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Tini a Tangaroa

A pilot multi vessel inshore trawl survey of northern FMA 2 (February-March 2025)

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PLAIN LANGUAGE SUMMARY

A pilot trawl survey of the inshore area of northern FMA 2 was conducted using three commercial vessels. The pilot survey demonstrated the ability for commercial vessels to undertake a structured research survey with limited direct supervision and facilitate the collection of accurate catch weights and sampling data from individual trawls following vessel unloading. For snapper and red gurnard, the pilot survey provided trawl survey biomass indices with a high degree of precision. The survey results were less reliable for tarakihi. The design of the next survey, scheduled for March 2026, will be modified to improve the utility of the survey for tarakihi. The pilot survey also yielded acceptable biomass indices for trevally, John dory, rig, and school shark.

EXECUTIVE SUMMARY

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The Fishery Management Area 2 (FMA 2) inshore trawl fisheries are dominated by catches of tarakihi, red gurnard and snapper, with smaller catches of trevally, rig, John dory, school shark and blue moki. The current monitoring of the main FMA 2 inshore finfish stocks is principally reliant on CPUE indices derived from the inshore trawl fishery, although some species have no established monitoring. A limitation of CPUE series is that changes in fisher behaviour associated with the avoidance of species where ACE is limiting, e.g. TAR 2 and SNA 2, are not always accounted for in the modelling process, with the result that CPUE can become an inaccurate estimate of abundance.

The FMA 2 inshore trawl sector recognised the opportunity to develop a trawl survey programme using commercial vessels. The primary objective of the programme is to provide ongoing monitoring of the abundance of the main FMA 2 inshore finfish species over the medium term (5–10 years). The programme was initiated as a pilot survey to determine the feasibility of conducting a trawl survey using multiple (three) commercial vessels.

The survey area encompassed the area of FMA 2 north of Cape Kidnappers in the 20–300 m depth range and was conducted during February-March 2025. The survey was based on a stratified random design and a total of 61 random trawl stations were completed, in accordance with survey protocols. Research trawl stations were conducted at pre-determined locations during regular fishing trips.

The pilot survey demonstrated the ability for commercial vessels to undertake a structured research survey with limited direct supervision. The catches from individual trawls were stored separately to enable trawl specific catch weights and species sampling to be conducted at the completion of each fishing trip. While conceptually this approach is relatively straightforward, the survey was successful due to the high level of cooperation between all parties (vessel operators, skippers, scientific staff, factory staff and managers).

The vessels participating in the survey were similar in size and used similar trawl gear. Exploratory analyses of the results from the pilot survey were equivocal as to whether or not there were significant vessel specific differences in the catch rates of the main species of interest. However, the analysis was limited by the relatively small number of survey trawls conducted by each vessel and differences in the location and timing of individual trawls. Additional data are required to determine the operational dimensions of the trawl gear (via acoustic monitoring) that may contribute to variation in species catch rates.

Regardless, for most of the key species of interest, the results of the pilot survey indicated that the approach was successful. For snapper and red gurnard, the pilot survey provided trawl survey biomass indices with a high degree of precision (coefficients of variation < 25%), either by vessel or combined across vessels. The survey results were less reliable for tarakihi due to the higher degree of temporal and spatial variation in tarakihi catch rates, related to the aggregation of tarakihi associated with spawning, which increased during the 6 week survey period. The design of future surveys will be modified to improve the utility of the survey for tarakihi, without compromising the applicability for the other main species by refining the stratification and beginning the survey a week or two later. In addition to the main target species, the pilot survey also yielded acceptable biomass indices for trevally, John dory, rig and school shark (CV typically 25–35%). However, the survey is unlikely to provide a reliable monitoring tool for gemfish, due to the variability in gemfish catches, or blue moki, probably due to the timing of the survey.

The pilot survey was not intended for direct comparison with the results of the previous ECNI *Kaharoa* trawl surveys conducted during the 1990s. Regardless, for most species, estimates of trawl survey biomass indices were broadly comparable between the *Kaharoa* surveys and the current study. Snapper was the exception with the biomass indices from the pilot survey approximately 5-fold greater compared to the earlier surveys; the magnitude of the difference in the snapper indices is unlikely to be attributable to the differences in vessel and gear, and is comparable to increases in CPUE observed since 2015–16

The Inshore Working Group reviewed the results of the pilot survey and recommended that the programme be continued in 2025–26 with a further survey in March 2026. This would evaluate the repeatability of the survey and enable an evaluation of the utility of the survey approach for monitoring the abundance of key stocks over the medium term (5–10 years), including decisions regarding the longer-term frequency of FMA 2 surveys. A number of other recommendations were provided for the design and implementation of the next survey.

1. INTRODUCTION

The Fishery Management Area 2 (FMA 2) inshore trawl fisheries are dominated by catches of tarakihi, red gurnard and snapper, with smaller catches of trevally, rig, John dory, school shark and blue moki. The current monitoring of the main FMA 2 inshore finfish stocks is principally reliant on CPUE indices derived from the inshore trawl fishery, although some species have no established monitoring (Table 1). For a number of species, the CPUE indices indicate that abundance has increased in recent years (e.g. snapper and rig) (Fisheries New Zealand 2024). Catches for some species are increasingly constrained by the TACC and that has the potential to influence the operation of the fishery and the reliability of the resulting CPUE indices.

The TACCs for the eastern stock of tarakihi have been reduced to facilitate stock rebuilding (Fisheries New Zealand 2024). The anticipated increase in the abundance of tarakihi within TAR 2 is likely to increasingly constrain the operation of the tarakihi target trawl fishery, reducing the utility of the CPUE indices to monitor trends in abundance during the rebuild phase.

Table 1: Summary of current monitoring for the FMA 2 inshore finfish stocks. Information sourced from Fisheries New Zealand (2024).

Fish stock	TACC 2024–25	Monitoring (assessment year)	Comments
TAR 2	1 104 t	CPUE indices, stock assessment (2022).	Combined CPUE indices with Bay of Plenty trawl fishery included in the eastern tarakihi stock assessment.
GUR 2	725 t	CPUE indices (2024).	Stock status evaluated based on reference period for CPUE indices.
RCO 2	500 t	CPUE indices (2018).	Recent catches have been minor (< 50 t per annum). RCO 2 includes FMA 8.
SNA 2	409 t	CPUE indices (2024).	Separate CPUE indices for northern and southern SNA 2. Likely linkage between northern SNA 2 and Bay of Plenty (part of SNA 1).
MOK 1	403 t	CPUE indices (2017).	No current assessment. Different CPUE trends from different method, area fisheries. Seasonal variation in abundance within FMA 2.
TRE 2	260 t	CPUE indices (2018).	No current assessment. TRE 2 is associated with Bay of Plenty trevally (part of TRE 1). Not well sampled by trawl surveys (e.g. *Kaharoa*).
SCH 2	198 t	New national indices for 2025 (in prep).	Uncertainty in stock boundaries. National index of abundance for SCH based on a VAST analysis of CPUE data..
JDO 2	135 t	CPUE indices (2023).	Stock status evaluated based on reference period for CPUE indices. JDO 2 includes FMA 8.
SPO 2	119 t	CPUE indices (2024).	Stock status evaluated based on reference period for CPUE indices.
SKI 2	403 t	CPUE indices, stock assessment (2023).	Combined assessment with SKI 1. Inshore trawl surveys have potential to monitor juvenile abundance (recruitment).

A limited series of inshore trawl surveys off the central east coast of the North Island (ECNI) was conducted by *Kaharoa* in the 1990s, primarily during February–March (Stevenson & Hanchet 1999). The trawl surveys were discontinued on the basis that the biomass estimates of the main species were either imprecise or highly variable between surveys and concern that the survey did not encompass the large areas deemed to be untrawlable (i.e. foul ground) (Escobar-Flores et al. 2024).

In 2019, Fisheries New Zealand contracted NIWA to investigate the re-instatement of the ECNI (FMA 2) inshore trawl survey. NIWA conducted a thorough review of the results from the previous surveys and refined the extent of trawlable ground within the survey area based on commercial data. The report concluded that it was possible for the survey to monitor the specified target species (snapper, red gurnard, tarakihi, trevally, and John dory), and barracouta, rig, and school shark, with acceptable precision. A series of three consecutive annual surveys using R.V. *Kaharoa* was proposed to provide a direct comparison with the results from the earlier (1990s) trawl surveys. The proposed trawl survey(s) did not proceed due to budgetary constraints.

R.V. *Kaharoa* was decommissioned in May 2025 and has been replaced by a new research vessel (R.V. *Kaharoa II*). Any opportunity to repeat a directly comparable survey using R.V. *Kaharoa* has passed and any new trawl surveys in FMA 2 will essentially represent a new time-series.

Internationally, multi vessel trawl surveys utilising commercial vessels have proved to be useful for the monitoring of the abundance of groundfish species, for example in the Gulf of St. Lawrence for the Northwest Atlantic Fisheries Organization (NAFO), surveys off the western Canadian coast monitoring a range of finfish species (including rockfish species), and the United States Northwest Fisheries Science Center West Coast Groundfish Bottom Trawl Survey.

The FMA 2 inshore trawl sector recognised the opportunity to develop a trawl survey programme using commercial vessels. The primary objective of the programme is to provide ongoing monitoring of the abundance of the main FMA 2 inshore finfish species over the medium term (5–10 years). The programme was initiated as a pilot survey to determine the utility of the approach. The pilot survey was funded by Seafood New Zealand and Fisheries New Zealand (under Project SEA2024-11). The overall programme objectives and specific objectives for 2024–25 are specified, as follows.

Programme objectives

FMA 2 commercial stakeholders have prioritised tarakihi as the primary species for the trawl survey, given the overall magnitude of the TACC and the requirement to monitor the stock during the rebuilding phase. Other species were prioritised based on the magnitude of the TACC and catch and the potential for the trawl survey to provide reliable indices of abundance.

1. To monitor the relative abundance of tarakihi within northern FMA 2 during 2024–25 to 2029–30 (5 years, annually) (priority 1).
2. To monitor the relative abundance of red gurnard and snapper (priority 2).
3. To monitor the relative abundance of a range of additional species, specifically John dory, red cod, gemfish (immature fish), rig (immature), school shark (immature), trevally and possibly blue moki (priority 3).

Specific objectives for 2024–25

The first phase of the project was to undertake a pilot survey to evaluate the utility and operational requirements of a multi vessel survey using commercial inshore trawl vessels. These results would be used to refine the design of a longer-term monitoring programme. The specific objectives for the project were as follows:

1. Design a pilot Industry based trawl survey (December 2024).
2. Complete operational plan to undertake pilot trawl survey in 2024–2025 (January 2025).
3. Conduct pilot survey in 2024–25 (late February and March 2025).
4. Review results of pilot survey (June 2025).

This report summarises the results of the 2025 pilot survey and provides recommendations for ongoing monitoring.

2. METHODS

2.1 Survey area

The FMA 2 inshore trawl fleet primarily operates in the area north of Cape Kidnappers, particularly between Mahia Peninsula and East Cape (Statistical Area 013) and Hawke Bay (northern Statistical Area 014). During 2007–08 to 2022–23, 79.2% of inshore trawls within FMA 2 were conducted north of Cape Kidnappers. This area also accounted for most (72–95%) of the FMA 2 catch of the main species of interest (Figure 1).

The previous ECNI *Kaharoa* inshore trawl surveys included the entire area of FMA 2 from Turakirae Head to Cape Runaway within the 20–400 m depth range, although a limited number of trawls were conducted in areas deeper than 300 m (Stevenson & Hanchet 1999).

The area of the pilot survey was limited to the northern portion of FMA 2 from Cape Kidnappers to Cape Runaway. This restricted area ensured that the vessels participating in the survey were relatively close to their home ports of Napier and Gisborne and reduced the overall scale of the survey and the associated operational constraints. Following a review of the pilot survey, consideration will be given to extending the survey area to incorporate the southern portion of FMA 2.

Within the survey area, most of the commercial trawling occurs within the 10–100 m depth range (Figure 2). Tarakihi target trawls extend into deeper water, although there is limited trawling deeper than 200 m. Nonetheless, commercial catch rates of tarakihi are relatively high in deeper water (200–300 m) indicating a significant abundance of tarakihi in the deeper areas.

During the previous survey design project (Escobar-Flores et al. 2024), it was proposed to extend the survey area to include the shallower areas of Hawke Bay (10–20 m) to improve the monitoring of red gurnard. However, catches of red gurnard are relatively small in that area, typically only about 7% of the red gurnard catch from Statistical Area 014 is caught shallower than 20 m. There are a number of areas that are closed to commercial trawling (at least for the larger vessels used for the survey) within the inner area of Hawke Bay. On balance, it was considered unnecessary to include the shallower depths within the current survey area.

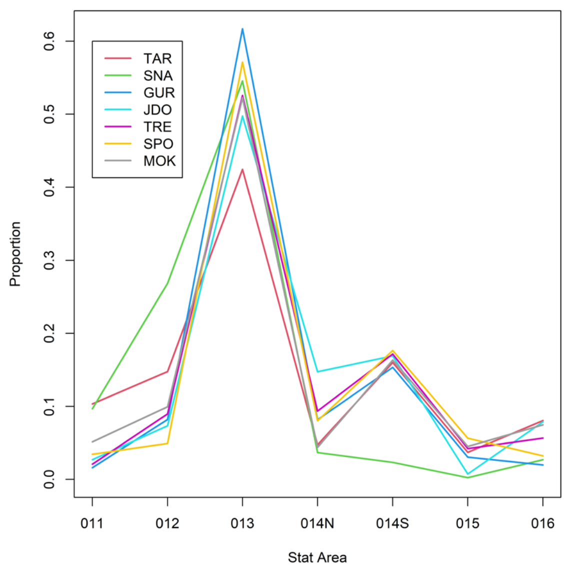

Figure 1: Proportional distribution of species catches between Statistical Areas comprising FMA 2 (2007–08 to 2022–23 combined). Statistical Area 014 is partitioned north (014N) and south (014S) of Cape Kidnappers corresponding to the southern boundary of the survey area.

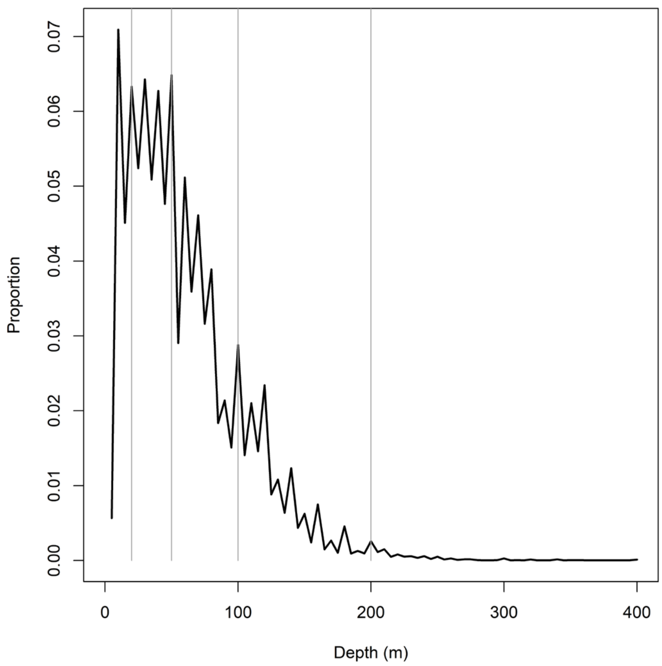

Figure 2: Depth distribution of trawls from FMA 2 north of Cape Kidnappers (N=90 469) (2007–08 to 2022–23 combined). The vertical lines correspond to the depths of the trawl survey strata boundaries.

2.2 Survey timing

Three of the four previous ECNI *Kaharoa* trawl surveys were conducted during February–March. The recent design project (Escobar-Flores et al. 2024) did not evaluate alternative options for the timing of the survey as the intention was to maintain comparability with the earlier surveys.

For the current survey, a review of the seasonal trends in commercial trawl catch rates for the main species of interest was conducted. For tarakihi, highest catch rates occurred in Statistical Area 012 (East Cape) with a strong peak in February–April in about 200 m depth. This distribution is consistent with the known spawning grounds for tarakihi. During the remainder of the year, catch rates of tarakihi were also relatively high in deeper water (200–300 m). There was also a smaller peak in catch rates in Statistical Area 013 during February–April. However, the analysis was limited by the relatively small number of trawl records from depths greater than 150 m.

The above observations are consistent with the relative distribution of tarakihi sampled from the previous Kaharoa trawl surveys conducted in February–March with highest catch rates of tarakihi north of Tologa Bay (Stevenson & Hanchet 1999). In general, trawl survey tarakihi catch rates from the strata north of Tologa Bay were larger from trawls in 100–250 m depth.

Similar analyses were carried out for red gurnard and snapper. The distribution of red gurnard was similar throughout the year with highest catch rates at depths of about 50 m, although catch rates in Statistical Area 012 were higher in February–April compared to the remainder of the year.

For snapper, catch rates were also highest in shallower areas (20–50 m) of Statistical Area 012 during October–January and February–September and were substantially lower in May–September.

Initially, two options for the timing of the survey were considered: February–March or June–July. A survey during spring (October–December) was discounted due to timing limitations for 2024–25 and, more importantly, the more variable seasonal conditions potentially influencing the availability of some species.

The timing was intended to maximise the proportion of the tarakihi stock available to the survey. During February–March, tarakihi migrate to spawn in an area off East Cape from the southern area of FMA 2 and, possibly from the eastern Bay of Plenty.

The February–March period also maintains comparability with the timing of the previous ECNI *Kaharoa* trawl surveys. On that basis, a six-week period was allocated for the survey from mid February to the end of March, allowing sufficient time for initial training and providing flexibility for the survey to be conducted in conjunction with commercial fishing operations.

2.3 Survey design

The study used a random stratified survey design (single phase). The spatial strata from the previous *Kaharoa* surveys provided the basis for the spatial stratification of the survey, partitioning the reduced survey area at Tologa Bay (strata 9–11 south of Tologa Bay and strata 12–15 north of Tologa Bay) and by depth (20–50, 50–100, 100–200, and 200–400 m) (Figure 3). The depth stratification broadly corresponds to the relative distributions of the three priority species: tarakihi, red gurnard and snapper.

The previous *Kaharoa* surveys identified a large area of untrawlable (foul) ground, although the extent of those areas was reduced following a review of commercial trawl activity (Escobar-Flores et al. 2024). Regardless, foul ground accounted for a considerable proportion of the survey area within strata deeper than 100 m. There was limited trawling conducted deeper than 200 m and very limited trawlable ground deeper than 300 m north of Tologa Bay (Figure 4). On that basis, stratum 15 was modified to limit the depth range to 200–300 m, excluding the 300–400 m depth range (Table 2 and Figure 3).

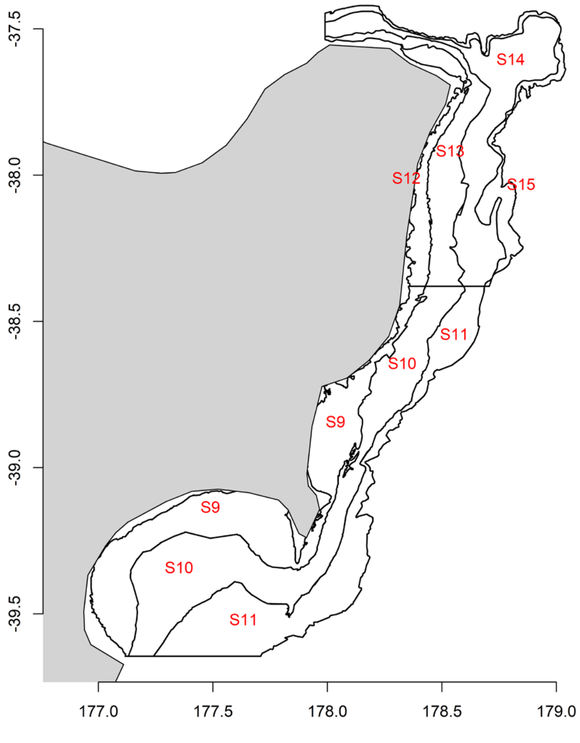

Figure 3: The seven trawl survey strata (modified from previous ECNI *Kaharoa* surveys).

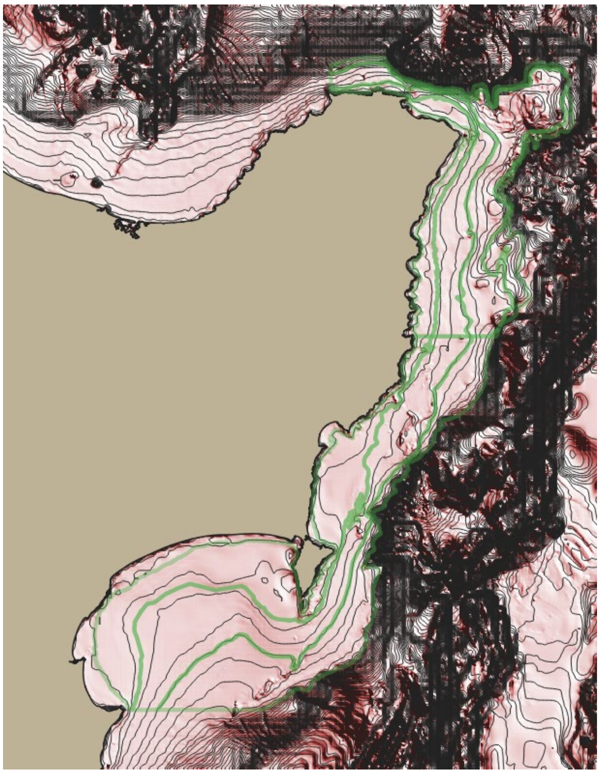

Figure 4: Bathymetry of the survey area (NZ region bathymetry 2016 from Mitchell et al. 2012). The black lines represent the 20 m depth contours. The green lines are the strata boundaries.

Table 2: Trawl survey strata and the number of stations completed during the survey.

Stratum	Location	Depth (m)	Area (km^2)	Number of stations	Density (stations per km^2)
S9	Kidnappers-Tologa	20–50 m	2 585.6	9	287.3
S10	Kidnappers-Tologa	50–100 m	2 779.6	9	308.8
S11	Kidnappers-Tologa	100–200 m	2 166.6	9	240.7
S12	Tologa-Runaway	20–50 m	589.5	8	73.7
S13	Tologa-Runaway	50–100 m	1 007.6	9	112.0
S14	Tologa-Runaway	100–200 m	1 803.0	11	163.9
S15	Tologa-Runaway	200–300 m	588.0	6	98.0
Total			8 934.3	61	146.5

Within the survey area, there are a number of areas that are closed to trawling either via regulation or voluntary agreements (Figure 5). Those areas were included in the stratum area definitions but not included in the generation of the survey stations. Similarly, there is a large area of untrawlable ground around Ranfurly Banks that represents a significant proportion of stratum S14.

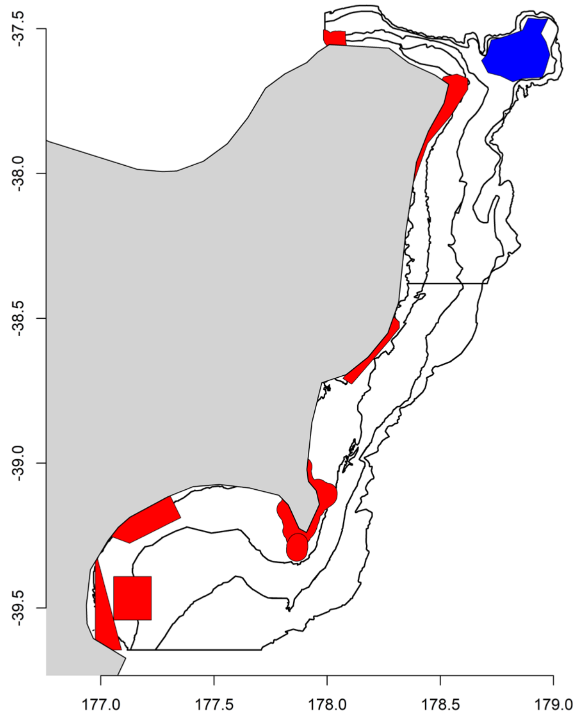

Figure 5: Survey strata boundaries overlaid with the areas closed to trawling within the survey area (red polygons) and the large area of untrawlable ground around Ranfurly Banks (blue polygon).

For each of the three vessels in the pilot study, three trawl stations were allocated for each stratum (representing a total of 21 stations per vessel). The spatial distribution of trawls was intended to enable survey results to be partitioned by vessel and enable comparisons of species catch rates between the individual vessels. Substantial differences between vessels may indicate differences in catchability and/or selectivity between vessels.

2.4 Vessels and gear

The survey was conducted using three locally based trawl vessels: *Giovannina*, *Bianca* and *Torea II* (Table 3). The vessels are owned and operated by Gisborne Fisheries, Fresh Regional Produce Limited and Star Fish Supply, respectively, with the latter two vessels also contract fishing for Moana New Zealand.

The three vessels are comparable in size and all capable of fishing to depths of at least 300 m. The vessels primarily operate in the FMA 2 inshore trawl fishery targeting tarakihi and red gurnard. The skippers who participated in the survey have a wealth of experience in the fishery (typically 30+ years) providing knowledge of the trawl grounds (areas of log debris, foul and known trawl lines) and the distribution and behaviour of the main target species.

Table 3: Characteristics of the three vessels that participated in the survey.

	Giovannina	*Bianca*	*Torea II*
Vessel length (LOA)	19.4 m	19.15 m	16 m
Vessel power (kW)	223 kW	272 kW (370 hp)	368 kW (500 hp)
Winch	Single winch	Single winch	Dual winches
Number crew (including skipper)	2	3	3
Vessel skipper (s) during survey	Blethyn Hulton	Ross Lepper Jason Naidanovich	Forest Brown
Home port	Gisborne	Napier	Napier
LFR	Gisborne Fisheries	Moana NZ	Moana NZ/Star Fish
MSA/MNZ Number	100985	133022	101992
Electronic Reporting	Olrac	Deckhand	Deckhand

The three vessels had a similar trawl net configuration: a "scraper" or "flats" trawl with a low headline (1.0–1.7 metres) and a wingspread of about 20 m (Table 4). These trawls are routinely used in the FMA 2 inshore trawl fishery with the low headline height intended to reduce the catch of snapper while maintaining catch rates for other species (primarily tarakihi and red gurnard). Trawl net plans were provided for *Bianca* and *Giovannina*.

There were considerable differences in the lengths of bridles and sweeps used by the three vessels during the survey. The intention was that vessels used their existing trawl gear rather than attempting to standardise the trawl gear among the vessels. Therefore, the differences in trawl gear set up are simply considered a component of the overall differences in fishing efficiency (fishing power) for the three vessels. The expectation is that for future surveys the individual vessels would maintain a comparable configuration of the trawl gear to that used in the pilot survey.

Calculation of the biomass indices requires an estimate of the area swept by individual trawls. Of the three vessels, only *Bianca* was fitted with trawl door sensors enabling direct measurement of door spread. For the other two vessels, a constant theoretical door spread was assumed. None of the vessel's trawl gear was equipped with a headline net monitor.

Table 4: Survey trawl gear configuration. The theoretical trawl gear dimensions are identified by an asterisk.

Metric	***Giovannina***	***Bianca***	***Torea II***
Trawl net design	155 foot "flats trawl" (Motueka Nets)	130 foot "flats trawl" (Motueka Nets)	Scraper (Napier built)
Doors type, size	Thyboron Type 2	Thyboron Type 4	Thyboron
Sweeps length (m)	128 m	240 m	150 m
Bridles length (m)	9 m	5 m	45 m
Groundrope length (m)	35 m	39.62 m	37 m
Groundrope config	60 mm rubber cookies over 12 mm wire	48 mm rubber cookies over 12 mm wire	60 mm/100 mm rubber cookies over 11 mm wire
Headline height (m)	1 m	1.5 m	1.7 m
Wingspread (m)	20 m*	NA	NA
Doorspread (m)	120 m*	108–168 m	97 m*
Codend mesh size (mm)	100 mm	105 mm	114 mm
Codend mesh type	2 panel 6 mm material T45	T90	T90
Sensors	No	Door spread	No

2.5 Timetable and survey plan

The survey was conducted within the scheduled period (17 February to 31 March 2025). Each vessel skipper and crew received training in the survey procedures by the survey coordinator (Brent Wood, NIWA). This either entailed direct supervision of the initial survey trawls conducted during a day trip in close proximity to the home port or a preliminary shoreside briefing prior to commencement of the first trip.

The individual vessels had the flexibility to conduct their allocated trawls at any time during the survey period. This was intended to enable vessels to conduct commercial fishing during the period and minimise disruptions due to weather.

Each vessel completed four fishing trips during the survey and typically conducted 3–5 survey trawls per trip.

2.6 Trawling procedure

A set of 25 random locations was generated within each stratum. excluding the areas closed to trawling either by regulation or voluntary agreement. The random locations were separated by a minimum distance of 3 nautical miles. For the smallest stratum (S12), this constraint limited the number of random locations that could be generated (15 only). Each random location was identified by a unique Station ID.

Within the survey area, there are areas of untrawlable ground due to log debris, typically in the vicinity of river mouths, foul ground and known hazards (e.g. shipwrecks). The initial set of random trawl stations was scrutinised by the vessel skippers and a number of locations were excluded, primarily within strata S12 (log debris) and S14 (foul ground around Ranfurly Banks). The unsuitability of those locations was corroborated by an examination of the commercial trawl start and end positions provided via statutory reporting. The locations of *Kaharoa* research trawls from previous surveys were also examined.

For each stratum, sufficient random locations were retained to allocate three primary stations to each vessel (a total of 9 per stratum) with an additional allocation of two reserve stations per stratum for each vessel. The stations were assigned to each vessel at random, with the exception that the stations for the first trip of each vessel were assigned based on proximity to the home port. This was intended to enable at-sea training to be conducted during a single day.

For each fishing trip, typically 3–5 survey trawls were completed, interspersed with commercial trawls. The procedures for survey trawls were similar to the protocols used for NIWA *Kaharoa* inshore trawl surveys. Trawling was limited to daylight hours (between 0600 and 1800 NZDT) and restricted to suitable sea conditions (at the discretion of the skipper).

The start position of the trawl was specified to be within 1 nautical mile of the station location. If deemed unsuitable for trawling, the station was abandoned and replaced with the next substitute station for the stratum.

The survey protocols specified a trawl duration of one hour at a speed of 3.2 knots (over the ground) maintaining adequate bottom contact throughout the duration of the trawl (with a minimum acceptable distance of 1.5 nautical miles). Skippers were instructed to trawl along the depth contour while remaining within the stratum. The general direction of the trawl was at the discretion of the skipper, generally towards the next survey or commercial trawl. The length of trawl warp deployed was also consistent with the normal fishing operation of the vessel. Fishing depth, trawl speed, warp length and door spread (*Bianca*) were recorded at regular (10 minute) intervals during the trawl.

2.7 Data collection

At sea, the trawl station data were primarily recorded using *Instructions for NIWA Fisheries Research Trawl Survey Data Forms* (NIWA Fisheries Centre 2003, NIWA Fisheries Centre n.d.). The Station Record form was completed by the vessel skipper for each survey trawl, including the collection of environmental data, including sea state and swell direction.

Statutory reporting via ER provided a complementary set of trawl records (flagged by Station ID) that were available as a daily report from FishServe. This enabled each vessel's survey activity to be monitored with minimal delay and provided (estimated) catches prior to vessel unloading.

The trawl Station Record forms were typically collated at the end of each fishing trip. The data forms were checked and corroborated with the data provided via the ER system.

For each survey trawl, catches were sorted by species and the estimated catches for all species (retained and discarded) were recorded via the statutory ER system. The conditions of the Special Permit allowed the retention of tarakihi, snapper and trevally below the Minimum Legal Size (MLS). The main species discarded were porcupine fish (POP), spiny dogfish (SPD), rough skates (RSK) and Broadnose sevengill shark (SEV). Species catches were not sorted by fish size (or condition) on board the vessel or during the unloading or receiving processes.

The catches from the individual survey trawls were labelled with the unique station ID and stored separately. The survey trawl catches were kept compartmentalised throughout vessel unloading and transportation to the processing facility. Catches from *Giovannina* were landed directly to Gisborne Fisheries, while catches from both *Bianca* and *Torea II* were unloaded in Napier and transported to Moana New Zealand's Auckland facility.

2.8 Catch and biological sampling

On arrival at the processing facilities, the species catches from each survey trawl were weighed separately and referenced by the station ID. This process provided accurate species catch weights for all commercial species from each survey trawl. The catch weighing procedure was overseen by NIWA sampling staff. The catch weights were also subsequently corroborated with the estimated catch weights recorded using the ER system.

Catch sampling was conducted by NIWA staff at Gisborne Fisheries and Moana New Zealand's Auckland facility. For tarakihi, snapper and red gurnard, sampling was conducted of all trawl survey catches following the weighing procedure. For each species, up to 100 fish were sampled per trawl. For smaller catches all fish were sampled, while an approximately random sample was selected from larger catches (exceeding 100 fish). The fish length (fork or total), sex and gonad condition (7 stage scale, see Appendix 2) were determined for all fish, and otoliths were collected from the first 20 fish sampled (per species). Data collection was via NIWA electronic measuring boards.

The catch weight and biological sampling data were compiled in a format compatible with the Fisheries New Zealand *trawl* database. For the species discarded at sea, the estimated catch weights recorded via ER were also included in the station catch records (flagged as estimated catches).

Final data collation, error checking and validation was conducted by NIWA staff. Data from each vessel were assigned a vessel specific survey code (*Bianca*, bia2501; *Giovannina*, gio2501; *Torea II*, tor2501) and the associated vessel and gear attributes were recorded in the relevant tables of the *trawl* database.

2.9 Analysis of data

For the main species of interest (tarakihi, snapper, red gurnard, rig, school shark, John dory, trevally), the species catch rates were determined for each trawl, expressed either as kg per trawl, kg per hour or kg per km^2 swept area. Swept area was calculated as the trawl path between the trawl doors with the door spread either measured directly (*Bianca*) or a default value assumed (*Giovannina* and *Torea II*).

The distributions of species catch or catch rates were examined spatially and relative to fishing depth and day of the survey. For each species, a simple Generalised Linear Model was configured to investigate the main sources of variation in the station catches, primarily to determine if there was any evidence of a significant difference in the catch rates for the three survey vessels.

For the main species of interest, stratum and survey biomass indices (and associated coefficients of variation, CV) were derived following Francis & Fu (2012). This included trawls with an acceptable performance (gear performance code 1 or 2), excluded a duplicated trawl, and assumed a default door spread value for *Giovannina* (120 m) and *Torea II* (97 m). All species were assumed to be fully available (1.0) and vulnerable (1.0) to the trawl gear (between the doors).

For each species, biomass indices were derived separately for each vessel and a combined index was calculated from all stations (all vessels combined). The analyses excluded stratum S15 due to the lack of data from one vessel. The vessel specific biomass indices were compared to identify any potential differences amongst the fleet.

For tarakihi, snapper and red gurnard, the length frequency data were used to calculate scaled survey length compositions (and CV) for male, female and all fish (Francis & Fu 2012) by vessel and combined. The resulting length compositions were compared to identify any appreciable differences in the length of fish caught between vessels. In addition, for each species, the average length of fish sampled from each trawl station was determined to investigate the main factors that may influence the size of fish caught, in particular to ascertain whether there were significant differences in the size of fish caught between the three vessels.

For tarakihi, snapper and red gurnard, the ovarian condition of sampled fish was summarised.

The survey biomass indices and scaled length compositions were also compared with the previous *Kaharoa* ECNI trawl surveys. The data from the *Kaharoa* surveys were reanalysed to encompass the comparable survey strata (S9-15).

3. RESULTS

3.1 Trawling details

All survey trawl stations were completed during the scheduled survey period. A total of 61 trawls were successfully completed (Table 5); almost all of the allotted three trawls per stratum for each vessel. The exception was *Bianca* who failed to conduct any trawls within stratum S15 due to the shortening of the vessel's trawl wire during the survey which prevented the vessel fishing deeper than 200 m.

Most of the trawls were completed at the primary stations in each stratum, although there were seven stations substituted, primarily due to untrawlable (foul) ground in the deeper area of stratum S14. One station was inadvertently duplicated by the two skippers of *Bianca* (S13), while extra substitute stations were conducted by *Giovannina* (S14) and *Bianca* (S14) (Table 5).

Table 5: The number of survey trawl stations completed by each vessel by stratum. The number of substituted trawls is in brackets. A duplicated station has been excluded.

Stratum	*Giovannina*	*Bianca*	*Torea II*
S9	3 (0)	3 (1)	3 (0)
S10	3 (0)	3 (0)	3 (0)
S11	3 (1)	3 (0)	3 (1)
S12	2 (0)	3 (0)	3 (0)
S13	3 (0)	3 (0)	3 (0)
S14	4 (2)	4 (2)	3 (0)
S15	3 (0)	0 (0)	3 (0)
Total	21 (3)	19 (3)	21 (1)

Giovannina completed most of the trawl stations early in the survey period, during 20 February to 1 March 2025, primarily those stations north of Gisborne (Figure 6 and Figure 7) (Appendix 1). The other two vessels completed most of their stations in the second half of March (15–30 March). Few survey trawls were completed during the first half of March due to persistent southerly weather systems with high winds (Figure 8) and large swells.

The random allocation of stations resulted in a broad spread of trawl effort, although limited sampling occurred in some areas, most notably the northern area of stratum S11 (Figure 7). The fixed allocation of 9 trawls per stratum resulted in a high density of trawl stations in the two smallest strata (S12 and S15) (Table 2).

Overall, most of the survey trawls were conducted in accordance with the protocols (Table 6). Trawl speeds approximated the target trawl speed of 3.2 knots and duration of one hour, although *Torea II* trawls were generally longer in duration and distance.

There were a small number of deviations from the survey protocol: two trawls crossed a stratum boundary (Figure 7) and two trawls started outside the 1 n. mile radius around the station position (Table 6).

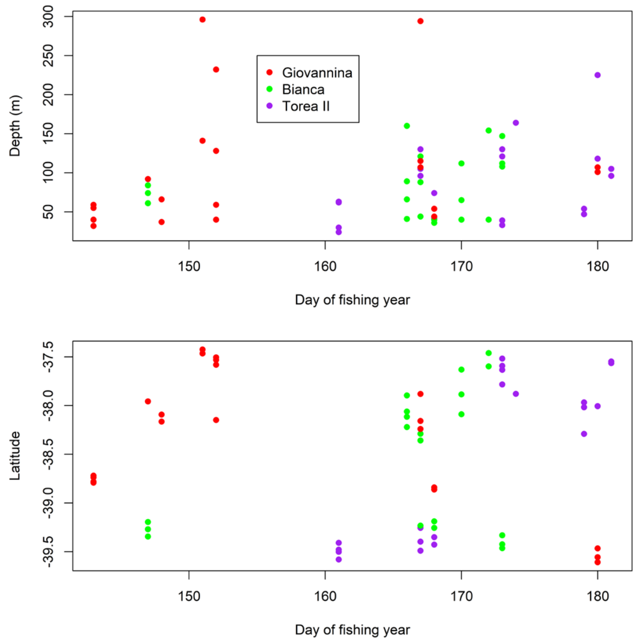

Figure 6: Start depth (top panel) and latitude (bottom panel) of the vessel's survey trawls by day of the fishing year (1 = 1 October 2024).

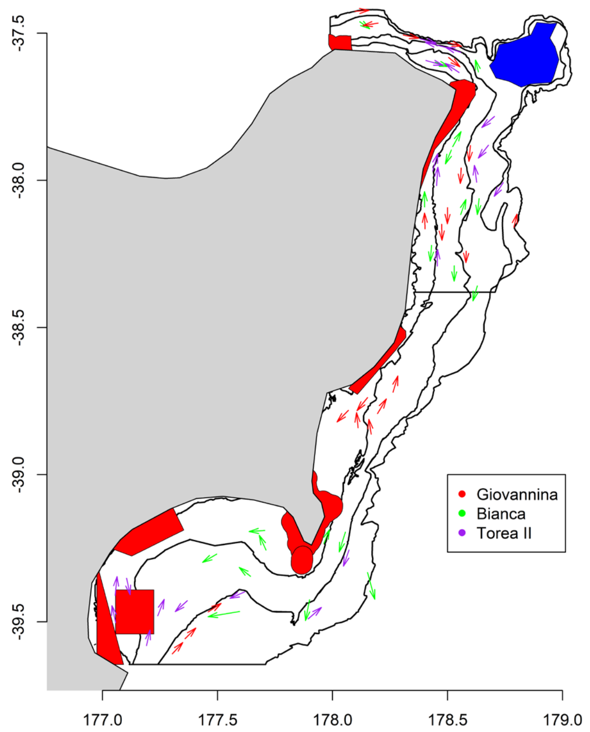

Figure 7: Survey trawl stations by vessel. The arrow denotes the direction of the trawl from start to end position. The boundaries of the survey strata (black lines) and trawl exclusion zones (red polygons) are also shown. The blue area represents the foul ground associated with Ranfurly Banks.

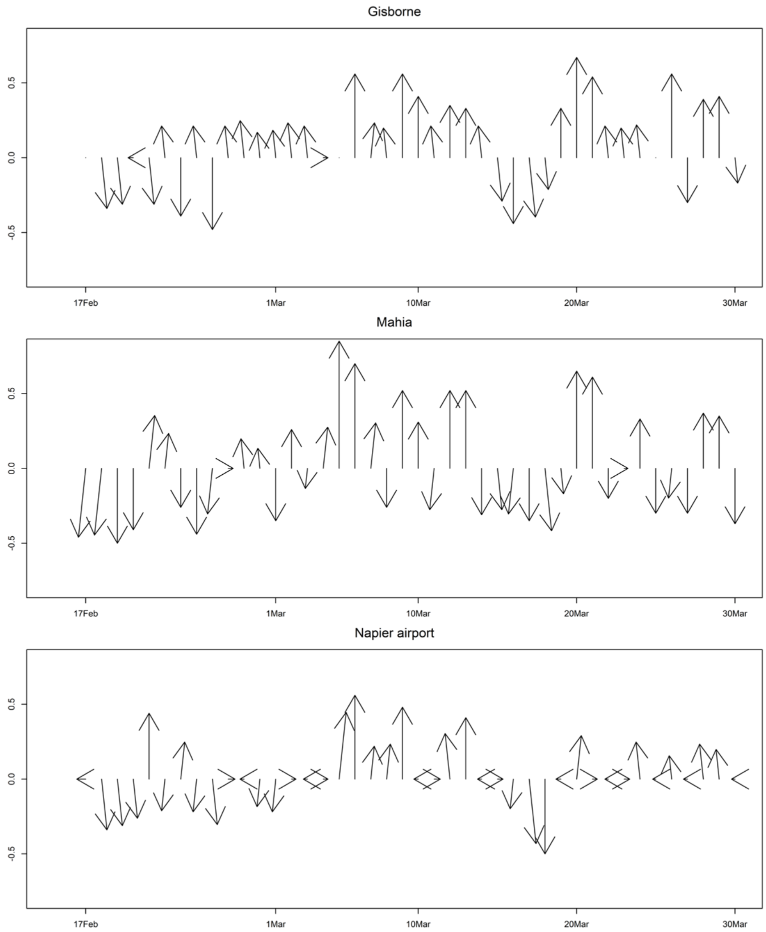

Figure 8: Daily wind vector plots of the maximum gusts recorded at Gisborne, Mahia and Napier airport weather stations during the trawl survey period. The vector lengths are proportional to the wind speed with a maximum value of 85 kph.

Table 6: Performance metrics for the individual survey trawls by vessel (average and minimum and maximum values in brackets).

Metric	*Giovannina*	*Bianca*	*Torea II*
Number of trawls (total)	21	19	21
Number of primary stations excluded	3	5	1
Number of substitute stations	3	3	1
Distance from specified station at start of trawl (km)	0.42 (0.08, 1.16)	0.90 (0.25, 3.7)	0.79 (0.06, 3.1)
Trawl speed (knots)	3.15 (2.8, 3.3)	3.13 (3.0, 3.2)	3.2 (3.1, 3.4)
Trawl duration	1.0 (0.75,1.1)	1.0 (0.83, 1.12)	1.1 (1.0, 1.25)
Trawl distance (n. mile)	3.12 (2.35, 3.49)	3.06 (2.40, 3.42)	3.43 (2.68, 3.96)
Trawl direction	156 (13, 358)	182 (1, 346)	129 (0, 303)
Depth start minus depth end (m)	2 (-11, 17)	1 (-20, 34)	1 (-6, 34)
Warp/Depth ratio	4.2 (2.6, 7.1)	4.1 (2.9, 6.3)	5.0 (2.9, 10.4)
Start time (decimal, NZST)	10.2 (5.1,16.2)	10.9 (5.4, 17.3)	11.0 (5.8, 17.8)
Door spread (m) (sensors)	NA	131 (107,168)	NA

The trawling details were accurately recorded using the Station Record form. Any potential errors in positional details were identified by reconciling the start and end positions with the ER data. The three vessels also recorded the environmental data for most trawl stations, although the bottom type and bottom contour fields were not recoded by the *Giovannina* skipper (Figure 9). There may also be differences in the interpretation of some of the variable categories between the vessels.

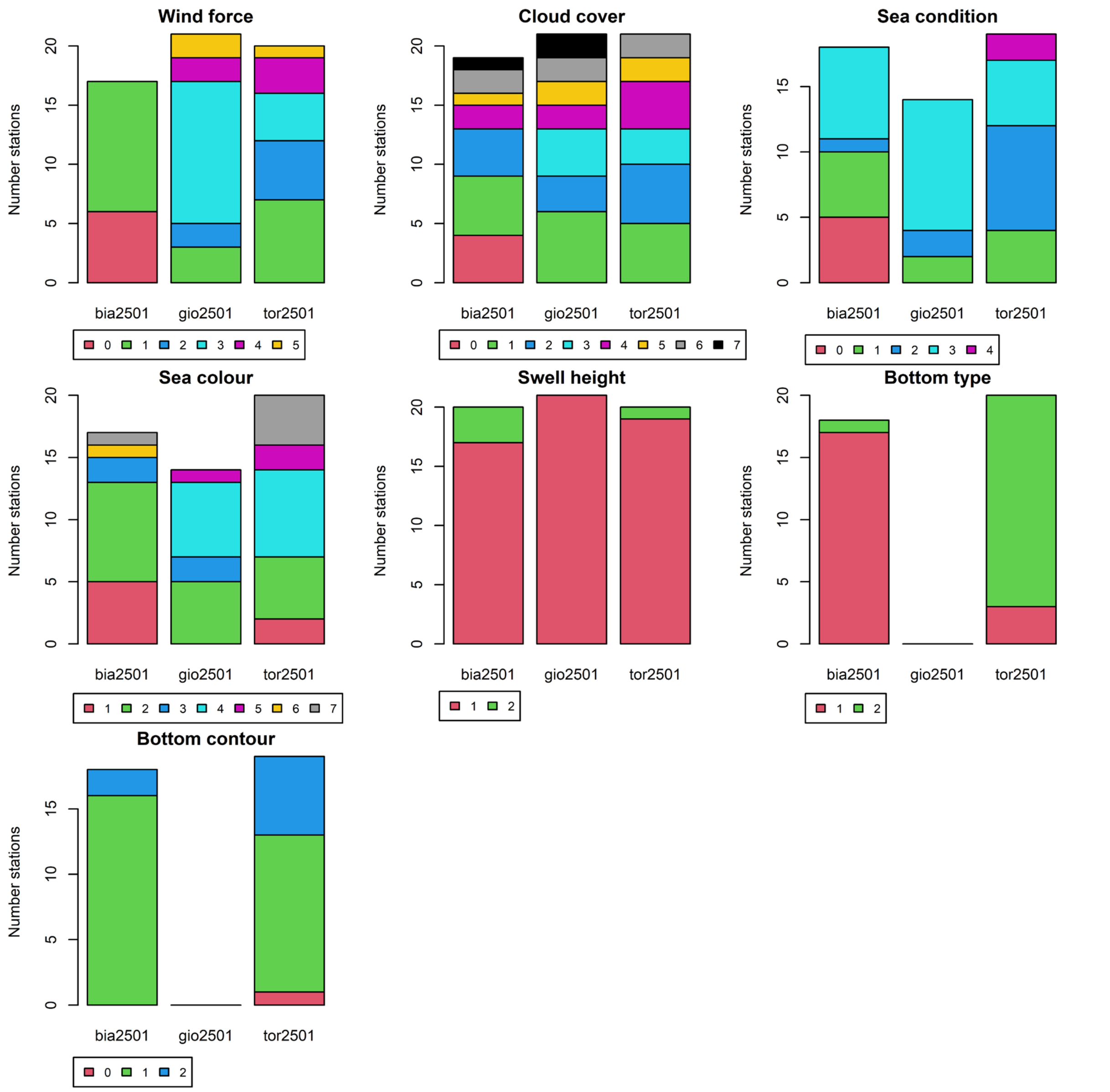

Figure 9: A summary of the environmental variables collected by the three vessels. The codes for each variable are detailed in the *Instructions for NIWA Fisheries Research Trawl Survey Data Forms* (NIWA Fisheries Centre 2003, NIWA Fisheries Centre n.d).

3.2 Catch composition

Snapper represented the largest component of the total survey catch and the second most frequently caught species during the survey following red gurnard (Table 7, Table 8 and Appendix 1). Catches of tarakihi were variable between vessels; relatively small catches by *Giovannina* and some larger catches (exceeding 500 kg) by *Torea II* and *Bianca.* Total catches of red gurnard were comparable between the three vessels and relatively consistent over all trawls. Rig, school shark and John dory were caught in small quantities from a high proportion of trawls. Similarly, relatively small catches of trevally were taken from most trawls, with the exception of a couple of larger catches (exceeding 100 kg) by *Torea II*. Most of the total gemfish catch was taken from a few trawls, while catches of red cod and blue moki were negligible (Table 7, Table 8 and Appendix 1).

Table 7: Total survey catches (kg) by species code and vessel for the species with a total catch of at least 100 kg.

Species code	Vessel			Total
	Bianca	*Giovannina*	*Torea II*	
SNA	2 106	2 084	3 570	7 759
TAR	1 186	270	2 494	3 950
GUR	785	934	639	2 358
TRE	274	230	798	1 302
SKI	7	534	484	1 025
SCH	143	216	310	669
POP	115	165	240	520
JDO	141	184	124	450
RSK	134	57	148	339
SPO	66	133	110	309
BAR	4	97	158	259
KAH	76	43	90	209
HOK	0	156	19	175
SPD	42	55	45	141
JMA	11	2	123	136
SEV	10	55	45	110
KIN	15	13	74	103

Table 8: Frequency of species catch (number of survey trawls) by vessel and total for the species with a total catch of at least 100 kg.

Species code	Vessel			Total
	Bianca	*Giovannina*	*Torea II*	
SNA	14	17	20	51
TAR	8	10	14	32
GUR	16	17	20	53
TRE	13	16	19	48
SKI	3	6	7	16
SCH	9	12	14	35
POP	11	16	17	44
JDO	10	15	15	40
RSK	8	11	10	29
SPO	11	14	13	38
BAR	2	6	12	20
KAH	8	3	4	15
HOK	0	2	1	3
SPD	6	14	8	28
JMA	6	3	17	26
SEV	1	2	3	6
KIN	2	3	5	10

For each of the main species of interest, a generic GLM model of the species catch (plus 0.1 kg offset) per trawl (natural logarithm) was used to investigate the explanatory power of a range of station variables; *Stratum* (7) and *Vessel* (3) were included as categoric variables, while the continuous variables were included as linear functions (*Duration*) or third order polynomial functions (*TimeStart*), *FyearDay*, *Heading*, *Depth* and *Speed*.

For all species, *Stratum* code accounted for most of the variation explained by the models (Table 9). This provides a degree of support for the existing area, depth, and spatial configuration of the survey strata. For most species, *Depth* accounted for a significant additional proportion of the explained variance, indicating that the stratum boundaries represent a relatively crude delineation of the depth distribution of each species (Figure 10). *Vessel* accounted for a small additional component of the explained variance and was significant (at the 1% level) for snapper and trevally (Table 9). Both models estimated lower *Vessel* coefficients for *Bianca* compared to the other two vessels (Figure 11), although the vessel coefficients are imprecise.

Table 9: Total (Null) deviance in the natural logarithm of species trawl catches (plus offset) (61 observations) and the deviance explained by each variable included in the generic explanatory model. Levels of significance: 0 '*', 0.001 '**', 0.01 '*'.**

						Species code
	SNA	TAR	GUR	TRE	SPO	JDO
Total Dev.	431.4	580.8	239.9	280.8	206.4	280.0
Variable						
Stratum	239.5***	280.2***	141.3***	111.2***	68.1**	119.4***
Vessel	16.1*	21.1	3.8	16.8*	1.0	11.6
Duration	1.7	0.0	1.3	0.0	10.7*	0.0
TimeStart	18.7*	30.7	9.0	19.7	7.7	0.3
FyearDay	18.9*	22.8	4.2	6.7	13.6	18.6
Heading	6.0	13.6	8.4	13.7	3.6	8.4
Depth	50.1*	45.3*	24.8***	17.9	5.8	29.7*
Speed	8.1	2.6	7.2	6.3	2.1	6.0

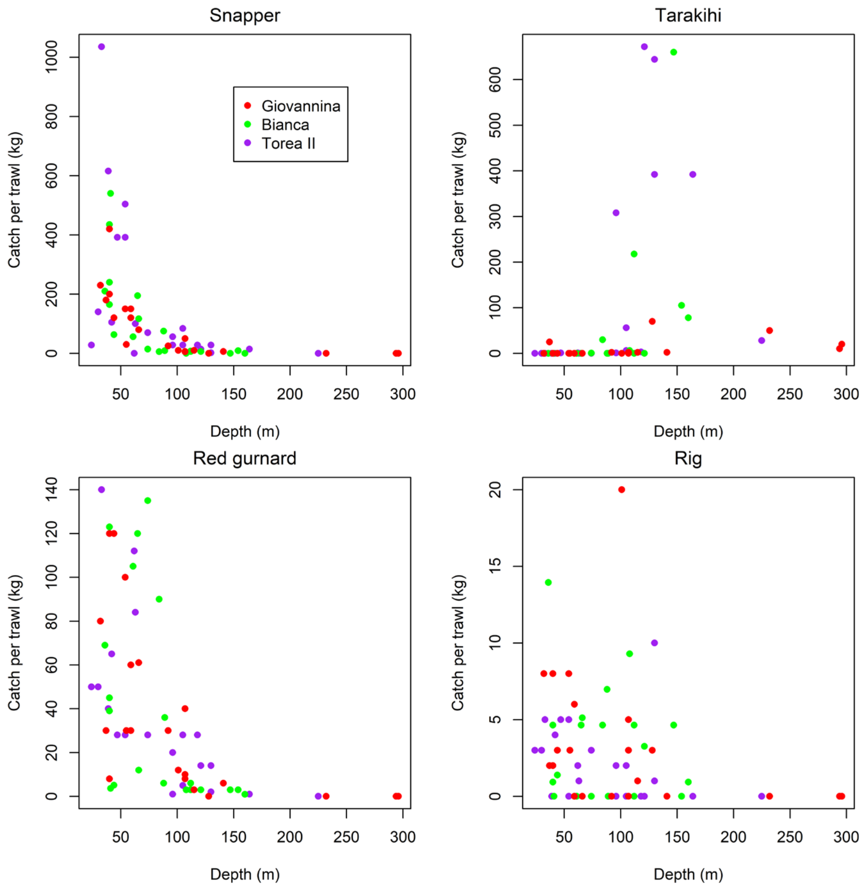

Figure 10: Depth distribution of trawl survey station catches by vessel for snapper, tarakihi, red gurnard and rig.

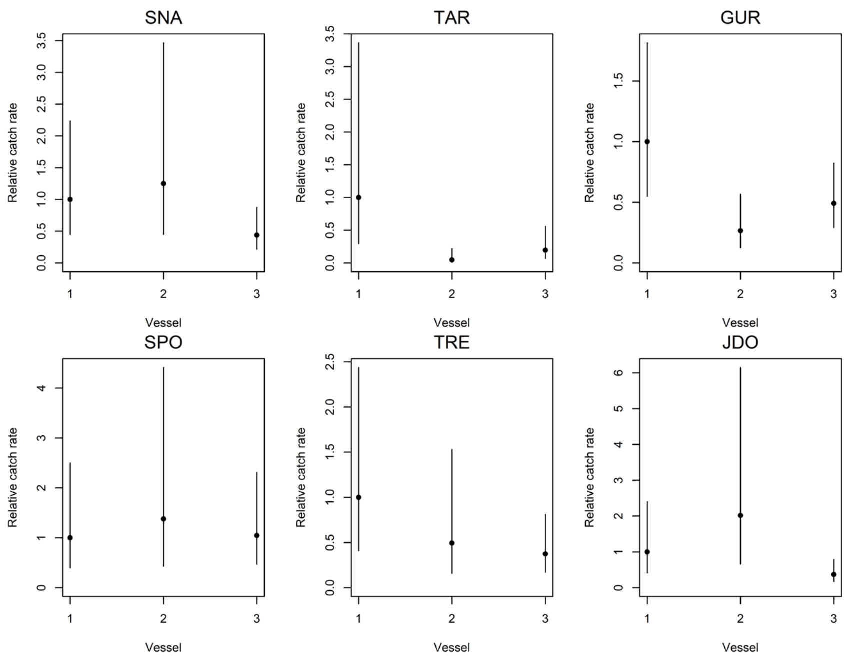

Figure 11: Vessel coefficients (and 95% confidence intervals) derived from exploratory GLMs of trawl station species catches (Vessel 1, *Torea II*; Vessel 2, *Giovannina*; Vessel 3, *Bianca*).

For the main species of interest, trawl survey biomass indices were generated for each vessel; i.e., treating the results from each vessel as an independent survey (Table 10). However, the lack of any strong indication that there are substantial differences in fishing power between the vessels also supports the amalgamation of the data from the three vessels as a unified survey. The amalgamated data set provides a higher level of sampling coverage, yielding more precise biomass indices (Table 11).

Table 10: Parameter settings for derivation of survey biomass indices and scaled length compositions.

Attribute	*Bianca*	*Giovannina*	*Torea II*	Combined
Strata	S9-14	S9-14	S9-14	S9-14
Gear perf	1 or 2	1 or 2	1 or 2	1 or 2
N. stations	19	18	18	55
Door spread	131 m (107–168)	120 m (default)	97 m (default)	Vessel specific
Distance	Start/end pos	Start/end pos	Start/end pos	Start/end pos
Catch weigh meth	1	1	1	1
Vulnerability	1	1	1	1
Availability	1	1	1	1

Table 11: Trawl survey biomass indices (t) and coefficient of variation (CV, %) for selected species by vessel and all vessels combined.

Species	*Bianca*		*Giovannina*		*Torea II*		Combined	
	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
TAR	875	63	77	74	1 664	43	818	36
SNA	1 247	26	1 684	15	2 035	15	1 664	11
GUR	591	15	929	16	707	15	744	11
SPO	66	56	126	30	106	25	99	19
SCH	161	51	80	43	264	38	164	29
JDO	123	69	182	24	142	28	149	24
RCO	1	100	6	76	0	100	3	66
SKI	4	68	40	80	208	82	73	68
TRE	160	21	212	38	461	35	285	22
MOK	0	-	14	48	0	-	5	55

Nonetheless, a comparison of the species biomass indices between vessels, expressed as ratios of the biomass indices for *Torea II*, revealed lower biomass indices from *Bianca* for all species, with statistically significant differences (at 10%) for snapper, trevally and gemfish. By comparison, biomass indices for tarakihi, school shark, gemfish and trevally from *Giovannina* were significantly lower than *Torea II* (Table 12). *Giovannina* yielded a significantly higher biomass index for red gurnard compared to *Bianca* and a significantly lower indices for tarakihi and school shark. However, these results do not adequately account for sampling variation as they are predicated on the stratified design of the survey. The biomass indices are also dependent on the assumed or observed values of door spread used to derive the area swept estimates of density for each trawl. For *Torea II*, the assumed value of door spread is below the minimum value observed for *Bianca* and well below the average value (Table 10).

Table 12: Ratio of vessel specific survey biomass indices for each species (and coefficient of variation CV) for *Bianca* and *Giovannina* relative to *Torea II*. * denotes a statistically significant difference from *Torea II* at the 10% level). NA, not available as biomass index for *Torea II* was zero.

Species	*Bianca*		*Giovannina*	
	Ratio	CV	Ratio	CV
TAR	0.526	76	0.046*	86
SNA	0.613*	30	0.828	21
GUR	0.836	21	1.314	22
SPO	0.623	61	1.189	39
SCH	0.610	64	0.303*	57
JDO	0.866	74	1.282	37
RCO	NA	NA	NA	NA
SKI	0.019*	107	0.192*	115
TRE	0.347*	41	0.460*	52
MOK	NA	NA	NA	NA

3.3 Length compositions

For the three main species of interest, almost all the individual trawl catches were sampled. A small number (8) of species catches were not sampled; those catches tended to be quite small (less than 20 kg), although a couple of larger catches were not sampled (Table 13). Regardless, the sampling encompassed a high proportion of the total catch of the three species (96% for red gurnard, 99% snapper, and ~100% tarakihi), resulting in the collection of comprehensive compositional data from the catch of each vessel and a comprehensive set of otoliths for each of those species (Table 13 and Figure 12).

The sampling protocol required collecting otoliths from the first 20 fish in the sampled catches (of up to 100 fish). Overall, smaller catches tended to be comprised of larger fish resulting in the disproportionate sampling of larger fish for otoliths in the total aggregated length sample for each species (Figure 13). For individual sampled catches of snapper and tarakihi, there was no indication of a strong bias in the selection of fish for otolith collection. However, the sampling procedure resulted in a positive bias in the length of red gurnard in the otolith subsamples (Figure 14).

Table 13: The number of trawls sampled, the number of fish measured and the number of fish sampled for otoliths by species and vessel. The total number of catches for each species is in brackets.

Species	Metric	*Bianca*	*Giovannina*	*Torea*	Total
SNA	N. Trawls	14 (14)	17 (17)	17 (20)	48 (51)
	N LF & Bio	862	1 007	1 112	2 981
	N otoliths	227	262	303	792
TAR	N. Trawls	7 (8)	10 (10)	14 (14)	31 (32)
	N LF & Bio	451	305	738	1 494
	N otoliths	121	122	193	436
GUR	N. Trawls	14 (16)	16 (17)	19 (20)	49 (53)
	N LF & Bio	901	949	935	27 85
	N otoliths	239	278	318	835

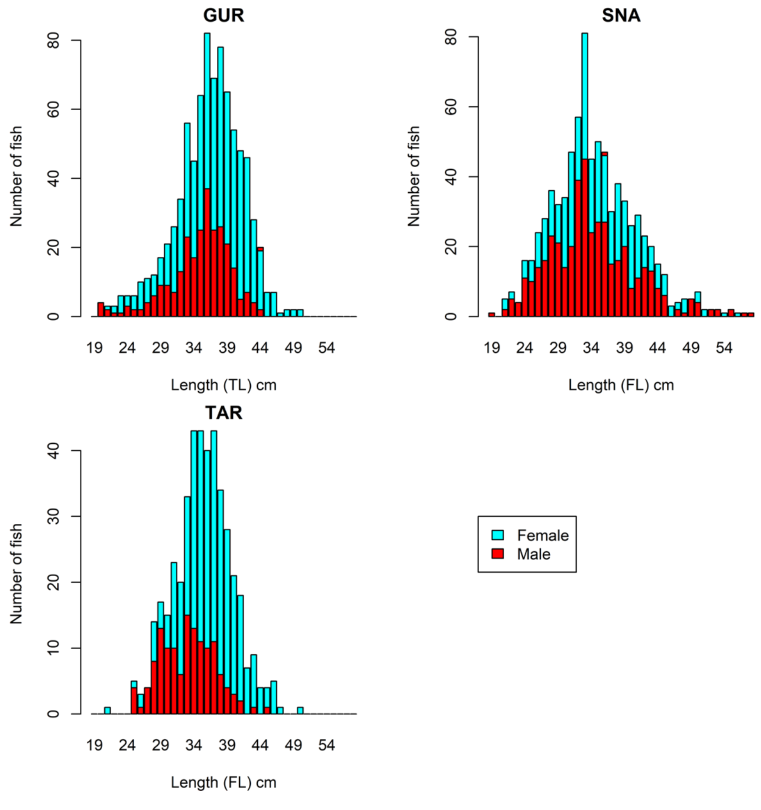

Figure 12: The number of fish sampled for otoliths by length class and sex for each of the sampled species (GUR, red gurnard; SNA, snapper; TAR, tarakihi).

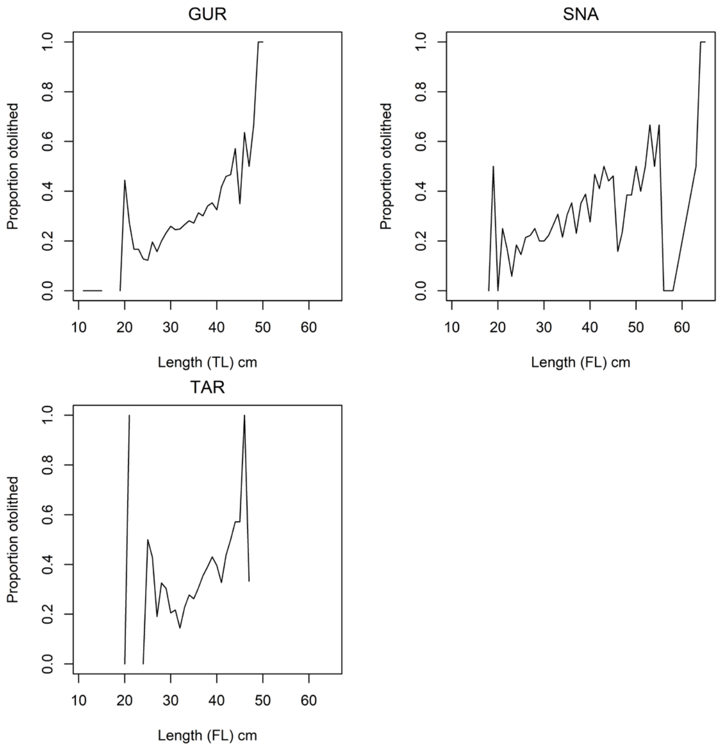

Figure 13: The proportion of fish sampled for otoliths from each length class (both sexes combined) of the total sampled catch by species (GUR, red gurnard; SNA, snapper; TAR, tarakihi).

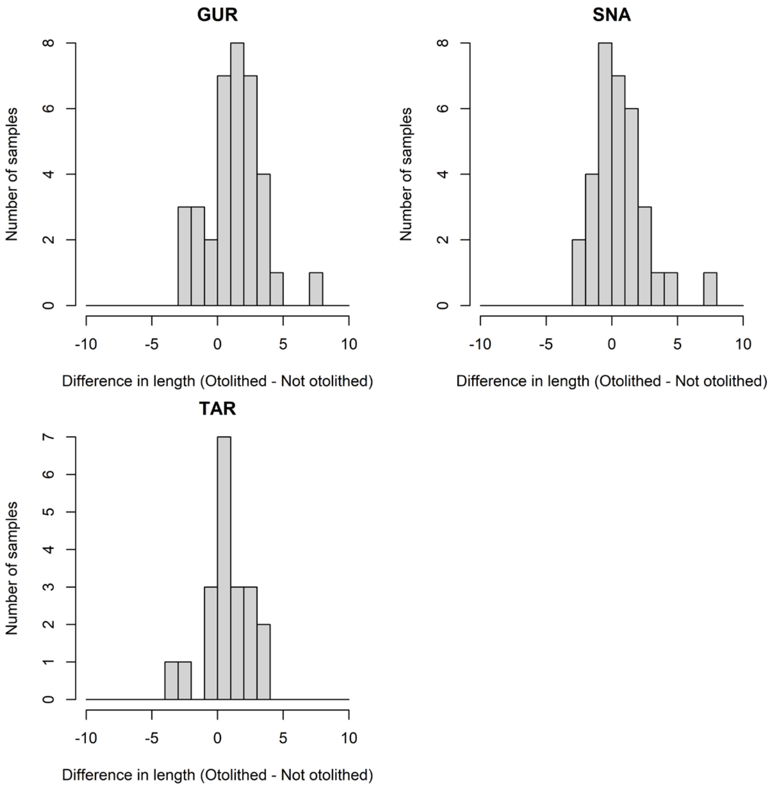

Figure 14: Difference in the average length of fish sampled or not sampled for otoliths from each trawl catch by species (both sexes combined) (GUR, red gurnard; SNA, snapper; TAR, tarakihi).

For the three sampled species, the variation in the average fish length between individual trawl samples was investigated. The data sets were limited to trawl stations with a minimum of 5 fish sampled per species, resulting in a limited number of observations for tarakihi. For each species, the stratum variable accounted for a high proportion of the variation in the length of fish caught. Larger fish were sampled from the deeper strata, particular in the southern strata S10 and S11 (Figure 15).

For snapper and red gurnard, there was no indication of a difference in average fish length between vessels, whereas smaller tarakihi were caught by *Giovannina* compared to the other two vessels (Figure 15). However, the limited number of samples (3) from *Giovannina* were collected earlier during the survey period and may not be directly comparable to the samples from the other two vessels.

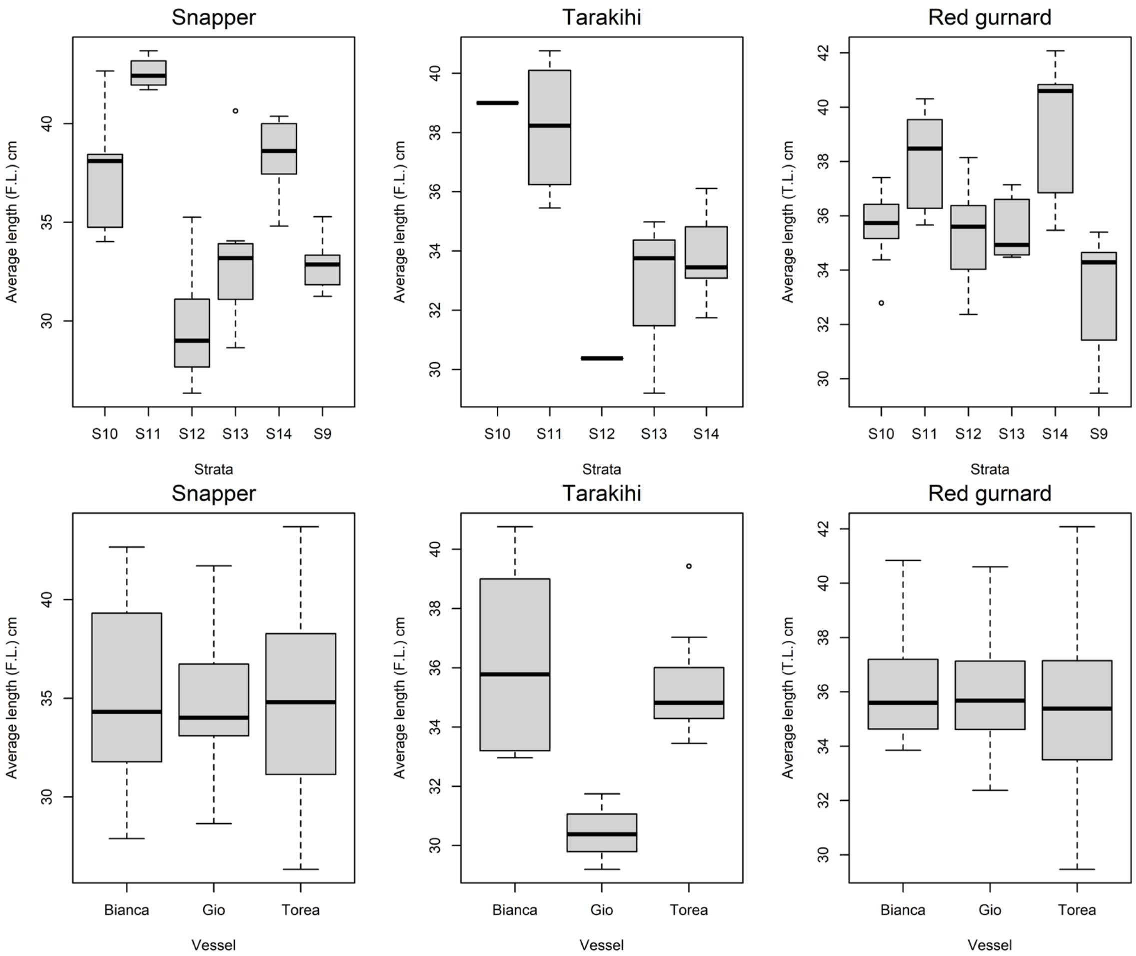

Figure 15: Boxplots of average fish length from individual trawl samples (minimum 5 fish) by strata (top panels) and vessel (bottom panels) for snapper, tarakihi and red gurnard.

3.4 Snapper

Snapper was caught in most of the survey trawls (51 of 61 stations) with the highest catch rates in the shallow northern stratum (S12) (Figure 16). Catch rates were lowest in the deeper strata, beyond 100 m (strata S11, S14 and S15). Catch rates also tended to be lower south of Mahia Peninsula, including Hawke Bay.

Trawl survey biomass indices for snapper, either by vessel or combined, were determined with high precision (Table 11) reflecting relatively consistent catch rates within individual strata. The two shallow strata (S9 and S12) accounted for 62% of the total biomass from the combined analysis (Figure 17). The relative distribution of biomass differed amongst the individual vessels with a higher proportion of the *Torea II* biomass taken in the northern strata (S12 and S13) compared to the other two vessels.

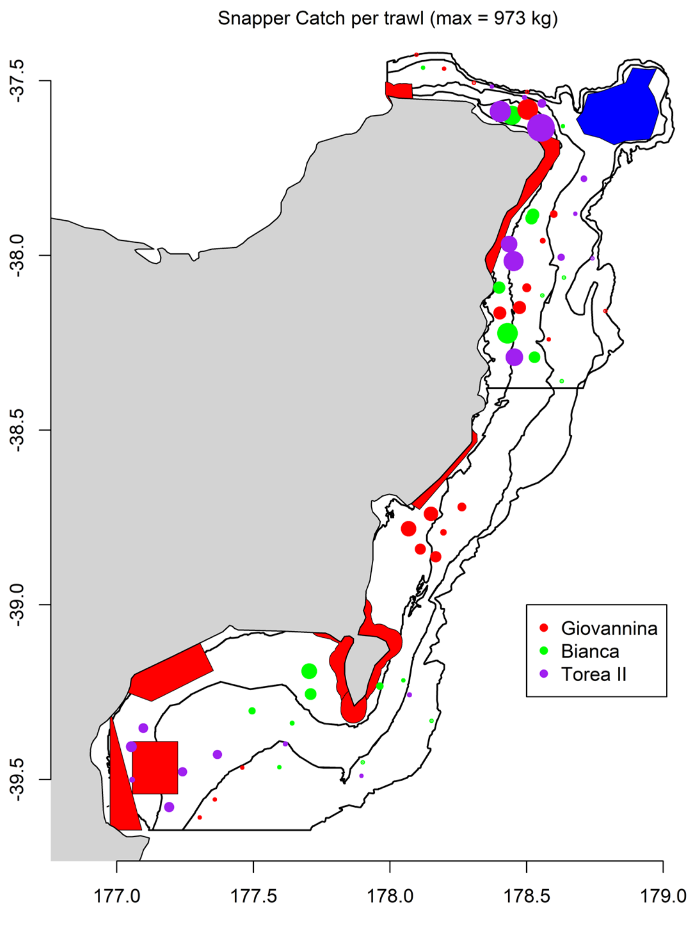

Figure 16: The relative catch (kg per trawl) of snapper from the individual survey trawls by vessel. The area of the circle is proportional to the magnitude of the catch. The boundaries of the survey strata (black lines) and trawl exclusion zones (red polygons) are also shown. The blue area represents the foul ground associated with Ranfurly Banks.

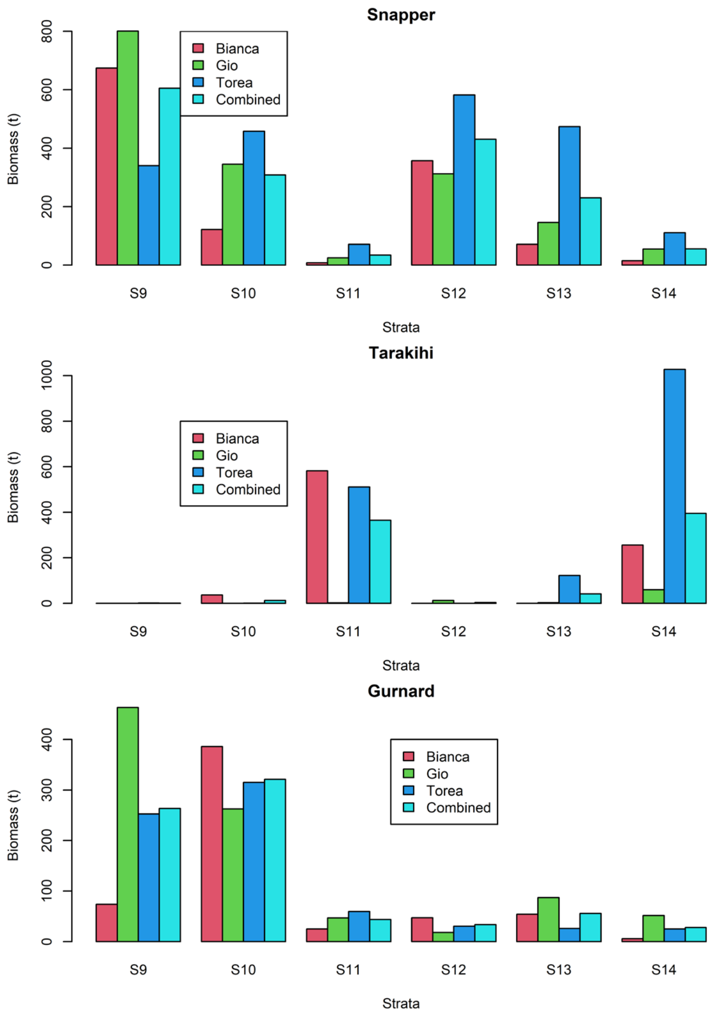

Figure 17: The distribution of trawl survey biomass (by vessel and combined) between strata for snapper, tarakihi and red gurnard. Stratum S15 was excluded from the biomass estimates.

Overall, the scaled length compositions of snapper were similar for the three vessels. The length compositions were composed of two modes of smaller fish (at about 25 cm and 29 cm F.L.) and a broader mode of larger fish with the tail of the distribution extending to about 50 cm (F.L.) (Figure 18). The proportions of smaller fish varied between vessels, probably related to sampling of local scale distributions of smaller snapper. There may also be differences in the retention rates of smaller snapper given the differences in the construction of the codends between the three vessels (Table 4).

For the dominant length classes (26–40 cm F.L.), the CV was less than 20% (Figure 19) and the overall mean weighted CV (MWCV) for the length composition was 23.1%.

The ovaries of most of the sampled female snapper were categorised as “resting” (stage 2) (Figure 20).

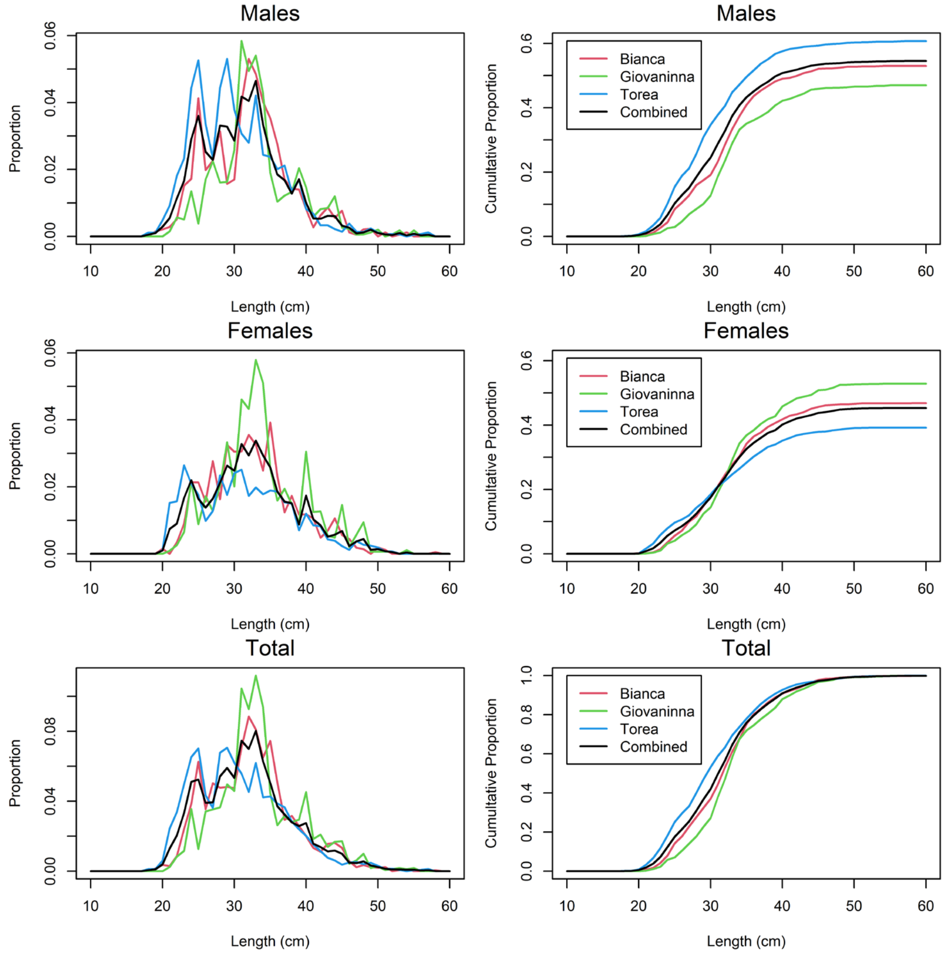

Figure 18: Scaled proportional length compositions (left) and cumulative proportions (right) derived for male, female and all (total) snapper by vessel and combined.

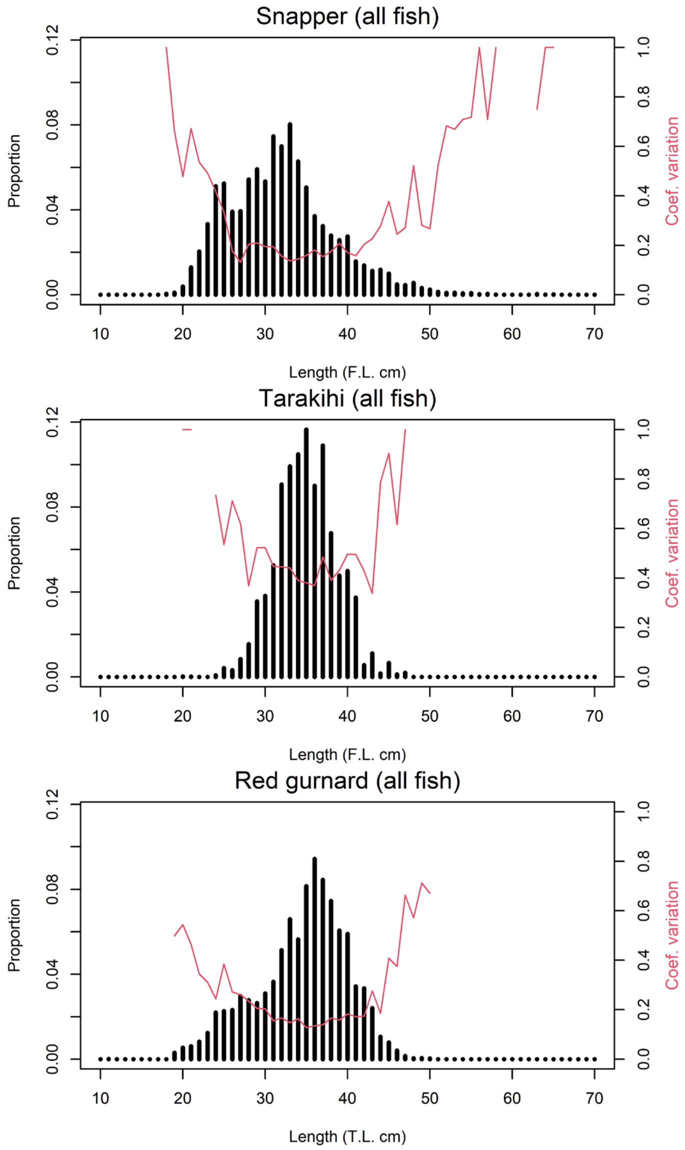

Figure 19: Scaled proportional length compositions derived for all snapper, tarakihi and red gurnard (bars) and the associated coefficient of variation (CV) for each length class (red line).

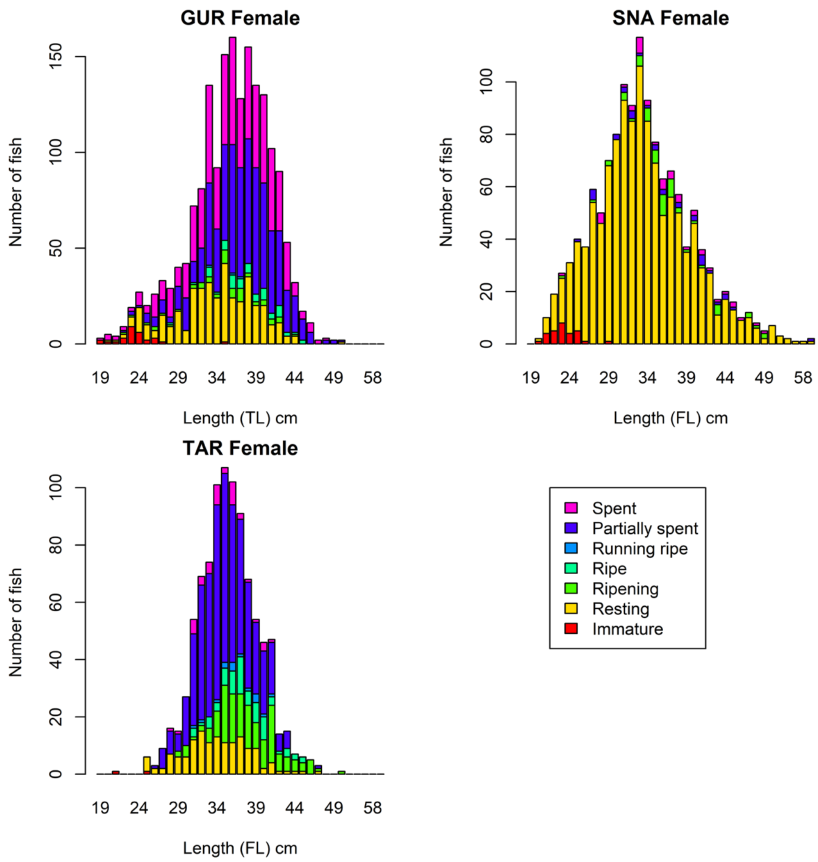

Figure 20: Number of female fish in each stage of ovarian development by length class for red gurnard, snapper and tarakihi (all samples combined).

3.5 Tarakihi

Catches of tarakihi differed considerably between vessels with minor catches by *Giovannina*. Larger catches were taken by *Bianca* and *Torea II* predominantly in the deeper strata (strata S11 and S13) (Figure 21). Correspondingly, the vessel specific biomass index derived for *Giovannina* was very low relative to the other vessels, while the biomass index for *Torea II* was considerably higher than *Bianca* (Table 11), primarily due to the magnitude of biomass in stratum S14 (Figure 17). The high variability in catch rates also resulted in a relatively high CV for the species; i.e., a CV of 36% for the combined vessel index.

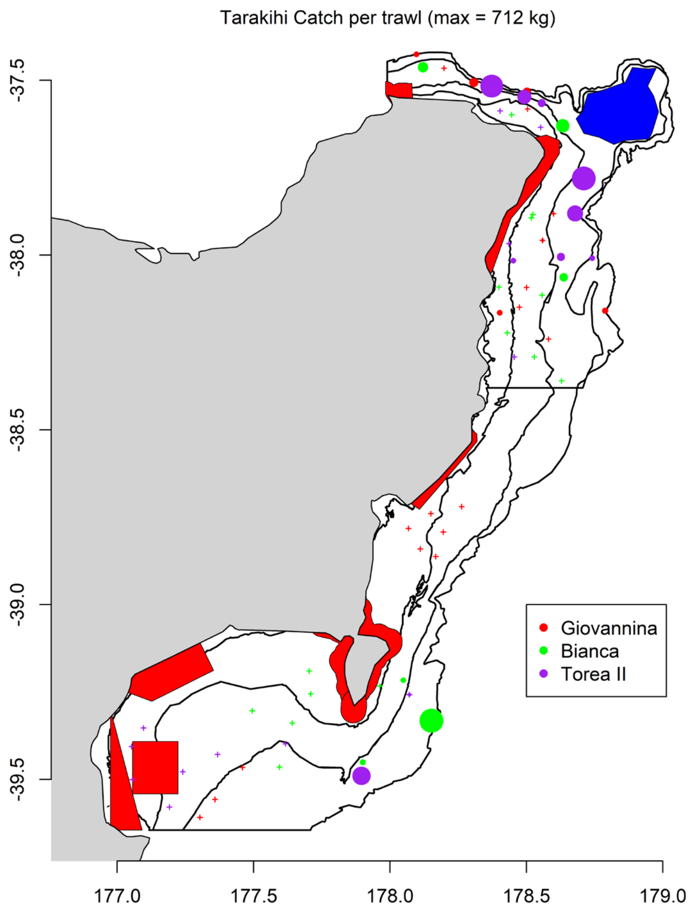

Figure 21: The relative catch (kg per trawl) of tarakihi from the individual survey trawls by vessel. The area of the circle is proportional to the magnitude of the catch. Trawls with no catch are represented by a plus symbol. The boundaries of the survey strata (black lines) and trawl exclusion zones (red polygons) are also shown. The blue area represents the foul ground associated with Ranfurly Banks.

For *Giovannina*, the scaled male and female length compositions were composed of smaller tarakihi compared to the other two vessels (Figure 22). The scaled length composition for *Bianca* was dominated by male fish, whereas the *Torea II* length composition was dominated by female fish, reflecting the influence of the skewed sex ratio of several larger catches. The variability in the sampled catch resulted in a relatively high MWCV of 44.1% for the combined length composition (Figure 19).

Most of the female tarakihi sampled from the *Giovannina* possessed ovaries in a resting or ripening state (Figure 23), while *Bianca* and *Torea II* female samples were dominated by actively spawning tarakihi (ripe, running ripe or partially spent).

These results indicate that *Giovannina* did not adequately sample the main spawning component of the stock, either because most of the vessel's survey trawls were completed before the main spawning period and/or the random trawl positions were outside the main spawning area. An examination of the commercial trawling conducted in association with the trawl survey identified an area of highest tarakihi catch rates around East Cape in a depth of 80–130 m (straddling the S13 and S14 strata). The limited number of *Giovannina* survey trawls in this area were completed before mid March, whereas the other vessels survey trawls were conducted in mid–late March.

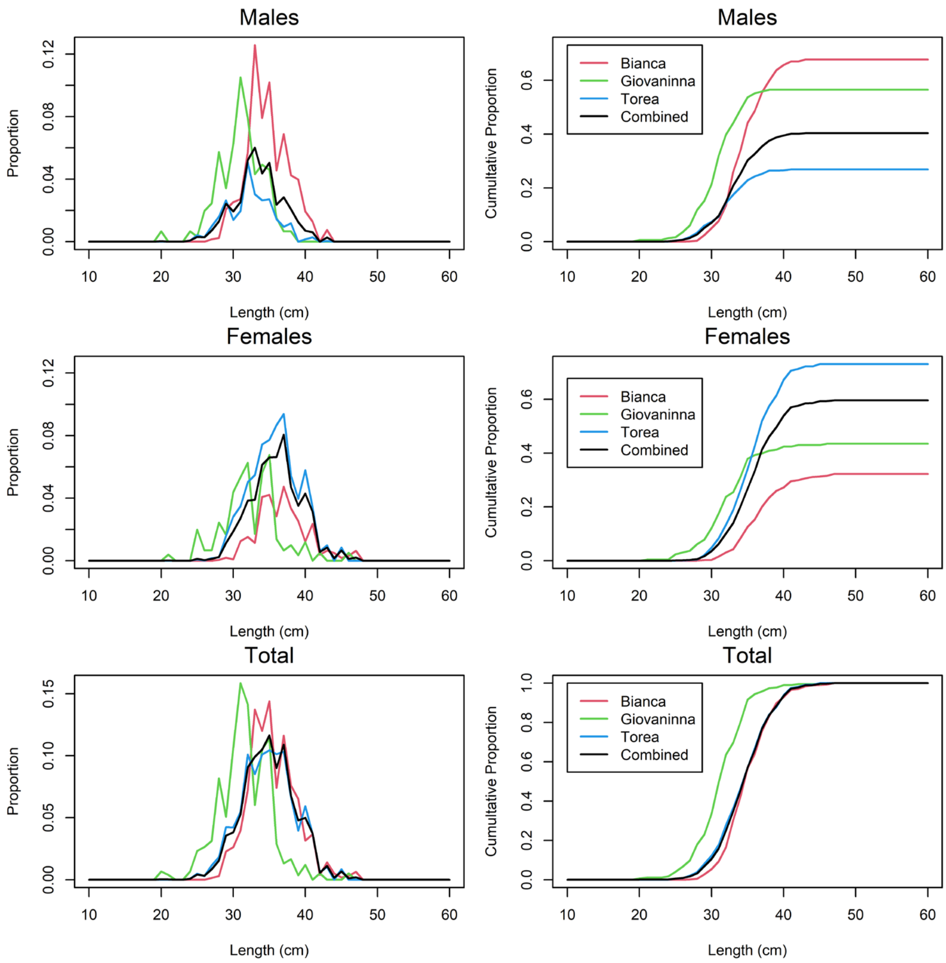

Figure 22: Scaled proportional length compositions (left) and cumulative proportions (right) derived for male, female and all (total) tarakihi by vessel and combined.

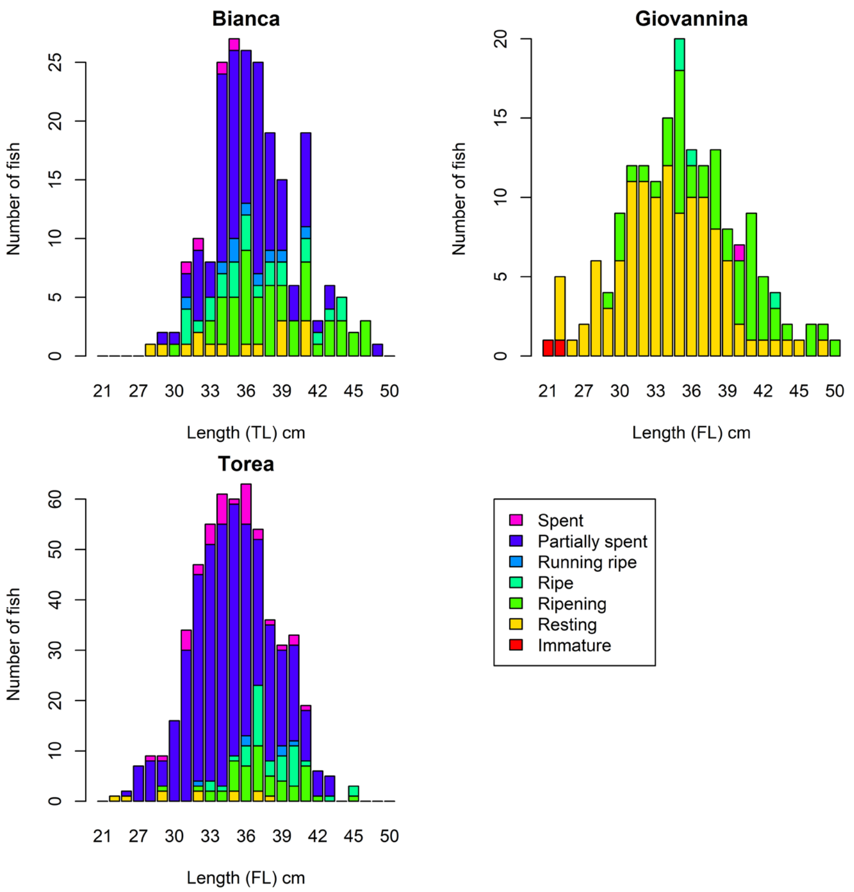

Figure 23: Number of female tarakihi in each stage of ovarian development by length class sampled from the catches of each survey vessel (all samples combined).

3.6 Red gurnard

Red gurnard were caught in most survey trawls (53 of 61 trawls) and catch rates were relatively consistent in the 20–100 m depth range throughout the survey area (Figure 24). Correspondingly, the survey biomass indices for red gurnard, by vessel and combined, were derived with a high level of precision (CV 11–16%) (Table 11).

The survey biomass was dominated by the two larger southern inshore strata (S9 and S10) which accounted for 78% of the combined index (Figure 17). The higher biomass index from *Giovannina* was attributable to considerably higher catch rates in stratum S9 compared to the other two vessels (Figure 17).

Compared to the other two vessels, the scaled length composition from *Torea II* was comprised of fewer large males and a higher proportion of smaller (20–30 cm T.L.) red gurnard (Figure 25). Smaller red gurnard tended to be caught in the shallower area of Hawke Bay where most of the trawls were conducted by *Torea II* (Figure 24). For the combined scaled length composition, the coefficient of variation for the main length classes (30–42 cm T.L.) was less than 20% and the total MWCV for the length composition was 18.8% (Figure 22).

Overall, female red gurnard ovaries were predominantly classified as resting, partially spent or spent (Figure 20). However, there were differences in the ovarian stages between the vessels whose catches were sampled by different staff at different processing facilities (*Giovannina* sampled in Gisborne; *Bianca* and *Torea II* sampled in Auckland) (Figure 26). *Giovannina* catch was predominantly composed of female fish with "resting" ovaries, whereas the other two vessels were dominated by partially spent and spent female fish. Most of the sampling of *Giovannina* catches occurred earlier in the survey period compared to the other two vessels. There was some indication of a transition from resting to ripening or ripe ovaries during late February and early March with partially spent or spent ovaries dominating the sampled catches in late March.

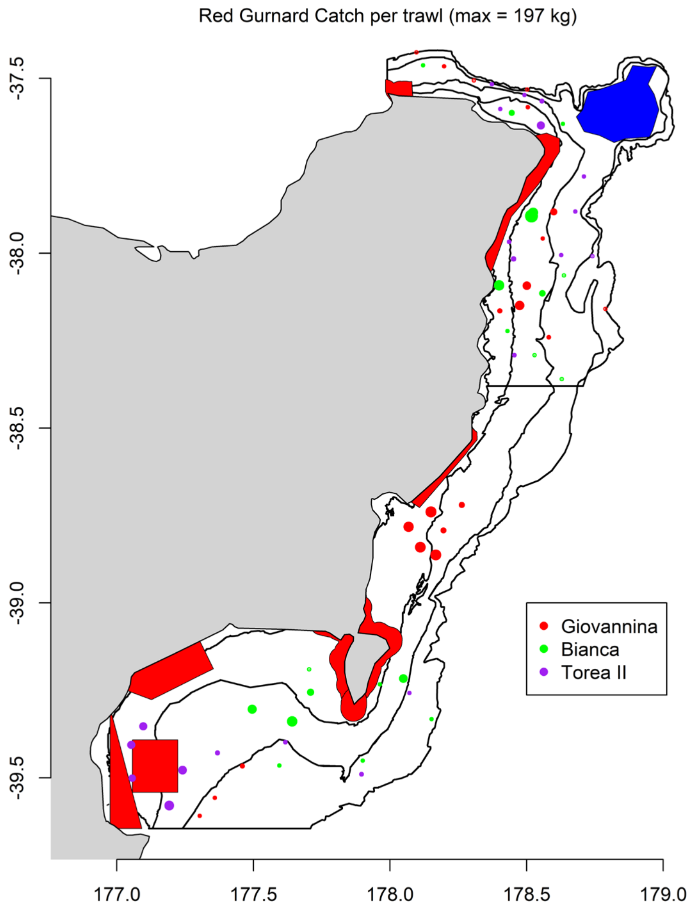

Figure 24: The relative catch (kg per trawl) of red gurnard from the individual survey trawls by vessel. The area of the circle is proportional to the magnitude of the catch. The boundaries of the survey strata (black lines) and trawl exclusion zones (red polygons) are also shown. The blue area represents the foul ground associated with Ranfurly Banks.

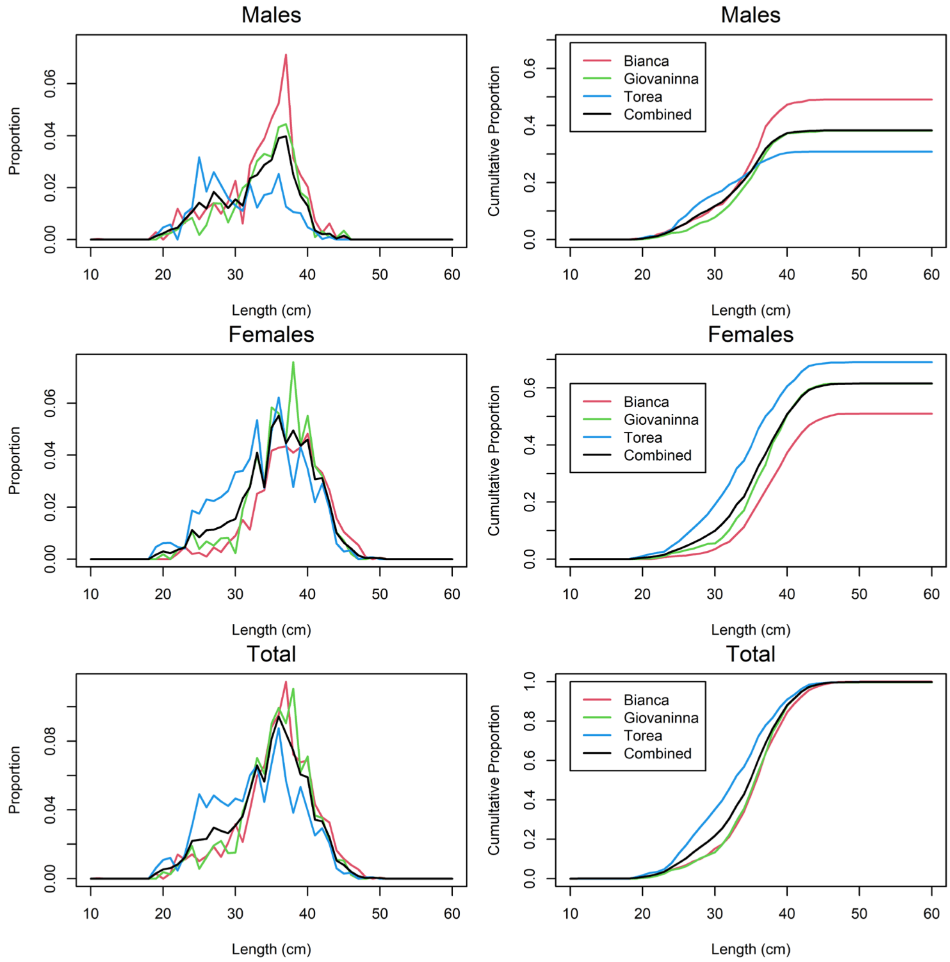

Figure 25: Scaled proportional length compositions (left) and cumulative proportions (right) derived for male, female and all (total) red gurnard by vessel and combined.

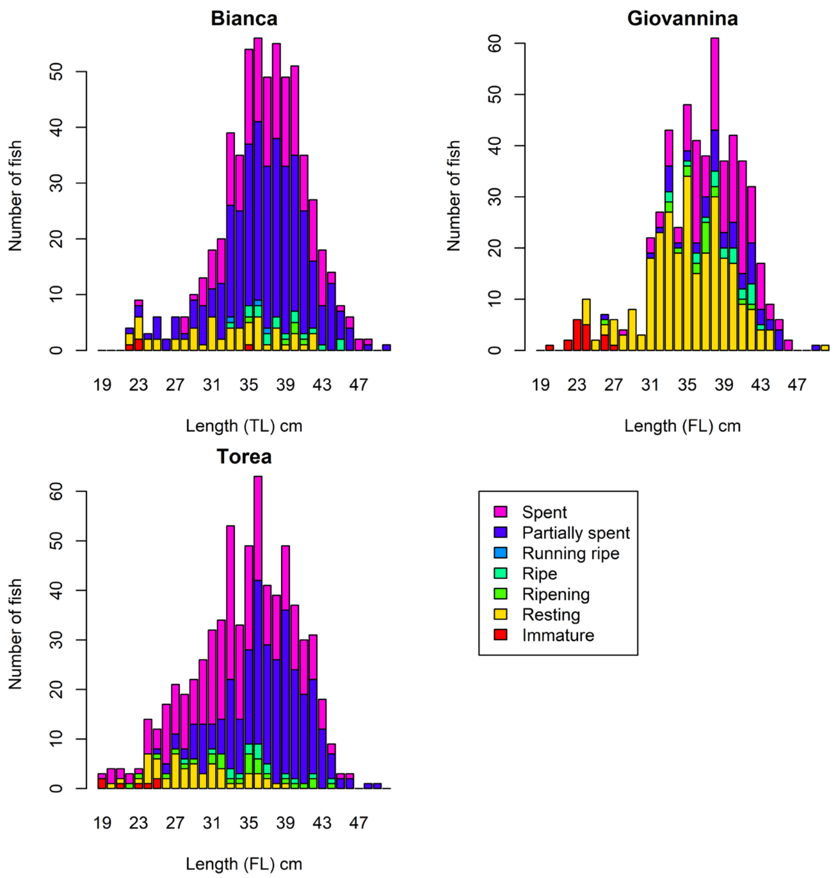

Figure 26: Number of female red gurnard in each stage of ovarian development by length class sampled from the catches of each survey vessel (all samples combined).

3.7 Other species

Trevally was caught frequently during the survey and catch rates were highest in the northern shallow stratum (S12) (Figure 27). The combined survey biomass index was determined with a CV of 22% (Table 11).

John dory, rig and school shark were caught in small quantities at a relatively high proportion of trawl stations (Figure 27). The resulting biomass indices for those species were low with moderate precision for the combined indices (CV 24%, 19% and 29%, respectively) (Table 11).

Gemfish was caught at a relatively small number of trawl stations, principally in the deeper strata around East Cape (strata S14 and S15). No sampling of the gemfish catch was undertaken to ascertain whether the catch was composed of prerecruit or adult gemfish.

Catches of red cod and blue moki were negligible.

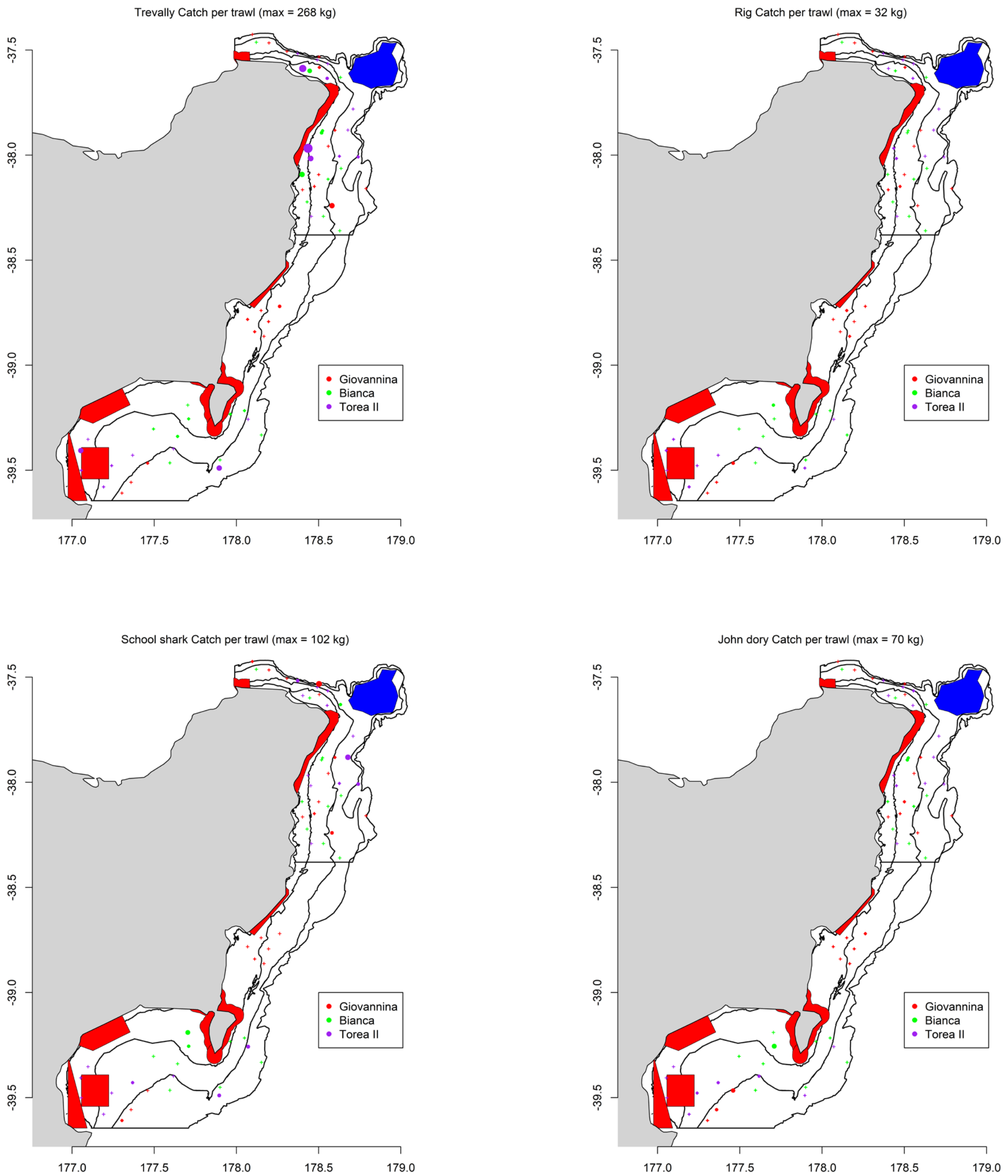

Figure 27: The relative catch (kg per trawl) of trevally, school shark, John dory and rig from the individual survey trawls by vessel. The area of the circle is proportional to the magnitude of the catch. The plus symbol represents no species catch from the trawl. The boundaries of the survey strata (black lines) and trawl exclusion zones (red polygons) are also shown. The blue area represents the foul ground associated with Ranfurly Banks.

3.8 Comparison with previous *Kaharoa* surveys

For the main species of interest, the trawl survey biomass indices and scaled length compositions were compared with the results from the three ECNI *Kaharoa* trawl surveys conducted in the 1990s. Data from those surveys were reanalysed to derive indices and length compositions from the comparable survey strata (strata S9–S15).

For most species, the combined vessel biomass indices from the current study were comparable to the biomass indices derived from the three *Kaharoa* trawl surveys (Table 14, Table 15, Figure 28). The notable exceptions are the very low biomass for red cod and the substantially larger biomass for snapper from the current study. The combined snapper biomass index is approximately 500% greater than the biomass indices from the three *Kaharoa* trawl surveys (Table 15).

Table 14: Trawl survey biomass indices (t) and coefficient of variation (CV, %) for selected species from the northern strata (S9–S15) of the 1990s ECNI *Kaharoa* trawl surveys and the biomass indices derived from the current study (all vessels combined, excluding S15).

Species	KAH9402		KAH9502		KAH9602		This study	
	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
TAR	838	24	657	26	797	16	818	36
SNA	296	22	298	13	362	24	1 664	11
GUR	634	22	141	31	500	40	744	11
SPO	98	20	46	36	112	33	99	19
SCH	225	23	128	25	186	27	164	29
JDO	211	38	131	22	137	59	149	24
RCO	236	55	270	51	1 367	89	3	66
SKI	61	37	99	59	38	43	73	68
TRE	165	28	185	30	126	20	285	22
MOK	33	65	40	33	52	67	5	55

Table 15: Ratio and coefficient of variation (CV, %) of the trawl survey biomass indices (t) from the current study and the corresponding indices from each of the 1990s ECNI *Kaharoa* trawl surveys.

Species	KAH9402		KAH9502		KAH9602	
	Ratio	CV	Ratio	CV	Ratio	CV
TAR	0.98	43	1.25	44	1.03	39
SNA	5.62	25	5.58	17	4.60	26
GUR	1.17	25	5.28	33	1.49	41
SPO	1.01	28	2.15	41	0.88	38
SCH	0.73	37	1.28	38	0.88	40
JDO	0.71	45	1.14	33	1.09	64
RCO	0.01	86	0.01	83	0.00	111
SKI	1.20	77	0.74	90	1.92	80
TRE	1.73	36	1.54	37	2.26	30
MOK	0.15	85	0.13	64	0.10	87

For snapper, there was a larger proportion of smaller (20–30 cm F.L.) fish sampled from the current survey compared to the three *Kaharoa* trawl surveys (Figure 29). This may indicate a period of stronger recruitment in recent years relative to the early 1990s.

For tarakihi, the length compositions from the 1994 and 1995 *Kaharoa* trawl surveys were similar to the length compositions (male, female, combined) from the current study, while the 1996 *Kaharoa* survey was composed of a higher proportion of smaller male fish (Figure 30).

For red gurnard, the sex ratio varied between the *Kaharoa* trawl surveys, particularly the proportion of smaller male fish (Figure 31). By comparison, the length composition of red gurnard from the current study was dominated by larger female fish (Figure 31).

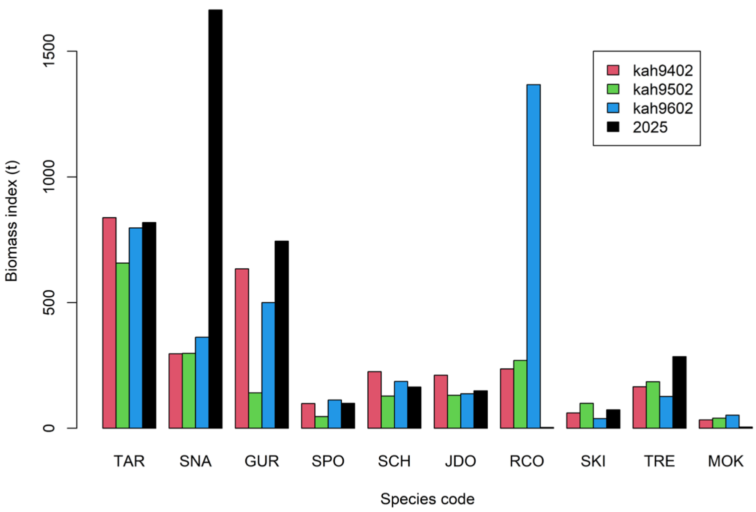

Figure 28: A comparison of the species biomass indices for the northern strata of the 1990s ECNI *Kaharoa* trawl surveys and the combined vessel indices from the current study (2025).

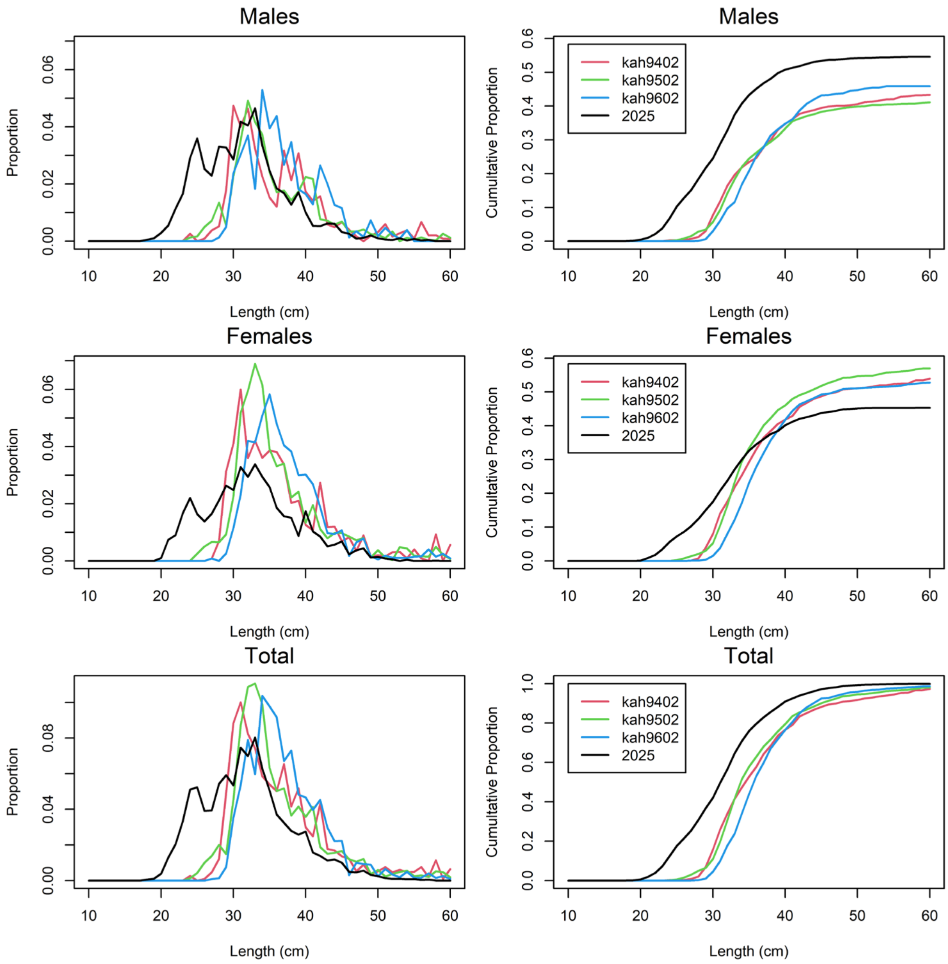

Figure 29: A comparison between the scaled length compositions of male, female and all snapper from the three *Kaharoa* trawl surveys (northern strata S9–S15 only) and the combined length composition from the current study (2025).

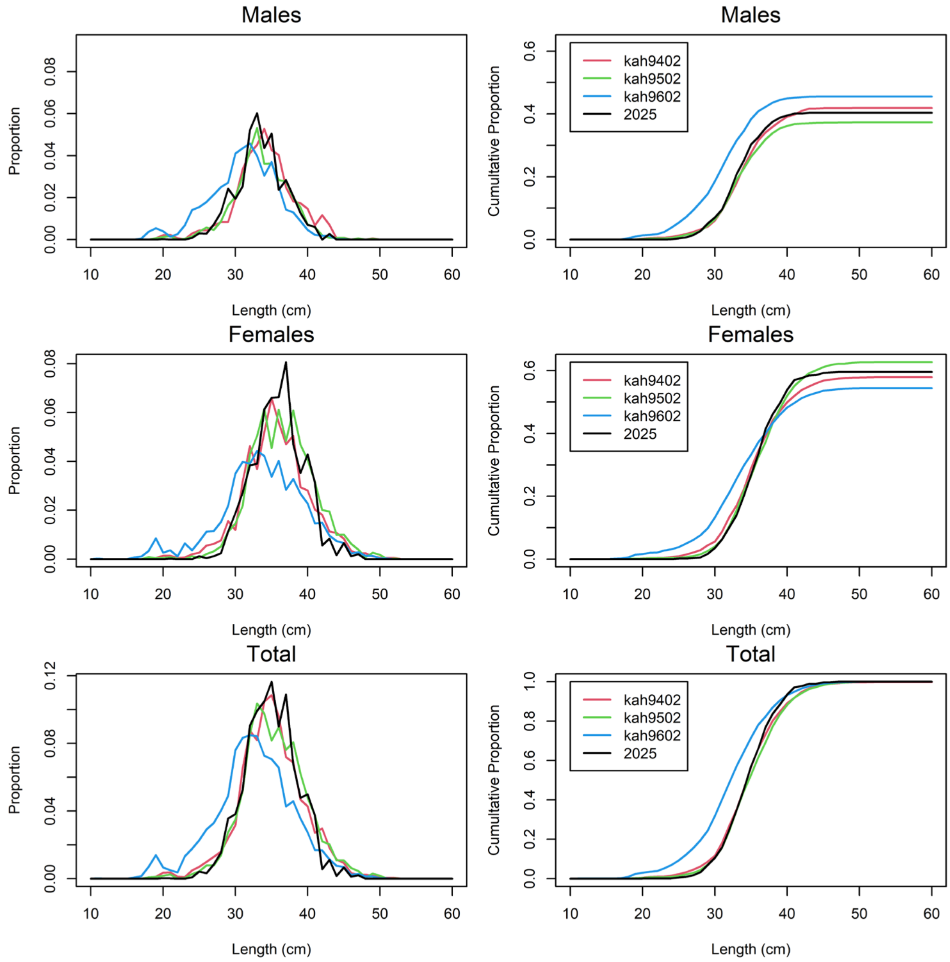

Figure 30: A comparison between the scaled length compositions of male, female and all tarakihi from the three *Kaharoa* trawl surveys (northern strata S9–S15 only) and the combined length composition from the current study (2025).

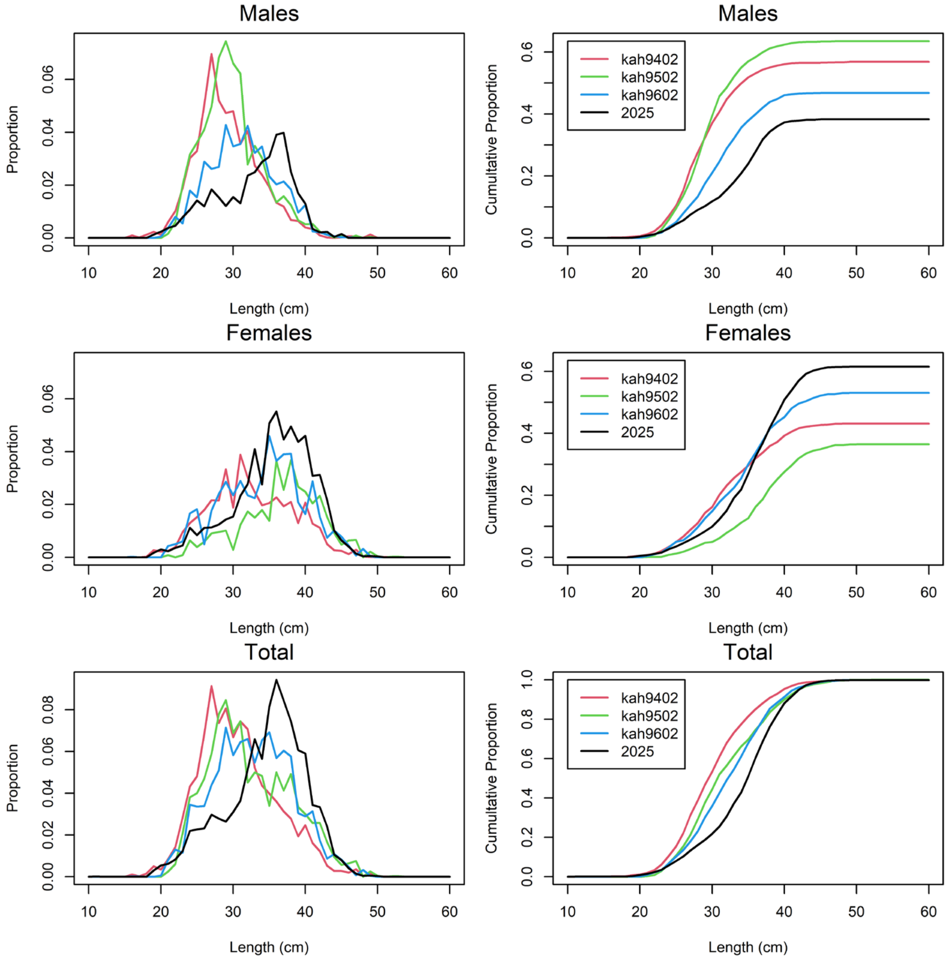

Figure 31: A comparison between the scaled length compositions of male, female and all red gurnard from the three *Kaharoa* trawl surveys (northern strata S9–S15 only) and the combined length composition from the current study (2025).

4. DISCUSSION

The pilot survey demonstrated the ability for commercial vessels to undertake a structured research survey where survey trawls were completed with limited direct supervision. The catches from individual trawls were compartmentalised to enable trawl specific catch weights and species sampling to be conducted at the completion of each fishing trip. While conceptually this approach is relatively straightforward, the success of the survey was due to the high level of cooperation between all parties (vessel operators, skippers, scientific staff, factory staff and managers).

The design of the project utilised the skipper's knowledge of the fishing grounds and the distribution of the main species of interest. Extreme weather events in recent years (including Cyclone Gabrielle) have resulted in terrestrial debris, particularly logs, being deposited in the inshore areas, mainly in close proximity to river mouths. These areas were identified by the vessel skippers and avoided during the survey, minimising potential damage to trawl gear and reducing the time required to locate alternative trawl stations. Similarly, the skippers were able to determine the suitability of potential trawl stations, particularly in the deeper areas of the survey. The survey provided an opportunity for scientific staff to engage more closely with the individual skippers and gain insights into the operation of the commercial fishery and the behaviour of the main fish species, for example seasonal changes in distribution related to spawning and local scale changes in distribution related to the prevailing environmental conditions. This knowledge will contribute to the design of future surveys and the analysis and interpretation of the trawl survey results. In turn, the direct involvement of the commercial sector in the survey programme is likely to increase the understanding of the science process and improve the overall acceptance of the results within the sector.

For the main species of interest, the data collection from the programme approached the quality of data collected from a trawl survey conducted by a dedicated research vessel, such as collected from the previous ECNI *Kaharoa* inshore trawl surveys. Utilising commercial vessels is likely to introduce an additional degree of variability into the process due to differences in the relative fishing power of the individual vessels and trawl gear. The selection of three vessels of comparable size using broadly comparable trawl nets is likely to have reduced the extent of the variability; although there are insufficient data available from the single pilot survey to accurately determine whether or not there were significant differences in the performance of the three vessels. Understanding the variability in catch rates would also be informed by obtaining operational measurements of the trawl gear dimensions (especially door spread) for all vessels.

The collaboration with NIWA provided additional project oversight, including the knowledge and expertise from their established inshore catch sampling and trawl survey programmes. The established NIWA sampling teams in Auckland and Napier provided the capacity to undertake the intensive sampling of the trawl survey catches in coordination with key staff at the processing facilities. The involvement of NIWA also provided an additional level of scrutiny over the entire project. In addition, prior to the commencement of the survey, camera monitoring systems had been installed onboard the three vessels. The imagery collected by the camera systems, integrated with GPS, provide further opportunity to scrutinise and validate the data collected from individual survey stations, if necessary.

For snapper and red gurnard, the pilot survey provided trawl survey biomass indices with a high degree of precision (CV < 25%) either for each vessel or combined across vessels. The survey results were less reliable for tarakihi due to the higher degree of temporal and spatial variation in tarakihi catch rates related to the aggregation of tarakihi associated with spawning. The design of future surveys will be modified to improve the utility of the survey for tarakihi, without compromising the results for the other main species. The pilot survey also yielded acceptable biomass indices for trevally, John dory, rig and school shark (CVs typically 25–35%). However, the survey is unlikely to provide a reliable monitoring tool for gemfish, due to the variability in gemfish catches, or blue moki, probably due to the timing of the survey.

The survey also provided spatially resolved length, sex and gonad stage data for tarakihi, snapper and red gurnard. These data will improve our overall understanding of the distribution of these species within the area of the survey and the definition of the spawning period for tarakihi and red gurnard. From those data, the survey scaled length compositions were derived for each species, revealing comparable results from the three vessels. The age determination of the associated otoliths collected from the sampled catch would enable the age composition of the surveyed populations to be determined.

Unlike dedicated inshore research surveys (e.g. *Kaharoa*), the pilot survey did not collect detailed catch weight data for non-commercial species, including benthic macroinvertebrates such as crustaceans, holothurians (sea cucumbers), ascidians (sea squirts) sponges and bryozoans. As such, the industry-based survey is not designed to collect data to support broader ecosystem monitoring. A full evaluation of the relative merits of the two approaches (dedicated research vs commercial vessels) is yet to be conducted. This will also require a thorough costing of the pilot survey, including accounting for the opportunity costs associated with the loss of vessel fishing time and the additional time spent by factory staff, vessel managers and other project participants.

The previous ECNI *Kaharoa* trawl surveys revealed a high interannual variability in the survey biomass indices from successive surveys for some species (e.g., red gurnard). Those results reduced the utility of the earlier trawl survey programme. It is envisaged that a further survey will be conducted in March 2026 for direct comparison with the results of the pilot survey. This will enable a more thorough evaluation of the trawl survey for monitoring the abundance of key stocks over the medium term (5–10 years), including decisions regarding the longer-term frequency of FMA 2 surveys.

The pilot survey was not intended for direct comparison with the results of the previous ECNI *Kaharoa* trawl surveys, due to differences in the vessel characteristics and particularly differences in the configuration of the trawl gear. The *Kaharoa* trawl surveys used a much larger, high-opening trawl net (Stevenson & Hanchet 1999) compared to the commercial vessels. Regardless, for most species, estimates of trawl survey biomass indices were broadly comparable between the *Kaharoa* surveys and the current study. Snapper was the exception with the biomass indices from the pilot survey approximately 5-fold greater compared to the earlier surveys; the magnitude of the difference for snapper alone is unlikely to be attributable to the differences in vessel and gear. However, the scale of increase in snapper indices is consistent with the increase in snapper CPUE from the FMA 2 trawl fishery over the last decade. This suggests that there may be some utility to broad comparisons between the results from the two sets of trawl surveys, providing some contrast with the stock abundance in the mid-1990s. There is also additional information available from comparing the length compositions of the main species between the two periods.

5. POTENTIAL RESEARCH

The Inshore Working Group reviewed the results of the pilot survey and recommended that the programme be continued in 2025–26. The main recommendations for 2025–26 are as follow.

- To repeat the survey in 2026 to determine the comparability of survey biomass estimates for key species between surveys in successive years. The intention is to retain the three vessels that participated in the pilot survey, potentially also including a new vessel being built for Gisborne Fisheries.
- To collect data on the dimensions of the trawl gear (using door spread sensors) to accurately determine effective door (and wing) spread and, thereby, determine the swept area for individual trawls. For the pilot survey, door spread measurements were only available for *Bianca*. Data collected from the two other vessels would enable the effective door spread to be retrospectively determined for the other two vessels. Ideally, all vessels would use door spread sensors during future surveys.
- The extent of any species specific differences in fishing power between the three vessels (“vessel effect”) could not be determined from the analysis of the limited data collected from the pilot survey. Such analyses should be routinely updated and refined with the additional data from the 2026 survey. Those analyses could also be augmented by extending the analysis to include the vessel specific catch and effort data from commercial trawls. This may enable increased standardisation of the results from the survey, improving the precision of the survey biomass indices and trends.
- For the pilot survey, the three vessels used trawl nets that were comparable in design, although there were differences in the overall gear configuration (length of bridles, sweeps, etc) that may have resulted in differences in the performance of the gear for some species. There is potential to standardise the gear between vessels, including the purchase of survey specific sets of trawl gear for each vessel. This may be appropriate over the longer term once the survey becomes embedded as an established monitoring programme. Otherwise, the differences in the efficiency of the trawl gear are likely to be encompassed in the overall species specific “vessel effect”. However, for 2026 it is recommended to standardise the codends used by the three vessels to ensure that the retention rates of smaller fish, particularly snapper, red gurnard, tarakihi and trevally, are directly comparable between the vessels.
- The results of the pilot survey and associated commercial trawls revealed seasonal and spatial trends in the distribution of tarakihi associated with the spawning aggregation in the area around East Cape (in about 80–130 m depth). It is recommended that the spatial stratification

of the trawl survey be modified to incorporate an additional stratum to encompass this area, thereby, ensuring adequate trawl stations are assigned to the area and reducing the overall variation in the tarakihi survey biomass indices. Similarly, the timing of the survey should be more closely aligned with the main spawning period. For 2025, it appears that the commencement of the survey in mid February preceded the main spawning period of mid-late March. An examination of commercial trawl catch and effort data from previous years also indicated that tarakihi catch rates off East Cape typically increased from mid February and peaked during mid-late March and then declined considerably during early-mid April. On that basis, it is recommended to delay the start of the survey for at least a couple of weeks (until early March) and defer trawling in the key tarakihi stratum until mid March, if possible.

- Locating suitable trawlable ground within the deeper stratum (S15) was difficult. This area is not usually fished by the inshore trawl fleet due to the bottom topography, strong tidal currents and distance from port and established fishing grounds. Limited trawling was also undertaken in this area during previous *Kaharoa* trawl surveys. It is proposed to exclude the area from future trawl surveys. This will be inconsequential for most of the species of interest, with the exception of tarakihi for which the stratum accounted for about 20% of the survey (strata S9–15) biomass from previous *Kaharoa* trawl surveys.
- Consider dividing the southern strata (S9–11) at Mahia Peninsula to partition Hawke Bay and delineate the northern and southern biological stocks of snapper within SNA 2. The smaller strata would also ensure a more even distribution of random trawl stations for each vessel throughout the area.
- Evaluate the merits of extending the survey area to include the southern portion of FMA 2, specifically from Cape Kidnappers to Cape Turnagain off the Wairarapa coast.
- Refine the survey protocols and instructions and the provision of at-sea training for all participating vessels at the commencement of each survey.
- Investigate the potential to further integrate the at-sea station data collection within existing Electronic Reporting platforms (Deckhand, OLRAC), e.g., to include trawl survey station codes (stratum and unique station ID), additional gear parameters (door spread, length of warp) and environmental parameters (e.g. swell height). There is also potential to collect temperature depth profiles from all survey trawls using the data loggers developed under the Moana project.
- Further consultation with Fisheries New Zealand around the access to camera monitoring images to corroborate survey catch and location data.
- Improved data management procedures for the integration of the trawl station data and the individual trawl catch weights and sampling data (by vessel trip). This would enable near real time data checking and could be used to allocate additional (second phase) trawl stations for key species, if necessary.
- Refine the protocols for sampling the catches of individual species; for example, the randomised otolith collection and ensure all small catches sampled. The sampling of catches (for length, sex and stage) could be extended to other species (i.e. TRE, SPO, SCH and JDO). This would improve the monitoring of rig and school shark as both species were landed in an unprocessed state during the survey to enable accurate catch weights to be determined.
- Review the frequency and intensity of otolith sampling for each species.

6. ACKNOWLEDGMENTS

The project was funded directly by Seafood New Zealand and Fisheries New Zealand (SEA2022-14) with the additional funding and support from the range of participants, including FMA 2 commercial operators and processors, fisheries managers and researchers. The success of the project was attributable to the high level of cooperation amongst the various organisations and individual, most notably.

- Skippers of *Giovannina* (Blethyn “Footy” Hulton), *Bianca* (Ross Lepper, Jason Naidanovich), *Torea II* (Forest Brown) and crew.
- Gisborne Fisheries and Moana New Zealand.

- Brent Wood (NIWA) – training, coordinator, sampling, data management.
- Vessel owners and managers: Salvatore Zame & Hilton Slement (Gisborne Fisheries), Hamish Quested (Fresh Regional Produce Fishing), Andy Claudatos & Dean Gulbransen (Star Fish), Nathan Reid (Moana NZ).
- Project managers: Tiff Bock & Rosa Edwards (Seafood NZ Inshore Council), Nathan Reid (Moana NZ), Richard O'Driscoll and Darren Parsons (NIWA).
- Factory staff at Moana NZ Auckland and Gisborne Fisheries.
- Sampling staff: Helena Armiger, Ollie Evans and team (NIWA, Auckland).
- Vessel unloading crews (Napier).
- FishServe: the provision of daily reports of survey trawls.
- Inshore Working Group: the review of survey design and results.
- Marc Griffiths (Inshore Working Group Chair): project coordination and review of the final report.

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APPENDIX 1: STATION DATA

Table A1: Summary of the trawl survey station data from each vessel.

Vessel	Station	Stratum	Date	Time	Start Lat/Long		End Lat/Long		Gear depth (m)		Distance	Door	Gear perf
					° ' S	° ' E	° ' S	° ' E	Min.	Max.	(n.miles)	spread	
Bianca	1	10	24/02/2025	523	391298	1780294	391586	1780168	83	84	3.04	130	1
Bianca	2	10	24/02/2025	940	392034	1773850	391880	1773536	73	74	2.87	136	1
Bianca	3	10	24/02/2025	1144	391823	1772972	391789	1772608	61	65	2.83	123	1
Bianca	4	13	15/03/2025	939	375361	1783107	375678	1782942	65	66	3.42	131	1
Bianca	5	14	15/03/2025	1224	380380	1783821	380708	1783769	159	165	3.30	168	1
Bianca	6	13	15/03/2025	1421	380688	1783345	380384	1783478	89	91	3.21	129	1
Bianca	7	12	15/03/2025	1719	381335	1782580	381654	1782549	40	41	3.19	110	1
Bianca	8	13	16/03/2025	545	381748	1783173	382055	1783170	81	88	3.07	128	1
Bianca	9	14	16/03/2025	746	382159	1783772	382469	1783657	121	129	3.22	136	1
Bianca	10	9	16/03/2025	1650	391398	1775776	391122	1775921	44	47	2.97	114	1
Bianca	11	9	17/03/2025	553	391533	1774257	391231	1774085	37	40	3.30	117	1
Bianca	12	9	17/03/2025	735	391140	1774223	391160	1773824	36	37	3.09	108	1
Bianca	13	12	19/03/2025	1044	380552	1782395	380218	1782403	36	42	3.34	111	1
Bianca	14	13	19/03/2025	1424	375302	1783142	375003	1783353	64	65	3.42	124	3
Bianca	15	14	19/03/2025	1628	373780	1783798	373546	1783728	96	112	2.40	147	1
Bianca	16	14	21/03/2025	834	372776	1780725	372907	1780980	120	154	2.41	160	1
Bianca	17	12	21/03/2025	1155	373592	1782675	373680	1783038	39	41	3.00	107	1
Bianca	18	11	22/03/2022	735	391993	1780912	392263	1780680	147	149	3.24	156	1
Bianca	19	11	22/03/2025	1035	392705	1775400	392979	1775288	109	129	2.87	147	1
Bianca	20	11	22/03/2025	1340	392790	1773569	392893	1773210	112	118	2.95	147	1
Gio	1	9	20/02/2025	604	384439	1780899	384692	1780637	36	40	3.25	NA	1
Gio	2	9	20/02/2025	828	384692	1780406	384927	1780116	32	38	3.26	NA	1
Gio	3	10	20/02/2025	1110	384754	1781172	384455	1781403	55	56	3.49	NA	1
Gio	4	10	20/02/2025	1309	384319	1781578	383988	1781704	59	63	3.45	NA	1
Gio	5	13	24/02/2025	1457	375747	1783355	380065	1783331	85	92	3.18	NA	1
Gio	6	12	25/02/2025	504	380990	1782413	380666	1782400	36	37	3.24	NA	1
Gio	7	13	25/02/2025	723	380557	1783002	380885	1782995	66	70	3.28	NA	1
Gio	8	14	28/02/2025	1221	372795	1781189	372843	1780792	136	141	3.18	NA	1
Gio	9	15	28/02/2025	1432	372554	1780582	372532	1780949	283	296	2.92	NA	1
Gio	10	14	1/03/2025	508	373036	1781843	373101	1782249	123	139	3.28	NA	1
Gio	11	15	1/03/2025	722	373192	1783013	373267	1783363	210	245	2.87	NA	1
Gio	12	12	1/03/2025	931	373494	1783025	373685	1783324	35	40	3.04	NA	1

Vessel	Station	Stratum	Date	Time	Start Lat/Long		End Lat/Long		Gear depth (m)		Distance	Door	Gear perf
Gio	13	13	1/03/2025	1501	380896	1782844	381223	1782855	59	62	3.27	NA	1
Gio	14	14	16/03/2025	903	375290	1783596	375612	1783556	106	107	3.23	NA	1
Gio	15	15	16/03/2025	1246	380955	1784729	380687	1784808	287	296	2.75	NA	1
Gio	16	14	16/03/2025	1613	381443	1783486	381678	1783476	108	115	2.35	NA	1
Gio	17	10	17/03/2025	1040	385176	1781006	384871	1780948	50	54	3.08	NA	1
Gio	18	9	17/03/2025	1249	385045	1780666	384735	1780624	39	45	3.11	NA	1
Gio	19	11	29/03/2025	600	393652	1771820	393423	1772092	107	109	3.10	NA	1
Gio	20	11	29/03/2025	741	393344	1772152	393126	1772435	107	109	3.08	NA	1
Gio	21	11	29/03/2025	933	392798	1772757	392624	1773093	98	101	3.12	NA	1
Torea II	1	10	10/03/2025	546	393476	1771150	393137	1771237	60	631	3.45	NA	1
Torea II	2	10	10/03/2025	741	392869	1771443	392547	1771607	58	63	3.46	NA	1
Torea II	3	9	10/03/2025	1055	393004	1770338	392671	1770450	24	30	3.44	NA	1
Torea II	4	9	10/03/2025	1335	392436	1770318	392046	1770345	30	33	3.90	NA	1
Torea II	5	11	16/03/2025	830	391545	1780426	391859	1780291	105	106	3.30	NA	1
Torea II	6	11	16/03/2025	1220	392938	1775371	392718	1775685	123	130	3.27	NA	1
Torea II	7	11	16/03/2025	1605	392388	1773702	392495	1773383	96	102	2.68	NA	1
Torea II	8	10	17/03/2025	640	392572	1772210	392782	1771907	74	75	3.14	NA	1
Torea II	9	9	17/03/2025	1010	392118	1770582	392482	1770621	41	42	3.65	NA	1
Torea II	10	12	22/03/2025	650	373807	1783312	373621	1782951	33	39	3.41	NA	1
Torea II	11	15	22/03/2025	950	373100	1782239	373204	1782675	125	130	3.61	NA	1
Torea II	12	12	22/03/2025	1405	373527	1782421	373637	1782849	38	40	3.56	NA	1
Torea II	13	14	22/03/2025	1750	374685	1784259	374935	1783932	120	122	3.59	NA	1
Torea II	14	14	23/03/2025	645	375284	1784070	375556	1783799	130	164	3.45	NA	1
Torea II	15	13	28/03/2025	1015	381749	1782732	381428	1782739	54	54	3.21	NA	1
Torea II	16	13	28/03/2025	1345	380096	1782712	375720	1782748	54	55	3.77	NA	1
Torea II	17	12	28/03/2025	1620	375805	1782615	375453	1782730	46	49	3.63	NA	1
Torea II	18	14	29/03/2025	830	380033	1783758	375716	1783783	118	118	3.17	NA	1
Torea II	19	15	29/03/2025	1715	380052	1784445	380320	1784246	223	2271	3.10	NA	1
Torea II	20	13	30/03/2025	650	373286	1782954	373195	1782467	97	100	3.96	NA	1
Torea II	21	15	30/03/2025	1055	373390	1783335	373280	1782952	88	105	3.22	NA	1

Table A2: Station catches (kg) for the priority species, by species code.

Vessel	Station	Species code									
		GUR	JDO	MOK	RCO	SCH	SKI	SNA	SPO	TAR	TRE
Bianca	1	80.5	5.0	0.0	0.0	4.0	1.0	14.5	5.0	28.5	14.5
Bianca	2	119.5	5.5	0.0	0.0	0.0	0.0	21.5	0.0	0.5	21.5
Bianca	3	91.0	5.5	0.0	0.0	0.0	0.0	53.0	0.0	0.0	8.5
Bianca	4	89.0	4.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	10.5
Bianca	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.5	0.0
Bianca	6	41.5	11.0	0.0	0.0	2.0	0.0	0.0	5.0	0.0	5.5
Bianca	7	1.5	0.0	0.0	0.0	0.0	0.0	524.0	0.0	0.0	4.5
Bianca	8	0.0	0.0	0.0	0.0	0.0	0.0	154.0	0.0	0.0	0.0
Bianca	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bianca	10	7.5	0.0	0.0	0.0	2.5	0.0	57.5	2.0	0.0	17.5
Bianca	11	52.5	70.5	0.0	0.0	31.0	0.0	154.5	2.0	0.0	15.5
Bianca	12	0.0	0.0	0.0	0.0	67.5	0.0	293.0	27.5	0.0	0.0
Bianca	13	122.5	7.0	0.0	0.0	3.0	0.0	174.5	2.0	0.0	85.0
Bianca	14	108.5	23.5	0.0	0.0	4.5	0.0	178.5	2.5	0.0	23.0
Bianca	15	4.5	0.0	0.0	1.0	26.5	0.0	12.0	2.0	211.0	0.0
Bianca	16	4.0	0.0	0.0	0.0	0.0	0.5	11.0	0.0	121.0	0.0
Bianca	17	35.0	0.0	0.0	0.0	2.0	0.0	449.0	6.5	0.0	62.0
Bianca	18	4.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	712.5	0.0
Bianca	19	13.5	2.5	0.0	0.0	0.0	0.0	0.0	6.0	33.5	2.0
Bianca	20	10.0	6.5	0.0	0.0	0.0	0.0	8.5	0.0	1.5	4.5
Gio	1	135.0	7.0	0.0	0.0	1.6	0.0	246.0	18.6	0.0	5.2
Gio	2	117.8	7.4	0.0	1.6	1.4	0.0	282.0	3.4	0.0	14.0
Gio	3	34.6	8.8	0.0	0.0	0.0	0.0	42.2	3.0	0.0	8.0
Gio	4	36.2	19.6	2.6	0.0	0.0	0.0	82.8	6.6	0.0	32.6
Gio	5	13.8	1.2	0.0	0.0	0.0	0.0	32.6	0.0	6.0	1.8
Gio	6	25.6	0.0	1.8	0.0	0.0	0.0	195.4	7.8	30.0	3.0
Gio	7	77.0	18.6	0.0	0.0	1.6	0.0	88.4	0.0	0.0	4.6
Gio	8	3.8	0.0	0.0	0.0	3.4	0.0	8.8	0.0	1.6	0.0
Gio	9	0.0	0.0	0.0	4.8	13.2	62.2	0.0	0.0	29.8	0.0
Gio	10	0.0	0.0	0.0	7.4	0.0	51.4	0.0	5.0	91.2	0.0
Gio	11	0.0	0.0	0.0	0.0	102.6	68.2	0.0	0.0	67.2	0.0
Gio	12	16.6	0.8	0.0	0.0	0.0	0.0	532.2	11.0	1.0	20.0
Gio	13	97.2	7.6	0.0	0.0	10.8	0.0	194.4	15.4	0.0	7.6
Gio	14	51.6	7.4	0.0	0.0	18.6	0.0	61.6	0.0	3.2	9.8
Gio	15	0.0	0.0	0.0	0.0	3.2	344.6	0.0	0.0	37.8	0.0
Gio	16	19.4	4.0	0.0	0.0	33.8	0.0	12.8	1.8	0.0	83.2
Gio	17	131.0	8.0	4.0	0.0	0.0	0.0	143.8	14.6	0.0	3.6
Gio	18	130.0	3.8	3.6	0.0	5.8	2.8	137.4	3.0	0.0	13.0
Gio	19	12.6	8.8	0.0	0.0	19.8	4.8	3.6	3.8	1.8	3.6
Gio	20	9.2	28.0	0.0	0.0	0.0	0.0	7.8	6.8	0.0	2.2
Gio	21	22.8	53.0	0.0	0.0	0.0	0.0	12.2	32.6	0.0	17.6
Torea II	1	105.0	9.0	0.0	0.0	1.0	0.0	112.0	17.5	0.5	6.0
Torea II	2	80.0	18.5	0.0	0.0	3.0	0.0	93.5	4.5	0.0	9.0
Torea II	3	56.5	0.0	0.0	0.0	0.0	0.0	32.0	0.0	1.0	10.5
Torea II	4	68.5	0.5	0.0	0.0	4.0	0.0	131.0	11.0	0.0	84.0
Torea II	5	5.5	1.5	0.0	0.0	42.0	0.0	23.5	2.5	8.0	2.0
Torea II	6	19.5	5.5	0.0	0.0	40.5	0.1	3.5	11.5	406.5	86.0
Torea II	7	19.0	24.5	0.0	0.0	3.0	0.0	25.5	3.0	1.0	1.0
Torea II	8	23.5	23.5	0.0	0.0	24.5	0.0	92.0	5.5	0.0	2.5
Torea II	9	68.0	2.5	0.0	0.0	0.0	0.0	102.0	9.5	0.0	1.0
Torea II	10	69.0	0.0	0.0	0.0	5.5	0.0	973.5	7.5	0.0	28.0
Torea II	11	2.5	0.0	0.0	26.5	33.0	2.5	14.0	1.0	641.0	1.5
Torea II	12	9.5	0.5	0.0	0.0	0.0	0.0	552.0	3.0	0.0	160.5
Torea II	13	13.0	2.0	0.0	0.5	0.0	27.5	45.0	0.0	706.5	3.5
Torea II	14	1.5	0.0	0.0	0.0	90.0	187.5	11.5	0.0	305.5	0.0
Torea II	15	18.5	0.0	0.0	0.0	0.0	0.0	375.5	0.0	0.0	0.0
Torea II	16	26.5	10.5	0.0	0.0	0.0	0.0	492.0	16.0	28.0	94.0
Torea II	17	17.0	5.5	0.0	0.0	0.0	0.0	332.0	17.0	0.5	268.5
Torea II	18	10.5	2.5	0.0	0.0	16.5	0.0	54.5	0.0	69.5	14.5
Torea II	19	0.0	0.0	0.0	0.0	35.5	258.0	0.0	0.0	30.5	22.5
Torea II	20	3.5	4.0	0.0	0.0	3.0	2.0	23.0	0.0	230.5	1.5
Torea II	21	22.0	14.0	2.5	2.0	8.5	6.5	81.5	0.0	65.5	1.5

APPENDIX 2: GONAD MATURITY STAGES

Stage	State	Males	Females
1	Immature	Testes small and translucent threadlike or narrow membranes.	Ovaries small and translucent. No developing oocytes.
2	Resting	Testes thin and flabby; white or transparent.	Ovaries are developed, but no developing eggs are visible.
3	Ripening	Testes firm and well developed, but milt is present.	Ovaries contain visible developing eggs, but no hyaline eggs present.
4	Ripe	Testes large, well developed; milt is present and flows when testis is cut, but not when body is squeezed.	Some or all eggs are hyaline, but eggs are not extruded when body is squeezed.
5	Running ripe	Testis is large, well formed; milt flows easily under pressure on the body.	Eggs flow freely from the ovary when it is cut or the body is pressed.
6	Partially spent	Testis somewhat flabby and may be slightly bloodshot but milt still flows freely under pressure on the body.	Ovary partially deflated, often bloodshot. Some hyaline and ovulated eggs present and flowing from a cut ovary or when the body is squeezed.
7	Spent	Testis is flabby and bloodshot. No milt in most of testis, but there may be some remaining near the lumen. Milt not easily expressed even when present.	Ovary bloodshot; ovary wall may appear thick and white. Some residual ovulated eggs may still remain but will not flow when body is squeezed.