand Ministry of Agriculture and Fisheries. No. 6*. 60 p.

Vooren, C.M. (1972). Postlarvae and juveniles of the tarakihi (teleostei: Cheilodactylidae) in New Zealand. *New Zealand Journal of Marine & Freshwater Research 6*: 602–618.

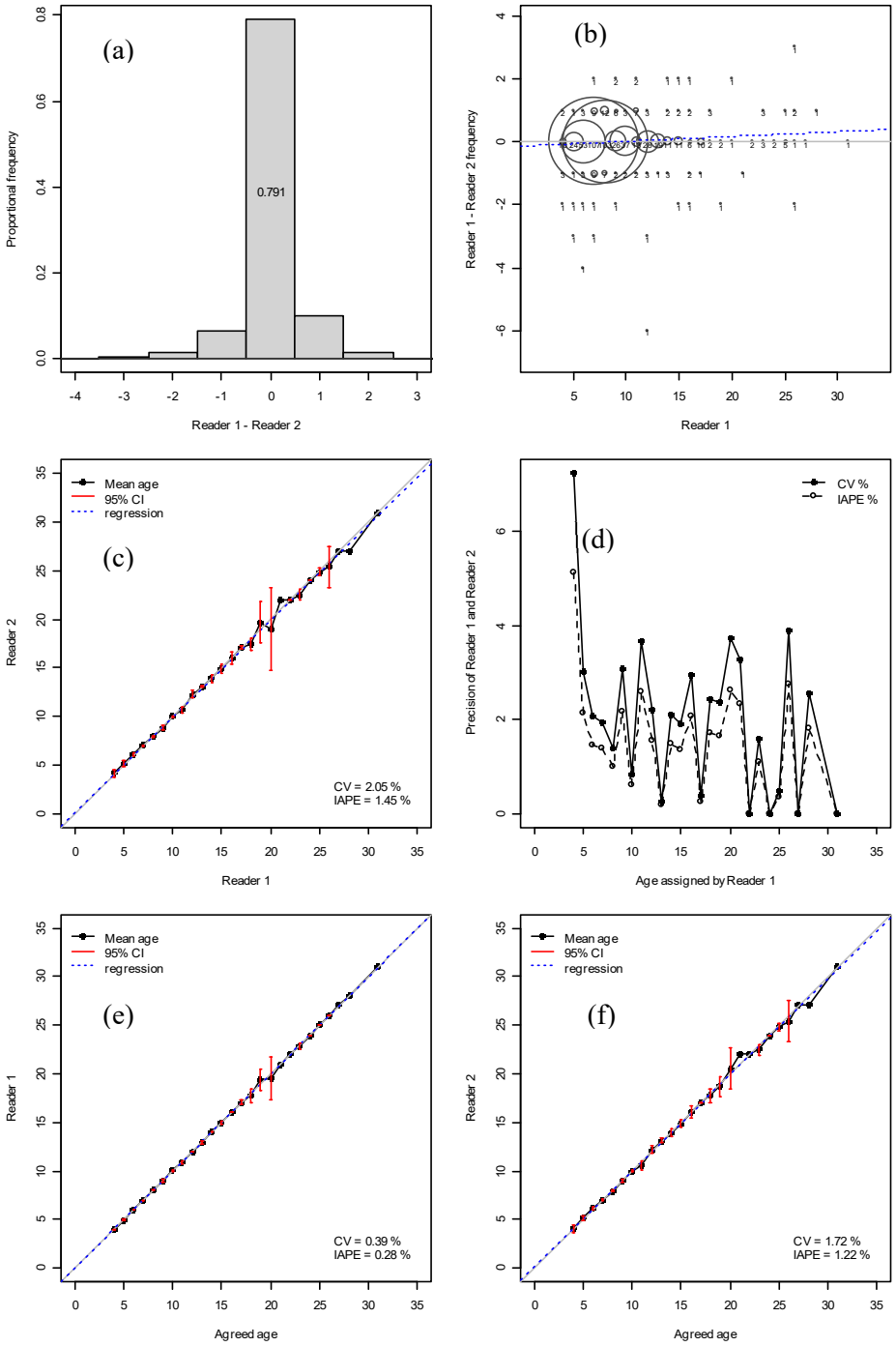
Vooren, C.M. (1975). Nursery grounds of tarakihi (Teleostei: Cheilodactylidae) around New Zealand. *New Zealand Journal of Marine and Freshwater Research 9*: 121–158.

Vooren, C.M.; Tong, L.T. (1973). A survey of the tarakihi *Cheilodactylus macropterus* (Bloch and Schneider) in the East Cape area, New Zealand, 26–30 March 1971. *Fisheries Research Bulletin No. 9*. 28 p. Fisheries Research Division, New Zealand Ministry of Agriculture and Fisheries.

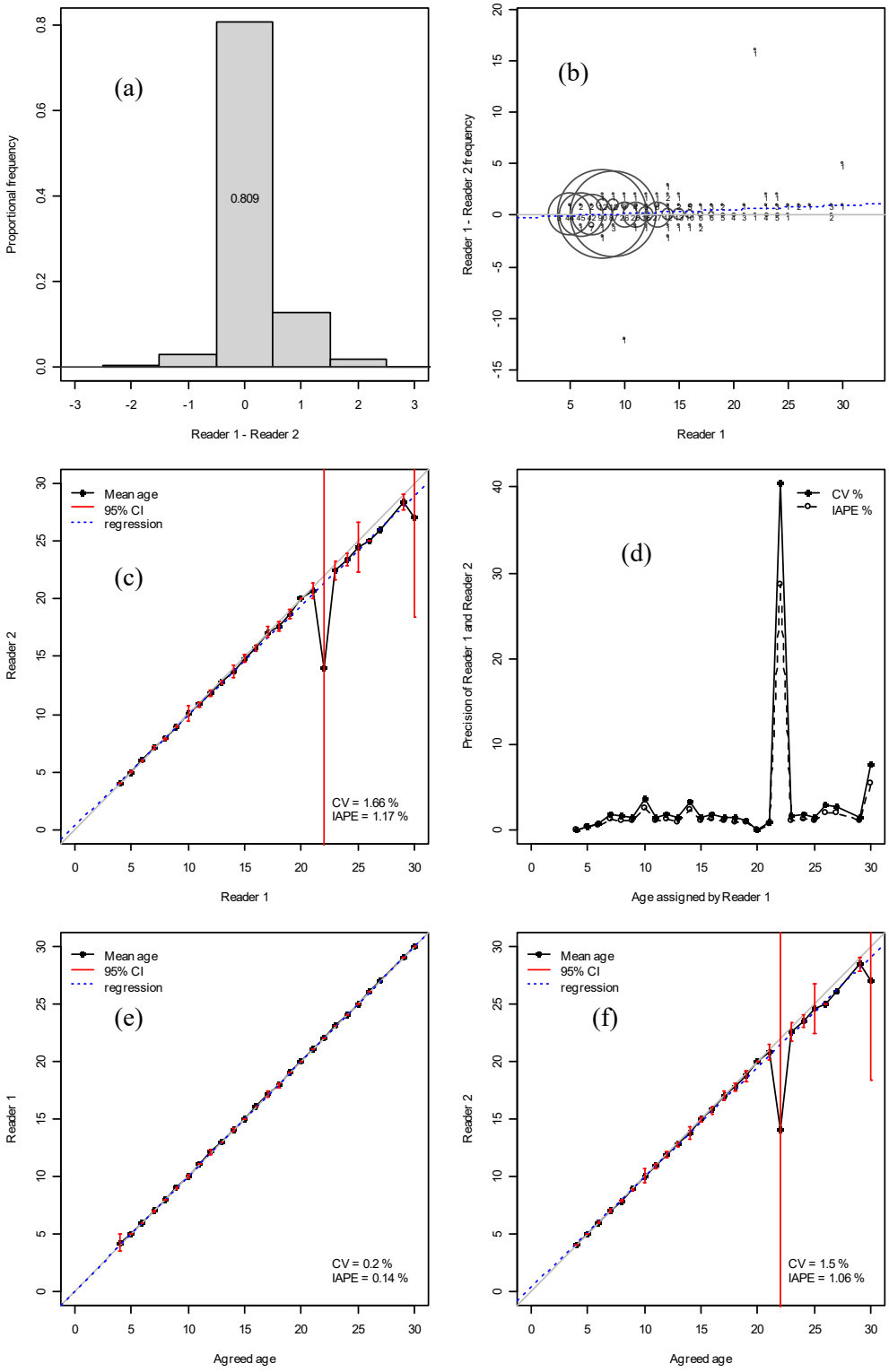
Walsh, C.; Horn, P.; McKenzie, J.; Ó Maolagáin, C.; Buckthought, D.; Stevenson, M.; Sutton, C. (2016). Age determination protocol for tarakihi (*Nemadactylus macropterus*). *New Zealand Fisheries Research Report 2016/13*. 37 p.

8. APPENDICES

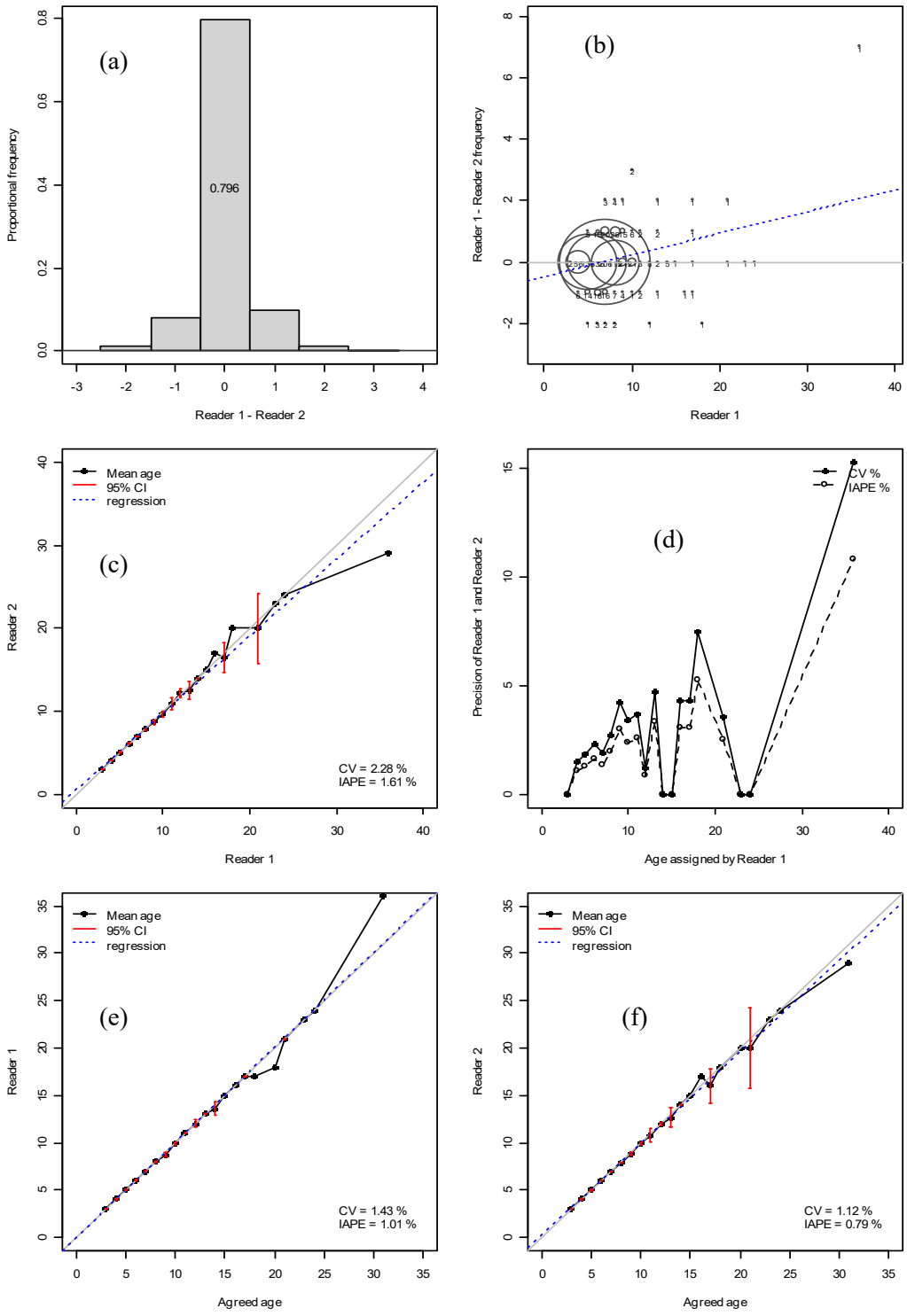
Appendix 1: Otolith reader precision results by sub-stock region



Appendix Figure 1: Results of between-reader comparison test (reader 1 and 2) for EN_HG otoliths collected in 2018–19 (n = 610): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

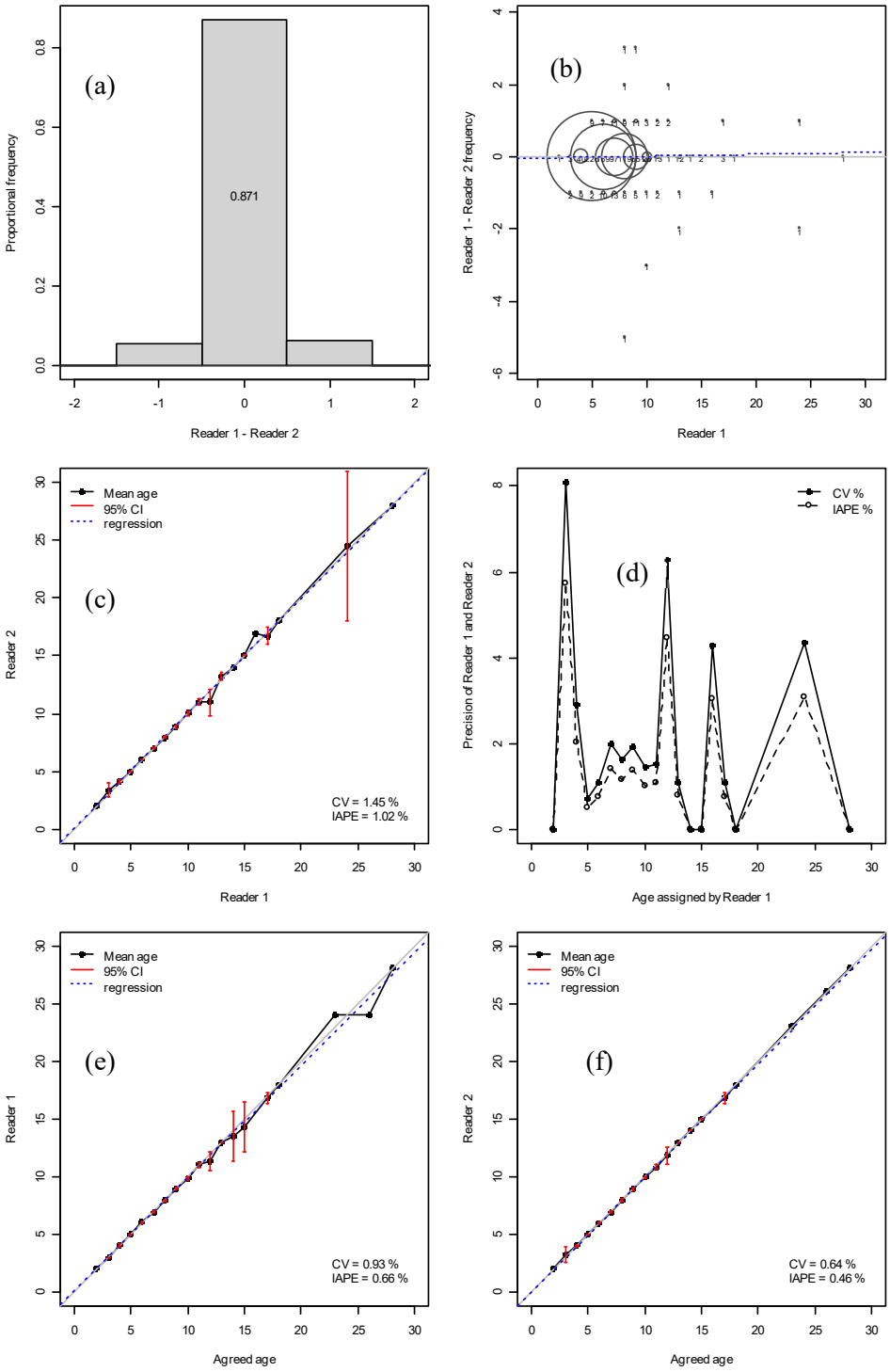


Appendix Figure 2: **Results of between-reader comparison test (reader 1 and 2) for EN_HG otoliths collected in 2019–20 (n = 600): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).**

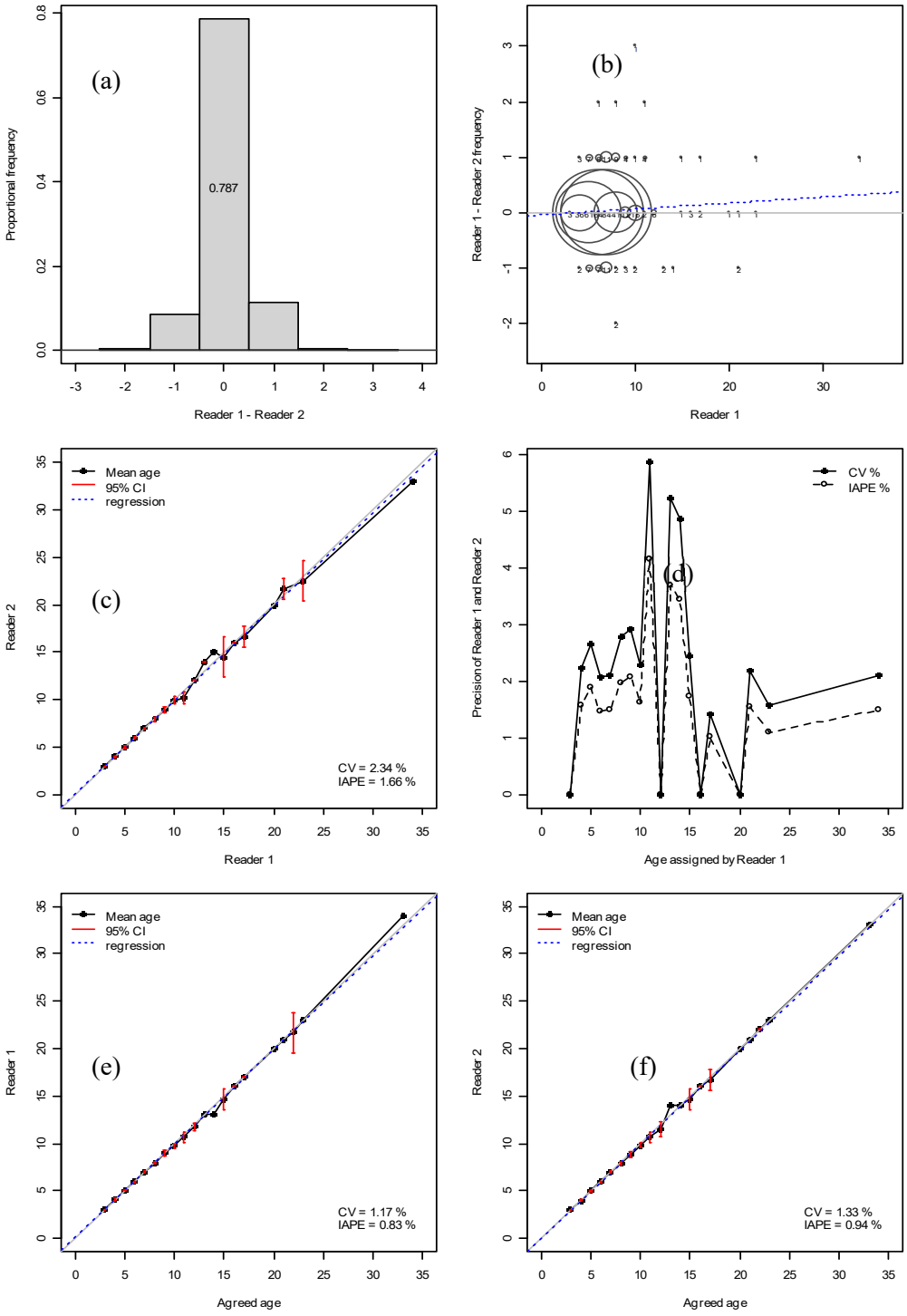


Appendix Figure 3: **Results of between-reader comparison test (reader 1 and 2) for BP_EC otoliths collected in 2018–19 (n = 901): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).**

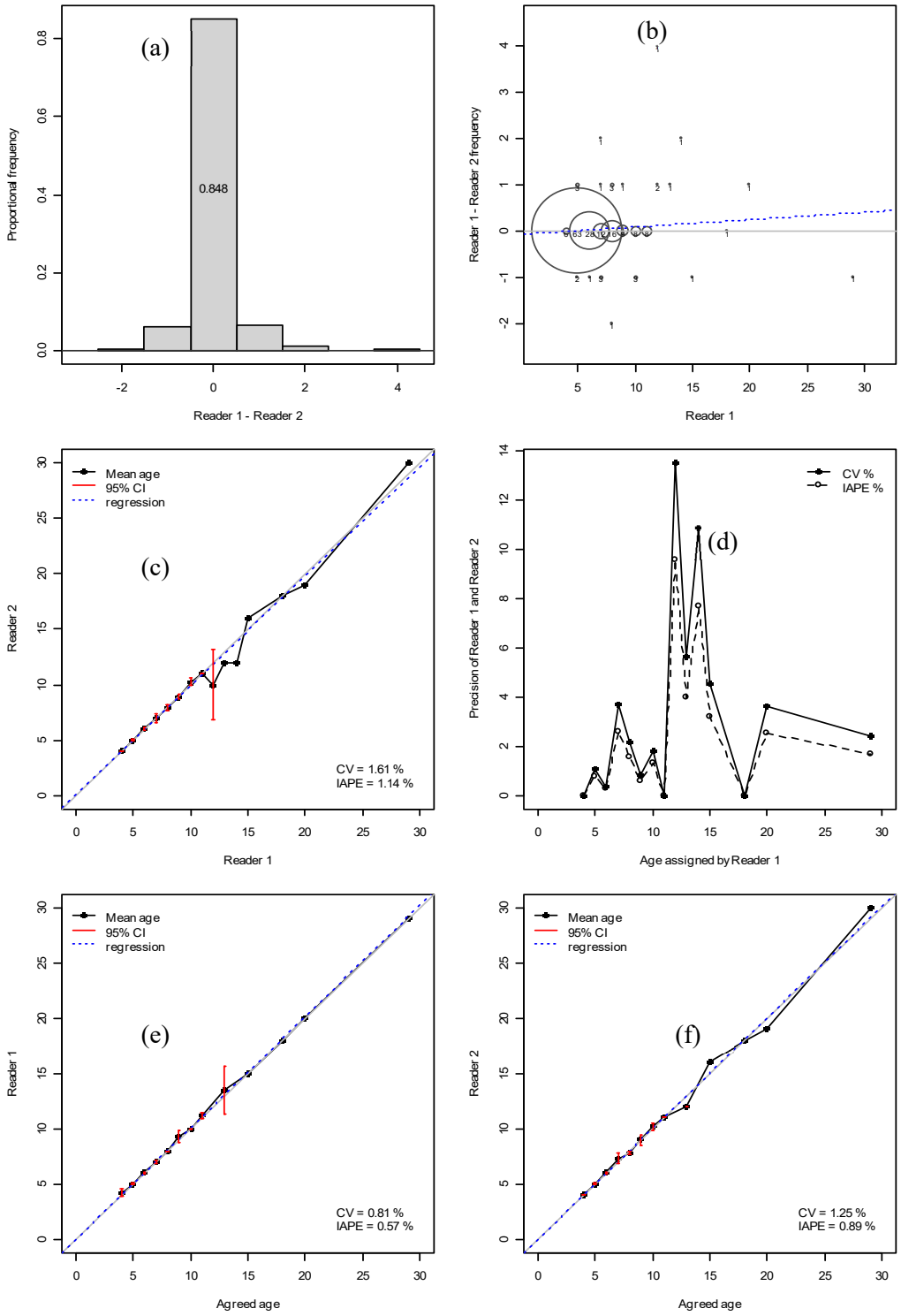
Appendix 1 cont: Otolith reader precision results by sub-stock region



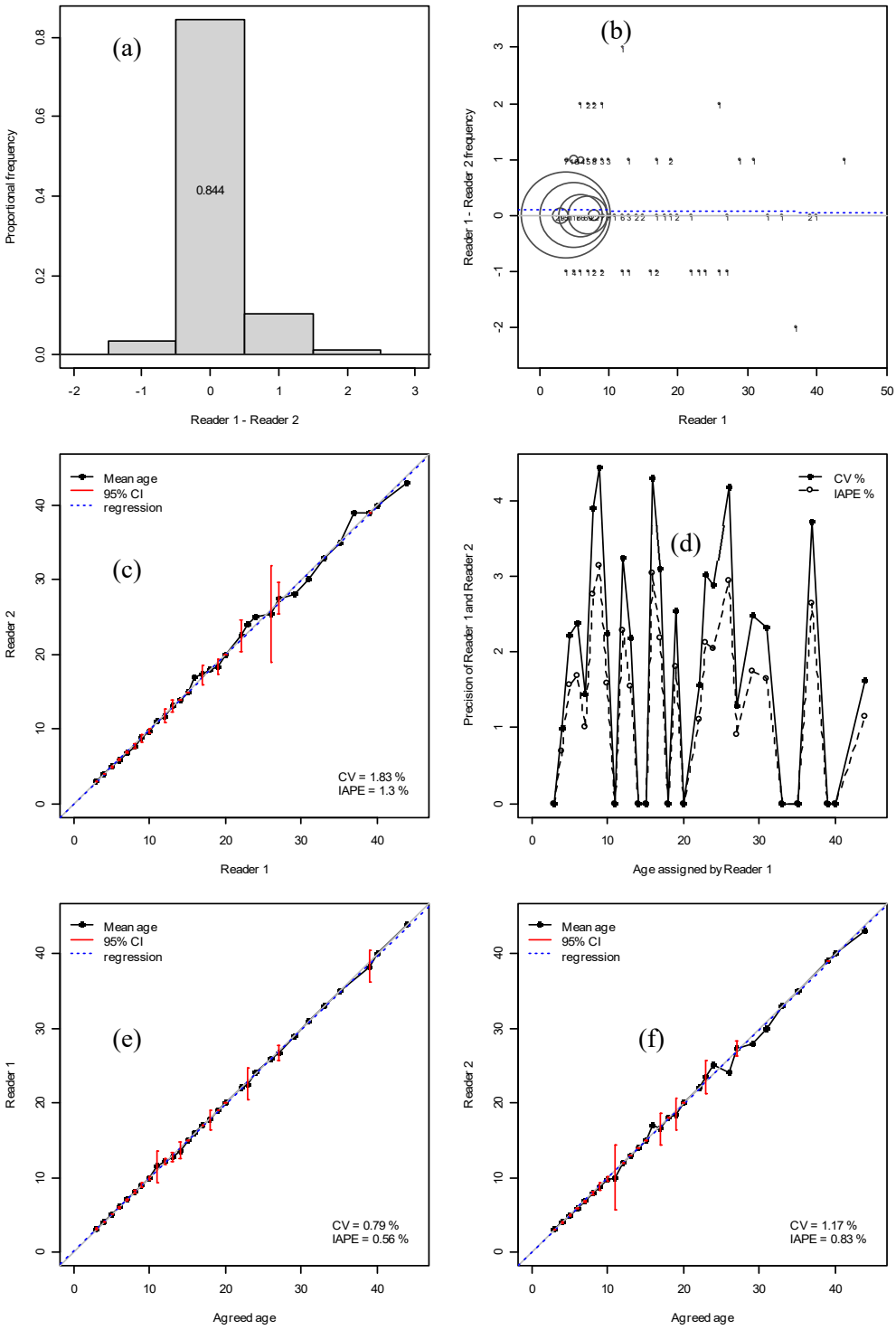
Appendix Figure 4: Results of between-reader comparison test (reader 1 and 2) for BP_EC otoliths collected in 2019–20 (n = 900): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).



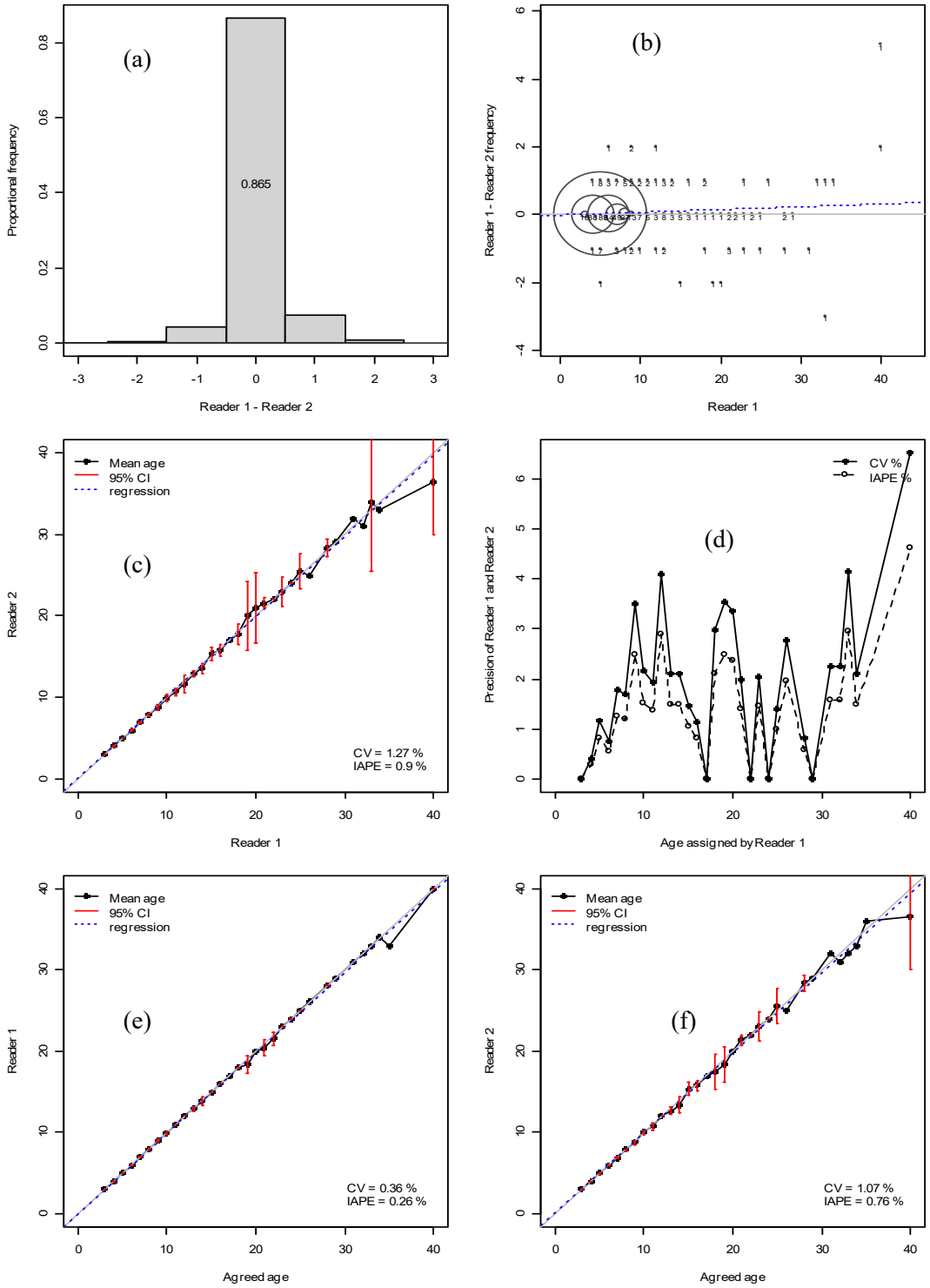
Appendix Figure 5: **Results of between-reader comparison test (reader 1 and 2) for CSTR otoliths collected in 2018–19 (n = 450): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).**



Appendix Figure 6: Results of between-reader comparison test (reader 1 and 2) for CSTR otoliths collected in 2019–20 (n = 180): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

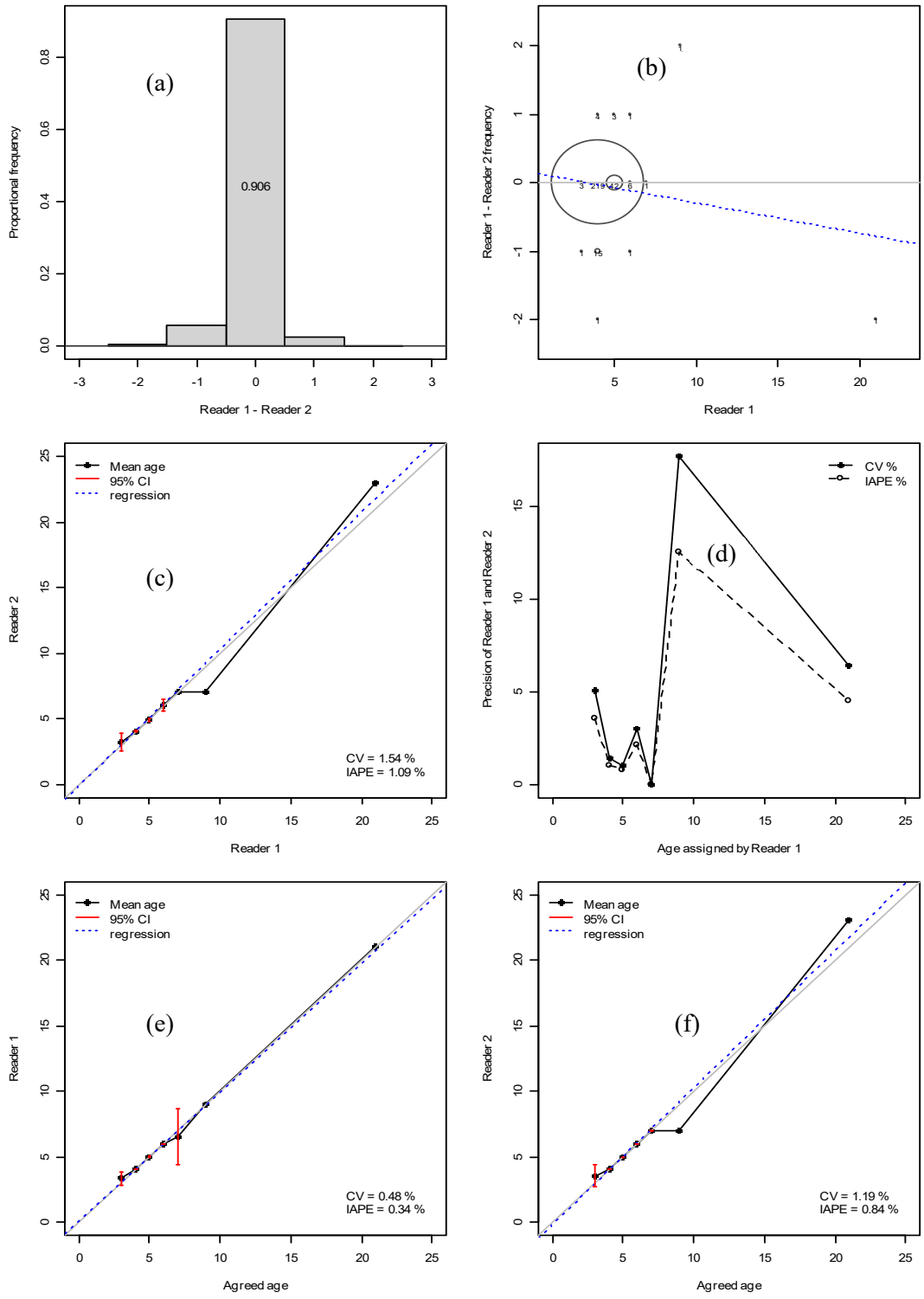


Appendix Figure 7: Results of between-reader comparison test (reader 1 and 2) for NBP otoliths collected in 2018–19 (n = 600): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).



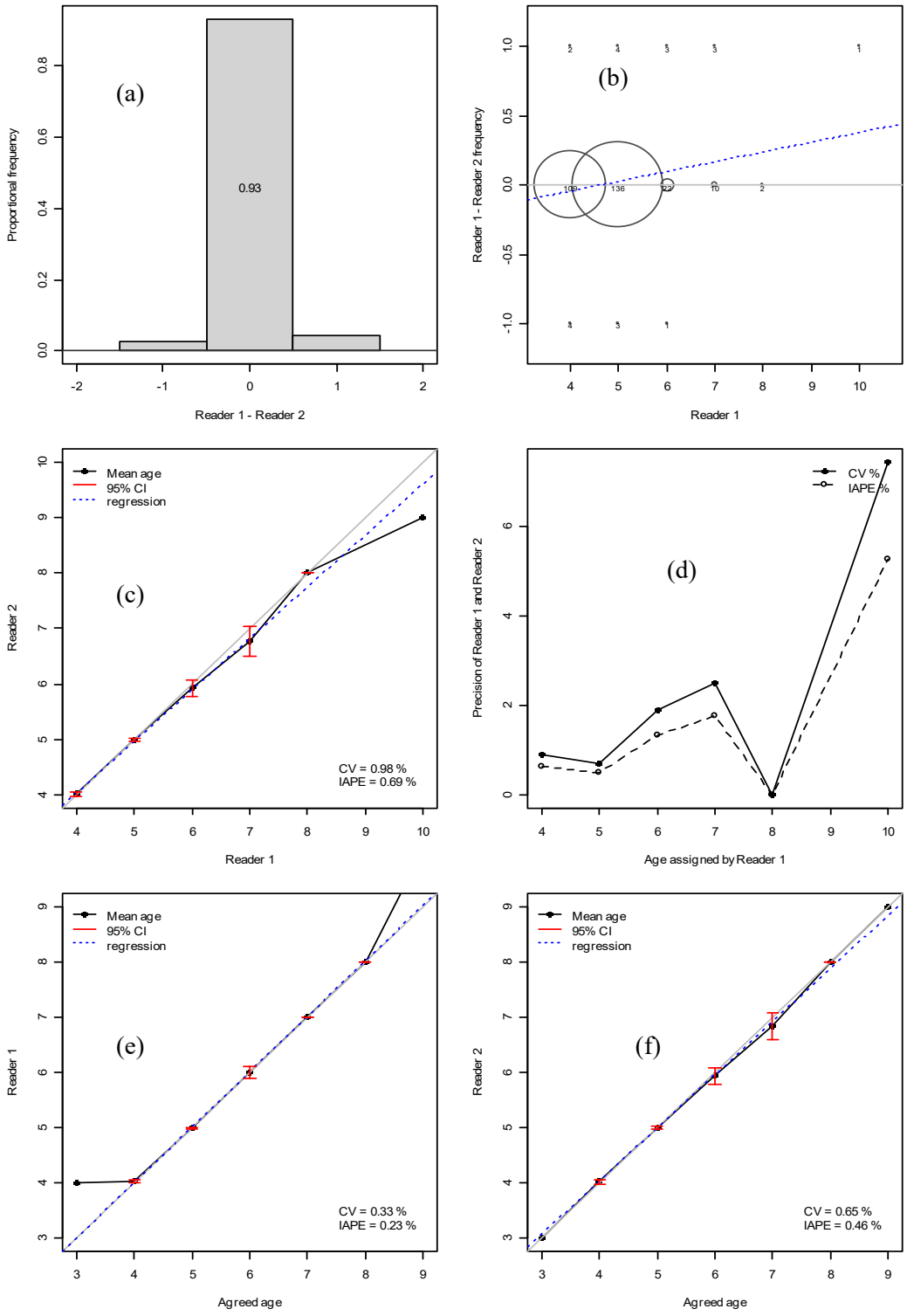
Appendix Figure 8: Results of between-reader comparison test (reader 1 and 2) for NBP otoliths collected in 2019–20 (n = 600): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region



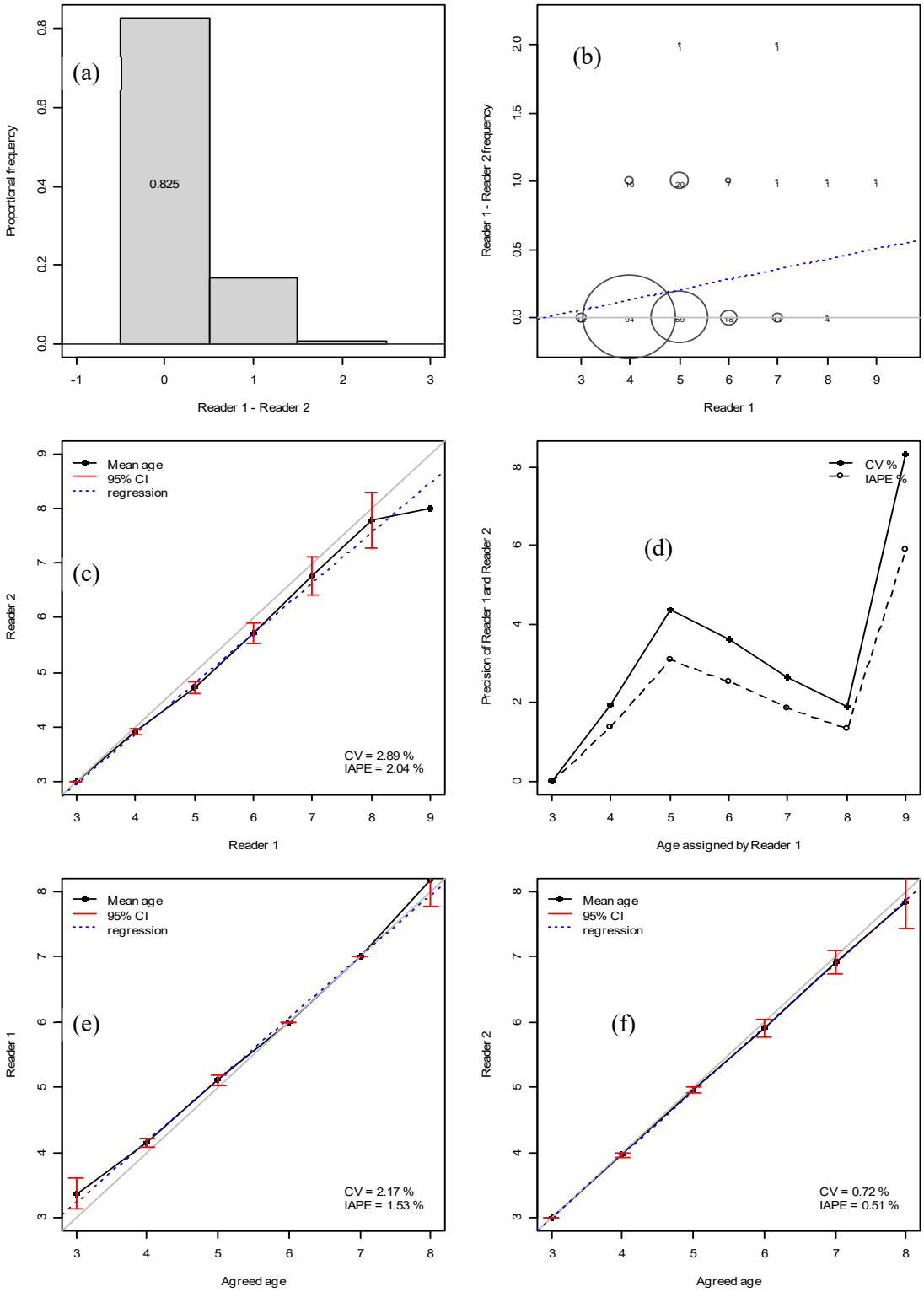
Appendix Figure 9: Results of between-reader comparison test (reader 1 and 2) for SBP otoliths collected in 2018–19 (n = 300): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region



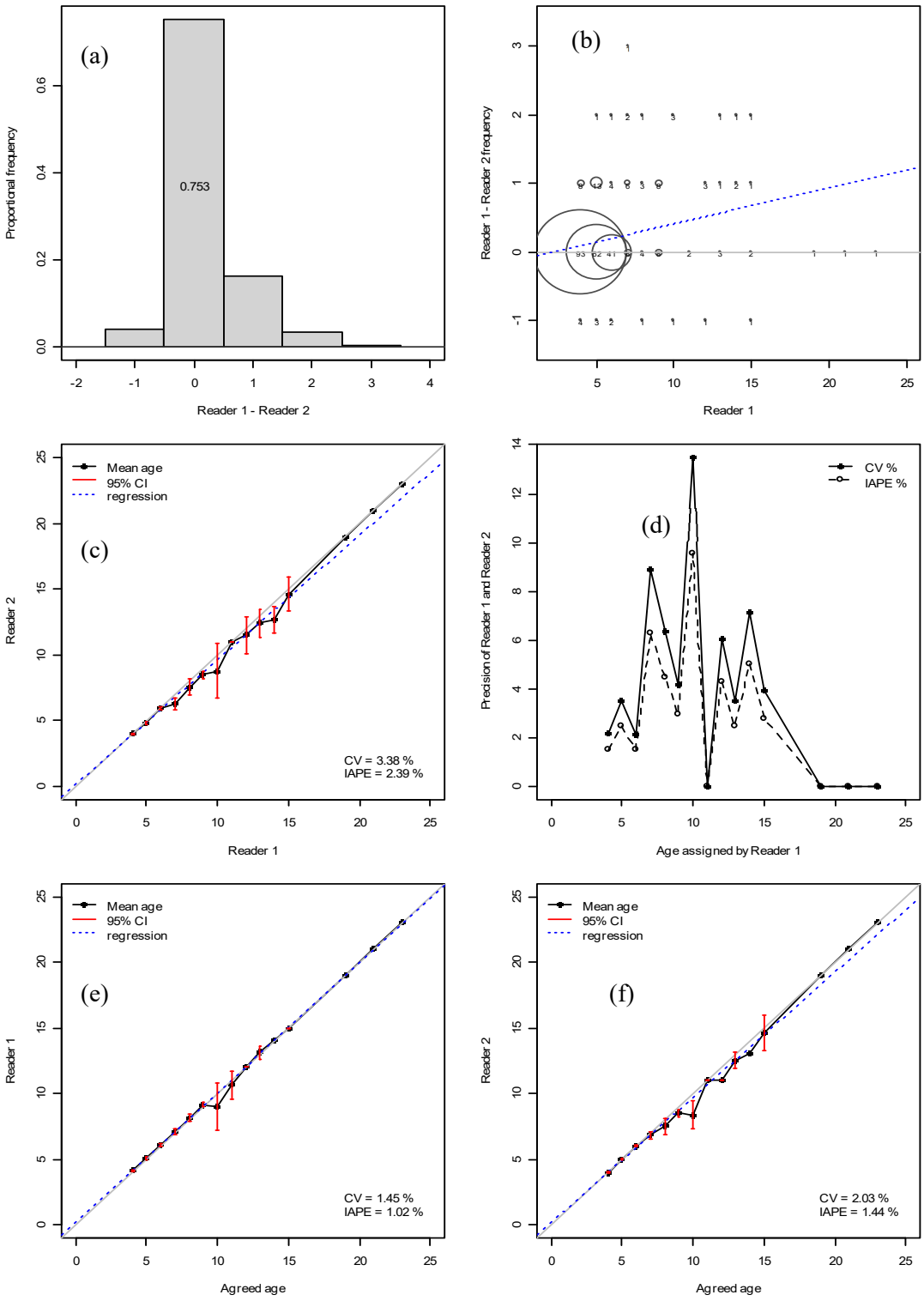
Appendix Figure 10: Results of between-reader comparison test (reader 1 and 2) for SBP otoliths collected in 2019–20 (n = 300): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region



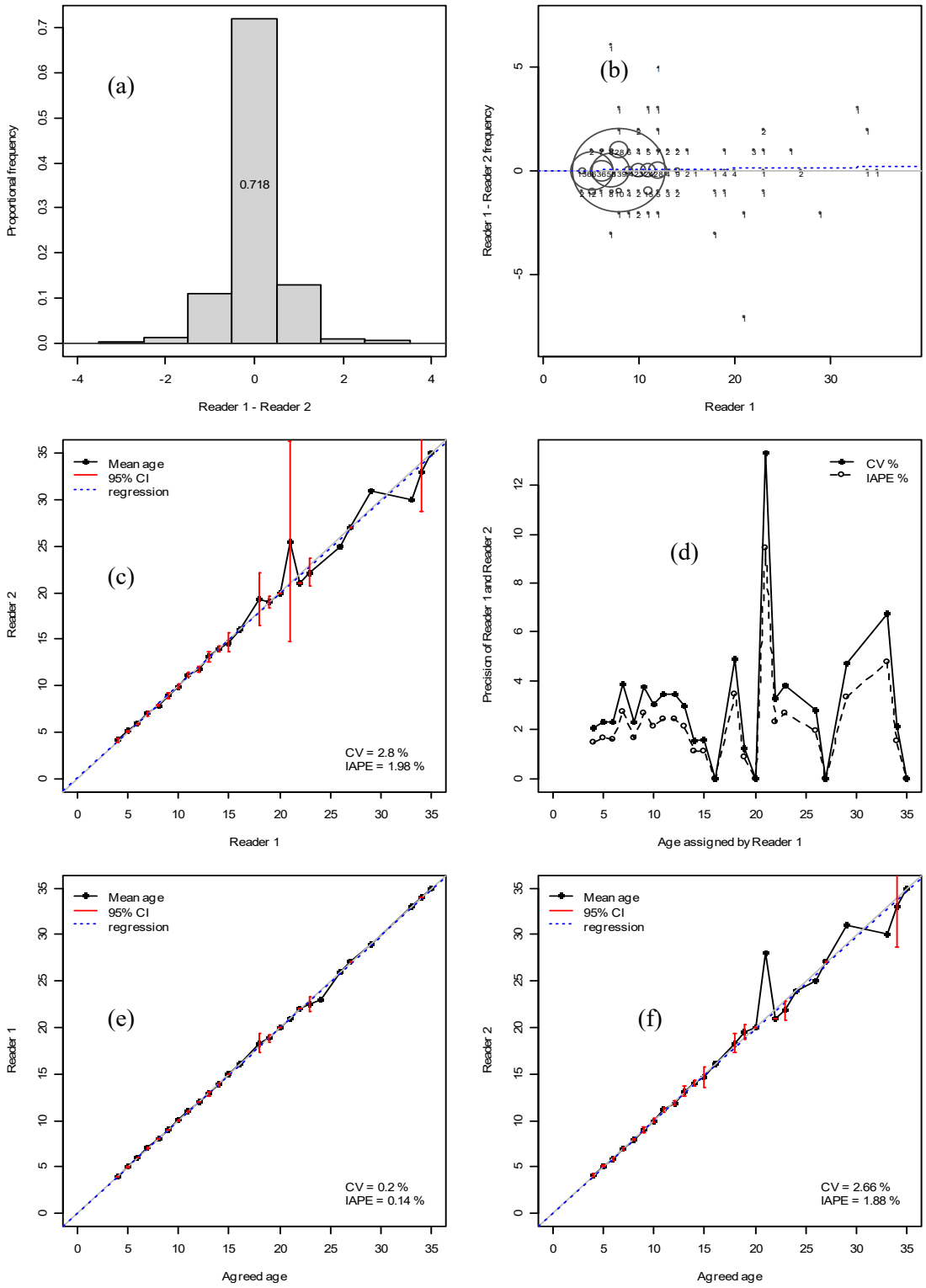
Appendix Figure 11: Results of between-reader comparison test (reader 1 and 2) for TAR 5 otoliths collected in 2018–19 (n = 240): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region



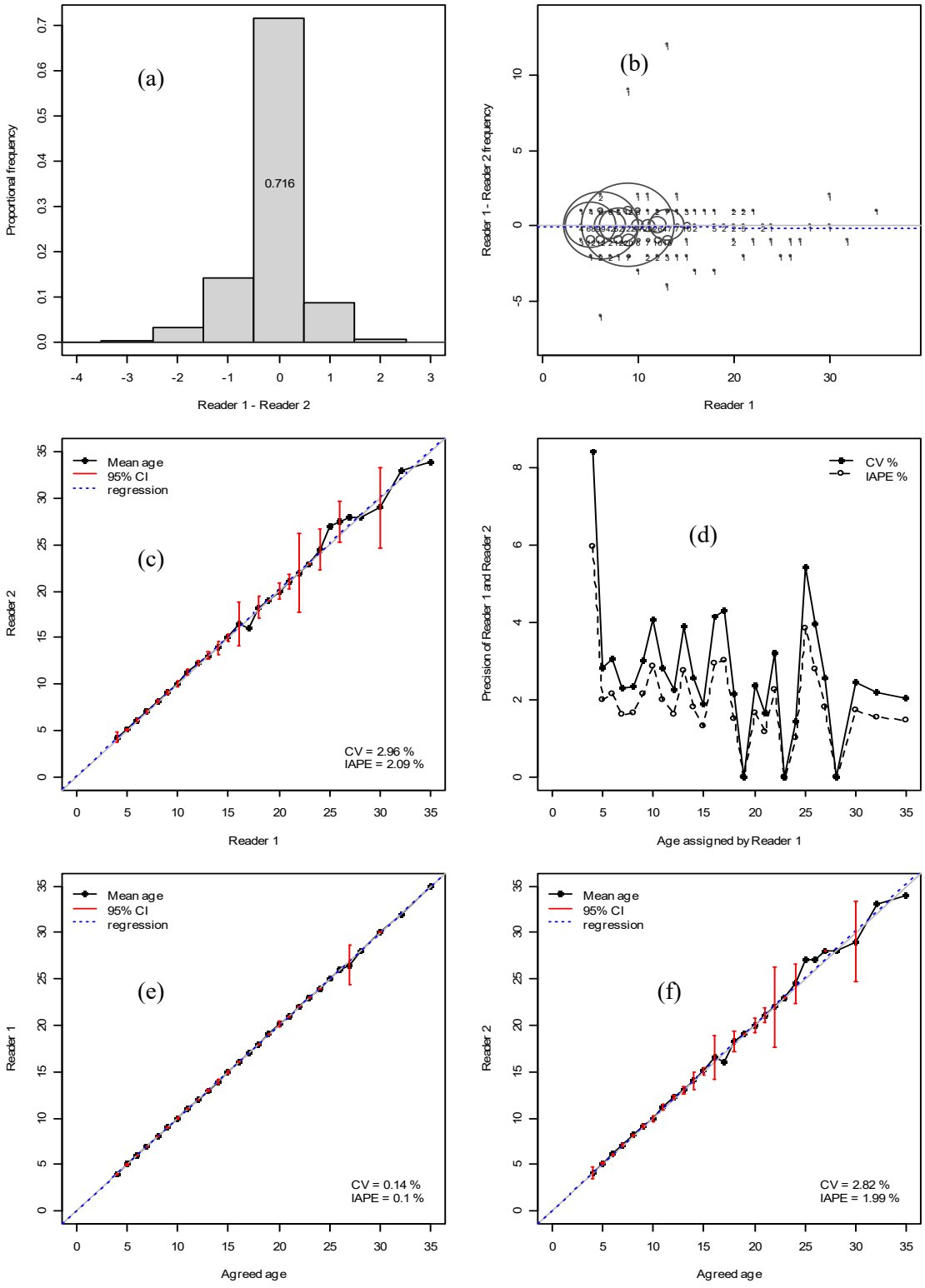
Appendix Figure 12: Results of between-reader comparison test (reader 1 and 2) for TAR 5 otoliths collected in 2019–20 (n = 300): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region

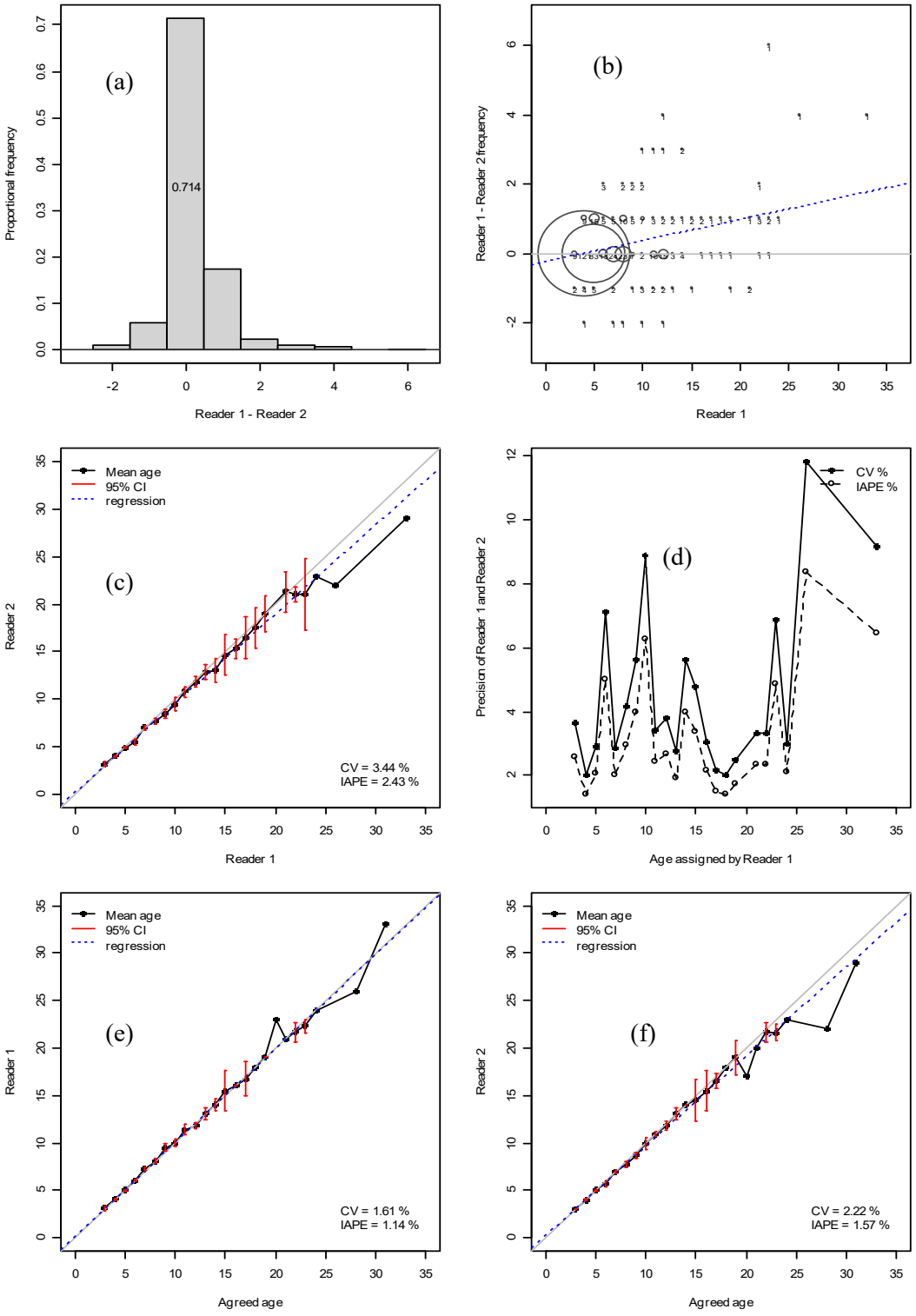


Appendix Figure 13: Results of between-reader comparison test (reader 1 and 2) for TAR 7 otoliths collected in 2018–19 (n = 600): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

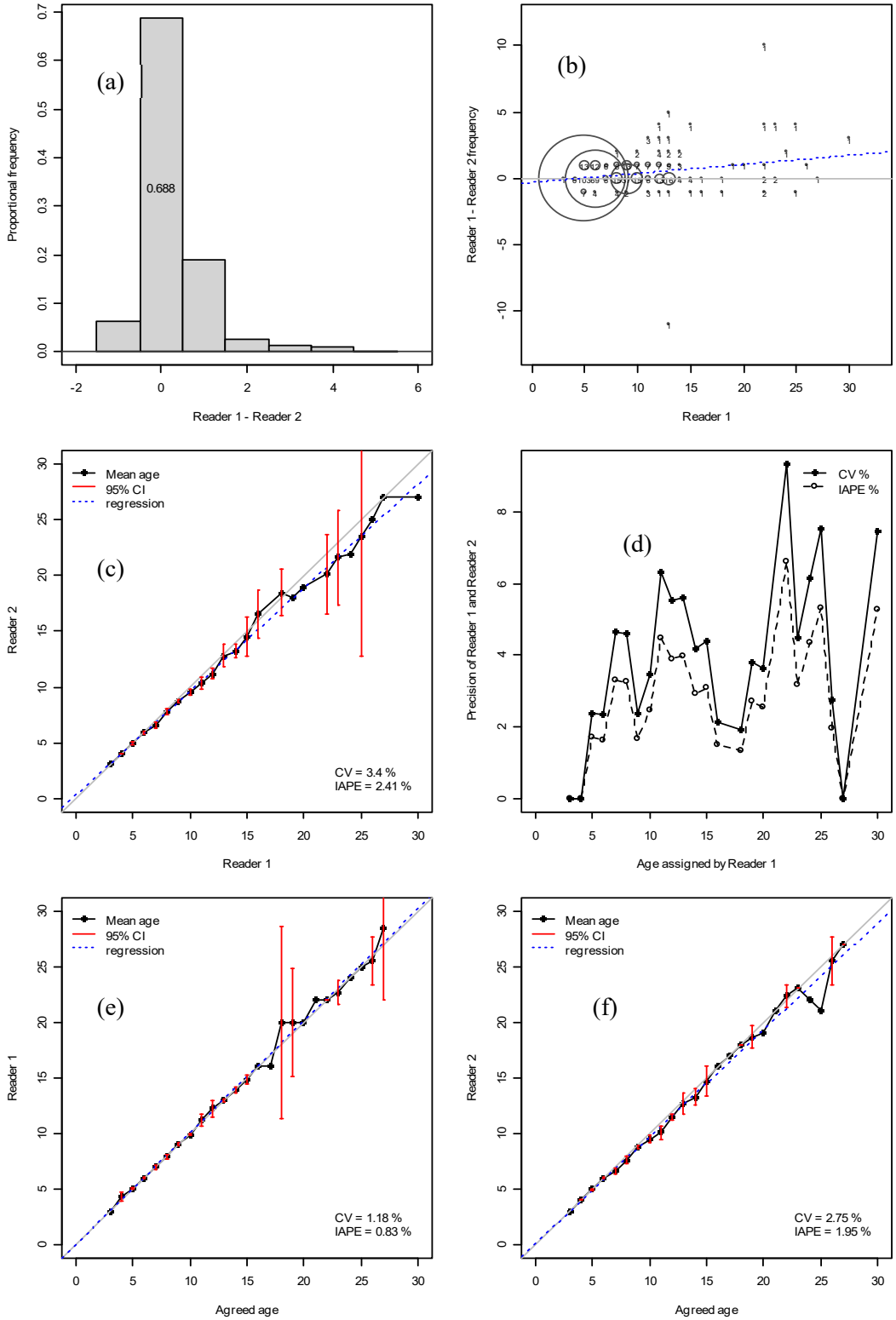
Appendix 1 cont: Otolith reader precision results by sub-stock region



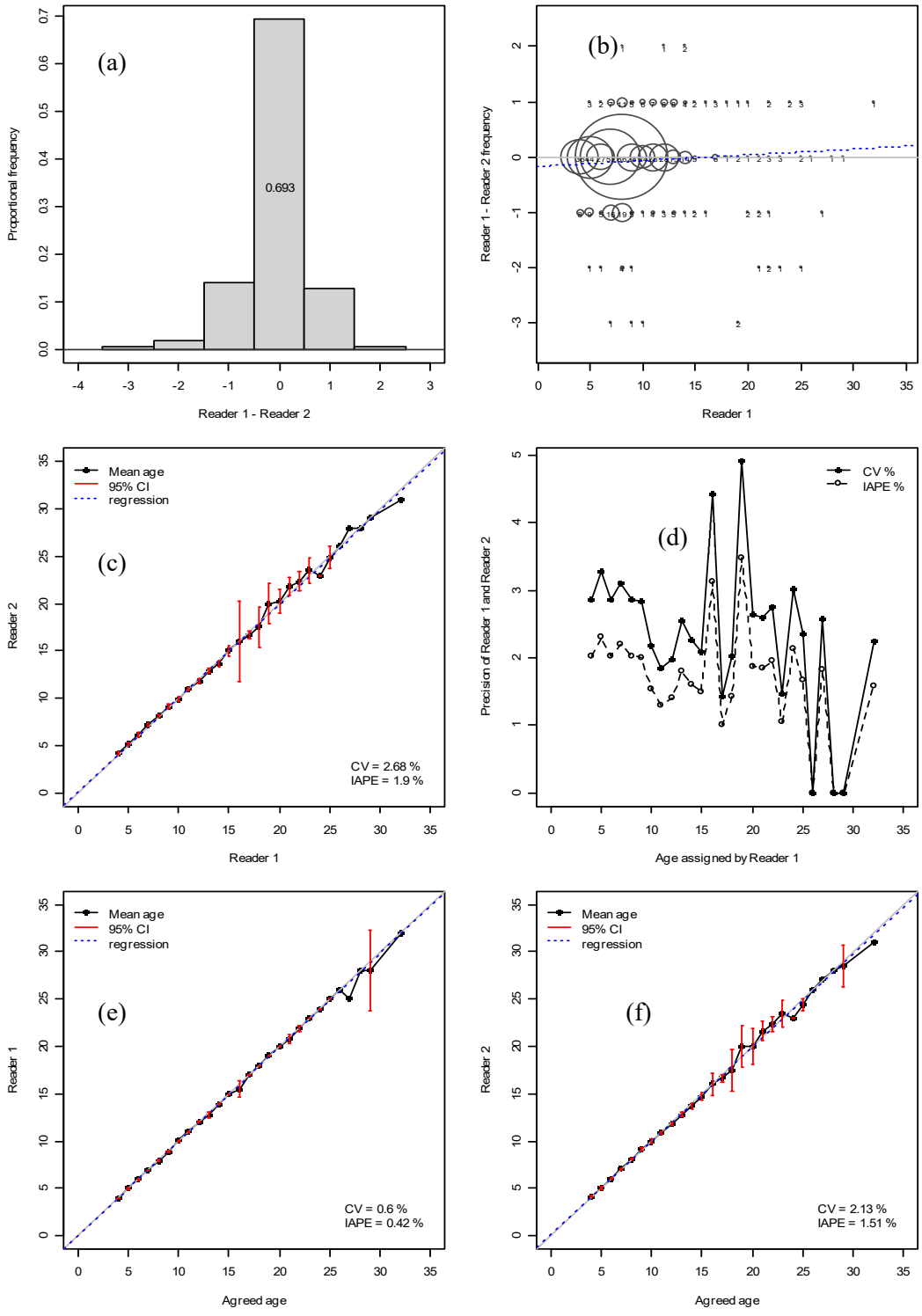
Appendix Figure 14: Results of between-reader comparison test (reader 1 and 2) for TAR 7 otoliths collected in 2019–20 (n = 750): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).



Appendix Figure 15: Results of between-reader comparison test (reader 1 and 2) for TAR 8 otoliths collected in 2018–19 (n = 450): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

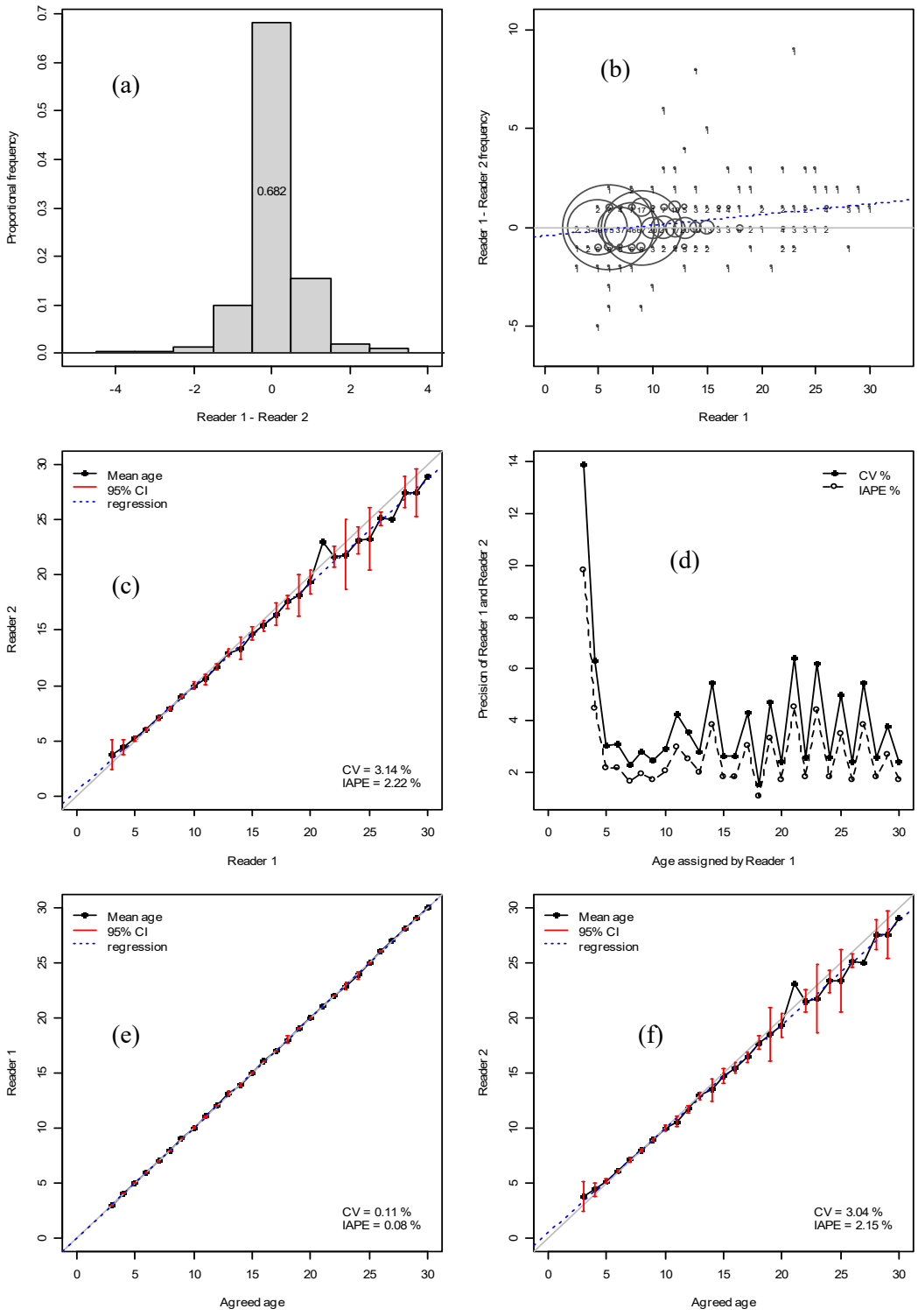


Appendix Figure 16: Results of between-reader comparison test (reader 1 and 2) for TAR 8 otoliths collected in 2019–20 (n = 450): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).



Appendix Figure 17: Results of between-reader comparison test (reader 1 and 2) for WCNI otoliths collected in 2018–19 (n = 602): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 1 cont: Otolith reader precision results by sub-stock region



Appendix Figure 18: Results of between-reader comparison test (reader 1 and 2) for WCNI otoliths collected in 2019–20 (n = 600): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 and agreed age; (f) bias plot between reader 2 and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).

Appendix 2: EN_HG bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
4	0.013	0.60	0.016	0.52	0.029	0.38	0.004	0.91	0.004	0.98	0.009	0.60
5	0.029	0.36	0.021	0.52	0.050	0.31	0.000	-	0.000	-	0.000	-
6	0.071	0.31	0.052	0.32	0.123	0.26	0.004	0.91	0.004	0.98	0.009	0.60
7	0.149	0.18	0.070	0.20	0.219	0.12	0.037	0.40	0.042	0.30	0.079	0.27
8	0.113	0.17	0.102	0.19	0.215	0.10	0.053	0.26	0.036	0.31	0.089	0.18
9	0.023	0.48	0.038	0.31	0.061	0.28	0.057	0.32	0.040	0.32	0.097	0.22
10	0.041	0.38	0.031	0.39	0.072	0.25	0.067	0.27	0.108	0.32	0.175	0.21
11	0.015	0.47	0.015	0.47	0.030	0.35	0.099	0.28	0.090	0.22	0.189	0.14
12	0.028	0.38	0.021	0.42	0.049	0.26	0.030	0.32	0.029	0.32	0.060	0.20
13	0.012	0.54	0.019	0.45	0.031	0.37	0.022	0.41	0.016	0.49	0.038	0.35
14	0.012	0.63	0.007	0.59	0.019	0.53	0.024	0.38	0.013	0.65	0.036	0.36
15	0.009	0.60	0.008	0.59	0.018	0.47	0.034	0.36	0.028	0.35	0.062	0.25
16	0.010	0.69	0.009	0.68	0.019	0.47	0.009	0.65	0.009	0.75	0.018	0.50
17	0.010	0.73	0.005	0.59	0.016	0.48	0.009	0.61	0.017	0.54	0.027	0.38
18	0.000	-	0.006	0.78	0.006	0.78	0.012	0.53	0.011	0.57	0.023	0.43
19	0.001	1.49	0.001	1.05	0.002	0.88	0.003	1.08	0.011	0.61	0.014	0.55
20	0.000	-	0.001	1.08	0.001	1.08	0.006	0.81	0.010	0.69	0.017	0.52
21	0.000	-	0.003	1.31	0.003	1.31	0.008	0.85	0.005	0.97	0.013	0.59
22	0.000	-	0.001	1.37	0.001	1.37	0.002	1.08	0.002	1.16	0.005	0.78
23	0.006	0.93	0.007	0.71	0.013	0.59	0.006	0.82	0.001	1.48	0.007	0.72
24	0.000	-	0.001	1.01	0.001	1.01	0.002	1.02	0.000	-	0.002	1.02
25	0.010	0.63	0.002	1.33	0.012	0.64	0.006	0.82	0.001	1.31	0.007	0.74
26	0.003	1.24	0.002	0.90	0.005	0.83	0.014	0.57	0.004	1.01	0.018	0.55
27	0.001	1.42	0.000	-	0.001	1.42	0.003	1.39	0.001	1.47	0.004	1.04
28	0.000	-	0.001	1.42	0.001	1.42	0.001	1.48	0.002	1.39	0.003	1.04
29	0.000	-	0.000	-	0.000	-	0.000	0.00	0.001	1.44	0.001	1.44
30	0.000	-	0.000	-	0.000	-	0.000	0.00	0.000	-	0.000	-
31	0.002	1.43	0.000	-	0.002	1.43	0.006	0.77	0.001	1.51	0.007	0.70
32	0.000	-	0.000	-	0.000	-	0.001	1.45	0.000	1.53	0.001	1.12
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	300		305		605		295		296		591	
mwcv	0.33		0.36		0.25		0.39		0.39		0.27	

Appendix 3: EN_HG bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.003	1.37	0.003	1.37	0.000	-	0.000	-	0.000	-
27	0.006	0.95	0.000	-	0.006	0.95	0.003	1.31	0.000	-	0.003	1.31
28	0.017	0.55	0.003	1.22	0.020	0.52	0.005	0.97	0.006	0.70	0.011	0.65
29	0.020	0.54	0.007	0.77	0.026	0.47	0.008	0.68	0.009	0.65	0.016	0.50
30	0.038	0.37	0.011	0.62	0.049	0.31	0.014	0.61	0.024	0.63	0.038	0.55
31	0.059	0.34	0.023	0.52	0.082	0.26	0.026	0.37	0.025	0.68	0.052	0.34
32	0.076	0.30	0.028	0.41	0.104	0.22	0.056	0.28	0.019	0.49	0.075	0.26
33	0.072	0.23	0.050	0.29	0.122	0.17	0.049	0.26	0.046	0.33	0.095	0.18
34	0.044	0.31	0.043	0.29	0.087	0.20	0.048	0.31	0.036	0.35	0.084	0.18
35	0.069	0.20	0.034	0.31	0.103	0.16	0.075	0.24	0.055	0.32	0.130	0.16
36	0.047	0.34	0.049	0.38	0.096	0.24	0.069	0.30	0.024	0.37	0.093	0.26
37	0.030	0.43	0.050	0.29	0.080	0.26	0.048	0.26	0.058	0.27	0.105	0.17
38	0.025	0.40	0.037	0.37	0.062	0.29	0.037	0.36	0.036	0.33	0.072	0.28
39	0.033	0.34	0.031	0.35	0.064	0.27	0.030	0.37	0.036	0.30	0.065	0.25
40	0.007	0.72	0.026	0.35	0.034	0.31	0.013	0.53	0.022	0.40	0.035	0.34
41	0.010	0.64	0.015	0.43	0.025	0.33	0.022	0.56	0.037	0.38	0.059	0.32
42	0.003	1.36	0.013	0.53	0.016	0.48	0.008	0.72	0.011	0.59	0.019	0.41
43	0.001	1.47	0.009	0.50	0.010	0.48	0.005	0.84	0.017	0.41	0.022	0.36
44	0.000	-	0.003	0.72	0.003	0.72	0.002	1.03	0.009	0.65	0.011	0.58
45	0.000	-	0.000	1.40	0.000	1.40	0.000	-	0.004	0.80	0.004	0.80
46	0.000	-	0.005	0.76	0.005	0.76	0.000	-	0.003	1.05	0.003	1.05
47	0.000	-	0.002	0.87	0.002	0.87	0.000	-	0.003	1.01	0.003	1.01
48	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.40	0.002	1.40
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.35	0.003	1.35
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	300		305		605		295		296		591	
mwcv	0.34		0.39		0.26		0.35		0.41		0.27	

Appendix 4: BP_EC bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.001	1.44	0.001	1.38	0.002	0.98	0.002	0.96	0.003	0.94	0.005	0.66
4	0.038	0.30	0.031	0.33	0.070	0.25	0.033	0.33	0.020	0.31	0.053	0.24
5	0.106	0.15	0.068	0.20	0.173	0.12	0.157	0.21	0.129	0.17	0.286	0.16
6	0.122	0.17	0.081	0.14	0.204	0.10	0.092	0.15	0.102	0.15	0.194	0.10
7	0.123	0.13	0.145	0.12	0.268	0.08	0.062	0.19	0.065	0.21	0.127	0.15
8	0.062	0.19	0.112	0.14	0.174	0.11	0.071	0.21	0.089	0.19	0.160	0.16
9	0.017	0.36	0.023	0.30	0.040	0.21	0.045	0.23	0.042	0.25	0.086	0.17
10	0.018	0.36	0.014	0.37	0.033	0.26	0.014	0.35	0.019	0.38	0.033	0.28
11	0.001	1.14	0.001	1.13	0.003	0.81	0.012	0.53	0.008	0.56	0.020	0.38
12	0.008	0.59	0.005	0.61	0.013	0.41	0.005	0.67	0.002	1.02	0.007	0.60
13	0.002	1.01	0.001	1.44	0.003	0.81	0.007	0.70	0.007	0.63	0.014	0.47
14	0.003	0.81	0.003	0.82	0.006	0.56	0.001	1.38	0.001	1.40	0.002	1.00
15	0.000	-	0.001	1.37	0.001	1.37	0.002	0.96	0.001	1.39	0.004	0.79
16	0.000	-	0.001	1.42	0.001	1.42	0.000	-	0.000	-	0.000	-
17	0.001	1.42	0.002	1.00	0.003	0.79	0.003	0.96	0.003	0.96	0.006	0.79
18	0.001	1.42	0.000	-	0.001	1.42	0.000	-	0.001	1.36	0.001	1.36
19	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
20	0.001	1.29	0.000	-	0.001	1.29	0.000	-	0.000	-	0.000	-
21	0.001	1.45	0.001	1.35	0.002	0.95	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.001	1.38	0.000	-	0.001	1.38	0.001	1.42	0.000	-	0.001	1.42
24	0.001	1.43	0.000	-	0.001	1.43	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.001	1.46	0.000	-	0.001	1.46
27	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
28	0.000	-	0.000	-	0.000	-	0.001	1.43	0.000	-	0.001	1.43
29	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.001	1.33	0.000	-	0.000	1.33	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	452		442		894		449		449		898	
mwcv	0.22		0.19		0.14		0.24		0.22		0.18	

Appendix 5: BP_EC bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.001	1.41	0.001	1.41	0.001	1.37	0.000	-	0.001	1.37
25	0.000	-	0.002	1.03	0.002	1.03	0.000	-	0.002	1.35	0.002	1.35
26	0.008	0.57	0.002	0.98	0.010	0.52	0.001	1.38	0.000	-	0.001	1.38
27	0.020	0.34	0.005	0.79	0.026	0.31	0.010	0.45	0.008	0.55	0.018	0.38
28	0.025	0.32	0.012	0.58	0.037	0.26	0.022	0.37	0.008	0.66	0.030	0.38
29	0.034	0.30	0.019	0.36	0.052	0.25	0.041	0.24	0.025	0.26	0.066	0.19
30	0.056	0.20	0.028	0.27	0.084	0.16	0.052	0.26	0.042	0.24	0.095	0.17
31	0.063	0.18	0.038	0.25	0.102	0.15	0.077	0.20	0.041	0.32	0.118	0.18
32	0.079	0.14	0.057	0.21	0.136	0.13	0.073	0.16	0.056	0.20	0.129	0.12
33	0.078	0.18	0.061	0.19	0.139	0.12	0.072	0.17	0.053	0.20	0.125	0.12
34	0.050	0.25	0.056	0.20	0.107	0.13	0.048	0.22	0.058	0.21	0.106	0.16
35	0.036	0.24	0.064	0.20	0.100	0.14	0.043	0.24	0.051	0.22	0.094	0.16
36	0.031	0.29	0.034	0.24	0.065	0.19	0.031	0.26	0.046	0.24	0.077	0.17
37	0.007	0.53	0.040	0.23	0.047	0.21	0.018	0.35	0.036	0.24	0.055	0.22
38	0.005	0.66	0.036	0.25	0.041	0.23	0.009	0.47	0.019	0.34	0.029	0.28
39	0.005	0.70	0.019	0.48	0.024	0.40	0.002	0.88	0.020	0.33	0.022	0.34
40	0.004	0.65	0.008	0.51	0.012	0.39	0.006	0.63	0.006	0.53	0.012	0.43
41	0.002	1.20	0.003	0.91	0.006	0.71	0.000	-	0.009	0.54	0.009	0.54
42	0.001	1.33	0.004	0.64	0.006	0.63	0.001	1.39	0.007	0.53	0.008	0.49
43	0.001	1.46	0.000	-	0.001	1.46	0.001	1.36	0.003	0.87	0.004	0.73
44	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
45	0.001	1.34	0.001	1.36	0.002	0.95	0.000	-	0.002	1.04	0.002	1.04
46	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
47	0.001	1.39	0.000	-	0.001	1.39	0.000	-	0.000	-	0.000	-
48	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	452		442		894		449		449		898	
mwcv	0.25		0.27		0.19		0.25		0.27		0.19	

Appendix 6: CSTR bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.002	1.34	0.003	1.25	0.005	0.91	0.000	-	0.000	-	0.000	-
4	0.028	0.51	0.071	0.42	0.099	0.41	0.017	0.60	0.029	0.51	0.046	0.38
5	0.078	0.25	0.061	0.25	0.139	0.20	0.172	0.48	0.255	0.17	0.427	0.24
6	0.099	0.18	0.126	0.18	0.224	0.12	0.056	0.42	0.126	0.33	0.183	0.20
7	0.108	0.28	0.139	0.17	0.247	0.15	0.020	0.78	0.048	0.40	0.068	0.37
8	0.062	0.25	0.068	0.29	0.130	0.18	0.046	0.40	0.045	0.68	0.091	0.41
9	0.021	0.54	0.021	0.41	0.042	0.36	0.005	1.42	0.050	0.42	0.056	0.42
10	0.021	0.42	0.027	0.48	0.048	0.29	0.005	1.40	0.053	0.36	0.057	0.37
11	0.004	0.91	0.008	0.82	0.012	0.67	0.000	-	0.050	0.69	0.050	0.69
12	0.012	0.73	0.008	0.73	0.019	0.48	0.000	-	0.000	-	0.000	-
13	0.000	-	0.002	1.36	0.002	1.36	0.005	1.36	0.005	1.36	0.009	1.36
14	0.000	-	0.002	1.39	0.002	1.39	0.000	-	0.000	-	0.000	-
15	0.002	1.45	0.004	0.97	0.006	0.79	0.000	-	0.005	1.40	0.005	1.40
16	0.000	-	0.005	1.15	0.005	1.15	0.000	-	0.000	-	0.000	-
17	0.003	1.36	0.004	0.95	0.006	0.77	0.000	-	0.000	-	0.000	-
18	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.48	0.003	1.48
19	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
20	0.000	-	0.002	1.34	0.002	1.34	0.000	-	0.003	1.52	0.003	1.52
21	0.002	1.40	0.000	-	0.002	1.40	0.000	-	0.000	-	0.000	-
22	0.002	1.38	0.003	1.18	0.005	0.90	0.000	-	0.000	-	0.000	-
23	0.000	-	0.002	1.39	0.002	1.39	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
27	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
28	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
29	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.50	0.003	1.50
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
33	0.002	1.36	0.000	-	0.002	1.36	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	191		259		450		60		118		178	
mwcv	0.32		0.35		0.25		0.71		0.60		0.51	

Appendix 7: CSTR bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
27	0.002	1.38	0.012	0.77	0.013	0.70	0.000	-	0.010	1.26	0.010	1.26
28	0.006	0.95	0.013	0.53	0.019	0.48	0.010	1.26	0.019	1.04	0.029	0.94
29	0.013	0.52	0.015	0.46	0.028	0.34	0.036	0.60	0.027	0.65	0.063	0.52
30	0.031	0.35	0.037	0.36	0.068	0.27	0.024	0.69	0.005	1.35	0.030	0.63
31	0.052	0.26	0.029	0.38	0.081	0.20	0.043	0.69	0.055	0.60	0.098	0.56
32	0.107	0.18	0.055	0.29	0.162	0.14	0.035	0.72	0.058	0.38	0.093	0.34
33	0.057	0.31	0.049	0.32	0.105	0.25	0.068	0.58	0.087	0.31	0.154	0.34
34	0.092	0.23	0.068	0.28	0.160	0.17	0.010	1.22	0.072	0.50	0.083	0.45
35	0.049	0.37	0.096	0.22	0.145	0.19	0.058	0.60	0.048	0.44	0.106	0.27
36	0.018	0.59	0.056	0.27	0.074	0.24	0.022	0.57	0.038	0.80	0.060	0.56
37	0.004	0.94	0.033	0.35	0.037	0.33	0.007	0.96	0.043	0.56	0.050	0.52
38	0.008	0.85	0.030	0.42	0.038	0.38	0.003	1.53	0.022	0.56	0.024	0.51
39	0.005	0.98	0.026	0.38	0.032	0.32	0.005	1.25	0.026	0.86	0.031	0.85
40	0.000	-	0.013	0.48	0.013	0.48	0.005	1.29	0.052	0.59	0.057	0.60
41	0.000	-	0.005	0.81	0.005	0.81	0.000	-	0.034	0.43	0.034	0.43
42	0.000	-	0.007	0.76	0.007	0.76	0.000	-	0.031	0.47	0.031	0.47
43	0.000	-	0.004	0.97	0.004	0.97	0.000	-	0.021	0.84	0.021	0.84
44	0.000	-	0.007	1.08	0.007	1.08	0.000	-	0.009	1.08	0.009	1.08
45	0.000	-	0.002	1.40	0.002	1.40	0.000	-	0.005	1.26	0.005	1.26
46	0.000	-	0.000	-	0.000	-	0.000	-	0.005	1.34	0.005	1.34
47	0.000	-	0.000	-	0.000	-	0.000	-	0.005	1.31	0.005	1.31
48	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.49	0.003	1.49
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	191		259		450		60		118		178	
mwcv	0.32		0.35		0.25		0.71		0.60		0.51	

Appendix 8: NBP bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.034	0.49	0.032	0.52	0.066	0.46	0.012	0.67	0.006	0.75	0.018	0.63
4	0.174	0.19	0.140	0.24	0.315	0.18	0.057	0.36	0.080	0.35	0.137	0.31
5	0.112	0.17	0.122	0.23	0.234	0.14	0.193	0.21	0.170	0.20	0.363	0.16
6	0.077	0.29	0.087	0.25	0.164	0.19	0.057	0.27	0.106	0.28	0.162	0.22
7	0.047	0.46	0.064	0.29	0.111	0.30	0.059	0.46	0.044	0.27	0.103	0.31
8	0.013	0.58	0.027	0.45	0.040	0.41	0.029	0.50	0.032	0.36	0.061	0.35
9	0.006	0.70	0.006	0.73	0.012	0.54	0.021	0.64	0.013	0.53	0.034	0.38
10	0.009	0.74	0.004	0.85	0.013	0.56	0.004	0.98	0.010	0.66	0.014	0.51
11	0.000	-	0.001	1.07	0.001	1.07	0.002	1.34	0.008	0.87	0.010	0.74
12	0.003	0.99	0.007	0.93	0.010	0.68	0.000	-	0.002	1.01	0.002	1.01
13	0.002	1.42	0.002	0.86	0.004	0.75	0.001	1.40	0.021	0.57	0.022	0.55
14	0.000	-	0.004	0.85	0.004	0.85	0.000	-	0.007	0.68	0.007	0.68
15	0.000	-	0.001	1.07	0.001	1.07	0.003	1.21	0.003	0.95	0.006	0.76
16	0.001	1.47	0.000	-	0.001	1.47	0.001	1.53	0.006	0.79	0.007	0.70
17	0.001	1.51	0.001	1.45	0.002	1.12	0.000	-	0.001	1.45	0.001	1.45
18	0.001	1.41	0.002	1.18	0.003	0.90	0.000	-	0.003	1.01	0.003	1.01
19	0.002	1.37	0.001	1.47	0.002	1.05	0.001	1.58	0.002	1.13	0.003	1.11
20	0.000	-	0.001	1.28	0.001	1.28	0.000	-	0.001	1.46	0.001	1.46
21	0.000	-	0.000	-	0.000	-	0.000	-	0.007	0.74	0.007	0.74
22	0.000	-	0.001	1.43	0.001	1.43	0.001	1.48	0.003	0.87	0.004	0.76
23	0.000	-	0.003	1.11	0.003	1.11	0.000	-	0.004	1.00	0.004	1.00
24	0.000	-	0.002	1.31	0.002	1.31	0.000	-	0.004	0.97	0.004	0.97
25	0.000	-	0.000	-	0.000	-	0.001	1.38	0.003	1.34	0.003	1.12
26	0.000	-	0.001	1.40	0.001	1.40	0.000	-	0.002	1.43	0.002	1.43
27	0.000	-	0.003	0.88	0.003	0.88	0.000	-	0.000	-	0.000	-
28	0.000	-	0.000	-	0.000	-	0.000	-	0.004	0.86	0.004	0.86
29	0.000	-	0.002	1.40	0.002	1.40	0.000	-	0.001	1.46	0.001	1.46
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.000	-	0.001	1.50	0.001	1.50	0.000	-	0.001	1.47	0.001	1.47
32	0.000	-	0.000	-	0.000	-	0.002	1.42	0.000	-	0.002	1.42
33	0.000	-	0.002	1.43	0.002	1.43	0.000	-	0.002	1.40	0.002	1.40
34	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.38	0.003	1.38
35+	0.001	-	0.004	1.43	0.004	1.43	0.000	-	0.009	1.36	0.009	1.36
n	266		330		596		244		354		596	
mwcv	0.29		0.34		0.26		0.36		0.38		0.31	

Appendix 9: NBP bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.56	0.001	1.56
25	0.013	0.52	0.000	-	0.013	0.52	0.005	0.83	0.001	1.50	0.006	0.74
26	0.018	0.47	0.025	0.42	0.043	0.33	0.010	0.60	0.003	1.02	0.013	0.55
27	0.036	0.42	0.014	0.49	0.050	0.35	0.016	0.54	0.012	0.57	0.028	0.39
28	0.045	0.32	0.028	0.36	0.074	0.23	0.018	0.41	0.032	0.43	0.051	0.35
29	0.056	0.32	0.048	0.31	0.104	0.27	0.044	0.37	0.032	0.41	0.076	0.35
30	0.069	0.28	0.055	0.30	0.124	0.18	0.074	0.31	0.063	0.29	0.137	0.25
31	0.059	0.23	0.039	0.31	0.098	0.17	0.090	0.23	0.056	0.28	0.146	0.15
32	0.058	0.29	0.055	0.25	0.113	0.19	0.071	0.32	0.050	0.30	0.121	0.20
33	0.054	0.29	0.061	0.22	0.116	0.18	0.052	0.44	0.045	0.29	0.097	0.29
34	0.037	0.32	0.037	0.43	0.074	0.22	0.026	0.37	0.062	0.29	0.088	0.23
35	0.010	0.66	0.038	0.34	0.049	0.29	0.021	0.40	0.041	0.34	0.062	0.30
36	0.006	0.83	0.023	0.40	0.029	0.32	0.008	0.65	0.023	0.38	0.031	0.33
37	0.003	1.21	0.021	0.45	0.024	0.45	0.006	0.71	0.014	0.57	0.020	0.53
38	0.006	0.80	0.015	0.59	0.021	0.54	0.001	1.50	0.012	0.60	0.013	0.59
39	0.004	0.97	0.017	0.50	0.020	0.43	0.003	1.00	0.005	0.75	0.008	0.61
40	0.004	0.89	0.007	0.74	0.011	0.65	0.001	1.47	0.009	0.67	0.010	0.63
41	0.000	-	0.010	0.58	0.010	0.58	0.000	-	0.010	0.54	0.010	0.54
42	0.002	0.87	0.005	0.71	0.008	0.60	0.000	-	0.010	0.75	0.010	0.75
43	0.000	-	0.001	1.26	0.001	1.26	0.000	-	0.016	0.56	0.016	0.56
44	0.000	-	0.000	-	0.000	-	0.000	-	0.011	0.60	0.011	0.60
45	0.000	-	0.008	0.66	0.008	0.66	0.000	-	0.012	0.55	0.012	0.55
46	0.000	-	0.002	1.00	0.002	1.00	0.000	-	0.015	0.64	0.015	0.64
47	0.000	-	0.000	-	0.000	-	0.000	-	0.010	0.71	0.010	0.71
48	0.000	-	0.003	0.97	0.003	0.97	0.000	-	0.004	1.00	0.004	1.00
49	0.000	-	0.000	-	0.000	-	0.000	-	0.003	1.35	0.003	1.35
50	0.000	-	0.004	0.91	0.004	0.91	0.001	1.40	0.002	1.37	0.002	1.06
51	0.000	-	0.002	1.34	0.002	1.34	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	266		330		596		244		354		596	
mwcv	0.36		0.38		0.27		0.37		0.41		0.31	

Appendix 10: SBP bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.009	0.80	0.008	0.85	0.017	0.61	0.000	-	0.004	1.39	0.004	1.39
4	0.414	0.10	0.390	0.14	0.804	0.07	0.212	0.32	0.215	0.29	0.427	0.28
5	0.092	0.36	0.056	0.37	0.149	0.31	0.208	0.22	0.251	0.24	0.460	0.20
6	0.007	0.93	0.014	0.69	0.021	0.64	0.031	0.73	0.043	0.66	0.074	0.66
7	0.006	0.95	0.000	-	0.006	0.95	0.011	1.11	0.016	1.09	0.027	1.06
8	0.000	-	0.000	-	0.000	-	0.002	1.44	0.002	1.48	0.004	1.26
9	0.000	-	0.002	1.37	0.002	1.37	0.003	1.42	0.000	-	0.003	1.42
10	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
11	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
12	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
13	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
14	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
15	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
16	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
17	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
18	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
19	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.002	1.43	0.000	-	0.002	1.43	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
27	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
28	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
29	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	159		140		299		139		161		300	
mwcv	0.18		0.2		0.14		0.34		0.33		0.31	

Appendix 11: SBP bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.009	1.11	0.003	1.43	0.012	0.81	0.000	-	0.005	1.31	0.005	1.31
25	0.016	0.65	0.054	0.74	0.070	0.65	0.011	1.13	0.019	0.62	0.030	0.53
26	0.116	0.32	0.058	0.45	0.174	0.31	0.032	0.55	0.032	0.66	0.063	0.52
27	0.106	0.25	0.098	0.32	0.204	0.22	0.081	0.36	0.059	0.49	0.140	0.32
28	0.111	0.22	0.090	0.33	0.201	0.20	0.083	0.30	0.106	0.32	0.189	0.26
29	0.072	0.38	0.055	0.45	0.126	0.36	0.073	0.32	0.071	0.25	0.144	0.21
30	0.056	0.39	0.050	0.47	0.106	0.38	0.064	0.28	0.065	0.27	0.129	0.21
31	0.019	0.58	0.036	0.46	0.054	0.42	0.056	0.39	0.080	0.37	0.136	0.31
32	0.011	0.79	0.006	1.05	0.017	0.62	0.028	0.55	0.039	0.67	0.067	0.57
33	0.004	1.10	0.011	0.72	0.015	0.65	0.033	0.50	0.025	0.70	0.058	0.54
34	0.005	1.02	0.006	1.04	0.011	0.73	0.005	0.97	0.021	0.57	0.026	0.55
35	0.004	1.38	0.002	1.46	0.006	1.01	0.002	1.41	0.004	1.27	0.007	1.18
36	0.000	-	0.000	-	0.000	-	0.000	-	0.006	0.94	0.006	0.94
37	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
38	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
39	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
40	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
41	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
42	0.002	1.46	0.002	1.46	0.004	1.25	0.000	-	0.000	-	0.000	-
43	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
44	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
45	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
46	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
47	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
48	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	159		140		299		139		161		300	
mwcv	0.36		0.47		0.34		0.40		0.45		0.35	

Appendix 12: TAR 5 bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.039	0.99	0.026	0.72	0.064	0.81	0.000	-	0.000	-	0.000	-
4	0.235	0.25	0.200	0.32	0.434	0.26	0.231	0.23	0.289	0.23	0.520	0.20
5	0.187	0.49	0.144	0.27	0.332	0.34	0.161	0.29	0.133	0.22	0.295	0.16
6	0.037	0.71	0.061	0.54	0.098	0.53	0.074	0.47	0.050	0.47	0.124	0.44
7	0.013	0.74	0.033	0.57	0.046	0.51	0.006	0.94	0.008	0.90	0.014	0.83
8	0.012	0.86	0.013	0.84	0.025	0.51	0.001	1.60	0.007	1.10	0.008	1.11
9	0.000	-	0.000	-	0.000	-	0.005	1.10	0.010	1.13	0.016	1.06
10	0.000	-	0.000	-	0.000	-	0.001	1.56	0.002	1.58	0.002	1.44
11	0.000	-	0.000	-	0.000	-	0.001	1.55	0.002	1.50	0.002	1.40
12	0.000	-	0.000	-	0.000	-	0.001	1.75	0.003	1.23	0.004	1.12
13	0.000	-	0.000	-	0.000	-	0.003	1.43	0.005	1.05	0.008	1.12
14	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.61	0.001	1.61
15	0.000	-	0.000	-	0.000	-	0.002	1.49	0.003	1.42	0.005	1.09
16	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
17	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
18	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
19	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.71	0.001	1.71
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.001	1.67	0.000	-	0.001	1.67
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.79	0.001	1.79
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
27	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
28	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
29	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	120		120		240		133		167		300	
mwcv	0.44		0.39		0.36		0.34		0.34		0.29	

Appendix 13: TAR 5 bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.004	1.39	0.000	-	0.004	1.39	0.000	-	0.000	-	0.000	-
24	0.004	1.36	0.000	-	0.004	1.36	0.000	-	0.000	-	0.000	-
25	0.017	1.05	0.013	1.11	0.030	1.00	0.000	-	0.000	-	0.000	-
26	0.018	0.81	0.009	0.89	0.027	0.71	0.002	1.60	0.000	-	0.002	1.60
27	0.030	0.68	0.013	0.79	0.043	0.63	0.021	0.83	0.025	0.96	0.046	0.58
28	0.059	0.60	0.059	0.50	0.118	0.51	0.050	0.63	0.063	0.51	0.113	0.49
29	0.071	0.31	0.047	0.42	0.118	0.22	0.086	0.48	0.061	0.51	0.147	0.43
30	0.068	0.29	0.063	0.57	0.131	0.32	0.043	0.55	0.069	0.64	0.112	0.53
31	0.084	0.64	0.083	0.29	0.167	0.39	0.093	0.37	0.075	0.36	0.168	0.31
32	0.039	0.46	0.065	0.47	0.105	0.38	0.059	0.29	0.058	0.66	0.117	0.41
33	0.081	0.51	0.024	0.67	0.105	0.48	0.047	0.46	0.034	0.65	0.081	0.31
34	0.032	0.93	0.032	0.59	0.064	0.67	0.034	0.71	0.036	0.71	0.070	0.67
35	0.016	1.06	0.042	0.57	0.057	0.60	0.027	0.85	0.024	0.45	0.051	0.56
36	0.000	2.27	0.008	1.20	0.009	1.13	0.006	0.90	0.013	0.70	0.019	0.63
37	0.000	-	0.005	1.24	0.005	1.24	0.010	0.74	0.018	0.73	0.028	0.65
38	0.000	-	0.000	-	0.000	-	0.001	1.61	0.014	0.85	0.014	0.86
39	0.000	-	0.008	1.11	0.008	1.11	0.002	1.39	0.004	1.03	0.007	1.05
40	0.000	-	0.000	-	0.000	-	0.001	1.63	0.009	0.89	0.010	0.90
41	0.000	-	0.000	-	0.000	-	0.002	1.42	0.003	1.33	0.005	1.29
42	0.000	-	0.004	1.42	0.004	1.42	0.002	1.46	0.003	1.17	0.005	1.06
43	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.32	0.002	1.32
44	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.35	0.002	1.35
45	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.64	0.001	1.64
46	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
47	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
48	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.54	0.001	1.54
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	120		120		240		133		167		300	
mwcv	0.58		0.56		0.48		0.55		0.63		0.50	

Appendix 14: TAR 7 bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
4	0.014	0.56	0.010	0.81	0.024	0.57	0.004	0.81	0.005	0.68	0.009	0.59
5	0.053	0.28	0.084	0.21	0.137	0.17	0.061	0.29	0.052	0.31	0.113	0.22
6	0.039	0.28	0.036	0.34	0.075	0.22	0.102	0.20	0.068	0.22	0.170	0.14
7	0.071	0.22	0.057	0.22	0.128	0.16	0.036	0.26	0.033	0.31	0.069	0.20
8	0.154	0.17	0.144	0.15	0.299	0.10	0.040	0.29	0.053	0.24	0.093	0.15
9	0.011	0.52	0.029	0.32	0.040	0.27	0.109	0.17	0.111	0.16	0.220	0.09
10	0.020	0.39	0.038	0.28	0.057	0.23	0.019	0.36	0.027	0.33	0.046	0.24
11	0.046	0.31	0.036	0.28	0.082	0.22	0.021	0.40	0.017	0.36	0.038	0.29
12	0.030	0.31	0.035	0.30	0.065	0.21	0.016	0.38	0.036	0.26	0.052	0.19
13	0.010	0.57	0.003	1.00	0.014	0.47	0.047	0.25	0.052	0.28	0.099	0.20
14	0.010	0.67	0.013	0.48	0.023	0.41	0.007	0.66	0.006	0.66	0.013	0.46
15	0.002	1.37	0.003	0.99	0.005	0.78	0.012	0.46	0.009	0.54	0.020	0.33
16	0.000	-	0.002	1.40	0.002	1.40	0.001	1.43	0.004	0.88	0.005	0.76
17	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.43	0.001	1.43
18	0.002	1.33	0.004	0.97	0.005	0.77	0.001	1.45	0.007	0.59	0.008	0.57
19	0.003	1.06	0.006	0.68	0.008	0.58	0.002	1.37	0.002	1.34	0.003	0.95
20	0.004	0.89	0.001	1.49	0.005	0.80	0.003	0.97	0.007	0.71	0.010	0.55
21	0.002	1.30	0.000	-	0.002	1.30	0.005	0.89	0.006	0.63	0.011	0.50
22	0.000	-	0.004	0.98	0.004	0.98	0.001	1.40	0.001	1.42	0.002	1.01
23	0.006	0.76	0.005	0.77	0.011	0.51	0.003	0.99	0.000	-	0.003	0.99
24	0.000	-	0.002	1.33	0.002	1.33	0.002	1.03	0.000	-	0.002	1.03
25	0.000	-	0.000	-	0.000	-	0.002	1.34	0.000	-	0.002	1.34
26	0.002	1.31	0.000	-	0.002	1.31	0.000	-	0.001	1.39	0.001	1.39
27	0.000	-	0.003	0.95	0.003	0.95	0.002	0.99	0.000	-	0.002	0.99
28	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.33	0.001	1.33
29	0.000	-	0.002	1.42	0.002	1.42	0.000	-	0.000	-	0.000	-
30	0.000	-	0.000	-	0.000	-	0.002	1.40	0.001	1.39	0.003	0.98
31	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.001	1.38	0.000	-	0.001	1.38
33	0.000	-	0.002	1.37	0.002	1.37	0.000	-	0.000	-	0.000	-
34	0.002	1.33	0.002	1.47	0.003	1.00	0.000	-	0.000	-	0.000	-
35+	0.001	1.48	0.000	-	0.001	1.48	0.000	-	0.001	1.44	0.001	1.44
n	287		313		600		367		380		747	
mwcv	0.3		0.3		0.22		0.3		0.3		0.21	

Appendix 15: TAR 7 bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.38	0.002	1.38
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.000	-	0.000	-	0.000	-	0.003	1.23	0.000	-	0.003	1.23
25	0.000	-	0.001	1.48	0.001	1.48	0.000	-	0.000	-	0.000	-
26	0.001	1.51	0.001	1.44	0.003	1.28	0.000	-	0.000	-	0.000	-
27	0.007	0.80	0.000	-	0.007	0.80	0.001	1.37	0.003	0.95	0.004	0.76
28	0.006	0.68	0.007	0.64	0.013	0.51	0.001	1.43	0.001	1.39	0.002	1.03
29	0.013	0.49	0.007	0.65	0.019	0.40	0.029	0.33	0.013	0.50	0.042	0.30
30	0.022	0.43	0.026	0.41	0.048	0.30	0.014	0.45	0.010	0.58	0.025	0.37
31	0.026	0.37	0.025	0.44	0.051	0.31	0.027	0.33	0.013	0.50	0.040	0.25
32	0.036	0.29	0.026	0.33	0.061	0.20	0.049	0.24	0.015	0.39	0.065	0.20
33	0.056	0.25	0.037	0.30	0.093	0.19	0.048	0.25	0.036	0.26	0.084	0.17
34	0.054	0.26	0.053	0.23	0.108	0.17	0.066	0.24	0.036	0.26	0.102	0.17
35	0.063	0.20	0.060	0.24	0.122	0.14	0.073	0.21	0.046	0.25	0.119	0.15
36	0.051	0.26	0.049	0.29	0.100	0.18	0.056	0.26	0.036	0.24	0.092	0.16
37	0.054	0.25	0.060	0.21	0.113	0.14	0.046	0.26	0.043	0.28	0.089	0.19
38	0.043	0.31	0.040	0.27	0.084	0.18	0.034	0.29	0.062	0.23	0.096	0.17
39	0.016	0.42	0.030	0.33	0.046	0.26	0.017	0.39	0.054	0.27	0.070	0.23
40	0.007	0.65	0.028	0.35	0.035	0.29	0.010	0.49	0.035	0.30	0.045	0.28
41	0.018	0.47	0.026	0.33	0.044	0.28	0.014	0.45	0.029	0.35	0.043	0.25
42	0.005	0.78	0.018	0.48	0.023	0.43	0.005	0.69	0.023	0.45	0.029	0.39
43	0.001	1.40	0.007	0.63	0.009	0.56	0.002	1.37	0.017	0.47	0.019	0.45
44	0.000	-	0.009	0.56	0.009	0.56	0.002	0.96	0.012	0.61	0.014	0.55
45	0.000	-	0.006	0.79	0.006	0.79	0.002	0.96	0.005	0.67	0.007	0.57
46	0.000	-	0.000	-	0.000	-	0.000	-	0.010	0.50	0.010	0.50
47	0.000	-	0.001	1.38	0.001	1.38	0.000	-	0.000	-	0.000	-
48	0.000	-	0.001	1.43	0.001	1.43	0.000	-	0.001	1.39	0.001	1.39
49	0.000	-	0.002	1.35	0.002	1.35	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	287		313		600		367		380		747	
mwcv	0.32		0.34		0.23		0.30		0.33		0.23	

Appendix 16: TAR 8 bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.005	0.95	0.011	0.66	0.016	0.65	0.000	-	0.002	1.44	0.002	1.44
4	0.144	0.30	0.142	0.25	0.286	0.25	0.013	0.63	0.012	0.69	0.025	0.47
5	0.097	0.22	0.104	0.29	0.200	0.22	0.132	0.23	0.136	0.33	0.268	0.26
6	0.025	0.40	0.017	0.47	0.042	0.28	0.091	0.21	0.087	0.34	0.178	0.19
7	0.018	0.47	0.053	0.41	0.071	0.36	0.020	0.43	0.009	0.71	0.029	0.37
8	0.043	0.38	0.054	0.33	0.097	0.25	0.040	0.43	0.022	0.38	0.062	0.28
9	0.013	0.64	0.028	0.40	0.042	0.38	0.080	0.44	0.039	0.49	0.119	0.25
10	0.012	1.01	0.013	0.60	0.025	0.60	0.029	0.52	0.017	0.57	0.046	0.29
11	0.008	1.06	0.036	0.42	0.044	0.45	0.024	0.49	0.010	0.72	0.034	0.43
12	0.037	0.59	0.036	0.48	0.073	0.48	0.041	0.71	0.033	0.42	0.074	0.33
13	0.007	0.91	0.005	0.87	0.012	0.63	0.054	0.85	0.024	0.53	0.078	0.46
14	0.008	1.06	0.011	0.68	0.019	0.63	0.013	1.00	0.011	0.76	0.023	0.50
15	0.008	1.08	0.000	-	0.008	1.08	0.012	1.12	0.003	1.03	0.015	0.77
16	0.000	-	0.005	0.92	0.005	0.92	0.001	1.62	0.000	-	0.001	1.62
17	0.003	1.28	0.008	0.71	0.011	0.66	0.000	-	0.001	1.54	0.001	1.54
18	0.000	-	0.004	1.32	0.004	1.32	0.006	1.34	0.002	1.47	0.008	1.00
19	0.004	1.31	0.005	1.02	0.009	0.96	0.000	-	0.011	0.71	0.011	0.71
20	0.000	-	0.001	1.48	0.001	1.48	0.000	-	0.001	1.51	0.001	1.51
21	0.001	1.43	0.000	-	0.001	1.43	0.000	-	0.006	1.28	0.006	1.28
22	0.000	-	0.007	0.90	0.007	0.90	0.002	1.41	0.002	1.18	0.003	0.93
23	0.012	1.03	0.009	0.68	0.021	0.73	0.000	-	0.004	0.88	0.004	0.88
24	0.000	-	0.003	1.31	0.003	1.31	0.000	-	0.001	1.47	0.001	1.47
25	0.000	-	0.000	-	0.000	-	0.000	-	0.006	1.26	0.006	1.26
26	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.12	0.002	1.12
27	0.000	-	0.000	-	0.000	-	0.005	1.04	0.000	-	0.005	1.04
28	0.001	1.44	0.000	-	0.001	1.44	0.000	-	0.000	-	0.000	-
29	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
30	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
31	0.000	-	0.001	1.45	0.001	1.45	0.000	-	0.000	-	0.000	-
32	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	191		257		448		197		248		445	
mwcv	0.44		0.4		0.36		0.45		0.48		0.33	

Appendix 17: TAR 8 bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
24	0.005	0.91	0.003	1.25	0.008	0.70	0.000	-	0.000	-	0.000	-
25	0.011	0.67	0.014	0.68	0.025	0.58	0.002	1.44	0.000	-	0.002	1.44
26	0.017	0.46	0.004	1.10	0.020	0.44	0.000	-	0.009	0.85	0.009	0.85
27	0.027	0.54	0.020	0.49	0.048	0.41	0.005	1.00	0.005	1.03	0.010	0.80
28	0.047	0.43	0.041	0.34	0.087	0.34	0.024	0.51	0.015	0.53	0.039	0.38
29	0.038	0.38	0.034	0.43	0.071	0.35	0.019	0.61	0.013	0.60	0.032	0.45
30	0.031	0.41	0.019	0.41	0.050	0.33	0.016	0.75	0.012	0.69	0.028	0.61
31	0.027	0.44	0.056	0.32	0.083	0.29	0.041	0.44	0.013	0.71	0.054	0.34
32	0.017	0.46	0.023	0.46	0.041	0.35	0.035	0.42	0.038	0.61	0.073	0.37
33	0.024	0.44	0.028	0.37	0.052	0.24	0.034	0.39	0.032	0.49	0.066	0.37
34	0.029	0.40	0.032	0.32	0.060	0.25	0.088	0.36	0.035	0.44	0.122	0.22
35	0.012	0.71	0.016	0.66	0.028	0.58	0.046	0.46	0.038	0.43	0.084	0.22
36	0.030	0.52	0.036	0.39	0.066	0.29	0.061	0.67	0.029	0.50	0.090	0.35
37	0.055	0.60	0.022	0.57	0.078	0.40	0.086	0.51	0.017	0.57	0.103	0.37
38	0.024	0.64	0.026	0.44	0.050	0.44	0.011	0.71	0.014	0.72	0.025	0.47
39	0.017	0.72	0.049	0.53	0.067	0.53	0.031	0.44	0.008	0.74	0.039	0.36
40	0.011	0.69	0.024	0.53	0.035	0.43	0.043	0.36	0.037	0.43	0.080	0.24
41	0.008	1.11	0.028	0.39	0.036	0.39	0.012	0.58	0.028	0.42	0.040	0.37
42	0.011	0.61	0.014	0.51	0.025	0.38	0.002	1.38	0.027	0.48	0.028	0.48
43	0.001	1.37	0.021	0.42	0.022	0.41	0.001	1.46	0.026	0.48	0.027	0.47
44	0.000	-	0.023	0.40	0.023	0.40	0.000	-	0.007	0.76	0.007	0.76
45	0.001	1.48	0.006	0.97	0.008	0.82	0.001	1.46	0.022	0.47	0.023	0.45
46	0.004	1.28	0.012	0.66	0.016	0.61	0.000	-	0.007	0.94	0.007	0.94
47	0.000	-	0.002	1.00	0.002	1.00	0.000	-	0.007	0.79	0.007	0.79
48	0.000	-	0.000	-	0.000	-	0.000	-	0.002	1.41	0.002	1.41
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	191		257		448		197		248		445	
mwcv	0.53		0.45		0.38		0.50		0.54		0.37	

Appendix 18: WCNI bottom trawl proportion-at-age by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
	P.j.	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
Age												
1	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
2	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
3	0.000	-	0.000	-	0.000	-	0.003	1.04	0.002	1.26	0.005	0.79
4	0.038	0.25	0.021	0.46	0.059	0.25	0.008	0.66	0.003	1.29	0.010	0.65
5	0.055	0.24	0.034	0.38	0.089	0.19	0.044	0.32	0.038	0.32	0.083	0.24
6	0.026	0.41	0.032	0.40	0.058	0.23	0.094	0.24	0.060	0.24	0.154	0.15
7	0.081	0.26	0.040	0.27	0.120	0.18	0.039	0.28	0.048	0.28	0.088	0.19
8	0.144	0.23	0.074	0.25	0.218	0.13	0.064	0.27	0.039	0.29	0.104	0.21
9	0.050	0.30	0.031	0.34	0.081	0.17	0.080	0.22	0.077	0.21	0.157	0.13
10	0.035	0.30	0.020	0.53	0.055	0.24	0.024	0.41	0.025	0.39	0.049	0.24
11	0.032	0.33	0.038	0.28	0.070	0.22	0.029	0.36	0.035	0.45	0.064	0.28
12	0.026	0.36	0.037	0.30	0.063	0.22	0.022	0.56	0.030	0.37	0.053	0.30
13	0.023	0.53	0.024	0.50	0.046	0.30	0.011	0.54	0.042	0.30	0.053	0.24
14	0.016	0.56	0.024	0.34	0.040	0.27	0.017	0.51	0.018	0.48	0.035	0.35
15	0.009	0.60	0.001	1.06	0.011	0.53	0.017	0.66	0.011	0.62	0.028	0.43
16	0.004	0.97	0.003	1.02	0.007	0.67	0.002	1.41	0.009	0.79	0.011	0.70
17	0.004	0.95	0.011	0.50	0.015	0.50	0.006	0.66	0.005	1.04	0.011	0.56
18	0.000	-	0.005	0.95	0.005	0.95	0.007	0.65	0.008	0.68	0.015	0.52
19	0.005	0.96	0.006	0.80	0.010	0.65	0.001	1.42	0.005	0.75	0.007	0.72
20	0.002	1.40	0.003	1.02	0.005	0.83	0.001	1.45	0.002	1.13	0.004	0.89
21	0.001	1.43	0.007	0.66	0.008	0.59	0.000	-	0.001	1.38	0.001	1.38
22	0.013	0.53	0.003	1.14	0.015	0.53	0.011	0.68	0.006	0.75	0.016	0.45
23	0.003	1.03	0.003	1.10	0.006	0.71	0.005	0.79	0.007	0.74	0.012	0.49
24	0.001	1.66	0.001	1.52	0.001	1.41	0.005	0.87	0.007	0.66	0.013	0.49
25	0.003	1.08	0.005	1.05	0.008	0.76	0.003	0.95	0.002	1.39	0.005	0.92
26	0.001	1.44	0.000	-	0.001	1.44	0.003	1.33	0.011	0.54	0.014	0.53
27	0.000	-	0.001	1.36	0.001	1.36	0.000	-	0.002	1.39	0.002	1.39
28	0.000	-	0.001	1.43	0.001	1.43	0.002	1.04	0.002	1.15	0.004	0.90
29	0.000	-	0.002	1.10	0.002	1.10	0.004	0.92	0.000	-	0.004	0.92
30	0.000	-	0.000	-	0.000	-	0.002	1.35	0.000	-	0.002	1.35
31	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
32	0.000	-	0.002	1.34	0.002	1.34	0.000	-	0.000	-	0.000	-
33	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
34	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
35+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	325		274		599		290		309		599	
mwcv	0.34		0.41		0.24		0.39		0.38		0.27	

Appendix 19: WCNI bottom trawl proportion-at-length (cm) by sex and combined for the 2018–19 and 2019–20 fishing years.

	2018–19						2019–20					
	males		females		combined		males		females		combined	
Length (cm)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
20	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
21	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
22	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
23	0.000	-	0.000	-	0.000	-	0.000	-	0.001	1.50	0.001	1.50
24	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
25	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
26	0.000	-	0.000	-	0.000	-	0.002	1.44	0.000	-	0.002	1.44
27	0.000	-	0.002	1.40	0.002	1.40	0.002	1.43	0.001	1.45	0.003	1.02
28	0.006	0.79	0.002	1.34	0.008	0.76	0.002	1.33	0.000	-	0.002	1.33
29	0.011	0.64	0.001	1.02	0.012	0.59	0.007	0.74	0.005	0.83	0.012	0.55
30	0.014	0.49	0.007	0.63	0.021	0.40	0.020	0.49	0.008	0.64	0.028	0.41
31	0.042	0.27	0.007	0.85	0.049	0.28	0.017	0.43	0.003	1.00	0.021	0.43
32	0.041	0.28	0.015	0.52	0.056	0.23	0.038	0.31	0.011	0.51	0.049	0.23
33	0.034	0.28	0.016	0.49	0.050	0.23	0.041	0.38	0.021	0.44	0.062	0.29
34	0.061	0.34	0.025	0.36	0.086	0.24	0.056	0.27	0.017	0.47	0.073	0.22
35	0.075	0.24	0.027	0.33	0.103	0.18	0.061	0.25	0.037	0.30	0.098	0.18
36	0.049	0.31	0.024	0.36	0.074	0.21	0.061	0.27	0.051	0.31	0.111	0.19
37	0.077	0.25	0.050	0.35	0.126	0.16	0.050	0.27	0.043	0.31	0.093	0.20
38	0.057	0.31	0.055	0.39	0.111	0.20	0.048	0.27	0.038	0.29	0.086	0.22
39	0.041	0.37	0.042	0.32	0.083	0.22	0.032	0.35	0.058	0.28	0.090	0.19
40	0.023	0.37	0.036	0.33	0.059	0.22	0.015	0.57	0.049	0.25	0.065	0.22
41	0.023	0.39	0.041	0.26	0.063	0.23	0.024	0.41	0.035	0.39	0.058	0.29
42	0.006	0.69	0.033	0.32	0.039	0.28	0.014	0.55	0.046	0.29	0.060	0.24
43	0.008	0.71	0.014	0.49	0.022	0.44	0.007	0.76	0.023	0.44	0.030	0.38
44	0.000	-	0.006	0.67	0.006	0.67	0.005	0.78	0.018	0.54	0.023	0.44
45	0.003	1.00	0.012	0.78	0.014	0.66	0.000	1.49	0.015	0.52	0.015	0.50
46	0.001	1.40	0.008	0.67	0.009	0.62	0.000	-	0.009	0.60	0.009	0.60
47	0.002	1.40	0.005	0.78	0.007	0.80	0.000	-	0.005	1.10	0.005	1.10
48	0.000	-	0.000	-	0.000	-	0.002	1.37	0.002	1.39	0.003	1.17
49	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
50	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
51	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
52	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
53	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
54	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
55	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
56	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
57	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
58	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
59	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
60+	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-	0.000	-
n	325		274		599		290		309		599	
mwcv	0.33		0.41		0.25		0.36		0.38		0.27	