New Zealand Inshore Trawl and Danish seine gear survey

Prepared for Seafood New Zealand

May 2026

Prepared by:
Emma G. Jones, Melanie J. Underwood, New Zealand Earth Sciences.

For any information regarding this report please contact:

Emma Jones
Fisheries scientist

+64 9 375 2056
Emma.Jones@earthsciences.nz

New Zealand Institute for Earth Science Limited
Private Bag 99940
Auckland 1149

Phone +64 9 375 2050

Client Report No: 2026011AK
Report date: May 2026
Project No: SNZ24101

Revision	Description	Date
Version 1.0	Final version sent to client	11 May 2026

Quality Assurance Statement		
	Reviewed by:	Dan MacGibbon
	Formatting checked by:	Alex Quigley
	Approved for release by:	Richard O'Driscoll

Contents

Tables

Figures

Executive summary

New Zealand's inshore fisheries are economically important but face increasing scrutiny over the ecological impacts of bottom-contact fishing methods such as bottom trawl and Danish seine. Understanding these impacts requires up-to-date, detailed knowledge of fishing gear configurations and how they have changed over time. A comprehensive baseline survey of the fleet in 2007 documented largely traditional gear, with regional differences and early pockets of innovation. Seventeen years on, a national repeat survey is timely to capture ongoing voluntary innovation and modernisation, providing robust New Zealand-specific data to better assess environmental impacts and improvements in selectivity, bycatch reduction, and benthic interaction in the inshore trawl and Danish seine fisheries.

An online questionnaire was followed with phone call interviews to increase participation resulting in a coverage of 44 inshore bottom-trawl vessels, representing roughly one-third of the current New Zealand inshore trawl fleet, and around half of the smaller number of Danish seines. Based on our responses, the fleet remains ageing, with most vessels over 30 years old, but technology uptake has increased since 2007, with between 20–47% of respondents investing in different fuel and trawl monitoring systems, although cost remains a barrier for smaller operators.

Compared with 2007, there were a greater proportion of commercially manufactured steel doors and fewer wooden doors, with commercial doors being heavier but built to more hydrodynamic, fuel-efficient designs. There seems to be enthusiastic uptake of more modern synthetic materials for warps and sweeps which are designed to be lighter and reduce impacts on the seabed. Some vessels have gone further, lifting sweeps off the seabed using discs or sections of buoyant rope, but no vessels reported fully off-bottom doors.

Net and groundgear designs, sizes and headline heights have not changed substantially overall, but there were a greater proportion of vessels using rubber cookie style ground gear compared to rope and chain combinations, with diameters of between 40–100 mm. The use of rubber material means in-water weights are much reduced and with most estimates being < 100 kg.

A substantial change since 2007 is the widespread voluntary adoption of larger codend mesh sizes and turned meshes (T90 or square), with 84% of respondents increasing mesh size and/or using turned mesh, indicating a fleet-level shift toward improved selectivity and reduced retention of undersized fish, albeit with outcomes influenced by species morphology and net construction details such as twine thickness, lengthener and codend dimensions.

The changes reflect a strong motivation to improve fishing practices; over 80% of respondents cited improved size selectivity of target species, reduction of unwanted bycatch as their rationale for gear set-ups. Improving fuel efficiency was a motivator for 72%, and over half were making changes to reduce the impacts of their fishing gear on the seabed. Confidence in effectiveness of changes varied from mostly high for selectivity and efficiency to moderate for reducing seabed impacts, with many expressing an interest in being provided with further information.

The proactive efforts and positive gear changes identified in this survey should be recognised and strengthened by expanding the survey to improve fleet-wide representativeness. However, there remains a need for New Zealand-specific empirical data on the impacts of trawl and Danish seine gear modifications to inform future innovation and public discussion.

1 Introduction

New Zealand's inshore commercial fisheries contribute significantly to the country's domestic economy, as well as providing high quality exports. Bottom trawling is one of the main fishing methods utilised both here and overseas. However, along with other methods, such as Danish seine, there is increasing scrutiny of the potential adverse impacts on seafloor habitats and the wider ecosystem in which they operate (i.e., levels of unintended catch).

To address this scrutiny, and better understand fishery impacts, it is important to start with an accurate and detailed understanding of the type and configuration of fishing gear currently in use in New Zealand, how this varies by region and fishery, and has changed over time. The Fisheries (Commercial Fishing) Regulations 2001 prescribe the trawl net restrictions within which commercial vessels must operate, and some characteristics of fishing gear are required to be reported to Fisheries New Zealand through reporting regulations. Along with vessel specifications, the wingspread and headline height of nets have historically been recorded by commercial fishers on the TCEPR and TCER forms, either estimated from the net plan, or measured using trawl monitoring equipment. The mesh sizes being used in nets was not recorded prior to the Electronic Reporting System (ERS) being introduced and was assumed to be the minimum legal mesh size for the area and fishery the vessel was operating in. Since 2019, codend mesh size is now recorded through the ERS along with the use of protected species mitigation devices. Where fisheries observers are onboard, more detailed information on the trawl gear set-up is often recorded, such as the type of trawl door, headline length as well as height, maximum size of ground gear, ground gear components and details of the trawl lengthener (Jones et al. 2021). However, observer coverage of the inshore fleet has been limited largely due to the difficulty of accommodating extra people onboard smaller vessels, has not been evenly distributed across all areas and fisheries and has now been superseded by the introduction of onboard cameras.

A Seafood Innovations-funded survey in 2007 gathered baseline information via face-to-face interviews with skippers of 153 trawlers operating in the inshore fisheries, representing approximately 80% of the fleet at the time (Clement & Associates Ltd 2008). The survey reported various metrics including the average age of the vessels used, engine horsepower, towing speed, door sizes, headline height and netting materials used. Many aspects, such as tow speed and headline height varied by region and depended on the target species. Codend mesh size was not specifically reported on, but the largest mesh size used in the net was noted. The netting materials used were considered relatively traditional, although "T90" mesh was starting to be used by a small proportion of vessels. This concept is to turn traditional diamond-shaped mesh 90°, which changes knot orientation and prevents mesh from closing up under tension. Keeping meshes open under tension improves water flow and size selectivity. The authors considered that whilst there were pockets of innovation, there were also some well-established regional practices that were focused on total catch efficacy rather than fuel efficiency.

Since then, a Fisheries New Zealand-funded project reviewing data collected on trawl gear through commercial fishing returns and the observer programme found evidence of reduced trawl headline height over time in some areas which was attributed to avoidance of snapper due to ACE limitations (Jones et al. 2021). A shift towards larger codend mesh sizes to reduce catches of unwanted and undersized fish was also evident. Increases in both codend and lengthener mesh size, and the use of turned mesh such as T90 and T45 (whereby the mesh is turned 45°) or square mesh were also found in a smaller-scale skipper interview study conducted by NIWA in 2014 in the South Island (E. Jones, unpublished data), and more recently as part of skipper interviews carried out for Moana Ltd of its own North Island skippers (Eayrs and Craig 2023). The latter study also noted a number of modifications that have been made by vessels to improve fuel efficiency and/or reduce seabed impact. The use of more efficient high aspect-ratio trawl door designs was reported. These designs have a reduced "footprint" compared to traditional trawl doors by virtue of narrower width, increased height and lower angle of attack, and have the potential to be fished off the seabed to further reduce impacts on the seafloor and improve fuel efficiency (He 2007; He and Winger 2010). The first known New Zealand trial of bottom trawling with trawl doors lifted off the seabed was undertaken by NIWA (Jones 2014; reported in Eayrs et al. 2020) and demonstrated a 16% reduction in fuel use, but also a reduction in total catch rates.

Seventeen years after the 2007 review, a repeat survey at a national fleet level is timely and important in order to document the nature of trawl and other gear used here in New Zealand, as well as the voluntary innovation and modernization of the fleet. This will ensure that there is accurate New Zealand-specific information with which to assess the impacts of bottom-contacting fishing gear on New Zealand marine environments. The objectives of the survey were to create an online questionnaire that could be sent to skippers and/or owners of vessels to record the components, configuration and operation of bottom trawl and Danish seine gear used by inshore vessels depending on the target species. The questionnaire was designed to provide Seafood New Zealand with a database of operator, gear details and gear improvements and innovations in the inshore trawl and Danish seine fisheries that allow some understanding of improvements in relation to key aspects such as improved selectivity, bycatch reduction and reduced benthic impact since the previous survey in 2007.

Methods

Questionnaire construction and distribution

A draft list of questions was prepared, with a starting point of the 2007 survey (Clement & Associates Ltd 2008). This consisted of 74 questions completed on a paper form as part of face-to-face interviews. The 2024 questionnaire dropped questions relating to the vessel, engine, propellor specifications and maintenance schedule, and did not seek detailed information about the percentage of time spent fishing for different species. Questions relating to trawl doors, wires, sweeps, bridles, net size and design including ground gear were retained (see Figure 1 for trawl components), along with questions on lengthener and codend configurations, the use of Precision Seafood Harvesting (PSH) or Modular Harvesting Systems (MHS) codends (Moran et al. 2023), now called "Flowmo" codends, and other selectivity or mitigation devices. Also included were questions to capture the motivation for changing gear configurations, and fishers perceptions of the effectiveness of changes made to their gear in relation to fuel use, LFR requirements, reducing seabed impacts, improving selectivity and/or unwanted bycatch, and improving efficiency (defined as increasing catch rates of target species) (see Appendix A).

Following review and refinement of the question list by Seafood New Zealand, the final questionnaire comprised 77 questions for trawl, 68 for Danish seine, with further questions if a second gear set up was described. The list of questions is provided in Appendix A. The online survey was created in Google Forms with a mixture of question styles. These included Likert categorical questions, whereby participants had the option of selecting check boxes; multi choice questions, whereby participants had the option of selecting multiple check boxes, and open-ended questions, where the participants provided descriptive text answers.

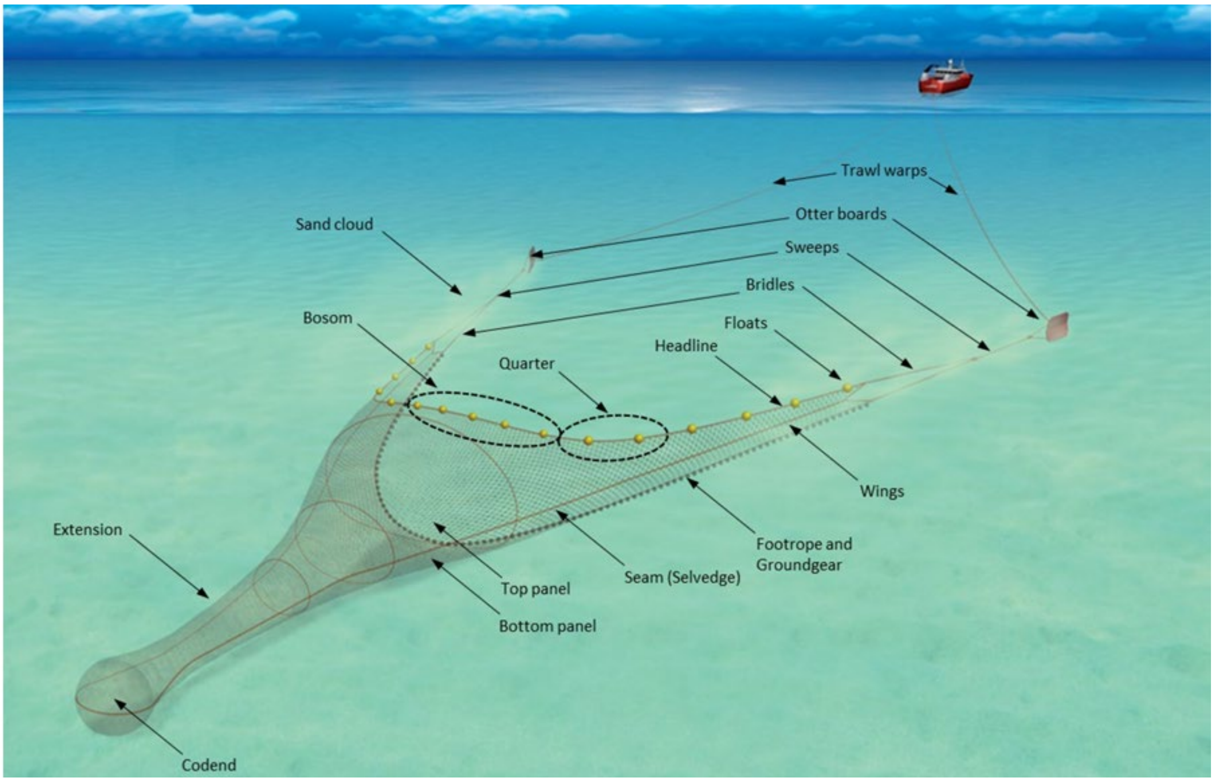


Figure 1: Diagram of a bottom trawl with key sections and components labelled. Image courtesy of Seafish Asset Bank.

The survey went live on the 27 May 2024 and was advertised on Seafood New Zealand social media channels and in person at the annual Federation of Commercial Fisherman's conference on the 31 May 2024, with cash prize incentives offered for early participation. In order to boost response rate, a second phase was carried out in January 2025 with a list of additional candidates identified from industry Inshore Council committee members contacted directly and encouraged or supported to complete the survey.

Data collation, grooming and analysis

Data entered via the online questionnaire was downloaded and reformatted into a series of tables for entry into a Microsoft Access database, similar to the 2007 survey data. Additional information on the vessels described was provided from the Fishserve database and matched to the vessel names to link information on vessel size and age.

The interview data mentioned above, collected by Eayrs and Craig (2023) from vessels fishing to Moana Ltd, were also provided to us from fishers who gave their permission for it to be shared. There was overlap in many of the questions asked and information provided in those interviews, and these data were transferred into our questionnaire fields where there was overlap.

Some basic data grooming was carried out, including standardization of terms such as manufacturer names, how warp to depth ratios were reported etc. Where an entry contained multiple different gear configurations, these were treated as separate data rows, labelled as T1, T2 etc. Therefore, a single vessel may have multiple fishing gear entries associated with it. In some cases, these entries were for different trawls, in others these entries were the same trawl and therefore contained duplicated information for some fields (i.e., door and sweep details), but with different components, such as a different headline configuration or codend mesh size.

Where answers were in the form of descriptive text, for example, ground gear descriptions, and perceptions of seabed contact, additional category fields were created to allow grouping and summarising of information. Where a range of numerical values were given, the maximum value was selected, whilst the range information was retained in an original descriptive text field. The survey allowed participants to provide information in both metric and imperial units, but the latter were converted to metric values for the database.

Not all entries had answers to all questions. Therefore, the sample size for different aspects of the survey varies. However, where information was not provided for lengthener and codend size and orientation, the minimum mesh size and standard diamond mesh orientation was assumed.

Through the grooming process, some multiple entries by the same participant were identified. These were combined or removed, and where a single entry referred to multiple vessels, these were separated and edited after contact with the participant to confirm the vessel for which trawl details had been provided.

The information collected has been summarised, either at a regional level or in some other way (e.g. target species, net type) in order to maintain confidentiality without losing value by combining different operations.

2 Results

Survey Process

The online survey format elicited an initial tranche of motivated respondents (n=20) within the first 3 months but did not achieve the desired participation rate. It is acknowledged that one-on-one interviews by phone or in person are the most effective method of engaging fishers where there are resources to do so.

Vessel and Operator Information

Following the phase two phone calls, a total of 51 entries to the online survey were received. Of these, four were excluded as duplicate entries or due to lack of sufficient information. Two more were excluded due to not being associated with a specific vessel. Information about seven additional vessels from a previous survey by Moana were provided. This allowed us to add in information for some but not all online questions. This resulted in 52 entries describing the gear configurations of inshore fishing vessels spread around New Zealand ports (see Figure 2). This included 44 trawl vessels (16 from the North Island and 27 from the South Island) and eight Danish seine vessels (five from North Island and three from South Island). Although the 2024 survey used the same fishing region categories as the 2007 survey, the sample size in 2024 was not sufficient to report on all these regions separately. Figure 2 indicates where regions have been combined.

A summary of vessel numbers, size and age is provided in Table 1. Vessel size ranged from 10.7 up to 27.2 m with a similar average size between regions apart from a smaller average in Hawke Bay. Engine power varied from 60 Hp up to over 1000 Hp, with an average of 356 Hp overall and median of 319 Hp. This was greater than the 2007 average (245 Hp, n=153), but the same regional pattern has persisted with vessels in the North Island having slightly greater power on average compared to vessels in the South Island. Similar to the 2007 survey, the inshore fleet is made up mainly of older vessels with 77% of respondents operating boats 30 years old or more, the oldest vessels being built in the 1940s and 50s and only a handful of more modern vessels under 15 years old. The fishing experience of the respondents was of a similar vintage with an average of around 30 years, although this number is skewed by some respondents that are owners of vessels that they previously skippered themselves but were now operated by presumably younger contract skippers.

Table 1: Summary of size, horsepower, and age of vessels by region and Island. See Figure 1 for locations of areas.

Region / Island	No. of vessels surveyed	Median vessel size & range (m)	Median age & range (years)	% of vessels over 30 years old	Median horsepower & range (Hp)
By region					
North	14	18.2 (11.7–25.8)	47 (9–78)	86	308 (114–1004)
Hawke Bay	7	13.3 (11.1–19.4)	41(16–47)	71	228(114–483)
Central & WCSI	14	14.6 (10.7–27.2)	41 (9–66)	94	180 (59–799)
ECSI & South	17	16.0 (11.2–24.3)	31 (9–56)	60	401 (100–900)
By Island					
North Island	22	16.8 (11.1–28.9)	43 (9–78)	80	305 (114–1004)
South Island	30	17.0 (10.7–27.2)	41 (9–66)	73	331 (59–900)
Overall	52	17	42	77	319

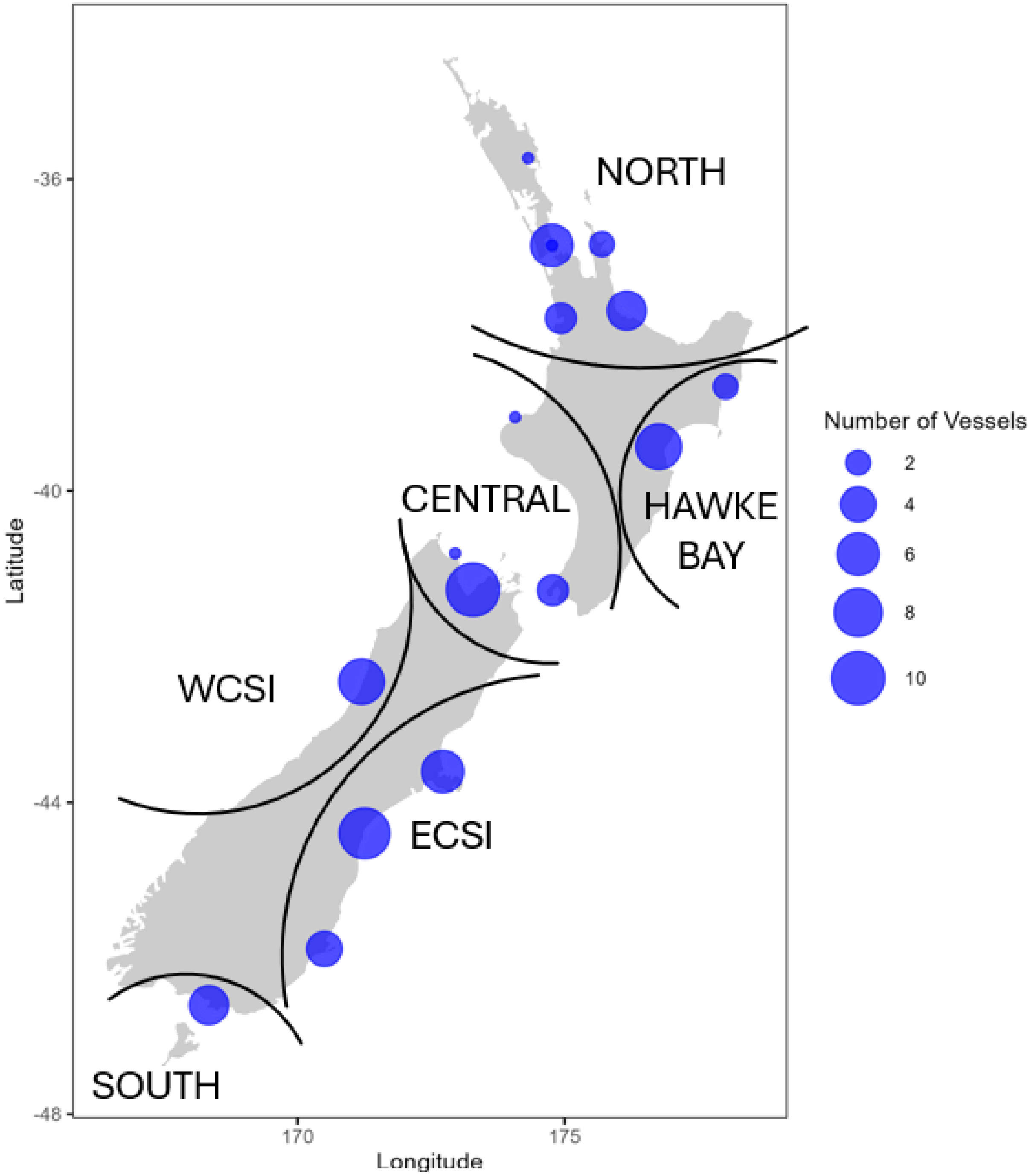


Figure 2: Areas of operation of trawl and Danish seine vessels included in this study. Most respondents listed more than one port or operation area. Ports included in each region: North - Auckland, Onehunga, Raglan, Whangarei and Whitianga, Manganui, Tauranga; Hawke Bay - Gisborne and Napier; Central - New Plymouth, Wellington, Nelson and Golden Bay; WCSI (West coast South Island) – Westport and Greymouth; ECSI (East Coast South Island) – Lyttleton, Timaru, Dunedin; South – Bluff.

Fuel use and electronic equipment

Overall, 65% of respondents ticked “yes” to knowing their power curve, with almost all providing estimates of fuel consumption per hour. However, only 22% had a flow gauge or fuel meter. This included vessels across a range of ages from 1974–2016, and therefore included older vessels that have been retrofitted and newer vessels with this technology likely built in. Fuel consumption varied depending on vessel size, ranging from 5–8 litres per hour up to 60 litres per hour for vessels under 20 m and from 40–100 litres per hour for vessels between 20 and 28 m.

The respondents also provided information on electronic equipment that they used to improve their fishing activities. Over 80% of those that answered this question (n=43) listed the use of a plotter and/or GPS, although it is almost certain this number should be 100% with absence of responses reflecting that these questions may have been overlooked with the online survey style. In relation to monitoring fishing performance, 47% of respondents said they used a net monitor, and 37% and 39% also listed a catch sensor and door spread sensors respectively. This is an increased uptake of this technology since the previous survey, where only 14% of vessels used a net monitor and just 1% of vessels overall had access to a catch monitor or door spread sensors. Five vessels reported using a seafloor mapping system such as WASP and one vessel was using a live camera system (Deepset).

Motivators driving fishing gear set-ups

Of those vessels that provided information, 61% (23 out of 38) had two or three different gear set ups. Six vessels had between four and seven different configurations. (Note that information provided by Moana skippers did not include this question and so these are not included).

Over 80% of respondents cited better selectivity (both size selectivity of target species and reduction of unwanted bycatch), along with improving catch efficiency (increasing catch rates of target species) as their rationale for gear set-ups. Improving fuel efficiency was a motivator for 72% of respondents and over half were making changes motivated by a desire to reduce the impacts of their fishing gear on the seabed.

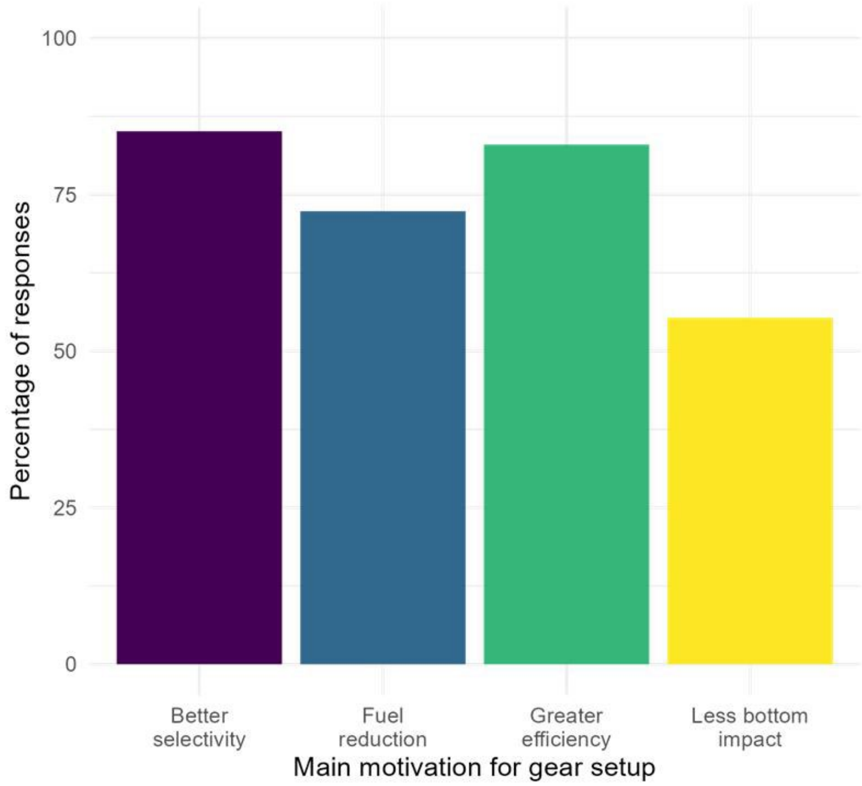


Figure 3: The percentage of respondents citing better selectivity (including bycatch reduction), fuel reduction, greater efficiency (target species catch rates).

Trawl doors and trawl warps

Trawl doors spread the trawl net horizontally and are one of the three main points of contact with the sea floor. Almost all trawl vessels (42 out of 44) were using steel trawl doors, with only one fisher using wooden doors and one using fibre glass. This contrasts with the 2007 survey results, where 24% of vessels used wooden doors, predominantly in the South Island. There were 34 responses that included a manufacturer, with 21 also providing a specific model. More than half of those providing manufacturer details (n=34) were using Thyborøn doors with the remainder from nine other manufactures including Bison, Poly-Ice (now part of Thyborøn) Polar, and Mørenot. Most doors reported were modern, hydrodynamic styles with cambered and multifoil designs along with a number of high aspect ratio designs (n=6) such as the Thyborøn Type 11 & 14, and Mørenot "Kiwi Injector" (see Appendix B for some examples of trawl door styles). Trawl door sizes ranged from 0.8-5 m^2 and 50-1000 kg in weight. Average door size and weight by category of vessel horsepower are given in Table 2 and are similar compared to the results of the 2007 census. Most doors reported were under 500 kg in weight, with the median weight across all regions around 300 kg (n=43) compared to 180 kg in the 2007 survey (n=124). There were more larger doors used in the northern region and smaller doors were used on average in the ECSI & Southland region (see Figure 4).

From those that provided the information (n=41), just over half used wire warps, whilst just under half have switched to Dyneema® or Dynex® warps. This synthetic rope material (ultra-high-molecular-weight polyethylene, UHMWPE) provides similar strength to steel wire but is much lighter and can therefore reduce fuel consumption. Wire warps were three or six strand with a diameter ranging from 10 mm up to almost 20 mm. Dyneema warps were up to 12 strand, with a similar diameter range.

Table 2: Trawl door size, weight, and vessel horsepower.

Vessel Hp	No. of vessels	Median door weight & range (kg)	Median door area & range (m^2)
Up to 199	14	115 (70–180)	1.1 (0.8–3.3)
200–399	10	300 (80–420)	1.5 (1.3–2.6)
400–599	11	350 (250–450)	2.5 (1.5–3.0)
600+	9	600 (50–1000)	2.7 (1.5–5.0)
Overall	44	300 (70–1000)	1.7 (0.8–5.0)

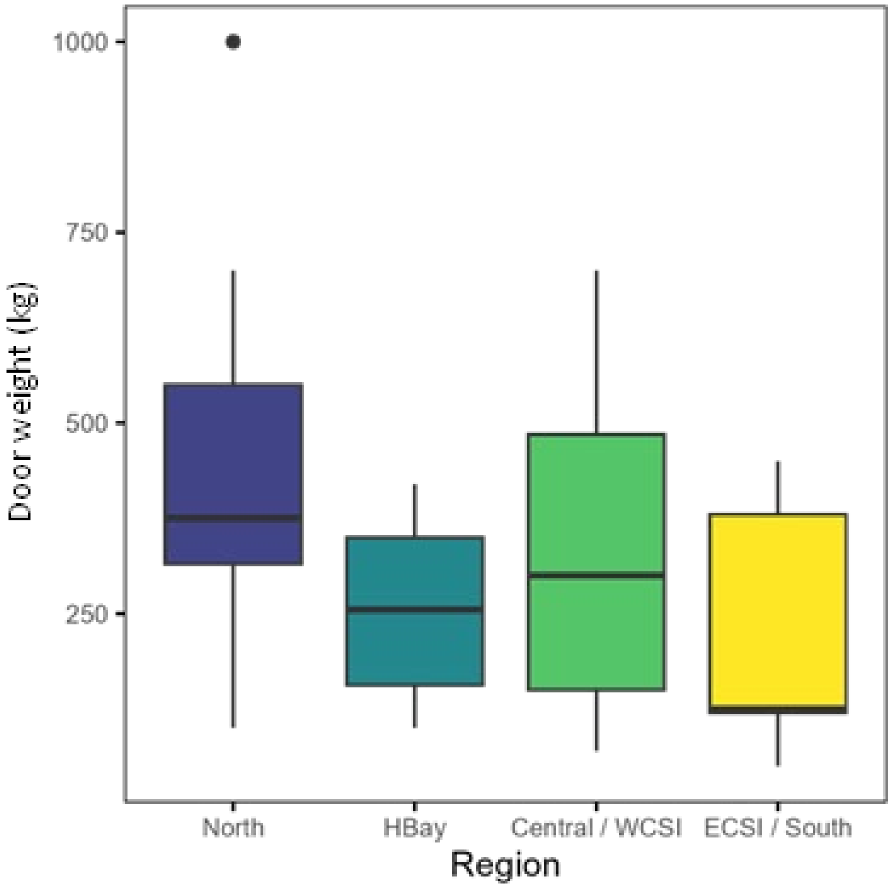


Figure 4: Variation in weight of trawl doors by region in the New Zealand inshore fishery. The box represents the interquartile range, with the median value also indicated for each region along with outlier values. See Figure 1 for definitions of regions.

None of the fishers responding to this survey were fishing with trawl doors lifted off the seabed, although one respondent had previously trialled this with NIWA (Jones et al. unpublished). A quarter of participants perceived their trawl doors had only light contact with the seafloor. Several respondents described backstrop set ups that resulted in positive tilt so that the forward part of the shoe (steel component attached to the base of the trawl to protect the door itself against wear) was clear of the seafloor and thus reducing the area of bottom contact of the trawl door (Valdemarsen et al. 2007).

Sweeps and bridles

The sweeps and bridles are wires that connect the trawl doors to the net and herd fish into its path. In addition to a primary set-up, three vessels reported additional sweep set-ups which are included as separate gears. Reported lower bridle lengths ranged from 2–50 m, with a median of 20 m, with sweep lengths from 45–300 m, and a median of 120 m. The combined length of bridles and sweeps ranged from 60–320 m with a median of 140 m. Figure 5 shows the range of sweep and bridle lengths by region. The longest combined sweeping distances (> 300 m) were reported from vessels in the northern region targeting tarakihi, trevally and snapper and from the central and WCSI areas targeting tarakihi and red gurnard (> 200 m). Vessels targeting flatfish (mainly from the ECSI and Southland ports) reported combined lengths of under 100 m.

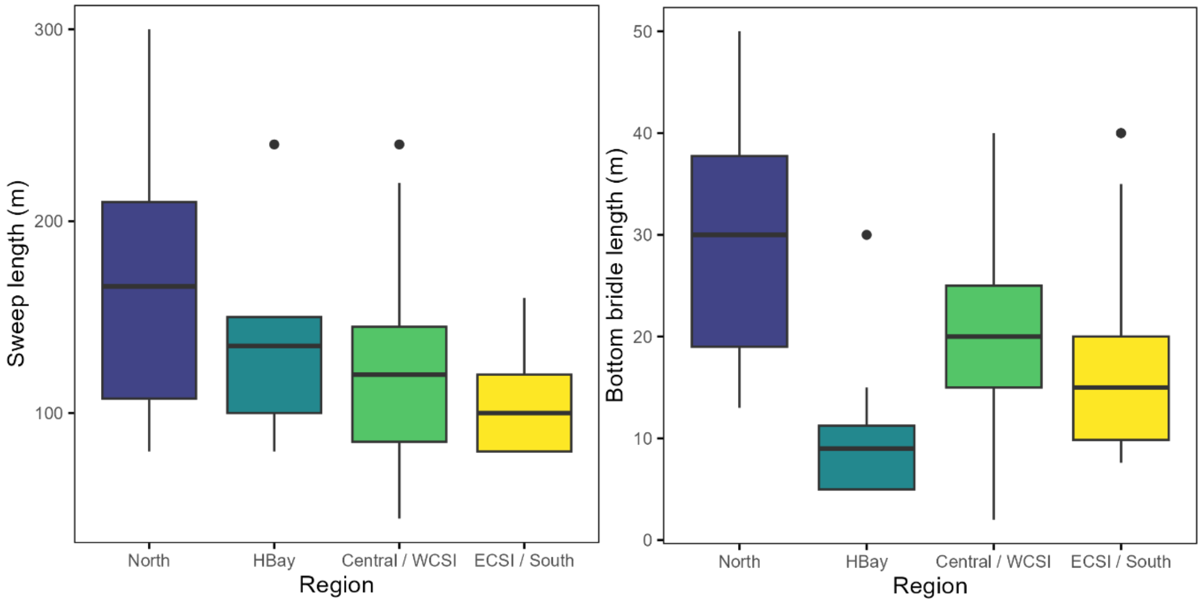


Figure 5: Length of sweeps (left plot) and bridles (right plot) by region. The boxes represent the interquartile range, with the median value also indicated for each region along with outlier values.

Half of the respondents used wire sweeps including plain wire and bonded or covered wire rope, but the other half reported using combination rope (38%), Dyneema® or Dynex® and rope (10%) (Figure 6). Combination rope is a composite of materials comprising a steel-wire core or multiple wire strands wrapped in a synthetic fibre such as polypropylene twine. These ropes have a larger diameter weight-for-weight than straight wire and are designed to “slide” more easily over the seabed without “digging in” on soft sediments. The most commonly used combination rope was Maletta rope which has originated from the Spanish fishing industry. Similar to Dynex/Dyneema warps, sweeps made of this material are lighter than steel wire of equivalent diameter and allow for reduction in drag and fuel savings.

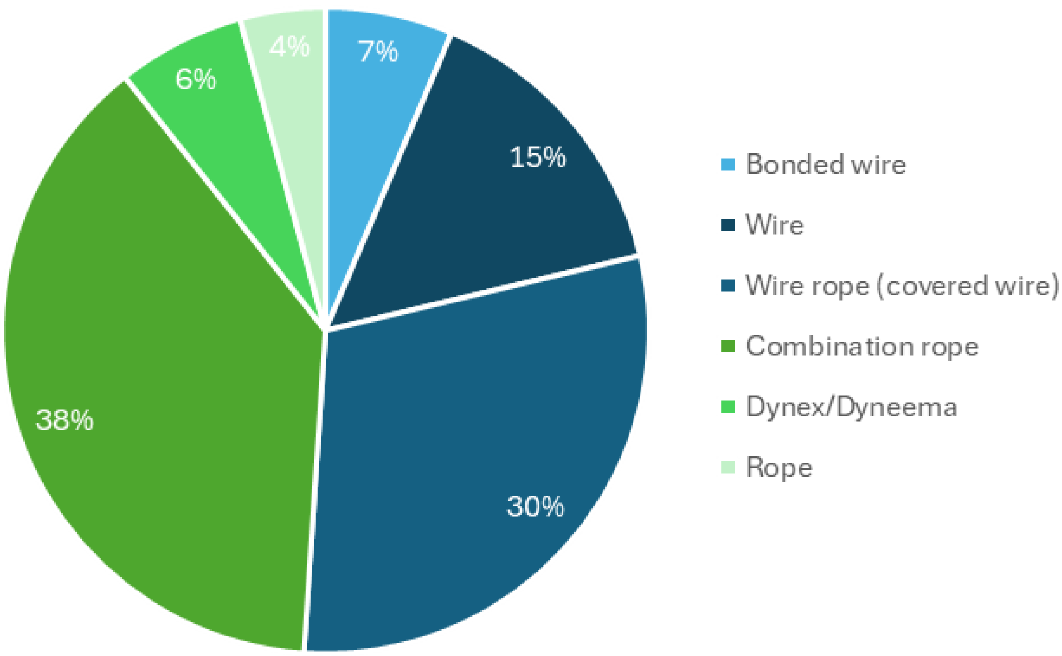


Figure 6: Proportion of trawl gear configurations using different sweep and bridle materials.

Respondents were asked about their perception of the extent of the contact of their sweeps with the seabed. Nearly all those using wire, bonded and covered wire sweeps described them as being on the seabed, some using the phrase “hard down”. Of those using sweeps made from alternatives to traditional wire, a greater proportion (52%) believed their sweeps were either in only light contact with the seabed, or at least partially lifted off the seabed. This included fishers who had intentionally ensured all, or portions of the sweeps were lifted off the seabed using rubber cookies spaced along the sweeps or by using sections of positively buoyant mooring rope material (n=7). Across all respondents 28% of fishers believed their sweeps had only light contact with the seabed.

Trawl net designs & headline height

There were eight trawl net manufacturing companies listed, along with three individual net makers. The main manufacturers were Motueka Nets (Nelson), Milligan Trawls (Auckland), Hampidjan NZ (South Island), and Cookes incorporating Gourocks (NZ-wide), together supplying half of the trawls described in the survey. Other manufacturers included Networkz (Dunedin), North Beach Nets (Greymouth), and Trawl Solutions (Beauline, Nelson). Just under 20% of nets were homemade or made by individual netmakers. Most nets were two panel design (80%), with a smaller number (17%) made from four panels, i.e. a top, bottom and two side panels. Trawls with side panels tend to have a more open cross section or fishing circle, allowing fish to swim more freely. This generally allows for meshes to be more open and can encourage escape. There were 55 trawl nets described, with nine vessels having two or more different nets. The most common trawl design was a “wing trawl” (40%) followed by a “scraper” or “scrapper” trawl (22%), flatfish and “low headline/low flyer” trawls (20% combined).

A summary of the different trawl net designs is given in Table 3. The three more common designs, each spanned a range of net sizes. Trawls described as “wing trawls” were all two panel designs and varied in size with ground gear lengths between 10–61 m length and a wide range of headline heights from 0.8 up to 6 m, with a median height of 2.5 m. There were also a wide range of target species listed (see Table 4) The “scraper trawl” design originated from overseas to target more bottom-dwelling species and is described as a relatively long low demersal trawl similar to a prawn trawl but with longer wings and a slightly higher headline compared to flatfish trawls (Seafish Gear database). New Zealand-made scraper trawls vary depending on the net maker, with both 2 panel and 4 panel designs, groundgear lengths between 18 and 48 m, and headline heights ranging from 1 to 4.5 m with a median value of 2.9 m, and a similar range of target species. Flatfish and low headline or “low flyer” trawls are usually two panel nets. There were a similar range of sizes to the other trawl styles, from 8 to 54 m in length of ground gear, but these trawls have the lowest headline heights (med = 1.5 m). Two further trawl types listed were “gurnard trawls” (n=2) and “box” trawls (n=2), with the latter being a four-panel design. The remaining trawl descriptions (11%) were not categorized.

Table 3: Summary of trawl net descriptors (length of ground gear (m) and headline height (m) by net design, along with target species (where bolded indicates most common species listed by 3 or more vessels). See Appendix C for common and scientific names of the species codes used.

Trawl net design	Median Groundrope length & range (m)	Median headline height & range (m)	Main Target species
Wing trawl (n=22)	28 (10– 61)	2.6 (0.8–6.0)	**SNA, GUR, TAR, TRE, STA,** ELE, JDO, FLA, SPO, MOK, WAR, LIN, BAR
Scraper trawl (n=12)	40.3 (18.3–48)	2.9 (1–4.5)	**GUR, TAR,** FLA, LIN, STA, SNA, ELE, SPO, SCH
Flatfish/low headline trawl (n=11)	33.5 (8–54)	1.5 (0.6–2.0)	**FLA, GUR, TAR,** STA, RCO, JDO, MOK
Gurnard trawl (n=2)	37 and 55	0.8	**GUR**
Box trawl (n=2)	38 m	2.8 and 5.0	SNA, TRE, TAR

Both wing trawls and scraper trawls were used in all areas targeting a wide range of species. Flatfish and low flyer trawls were used predominantly in the South Island and Hawke Bay targeting flatfish, but also red gurnard, and tarakihi. Headline heights on all net designs used on vessels fishing in the northern region were higher than 2 m, with a median headline height of 2.8 m (Figure 7). In the Hawke Bay region, the vessels in this survey mainly used flatfish and scraper trawls and the headline height for these vessels was lower than 2 m. Headline heights of trawls in the central and WCSI areas were generally between 0.8 and 3 m, with a few higher values up to 6 m. In this area, there is a strong desire to avoid catching too much snapper with some nets being designed with reduced headline heights and minimal or no veranda. The veranda is the overhang of the headline and top panel compared to the groundrope of the bottom panel. Having no or minimal overhang and lower headline height increases the opportunity for stronger-swimming species such as snapper to rise up and escape over the top of the net. Along the east coast of the South Island and southern area, there was a wide range of trawl headlines in use from flatfish nets with headlines under a meter to scraper and wing trawls with headlines of between 4 and 6 m. In these fisheries, avoiding incidental capture of protected species such as Hector’s dolphins is an important issue and in certain areas, the use of ties to limit the headline height are required.

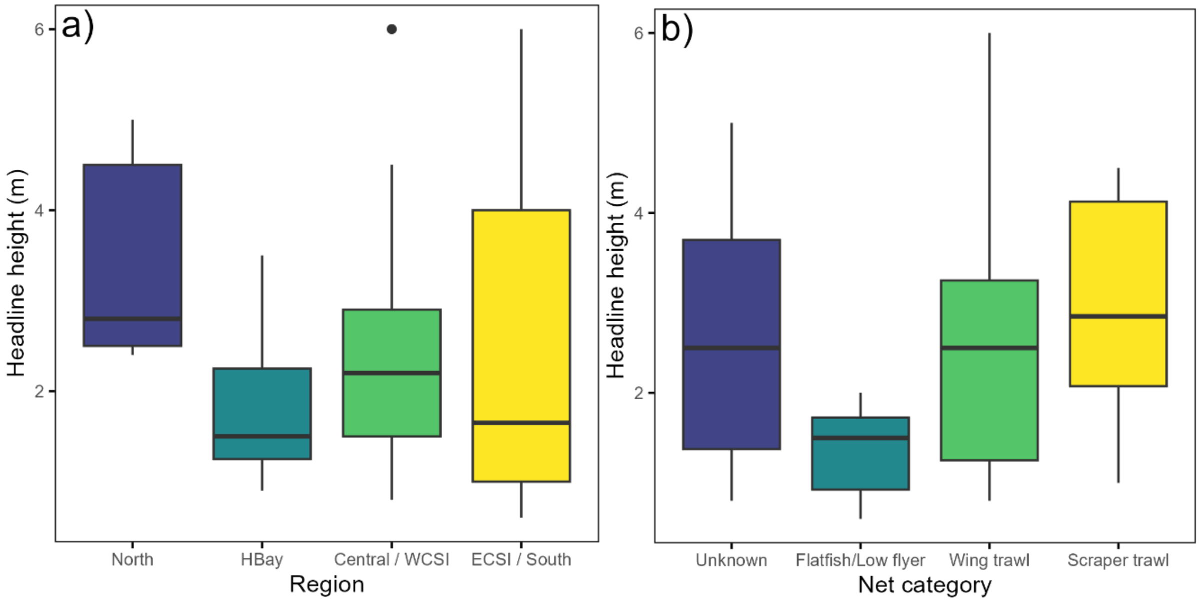


Figure 7: Headline height (m) of trawls by (a) region and (b) trawl design category. The boxes represent the interquartile range, with the median value also indicated with outlier values.

Ground gear

Trawl ground gear includes a variety of components attached to the footrope or groundrope of a trawl net to maintain contact with the seabed and protect the net from damage. The length of groundrope reported from the 55 different trawl nets used across the 44 vessels varied from <10 m up to 61 m with the majority being between 20 and 50 m in length (see Figure 8), and a median size of 34.4 m.

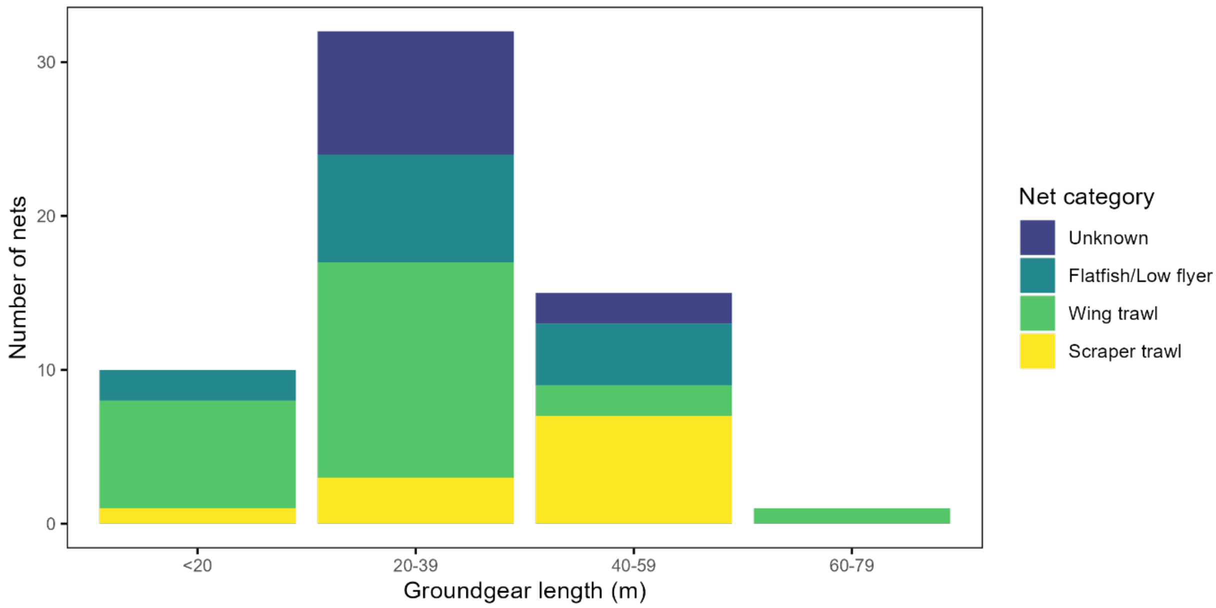


Figure 8: Size range of different trawl net design categories by ground gear length.

We allocated each ground gear description to one of six categories which were based approximately on descriptions sourced from the UK Seafish gear database: bare fishing lines made from wire rope and/or rope (Figure 8 (a) and (b)); fishing lines described only as chain (not shown); wire rope combined with chain (Figure 8 (c)) and with chain bights or dropped chain (Figure 8 (d)); rubber cookies or discs (Figure 8 (e)); and rubber cookies with larger diameter discs (Figure 9 (f)). None of the nets described in this survey mentioned bobbin or rockhopper style ground gear.

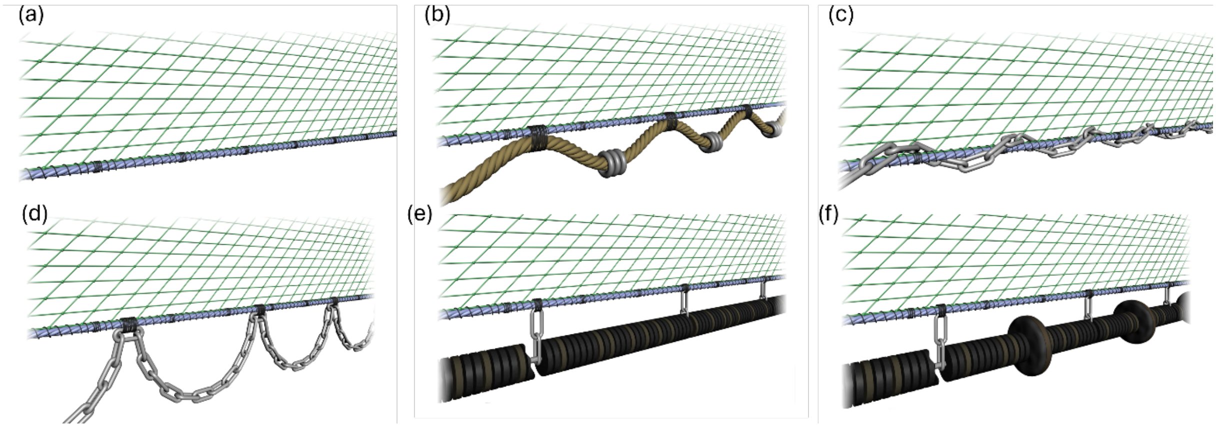


Figure 9: Ground gear categories. (a) bare fishing line, (b) rope footrope, (c) wrapped chain footrope, (d) "chain bights" or dropped chain footrope (e) rubber leg or "rubber cookie" footrope, (f) small disc footrope (Images and descriptions courtesy of Seafish Asset Bank).

Over half of the trawl net configurations had "rubber cookie" groundgear (Table 4 and Figure 10), with rubber discs threaded onto a wire, wire rope or chain, and linked to the ground rope via chain droppers. Two respondents used two sizes of discs (cookies & discs, Figure 8 (f)). Rubber cookies were the most common groundgear type for "wing", "scraper" and "gurnard" trawl designs (Table 4), and used across all regions. The size of the rubber cookies was between 40–100 mm in diameter, with some larger discs up to 300 mm. The total weight of rubber cookie groundgear was estimated at 35–334 kg. These values likely contain a mix of weights in air and in water, since rubber loses up to 95% of its weight in water, and to a lesser degree other components. It's likely that most groundgear weights for cookie style configurations were <100 kg in water.

The remainder of trawls had ground gear consisting of wire rope/rope (Figure 8 (a) and (b)), and chain (Figure 10), with the combination of chain either wrapped around the "bolsh line" (Figure 9 (c), or attached on droppers (Figure 9 (d)). These ground gear categories were used with "wing", "scraper", flatfish and "low flyer" trawl designs (Table 4). Wire rope between 10 and 16 mm was used along with short link chain, estimated at between 30 and 55mm outside diameter. The overall diameter of these ground gears was not precisely known, with weights reported as between 20–120 kg, but again potentially less than 100 kg in water.

Although sample size is smaller than in 2007, the 2024 results, if representative of the wider fleet, suggest that the rubber cookie style of groundgear has become more common than in 2007 when it made up 29% of ground gear descriptions, whilst rope and chain ground gear was the most common (Clement & Associates 2008).

Table 4: Summary of different ground gear types by trawl design.

Trawl type / Ground gear category	Wing trawl	Scraper trawl	Flatfish / low flyer trawl	Gurnard trawl	Box trawl	No description	Total
Wire rope/rope	3					1	4
Chain	1		4				5
Wire/rope/chain	1	1	1				3
Wire/rope/dropped chain	6	2	1		1		10
Rubber cookies	11	6	4	2		7	30
Rubber cookies & discs					1	1	2
No description			1				1
Total	22	9	11	2	2	9	55

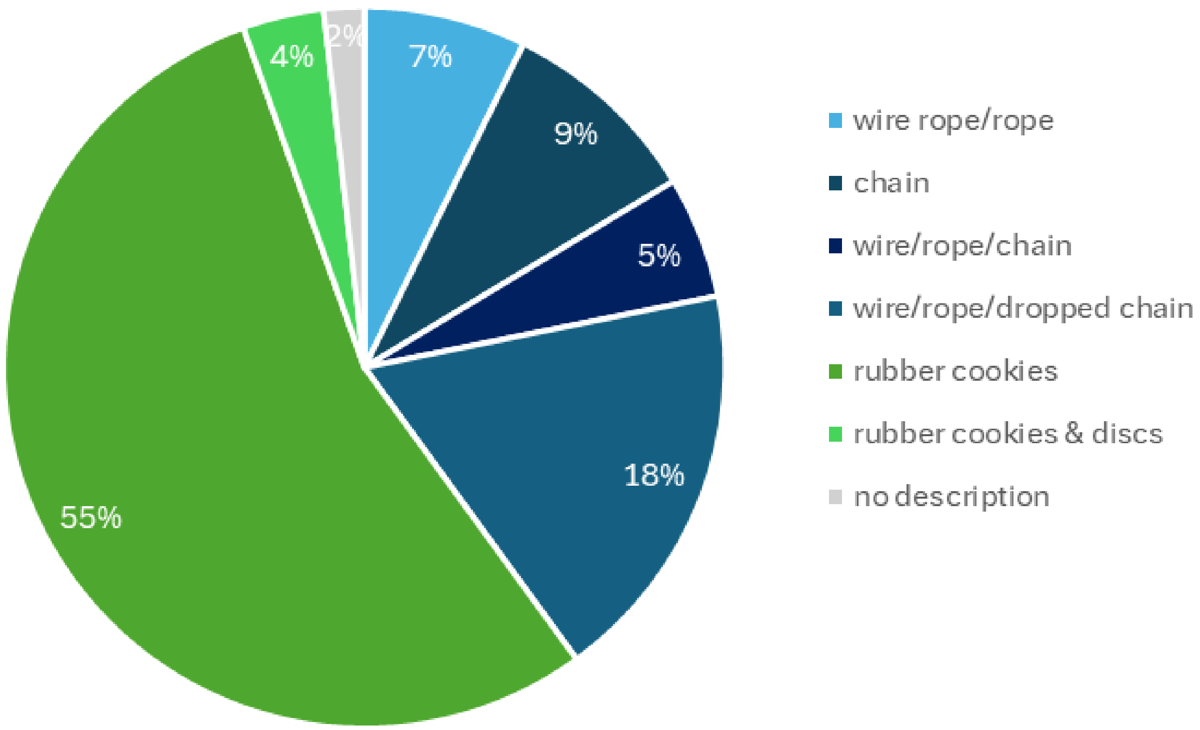


Figure 10: Percentage frequency of different groundgear types used in inshore trawls.

Target species, unwanted bycatch, and towing speeds.

The inshore trawlers documented in this study target a wide range of species. Most respondents listed two or more target species, with red gurnard the most commonly listed overall (24 trawl configurations had red gurnard as a target), followed by tarakihi (n=16), snapper (n=14) and flatfish (n=13). Tow speeds ranged from 2 to 4 knots. Table 5 provides the average tow speeds for various target species or species mixes across the four regions where there were at least three responses across all areas. The average tow speed for when red gurnard was the target species was 2.8 knots across all areas. Tow speeds were higher when snapper, trevally or tarakihi were the target species. The lowest tow speeds were in the South Island when species such as flatfish, star gazers and elephant fish were the main target. Overall these tow speeds are similar to those found in the 2007 survey which ranged from 2.6 knots for flatfish to 3.5 for trevally (Clement & Associates 2008).

Table 5: Regional average tow speeds in knots by target species or target species group. The range of speeds for each species/species group overall are also given.

Target species or species mix	North	HBAY	Central & WCSI	ECSI & Southland	Overall
Red gurnard	2.8	2.8	2.9	2.8	2.8 (2.5–3.5)
Snapper or snapper & trevally.	3.0		2.6		3.1 (2.6–4.0)
Tarakihi		3.1	3.1		3.1 (2.8–3.5)
Flatfish		2.6	2.4	2.3	2.3 (2.0–2.6)
Tarakihi and snapper species mixes incl. trevally, red gurnard, John dory, rig, red cod & flatfish	3.3	2.8	2.9	3.0	3.1 (2.5–4.0)
Stargazer			2.8	2.4	2.5 (2.3–2.8)
Elephant fish				2.5	2.5 (2.4–2.5)
Elephant fish, flatfish, red gurnard, tarakihi & rig				2.8	2.8 (2.5–3.0)
Overall	3.2	2.8	2.9	2.6	2.9 (2.0–4.0)

The most often cited unwanted species were spiny dogfish, listed by 16 respondents, snapper (n=10), and undersized juvenile fish (n=11). Other unwanted bycatch included: porcupine fish, sting rays and eagle rays, skate, ghost shark, gemfish, rattails, and carpet sharks.

Netting characteristics (lengthener and codend configurations)

This survey did not specifically collect information on mesh sizes in the forward parts of the trawl, but some information provided from vessels fishing in the northern region indicated that mesh sizes in the wings and front ends of the trawls is similar to the 2007 survey with up to 8-12" (200–305 mm) mesh sizes used in the wings and up to 6" (154 mm) used in the trawl mouth. The current survey focused on information on lengthener and codend characteristics including mesh size, orientation, twine diameter, number of meshes round (equating to circumference) and length of these different sections of the net. When summarising these data, note that where a mesh size and/or orientation was not provided in the survey entry, we assumed the minimum size and standard diamond orientation.

The minimum mesh size allowed in trawl nets varies between areas, fisheries and target species. In inshore fisheries (other than for squid), the minimum mesh size is 100 mm for all areas except FMAs 1 and 9, where the minimum mesh size is 125 mm. It is common for vessels to use a mesh slightly larger than the minimum to allow for shrinkage, so 127mm is often used in northern areas and 102mm elsewhere.

A total of 33 out 44 trawl vessels (75%) used at least one codend configuration with a mesh size that was larger than the minimum mesh, i.e. 130mm or larger in the northern regions and 108 mm elsewhere. A further six vessels were using minimum mesh size but in T90 or square (T45) orientation. Turning the mesh orientation in this way opens up the mesh and improves water flow and the release of undersized fish with a more rounded cross-section such as red gurnard and red cod. One vessel was using a rigid frame in the mesh codend to stretch open the meshes, and another vessel has replaced traditional mesh codends entirely with a rigid “cage” style codend made from steel mesh with aperture sizes that are optimized depending on the target species. Therefore 89% of the respondents had made some improvement to selectivity through use of larger and/or turned codend mesh. Three vessels reported using PSH codends which are made from high strength composite fabric tubes with escapement apertures instead of meshes (Moran et al. 2023). The apertures used in the inshore fleet are a rounded rectangular shape (35 ×100 mm).

Table 6 and Figure 11 summarise the mesh size and orientation of all lengtheners and codends reported in the survey, multiple codends from some vessels. Of the sixty codend configurations described from 44 vessels, 58% of codends were made from 5” (~125 mm) mesh and 10% were made from 6” (~150 mm) mesh or larger. This includes vessels who benefitted from company initiatives to facilitate the use of larger mesh codends, such as those initiated by Talley’s and Hawkes Bay Seafood. For example, between 2013 and 2017, Talley’s made a substantial investment, providing 75 larger mesh 5” codends to vessels fishing for its quota in an effort to reduce catches of undersized fish. Across all areas, almost 40% of codends were made from tuned meshes, with T45 or square mesh codends more popular than T90. In the northern regions, a number of vessels reported using mesh sizes larger than 5”, including 6” (152-154 mm) square mesh codends. In addition, almost half the vessels surveyed were using extension or lengthener pieces with turned mesh (either T45 or T90) (Table 6 and Figure 11).

A caveat to the likely improvement in selectivity with the use of larger mesh sizes is that some codends were made from double stranded twine rather than single twine. This increases the equivalent twine thickness from 5 or 6 mm up to 10–12 mm, offsetting some of the selectivity gains (i.e. increased release of smaller sized fish) due to a smaller effective mesh opening and increased bending stiffness of the thicker twine. The circumference of the codend, or the number of meshes per panel also has the potential to influence the selectivity. Depending on the mesh sizes in adjacent panels, the use of codends with a higher number of meshes round compared to the extension/lengthener piece may also potentially close up meshes and impact selectivity, whilst fewer meshes round can open meshes up and improve selectivity.

Table 6: Lengthener and codend configurations by region. Mesh sizes are given in inches and mm.

Mesh size & orientation	Central &WCSI	ECSI & South	HBAY	North	All
Lengtheners					
4" (102 mm) Diamond mesh		1	4	3	**8**
4" (102 mm) Square (T45) mesh		2			**2**
4" (102 mm) T90 mesh	1				**1**
4.5" (108-114 mm) Diamond mesh	4				**4**
4.5" (108-114 mm) Square (T45) mesh	1	1			**2**
4.5" (114 mm) T90 mesh	2	1			**3**
4.75" (120 mm) T90 mesh	1				**1**
5" (125 -127 mm) Diamond mesh	2	5		7	**14**
5" (127 mm) Square (T45) mesh	3	3	1		**7**
5" (127 mm) T90 mesh	6	2	2		**10**
> 5" (130-154 mm) Diamond mesh	1	1	1	1	**4**
> 5" (130-154 mm) Square T45 mesh		2		1	**3**
> 5" (130-154 mm) T90 mesh	1				**1**
Codends					
4" (102 mm) Diamond mesh		3	1		**4**
4" (102 mm) Square (T45) mesh			1		**1**
4" (102 mm) T90 mesh	1				**1**
4.5" (108-114 mm) Diamond mesh					
4.5" (114 mm) Square (T45) mesh			2		**2**
4.5" (114 mm) T90 mesh	1				**1**
4.75" (121 mm) Square (T45) mesh		1			**1**
5" (125 -127 mm) Diamond mesh	16	5	1	1	**23**
5" (127 mm) Square (T45) mesh	1	1	1	4	**7**
5" (127 mm) T90 mesh	1	3			**4**
> 5" (135-154 mm) Diamond mesh		3		1	**4**
> 5" (135-154 mm) Square T45 mesh	1			4	**5**
> 5" (135-154 mm) T90 mesh		1			**1**
Box frame with stretched 5" (127mm) Diamond mesh		1			**1**
Box frame with rigid steel rectangular apertures (100 x 50 mm)			1		**1**
Box frame with rigid steel rectangular apertures (100 x 100 mm)			1		**1**
PSH codend with rigid apertures (100 x 35mm)	1			2	**3**

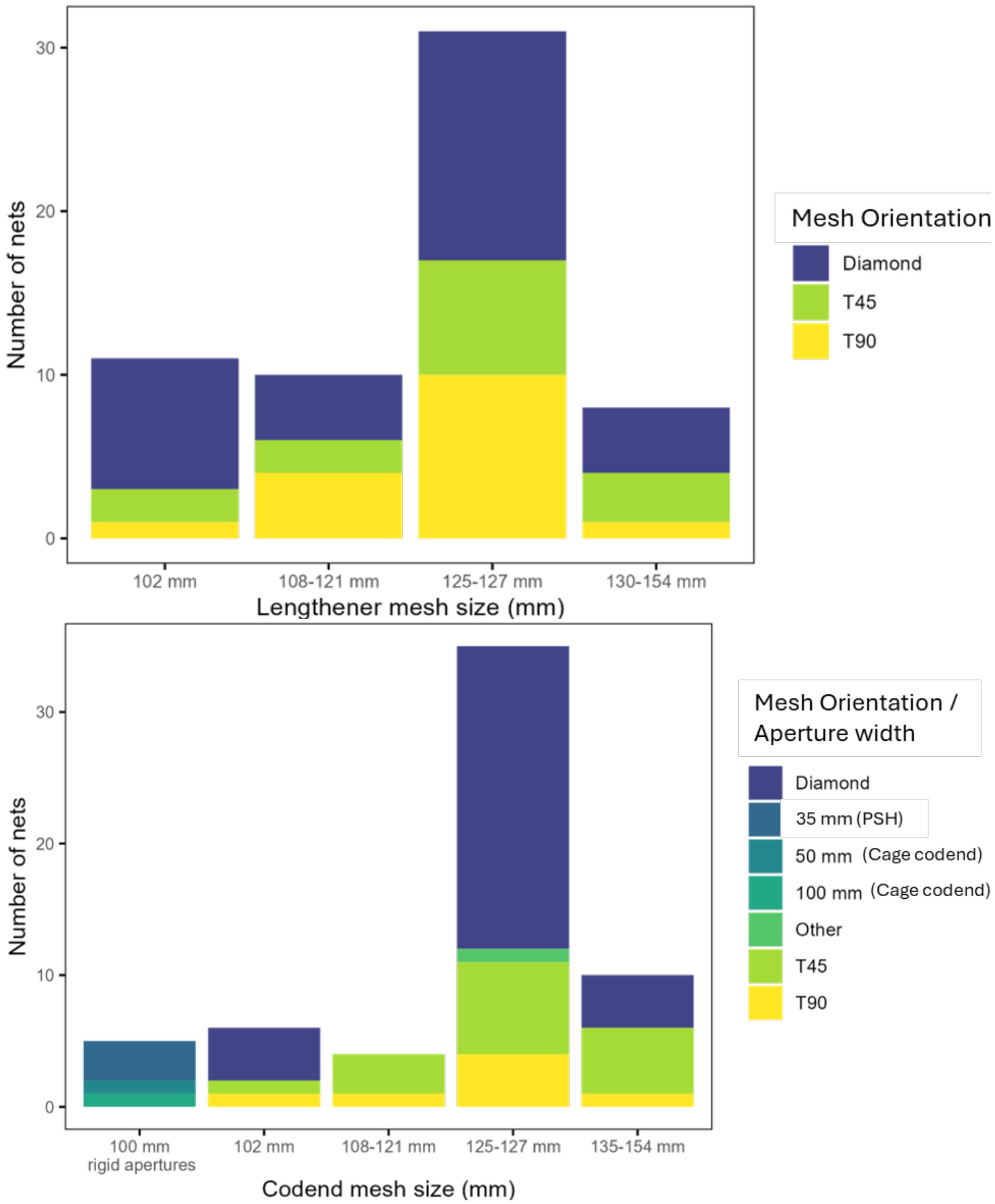


Figure 11: Frequency of different mesh sizes and orientations used in both lengthener (top) and codend (bottom) trawls. For codends only, additional categories for rigid apertures were included where mesh orientation is replaced by aperture width, e.g., 100 m x 35 mm.

Danish seine

Skippers from eight Danish seine vessels provided responses to the survey; five from the North Island and three from the South Island. The size range of vessels was 11.6 up to 24.3 m, with engine power between 114 and 648 Hp and fuel use of 5 up to 40 litres per hour. Several responding skippers expressed that Danish seining was more fuel efficient than trawling. All vessels were over 30 years old. The main target species in the northern fisheries were snapper, red gurnard, John dory and tarakihi, whilst the seiners in the south targeted flatfish alongside John dory and red gurnard. Unwanted bycatch species included undersized fish along with porcupine fish, and sting rays and in the north and snapper and rig in the south.

Danish seining differs from demersal trawling in both the configuration of the net and how it is operated. There are no doors, with long seine ropes used instead of warps and sweeps to herd the fish into the path of the net. The gear is set out from the vessel using a marker buoy which the vessel circles back to retrieve once both the ropes and net are in the water before towing and winching commences to draw the ropes together, close up and haul the net onboard (Figure 12). Tow speeds during this process vary from 0.3 to 1.5 knots at the start to herd fish into the path of the approaching net, up to 3 to 5 knots at the end, influenced also by tides, weather conditions and target species (e.g. slower speeds were optimal for targeting flatfish and avoiding snapper).

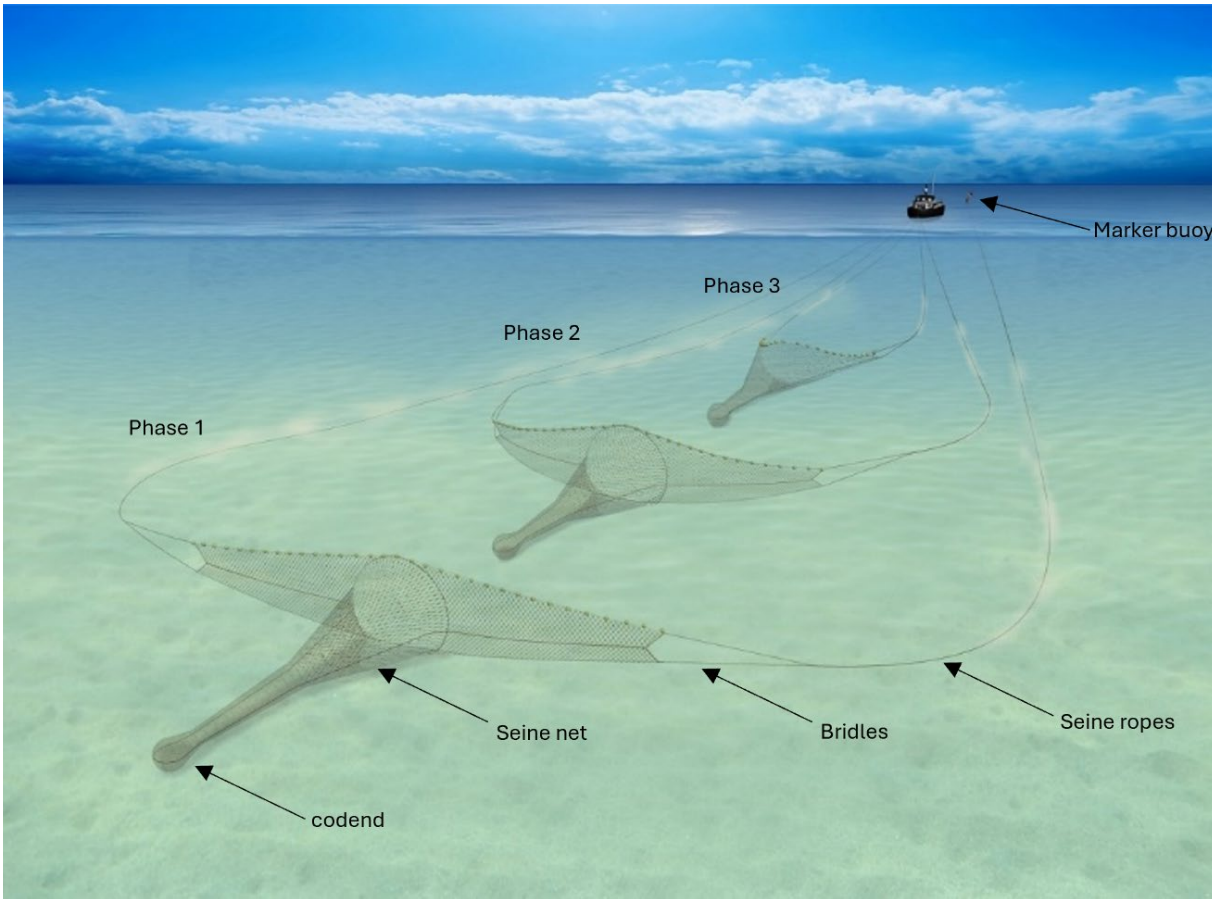


Figure 12: Diagram showing the main phases of setting and retrieving a Danish seine with key components labelled. Image courtesy of Seafish Asset Bank.

The seine ropes used were 18-30 mm diameter polypropylene. Some respondents provided additional information including that their ropes are weighted with a lead core or lead beads to keep the rope in contact with the seabed, equating to around 8-9 kg per 100 m in water. It is not known if this can be assumed for all respondents. The lengths of rope used varied between 2000 and 4500 m on each side (median of 2200 m). The design of nets, where specified, included two-panel Australian whiting seine nets, and "wing nets" made with both two and four panels. Bridle lengths reported were between 10 and 54 m along. Ground rope lengths were from 13 m up to 55 m on the largest vessel. Ground gear descriptions included rope weighted with lead, chain, and a combination of rope with looped chain. The type of rope used, where described, included buoyant polypropylene and dyneema material. Estimated weight of the net ground gears described varied from less than 30 kg (in air) where only weighted rope was used, up to approximately 100 kg where chain was added. Danish seine skippers listed reducing bottom contact as a driver for their gear set up, with the ground gear weighted only enough to ensure contact with the seabed and effective herding. Some respondents also commented that this technique could only be used on relatively smooth, clean ground.

Reported headline height varied from 1m up to 10 m in height, with a median of 3 m. Heights over 3 m were mainly when targeting snapper, whilst heights of 1–2 m were used for flatfish and red gurnard. Some vessels reported adjusted the headline height for different target species by adding or removing floatation.

Where information was provided, large mesh of 9–12" (230–300 mm) was used in the forward part of the net. Lengtheners were mainly diamond mesh, with 100, 127, and 152 mm mesh sizes all being used, both single and double stranded. All but one codend configuration described was 127 mm or 152 mm. The choice of larger and square mesh configurations on some vessels was driven by the desire to reduce catches of juvenile fish. Some noted that 127 mm was preferred where small fish were not a problem and for targeting tarakihi.

Perceived effectiveness of gear modifications

The survey asked how effective fishers believed their modifications were in relation to improving efficiency at catching target species, better size selectivity (including release of undersized fish) and reducing the impact of the trawl on the seabed. The survey answers indicated that fishers were very confident in modifications in relation to improving efficiency and selectivity, with > 80% of respondents indicating that they believed their gear set-up was moderately or very effective. There was less confidence in relation to seabed impacts, but 56% of fishers indicated that they believed that their trawl set-up was very or moderately effective. Many respondents expressed interest in access to further information in areas such as technology development, especially trawl doors, bycatch reduction, and reducing bottom contact.

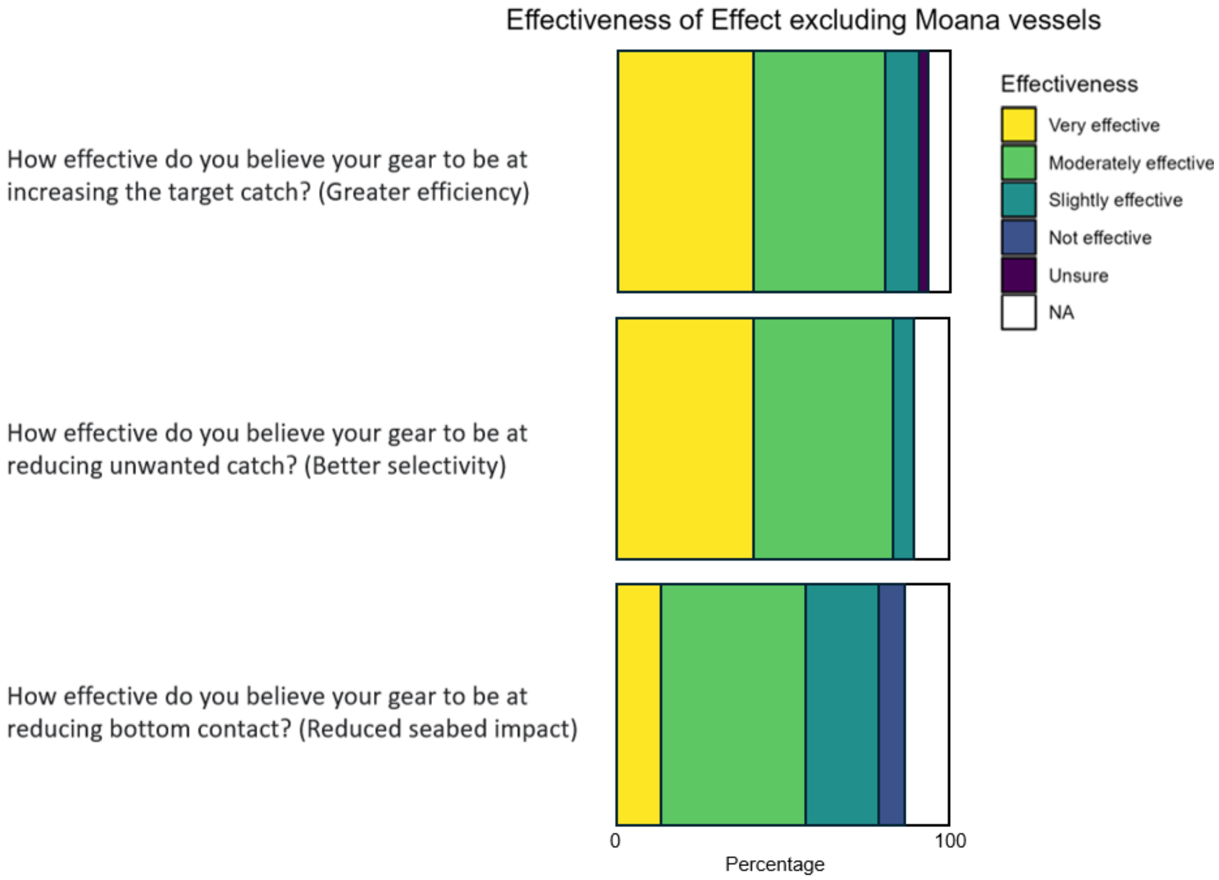


Figure 13: Fisher perceptions of effectiveness of trawl gear configurations in relation to improving target species efficiency, improving selectivity and reducing impacts on the seabed.

3 Discussion

The survey provided detailed information on 44 inshore vessels operating bottom trawls which represents a sub-set of the inshore fleet. MacGibbon et al. (2024) reported 124 vessels were active in inshore trawl fisheries in 2022, defined as contacting the sea bed by bottom trawl or midwater trawl within 1 metre of the seabed while targeting species defined as inshore (see Table 2 in the report). This included a small number of larger vessels (> 28 m) targeting species such as barracouta and squid that are defined as inshore stocks. More recently, Seafood New Zealand reported 149 vessels (137 trawl and 12 Danish seine) as active in the 2024/2025 fishing year (SNZ. unpublished data). Therefore, we estimate that our survey has captured around one third of the current trawl fleet and half the smaller Danish seine fleet. The findings are discussed in the context of comparison with the results of the 2007 survey, noting that this survey gathered data from an estimated 80% of the fleet at the time (Clement & Associates Ltd 2008).

This remains an ageing fleet with vessels largely older than 30 years, and a small number of newer additions. All respondents in 2024 monitored their fuel use, with around 20% using a flow gauge or fuel meter, others using manual means. Compared to the previous survey in 2007, which reported very low use of gear monitoring equipment, a higher proportion of vessels (between 37–47%) had invested in trawl monitoring technology including net monitors, catch sensors and door spread sensors which, together with more sophisticated seabed mapping tools used by some vessels, have improved the efficiency of trawling operations on those vessels. However, the cost of this technology investment remains a barrier to many smaller operations.

The survey collected information on the configuration of bottom trawls including the trawl doors, warps, sweeps, bridles, net designs, headline heights, groundgear configurations and lengthener and codends. The majority of trawl doors in use in 2024 were under 500 kg, with the median door weight across all regions of around 300 kg. Whilst the range of door weights was similar to 2007, there were a greater proportion of lighter doors weighing under 200 kg and a median weight of 180 kg. This was due to there being more wooden doors in use in 2007; a quarter were wooden, many being “homemade”. In the 2024 survey, almost all doors described were steel and commercially made. Where the manufacturer and model were provided, they were largely modern hydrodynamically efficient designs e.g. cambered and with one or more foils, including some high aspect ratio designs that reduce the area in contact with the seabed. A quarter of participants in 2024 perceived their trawl doors had light contact with the seafloor and some described set ups designed to reduce the area of contact of the door with the seabed. However, none of the fishers participating in the survey were fishing with trawl doors lifted fully off the bottom.

In 2007, 90% of vessels were using wire warps with only 10% (15 out of 153) using rope or Dynex, although another 5% mentioned an interest in trialling Dynex at the time. This lighter stronger material can contribute to fuel savings through reduced drag, and in the 2024 survey, just under half of the respondents (n=20) were using this synthetic material for their warps.

There has also been a transition away from standard wire sweeps, which made up 69% of reported gear configurations in 2007, along with 20% using bonded wire, compared to 15% and 7% respectively in the current survey (Figure 14). Instead, combination rope, consisting of wire strands wrapped in layers of synthetic fibre such as polypropylene was the most popular choice of sweep material (38%), with Dyneema and rope sweeps making up a combined 10%. With this change to lighter materials, many participants (28% overall) believe that their sweeps are either in only light contact with the seabed, or at least partially lifted off the seabed using rubber discs. The use of discs to lift sweeps clear of the seafloor has been shown in fisheries overseas to be effective at reducing seabed interactions whilst not substantially reducing catches of the target species in the Bering Sea flatfish trawl fishery (Rose et al. 2010) and the US west coast groundfish fishery (Lomeli et al. 2019). The range of sweep and bridle lengths used by vessels in 2024 was similar to 2007, but the combined lengths of around 100 m for sweeps and bridles in 2007 was slightly less than the 150 m recorded in 2024. Whilst Danish seine vessels operate much longer seine ropes and ground gear, these are also made from buoyant rope and synthetic materials, weighted only for light ground contact.

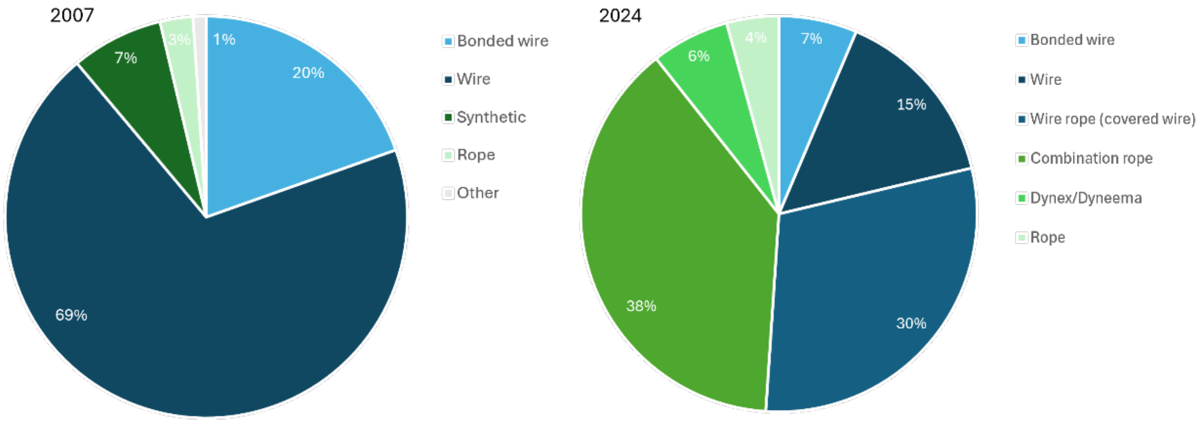


Figure 14: Comparison of the percentage of vessels using different sweep and bridle materials in the 2007 and 2024 surveys. There are some differences in categories between the two surveys.

A number of net makers and net designs were reported in both surveys. In 2007 the most commonly used trawl designs were wing and flatfish trawls, with scraper trawls being less common. Scraper trawls were more popular in the 2024 survey. The range of headline heights reported in both surveys was similar, with variation depending on net design and region, but overall median values in both surveys of 2.1 m and only a small proportion of vessels reporting headline heights of over 4 m. The range of net sizes used has also not changed substantially, with ground gear lengths in 2007 recorded from 13.7 up to 67 m, and an overall average of 25 m (median of 24 m) compared to 32 m in 2024 (range of 8m up to 61 m and median value of 34 m).

In the most recent survey, groundgear consisted of rope, chain, and combinations of both weighing up to 120 kg in air total, and rubber cookie configurations, weighing up to 334 kg in air, but estimated to be less than 100 kg in water due to the use of rubber material. The reported types and dimensions of ground gear are not much changed from 2007, other than the rubber cookie style being more common compared to the results of 2007 when chain ground gear was the dominant configuration used (Figure 15). The range of ground gear weights in 2007 were also very similar; between 30-150 kg for chain and rope bound gear and up to 350 kg in air for rubber cookies, although these data were only available for a smaller sub-sample of vessels (n=28).

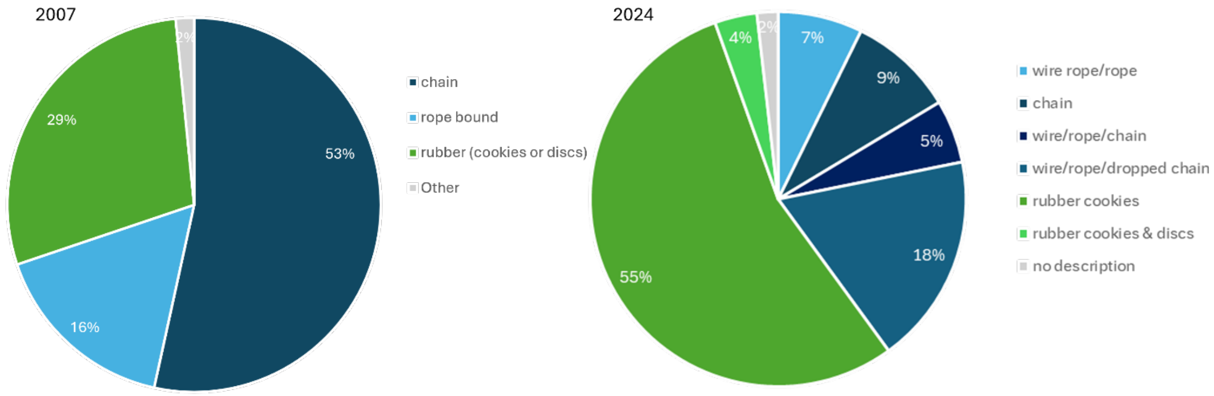


Figure 15: Comparison of the percentage of different groundgear types used in inshore trawls in the 2007 and 2024 surveys. There are some differences in categories between the two surveys.

The dimensions of groundgear reported from the New Zealand inshore fleet is comparable to other inshore fleets such as the Commonwealth Trawl Sector (CTS) in southern Australia (Broadhurst et al. 2023), and smaller than the bobbin and rockhopper rigs used in some European fleets and New Zealand deepwater fisheries, where steel or rubber bobbins and discs can be as much as 800 mm in diameter (O'Neill et al. 2024; Rowden et al. 2024).

In relation to netting characteristics of the trawls, the 2007 survey reported on the largest mesh sizes being used which is assumed to pertain to mesh in the wings and foreward parts of the trawl. Comments at the time indicated that fishers used large mesh sizes in these forward areas of the trawl to reduce drag and improve fuel efficiency, as well as improving selectivity. Codend data were not specifically collected in 2007, and we assume that most vessels were using minimum mesh sizes at that time, although a small number of participants commented that they had or intended to change to large mesh or 5” codends. The 2024 survey found that a significant proportion (75% of respondents to the survey) have increased the mesh size used in their codend above the minimum size required in their fishery areas with the intention of improving selectivity, reducing unwanted bycatch including undersized fish, and improving catch quality. If the survey sample is representative of the wider fleet, codends of 127 mm are now relatively standard in all regions and mesh sizes up to 154 mm are also in use. The use of turned mesh, either T90 or square, is also more prevalent, along with several fishers using rigid frames in the codend to better stabilize mesh openness. In 2007, 6% of vessels overall were reported to be using turned mesh in the trawl, most often in the form of ‘turbo’, T90 lengthener pieces. In 2024, 50% of lengtheners and 38% of all codend configurations reported were using either T90 or square mesh.

Overall, 84% of respondents had either increased mesh size above minimum and/or used a turned mesh codend. This represents a significant change to the fleet-level selectivity patterns and reduction in retention of undersized fish. It should be noted that twine material and thickness, knotted or knotless, the use of double-stranded twine or single twine and the number of meshes round in relation to the adjacent netting panels can all impact the selectivity of a particular configuration both positively and negatively (e.g. Sala and Lucchetti 2011; Herrmann et al. 2013). Also, the benefits of using turned mesh are optimal for fish species with a round cross section (e.g. red gurnard), but less beneficial for species with an elliptical or flattened cross section (e.g. Bayse et al. 2016) such as snapper and flatfish. The high strength composite fabric codends (PSH/MHS) being used by 3 vessels participating in the survey were provided to them by the companies participating in the development of this innovation. The primary benefit of this technology is reduced water flow inside the codend, resulting in fish being brought onboard alive and in good condition, improving catch quality and the option to release unwanted catch alive. Limited information is available, but some early trials indicate reduced catch of undersized tarakihi compared to 100 mm diamond mesh codends (Chambers et al. 2021). Other modifications to avoid unwanted catch such as snapper included changes to towing speed, lowering headline heights, and reducing the extent of the trawl veranda.

Information on a smaller number of Danish seine vessels was also collated. These vessels were of a comparable size and horsepower to trawlers, but the method was reported as more fuel efficient than trawlers. There were several seine net designs used, all characterized by long weighted polypropylene seine ropes up to 4500 m in place of warps, trawl doors and sweeps. The ground gear configurations of rope and chain were of similar dimension to trawl nets and weighted to achieve ground contact sufficient to herd fish effectively. Headline heights were also similar, varying depending on target species and region and a range of mesh sizes up to 152 mm including turned mesh, but 127 mm was preferred by some to minimise losing too many marketable fish. Danish seine skippers noted that this fishing method is restricted to flat soft sediment habitats.

4 Summary and recommendations

The 2024 survey collected detailed gear and operational information from 44 inshore trawl vessels, representing about one third of the current trawl fleet and around half of the Danish seine fleet, and allows comparison with a 2007 survey that covered most of the fleet at that time. This remains a fleet of ageing vessels, but as would be expected in any industry, there has been uptake of technological advances as they have become available. This includes more hydrodynamic trawl door designs, modern lightweight materials, such as Dyneema, and catch and trawl monitoring and seafloor mapping technology, all of which help to make fishing operations more efficient. The cost of some of this modernization remains a significant barrier to many operators.

Net designs and size described in the two surveys have not changed substantially, but scraper trawls made up a greater proportion of the 2024 survey sample and similarly, the use of rubber cookie ground gear. The buoyancy of rubber in water means that in-water weight of this gear is reduced, with many estimated to be <100 kg. A number of fishers od both trawl and Danish seine reported that they have lightened their trawl gear to reduce impacts on the seafloor; for example some trawlers have modified their sweeps to lift sections off the seafloor and reduce contact. An impressive 84% of respondents have made voluntary changes to increase codend and lengthener mesh size and/or use of turned mesh orientation to reduce bycatch of undersized and unwanted species. Several have even utilized rigid frames in the codend to enhance and “stabilize” mesh openings, again at their own cost and risk. Innovative PSH codends provided to vessels through the research programme are also in use on three vessels. Survey participants indicated strong confidence in the efficacy of their gear set-ups in relation to improved catch efficiency, selectivity and bycatch reduction, and moderate confidence in changes to reduce seabed impacts.

Given the negative perception the fishing industry faces in relation to the impacts of bottom-contacting methods, the efforts of participating fishers and the positive aspects of the results of this survey should be acknowledged and strengthened by extending the survey to increase participation of the wider fleet to boost confidence in representativeness of these results.

Independent empirical data on the impacts of the changes made that is specific to New Zealand seafloor habitats and fishing fleets is largely lacking, particularly for seabed impacts, and is essential to effectively engage in the public commentary on bottom-contacting fishing gears as well as better facilitate future innovation and uptake.

The development of a programme to collect such empirical data on the interactions of New Zealand-specific trawl gear with seafloor habitats incorporating effects on catch efficiency would allow a more accurate understanding of the environmental impacts of current standard, modified and potential future gear configurations. Such a programme should be co-developed and supported by industry, government, and science-providers working together to ensure the data collected are appropriate, scientifically robust, and accompanied by effective pathways for knowledge sharing, and wider gear trials where the risk and cost to small operators to trial innovation is subsidised to incentivize uptake.

5 Acknowledgements

The authors would like to thank all the fishers who took the time to complete the questionnaire and contribute their knowledge and Josh Donker and Glen Curtis at Motueka nets for also providing valuable information. We also acknowledge Steve Eayrs, Tony Craig and Moana Ltd for contributing the earlier survey information. Thanks also to Tiff Bock and Tamar Wells of Seafood New Zealand for their support and feedback during the project. Dan MacGibbon provided a valuable review of this report.

6 References

Bayse, S.M., Herrmann, B., Lenoir, H., Depestele, J., Polet, H., Vanderperren, E., Verschueren, B. (2016) Could a T90 mesh codend improve selectivity in the Belgian beam trawl fishery? *Fisheries Research*, 174: 201-209.

Broadhurst, M.K., Knuckey, I.A., Millar, R.B. (2023) No effects of ground-gear diameter on the performance of a south-eastern Australian fish trawl. *Fisheries Research*, 263: 106695. https://doi.org/10.1016/j.fishres.2023.106695

Chambers, M.S., Middleton, D.A.J., Moran, D., Janssen, G. (2021) An alternate-tow net A vs. net B comparison. *New Zealand Fisheries Assessment Report 2021*, 52: 43.

Clement & Associates Ltd (2008) *New Zealand Inshore Trawl Gear and Operations Survey*. Report prepared for Seafood Innovations Ltd: 31.

Eayrs, S., Craig, T. (2023) *A review of Moana New Zealand's efforts to reduce seabed contact by fishers engaged in bottom trawl, Danish seining, and bottom longline fishing in New Zealand*. Report prepared for Moana New Zealand Ltd: 15.

Eayrs, S., Craig, T., Short, K. (2020) *Mitigation techniques to reduce benthic impacts of trawling*. Client Report prepared for the Department of Conservation: 125.

He, P. (2007) Technical Measures to Reduce Seabed Impact of Mobile Fishing Gears. In: S.J. Kennelly (Ed). *By-catch Reduction in the World's Fisheries*. Springer, The Netherlands:141–180.

He, P., Winger, P.D. (2010) Effect of trawling on the seabed and mitigation measures to reduce impact. In: P. He (Ed). *Behavior of Marine Fishes: Capture Processes and Conservation Challenges*. Wiley-Blackwell, Oxford: 295–314.

Herrmann, B., Wienbeck, H., Moderhak, W., Stepputtis, D., Krag, L.A. (2013) The influence of twine thickness, twine number and netting orientation on codend selectivity. *Fisheries Research*, 145: 22–36. https://doi.org/10.1016/j.fishres.2013.03.002

Jones, E.G. (2014) *Voyage Report (NAN1402): trials of semi-pelagic trawl doors*. Unpublished Report provided to FINZ: 24.

Jones, E.G., MacGibbon, D.J., Baird, S.J., Hurst, R. (2021) Gear use in New Zealand inshore trawl fisheries. *New Zealand Fisheries Assessment Report*, 2021/30: 85.

Lomeli, M.J.M., Wakefield, W.W., Herrmann, B. (2019) Evaluating off-bottom sweeps of a U.S. West Coast groundfish bottom trawl: Effects on catch efficiency and seafloor interactions. *Fisheries Research*, 213: 204–211. https://doi.org/10.1016/j.fishres.2019.01.016

MacGibbon, D.J., Mules, R., Goode, S. (2024) Extent and intensity of bottom contact by commercial trawling in New Zealand waters, 1990–2022. *New Zealand Aquatic Environment and Biodiversity Report,* 344: 80.

Moran, D., Black, S.E., Bell, E., Bell, P., Chambers, B., Ford, S., Hamill, J., Knox, G., Runarsson, A., Ruza, I., Horn, S., Olsen, L., Day, J., Thomas, S., Woods, D., Janssen, G. (2023) Catching better quality fish with novel codend technology: Precision Seafood Harvesting. *Fisheries Research*, 260.

O'Neill, F.G., Eighani, M., Savina, E. (2024) Sediment penetration by towed, seabed-contacting, fishing gear components. *Marine Pollution Bulletin*, 209: 117229. https://doi.org/10.1016/j.marpolbul.2024.117229

Rose, C., Munk, E., Hammond, C., Stoner, A. (2010) Effective herding of flatfish by cables with minimal seafloor contact. *Fishery Bulletin,* 108(2): 136–144.

Rowden, A.A., Anderson, O.F., Neubauer, P., Hamill, J., Bowden, D.A., Tremblay Boyer, L., Charsley, A., MacGibbon, D. (2024) Spatially explicit benthic impact assessments for bottom trawling in New Zealand. *New Zealand Aquatic Environment and Biodiversity Report,* 329: 118.

Sala, A., Lucchetti, A. (2011) Effect of mesh size and codend circumference on selectivity in the Mediterranean demersal trawl fisheries. *Fisheries Research*, 110(2): 252–258. https://doi.org/10.1016/j.fishres.2011.04.012

Valdemarsen, J.W., Jørgensen, T., Engas, A. (2007) Options to mitigate bottom habitat impact of dragged gears. *FAO Fisheries Technical Paper*, 506. Food and Agriculture Organization of the United Nations, Rome.

Appendix A Online survey questions

Help secure the future of our inshore fisheries

You will be aware of the negative public perception of bottom trawling in our fisheries. This is largely due to a lack of understanding of how this kind of fishing works.

Over 75 percent of our catch comes from trawling – without it, we would have little left, leaving many Kiwis with little to no access to fish caught in New Zealand waters.

To be more effective in supporting your interests, Seafood New Zealand has created this survey to better understand the nature of trawl and Danish seine fishing in the inshore sector.

Having solid data about how our inshore fleet fishes will support our ongoing work to maintain social license and access to fishing grounds.

Information from this survey will also feed into innovation projects and other initiatives that look to improve profitability/productivity and our environmental performance. For example, through this survey we want to improve our understanding of how different gear set ups can;

- reduce fuel costs
- reduce unwanted catch (avoid deemed values or unnecessary ACE costs)
- reduce bottom impacts.

The survey takes 20 to 30 minutes to complete. There are questions for both trawling and Danish seine. You will be asked to select the method you use and will then be directed to the appropriate section. If you use both methods, please complete both sections.

For the data to be useful, we need to understand the details. We will be asking for specific information on your vessel and the gear you use e.g. warps, nets, doors.

The data collected will be compiled into a database held by Seafood New Zealand and compared with earlier surveys to understand the changes over time and the current innovations occurring across the fleet. **Any information you provide will be treated as confidential and survey results will only be presented as part of a combined summary - no individual responses will be shared.**

Seafood New Zealand really appreciates your help with this important mahi (work).

Effect of your changes

When setting up your trawl/Danish seine, what is the main motivation for any changes, and how effective to you believe your gear to be? (Select as many as apply)

- [ ] Fuel reduction
- [ ] LFR requirement/approval
- [ ] Less bottom impact
- [ ] Better selectivity - reduction in unwanted bycatch
- [ ] Greater efficiency - increase in target catch rate
- [ ] Other

Please specify 'other' here

Please indicate the effectiveness of main motivations checked above

Fuel reduction: % of reduction

% of reduction

Less bottom contact:

1. Not effective	2. Slightly effective	3. Moderately effective	4. Very effective	5. Unsure

Better selectivity - reduction in unwanted bycatch:

1. Not effective	2. Slightly effective	3. Moderately effective	4. Very effective	5. Unsure

Greater efficiency - increase in target catch rate:

1. Not effective	2. Slightly effective	3. Moderately effective	4. Very effective	5. Unsure

Have you made adjustments that **didn't work**? Please provide more information if possible.

gear set-ups that didn't work

If you had one piece of advice to another trawler/seiner on gear set-up – what would that be?

Your answer

Is there a particular area of gear changes/improvements you would like to know more about?

Your answer

Skipper Information

Skipper name

Contact number (if OK to contact)

Are you an owner operator? *

Yes | No

Trawl or Danish Seine? *

- ☐ Trawl
- ☐ Danish seine

How many years operating?

Years trawling

Years Danish seining

Which region do you usually operate in? *

AKL - Auckland | HBAY - Hawkes bay | NPL - New Plymouth | WGTN - Wellington | NSN - Nelson | LYT - Lyttleton | TIM - Timaru | BLF - Bluff | DUD - Dunedin | WANG - Wanganui | BOP - Bay of Plenty | W.C.S.I. - West Coast South Island | Other

Vessel information, fuel use and additional equipment

Vessel information

Vessel name

Fuel Use

Do you know your power output/fuel use curve for your engine?

- Yes
- No

If yes, please provide details (if possible)

Your answer

If not, how much fuel per hour do you use during towing?

Your answer

Do you have a fuel monitoring system?

- No
- Flow gauge
- Pressure gauge
- Other

Please specify 'Other" here

Electronic Equipment

What electronic equipment do you use to improve your fishing activity?

GPS | Plotter | Net monitor (echosounder) | Catch sensor

Door spread sensor (trawl only) | Other

Please specify 'Other' here ____________________

What other equipment do you have on your net?

☐ Lights	type	count
☐ Cameras	type	count
☐ Selectivity grids	type	count
☐ Mammal deterrents/pingers	type	count
☐ Larger mesh escape panels	type	count
☐ Other		
Specify 'other' here	type	count

When and why do you use the equipment mentioned above?

Your answer

Provide further information here if desired:

Your answer

Questions from here on are separated into trawl specific and danish seine specific questions. Please select which questions to answer. *
If answering both trawl and Danish seine, please answer trawl questions first:

Trawl specific questions

Danish seine questions

Trawl Specific questions:

How many different trawls, or trawl gear set-ups do you use?

Your answer

There is the opportunity to fill in two gear set-ups.

Thinking of your **main gear set-up** answer the following questions. If you make other adjustments for different species or conditions, you will have an opportunity to describe that in a second gear set-up section.

Target species main (stock code):

eg SNA

Target species other (stock code/s):

eg SNA

Unwanted bycatch species (stock code/s)

eg SNA

Tow speed (knots):

knots

What are the drivers for this gear set-up? *

- [ ] Target species
- [ ] Unwanted bycatch
- [ ] Fishing conditions / seasons
- [ ] Target size
- [ ] Other

Please specify 'other' here

Please provide details

Your answer

Warps

Warp material

- Wire
- Dyneema
- Rope
- Other

Specify 'other' here

Lay (L or R) or both

- Left
- Right
- Both

Number of strands:

Your answer

Warp diameter (mm):

Your answer

Shallow fishing warp to depth ratio (<50 m/ 25 fathoms):

ratio, eg 3:1 or 200m

- meters
- fathoms

Deep fishing warp to depth ratio (>50 m/ 25 fathoms):

ratio, eg 3:1 or 200m

- meters
- fathoms

Trawl Doors - gear set-up #1

Door manufacturer and type

Your answer

Door material:

- steel
- wood
- Other

Please specify other material

Door size: area (m^2)

squared meters

Door size: weight (kg)

Door weight in kg

Describe your door position in relation to seafloor:

Your answer

Sweeps and Bridles - gear set-up #1

Top bridle length:

Your answer

- ○ meters
- ○ feet

Bottom bridle length:

Your answer

- ○ meters
- ○ feet

Top bridle diameter (mm)

Your answer

Bottom bridle diameter (mm)

Your answer

Sweep length:

Your answer

- ○ meters
- ○ feet

Sweep diameter (mm)

Your answer

Sweep material

- ○ Wire
- ○ Wire rope (covered wire)
- ○ Chain
- ○ Bonded
- ○ Other

Specify 'other' here

Sweep length:

Your answer

- meters
- feet

Sweep diameter (mm)

Your answer

Sweep material

- Wire
- Wire rope (covered wire)
- Chain
- Bonded
- Other

Specify 'other' here

Describe your sweep position in relation to seafloor:

Your answer

Fishing net - gear set-up #1

Name/type of net:

Your answer

Manufacturer:

Your answer

Is your trawl design

- 2-panel trawl
- 4-panel trawl

Ground rope length:

Your answer

- meters
- feet

Ground rope weight (kg):

kg

Please describe your ground rope set-up - all materials and diameters:

e.g., 22mm Ø stainless steel wire rope, threaded with 20 inch diameter rubber cookies.

Your answer

Float set up:

number, size, spacing

Headline height:

Your answer

- ◯ meters
- ◯ feet

- ◯ Estimated
- ◯ Measured

Where is the headline in relation to the groundrope?

- ◯ Directly above
- ◯ Ahead
- ◯ Behind

If you answer ahead or behind, indicate how far:

Your answer

- ◯ meters
- ◯ feet

Do you use ties to restrict height?

- ◯ Yes
- ◯ No

Lengthener - gear set-up #1

Lengthener length:

Your answer

○ meters

○ feet

Lengthener mesh size:

in inches

Total number of meshes round:

total number of meshes round

Lengthener mesh orientation:

○ Diamond (standard)

○ T90

○ Square (T45)

○ Other

specify other

Lengthener mesh: Material

Your answer

Lengthener mesh:

○ Single strand

○ Twist

○ Knotless

○ Double strand

○ Braid

○ Knotted

Codend - gear set-up #1

Codend length:

Your answer

- ○ meters
- ○ feet

Codend mesh size:

in inches

Total number of meshes round:

number of meshes

Codend mesh orientation:

- ○ Diamond (standard)
- ○ T90
- ○ Square (T45)
- ○ Other

specify other

Codend mesh: Material

Your answer

Codend mesh: Twine thickness

in mm

Codend mesh:

○ Single strand	○ Twist	○ Knotless
○ Double strand	○ Braid	○ Knotted

PSH only

Number of modules:

Your answer

module apertures:

- [ ] Circle - 48mm
- [ ] Circle - 43mm
- [ ] Circle - 36mm
- [ ] Slot - 100 x 35mm

Do you have any comments about using PSH?

Your answer

Please provide any details you would like about trawl gear set-up #1

Your answer

Do you change this set-up for other species or conditions? *

Yes No

Danish seining specific questions:

How many different Danish seines, or danish seine gear set-ups do you use?

Your answer

There is the oportunity to fill in two gear set-ups.

Thinking of your **main gear set-up** answer the following questions. If you make other adjustments for different species or conditions, you will have an opportunity to describe that in a second gear set-up section.

Target species main (stock code):

eg SNA

Target species other (stock code/s):

eg SNA

Main unwanted bycatch species (stock code/s):

eg SNA

Retrieval speed (knots):

knots

What are the drivers for this gear set-up? *

- [ ] Target species
- [ ] Unwanted bycatch
- [ ] Fishing conditions/ season
- [ ] Target size
- [ ] Other

Please specify 'other' here

Please provide details

Your answer

Seine ropes

What is the length of your seine ropes?

Your answer

- ◯ meters
- ◯ feet

Seine rope material

- ◯ Wire
- ◯ Dyneema
- ◯ Rope
- ◯ Other

Please specify

Lay (if applicable):

- ◯ Left
- ◯ Right
- ◯ Both

Number of strands:

Your answer

Seine rope diameter (mm):

mm

What is the range of seine rope deployed in different conditions?

Your answer

Sweeps and Bridles - gear set-up #1

Top bridle length:

Your answer

- meters
- feet

Bottom bridle length:

Your answer

- meters
- feet

Top bridle diameter (mm)

Your answer

Bottom bridle diameter (mm)

Your answer

Sweep length:

Your answer

- meters
- feet

Sweep diameter (mm)

in mm

Sweep material

- Wire
- Wire rope (covered wire)
- Chain
- Bonded
- Other

Describe your sweep position in relation to seafloor:

Your answer

Fishing net - gear set-up #1

Name/type of net:

Your answer

Manufacturer:

Your answer

Is your Danish seine design

- ◯ 2-panel trawl
- ◯ 4-panel trawl

Ground rope length:

Your answer

- ◯ meters
- ◯ feet

Please describe your ground rope set-up - all materials and diameters:
e.g., 22mm Ø stainless steel wire rope, threaded with 20 inch diameter rubber cookies.

Your answer

Float set up

number, size, spacing

Headline height:

Your answer

- ◯ meters
- ◯ feet

- ◯ Estimated
- ◯ Measured

When the seine is hauled, where is the headline in relation to the groundrope?

- ◯ Directly above
- ◯ Ahead
- ◯ Behind

If you answer ahead or behind, indicate how far:

Your answer

- ◯ meters
- ◯ feet

Do you use ties to restrict height?

- ◯ Yes
- ◯ No

Lengthener - gear set-up #1

Lengthener length:

Your answer

- meters
- feet

Lengthener mesh size:

in inches

Total number of meshes round:

total number of meshes round

Lengthener mesh orientation:

- Diamond (standard)
- T90
- Square (T45)
- Other

Lengthener mesh: Material

Your answer

Lengthener mesh:

- Single strand
- Twist
- Knotless
- Double strand
- Braid
- Knotted

Codend - gear set-up #1

Codend length:

Your answer

- meters
- feet

Codend mesh size:

in inches

Total number of meshes round:

number of meshes

Codend mesh orientation:

- Diamond (standard)
- T90
- Square (T45)
- Other

Codend mesh: Material

Your answer

Codend mesh: Twine thickness

in mm

Codend mesh:

- Single strand
- Double strand
- Twist
- Braid
- Knotless
- Knotted

Please provide any details you would like about Danish seine gear set-up #1

Your answer

Do you change this set-up for other species or conditions? *

Yes No

Follow up questions

Are you happy for us to contact you about your answers?

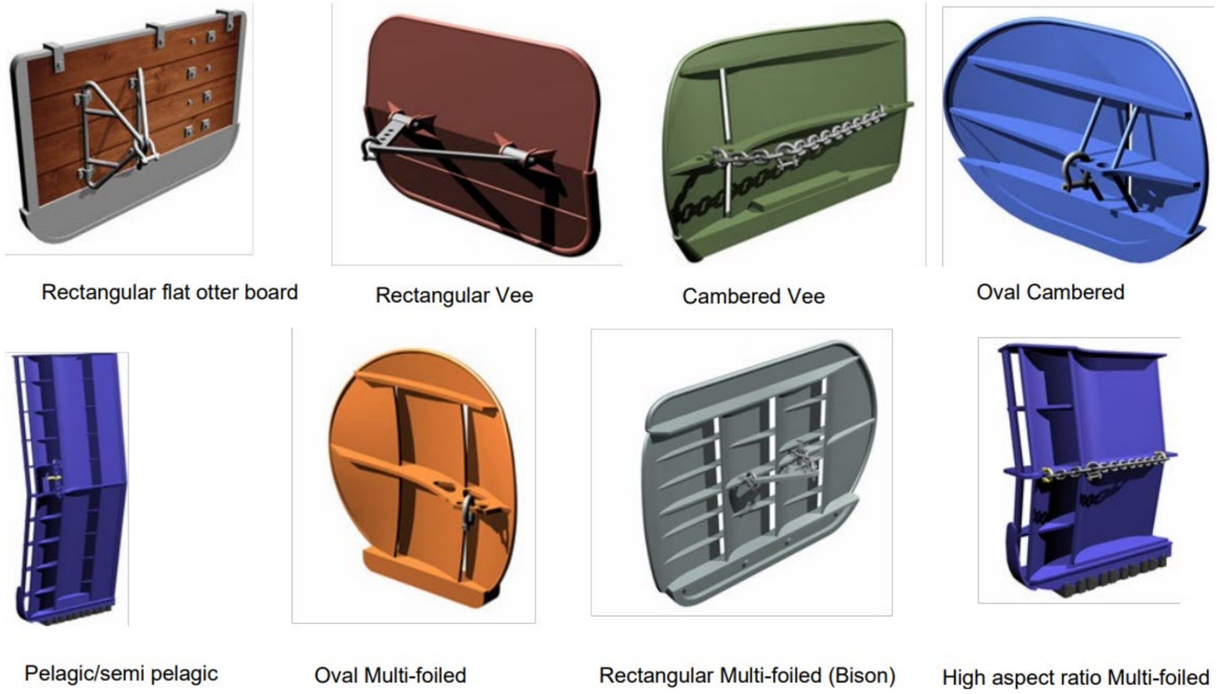
- Yes
- No

Anything else you would like to tell us about?

E.g. other gear set-ups not mentioned...

Click here to finish survey

Appendix B Trawl door designs.



Images of different styles of trawl door in use in bottom trawl fisheries. (Images courtesy of Seafish Asset Bank).

Appendix C Fish Species codes.

Species code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
ELE	Elephant fish	*Callorhinchus milii*
FLA	Flatfish sp.	
JDO	John dory	*Zeus faber*
GUR	Red gurnard	*Chelidonichthys kumu*
MOK	Moki	*Latridopsis ciliaris*
LIN	Ling	*Genypterus blacodes*
RCO	Red cod	*Pseudophycis bachus*
SCH	School shark	*Galeorhinus galeus*
SNA	Snapper	*Chrysophrys auratus*
SPO	Rig	*Mustelus lenticulatus*
STA	Stargazer sp.	*Kathetostoma sp*
TAR	tarakihi	*Nemadactylus macropterus*
TRE	Trevally	*Pseudocaranx georgianus*
WAR	Common warehou	*Seriolella brama*