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Tini a Tangaroa

Gear use in New Zealand inshore trawl fisheries

New Zealand Fisheries Assessment Report 2021/30

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Commercial fishers use a variety of different trawl gear within the constraints of the Fisheries (Commercial Fishing) Regulations 2001. The selectivity of these trawl gears will vary, and these differences will be reflected in the variation in catchability, i.e., the relationship between CPUE and the true population size of the different fish species targeted. Quantifying and understanding current and historic changes in commercial trawl gear selectivity is important for both effective use of CPUE indices, as well as assisting with innovation in fisheries to improve selectivity and reduce unwanted bycatch. With the roll out of commercial electronic catch and position reporting, there is an opportunity to build on the gear type information that will be collected via this new digital system. This report details the outcomes of a desk-based study of trawl gear information currently available, and a workshop held in June 2019 to determine what attributes should be collected from fishers to better understand trawl selectivity.

TCER and TCEPR forms provided limited information on net size, and some variation in headline height by target species. Recent changes to headline height indicated avoidance of snapper in some areas. Beyond that, these data provide no information with which to understand how trawl gear is being adapted and modified. The more detailed data collected by Fisheries New Zealand observers can provide a better picture of the size and configurations of trawls used in different areas. There were clear differences between areas reflecting the different target species, types of vessels operating, and the nets used. Observer-collected data on codend mesh size also indicated a shift away from the minimum codend and lengthener mesh sizes in some areas. This is in line with anecdotal information that many vessels are adopting larger codend and lengthener mesh sizes to reduce catch of undersized fish and was corroborated by the more recent electronic reporting data available. The use of different mesh orientations such as square mesh and T90 were also reported by Fisheries New Zealand observers. These data did not suggest any increase in uptake of T90 compared with a previous survey of the fleet in 2007. This may however reflect the targeted observer coverage of certain parts of the inshore fleet, such as vessels using the recently introduced Modular Harvesting System codend and lengthener gear. Vessels using this gear type in Fishery Management Area 1 had longer sweep and bridle lengths, and wider wing and door spreads compared with conventional gear. The 'mesh' configuration for MHS lengtheners and codends was usually left either blank or categorised as 'O' for other, and there is a need for more clarity on how the aperture sizes are recorded.

A workshop was convened on the 26th June 2019 to discuss the metrics already being reported and the value and practicalities of expanding the information collected through the Electronic Reporting System. The 25 participants included science providers, Fisheries New Zealand (science, management, and observers), and the commercial fishing industry. The output from the workshop on the day was a table of possible attributes that could be collected by vessel skippers. This list was circulated to the participants after the workshop for further review and priority ranking.

From the collated responses, the recommended priority attributes that should be considered for inclusion in the new electronic catch and position reporting system are: door spread, ground gear rope length, sweep and bridle lengths, and codend mesh size and orientation. Other attributes that were also considered important by some included: door size/area, minimum and maximum towing speeds, and lengthener configurations.

1. INTRODUCTION

Improving fishing gear selectivity is often put forward as an objective for fisheries management to minimise the bycatch of undersized and non-target fish, and to address poor fishing practices leading to waste and lost value. Gear selectivity refers to which species and size of fish will be caught by a given gear type, and which fish will escape.

The selection of fish by a fishing gear can be considered to be the process which causes the catch to have a different composition to that of the fish population in the geographical area in which the gear is being used (Wileman et al. 1992). The selectivity of a fishing gear is therefore a measurement of the selection process. It will be determined by the reactions of fish to the various components of the trawl, from the trawl doors all the way through to the size and shape of the mesh openings in the codend. These reactions will be species and size-specific and will be influenced by environmental factors, such as substrate type, water clarity, prevailing currents, etc. Out of all these components, the selection process that is most straightforward to quantify is that of the netting itself, which is referred to as mesh selection.

Changes in the configuration of commercial trawl gear that change the selective properties of the fishery affect the interpretation of catch per unit of effort (CPUE) data that is commonly used as an index of abundance for the management of New Zealand fish stocks. The relationship between CPUE and the true population size is defined as catchability (Arreguín-Sánchez 1996). Catchability is strongly related to gear selectivity, as well as fish availability on the ground and vulnerability (the probability of encounter of the fishing gear and the fish). If the differences in gear use and historical changes in gear are not effectively accounted for in CPUE indices, there is a risk that the absence of these data may impact on the accuracy of the information that is used to inform science and fisheries management.

The Fisheries (Commercial Fishing) Regulations 2001 prescribe trawl net restrictions; however, within this there are variations in the type of trawl gear that is used across New Zealand. Commercial fishers are required to report some trawl gear characteristics to Fisheries New Zealand through reporting regulations (Appendix 1). These requirements have previously included relatively limited information on the trawl gear (e.g., TCEPR (Trawl Catch, Effort and Processing Return) and TCER (Trawl Catch Effort Return) forms, as shown in Appendix 2), and there is limited documentation of the specific configurations and components of trawl gear in use and inferred selectivity across New Zealand currently, or any historical changes.

A survey commissioned by Seafood Innovations Ltd and SEAFIC in 2007 carried out face-to-face or phone interviews to gather information on 153 trawlers, representing 81% of the inshore fleet of approximately 188 vessels (Clement & Associates 2008). The aim of the study was to deliver a baseline picture of trawl gear used in the inshore fishing fleet and identify opportunities to explore drag reduction and improve fuel efficiency. The survey collected detailed information on: the size, age, and type of vessels; vessel engineering information (engine make, including Hp, propeller specifications); trawl door material, size, and weight; warp information (material, diameter); sweep and bridle lengths; the type of trawl used (style, manufacturer, groundrope length and material); netting characteristics (e.g., twine surface area, largest mesh size used, material, and use of knotless netting); use of monitoring equipment, headline height, and tow speed in relation to target species.

The survey characterised three types of nets; high (> 4 m), medium (2–3 m) and low (1–2 m) opening nets based on net styles for targeting different species. Although codend length was included in the survey questionnaire, the codend mesh size was not recorded. This may have reflected that vessels were largely using the minimum mesh size allowed under regulations. The largest mesh size for other parts of the trawl in most nets was recorded as 6″ (152 mm) for low and medium opening trawls and 12″ (305 mm) in high opening trawls. The survey followed on from the recent introduction of T90 style netting, where diamond mesh panels are hung at a different angle, so that the mesh is turned 90° to the standard orientation. This change in orientation opens the meshes up, even under tension, improving water flow through the net and the opportunities for under-sized fish to escape. The survey found that overall, 6% of vessels used T90 netting in the trawl, mainly in low to medium opening style nets.

In 2014–2015, NIWA undertook an informal pilot study to interview skippers and identify what gear innovations were being trialled relating to bycatch reduction in the industry at that time. Face-to-face and phone interviews were carried out with skippers/owners of 30 vessels mainly from Fishery Management Area (FMA) 7 (Tasman and Golden bays, Cook Strait, and the west coast South Island), but also the east coast of the South Island (FMA 3), and a smaller number of interviews from the east coast North Island (FMA 2). From the combined interviews, over 50% of skippers had trialled increased mesh sizes (i.e., mesh sizes greater than 100 mm) in the codend for at least some of their fishing activities, although only one third continued with the new mesh size (E. Jones, NIWA, unpublished data). The use of T90 was mostly restricted to the lengthener and had been adopted by about one third of vessels at the time.

Together, these studies provide a baseline of inshore trawl gear configurations from over 10 years ago, and some evidence of changes to gear configurations, particularly codend and lengtheners that have occurred since at least 2014. A more comprehensive understanding of these changes and the current status has been identified as an information gap by scientists and fishery managers.

Both Fisheries New Zealand and Fisheries Inshore New Zealand (industry) have an increased focus on fostering gear innovation in New Zealand's fisheries, specifically inshore. There is also greater public scrutiny on how inshore fisheries are managed, including concerns associated with protected species interactions, bycatch of undersized and non-target fish, benthic disturbances, and poor fishing practices leading to waste and lost value. These factors are driving the desire to encourage greater levels of gear innovation to support the sustainable use of our fisheries resources, reduce the adverse environmental effects of fishing, and to increase the value of seafood caught.

Having a better understanding of trawl gear use throughout New Zealand waters will assist the encouragement of greater levels of innovation. This could be achieved through sharing knowledge (where not commercially sensitive) of gear innovations that are already occurring throughout the fisheries and identifying issues with existing gear use and finding solutions.

With the roll out of commercial electronic catch and position reporting, there is an opportunity to build on the gear type information that will be collected via this new digital system. Electronic reporting allows for more data fields to be recorded than previously because there is no physical space limitation as there is with the paper forms used previously. For this information to be of most use to stock assessment and management processes, it should be collected at the fishing event level. Collecting gear type information via the electronic system provides the ability to match gear information to a fisher's catch effort.

This report represents phase 1 of a broader Fisheries New Zealand initiative to improve the information available on trawl gear characteristics and encourage greater levels of innovation within the New Zealand inshore fleet (Figure 1). The purpose of this project was to undertake a stocktake of currently available information on inshore trawl gear and determine what information should ideally be collected in the future.

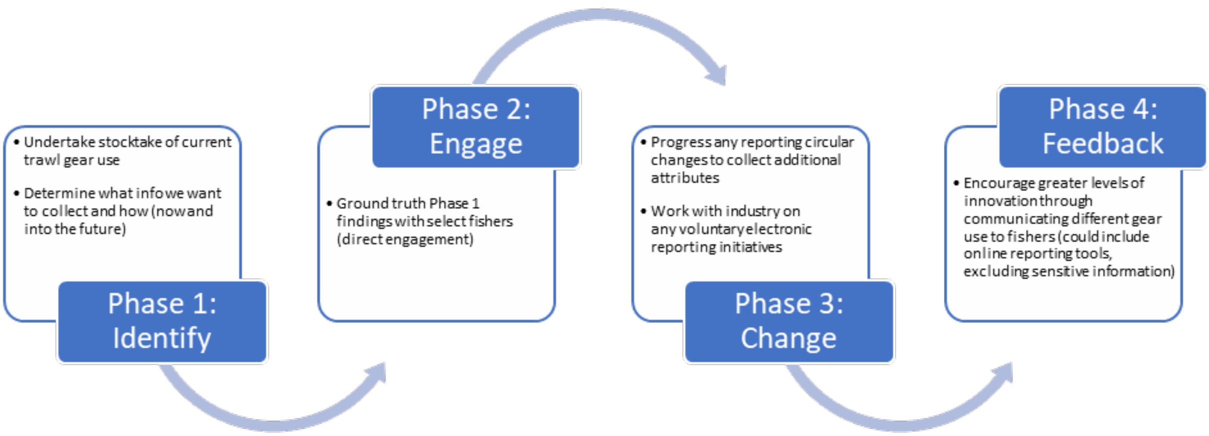


Figure 1: Proposed phases of Fisheries New Zealand gear use project.

The Specific Objectives of the project were:

1. Complete a desktop assessment of gear used across New Zealand inshore trawl fisheries using data from the observer programme and commercial fishing returns for the 2017–18 fishing year.

2. Facilitate workshops with gear experts, government, industry and non-commercial fishing interests to determine what attributes should be collected from fishers to better understand trawl selectivity (over and above what is required under the new digital system).

3. Provide recommendations on attributes that could be collected from fishers on their trawl gear characteristics via the new electronic catch and position reporting system (or voluntarily).

This report presents the results of the desktop analysis, the outcomes of a one-day workshop that engaged with gear experts, government, and industry representatives (non-commercial fishing interests were invited but were unable to attend), along with final recommendations.

2. METHODS

For the purposes of this project 'inshore trawl fisheries' were defined using the same criteria as used for trawl footprint assessment project: 'Monitoring the trawl footprint (including coastal)' (Fisheries New Zealand project BEN201801, Baird & Mules 2021). Under this definition, selected fish stocks in seven Fisheries Management Areas were defined as inshore, based on knowledge of vessel sizes used to target these species, and depth fished, for FMAs 1–3, 5, 7–9. Table 1 defines the target species for those inshore fish stocks:

BAR, ELE, FLA, GUR, JDO, KAH, LEA, MOK, RCO, RSK, SCH, SKI, SNA, SPD, SPO, SSK, STA, TAR, TRE, WAR.

Most of the effort for these target fish stocks is by vessels shorter than 28 m. Figure 2 shows the fish stocks grouped by FMA. It is noted that some fish stocks included in this definition are targeted by vessels greater than 28 m in length. An example is BAR 1, where although barracouta is assigned as an inshore species, there is some targeted fishing occurring in FMA 3 (which is part of BAR 1) by larger trawlers, including vessels over 46 m outside the 12 nm (territorial) boundary.

Table 1: List of inshore target species included in this analysis.

Target code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
ELE	Elephant fish	*Callorhinus millii*
FLA	Flatfish	*Rhombosolea retiaria, R. plebeia, R. tapirina, Pelotretis flavilatus*
GUR	Red gurnard	*Chelidonichthys kumu*
JDO	John dory	*Zeus faber*
KAH	Kahawai	*Arripis trutta*
LEA	Leatherjacket	*Parika scaber*
MOK	Moki	*Latridopsis ciliaris*
RCO	Red cod	*Pseudophycis bachus*
RSK	Rough skate	*Zearaja nasuta*
SCH	School shark	*Galeorhinus galeus*
SKI	Gemfish	*Rexea solandri*
SNA	Snapper	*Chrysophrys auratus*
SPD	Spiny dogfish	*Squalus acanthias*
SPO	Rig	*Mustelus lenticulatus*
SSK	Smooth skate	*Dipturus innominatus*
STA	Giant stargazer	*Kathetostoma giganteum*
TAR	Tarakihi	*Nemadactylus macropterus*
TRE	Trevally	*Pseudocaranx dentex*
WAR	Blue warehou	*Seriolella brama*

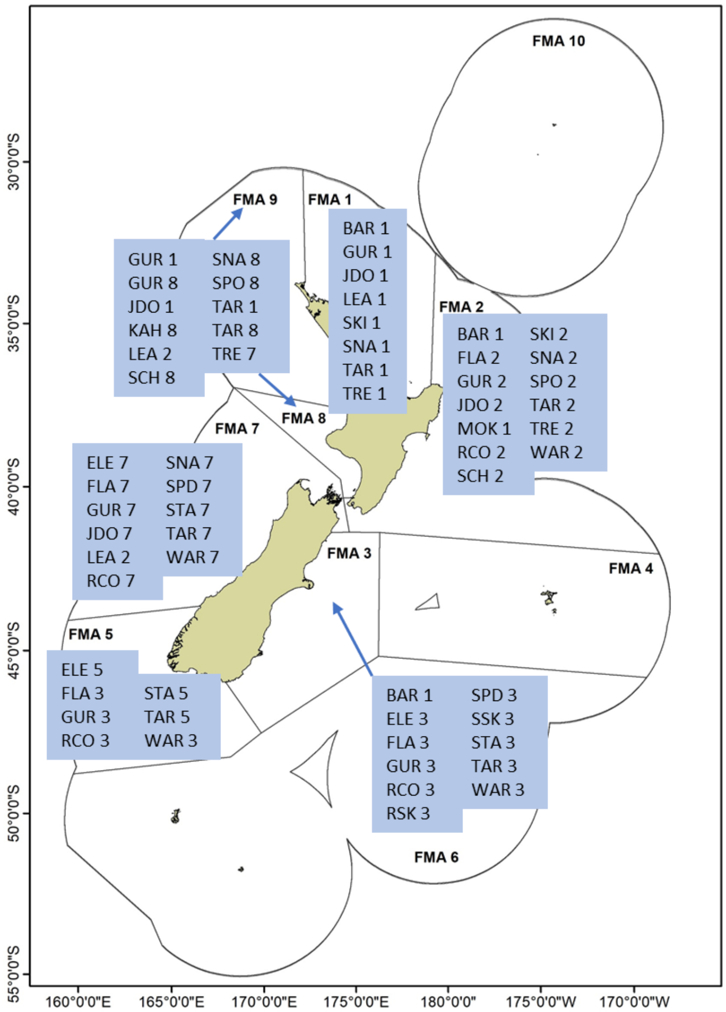


Figure 2: List of fishstocks grouped by FMA that are defined as part of 'inshore fisheries' for the purpose of this report.

Information from the commercial industry was collected from TCEPR and TCER forms (as shown in Appendix 2) prior to 2019, and by the new Electronic Reporting System (ERS) from 2019 onwards. Data used included:

- Gear code: this defined conventional bottom trawl (BT), midwater trawl (MT), pair trawl methods (BPT and MPT), and new gear configurations PRB and PRM. The latter are conventional bottom or midwater trawls fitted with a patented Modular Harvest System (MHS) developed by the Precision Seafood Harvesting (PSH) programme. The MHS consists of PVC-style lengthener and codend sections which replace conventional mesh sections at the end of the trawl.

- Design wing spread (m): this value is generally an estimate from the net plan of the width at which the net operates.

- Design headline height (m): estimated or measured height of the headline above the ground.

- Groundrope depth (m): measured depth from the sea surface to the depth of the ground gear.

From 2019 onwards, additional metrics available included:

- Number of nets: i.e., whether a twin or triple rig is used.

- Codend mesh size (mm): the minimum mesh size of the codend or codends of the trawl net.

- Mitigation device codes: currently refers to the use of a range of protected species mitigation devices, mainly for seabirds and marine mammals (e.g., bird bafflers or sea lion exclusion device (SLED)).

Fisheries New Zealand observers collect many more metrics in addition to those listed above on a Trawl Gear Details Form (see Appendix 4) including: number of warps; door type/area; door spread; sweep and bridle lengths; headline length; maximum size of ground gear; ground gear components; number of codends; and mesh size of lengthener.

A groomed data extract used for the trawl footprint project (BEN201801) included information from the commercial industry, including data from Fisheries New Zealand observers. From commercial operators, data from the 2017–18 year and available data from the 2018–19 year were used. Given the much lower sampling intensity of observer-collected data in the inshore fishery, data from the previous 5 years were utilised.

Plots of the location of the records were used to identify outliers, although the scope of this project did not allow thorough grooming and error fixing. The majority of trips were shallower than 300 m, but a small number of trips deeper than 300 m were examined. The maximum depth of these locations was 405 m. Reported target species at depths deeper than 300 m were gemfish, tarakihi, barracouta, and red cod, and the trips were retained in the dataset. The data provided were summarised into a series of tables and box plots presenting the spread of data for different FMAs and, within each FMA, the range and median values for the parameters recorded by gear type and by species.

3. RESULTS

3.1 TCER and TCEPR forms

Data collected from TCEPR and TCER forms are summarised in Table 2. The number of vessels operating within the different FMAs varied from 13 in FMA 9 to 68 in FMA 3, with 6270 individual trips and nearly 40 000 unique tows. For each gear type, three gear parameter variables are traditionally recorded by fishers; the number of nets, the design wing spread (effort width), and the headline height (effort height). Number of nets was recorded in all records, the effort width and height values were generally recorded for over 97% of tows, except in FMA 1 where width was recorded for 64.5% of tows.

Table 2: Summary of gear parameter data reported on TCEPR and TCER forms during the 2017–18 year. For each FMA, the number of vessels, unique trips, and tows for which gear parameters were recorded is given, along with the percentage of tows for which values were recorded.

FMA	No. vessels	No. trips	No. tows	Effort width (%)	Effort height (%)	Number of nets (%)
FMA 1	18	567	5 677	64.5	99.9	100
FMA 2	32	956	6 425	97.0	100.0	100
FMA 3	68	2 688	11 213	100.0	98.6	100
FMA 5	24	407	2 918	100.0	100.0	100
FMA 7	43	1 008	8 441	100.0	100.0	100
FMA 8	25	340	1 729	100.0	100.0	100
FMA 9	13	304	2 483	98.8	100.0	100

Table 3 summarises the gear information by both FMA and gear code. Bottom trawl with conventional codends (BT) was the most reported gear code, used on 34 806 tows (nearly 90% of all tows) for the combined FMAs. Vessels reported using MHS codends on bottom trawls (gear code PRB) on 3644 tows (1.1%) in four FMAs (FMA 1, 2, 8, and 9), with the majority of use in FMA 1 and FMA 9. The use of standard midwater gear was recorded on 434 tows in 27 trips and from 7 vessels, all operating in FMA 3. The midwater version of the MHS codend (gear code PRM) was reported on just 2 tows from 2 trips by 2 vessels, also in FMA 3.

Figure 3 presents summary box plots of the three gear parameters recorded by FMA for the three main gear codes used: BT (bottom trawl), MW (midwater trawl), and PRB (bottom trawl with MHS codend). The number of nets used per trawl (Effort Total Count) was 1 in all groups except for some records in FMA 5, where 2 nets were reported. It is known that one or more vessels operate twin trawls in this area. For bottom trawls with conventional mesh codends (BT), the reported net widths were generally between 10 and 30 m, with median values around 20 m, lower in FMA 3 (15 m) and slightly higher in FMA 9 (21 m). Maximum net widths up to 80–100 m were recorded in all FMAs apart from FMA 2. Vessels that reported using the MHS codends (PRB) reported slightly larger net widths of about 25–30 m compared with standard BT trawls and maximum values of 80–130 m. The width of midwater trawls used in FMA 3 was generally between 80 and 116 m, with a maximum reported value of 150 m. These values reflect the inclusion of barracouta as a target species in this FMA, resulting in the inclusion of larger vessels which fish this species at certain times of the year (see Figure 3-3 in Appendix 3).

Reported headline heights of conventional bottom trawls were mainly within the range of 1–4.5 m in most FMAs. Median heights were lowest around the South Island in FMA 3 and FMA 5 (1 m), where species such as flatfish, red cod, elephant fish, and stargazer are commonly targeted, and highest in FMAs 1 and 2 (4 m), where snapper and/or tarakihi are common target species (see Table 3). From the west coast FMAs (7, 8, and 9), median headline heights were lower at around 2 m. Some higher outlier values of up 10–15 m were reported in FMAs 3, 5, and 7 (Figure 3). Reported headline heights associated with the PRB gear in FMAs 1 and 2 were similar to BT gear at about 4 m, but variable off the west coast. In FMA 8, there were far fewer events using PRB, and a higher headline height compared with BT at about 6 m. In FMA 9, there were again fewer events but, in this area, the median headline height was low (2 m) for both BT and PRB.

It is noted that although recorded at the event level, default values are generally in use. For 95% of trips in the 2017–18 year, a single value for headline height was entered for all tows in the trip, and a single value for wing spread was used for 98% of all trips.

Table 3: **Summary of data for the three gear parameters collected on TCEPR and TCER forms during the 2017–18 year. The 'width' and 'height' parameters are given in metres. For each FMA, the range (min, max), median, mean, 25th and 75th percentile (q1 and q3) values for each parameter is provided for each gear code (defined in text above), along with the number of unique vessels, trips, and tows for each combination.**

FMA	Code	Gear parameter	min	q1	median	mean	q3	max	No. tows	No. vessels	No. trips
FMA 1	BT	width	12	15	22	22	27	80	2 453	16	281
	BT	height	1.2	2	4	3	4	35	3 087	17	329
	BT	count	1	1	1	1	1	1	251	3	28
	PRB	width	0	25	30	30	30	80	1 200	8	182
	PRB	height	0	2.5	4	5	4	45	2 579	9	271
	PRB	count	1	1	1	1	1	1	257	2	49
FMA 2	BT	width	0.35	18	25	23	28	36	5 846	31	886
	BT	height	0.2	2	4	3	4.5	45	6 040	32	906
	BT	count	1	1	1	1	1	1	424	3	45
	PRB	width	24	30	30	31	30	130	378	4	53
	PRB	height	3	3	4	4	4	14	378	4	53
	PRB	count	1	1	1	1	1	1	211	2	28
FMA 3	BT	width	0.8	10	15	19	23	87	10 771	61	2 660
	BT	height	0.1	1	1	2	2.5	20	10 771	61	2 660
	BT	count	1	1	1	1	1	2	92	6	15
	MW	width	80	90	116	109	116	150	434	7	27
	MW	height	24	27	30	32	32	50	282	5	17
	MW	count	1	1	1	18	25	101	406	7	25
	PRM	width	45	62.75	80.5	81	98.25	116	2	2	2
	PRM	height	3.5	3.5	3.5	4	3.5	3.5	1	1	1
	PRM	count	2	9	16	16	23	30	2	2	2
FMA 5	BT	width	0.8	10	20	24	33	80	2 901	24	407
	BT	height	0.09	1	1	1	1	20	2 901	24	407
	BT	count	1	2	2	2	2	2	317	2	36
FMA7	BT	width	1	15	20	23	30	80	8 437	43	1 008
	BT	height	0.1	1.5	2	2	3	20	8 437	43	1 008
	BT	count	1	1	1	1	1	1	709	8	69
FMA 8	BT	width	2.5	15	18	22	25	80	1 689	25	318
	BT	height	1	1.5	2	3	3	7.5	1 689	25	318
	BT	count	1	1	1	1	1	1	278	7	26
	PRB	width	24	24	26	28	26	80	40	2	23
	PRB	height	1.5	5	6	5	6	6	40	2	23
FMA 9	BT	width	6.5	18	21	27	30	100	1 811	12	259
	BT	height	0.5	1.5	2	3	4	35	1 841	12	261
	BT	count	1	1	1	1	1	1	918	3	57
	PRB	width	8	30	30	49	80	80	642	3	69
	PRB	height	0.5	1.5	2	2	2.5	5.5	642	3	69

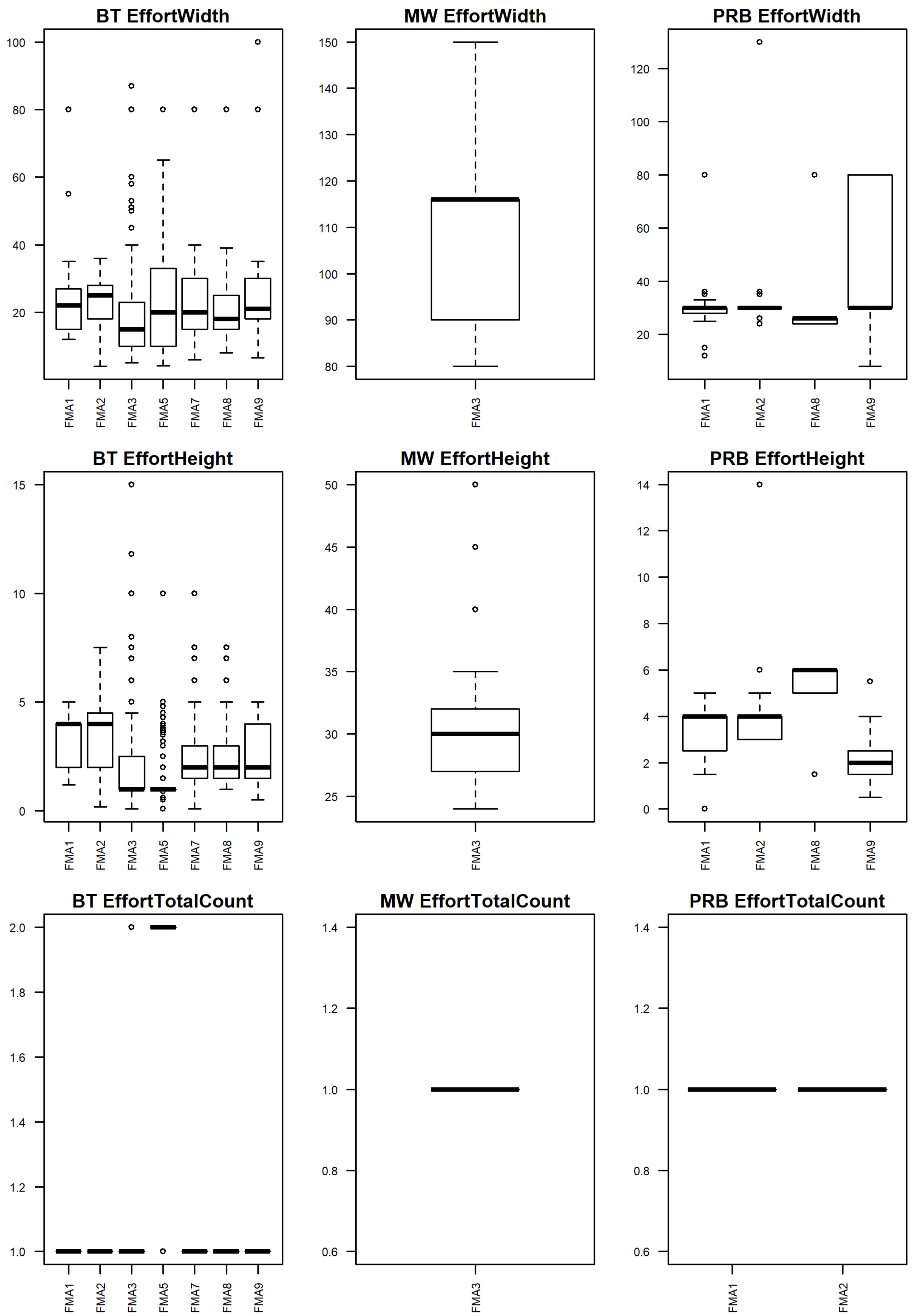


Figure 3: Summary of data collected from TCER and TCEPR forms on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range. and outlier values for each metric for three gear codes (BT = bottom trawl with mesh codend, MW = midwater trawl with mesh, and PRB = bottom trawl non-mesh codend).

The net characteristics reported by FMA represent a range of net designs and sizes, each fished differently when targeting different species. Within each FMA, between 5 and 10 species were targeted. Appendix 3 summarises gear information by target species and gear code for each FMA (Figures 3-1 to 3-7 and Tables 3-1 to 3-7 in Appendix 3).

In FMA 1, seven species were targeted with bottom trawl gear, most commonly snapper, tarakihi, and trevally. Trawl width ranged from 12 to 35 m (values of 0 and 3 m are assumed to be errors) and trawl height ranged from 1.2 to 5 m (Figure 3-1 and Table 3-1). Overall median reported trawl width and headline height were 22 m and 4 m for BT and 30 m and 4 m for PRB. This pattern of greater net width associated with the PRB gear was consistent for the most common target species: 20 m for BT targeting snapper compared with 28 m from vessels using PRB, and a similar difference when tarakihi was the target species (Table 3-1). There was less difference between the gear widths when targeting trevally, with median values of 27 and 30 m, respectively, and no difference for John dory (25 m for both). A single vessel using smaller trawl gear reported a net width of 12 m for both BT and PRB targeting gurnard and leatherjacket. Reported median BT headline height was 4 m when targeting both snapper and tarakihi, 4.5 m for gemfish (SKI), and 2.5 m for all other species. Headline height reported by vessels using PRB codends was more variable for different species, but the overall range was similar (2.5–4.5 m).

In FMA 2, there were fewer vessels using PRB compared with in FMA 1. Tarakihi was the most common target species for both gear methods, followed by gurnard, with a further six species targeted using BT gear and two species with PRB (Table 3-2). Reported net widths ranged from 12 to 36 m (not including outliers) and reported headline height from 1 to 6 m. The median net width for BT ranged from 18 to 28 m for the six species but was consistently 30 m for vessels using PRB for all species (Figure 3-2). Median headline height values reported for gear method BT ranged from 2.5 m when targeting red gurnard, 4–5 m for other species except blue warehou, for which the median height was 6 m. For gear method PRB, the median headline height was slightly lower at 3–4 m.

In FMA 8, seven species were targeted by vessels using BT, mainly gurnard and tarakihi (Figure 3-6 and Table 3-6). For gurnard, trevally, and snapper, BT net width ranged from 16 to 20m. For tarakihi, John dory, and school shark, median width was 25 m; the median width was up to 36 m for rig. Headline height was 2–3 m for all target species except snapper, which was higher at 5 m. Only one vessel reported using the PRB gear in FMA 8, when targeting mainly tarakihi and trevally with a median width of around 25 m and high headline height of 5.5–6 m.

In neighbouring FMA 9, trevally, gurnard, and tarakihi were the most commonly targeted species (Table 3-7 and Figure 3-7). A median trawl width of 22 m was reported for both trevally and tarakihi, with relatively low headline heights of 2.2–2.5 m; similar median dimensions were reported for both John dory and school shark. For gurnard and rig, smaller net widths of 8.9 and 15m and lower heights of 1.5 m were recorded. In contrast, when targeting snapper, median net width was 30 m and headline height was higher at 5 m. Compared with bottom trawl, median net width values were greater for PRB for the same target species, ranging from 29 to 33 m. Median net heights were similar for the same target species except for snapper, which was 2.5 m for PRB compared with 5 m for BT.

In FMA 3, there were 10 species targeted by vessels using gear method BT, with flatfish, barracouta, and tarakihi the most common (Table 3-3). Overall median reported trawl net dimensions were lowest in this FMA, but when split into the different target species, the values were quite variable, reflecting different sizes of vessel and net used (Figure 3-3 and Table 3-3). Vessels targeting flatfish, rough skate, gurnard, and elephant fish reported median net widths of 8–12 m, with median headline heights of 1 m. Median widths were larger (18–24 m) for vessels targeting barracouta, tarakihi, red cod, and warehou with median headline heights reported as 1.8–4 m. The midwater trawl was only used to target barracouta in FMA 3 and, as noted previously, these nets are used by larger factory vessels fishing further offshore but still within FMA 3. Two vessels reported using the PRM (midwater trawls with MHS codends) gear method on 2 tows in 2 trips, also for barracouta. However, the data on gear dimensions for these tows did not support this reported gear code. No vessels reported using the PRB method in FMA 3. Effort count was one for all BT and target species combinations but counts of up to 101 were reported for midwater gear methods, and the median count for PRM was 16. It is assumed that these are errors.

Bottom trawl was the only method reported from FMA 5 (Table 3-4), with twin trawling reported (count = 2 trawls) for four of the six target species. The most common target species was flatfish, followed by stargazer. Median width ranged from 18 m reported when targeting flatfish to 39 m for elephant fish and 80 m reported for red cod from one trip (Figure 3-4). The median headline heights were 1–1.5 m for flatfish, elephant fish, stargazer and red gurnard, and 3.5 m for red cod and tarakihi. Bottom trawl was again the only method reported from FMA 7 (Table 3-5), targeting mainly flatfish, tarakihi, and gurnard, along with 6 other species to a lesser extent. Median net width and headline height for tows where flatfish were the target (16 m width and 1.6 m height) were similar to net dimensions reported for the same target species in FMA 5, and slightly larger than flatfish nets used in FMA 3. The median reported net width when targeting other species was 20–30 m, with a net height of about 2–3 m, except for a small number of tows targeting leatherjacket where headline heights of up to 7.5 m with a median of 5 m were reported.

A similarity in gear parameters among target species within an FMA is not entirely surprising given that a lot of inshore fisheries operate as mixed target fisheries and vessels will often target several species with the same gear. Some variation is likely when target species occur at different depths which alters the values of some gear parameters, e.g., at greater depths more warp wire is needed which in turn can increase door spread and can result in lower headline heights. Towing speed (which can be species dependent) can also affect other gear parameters, e.g., faster speeds can increase door spread and hence reduce headline height. There were also some clear species-specific patterns in the FMAs. Snapper was a target species in all North Island FMAs and FMA 7, although less commonly targeted off the west coast compared with FMAs 1 and 2. Trawl net widths ranged from 20 to 30 m with consistently higher headline heights compared with other target species: median headline height values of 4–5 m, and maximum headline heights of up to 7.5 m. Exceptions to this pattern were PRB gear in FMA 9 and BT gear in FMA 7. The latter could be due to the increased abundance of snapper in Tasman Bay and Golden Bay, with a number of fishers who do not have snapper quota lowering their headline heights to avoid catching snapper (D. MacGibbon, NIWA, pers. comm. with local skippers during the 2019 WCSI inshore trawl survey). Tarakihi was in the top 4 target species in all FMAs, with intermediate median net widths of 18–25 m and headline heights of 2–3 m off the west coast and up to 4 m in FMAs 1 and 2. Both snapper and tarakihi are also targeted using the PRB gear method, with wider wing spread, but variable headline height. Red gurnard was also a target species in all areas, with a similar range of wing spreads to that for tarakihi, but generally lower headline heights (1–2.5 m).

3.2 Electronic Reporting System

Electronic Reporting has been rolled out to the inshore fleet, and at the time of the data extract for this project in June 2019, 5698 records were available. The primary new metrics now being collected are codend mesh size (mm) and the use of non-fish bycatch mitigation devices. Figure 4 provides a summary of reported codend mesh size by FMA for the time period covered in this report (within the calendar years 2017 and 2018) and Figure 5 shows the information by species for each FMA. Codend mesh sizes used in standard bottom trawls ranged from 100 mm (the minimum legal mesh size for targeting inshore finfish) up to 200 mm. The smallest median mesh sizes were 100 mm in FMAs 2 and 7, whereas in FMAs 1, 3, 5, 8, and 9, the median mesh size was higher.

In FMAs 1 and 9, 125 mm is the minimum mesh size for use in a bottom trawl targeting snapper in water depths shallower 200 m. This is largely what was reported, as shown in Figure 5. Mesh sizes ranging from 100 to 125 mm were recorded when targeting barracouta and gemfish and some records of 150 mm when targeting snapper and trevally in FMA 1. Outside FMAs 1 and 9, the minimum legal codend mesh size is 100 mm, however, overall median mesh sizes were higher than the minimum in FMAs 3, 5, and 8. In FMA 3, although barracouta were mainly targeted with 100 mm, a median size of 125 mm was reported for most other species, with maximum mesh sizes of 150 mm for five species and 200 mm for targeting tarakihi. In FMA 5, the median codend mesh size for stargazer was 120 mm, 125 mm for red gurnard and flatfish (with up to 140 mm reported), and 100 mm when targeting red cod and tarakihi. In FMA 8, median codend mesh size was between 115 and 130 mm for all species except snapper, which was 100 mm. In FMA 2, although the overall median mesh size was 100 mm, up to 150 mm was reported when targeting red gurnard and 128 mm for John dory, moki, and trevally. In FMA 7, the minimum mesh size was the most commonly used for red gurnard, snapper, tarakihi, and blue warehou, although up to 127 mm was reported for flatfish. It is assumed that in most trawls the mesh orientation is diamond mesh, although other configurations such as T90 and square mesh are also known to be used.

The non-mesh MHS codends developed under the Precision Seafood Harvesting programme are made of a PVC-type material with escape apertures of varying sizes and densities in the sections forward of the terminal end. The terminal end of the MHS has no apertures, and vessels using bottom trawls with MHS gear (PRB) are instructed to record mesh size as zero (see Appendix 1). Despite this instruction, there were some records in FMA 1 of just over 125 mm and records of 100 mm for this type of midwater codends.

The new ERS also includes reporting of bycatch mitigation devices used. At the time of this study, a total of six devices are defined, five of which relate to seabird mitigation (Table 4). The most commonly reported devices used were bird bafflers with two perpendicular booms and bafflers with a curtain between the booms. The next most used were streamers (tori lines) and four boom bafflers. The sixth device listed was Dolphin Dissuader Device (DDD), which was reported as used on 84 tows. Information on the ‘other’ devices listed on a further 178 tows was not available.

Table 4: **Mitigation devices reported as part of the Electronic Reporting System (ERS). The reported number of tows that used each device are given.**

Mitigation device	No. of tows
Bird baffler - four boom	206
Bird baffler - two booms perpendicular to vessel	2 126
Bird baffler - with a curtain between booms	1 592
Streamers (tori lines)	512
Warp deflector	174
Dolphin Dissuasive Devices (DDD) (pingers)	84
Other	178

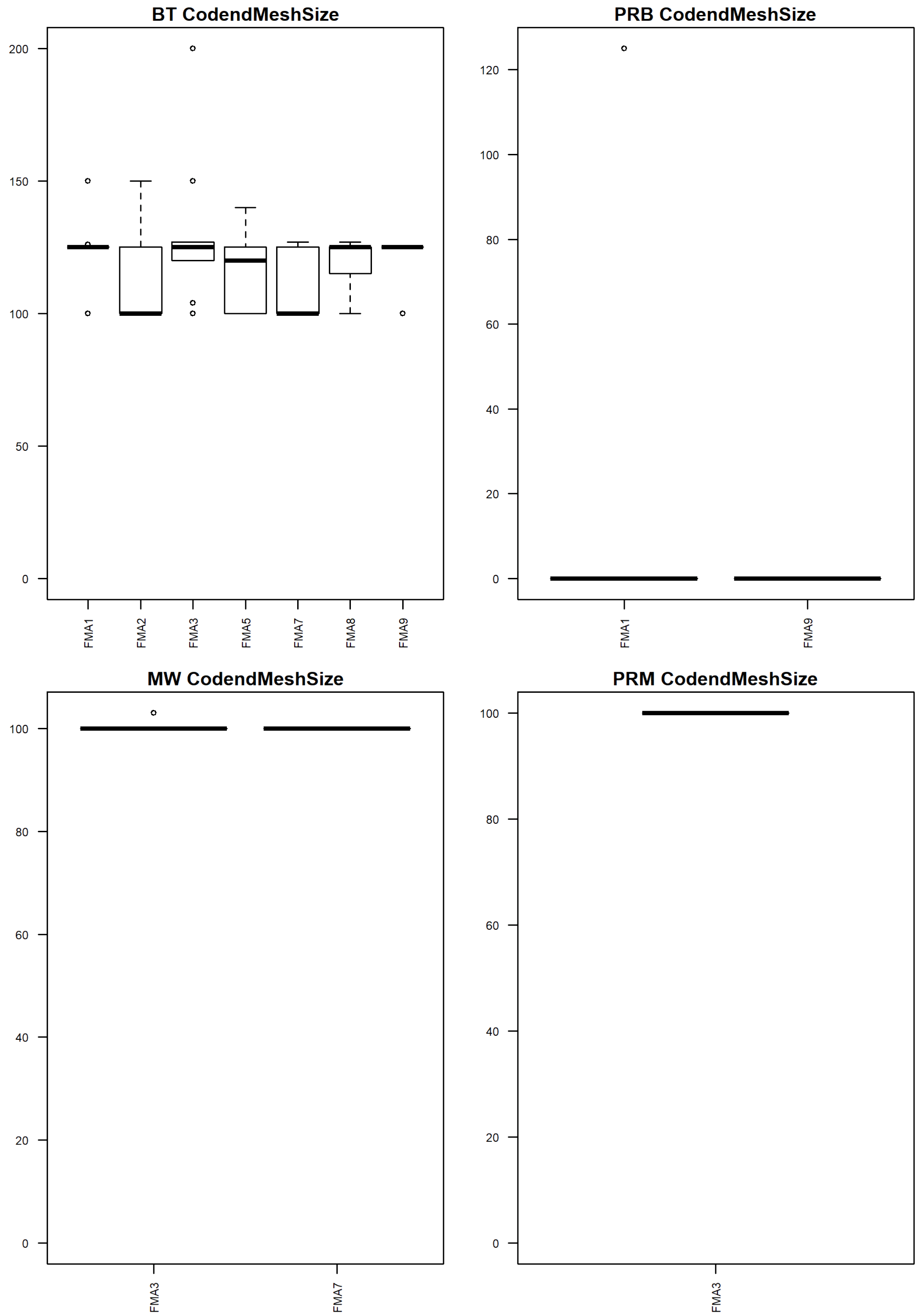


Figure 4: Summary of codend mesh size (mm) data collected from ERS, by gear type and FMA. Box plots give the median, interquartile range, and outlier values for each metric for three gear codes (BT = bottom trawl with mesh codend, MW = midwater trawl, and PRB = bottom trawl non-mesh codend).

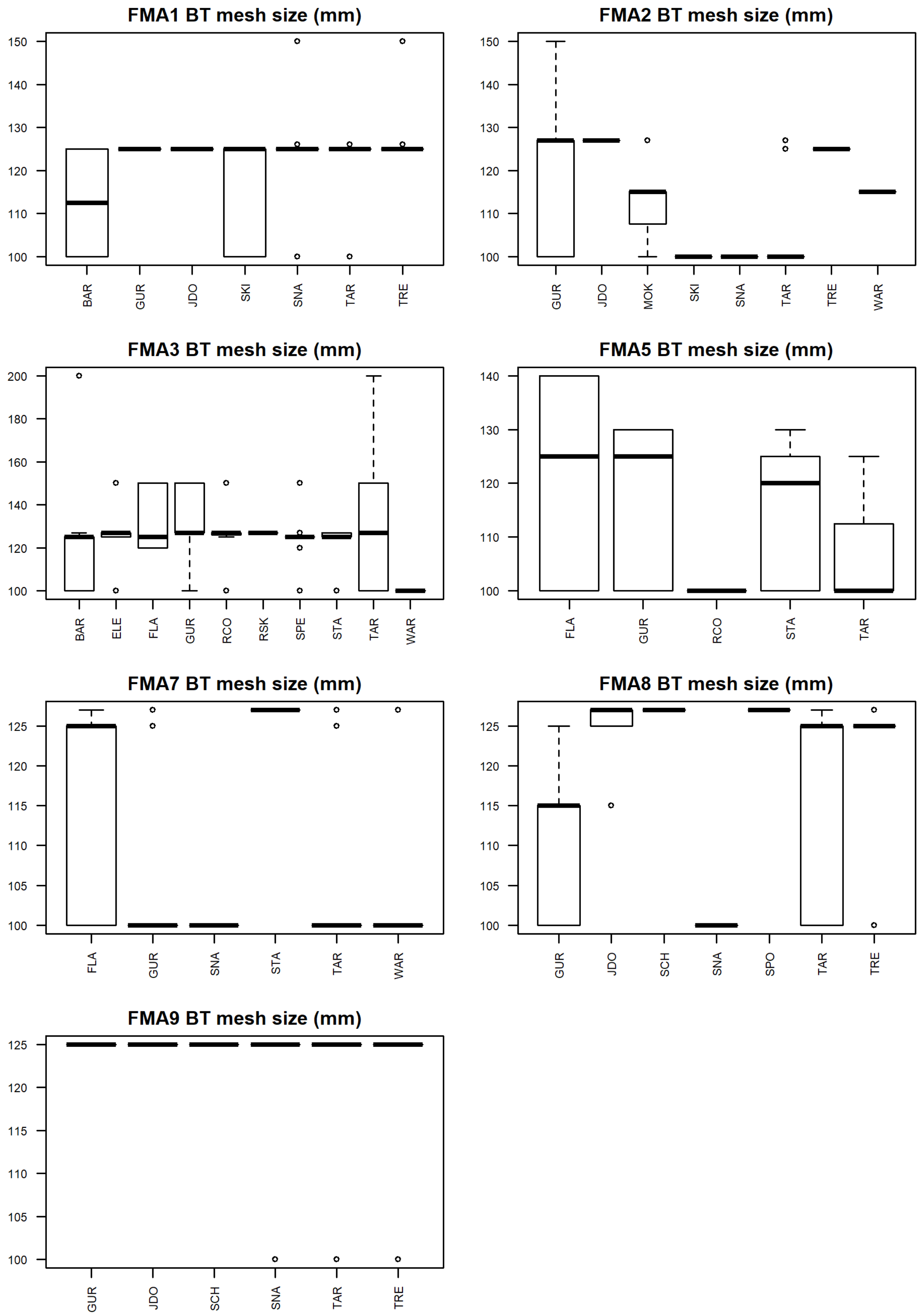


Figure 5: Summary of data collected from ERS on codend mesh size by target species for each FMA for bottom trawl. Box plots give the median, interquartile range, and outlier values. Target codes are defined in Table 1.

3.3 Observer data

Information on gear parameters recorded by Fisheries New Zealand observers was available from 290 trips for a 5-year period (Table 5). The number of trips completed each year varied from 40 to 79. The coverage was not evenly spread across the fishery areas, with most trips taking place in FMA 1 and FMA 3 each year, with a smaller number in FMA 2 and FMA 9, just one trip from FMAs 7 and 8, and no trips completed in FMA 5. In FMA 1, most trips were on vessels using conventional bottom trawl gear in the first two years, but with an increasing proportion being on vessels using PRB codends in the 2015–16 and 2016–17 fishing years. This emphasis presumably reflects the focus on monitoring the performance of this configuration as it was being developed through the PSH programme. A similar pattern was also apparent in FMA 2 and FMA 9. In FMA 3, the coverage was focused mainly on the midwater fleet, with a smaller number of trips on bottom trawls in this area. Summary box plots of all the gear parameters recorded across FMAs and gear types for each year are given in Appendix 5. For FMA 1 only, the data are also presented by target species in Appendix 6.

Table 5: Summary of observer coverage by fishing year and area. Numbers represent the number of observed trips. – no data.

						Fishing year
	2013–14	2014–15	2015–16	2016–17	2017–18	Total
FMA 1	24	23	20	25	8	100
FMA 2	5	5	2	11	2	25
FMA 3	34	18	18	30	29	129
FMA 7	–	1	–	–	–	1
FMA 8	–	–	–	1	–	1
FMA 9	6	8	7	12	1	34
Total	69	55	47	79	40	290

FMA 1

Door spread in bottom trawls observed in FMA 1 was mainly between 70 and 100 m in the first two years examined, with some larger values up to 300 m. Between the 2015–16 and 2016–17 fishing years, door spreads up to 200 m were recorded for both gear codes (BT and PRB), particularly for snapper, tarakihi, and trevally. More recently, the median value was back to about 110 m for gear code BT and a little higher for PRB targeting trevally (Appendix 5 and Figures 6-1 to 6-6 in Appendix 6). When separated by species, door spreads on vessels targeting red gurnard were generally lower (under 100 m). Door spread when targeting snapper was about 90–110 m, whereas generally higher door spreads were reported when targeting gemfish and also trevally (Figures 6-1 to 6-5).

A similar pattern was observed in door area, with door size of around 2 m^2 reported on trips in 2013–14, 2–4 m^2 on trips observed between 2014–15 and 2016–17, and back to 2 m^2 in the last fishing year (Appendix 5). Observers also recorded the type of trawl door used by a vessel. The most reported door type on observer trips was a low aspect ratio door, traditionally used for bottom trawling. This type of door was reported from 55% of trips and 67% of individual tow events. High aspect ratio doors (designed more for midwater trawling) were reported as being used by 42% of vessels, but on only 20% of all tows. Combination doors (designed for use in both bottom and midwater trawling) were used by 34% of vessels but on less than 10% of tows. Many vessels were reported to use multiple different door types and sizes on different trips. By target species, low aspect ratio doors were most commonly used for John dory, gurnard, and snapper, whereas high aspect ratio doors were more commonly used for tarakihi and trevally. For all door types, the median door size in FMA 1 was around 2 m^2, and low aspect ratio doors were generally slightly smaller (1.9 m^2) than high aspect ratio doors (2.8 m^2).

Sweep lengths ranged from 15 to 400 m but were generally between 50 and 150 m with a median for all years of around 100 m (Appendix 5). The values at each end of the range may represent specific gear configurations or recorder error. Lengths over 200 m reported for both BT and PRB gear codes were mainly when targeting snapper, tarakihi, and trevally (Figures 6-11to 6-15). For all years, median sweep lengths were shorter for red gurnard and John dory and longer for trevally and gemfish (in particular), and, for each species, were longer for PRB gear than BT. Bridle lengths were mainly 30–40 m, with greater variation in some years than others (Figures 6-16 to 6-20). Some very short and long values were reported for a small number of trips, e.g., one vessel used 320 m sweeps with 10 m bridles on one trip, resulting in very wide door spread and lower headline values. Similar to sweep lengths, bridle lengths were generally shorter when gurnard and John dory were being targeted and longer when snapper and tarakihi were targeted, and also shorter for BT gear compared with PRB gear.

Reported wing spreads were mainly 15–30 m, with larger values recorded in the 2017–18 (Appendix 5). The median wing spreads over the whole time period were similar to those reported from commercial data, with wider spreads from trawls using PRB codends. Separated by species, the observer-reported wing spread values for the 2017–18 fishing year are consistent with those reported from the commercial data for snapper and trevally for both gear types (Figures 6-6 to 6-10). The range of observer-reported headline heights was consistently 2–5 m, but with up to 7 m in some years (Figures 6-6 to 6-10). In the most recent fishing year, the median observer-reported headline height for snapper in BT was 5 m, which is higher than reported from commercial data, but the range of 2–6 m was similar. Headline lengths give an indication of net size (Figures 6-6 to 6-10). These were generally reported as between about 30–40 m in most years, with no discernible pattern by species, but some vessels used much larger nets with headline lengths up to 120 m on some tows.

The maximum ground gear sizes were recorded as 10–600 mm. There were no codes describing the type of ground gear, but the smaller values were likely associated with chain and wire combinations, whereas the larger values of 500–600 mm were more likely to be bobbin-rigged ground gear. The median size was 65 mm for BT and 80 mm for PRB with no clear patterns by target species.

Observer-reported mesh sizes for lengthener sections of the net were mainly 100–150 mm for both gear types, but with some measurements of up to 300 mm reported on some trips. Reported codend mesh sizes in FMA 1 were generally between 100 and 125 mm, apart from in the 2017–18 fishing year, when the maximum was 150 mm (6″) (Appendix 5). When analysed by species, this increase in mesh size was specifically used when targeting snapper (Figures 6-16 to Figure 6-20). This is consistent with the ERS data indicating a move by some vessels to larger codend mesh sizes.

Observers also recorded the configuration of meshes used in codends and lengtheners with the following codes: ‘D’ for conventional diamond-shaped mesh, ‘S’ for square mesh (when the mesh opening is designed to be square-shaped), ‘T’ for T90 (diamond mesh that has been turned 90° to create a more open aperture under tension), and ‘O’ for other configurations. In FMA 1, two vessels reported using square mesh codends, but these were associated with the PRB gear code, so are assumed not to refer to a mesh codend. Four vessels were reported to be using T90 codends on four trips, representing around 4% of all fishing events. The mesh size of these T90 codends was reported as 120–135 mm, with snapper, tarakihi, trevally, and John dory as target species. There was no clear trend in increased or sustained uptake of this mesh configuration, or square mesh, but this may reflect the focus on monitoring vessels moving to PRB gear. Use of T90 mesh in lengtheners was slightly more widespread and was reported from six vessels on 11 trips, which equated to 8.7% of all BT events (tows) in FMA 1. Of those six vessels, three had also used T90 mesh in the codend on some tows, and three used the T90 lengthener in combination with PRB codends. The mesh size of T90 lengtheners ranged from 100 to 150 mm for target species including red gurnard, John dory, snapper, tarakihi, and trevally.

Trips on vessels using trawls with PRB codends were mostly in FMA 1. In earlier years, few vessels were operating with this gear. The door areas were reported as 1–2.5 m^2 with door spreads of around

70 m, sweep lengths of 100–150 m, and wing spreads of approximately 20 m. As more vessels took up the PRB gear, the variation in gear metrics increased. These values are on a par with vessels using conventional BT gear but, as noted above, the wing and door spreads, and sweep and bridle lengths, reported from vessels operating PRB gears all tend to be wider or longer. The reported 'mesh' sizes for lengtheners and codends varied from 0 to 150 mm. The 'mesh' configuration code for PRB was usually left either blank or given as 'O' for other, although in some records other codes were used. It is not clear how these metrics are being recorded for this new codend configuration.

FMA 2 and FMA 9

There were few differences in gear parameters recorded for bottom trawls in FMAs 2 and 9 compared with FMA 1 in most years. There were some higher headline height values in FMA 2 in one year (up to 7 m), and lower values reported in FMA 9 (around 1–2 m) in several years compared with FMA 1 (Appendix 5). These variations appeared to reflect coverage of particular vessels in those years that fished nets with higher or lower headlines, targeting tarakihi in FMA 2 and a range of species in FMA 9. The lower headline heights in FMA 9 included both BT gear and, in the most recent year, PRB gear. The latter was consistent with the TCER and TCEPR data (see Table 3-7). The use of lower headlines in this area could be due to fishers trying to avoid catching snapper for which they have no quota. This has been an issue for fishers further south in FMA 7 (Tasman Bay and Golden Bay) in recent years, where snapper abundance has been increasing (Dan MacGibbon, NIWA, pers comm. with skippers during the 2019 WCSI inshore trawl survey). The use of T90 lengtheners and/or codends was reported in both these areas, but only on a very small number of trips targeting snapper, trevally, and tarakihi. Lengthener mesh sizes up to 150 mm were reported in FMA 9, with codend mesh size between 100 and 125 mm in all years up to 2016–17 (no trips in the last year analysed). In FMA 2, both lengthener and codend mesh sizes up to 125 mm (i.e., greater than the minimum of 100 mm) were reported from one or more trips in all years that observers sampled bottom trawl vessels in this area, i.e., since 2013–14.

FMA 3

The metrics recorded for bottom trawls observed in FMA 3 were indicative of coverage being limited to larger vessels almost exclusively targeting barracouta, as shown in Table 6. The larger nets used to target this species had greater swept area but shorter bridles and lower headline heights (Appendix 5). Door size was much larger than other FMAs, with areas of around 7–8 m^2, and a wide range of door spreads reported in most years, from 50 to 250 m, and an overall median spread of 145 m. Sweep lengths were generally greater than 100 m, up to 250 m on some vessels. Bridle lengths were about 10m. The headline lengths of the nets used were mainly 40–100m, with wing spreads reported to be generally 40–50 m, but up to 80 m, and headline heights were 3–4 m. Maximum ground gear was larger than in other areas, 300–500mm, with a median of 300 mm. Codend mesh sizes reported by observers showed no increasing trend over the time period, being consistently 100 mm, but with some indication that mesh sizes of around 125 mm were being used in lengtheners. There was no reported use of square mesh or T90 in bottom trawls in this FMA.

Table 6: Number of observed trips by target species and fishing year for FMA 3. Target codes are defined in Table 1.

Fishing year	BAR	RCO	WAR
2013–14	33	1	1
2014–15	14	1	5
2015–16	17	0	1
2016–17	29	0	4
2017–18	29	0	1
Total	122	2	12

The observer information does not match the median values reported in the most recent TCER and TCEPR data for this area, where net spreads were around 15 m and headline heights were 1–2 m. These values are more typical of small vessels targeting species such as flatfish, which are unable to accommodate observers and so are not represented in the observer data.

FMA 3 was the only area for which midwater trawling was covered by observers each year (Appendix 5), targeting barracouta, or occasionally warehou. The nets used are large, with headline lengths of up to 100 m, sweeps generally 100–200 m and doors of 10 m^2. The reported door spreads were 60–250 m, mostly 100–200 m, and wing spreads were reported as about 40–50 m, sometimes up to 80 m. Headline heights were mainly between 60 and 80 m, and mesh sizes were consistent at around 120–125 mm in the lengthener and 100 mm in the codend. A square mesh (100 mm) codend and lengthener was reported as being used in a midwater trawl by one vessel on multiple trips. T90 mesh was used in the codend and lengthener of a midwater trawl by another vessel on two trips out of many by this vessel over the time period covered.

3.4 Workshop description and outputs

A workshop was convened on the 26th June 2019 to discuss the metrics already being reported and the value and practicalities of expanding the information collected through the ERS. The 25 participants included science providers, Fisheries New Zealand (science, management, and observers), and the commercial fishing industry (see Appendix 7 and Appendix 8 for the participant list and agenda). The workshop included introductory presentations to stimulate discussion on aspects of fishing gear selectivity and fish behaviour, how catchability and fishing gear metrics are incorporated into the stock assessment process, and the relevance of different gear components on benthic impact. Following some discussion, the workshop participants engaged in an exercise to compile a list of possible parameters that could be recorded under a series of themes which included ‘Vessel’, ‘Gear’, ‘Environmental’, and ‘Bycatch’. Participants were asked to write important metrics on Post-it notes, collated under the above groups. All suggestions were then discussed during the workshop and a table of attributes was compiled. Workshop discussion included which aspects of fishery management and/or science the metric was relevant for, how straightforward or otherwise it would be to record, and what frequency of recording was appropriate. After the workshop, this final table was circulated, and participants were asked to select what they considered were the five top-ranking or highest priority attributes that could be recorded.

Table 7 lists 34 attributes identified on the day and their relevance to improved understanding of selectivity, CPUE analysis, interaction with the seabed (benthic impact/footprint), and protected species mitigation; suggested frequency of recording; and comments on practicability to record. The table summarises the number of participants that suggested each attribute during the workshop (the ‘No. of Post-it notes’ count column), as well as the outcome of post-workshop feedback (the ‘No. ranking highly column’).

Table 7: List of potential attributes suggested for including in the Electronic Reporting System. Parameters are listed along with their potential for improved understanding of: S=selectivity, CPUE = Catch Per Unit Effort (CPUE) analysis and stock assessment, B = Benthic footprint/impact, and P = mitigation of protected species. 'No. of Post-it notes' provides the no. of participants who listed this metric as important during the workshop (i.e., written on a Post-it note). 'No. Ranking highly' provides the number of participants that listed that attribute in their top five as part of the post-workshop consultation, e.g., 12 = 12 participants ranked door spread amongst the top 5 metrics to record. Rankings in bold indicate attributes recommended for inclusion in the ERS. (Continued on next two pages)

Parameter	S	C	B	P	Frequency of recording	Practicability & other comments	No. of Post-it notes	No. ranking highly
Vessel tonnage	x	x	x		Once, or when changed	Straightforward to record, but already recorded when vessel is registered, can this be accessed and linked to vessel ID?	2	
Horsepower: main & auxiliary	x	x	x		Once, or when changed	As above.	3	1
Bollard pull	x	x			Once, or when changed	Impacts vessel's power, e.g., when hauling. A yes/no category recorded when vessel surveyed.	2	2
Open prop/nozzle	x	x			Once, or when changed	y/n generic to vessel. Recorded with Maritime New Zealand. H.P x 1.25 = effect of nozzle.	1	1
Warp length	x	x	x		Fishing event	Straightforward to record. Already recorded in deepwater fisheries.	3	2
Door size / area			x	x	Trip	Straightforward to record or acquire if door type/make is recorded? Could this be inferred if size of trawl gear known?	5	**4**
Door type, weight			x		Trip	Straightforward to record or acquire if door type/make is recorded?	With above	1
Pelagic/demersal/ semi-pelagic	x	x	x		Fishing event	Categorical – if doors fished off the bottom with net on bottom, may affect herding & therefore selectivity. May not be clear cut.		2
Door spread	x	x	x		Fishing event, or trip if no sensors.	May be recorded from a sensor or calculated - should note which method. Considered more important than wing spread by workshop attendees. Ideally tow by tow if recorded by sensor, or at trip level if not.	8	**12**
Door angle of attack			x		Fishing event	Not simple to record – would have to be calculated each time or could be measured off marks on the skid.	1	1
Clump weight (twin/multiple trawls)			x	x	Trip /Fishing event	Used with twin or multiple nets.	1	2
Sweep material / diameter	x	x			Trip	May or may not be changed often – material used affects diameter, drag, and herding and therefore selectivity. Depending on length, angle of attack may not be constant.	2	
Sweep length	x	x	x		Trip	Straightforward to record.	4	**5**

Parameter	S	C	B	P	Frequency of recording	Practicability & other comments	No. of Post-it notes	No. ranking highly
Bridle length	x	x	x		Trip	Straightforward to record. Minor changes with extensions to adjust bottom contact and headline height.	With above	**4**
Fishing circle area	x	x	x	x	Trip	Calculated from number of meshes round and mesh size. Straightforward to record. Indicative of size of net, although headline height would still be variable.	2	3
Ground rope length	x	x	x		Trip	Straightforward to record. Indicative of possible wing spread.	3	**6**
Ground gear type	x	x	x	x	Trip	Not straightforward? Many components/metrics could be recorded. Example – Observers record max. diameter of ground gear components but may only reflect dimensions in the centre. Could this be recorded from pre-defined general categories?	6	2
Headline length	x	x		x	Trip	Straightforward to record. Combined with ground rope length will provide an indication of the overhang of the headline, i.e., the ‘veranda’, which affects selectivity of certain species, e.g., snapper.	1	3
Headline height	x	x		x	Fishing event	May be recorded from a sensor or generic estimate from net plan. Will vary with fishing depth and other factors, e.g., layback, so generic values may not be useful? Has significant effect on catchability of different species.	1	2
Lengthener mesh size	x	x		x	Fishing event	Needs to be defined to include the full length of this net component. Could also include twine type (double / single) and thickness.	5	3
Lengthener mesh orientation	x	x			Fishing event	Whether mesh is square, diamond, T90 or other. Needs to be defined to include the full length of this net component.	With above	3
Escape panel	x	x			Fishing event	Would need to define dimensions, location, and configuration, e.g., mesh size or other.		
Codend mesh size	x	x			Fishing event	Would need a clear definition of how to measure.	4	**6**
Codend mesh orientation	x	x			Fishing event	Whether mesh is square, diamond, T90, or other.	6	**5**
Codend twine thickness knot/knotless/ single / double	x	x			Fishing event	Thickness and single / double not thought to be important. Knotless / knotted more so.	1	
Min & max speed	x	x		x	Fishing event	Not straightforward to record, already estimate an average speed. Explore GPS data?	1	4

Parameter	S	C	B	P	Frequency of recording	Practicability & other comments	No. of Post-it notes	No. ranking highly
End depth		x	x	x	Fishing event	Already record a start depth. Would provide a depth range. Suggested it could be estimated from existing bathymetry – but accurate bathymetric data are not available for many areas if not on major shipping routes. From vessel's VMS? Most vessels will have a sounder.	2	2
Gradient		x			Fishing event	Strategies such as fishing uphill known for targeting or avoiding particular species. Could be ascertained if start and end depth recorded.	1	
Floatation / Lift	x	x		x	Trip /Fishing event	Referring to headline floatation? Can be variable from event to event or may be constant over a trip. Effect on headline height.	1	
Mitigation devices		x		x	Trip /Fishing event	Currently in New Zealand, this phrase is specific to mitigation devices used in relation to non-fish protected species only, e.g., seabirds. Internationally refers to both fish and non-fish bycatch mitigation devices, e.g., Turtle Excluder devices, square mesh panels, escape panels, grids etc. If extended to fish bycatch in New Zealand, would require a redefining of 'mitigation'. Could include new 4 letter codes in current reporting, e.g., scampi.	3	2
Research tow	x	x			Trip /Fishing event	Distinguishing research / innovation tows under special permits from true commercial tows.	1	3
Skipper effect	x	x	x	x	Trip or event level?	Already recorded under ERS. More than one operator likely during a trip, but group considered that any other operators during a trip would follow skipper's instructions, therefore should be recorded at trip level.	3	2
Net plan	x	x	x	x	Trip /Fishing event	Provision of a digitised net plan, if available, would negate necessity to record many of above attributes (i.e., defaults automatically loaded into trip record with provision for fisher to alter with each tow if needed). Issues around vessel or net shed IP. May still be more useful to have the specifics listed in a database where they are more accessible.		1
Sea state / water clarity	x	x		x	Fishing event	Clear definitions would be needed otherwise subjective. May be possible to link fishing events to predicted SST and other met data which may negate need for fishers to provide.	1	1

Of the 34 attributes identified, 26 were considered relevant to an improved understanding of selectivity, 30 relevant to CPUE analysis, 17 relevant to benthic impact/footprint, and 14 to protected species mitigation. Only four attributes were considered relevant to all these research and management themes; fishing circle area (representing net size), ground gear type, the 'skipper effect', and 'net plan' (which encompasses many of the individual metrics listed). When considering the frequency at which attributes should be recorded, four were specific to the vessel (e.g., tonnage, horsepower, propellor type), so should only need to be recorded once, unless an attribute was modified. Nine could be recorded once per trip, such as net and door dimensions, with another seven potentially at a trip or fishing event level depending on the vessel activities (e.g., net floatation, mitigation device use). The remaining fourteen attributes were considered fishing event level metrics, (e.g., door spread, warp length, sea state, mesh configurations).

The most frequently mentioned attributes (by four or more individuals) during the workshop included door spread (n=8), codend mesh orientation (n=6), door size/type/weight (n=5), ground gear type (n=5), lengthener configuration (including mesh orientation and size) (n=5), sweep and bridle lengths (n=4), and codend mesh size (n=4). Of the 25 workshop attendees, 15 participants provided feedback on the table of attributes and which ones they considered their top five or highest priority attributes for incorporation into the ERS. The 'No. ranking highly' column gives the number of respondents that listed each attribute in their high priority list. Where multiple attributes were listed as equally important, these were all incorporated into the final tally (i.e., more than five attributes were considered high priority by some individuals). From the post-workshop responses, the following attributes were ranked high priority by 4 or more respondents:
:

- Door spread (n=12)
- Ground gear rope length (n=6)
- Codend mesh size (n=6)
- Sweep and bridle lengths (n=5)
- Codend mesh orientation (n=5)
- Door size/area (n=4)
- Minimum and maximum towing speeds (n=4)

The post-workshop rankings were reasonably consistent with rankings on the day, with five metrics in common, but ground gear length replaced ground gear type, and towing speed was listed more frequently than lengthener configuration (mesh size and orientation). Recording of these metrics would be at a trip level for three (ground gear length, sweep and bridle lengths, and door size), and fishing event level for the other four (door spread, mesh size, mesh orientation, and towing speed). From the two lists of higher ranked metrics, most were considered straightforward to record, although it was noted that some require clear definitions, such as measurement of mesh size and what constitutes the lengthener section. Ground gear type was not considered straightforward with so many different components, and maximum and minimum towing speeds were also considered difficult to monitor.

In addition to listing possible parameters that could be recorded, the workshop provided the opportunity to discuss a range of relevant issues, summarised below.

1. Influence of components ahead of the gear to catch fish—the net 'just collects them'.
2. Influence of hauling power and how this affects certain species.
3. Many changes being driven by the need to avoid capture of certain species due to Allowable Catch Entitlement availability.
4. Clear definitions required for each metric and how it should be recorded. For example, mesh size can be measured in a number of ways, e.g., inside mesh, knot centre-to-knot centre, etc.
5. Minimising duplication and streamlining reporting activities is important. Some of the vessel related metrics are already recorded as part of vessel registration and potentially could be accessed from these existing databases. Reliance on other databases may prove a barrier to

accessing this information, and the advantages of ERS are already clear where some metrics require only a one-off entry and can automatically populate relevant fields.

6. Another aspect related to recording extra information was net shed intellectual property around net designs.
7. Concerns raised related to information that might be gathered for the purposes of future spatial restrictions based on benthic impacts.
8. Discussion around technology development or ‘creep’ and monitoring capability that is estimated to have improved efficiency/fish finding by 20–30% in the last 20 years.

4. CONCLUSIONS

TCER and TCEPR forms provided limited information on net size (wing spread and headline height), suggesting some variation in headline height by target species: higher headline height for snapper in particular, with some indication of headline height being reduced more recently in some areas. Beyond that, these data provide no information with which to understand how trawl gear is being adapted and modified. Records comprised largely generic values derived from net plans/net makers advice and therefore collection at the event level does not provide any insight into variation in performance.

Assessment of the Fisheries New Zealand observer data highlighted the potential value of collecting other metrics such as door size and spread, headline length, maximum ground gear size, mesh configuration and size in lengtheners and codends, etc. There were some clear differences in these metrics in different areas reflecting the target species, types of vessels operating, and the nets used. The same patterns of headline height as seen in the commercial data for different target species were apparent, and also a pattern of longer sweep and bridle lengths when targeting species such as snapper, tarakihi, and trevally compared with red gurnard and John dory. Observer coverage indicated that codend mesh sizes larger than the minimum were being used by some vessels in FMA 2 (up to 125 mm) as early as 2013–14, and up to 150 mm in FMA 1 in 2017–18 when targeting snapper. There was limited uptake of alternative mesh configurations such as T90 on observed trips. However, caveats are necessary; the Fisheries New Zealand observer coverage is not evenly spread across the whole fleet, being dependent on several factors such as limited access to smaller vessels or a focus on monitoring particular fisheries or gear. As an example, the data from FMA 3 are restricted to larger vessels fishing for barracouta and are not fully representative of the wider inshore fleet targeting other species such as flatfish and tarakihi. In FMA 1, the monitoring of vessels converting to PRB gear has been the priority, although it is apparent that there are some inconsistencies and gaps in the way this gear type is documented, including adequate information on size and shape of apertures in the lengthener and codend parts of the net. The accuracy of any of these data is dependent on the availability of net plans and knowledge of the skipper.

Currently, the new ERS captures two additional metrics: the codend mesh size and any mitigation devices. The data collected to date indicate a shift away from the minimum mesh sizes (100 mm in most FMAs apart from in FMAs 1 and 9, where 125 mm is the minimum) across all FMAs to some extent, which is in line with Fisheries New Zealand observer information, anecdotal knowledge, and the previous NIWA-funded pilot study (E. Jones, NIWA, unpublished data). The use of mitigation codes is a useful step, although these are currently restricted to protected bycatch species only. Such codes could be expanded to include mitigation devices relating to finfish such as grids and escape panels, etc.

It is of interest to compare the results of this analysis with those of the survey commissioned by Seafood Innovations Ltd and SEAFIC over a decade ago, but differences in the metrics assessed and the way the data have been collected and presented limit direct comparisons. The main difference between the 2007 study and current study is the existence now of the PSH Modular Harvesting System (gear codes PRB and PRM), which did not exist at the time of the earlier survey. The range in size of trawl doors in use and the headline height reported for different species appeared to be similar.

The regional differences in trawl gear around the country were also consistent across the two studies. The previous report presented headline height results pre-grouped into low (average of 1–2 m), medium (average of 3 m), and high (average of 4–5 m) trawl nets, with average values by region. The average height for 'high' headline trawls, described as being used to target snapper and trevally, was 5 m for the "North" (covered by FMAs 1 and 9), "Hawke's Bay" (included within FMA 2), and "Central" (included FMA 8, northern part of FMA 7 and southern FMA 2). In the current study, median headline heights using conventional trawl codends (BT) and targeting snapper were 4–5 m in FMAs 1, 2, 8, and 9, suggesting little change, but, in FMA 7, the 2 m median headline height is thought to reflect anecdotal information that vessels in Golden Bay and Tasman Bay are lowering headline heights to avoid snapper, even when it is the reported target species. Vessels targeting snapper using the Modular Harvesting System codends (PRB) also reported lower headline heights further north off the west coast in FMA 9. Although trevally is grouped with snapper as a schooling species requiring a higher headline net, the median heights reported in the TCER and TCEPR data for this target species were also low (2–3 m) in FMAs 1 and 9 and for the BT gear code in FMA 8. This may also reflect modifications to the trawl gear to avoid catching snapper in these areas. The Seafood Innovations Ltd report also presented information on the largest mesh size in the trawl, which does not usually equate to mesh sizes used in the lengthener or codend as collected in the ERS and observer data. Mesh panels of T90 were used by about 6% of vessels in 2007, mainly in low and medium opening trawls. The more recent observer data did not suggest any increase in uptake of this product, but this may reflect the limitations of the observer coverage across the inshore fleet.

5. RECOMMENDATIONS

Consolidating the priority rankings from the workshop, the recommendations are:

1. That the ERS continues to record codend mesh size and is expanded to collect information on the following parameters:
    - Door spread
    - Ground gear rope length
    - Sweep and bridle lengths
    - Codend mesh orientation

2. That additional metrics that could be considered are:
    - Door size/area
    - Minimum and maximum towing speeds
    - Lengthener configurations (this would require codes for configuration types to be developed)
    - Ground gear type (this would require codes for configuration types to be developed)

3. That mitigation devices are expanded to include fish bycatch reduction devices.

The workshop highlighted the knowledge and interest of skippers in sharing information on trawl gear configurations. The ERS reporting could be supplemented with periodic face-to-face interview surveys to gain more detailed snap shots of the changes in trawl gear use in the fleet although care should be taken not to over-burden individuals.

6. ACKNOWLEDGMENTS

We thank Fisheries New Zealand for funding this work under project SOW19942. We thank all the workshop participants for their attendance and valuable contributions on the day, and those who also provided follow-up feedback; Alicia McKinnon (Fisheries New Zealand) for assisting with the organisation of the workshop; and Ian Tuck (NIWA) for reviewing this report.

7. REFERENCES

Arreguín-Sánchez, F. (1996). Catchability: a key parameter for fish stock assessment. *Reviews in Fish Biology and Fisheries 6*: 221–242.

Baird, S.J.; Mules, R. (2021). Extent of bottom contact by commercial fishing activity in New Zealand waters, for 1989–90 to 2017–18. *New Zealand Aquatic Environment and Biodiversity Report No. 259.* 143 p.

Clement & Associates Ltd (2008). New Zealand Inshore Trawl Gear and Operations Survey. A report commissioned by Seafood Innovations Ltd and SeaFIC and prepared by Clement & Associates Ltd. 31p.

Wileman, D.A.; Ferro, R.S.T.; Fonteyne, R.; Millar, R.B. (1992). Manual of methods of measuring the selectivity of towed fishing gears. *ICES Cooperative Research Report 215*. 126 p.

APPENDIX 1: TRAWL FISH CATCH REPORT

Trawl catch and effort information that is required to be reported under the Fisheries (E-logbook Users Instructions and Codes) Circular (No.2) 2018: https://www.fisheries.govt.nz/dmsdocument/32428-fisheries-e-logbook-users-instructions-and-codes-circular-nov-2018-f

Attribute Name	Instruction
Trip ID	This ID must match the one given in the trip start report.
Client number	Enter the client number of the permit holder.
Fishing under High Seas Permit?	Enter yes or no.
Is vessel used?	Enter yes or no.
Vessel number	Enter the vessel's registration number as shown on its certificate of registration.
Fishing method code	Enter the code for the fishing method used on this fishing event. *See* Part 7 of Schedule 2. Codes BPT (bottom pair trawl) and MPT (midwater pair trawl) should be used only if 2 vessels are used to tow a single net. Note that 'bottom trawl' and 'midwater trawl' refer to the design of trawl nets and not whether the gear is fished on the bottom or not. For example, a trawl net designed as midwater trawl gear can be fished on the bottom. If you use midwater trawl gear on the bottom, select the MW (midwater trawl) fishing method code. The codes PRB (precision bottom trawl) and PRM (precision midwater trawl) refer to types of trawl gear developed under the Primary Growth Partnership Precision Seafood Harvesting Programme.
Target species code	Enter the species code of the main species you are trying to catch during this tow. It may not be the species you actually catch most of. *See* Part 1 of Schedule 2.
Mitigation device codes	If mitigation devices are used, enter the code for each device used (see Part 8 of Schedule 2).
Number of nets	This refers to the number of nets, and not to the number of codends. If using a twin-rig set-up, enter 2. If 3 trawl nets are used, enter 3.
Vessel pair number	Only required for fishing method codes BPT and MPT. Enter the vessel registration number of the second vessel.
Wingspread (metres)	Enter the distance between the wings of the net. This must be one of the following: – the design wingspread of the trawl net. If the net has been modified since it was manufactured, enter the wingspread that the net is currently designed to operate at; – the distance as measured by spread sensors, if available. The number you enter must represent the wingspread during the entire tow.

Attribute Name	Instruction
	If you are using more than 1 net, you must enter the combined wingspread of all the nets.
Headline height (metres)	Enter the distance from the groundrope to the headline. This must be 1 of the following: – the headline height that the trawl net is designed to operate at. If the net has been modified since it was manufactured, enter the headline height that the net is currently designed to operate at. If you operate your trawl net at a different headline height than its design, record the headline height at which you operate; – the distance as measured by a net monitor, if available. The number you enter must represent the headline height during the entire tow.
Codend mesh size (millimetres)	Enter the minimum mesh size of the codend or codends of your trawl net. Enter “0” if fishing method code is PRB or PRM.
Groundrope depth (metres)	Enter the distance from the surface of the sea to the groundrope of the net when the net reaches the target depth.
Bottom depth (metres)	Enter, the depth of the water at the groundrope when the net reaches the target depth.
Speed (knots)	Enter the average speed of your vessel during the tow.
Is net lost?	Enter *Yes* if the trawl net or any key component of trawl gear is lost. Put any additional details in the Notes field. In this case, record the date, time and position in the *start location* and leave the *finish location* empty.
Start details (date/time/position)	The start details record when and where the vessel is immediately after the net first reaches its intended depth and position (for example, when the brakes are applied). Information about the system/manual fields is in clauses 8 and 9.
Finish details (date/time/position)	The finish details record when and where the vessel is immediately before the net leaves its intended depth and position (for example, when the brakes come off). Information about the system/manual fields is in clauses 8 and 9.
Total estimated catch (kg)	Enter the total weight of fish caught in the net from this tow (or the combined weight from all nets if more than 1 net is used in a single tow).
Catch records	See below.
Is NFPS catch present?	Enter yes or no.
Amendment reason	You must complete this if you are amending a report (e.g. by updating, correcting, or adding to it).
Notes	Enter any additional notes here. There are no restrictions on what you can include.

APPENDIX 2: TCEPR AND TCER FORMS

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

Trawl, Catch, Effort and Processing Return

To be completed on each day at sea

Date	Vessel's registration number (your vessel)	Vessel name (your vessel)
20/11/02	69054	Viking King
	Vessel registration number of other vessel (if pair fishing)	

Position at midday (noon)			
Latitude		Longitude	E/W
40 – 12	S	173 – 21	E

Water temperature at shot 1	
Surface	Bottom
14.6□	14.4□

Page	1
of	1

Shot	Time	Latitude Deg	Latitude Min		Longitude Deg	Longitude Min	E/W	Gear code / Headline height	Depth groundrope / Depth bottom	Trawling speed	Target species	Quantity	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)	Species code / Quantity (kg)
1 START	0800	40	08	S	173	27	E	BT 35	95	5.0	JMA	Total (kg)	JMA	BAR			
END	1140	40	11	S	173	20	E	7	95			5000	4000	1000			
2 START	1220	40	14	S	173	17	E	BT 35	85	4.8	JMA	Total (kg)	JMA	BAR	FRO	TAR	
END	1650	40	20	S	173	36	E	7	85			7000	4500	2000	300	200	
3 START	2205	40	26	S	174	05	E	MW 40	99	5.2	JMA	Total (kg)	JMA	SPD			
END	2340	40	25	S	174	02	E	40	130			15150	15000	150			
4 START				S								Total (kg)					
END				S													
5 START				S								Total (kg)					
END				S													
6 START				S								Total (kg)					
END				S													

Estimated catch by species in order of quantity

Daily Processing Summary

Species	Processed state	Number of processed units	Unit weight (kg)	Processed catch weight (kg)	Conversion factor	Calculated weight before processing (kg)
JMA	HGU	266	21.5	5719	1.5	8579
FRO	DRE	12	21.5	258	1.8	464
BAR	DRE	90	21.5	1935	1.55	2999
BAR	DRE	5	20.0	100	1.55	155
TAR	SKF	5	21.5	107.5	2.8	301

Species	Processed state	Number of processed units	Unit weight (kg)	Processed catch weight (kg)	Conversion factor	Calculated weight before processing (kg)
SPD	DIS	N/A	N/A	N/A	N/A	150

I declare that the information I have given on this return is correct and complete, and that I have read and understood the explanatory notes supplied with this return.

Product from offal only: Meal (kg)	Product from offal only: Oil (litres)	Activity comment (Transhipping, steaming etc)	Permit holder's name	Permit holder's client number	Signature of master	Date signed
150			John Citizen	8459894	J Bloggs.	21/11/02

Ministry of Fisheries
Te Tautiaki i nga tini a Tangaroa

Trawl Catch Effort Return

TCE 1234567

1. Complete **separate returns for each fishing trip** and a **separate column for each shot**. Start a new return if you change gear during a trip.
2. Write the gear code ____ design wingspread ____ m and design headline height ____ . ____ m of gear used for these shots.

Shot number (since start of trip) and target species	Shot no. / Target species	Shot no. / Target species	Shot no. / Target species	Shot no. / Target species
Date: start of shot (dd/mm/yy)	/ /	/ /	/ /	/ /
Time: start of shot (24-hr clock)	:	:	:	:
Latitude: start of shot (degrees minutes)	° ' S	° ' S	° ' S	° ' S
Longitude: start of shot (degrees minutes E/W)	° ' E/W	° ' E/W	° ' E/W	° ' E/W
Depths at start of shot: Groundrope / Bottom	m / m	m / m	m / m	m / m
Average trawling speed (knots)	. knots	. knots	. knots	. knots
Time: end of shot (24-hr clock)	:	:	:	:
Non-fish / Protected species catch?	Yes ✓ No ✓	Yes ✓ No ✓	Yes ✓ No ✓	Yes ✓ No ✓
Write the species code and **estimated greenweight** of each **quota and non-quota** species caught during each shot. *For example, if you catch 1100 kg of snapper, write:* S N A 1 1 0 0 .0kg **More than 8 species?** List the 8 species that you caught most of (by greenweight).	.0kg .0kg .0kg .0kg .0kg .0kg .0kg .0kg	.0kg .0kg .0kg .0kg .0kg .0kg .0kg .0kg	.0kg .0kg .0kg .0kg .0kg .0kg .0kg .0kg	.0kg .0kg .0kg .0kg .0kg .0kg .0kg .0kg
Weight of **all other** species caught this shot	All other species .0kg	All other species .0kg	All other species .0kg	All other species .0kg

3. Permit holder and vessel details

Name of permit holder ____

Client number of permit holder ____

Name of fisher *(first letter of first name then first four letters of surname)* ____

Name of vessel ____

Registration number of vessel ____

Registration number of other vessel (paired fishing) ____

I declare that the information I have given on this return is correct and complete, and that I have read and understood the explanatory notes supplied with this return.

Signature of permit holder or authorised person ____

Date signed / /20

Do not forget that you need to complete a landing return. Send completed returns to PO Box 297, Wellington (NZ).

APPENDIX 3: SUMMARY PLOTS & TABLES OF GEAR PARAMETERS FROM TECPR/TCER FORMS BY SPECIES FOR EACH FMA

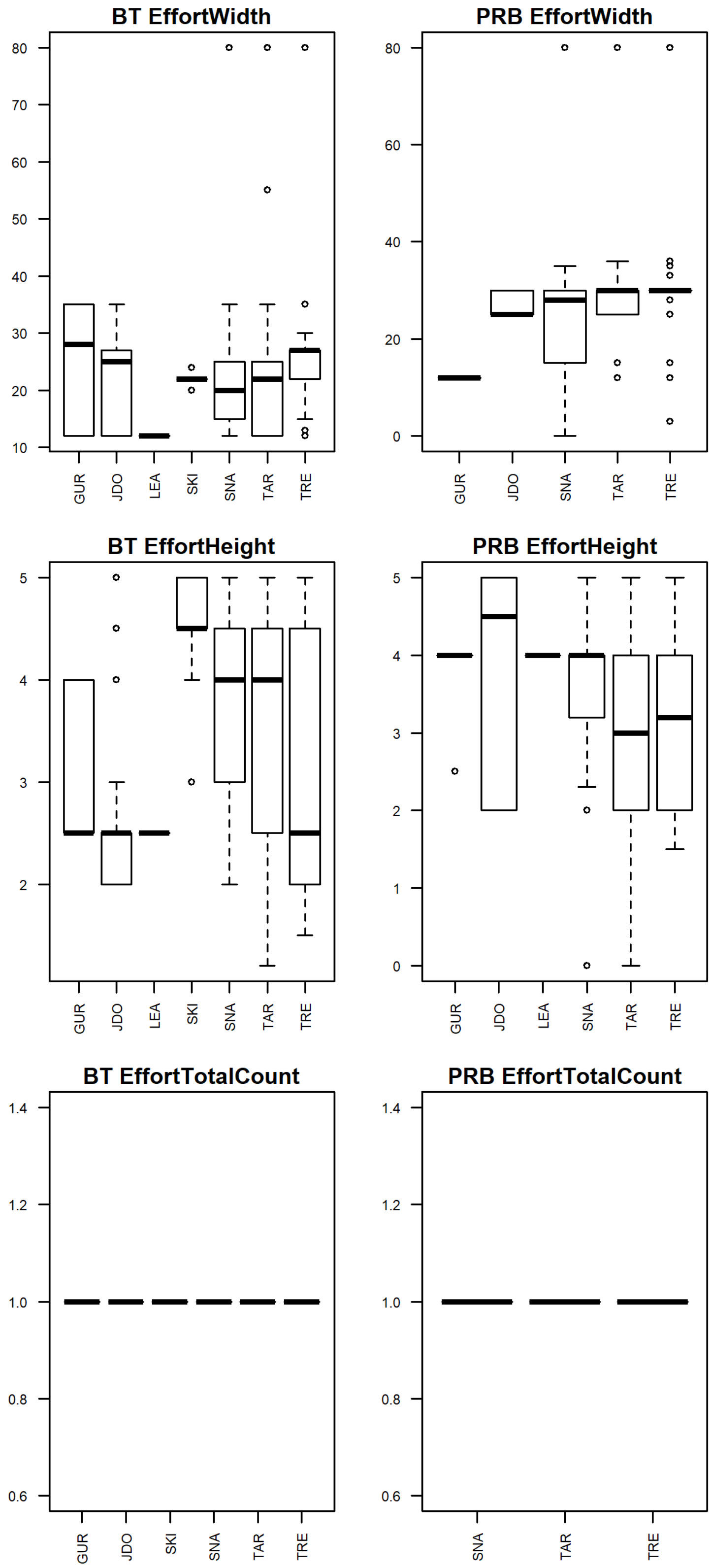


Figure 3-1: Summary of data collected from TCER and TCEPR forms in FMA 1 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend, PRB = bottom trawl non-mesh codend). Target species codes are defined in Table 1.

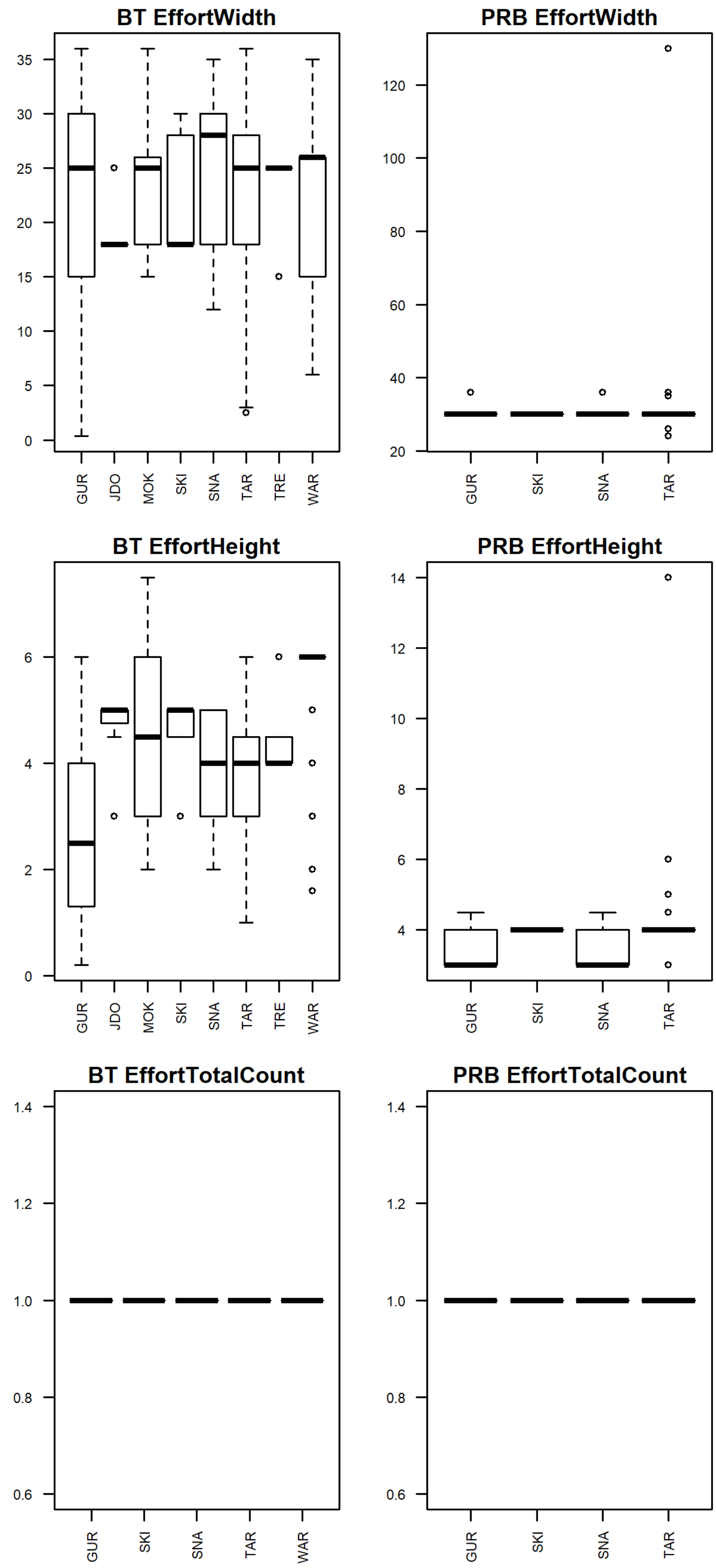


Figure 3-2: Summary of data collected from TCER and TCEPR forms in FMA 2 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric for by gear code (BT = bottom trawl with mesh codend, PRB = bottom trawl non-mesh codend). Target species codes are defined in Table 1.

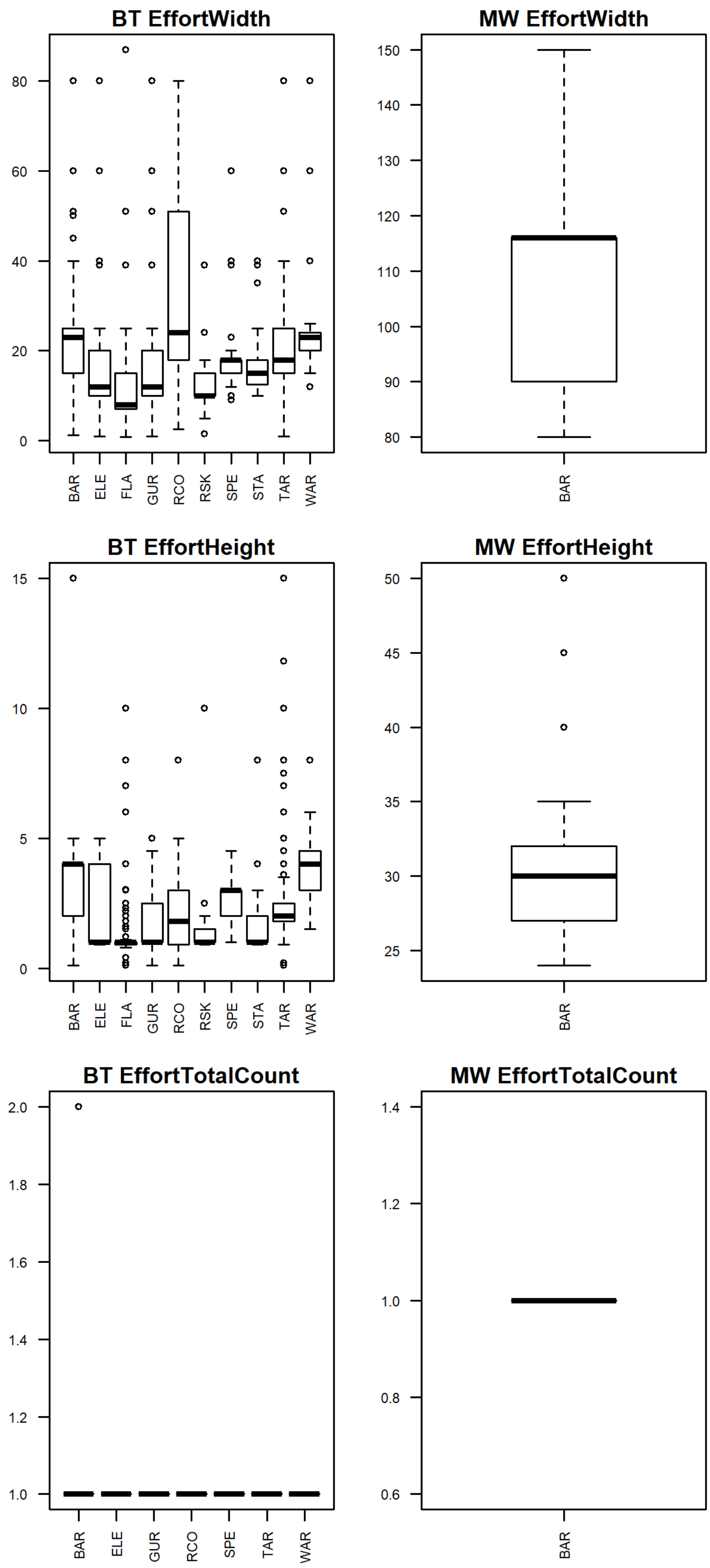


Figure 3-3: Summary of data collected from TCER and TCEPR forms in FMA 3 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend, MW = midwater trawl with mesh). Target species codes are defined in Table 1.

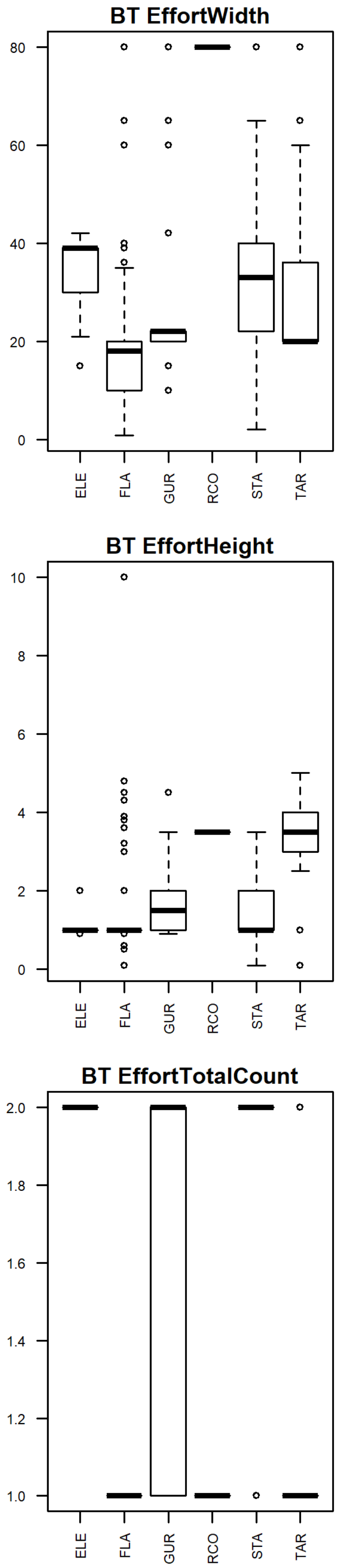


Figure 3-4: Summary of data collected from TCER and TCEPR forms in FMA 5 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend). Target species codes are defined in Table 1.

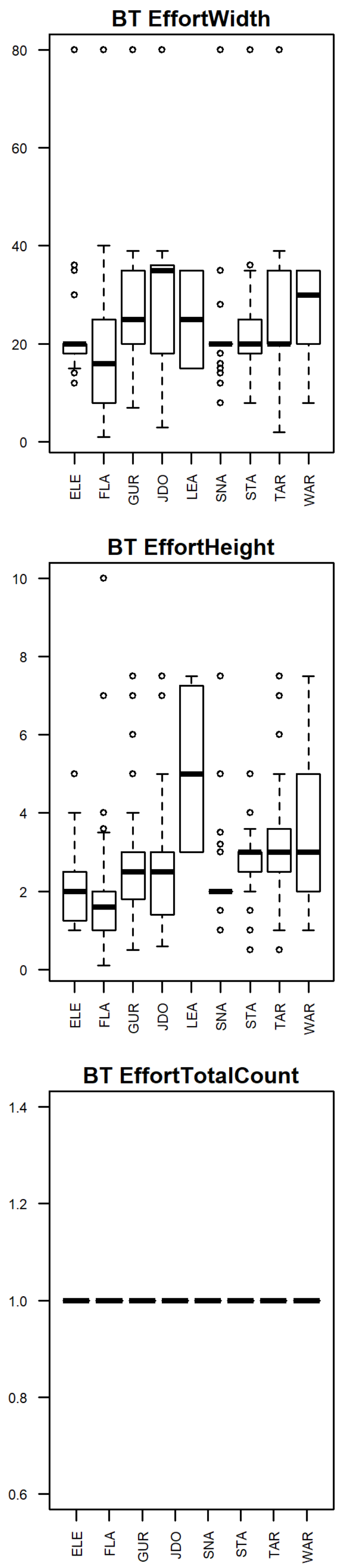


Figure 3-5: Summary of data collected from TCER and TCEPR forms in FMA 7 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend). Target species codes are defined in Table 1.

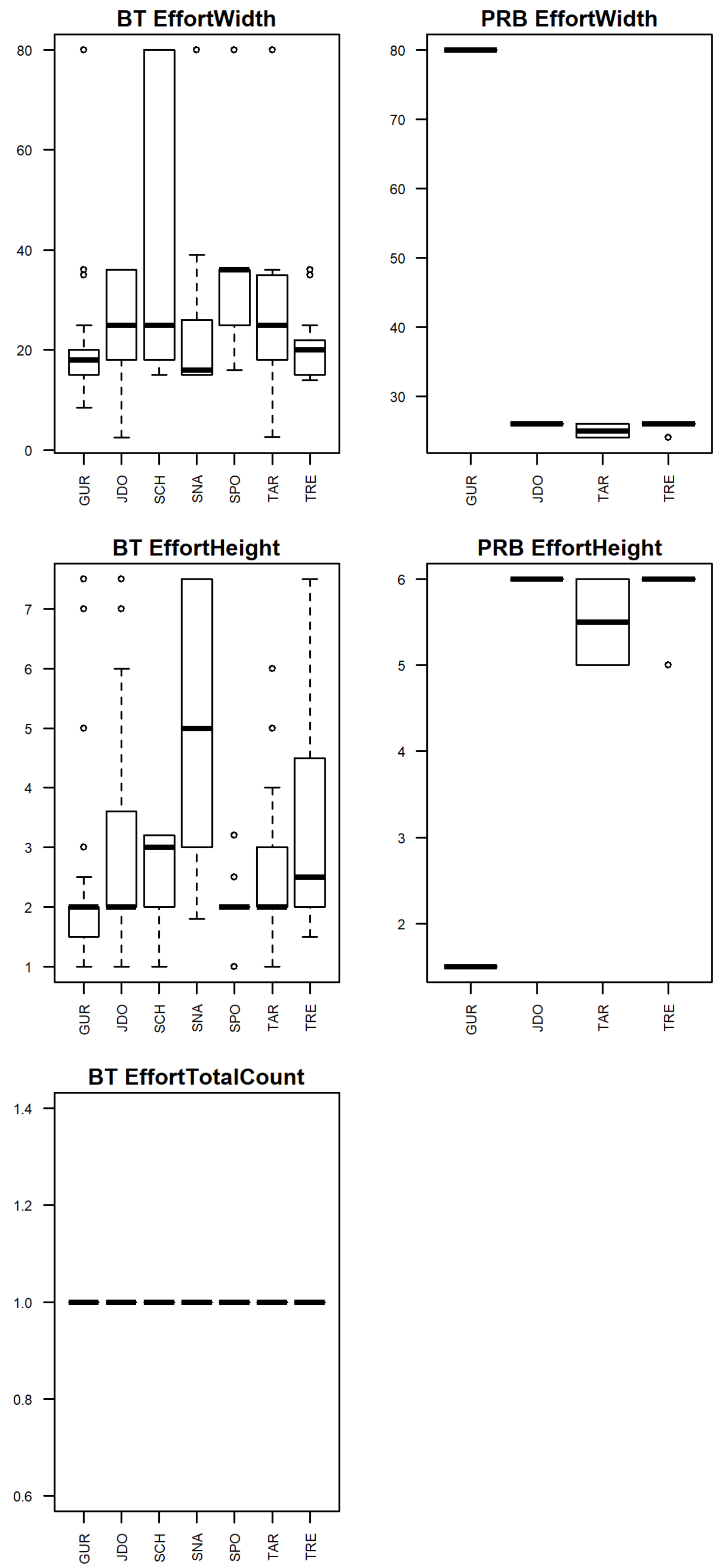


Figure 3-6: Summary of data collected from TCER and TCEPR forms in FMA 8 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend, PRB = bottom trawl non-mesh codend). Target species codes are defined in Table 1.

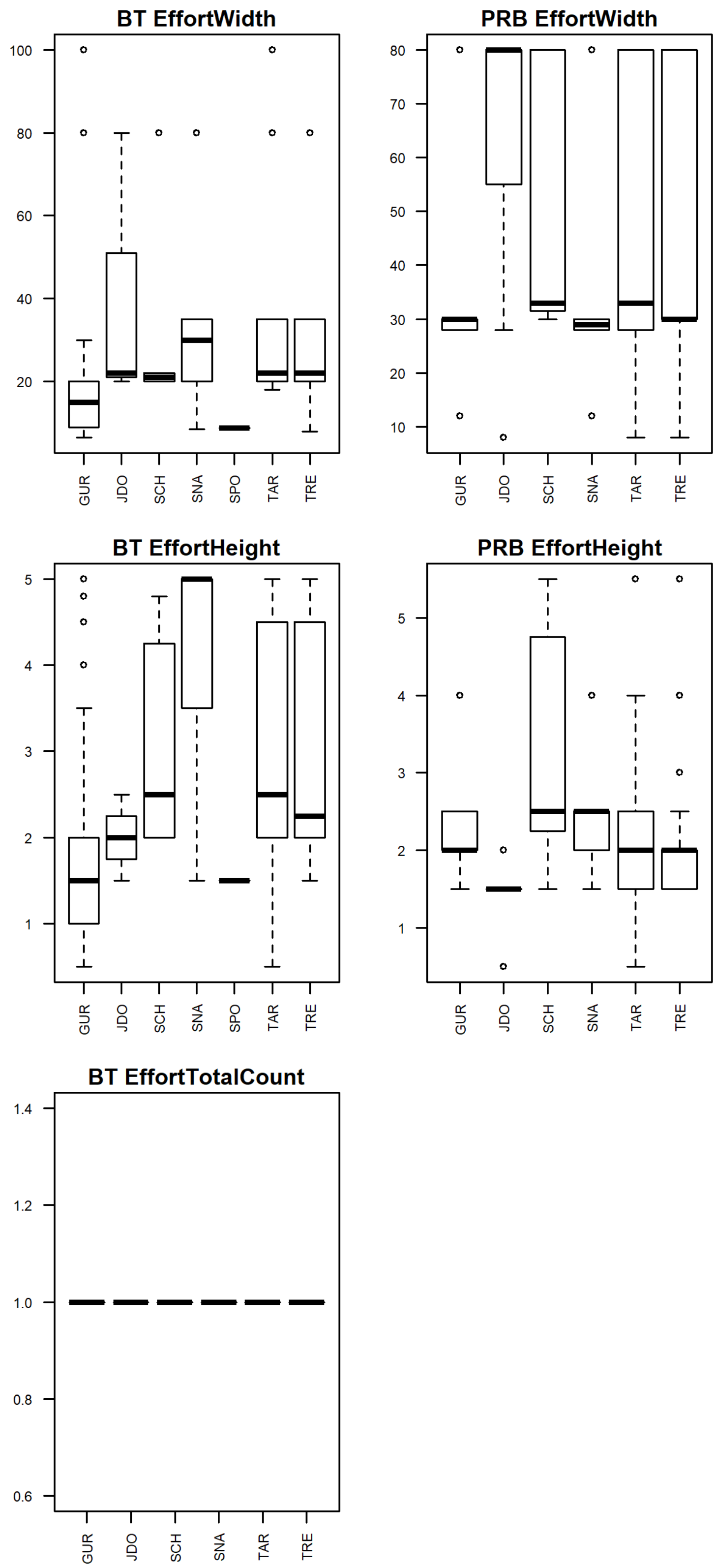


Figure 3-7: Summary of data collected from TCER and TCEPR forms in FMA 9 on net width (EffortWidth), headline height (EffortHeight), and number of nets used (EffortTotalCount). Box plots give the median, interquartile range, and outlier values for each metric by gear code (BT = bottom trawl with mesh codend, PRB = bottom trawl non-mesh codend). Target species codes are defined in Table 1.

Table 3-1: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 1. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	GUR	width	12	12	28	24.4	35	35	10	3	6
BT	GUR	height	2.5	2.5	2.5	3.1	4	4	10	3	6
BT	GUR	count	1	1	1	1	1	1	4	1	2
PRB	GUR	width	12	12	12	12	12	12	1	1	1
PRB	GUR	height	2.5	4	4	3.8	4	4	8	2	4
BT	JDO	width	12	12	25	20.6	27	35	562	8	86
BT	JDO	height	2	2	2.5	2.6	2.5	5	571	9	88
BT	JDO	count	1	1	1	1	1	1	8	1	2
PRB	JDO	width	25	25	25	26.9	30	30	68	4	14
PRB	JDO	height	2	2	4.5	3.9	5	5	84	5	23
BT	LEA	width	12	12	12	12	12	12	5	1	2
BT	LEA	height	2.5	2.5	2.5	2.5	2.5	2.5	5	1	2
PRB	LEA	height	4	4	4	4	4	4	6	1	1
BT	SKI	width	20	22	22	22.2	22	24	35	3	10
BT	SKI	height	3	4.5	4.5	4.5	4.9	5	34	4	13
BT	SKI	count	1	1	1	1	1	1	9	2	2
BT	SNA	width	12	15	20	20.5	25	80	747	14	132
BT	SNA	height	2	3	4	3.7	4.5	5	935	15	165
BT	SNA	count	1	1	1	1	1	1	100	2	17
PRB	SNA	width	0	15	28	25.2	30	80	354	8	107
PRB	SNA	height	0	3.2	4	3.6	4	5	1436	9	191
PRB	SNA	count	1	1	1	1	1	1	68	1	26
BT	TAR	width	12	12	22	21.6	25	80	689	14	149
BT	TAR	height	1.2	2.5	4	3.5	4.5	5	1080	15	194
BT	TAR	count	1	1	1	1	1	1	94	2	20
PRB	TAR	width	12	25	30	32.2	30	80	257	7	98
PRB	TAR	height	0	2	3	3.1	4	5	371	9	137
PRB	TAR	count	1	1	1	1	1	1	11	2	9
BT	TRE	width	12	22	27	26.4	27	80	412	13	91
BT	TRE	height	1.5	2	2.5	3.2	4.5	5	454	14	101
BT	TRE	count	1	1	1	1	1	1	42	2	7
PRB	TRE	width	3	30	30	32.5	30	80	520	7	117
PRB	TRE	height	1.5	2	3.2	3.2	4	5	557	9	128
PRB	TRE	count	1	1	1	1	1	1	178	2	39

Table 3-2: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 2. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	GUR	width	0.35	15	25	22.6	30	36	2436	23	599
BT	GUR	height	0.2	1.3	2.5	2.8	4	6	2434	23	599
BT	GUR	count	1	1	1	1	1	1	15	3	9
PRB	GUR	width	30	30	30	30.4	30	36	31	3	12
PRB	GUR	height	3	3	3	3.5	4	4.5	31	3	12
PRB	GUR	count	1	1	1	1	1	1	10	2	6
BT	JDO	width	18	18	18	19.2	18	25	12	2	7
BT	JDO	height	3	4.9	5	4.8	5	5	12	2	7
BT	MOK	width	15	18	25	23.1	26	36	127	10	51
BT	MOK	height	2	3	4.5	4.5	5.8	7.5	126	10	50
BT	SKI	width	18	18	18	21.5	28	30	104	7	34
BT	SKI	height	3	4.5	5	4.5	5	5	104	7	34
BT	SKI	count	1	1	1	1	1	1	23	2	7
PRB	SKI	width	30	30	30	30	30	30	5	2	2
PRB	SKI	height	4	4	4	4	4	4	5	2	2
PRB	SKI	count	1	1	1	1	1	1	5	2	2
BT	SNA	width	12	18	28	25.1	30	35	195	13	63
BT	SNA	height	2	3	4	3.8	5	5	198	14	64
BT	SNA	count	1	1	1	1	1	1	65	3	12
PRB	SNA	width	30	30	30	30.9	30	36	14	3	7
PRB	SNA	height	3	3	3	3.4	3.8	4.5	14	3	7
PRB	SNA	count	1	1	1	1	1	1	2	1	2
BT	TAR	width	2.5	18	25	23.2	28	36	2794	24	432
BT	TAR	height	1	3	4	3.7	4.5	6	2974	25	452
BT	TAR	count	1	1	1	1	1	1	321	3	44
PRB	TAR	width	24	30	30	31.2	30	130	329	4	52
PRB	TAR	height	3	4	4	3.9	4	14	329	4	52
PRB	TAR	count	1	1	1	1	1	1	195	2	28
BT	TRE	width	15	25	25	23.6	25	25	7	2	5
BT	TRE	height	4	4	4	4.4	4.5	6	7	2	5
BT	WAR	width	6	15	26	22.2	26	35	177	12	78
BT	WAR	height	1.6	6	6	5.6	6	6	177	12	78
BT	WAR	count	1	1	1	1	1	1	1	1	1

Table 3-3: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–2018 year by trawl method and target species for FMA 3. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	BAR	width	1.2	15	23	25.3	25	80	1692	25	376
BT	BAR	height	0.1	2	4	3.3	4	15	1690	25	375
BT	BAR	count	1	1	1	1.1	1	2	47	5	12
MW	BAR	width	80	90	116	108.6	116	150	434	7	27
MW	BAR	height	24	27	30	31.7	32	50	282	5	17
MW	BAR	count	1	1	1	17.7	25	101	406	7	25
PRM	BAR	width	45	62.8	80.5	80.5	98.2	116	2	2	2
PRM	BAR	height	3.5	3.5	3.5	3.5	3.5	3.5	1	1	1
PRM	BAR	count	2	9	16	16	23	30	2	2	2
BT	ELE	width	1	10	12	20	20	80	546	27	218
BT	ELE	height	0.9	1	1	2.2	4	5	546	27	218
BT	ELE	count	1	1	1	1	1	1	7	1	3
BT	FLA	width	0.8	7	8	11.3	15	87	4215	34	1477
BT	FLA	height	0.1	0.9	1	0.9	1	10	4215	34	1477
BT	GUR	width	1	10	12	20	20	80	655	29	265
BT	GUR	height	0.1	1	1	1.7	2.5	5	655	29	265
BT	GUR	count	1	1	1	1	1	1	4	1	1
BT	RCO	width	2.5	18	24	31.7	51	80	836	29	341
BT	RCO	height	0.1	0.9	1.8	1.9	3	8	836	29	341
BT	RCO	count	1	1	1	1	1	1	8	1	2
BT	RSK	width	1.5	10	10	11.3	15	39	227	13	78
BT	RSK	height	0.9	1	1	1.5	1.5	10	227	13	78
BT	SPE	width	9	15	18	19.3	18	60	295	9	74
BT	SPE	height	1	2	3	2.6	3	4.5	295	9	74
BT	SPE	count	1	1	1	1	1	1	3	1	2
BT	STA	width	10	13.8	15	16.5	18	40	232	15	92
BT	STA	height	0.9	1	1	1.6	2	8	232	15	92
BT	TAR	width	1	15	18	22.9	25	80	1853	36	486
BT	TAR	height	0.1	1.8	2	2.2	2.5	15	1852	36	485
BT	TAR	count	1	1	1	1	1	1	22	2	5
BT	WAR	width	12	20	23	26.4	24	80	224	12	78
BT	WAR	height	1.5	3	4	3.7	4.2	8	224	12	78
BT	WAR	count	1	1	1	1	1	1	1	1	1

Table 3-4: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 5. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	ELE	width	15	30	39	34.9	39	42	65	7	29
BT	ELE	height	0.9	1	1	1.2	1	2	65	7	29
BT	ELE	count	2	2	2	2	2	2	16	1	6
BT	FLA	width	0.8	10	18	17.1	20	80	1659	17	249
BT	FLA	height	0.1	1	1	1	1	10	1658	17	249
BT	FLA	count	1	1	1	1	1	1	19	1	3
BT	GUR	width	10	20	22	27.7	22	80	156	8	40
BT	GUR	height	0.9	1	1.5	1.7	2	4.5	156	8	40
BT	GUR	count	1	1	2	1.6	2	2	35	2	15
BT	RCO	width	80	80	80	80	80	80	1	1	1
BT	RCO	height	3.5	3.5	3.5	3.5	3.5	3.5	1	1	1
BT	RCO	count	1	1	1	1	1	1	1	1	1
BT	STA	width	2	22	33	33.4	41	80	975	16	127
BT	STA	height	0.09	1	1	1.5	2	3.8	975	16	127
BT	STA	count	1	2	2	1.8	2	2	248	2	31
BT	TAR	width	20	20	20	32.9	34.5	80	62	8	32
BT	TAR	height	0.1	3	3.5	3.5	4	5	62	8	32
BT	TAR	count	1	1	1	1.1	1	2	15	2	7

Table 3-5: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 7. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	ELE	width	12	18	20	22	20	80	36	12	17
BT	ELE	height	1	1.4	2	2.2	2.5	5	36	12	17
BT	ELE	count	1	1	1	1	1	1	4	1	2
BT	FLA	width	1	8	16	18.9	25	80	4246	33	605
BT	FLA	height	0.1	1	1.6	1.7	2	10	4238	33	605
BT	FLA	count	1	1	1	1	1	1	168	4	25
BT	GUR	width	7	20	25	27.2	35	80	1076	28	304
BT	GUR	height	0.5	1.8	2.5	2.6	3	7.5	1076	28	304
BT	GUR	count	1	1	1	1	1	1	114	6	38
BT	JDO	width	3	18	35	29.8	36	80	461	18	104
BT	JDO	height	0.6	1.4	2.5	2.6	3	7.5	461	18	104
BT	JDO	count	1	1	1	1	1	1	40	4	10
BT	LEA	width	15	15	25	25	35	35	4	2	4
BT	LEA	height	3	3	5	5.1	7.1	7.5	4	2	4
BT	SNA	width	8	20	20	20.5	20	80	288	11	69
BT	SNA	height	1	2	2	2.3	2	7.5	288	11	69
BT	SNA	count	1	1	1	1	1	1	5	1	1
BT	STA	width	8	18	20	26.4	25	80	335	15	96
BT	STA	height	0.5	2.5	3	2.8	3	5	335	15	96
BT	STA	count	1	1	1	1	1	1	96	3	21
BT	TAR	width	2	20	20	30.3	35	80	1523	25	241
BT	TAR	height	0.5	2.5	3	3	3.6	7.5	1523	25	241
BT	TAR	count	1	1	1	1	1	1	231	6	36
BT	WAR	width	8	20	30	27.7	35	35	451	14	98
BT	WAR	height	1	2	3	3.4	5	7.5	449	14	98
BT	WAR	count	1	1	1	1	1	1	47	2	7

Table 3-6: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 8. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	GUR	width	8.5	15	18	17.5	20	80	701	16	167
BT	GUR	height	1	1.5	2	1.8	2	7.5	701	16	167
BT	GUR	count	1	1	1	1	1	1	18	4	5
PRB	GUR	width	80	80	80	80	80	80	2	1	1
PRB	GUR	height	1.5	1.5	1.5	1.5	1.5	1.5	2	1	1
BT	JDO	width	2.5	18	25	24.6	36	36	248	11	80
BT	JDO	height	1	2	2	3	3.6	7.5	248	11	80
BT	JDO	count	1	1	1	1	1	1	1	1	1
PRB	JDO	width	26	26	26	26	26	26	5	1	3
PRB	JDO	height	6	6	6	6	6	6	5	1	3
BT	SCH	width	15	18	25	40.8	80	80	65	5	15
BT	SCH	height	1	2	3	2.6	3.2	3.2	65	5	15
BT	SCH	count	1	1	1	1	1	1	8	2	2
BT	SNA	width	15	15	16	24.1	26	80	79	9	28
BT	SNA	height	1.8	3	5	4.9	7.5	7.5	79	9	28
BT	SNA	count	1	1	1	1	1	1	16	2	3
BT	SPO	width	16	25	36	32.1	36	80	34	3	13
BT	SPO	height	1	2	2	1.9	2	3.2	34	3	13
BT	SPO	count	1	1	1	1	1	1	5	1	1
BT	TAR	width	2.6	18	25	26.5	35	80	394	15	113
BT	TAR	height	1	2	2	2.7	3	6	394	15	113
BT	TAR	count	1	1	1	1	1	1	137	5	20
PRB	TAR	width	24	24	25	25	26	26	24	1	16
PRB	TAR	height	5	5	5.5	5.5	6	6	24	1	16
BT	TRE	width	14	15	20	20.6	22	36	168	10	39
BT	TRE	height	1.5	2	2.5	3.5	4.5	7.5	168	10	39
BT	TRE	count	1	1	1	1	1	1	93	4	14
PRB	TRE	width	24	26	26	25.8	26	26	9	1	7
PRB	TRE	height	5	6	6	5.9	6	6	9	1	7

Table 3-7: Summary of data on gear parameters collected on TCEPR and TCER forms during the 2017–18 year by trawl method and target species for FMA 9. For each method and species combination, the number of vessels, unique trips and tows for which gear parameters were recorded is given. Target species codes are defined in Table 1.

Method	Target	Gear parameter	min	q1	median	mean	q3	max	Ntows	Nvessels	Ntrips
BT	GUR	width	6.5	9	15	18.8	20	100	601	8	186
BT	GUR	height	0.5	1.1	1.5	1.9	2	5	602	8	187
BT	GUR	count	1	1	1	1	1	1	82	1	24
PRB	GUR	width	12	28	30	37.4	30	80	157	3	35
PRB	GUR	height	1.5	2	2	2.1	2.5	4	157	3	35
BT	JDO	width	20	21.5	22	36	36.5	80	4	2	4
BT	JDO	height	1.5	1.9	2	2	2.1	2.5	4	2	4
BT	JDO	count	1	1	1	1	1	1	3	1	3
PRB	JDO	width	8	67.5	80	66.2	80	80	24	2	8
PRB	JDO	height	0.5	1.5	1.5	1.5	1.5	2	24	2	8
BT	SCH	width	20	20	21	31.6	22	80	27	2	10
BT	SCH	height	2	2	2.5	3	4.2	4.8	27	2	10
BT	SCH	count	1	1	1	1	1	1	22	1	9
PRB	SCH	width	30	31.5	33	52.3	80	80	7	1	5
PRB	SCH	height	1.5	2.2	2.5	3.4	4.8	5.5	7	1	5
BT	SNA	width	8.5	20	30	33.5	35	80	81	6	19
BT	SNA	height	1.5	3.5	5	4.2	5	5	80	6	19
BT	SNA	count	1	1	1	1	1	1	52	2	8
PRB	SNA	width	12	28	29	37.4	30	80	14	3	9
PRB	SNA	height	1.5	2	2.5	2.5	2.5	4	14	3	9
BT	SPO	width	8.9	8.9	8.9	8.9	8.9	8.9	1	1	1
BT	SPO	height	1.5	1.5	1.5	1.5	1.5	1.5	1	1	1
BT	TAR	width	18	20	22	34.2	35	100	316	8	72
BT	TAR	height	0.5	2	2.5	3.1	4.5	5	316	8	72
BT	TAR	count	1	1	1	1	1	1	204	3	42
PRB	TAR	width	8	28	33	53.7	80	80	256	3	58
PRB	TAR	height	0.5	1.5	2	2	2.5	5.5	256	3	58
BT	TRE	width	8	20	22	29	35	80	781	7	91
BT	TRE	height	1.5	2	2.2	3	4.5	5	810	7	93
BT	TRE	count	1	1	1	1	1	1	555	3	52
PRB	TRE	width	8	30	30	49.6	80	80	184	3	38
PRB	TRE	height	1.5	1.5	2	2	2	5.5	184	3	38

APPENDIX 4: OBSERVER TRAWL GEAR DETAILS FORM

1. Record theTrip Number [ ]

Trawl Gear Details Form (Version 1- December 2007)

2. Describe the trawling gear used by the vessel. You should use a separate column for each different trawl system.

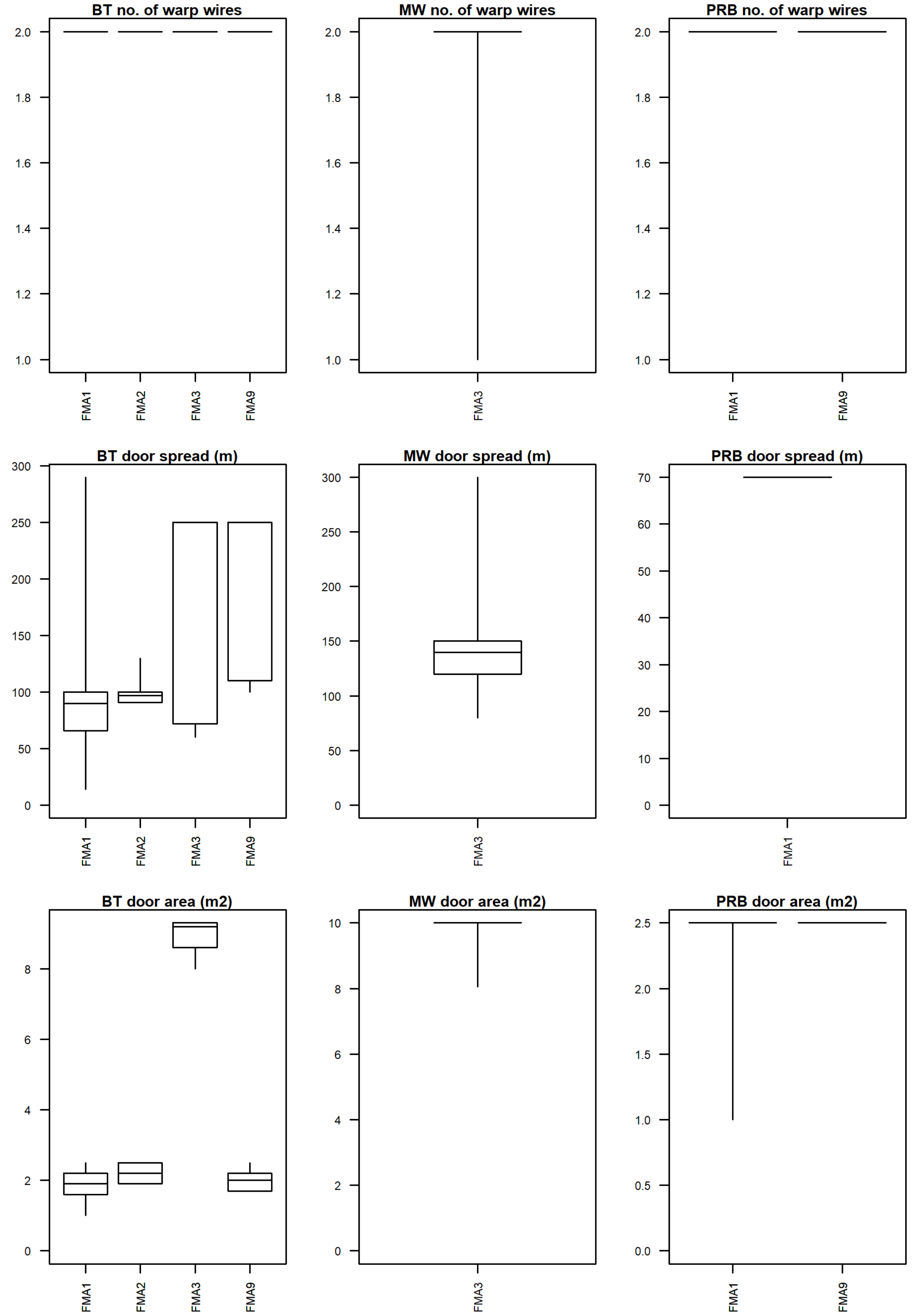
Gear equipment code			
Observer code(s)	. and .	. and .	. and .
No of Warps/Doorspread	Number D/spread (m)	Number D/spread (m)	Number D/spread (m)
Door type and Area	Type Area . (m^2)	Type Area . (m^2)	Type Area . (m^2)
Sweep length	(m)	(m)	(m)
Top bridle length	(m)	(m)	(m)
Trawl wingless?	Y N U	Y N U	Y N U
Design headline height	. (m)	. (m)	. (m)
Headline length/Wingspread	(m) W/spread (m)	(m) W/spread (m)	(m) W/spread (m)
Max size of groundgear	(mm)	(mm)	(mm)
Groundgear components			
Number of codends			
Lengthener mesh	Size (mm) Config	Size (mm) Config	Size (mm) Config
Codend mesh	Size (mm) Config	Size (mm) Config	Size (mm) Config
General features			

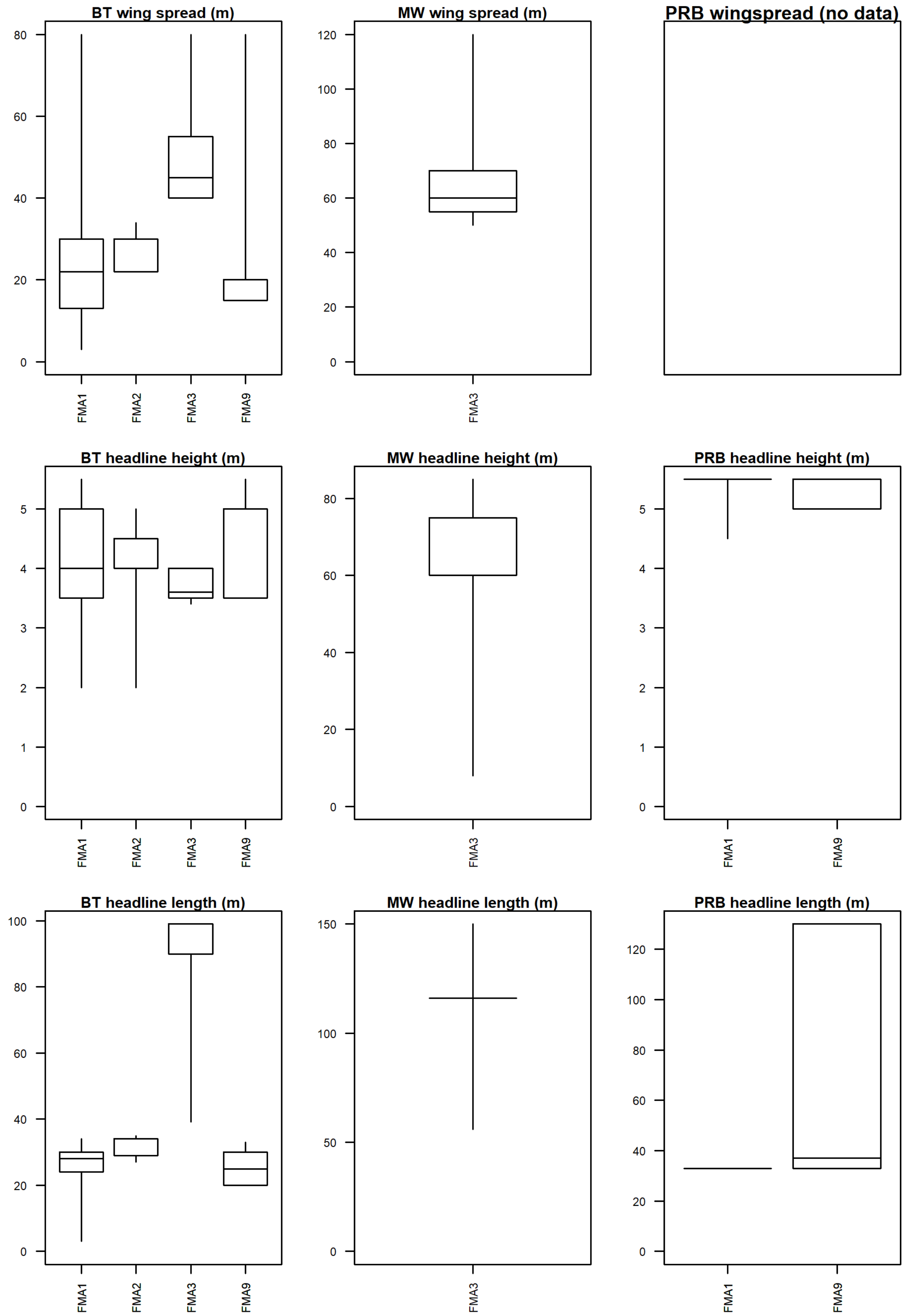
3. Record any additional comments

4. This form is page number [ ] for this trip. Is this form the last page for this trip? ⟶ Yes [ ] No [ ]

APPENDIX 5: SUMMARY PLOTS OF OBSERVER DATA BY YEAR, GEAR, AND FMA

2013–14

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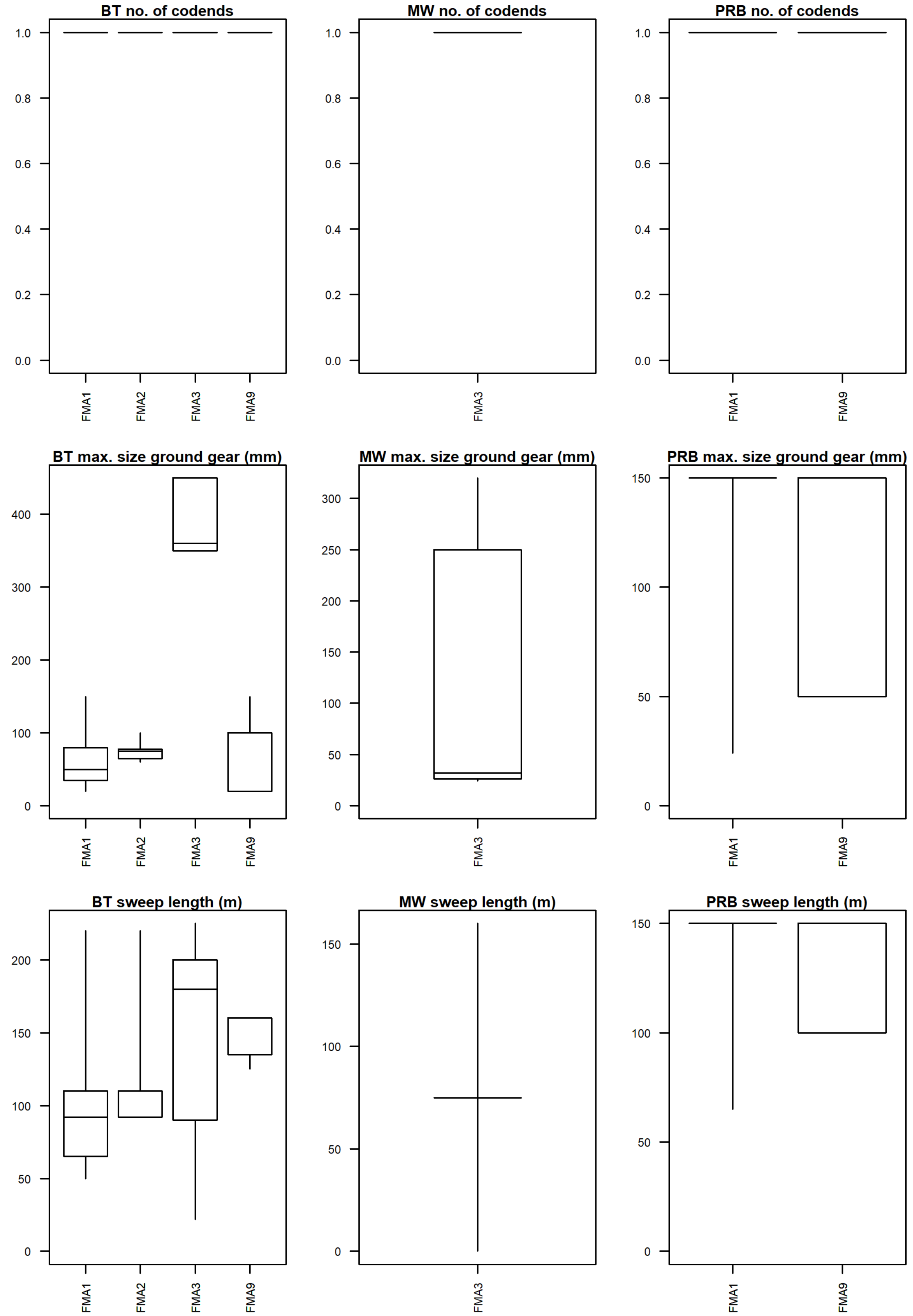
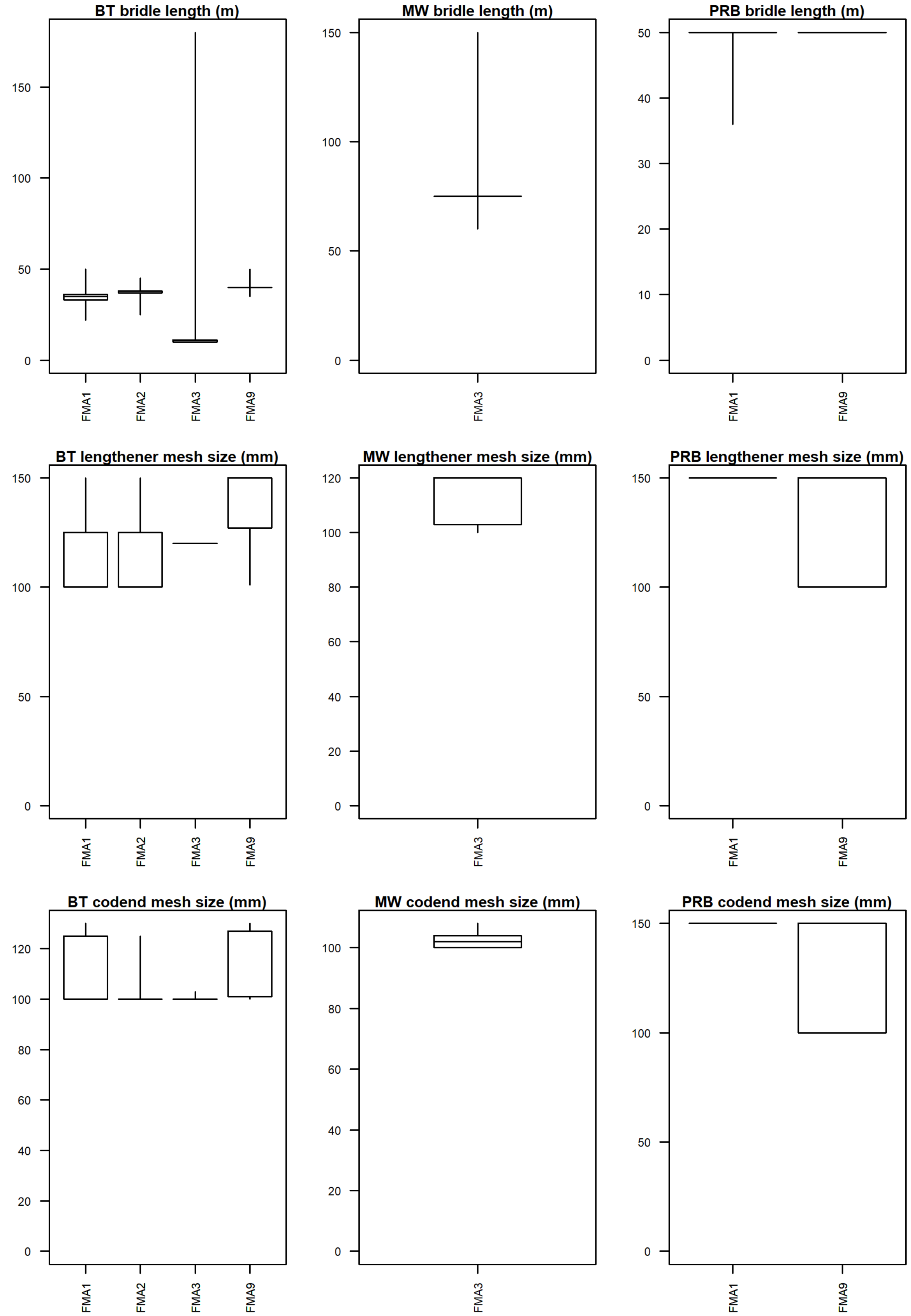
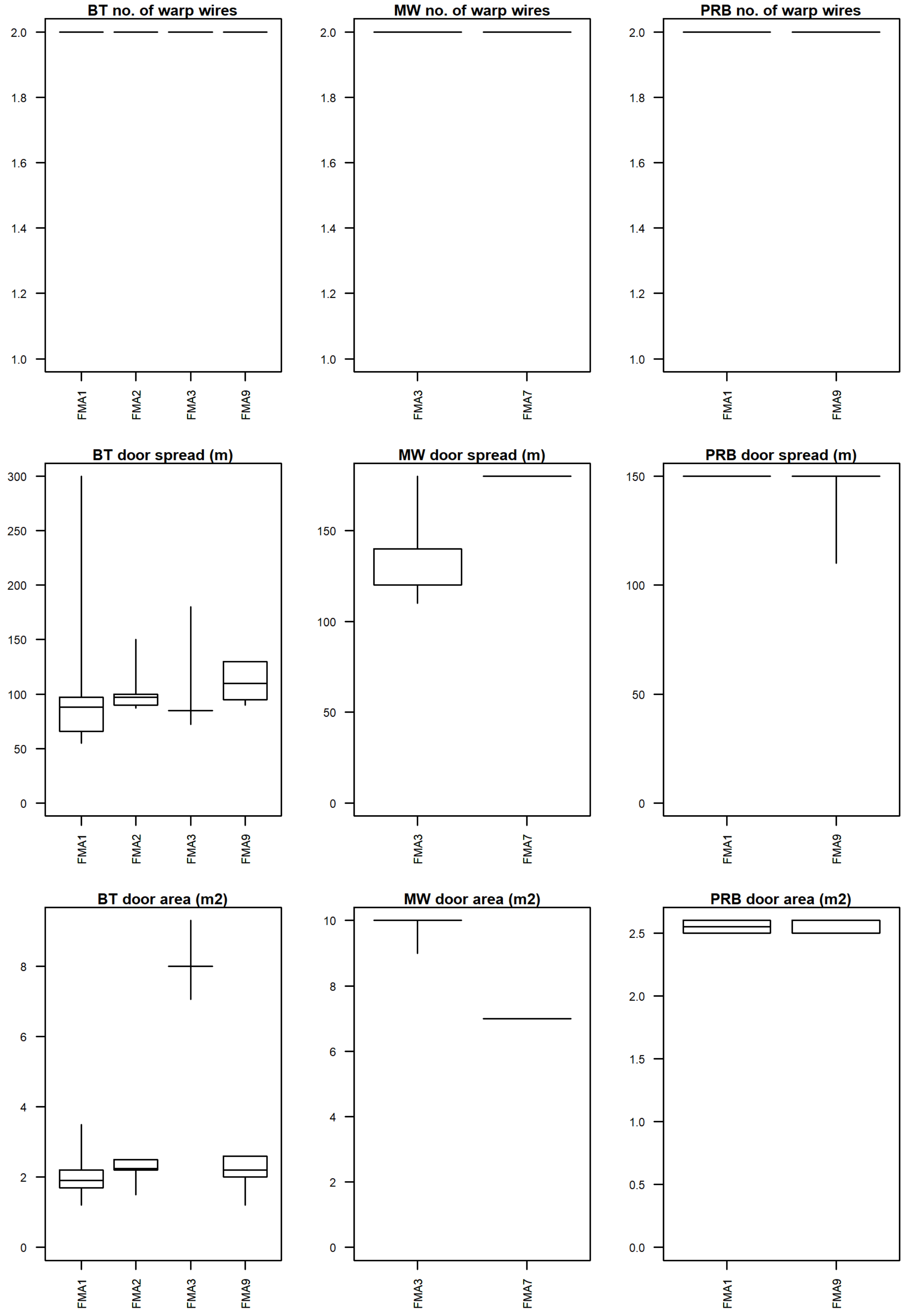
MW wing spread (m)
PRB wingspread (no data)
BT headline height (m)
MW headline height (m)
PRB headline height (m)
BT headline length (m)
MW headline length (m)
PRB headline length (m)
FMA1
FMA2
FMA3
FMA9

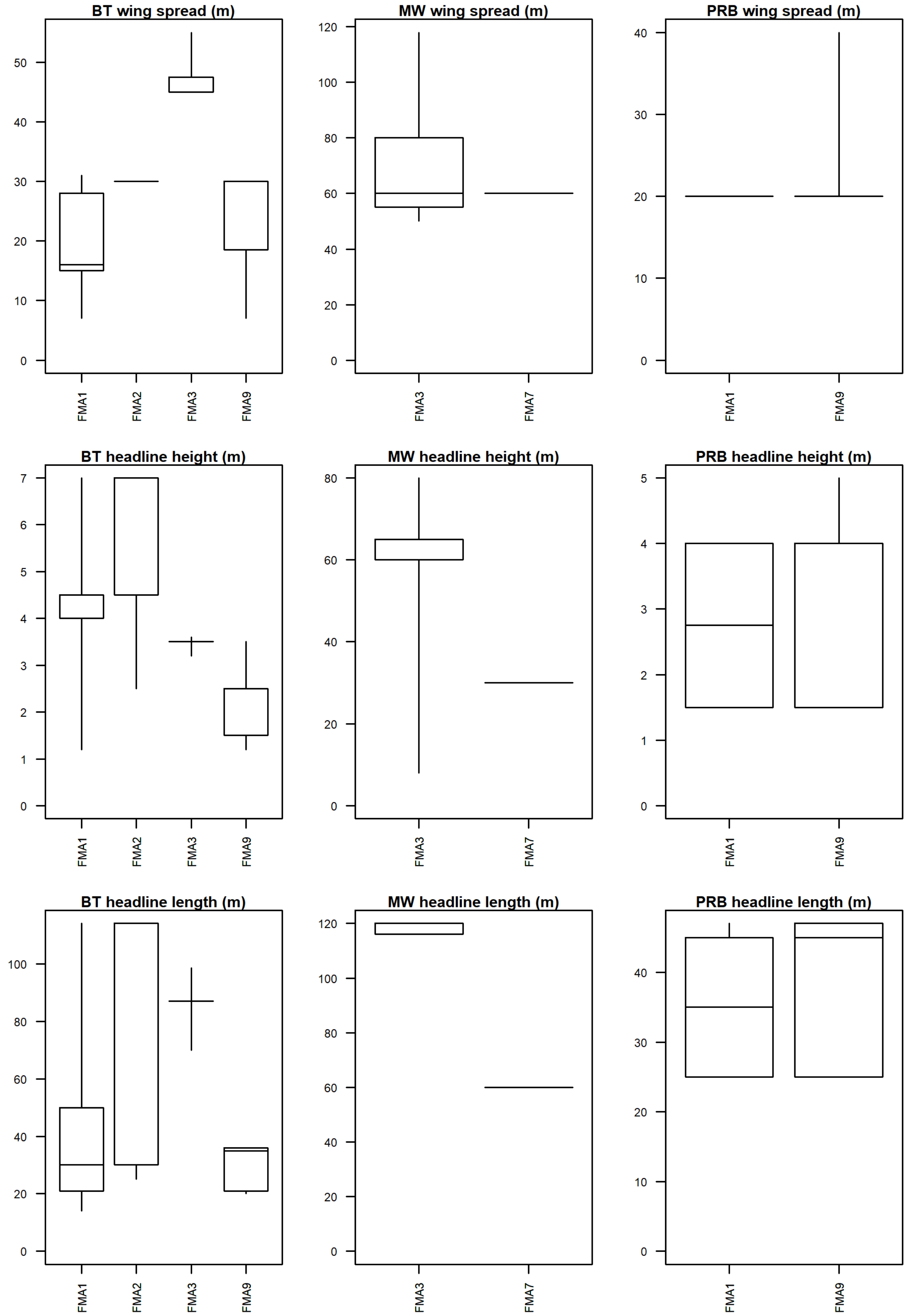

BT no. of codends
MW no. of codends
PRB no. of codends
BT max. size ground gear (mm)
MW max. size ground gear (mm)
PRB max. size ground gear (mm)
BT sweep length (m)
MW sweep length (m)
PRB sweep length (m)
FMA1
FMA2
FMA3
FMA9

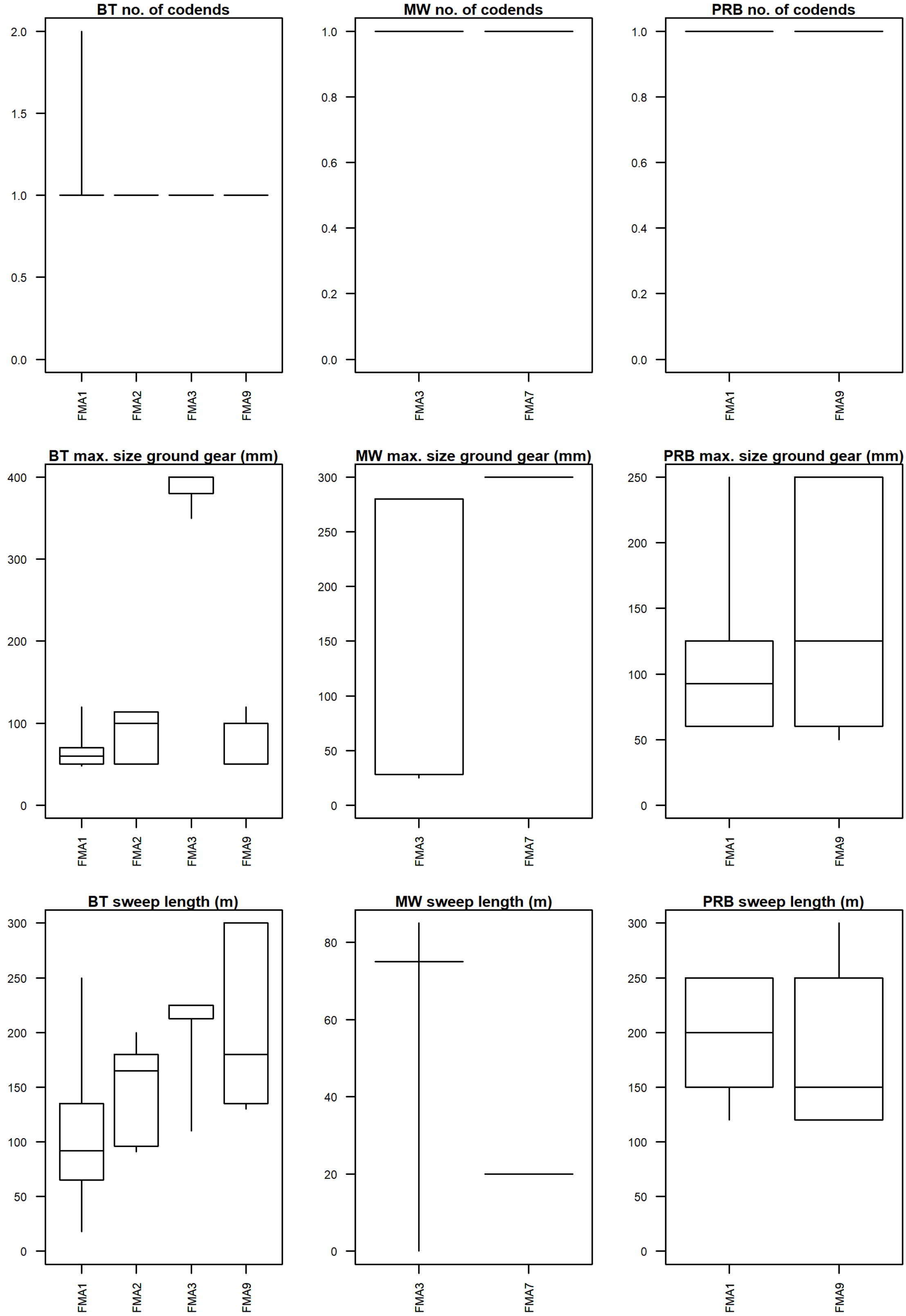

BT bridle length (m)
0
50
100
150
FMA1
FMA2
FMA3
FMA9
MW bridle length (m)
0
50
100
150
FMA3
PRB bridle length (m)
0
10
20
30
40
50
FMA1
FMA9
BT lengthener mesh size (mm)
0
50
100
150
FMA1
FMA2
FMA3
FMA9
MW lengthener mesh size (mm)
0
20
40
60
80
100
120
FMA3
PRB lengthener mesh size (mm)
0
50
100
150
FMA1
FMA9
BT codend mesh size (mm)
0
20
40
60
80
100
120
FMA1
FMA2
FMA3
FMA9
MW codend mesh size (mm)
0
20
40
60
80
100
FMA3
PRB codend mesh size (mm)
0
50
100
150
FMA1
FMA9

2014–15

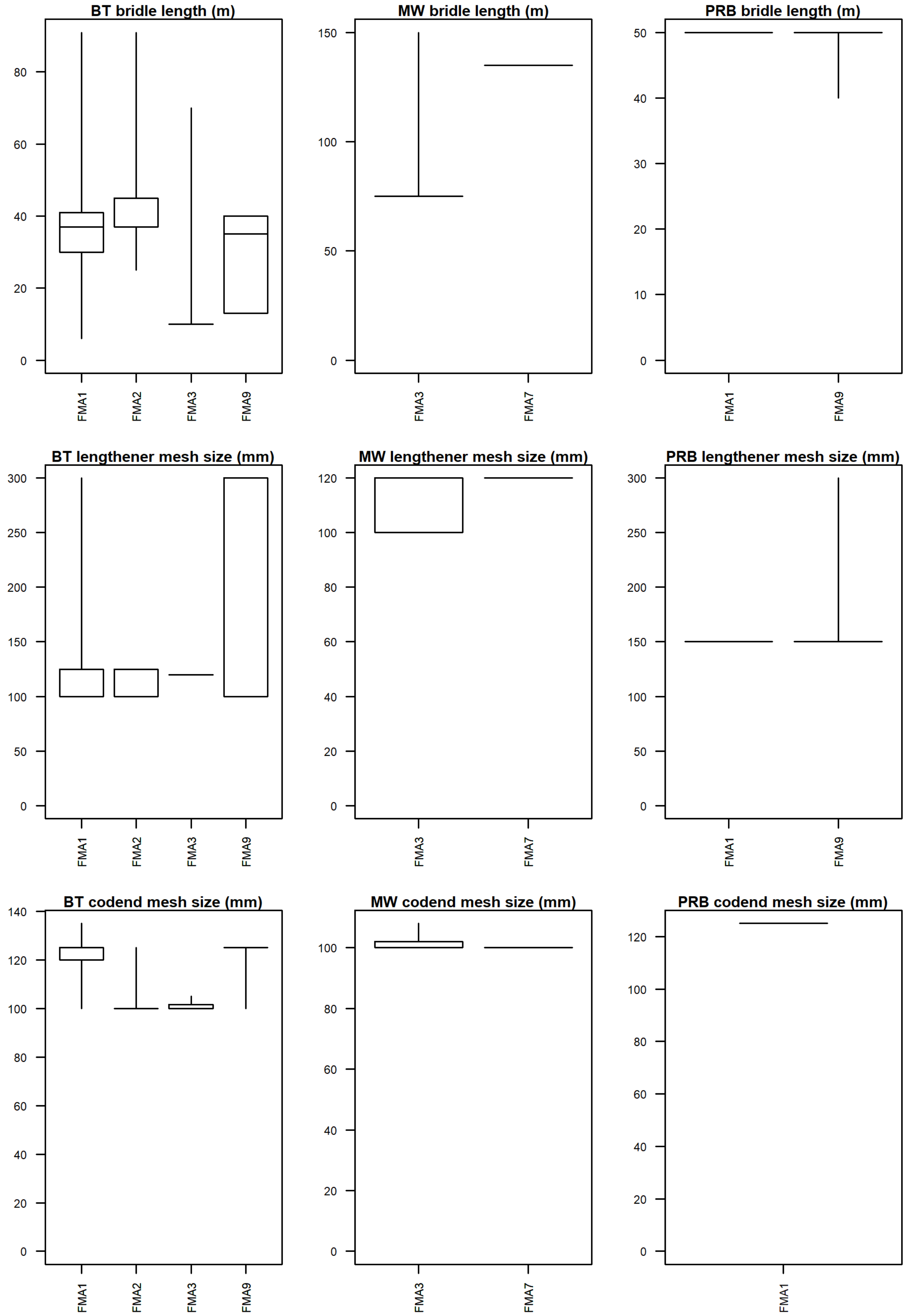


BT no. of warp wires
2.0
1.8
1.6
1.4
1.2
1.0
FMA1
FMA2
FMA3
FMA9
MW no. of warp wires
FMA3
FMA7
PRB no. of warp wires
FMA1
FMA9
BT door spread (m)
300
250
200
150
100
50
0
MW door spread (m)
150
100
50
0
PRB door spread (m)
150
100
50
0
BT door area (m2)
8
6
4
2
0
MW door area (m2)
10
8
6
4
2
0
PRB door area (m2)
2.5
2.0
1.5
1.0
0.5
0.0

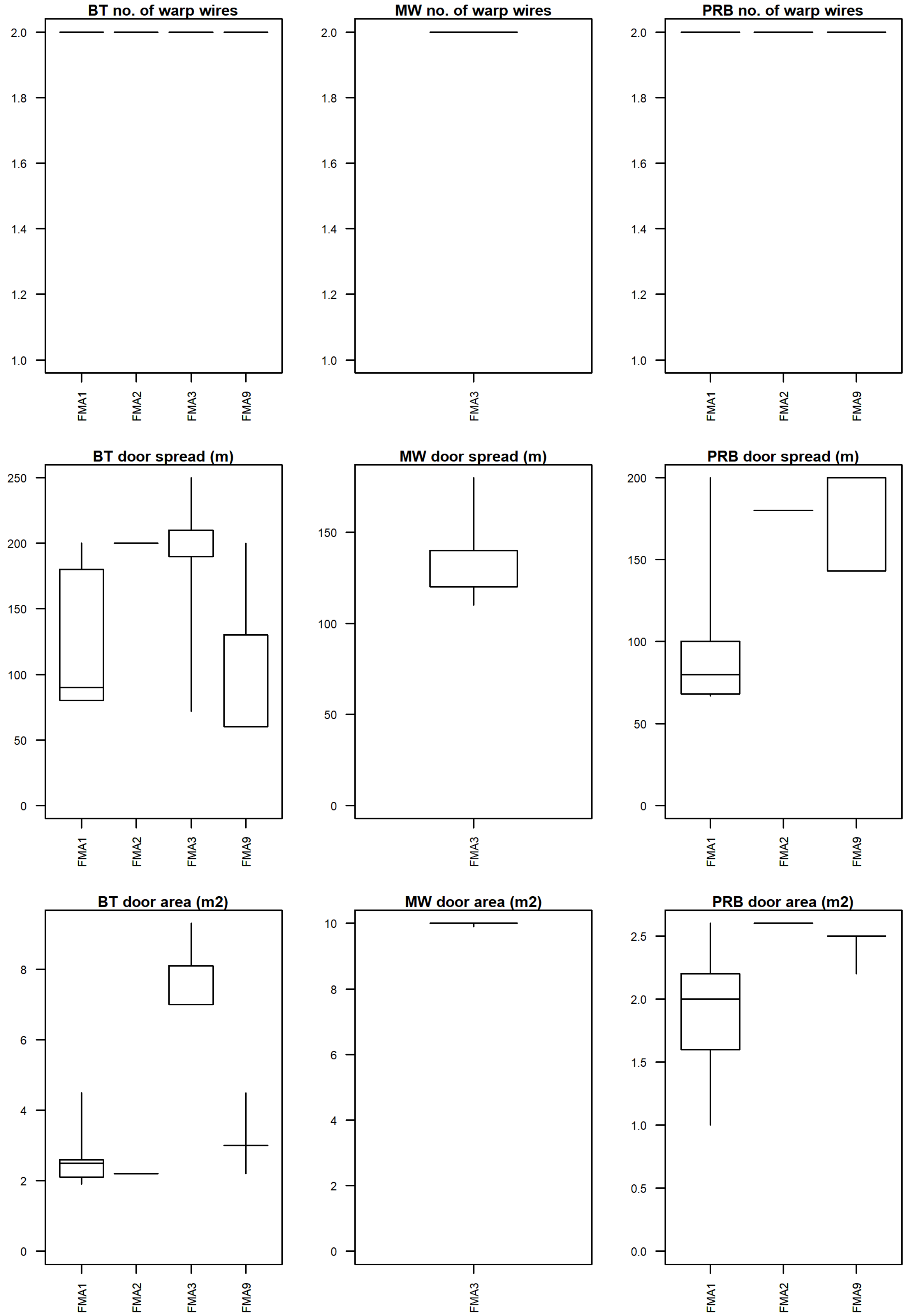

BT wing spread (m)
MW wing spread (m)
PRB wing spread (m)
BT headline height (m)
MW headline height (m)
PRB headline height (m)
BT headline length (m)
MW headline length (m)
PRB headline length (m)
FMA1
FMA2
FMA3
FMA7
FMA9



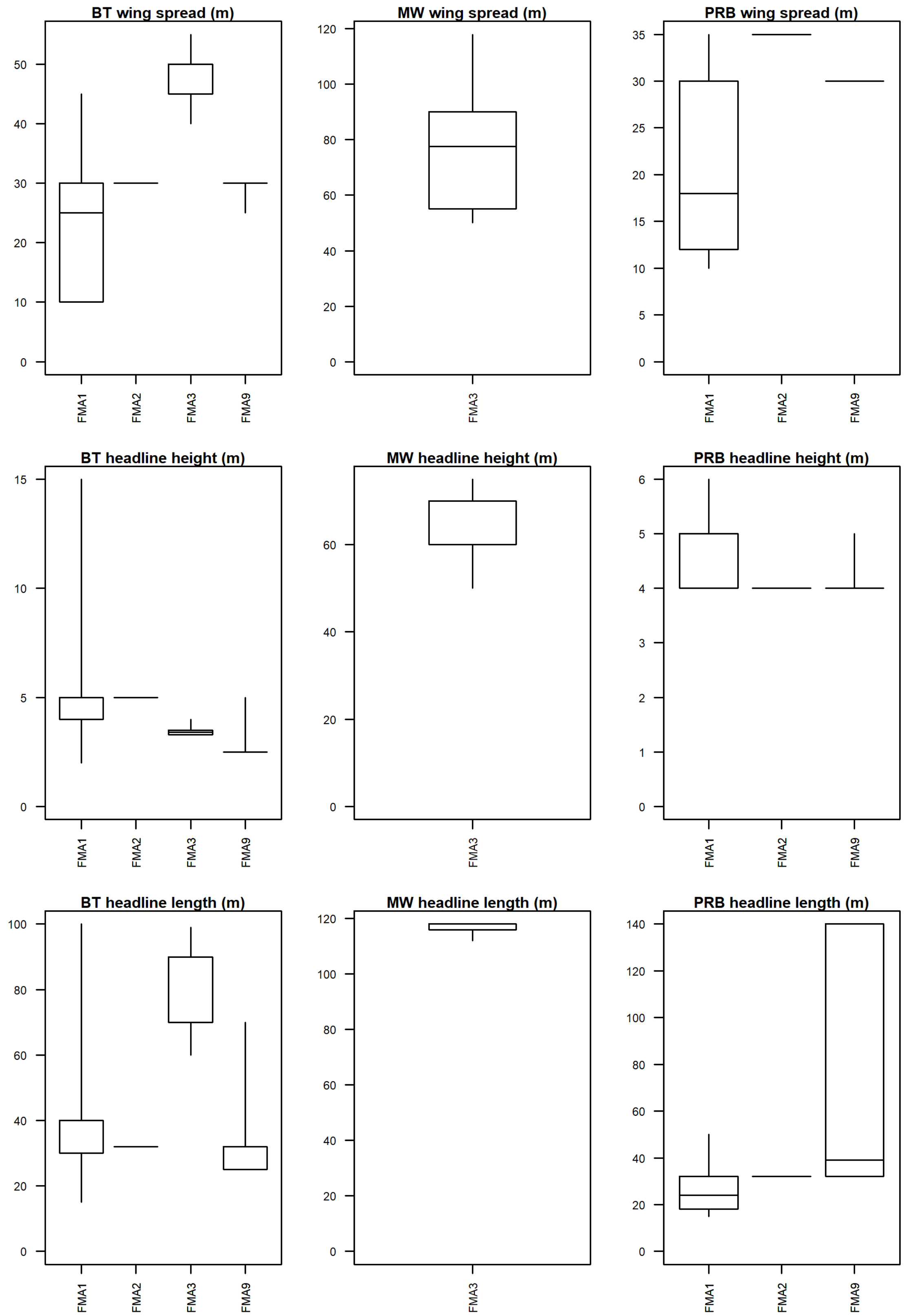
BT no. of codends
2.0
1.5
1.0
0.5
0.0
FMA1
FMA2
FMA3
FMA9
MW no. of codends
1.0
0.8
0.6
0.4
0.2
0.0
FMA3
FMA7
PRB no. of codends
1.0
0.8
0.6
0.4
0.2
0.0
FMA1
FMA9
BT max. size ground gear (mm)
400
300
200
100
0
FMA1
FMA2
FMA3
FMA9
MW max. size ground gear (mm)
300
250
200
150
100
50
0
FMA3
FMA7
PRB max. size ground gear (mm)
250
200
150
100
50
0
FMA1
FMA9
BT sweep length (m)
300
250
200
150
100
50
0
FMA1
FMA2
FMA3
FMA9
MW sweep length (m)
80
60
40
20
0
FMA3
FMA7
PRB sweep length (m)
300
250
200
150
100
50
0
FMA1
FMA9

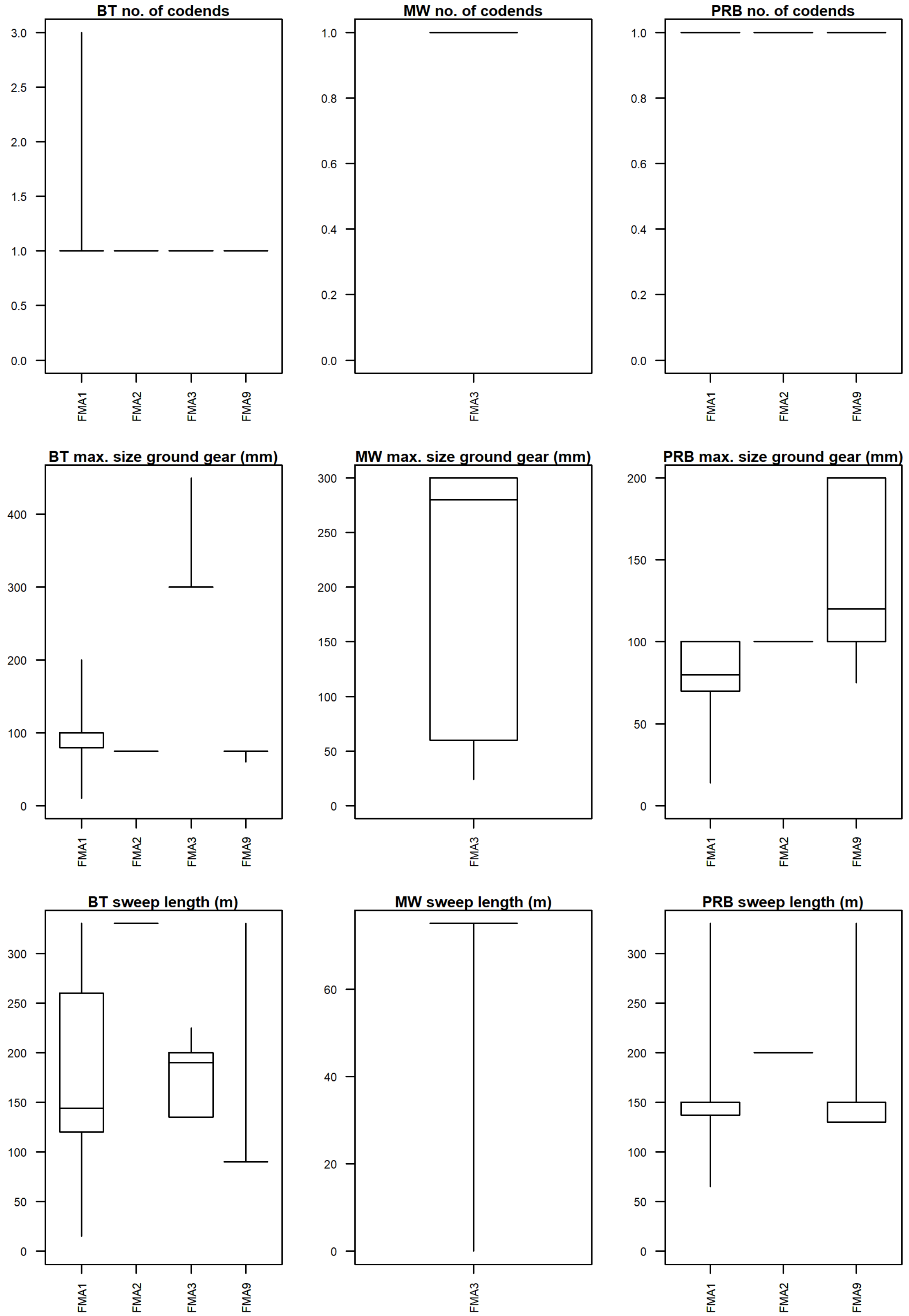

BT bridle length (m)
MW bridle length (m)
PRB bridle length (m)
BT lengthener mesh size (mm)
MW lengthener mesh size (mm)
PRB lengthener mesh size (mm)
BT codend mesh size (mm)
MW codend mesh size (mm)
PRB codend mesh size (mm)
FMA1
FMA2
FMA3
FMA7
FMA9

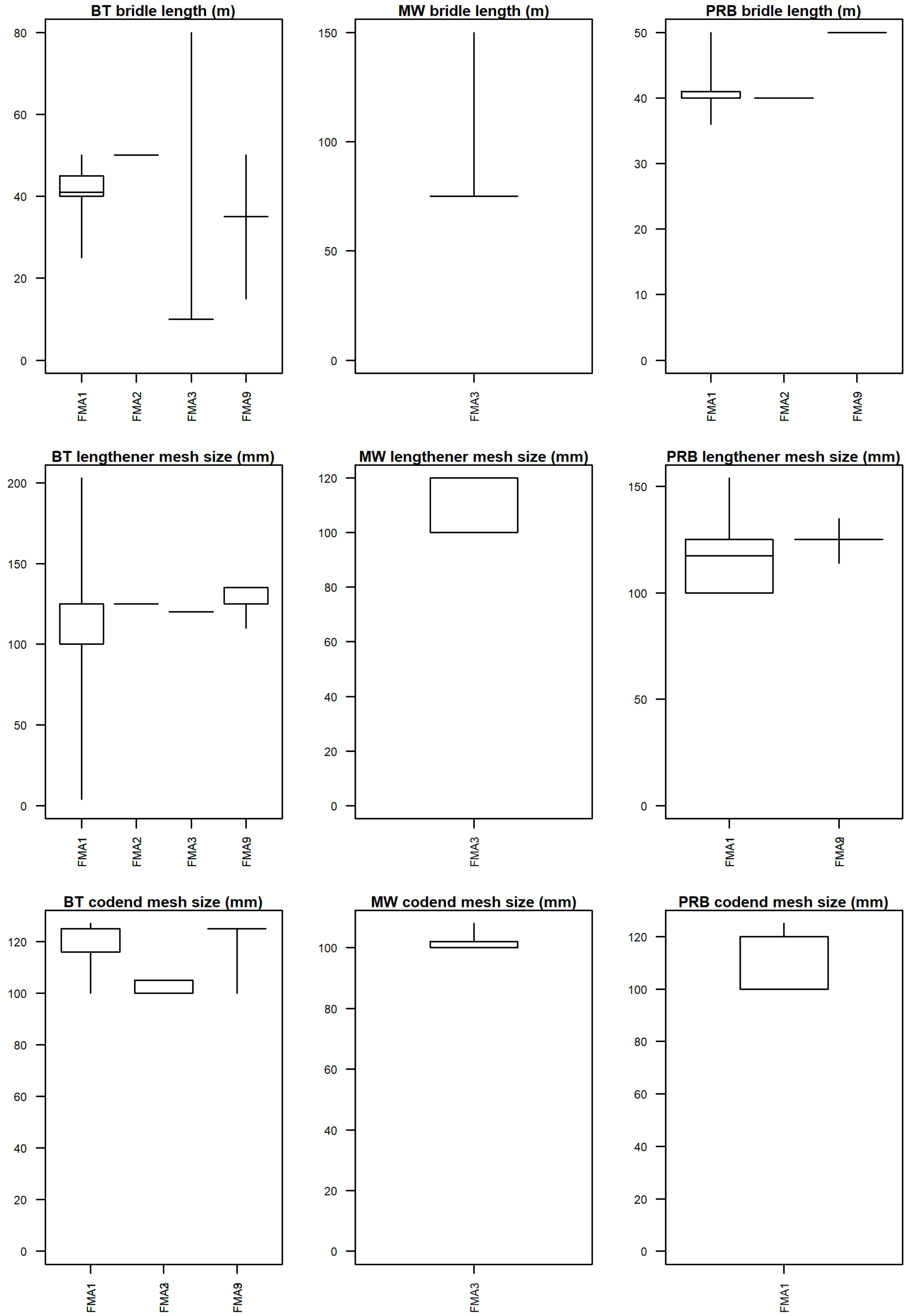
2015–16



BT no. of warp wires
MW no. of warp wires
PRB no. of warp wires
BT door spread (m)
MW door spread (m)
PRB door spread (m)
BT door area (m2)
MW door area (m2)
PRB door area (m2)
FMA1
FMA2
FMA3
FMA9

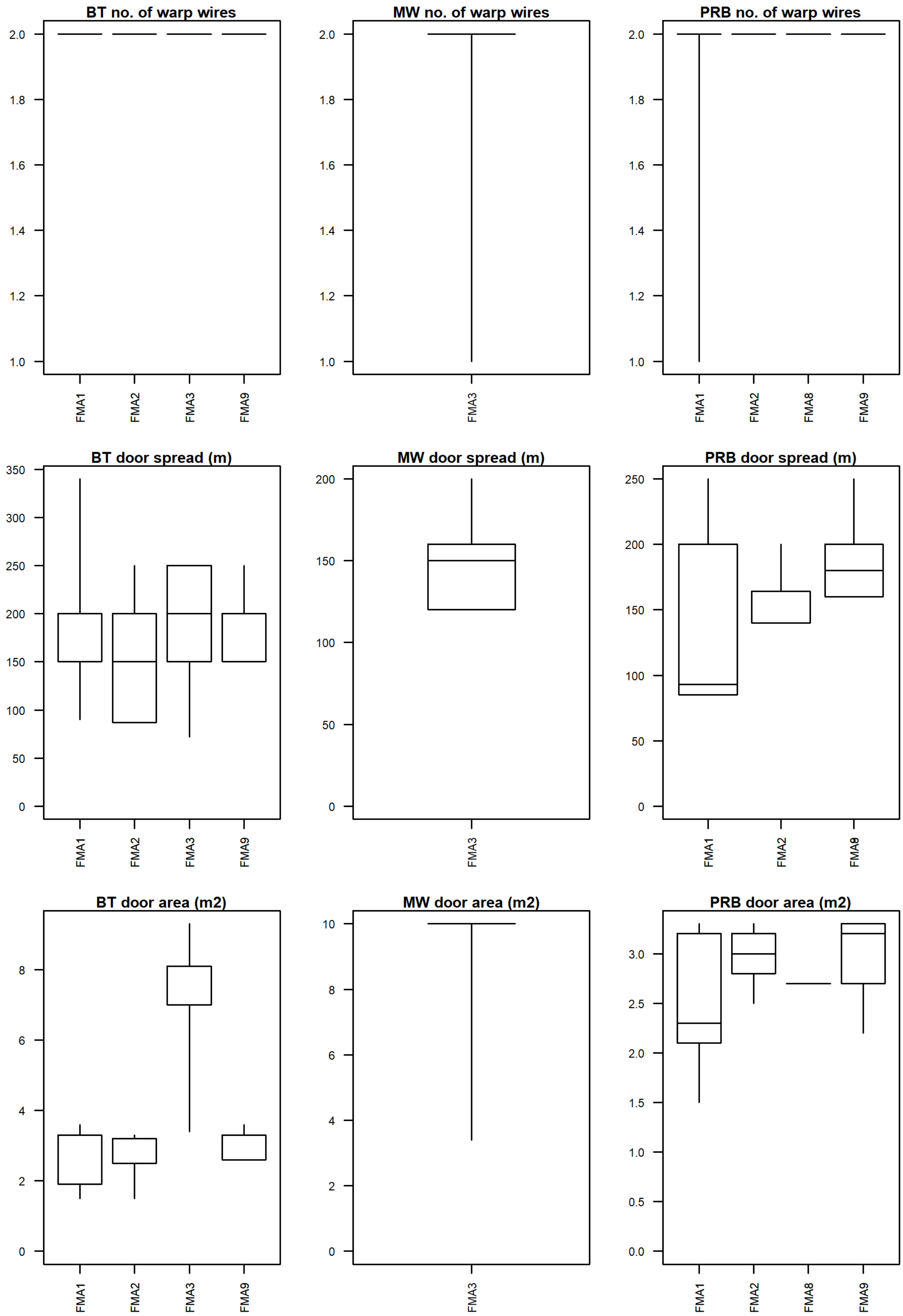

BT wing spread (m)
0 10 20 30 40 50
FMA1 FMA2 FMA3 FMA9
MW wing spread (m)
0 20 40 60 80 100 120
FMA3
PRB wing spread (m)
0 5 10 15 20 25 30 35
FMA1 FMA2 FMA9
BT headline height (m)
0 5 10 15
FMA1 FMA2 FMA3 FMA9
MW headline height (m)
0 20 40 60
FMA3
PRB headline height (m)
0 1 2 3 4 5 6
FMA1 FMA2 FMA9
BT headline length (m)
0 20 40 60 80 100
FMA1 FMA2 FMA3 FMA9
MW headline length (m)
0 20 40 60 80 100 120
FMA3
PRB headline length (m)
0 20 40 60 80 100 120 140
FMA1 FMA2 FMA9


BT no. of codends
MW no. of codends
PRB no. of codends
BT max. size ground gear (mm)
MW max. size ground gear (mm)
PRB max. size ground gear (mm)
BT sweep length (m)
MW sweep length (m)
PRB sweep length (m)
FMA1
FMA2
FMA3
FMA9

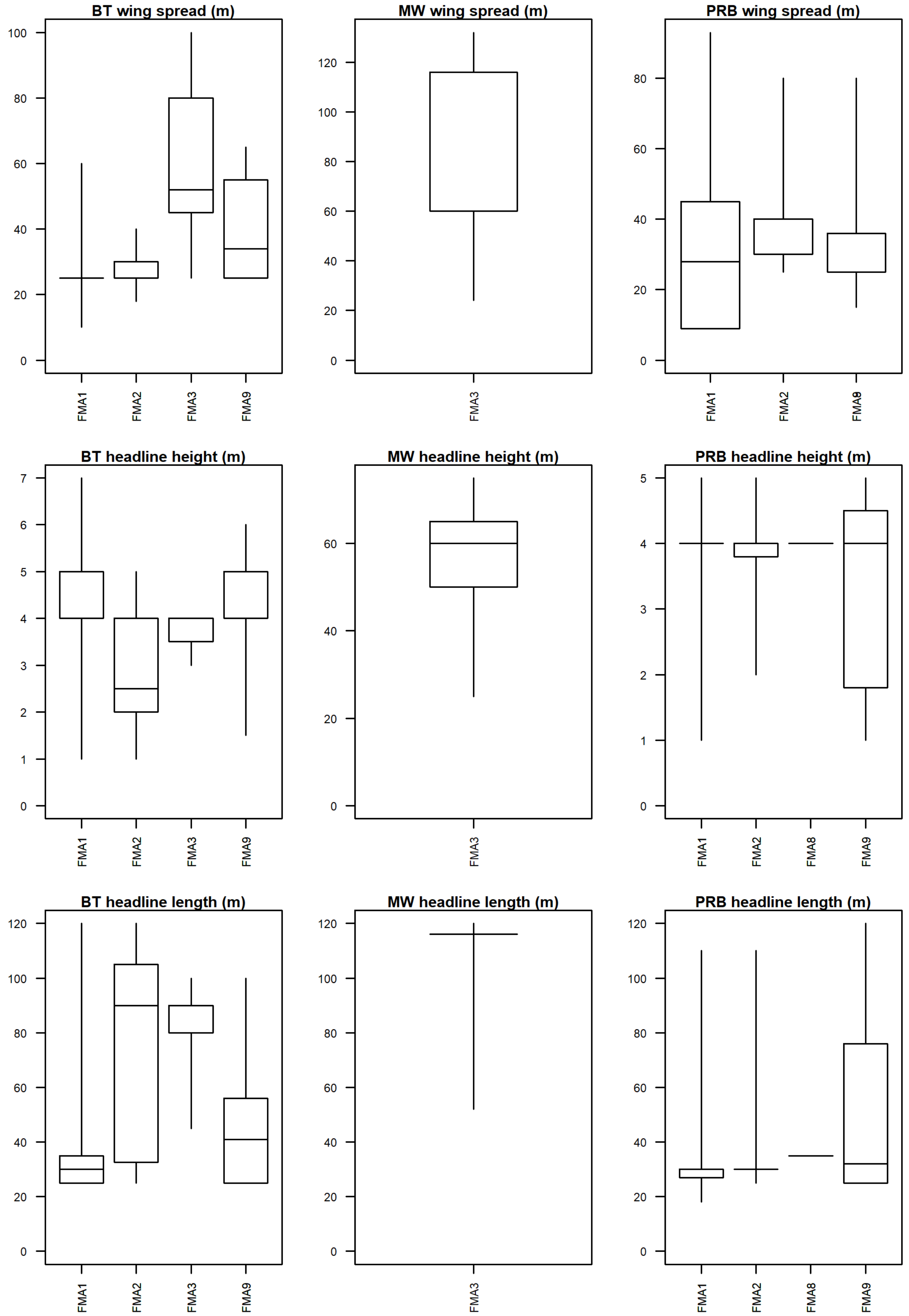


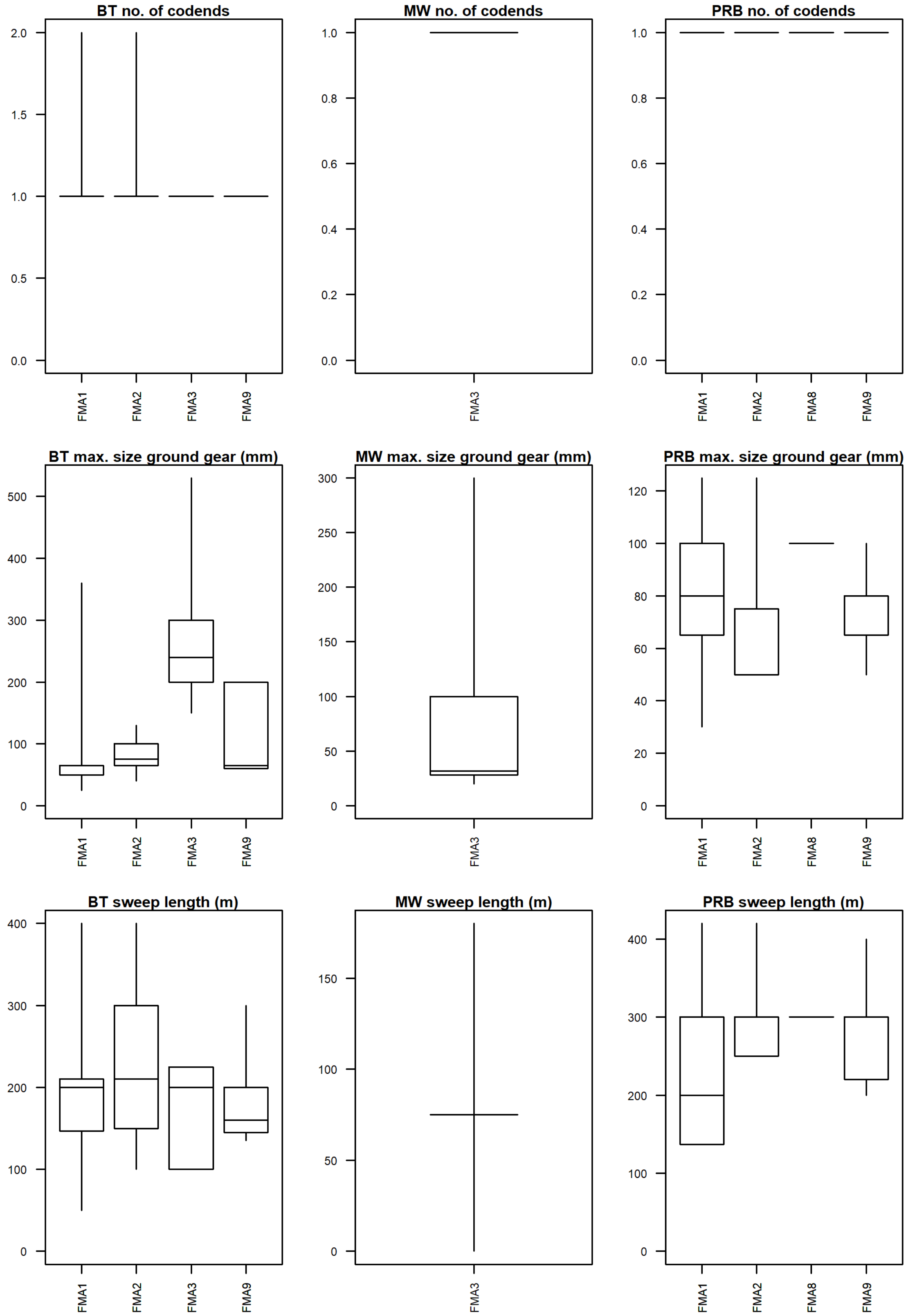
BT bridle length (m)
MW bridle length (m)
PRB bridle length (m)
BT lengthener mesh size (mm)
MW lengthener mesh size (mm)
PRB lengthener mesh size (mm)
BT codend mesh size (mm)
MW codend mesh size (mm)
PRB codend mesh size (mm)
FMA1
FMA2
FMA3
FMA9

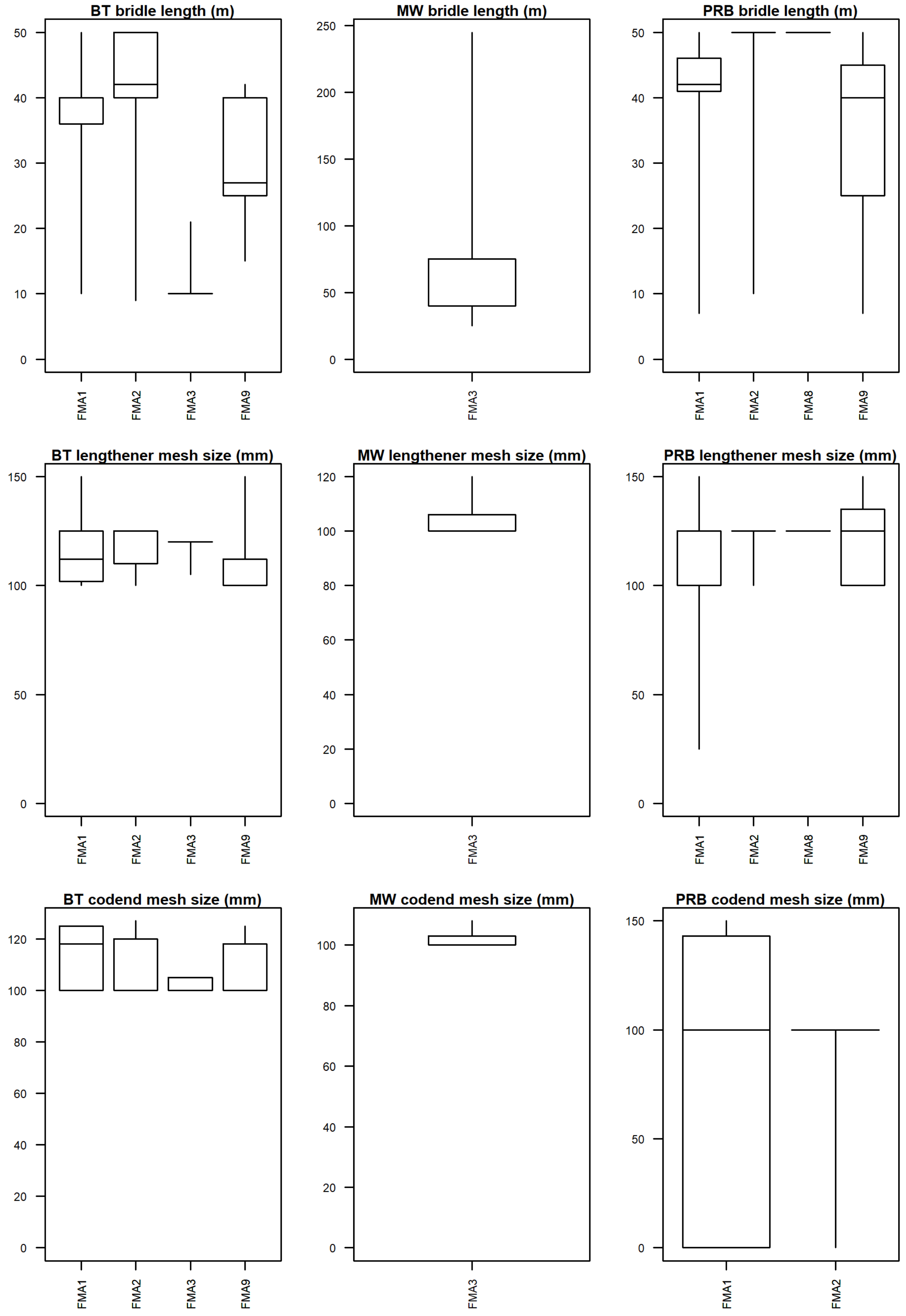
2016–17



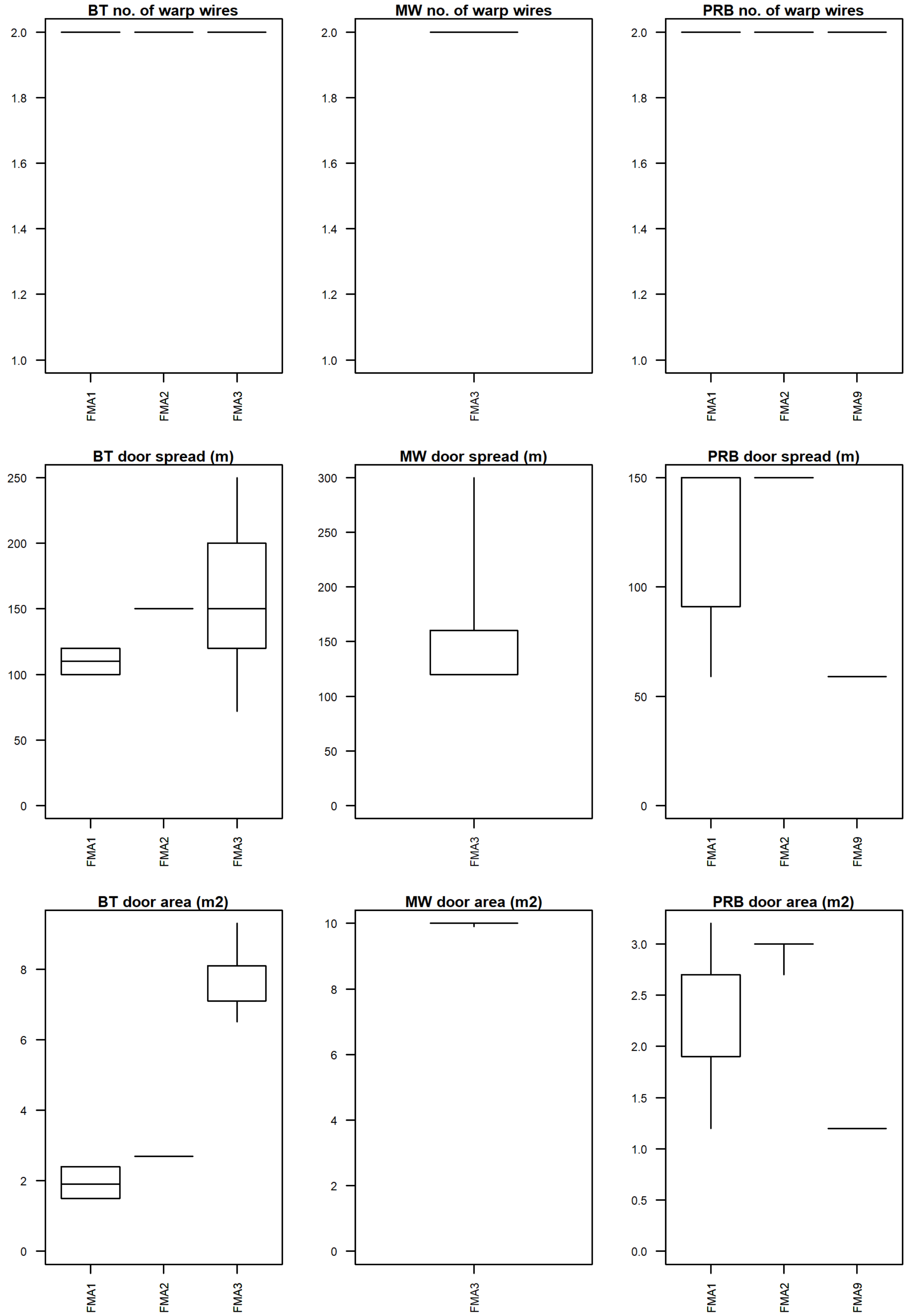
BT no. of warp wires
MW no. of warp wires
PRB no. of warp wires
2.0
1.8
1.6
1.4
1.2
1.0
FMA1
FMA2
FMA3
FMA8
FMA9
BT door spread (m)
MW door spread (m)
PRB door spread (m)
350
300
250
200
150
100
50
0
BT door area (m2)
MW door area (m2)
PRB door area (m2)
10
8
6
4
2
3.0
2.5
1.5
0.5
0.0

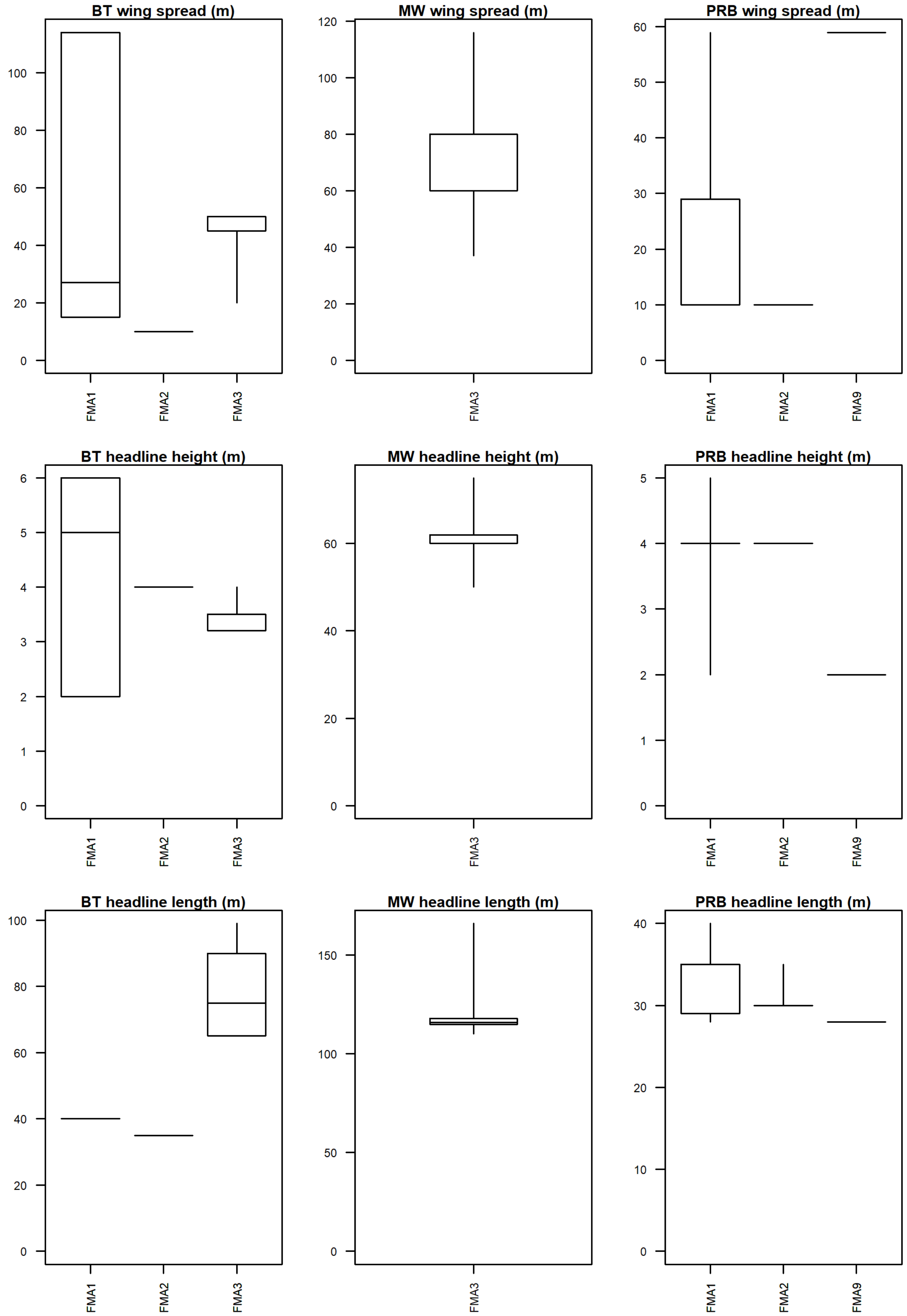

BT wing spread (m)
MW wing spread (m)
PRB wing spread (m)
BT headline height (m)
MW headline height (m)
PRB headline height (m)
BT headline length (m)
MW headline length (m)
PRB headline length (m)
FMA1
FMA2
FMA3
FMA8
FMA9

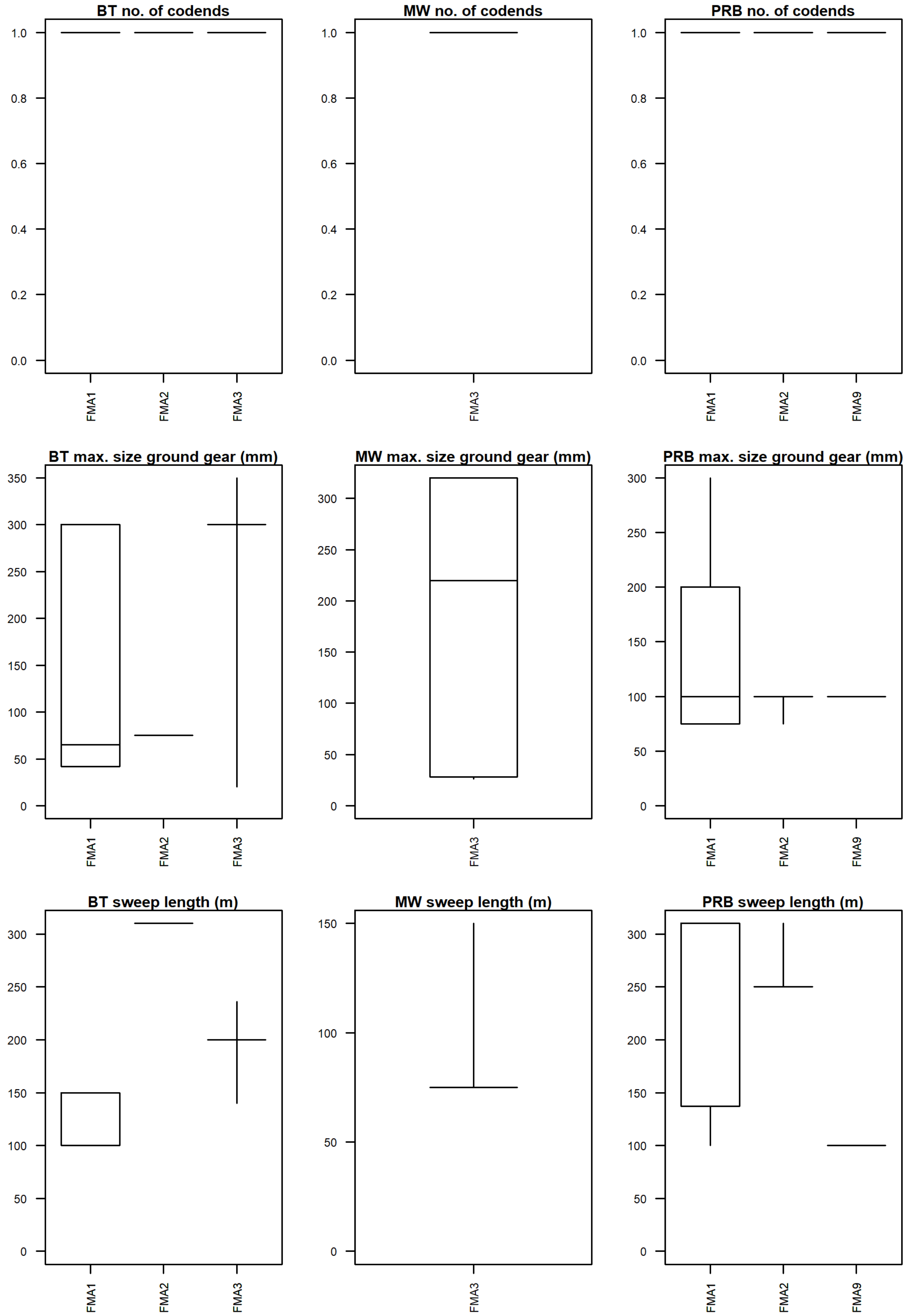

BT no. of codends
MW no. of codends
PRB no. of codends
BT max. size ground gear (mm)
MW max. size ground gear (mm)
PRB max. size ground gear (mm)
BT sweep length (m)
MW sweep length (m)
PRB sweep length (m)
FMA1
FMA2
FMA3
FMA8
FMA9

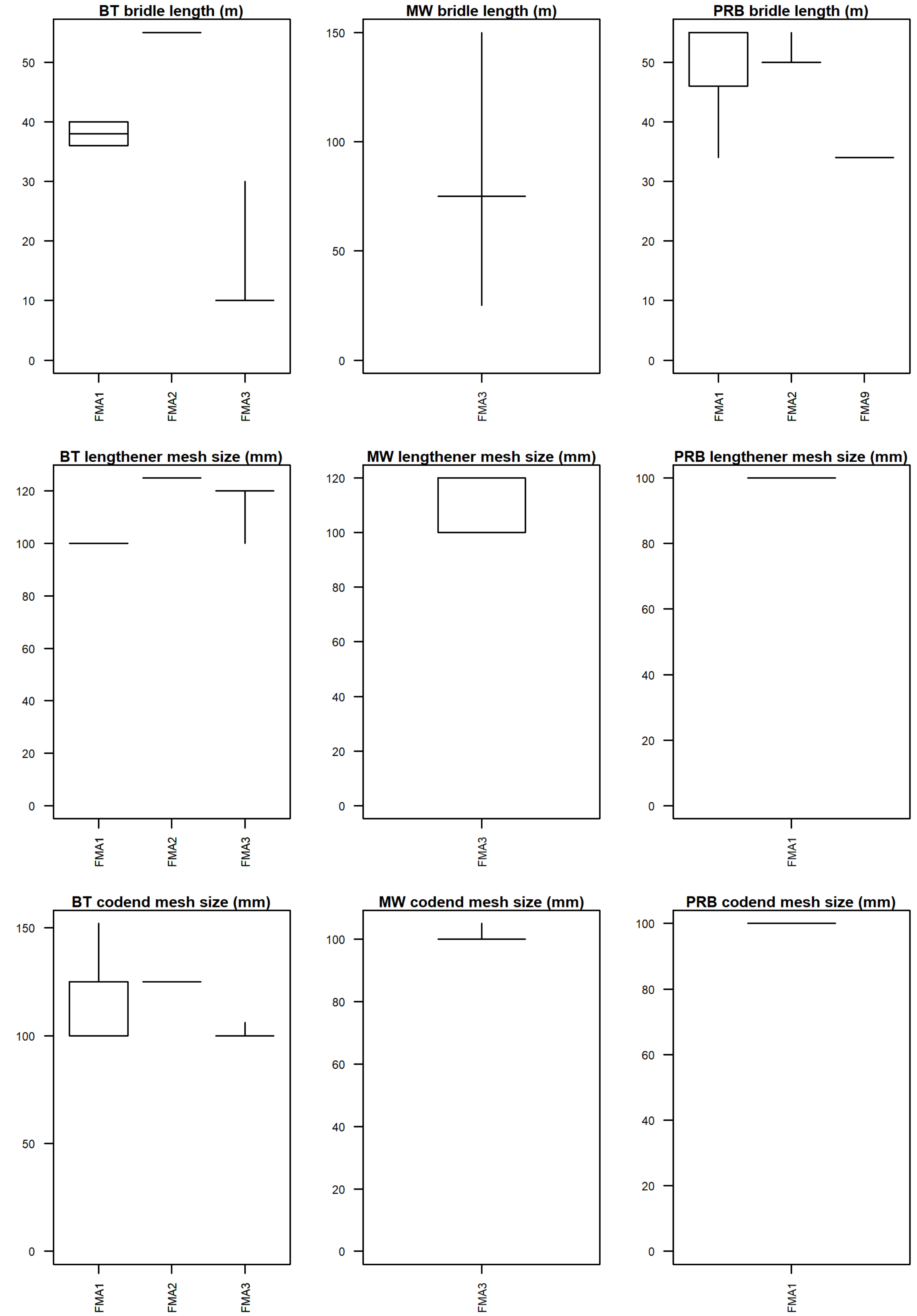

BT bridle length (m)
0
10
20
30
40
50
FMA1
FMA2
FMA3
FMA9
MW bridle length (m)
0
50
100
150
200
250
FMA3
PRB bridle length (m)
0
10
20
30
40
50
FMA1
FMA2
FMA8
FMA9
BT lengthener mesh size (mm)
0
50
100
150
FMA1
FMA2
FMA3
FMA9
MW lengthener mesh size (mm)
0
20
40
60
80
100
120
FMA3
PRB lengthener mesh size (mm)
0
50
100
150
FMA1
FMA2
FMA8
FMA9
BT codend mesh size (mm)
0
20
40
60
80
100
120
FMA1
FMA2
FMA3
FMA9
MW codend mesh size (mm)
0
20
40
60
80
100
FMA3
PRB codend mesh size (mm)
0
50
100
150
FMA1
FMA2

2017–18


BT no. of warp wires
MW no. of warp wires
PRB no. of warp wires
BT door spread (m)
MW door spread (m)
PRB door spread (m)
BT door area (m2)
MW door area (m2)
PRB door area (m2)
FMA1
FMA2
FMA3
FMA9


BT wing spread (m)
0
20
40
60
80
100
FMA1
FMA2
FMA3
MW wing spread (m)
0
20
40
60
80
100
120
FMA3
PRB wing spread (m)
0
10
20
30
40
50
60
FMA1
FMA2
FMA9
BT headline height (m)
0
1
2
3
4
5
6
FMA1
FMA2
FMA3
MW headline height (m)
0
20
40
60
FMA3
PRB headline height (m)
0
1
2
3
4
5
FMA1
FMA2
FMA9
BT headline length (m)
0
20
40
60
80
100
FMA1
FMA2
FMA3
MW headline length (m)
0
50
100
150
FMA3
PRB headline length (m)
0
10
20
30
40
FMA1
FMA2
FMA9


BT no. of codends
MW no. of codends
PRB no. of codends
BT max. size ground gear (mm)
MW max. size ground gear (mm)
PRB max. size ground gear (mm)
BT sweep length (m)
MW sweep length (m)
PRB sweep length (m)
FMA1
FMA2
FMA3
FMA9


BT bridle length (m)
0 10 20 30 40 50
FMA1 FMA2 FMA3
MW bridle length (m)
0 50 100 150
FMA3
PRB bridle length (m)
0 10 20 30 40 50
FMA1 FMA2 FMA9
BT lengthener mesh size (mm)
0 20 40 60 80 100 120
FMA1 FMA2 FMA3
MW lengthener mesh size (mm)
0 20 40 60 80 100 120
FMA3
PRB lengthener mesh size (mm)
0 20 40 60 80 100
FMA1
BT codend mesh size (mm)
0 50 100 150
FMA1 FMA2 FMA3
MW codend mesh size (mm)
0 20 40 60 80 100
FMA3
PRB codend mesh size (mm)
0 20 40 60 80 100
FMA1

APPENDIX 6: GEAR PARAMETER SUMMARIES BY TARGET SPECIES FOR FMA 1 FROM OBSERVER DATA.

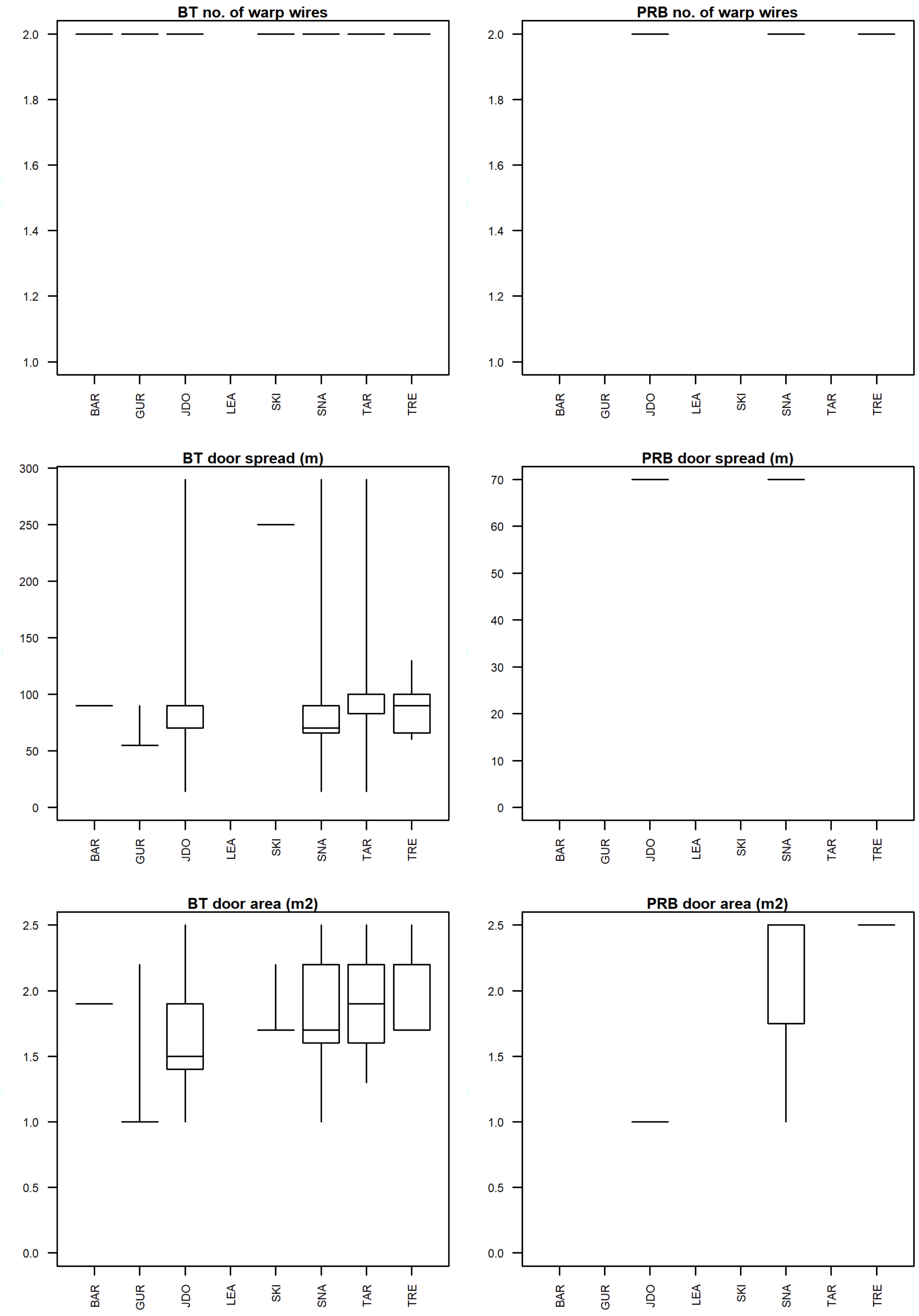


Figure 6-1: Box plots of number of warp wires, door spread, and door area by target species for FMA 1 for the 2013–14 fishing year from observer data. Target species codes are defined in Table 1.

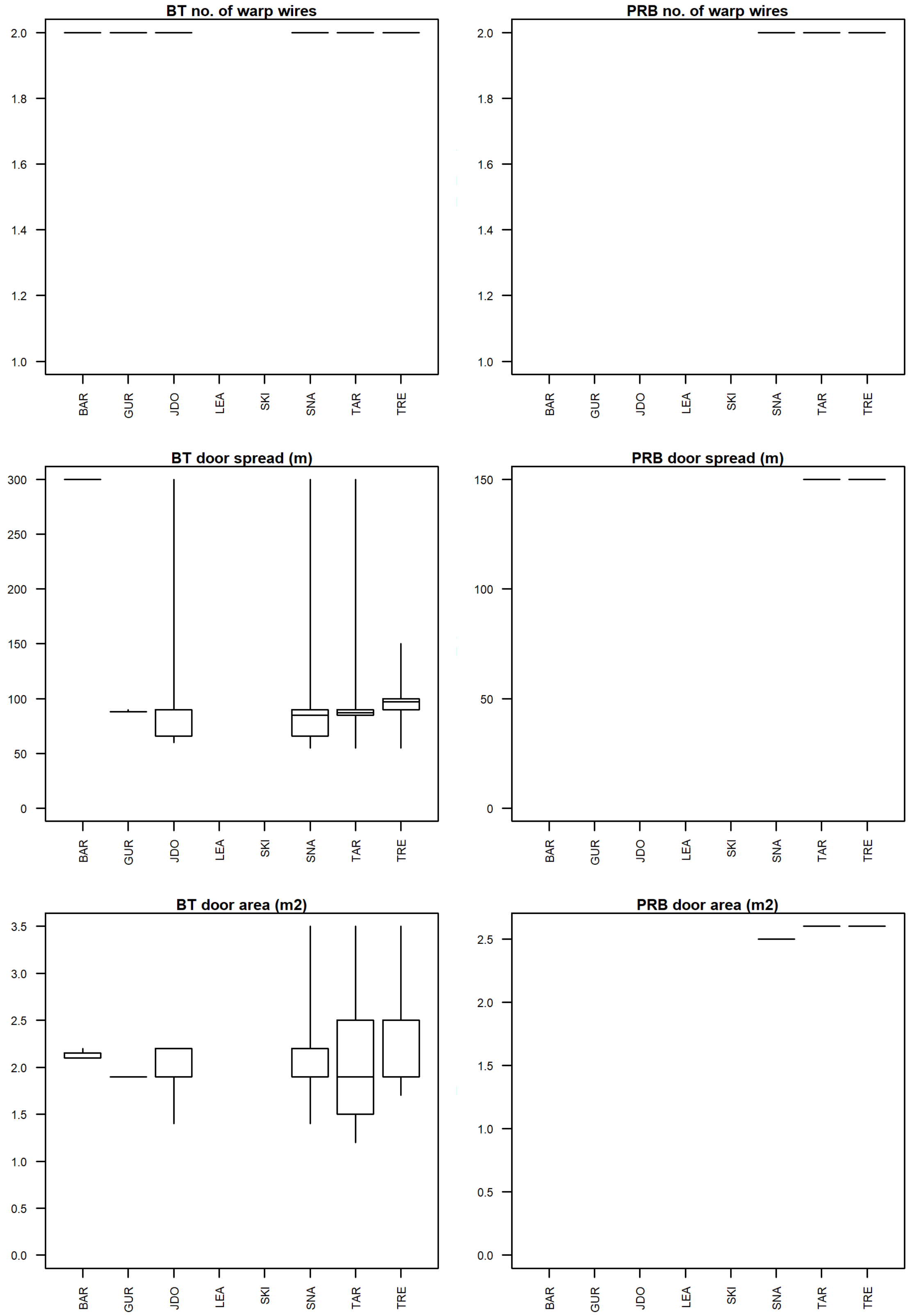


Figure 6-2: Box plots of number of warp wires, door spread, and door area by target species for FMA 1 for the 2014–15 fishing year from observer data. Target species codes are defined in Table 1.

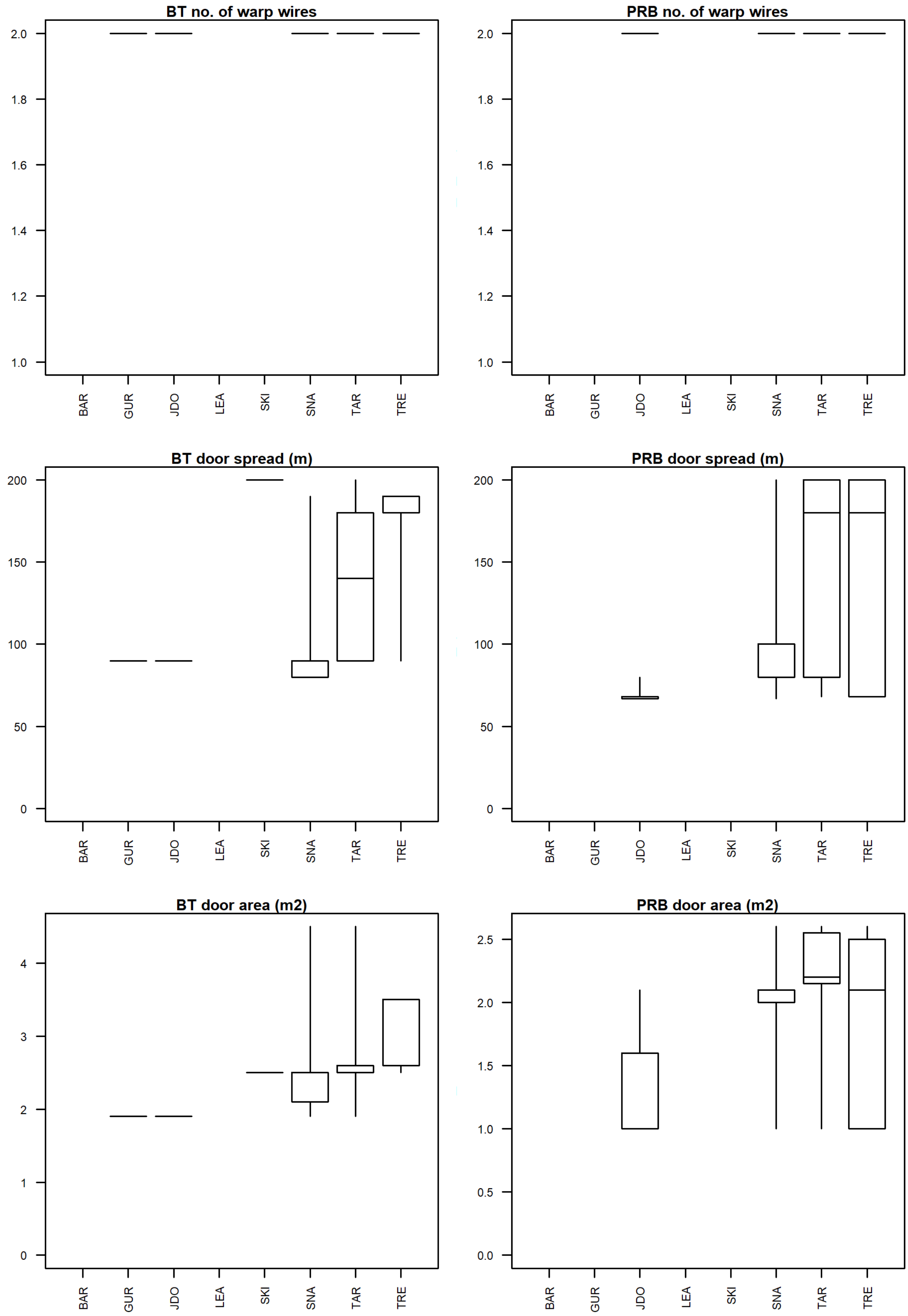


Figure 6-3: Box plots of number of warp wires, door spread, and door area by target species for FMA 1 for the 2015–16 fishing year from observer data. Target species codes are defined in Table 1.

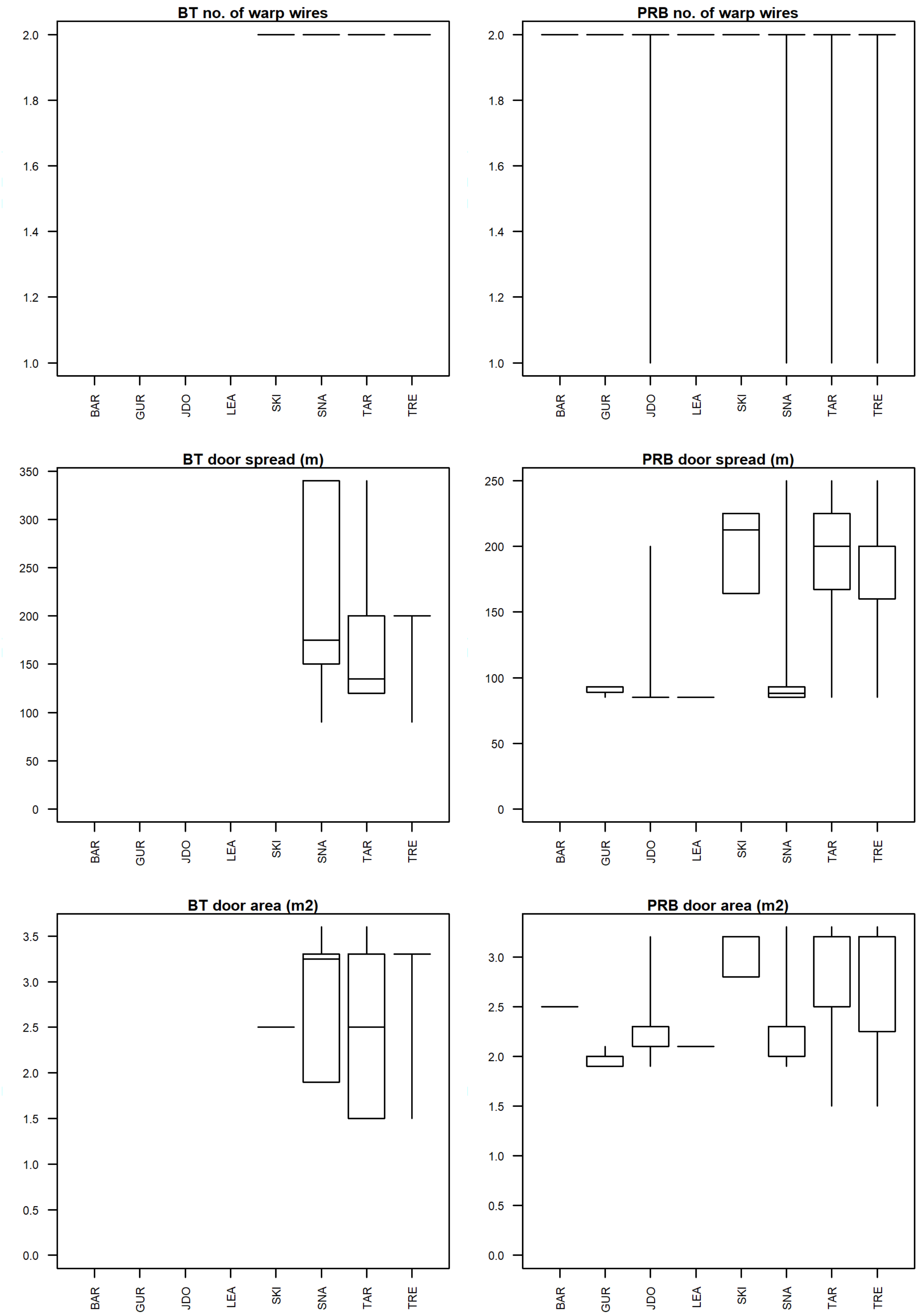


Figure 6-4: Box plots of number of warp wires, door spread, and door area by target species for FMA 1 for the 2016–17 fishing year from observer data. Target species codes are defined in Table 1.

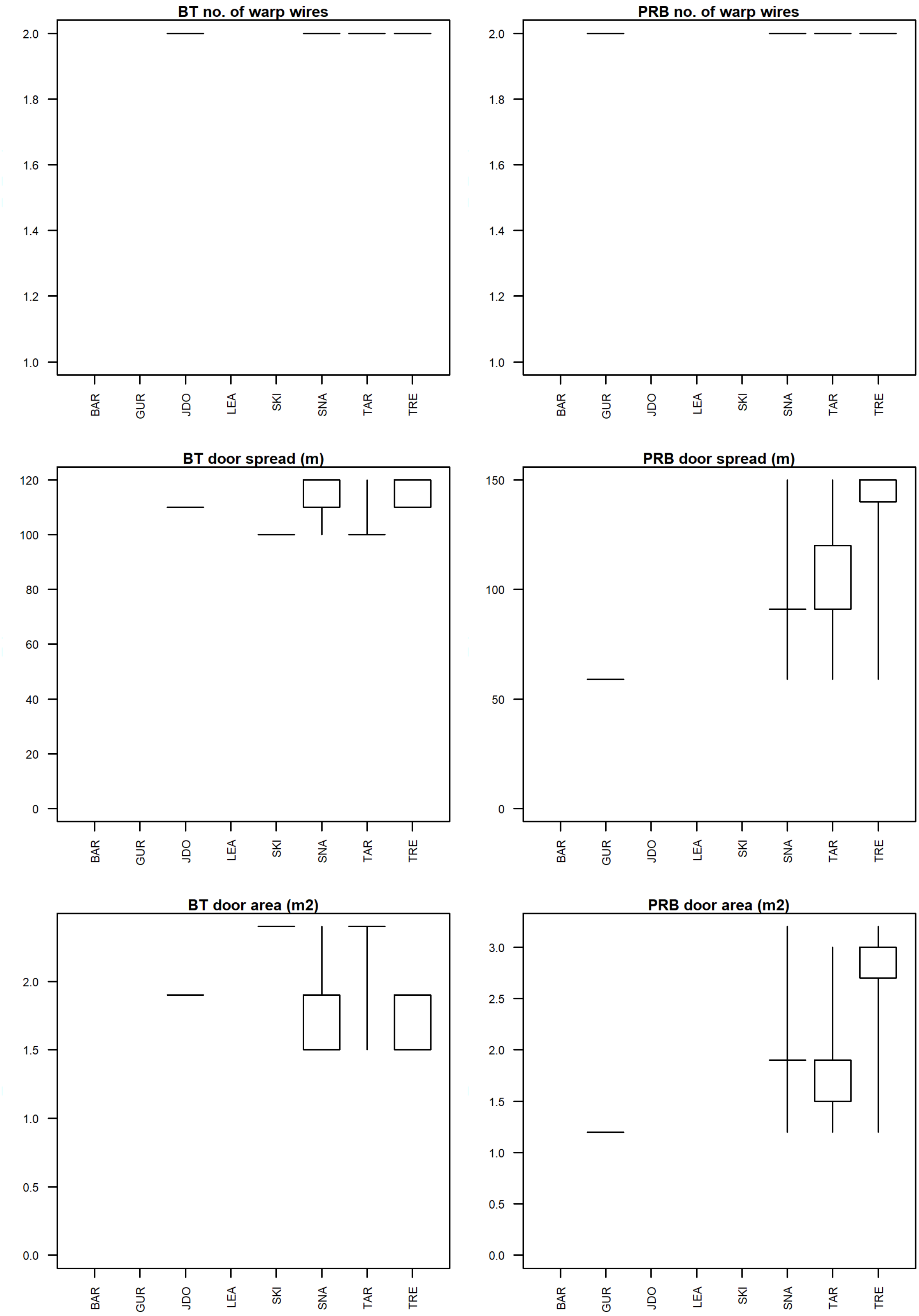


Figure 6-5: Box plots of number of warp wires, door spread, and door area by target species for FMA 1 for the 2017–18 fishing year from observer data. Target species codes are defined in Table 1.

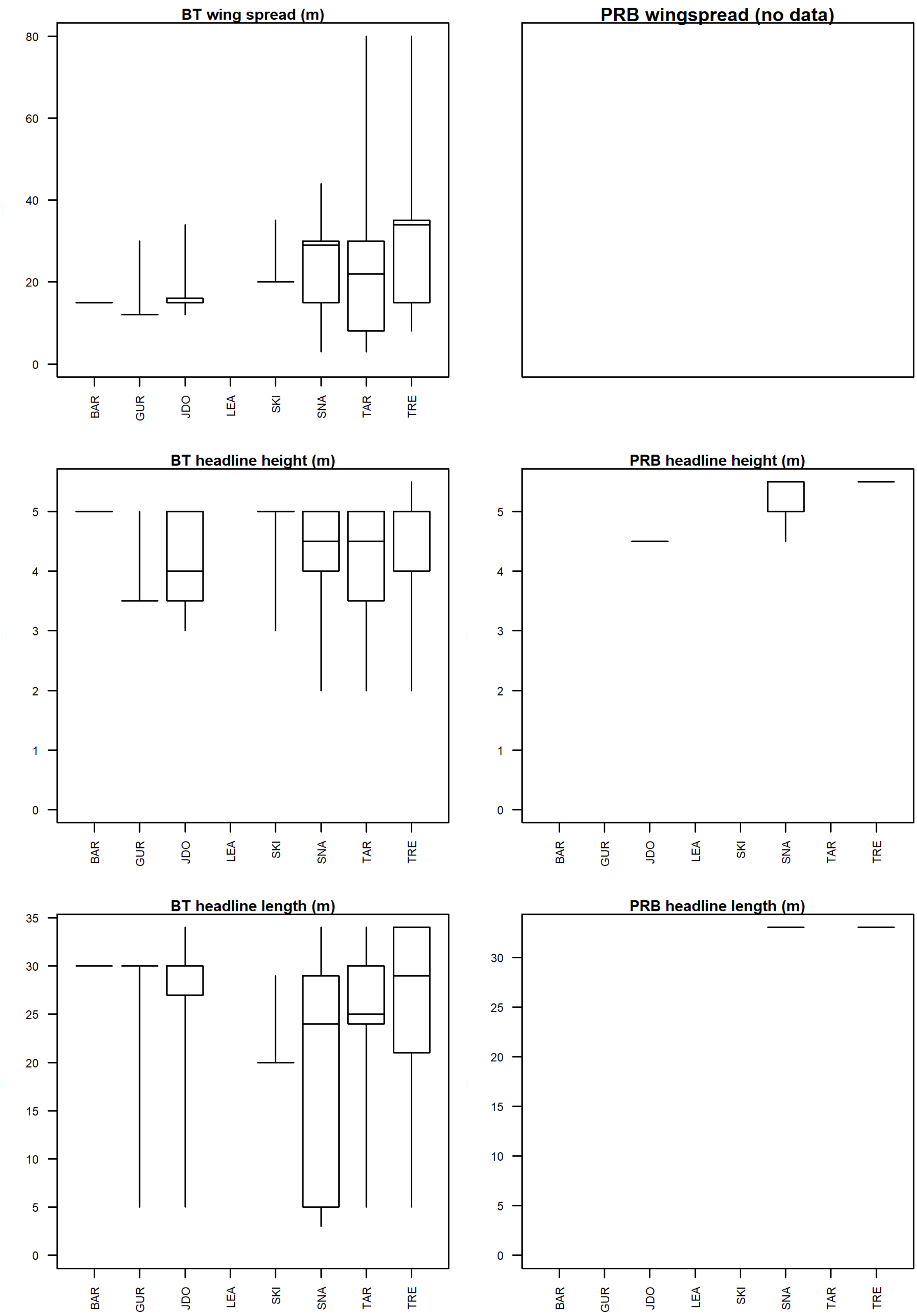


Figure 6-6: Box plots of wing spread, headline height, and headline length by target species for FMA 1 for the 2013–14 fishing year from observer data. Target species codes are defined in Table 1.

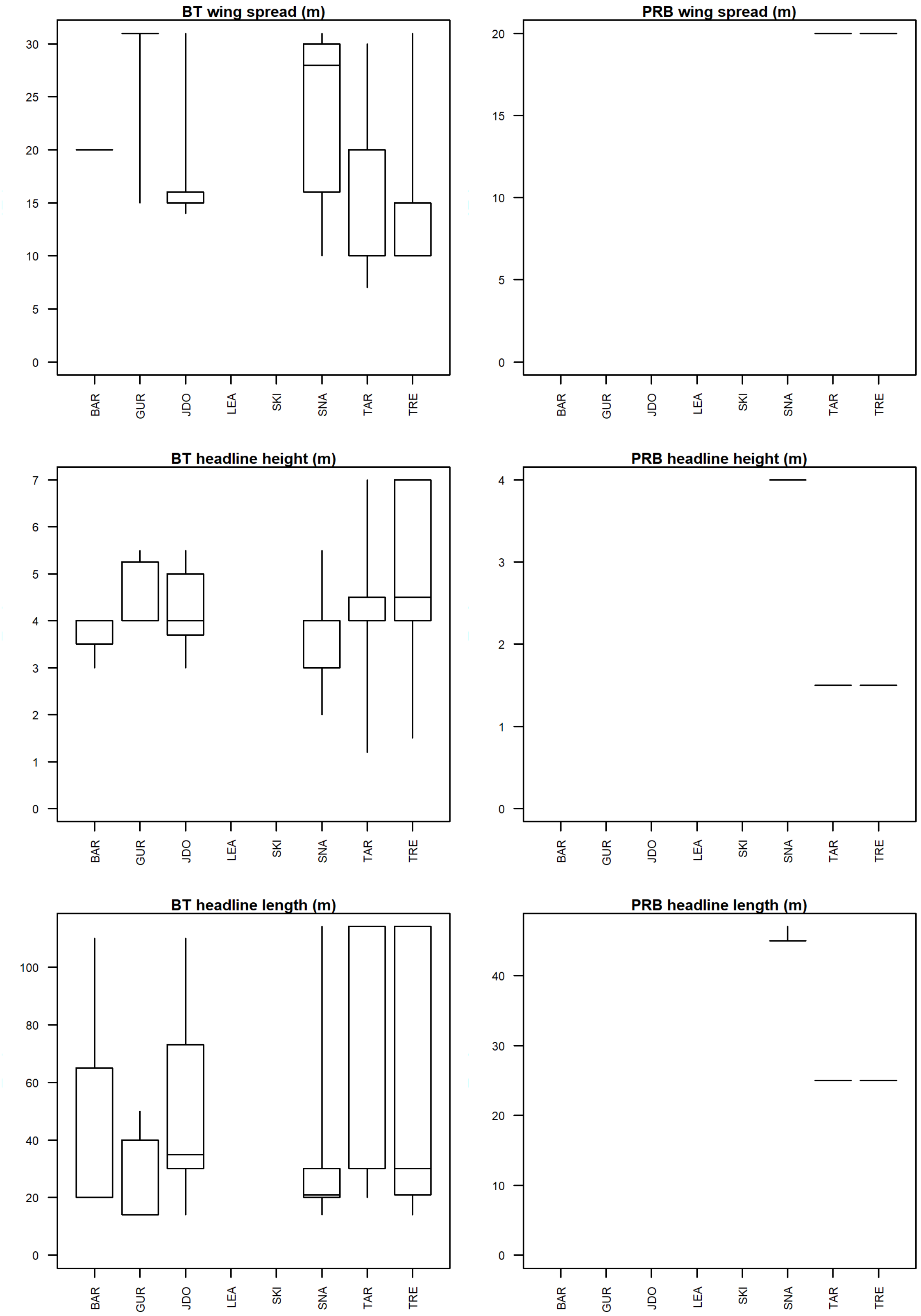


Figure 6-7: Box plots of wing spread, headline height, and headline length by target species for FMA 1 for the 2014–15 fishing year from observer data. Target species codes are defined in Table 1.

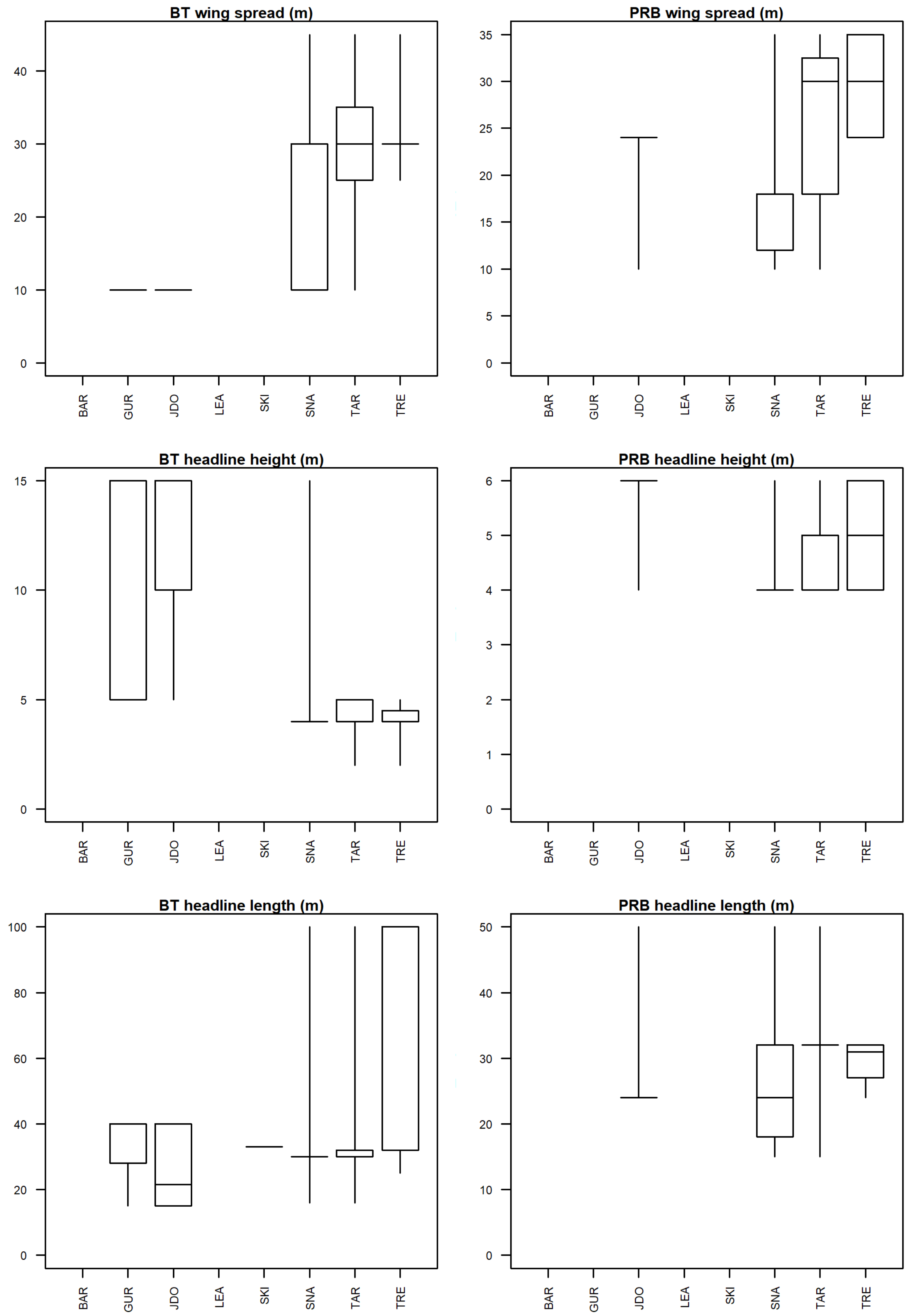


Figure 6-8: Box plots of wing spread, headline height, and headline length by target species for FMA 1 for the 2015–16 fishing year from observer data. Target species codes are defined in Table 1.

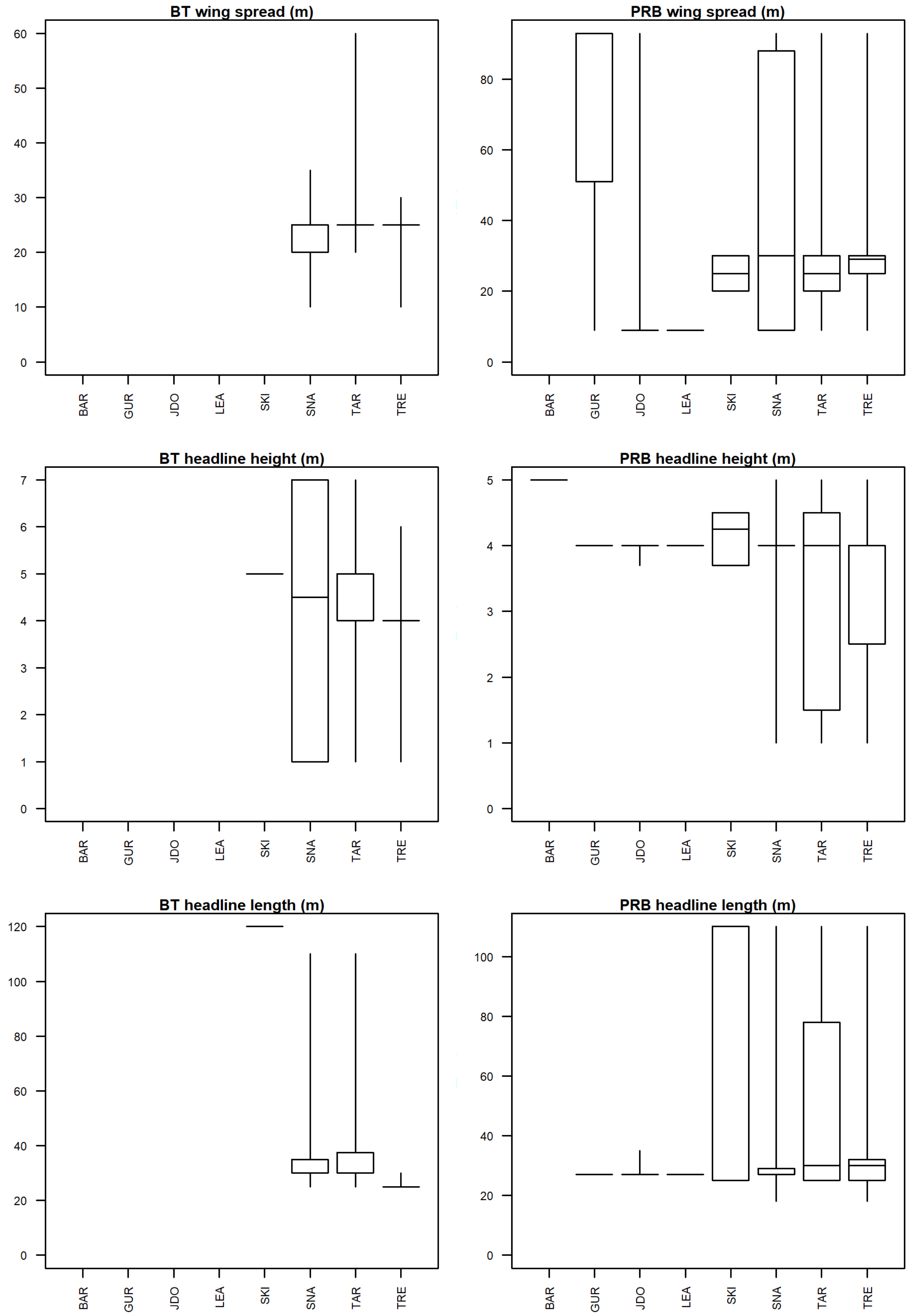


Figure 6-9: Box plots of wing spread, headline height, and headline length by target species for FMA 1 for the 2016–17 fishing year from observer data. Target species codes are defined in Table 1.

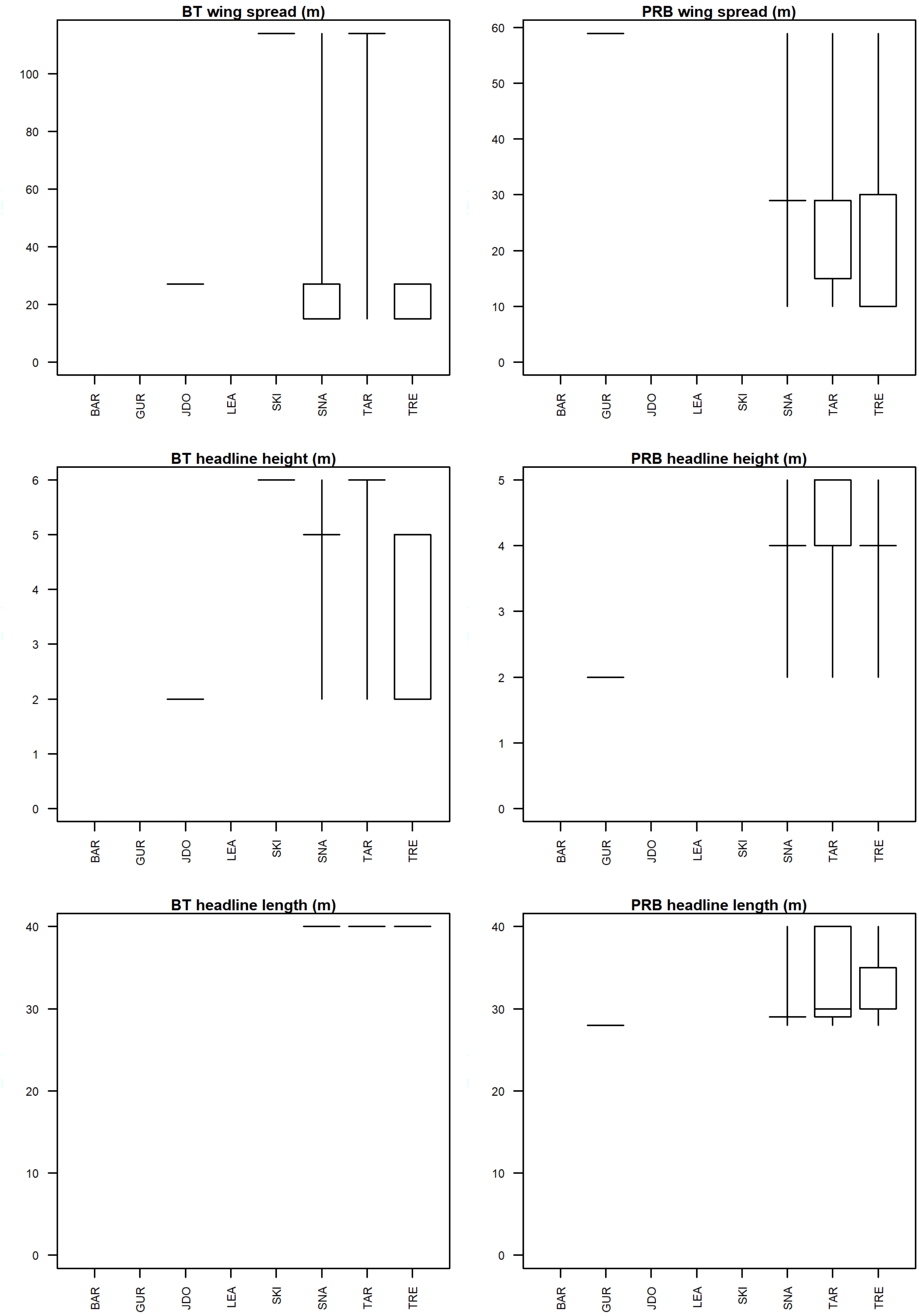


Figure 6-10: Box plots of wing spread, headline height, and headline length by target species for FMA 1 for the 2017–18 fishing year from observer data. Target species codes are defined in Table 1.

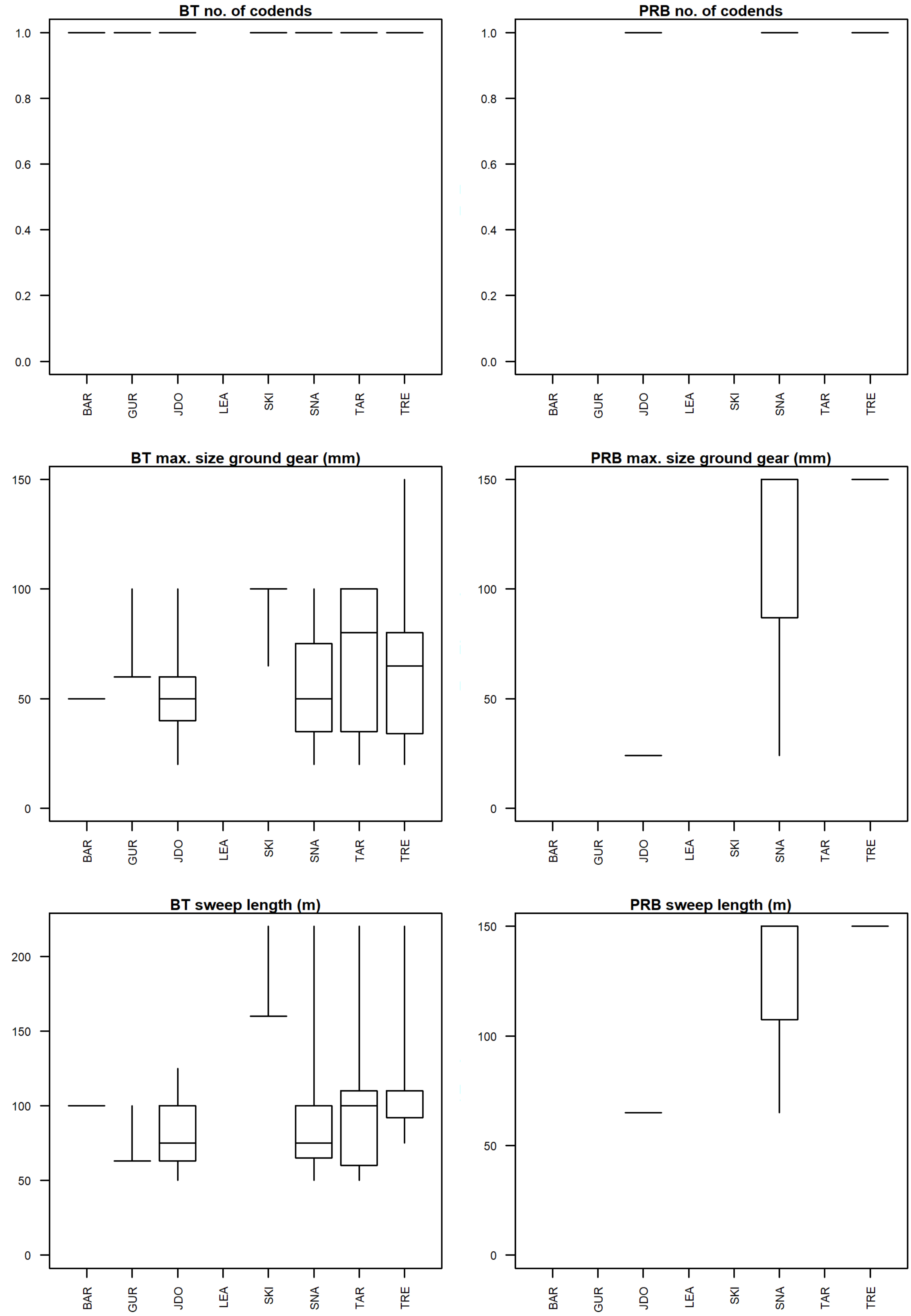


Figure 6-11: Box plots of number of codends, maximum size of ground gear, and sweep length by target species for FMA 1 for the 2013–14 fishing year from observer data. Target species codes are defined in Table 1.

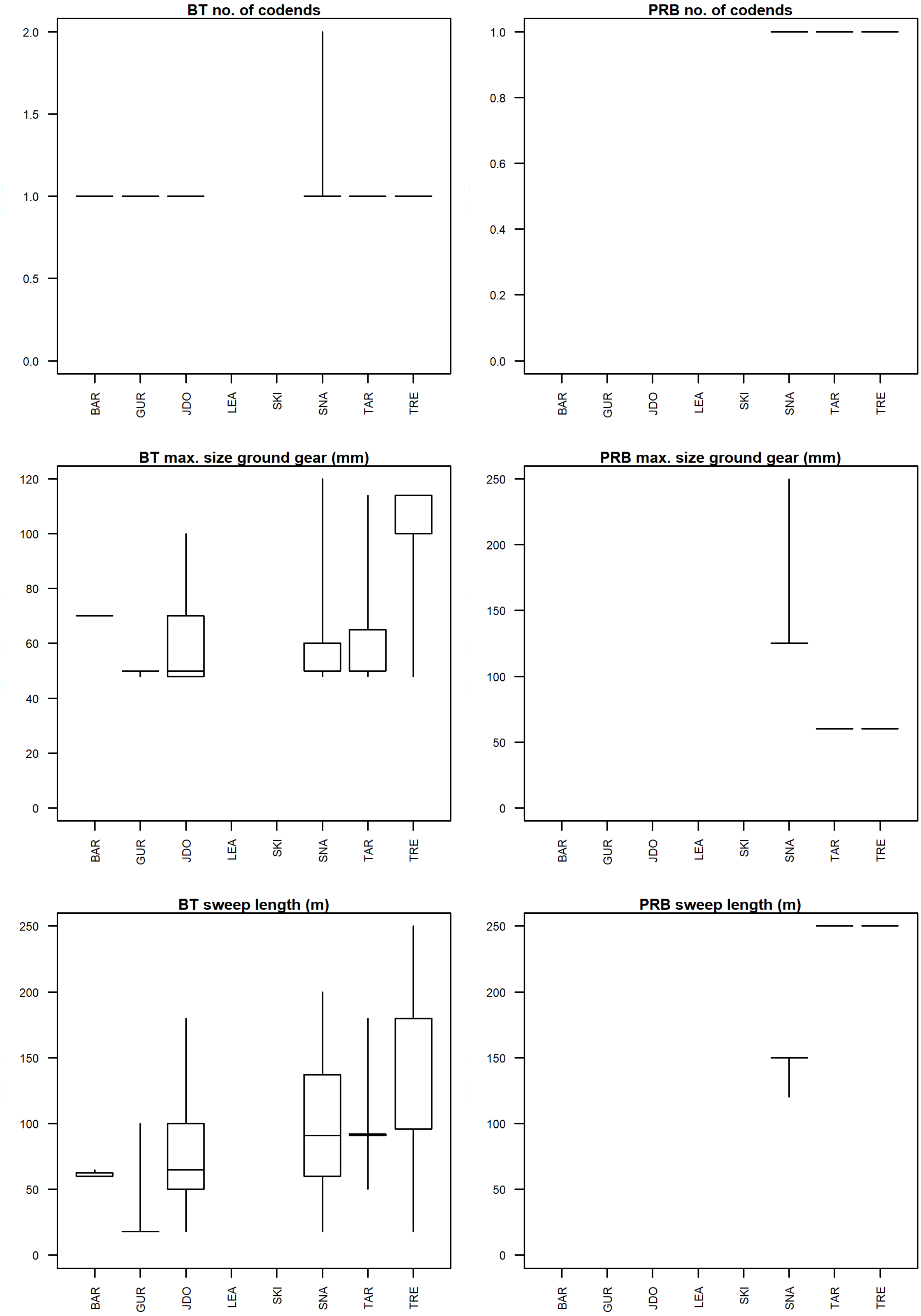


Figure 6-12: Box plots of number of codends, maximum size of ground gear, and sweep length by target species for FMA 1 for the 2014–15 fishing year from observer data. Target species codes are defined in Table 1.

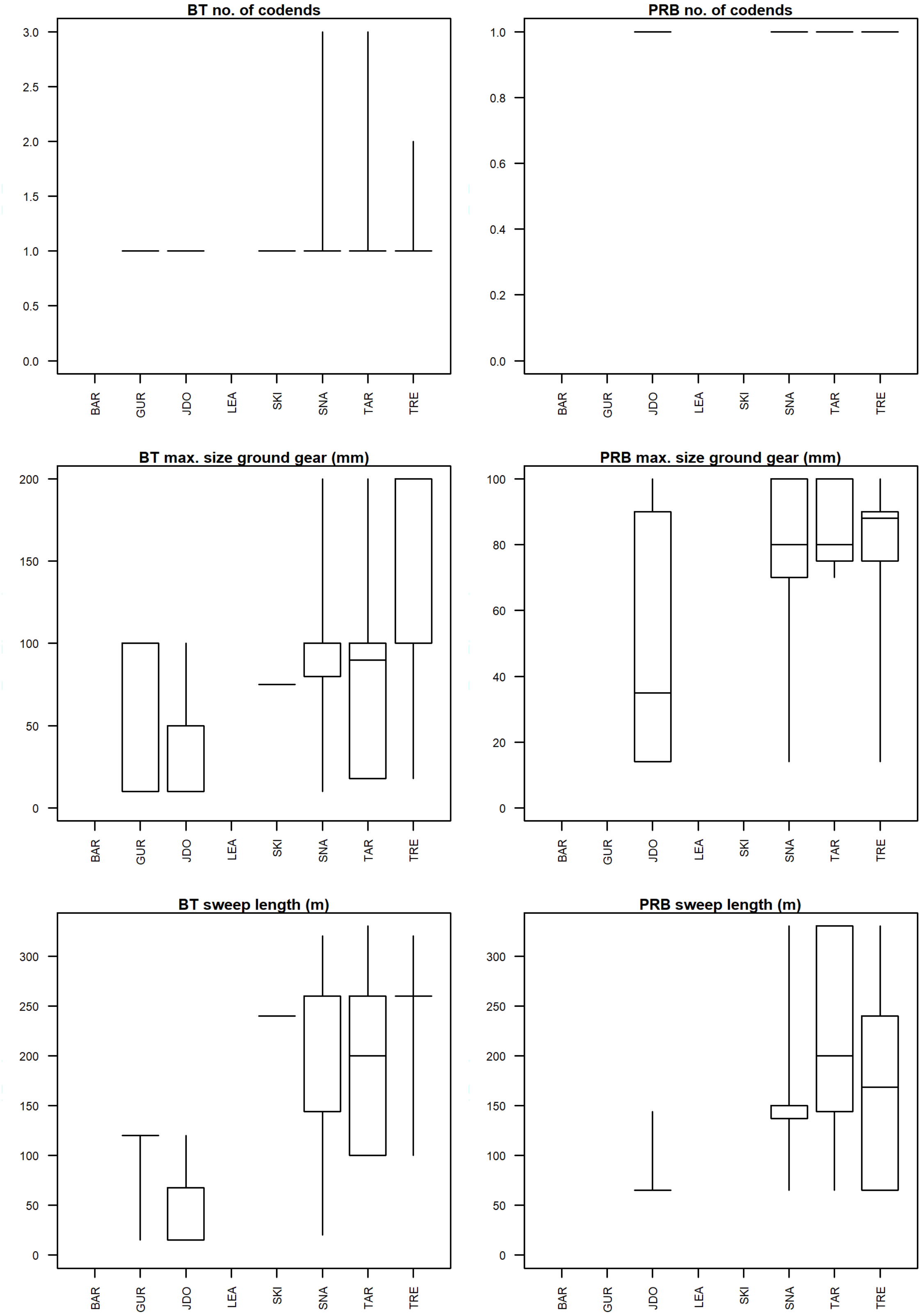


Figure 6-13: Box plots of number of codends, maximum size of ground gear, and sweep length by target species for FMA 1 for the 2015–16 fishing year from observer data. Target species codes are defined in Table 1.

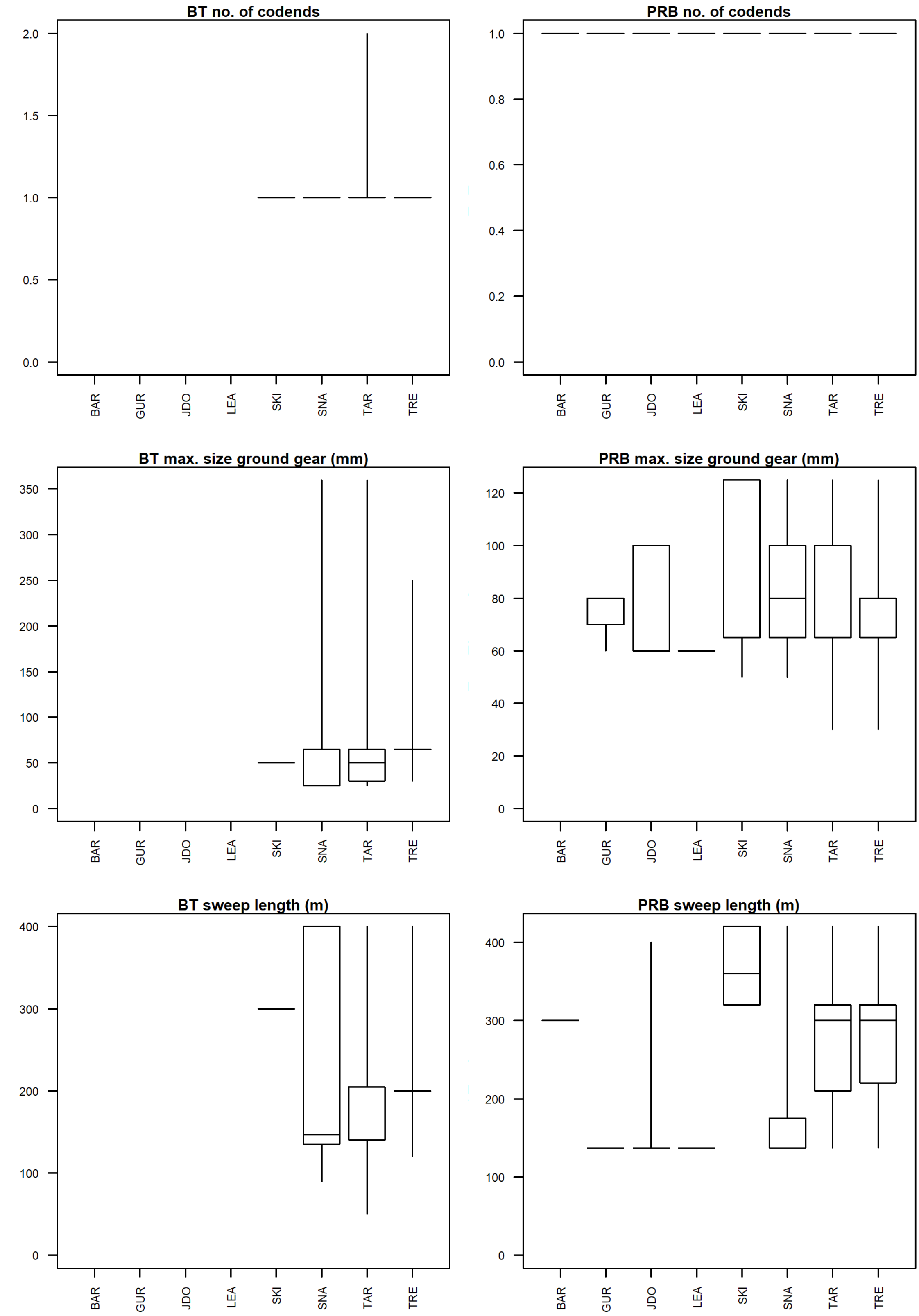


Figure 6-14: Box plots of number of codends, maximum size of ground gear, and sweep length by target species for FMA 1 for the 2016–17 fishing year from observer data. Target species codes are defined in Table 1.

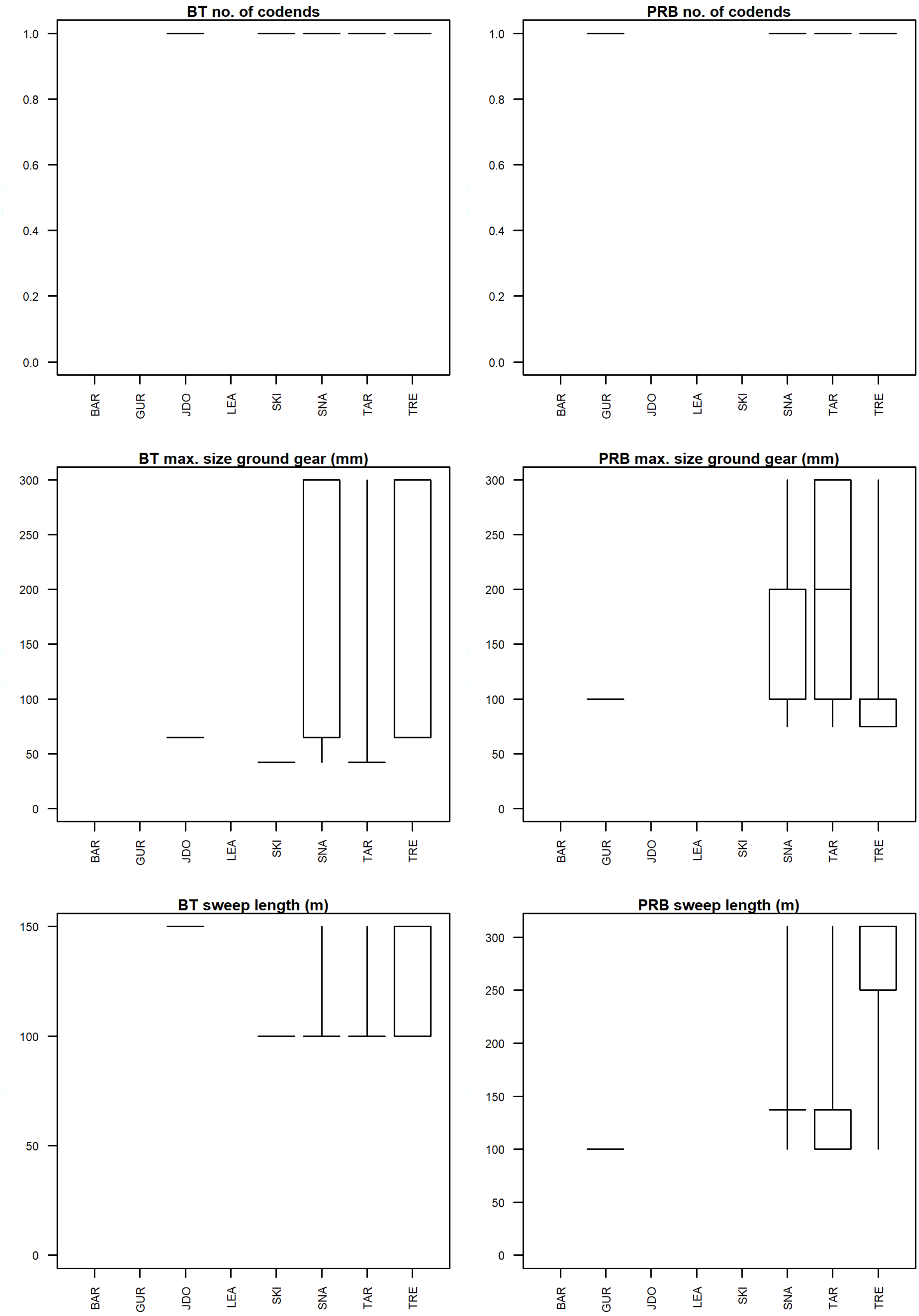


Figure 6-15: Box plots of number of codends, maximum size of ground gear, and sweep length by target species for FMA 1 for the 2017–18 fishing year from observer data. Target species codes are defined in Table 1.

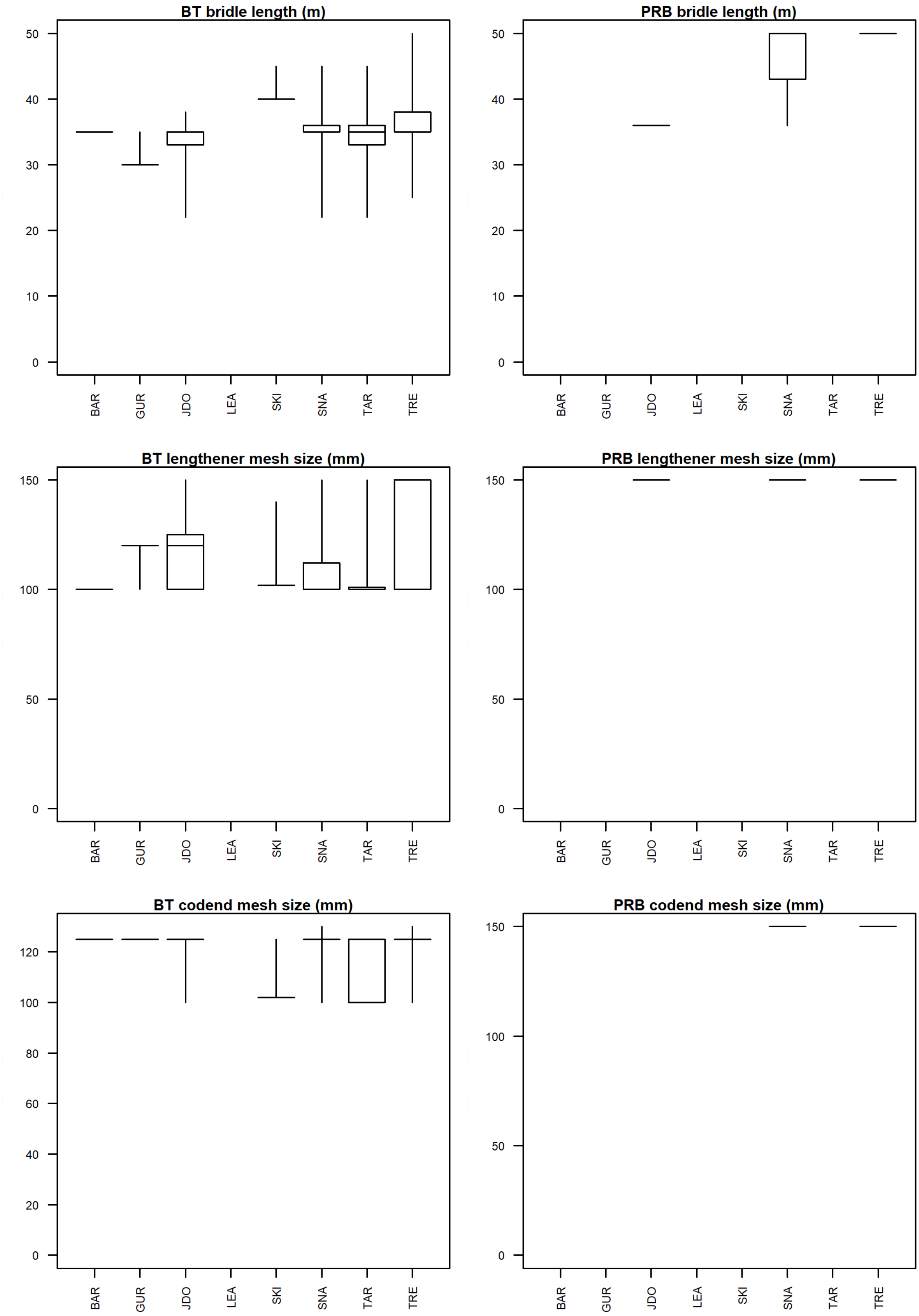


Figure 6-16: Box plots of bridle length, lengthener mesh, and codend mesh by target species for FMA 1 for the 2013–14 fishing year from observer data. Target species codes are defined in Table 1.

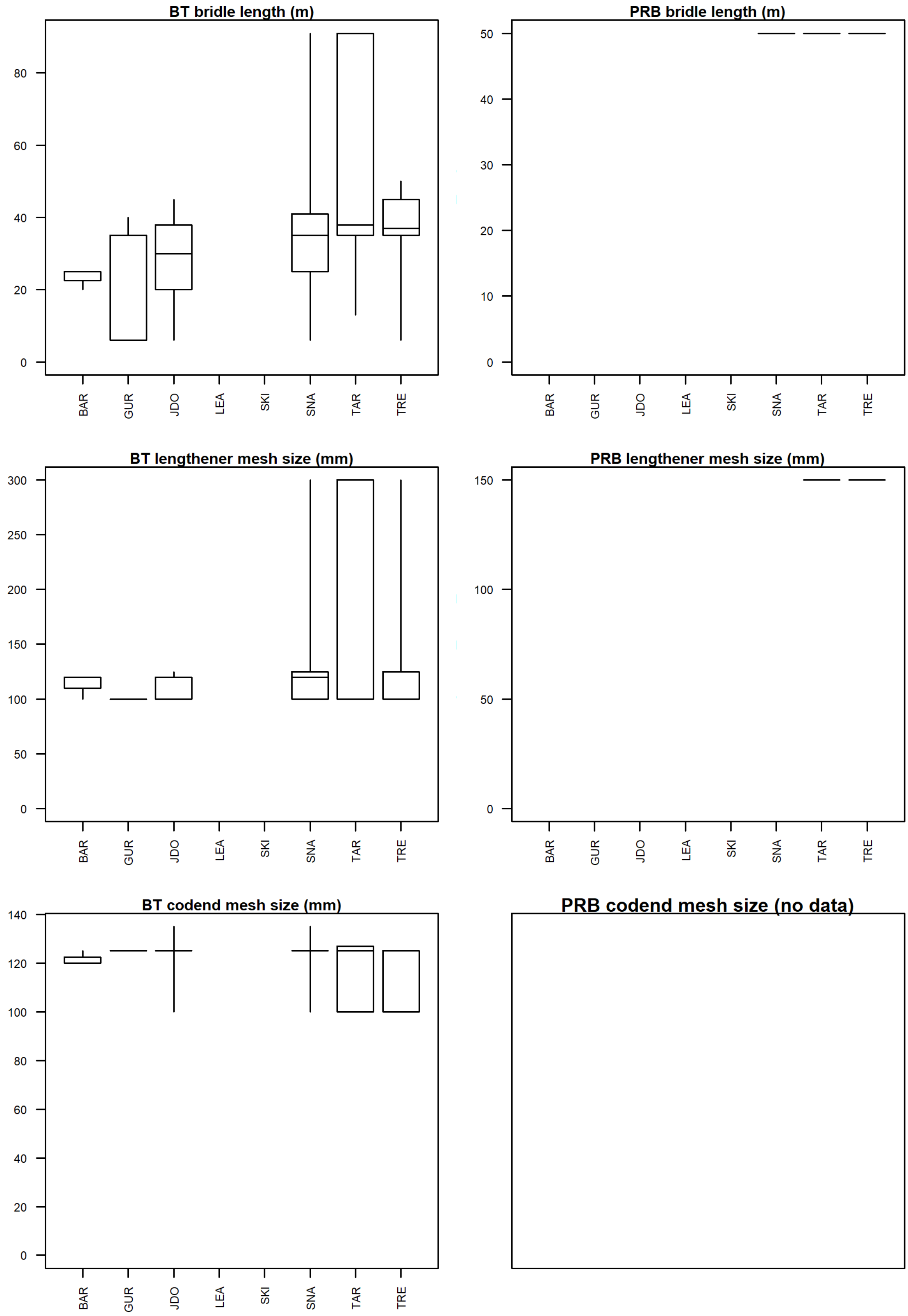


Figure 6-17: Box plots of bridle length, lengthener mesh, and codend mesh by target species for FMA 1 for the 2014–15 fishing year from observer data. Target species codes are defined in Table 1.

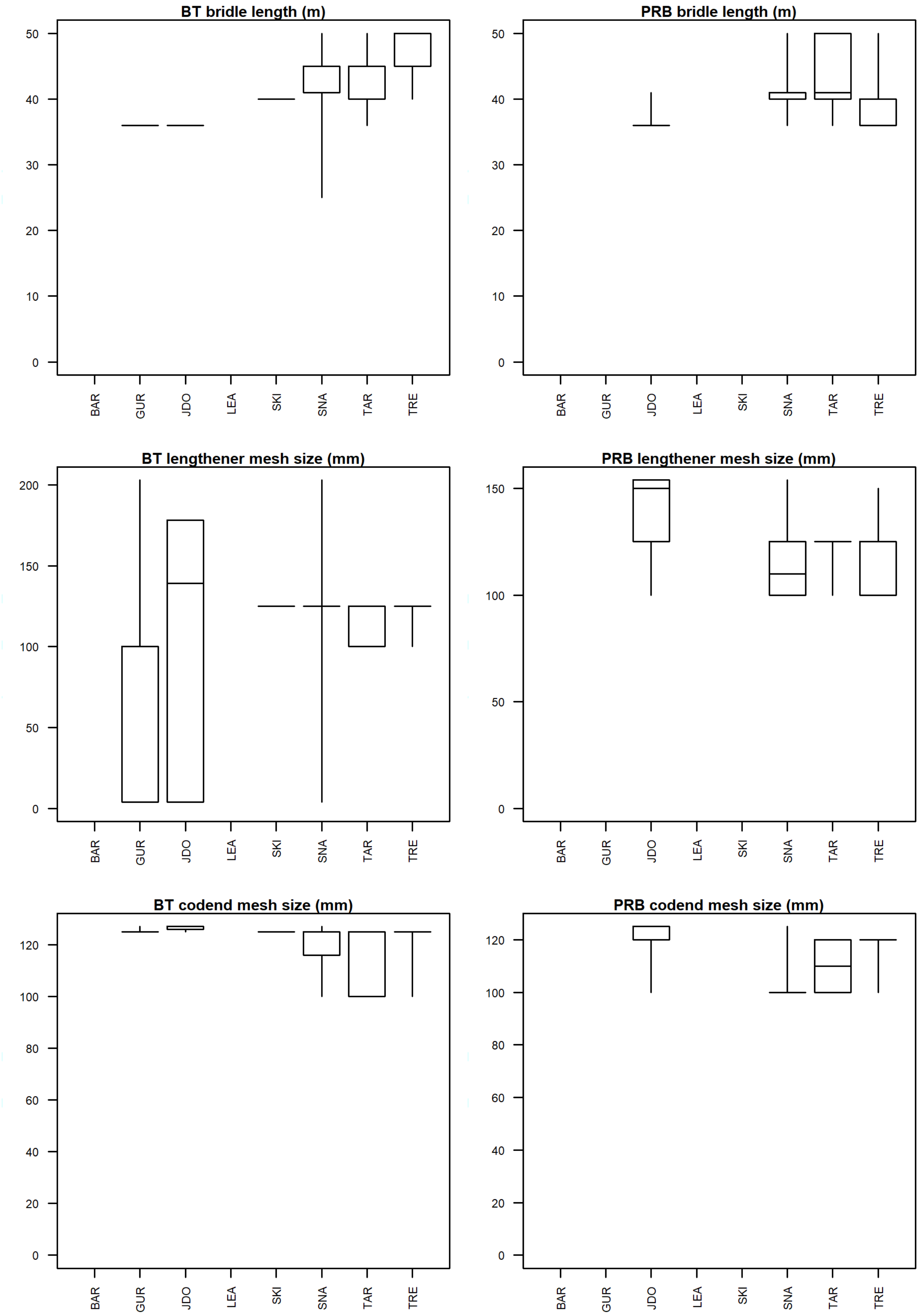


Figure 6-18: Box plots of bridle length, lengthener mesh, and codend mesh by target species for FMA 1 for the 2015–16 fishing year from observer data. Target species codes are defined in Table 1.

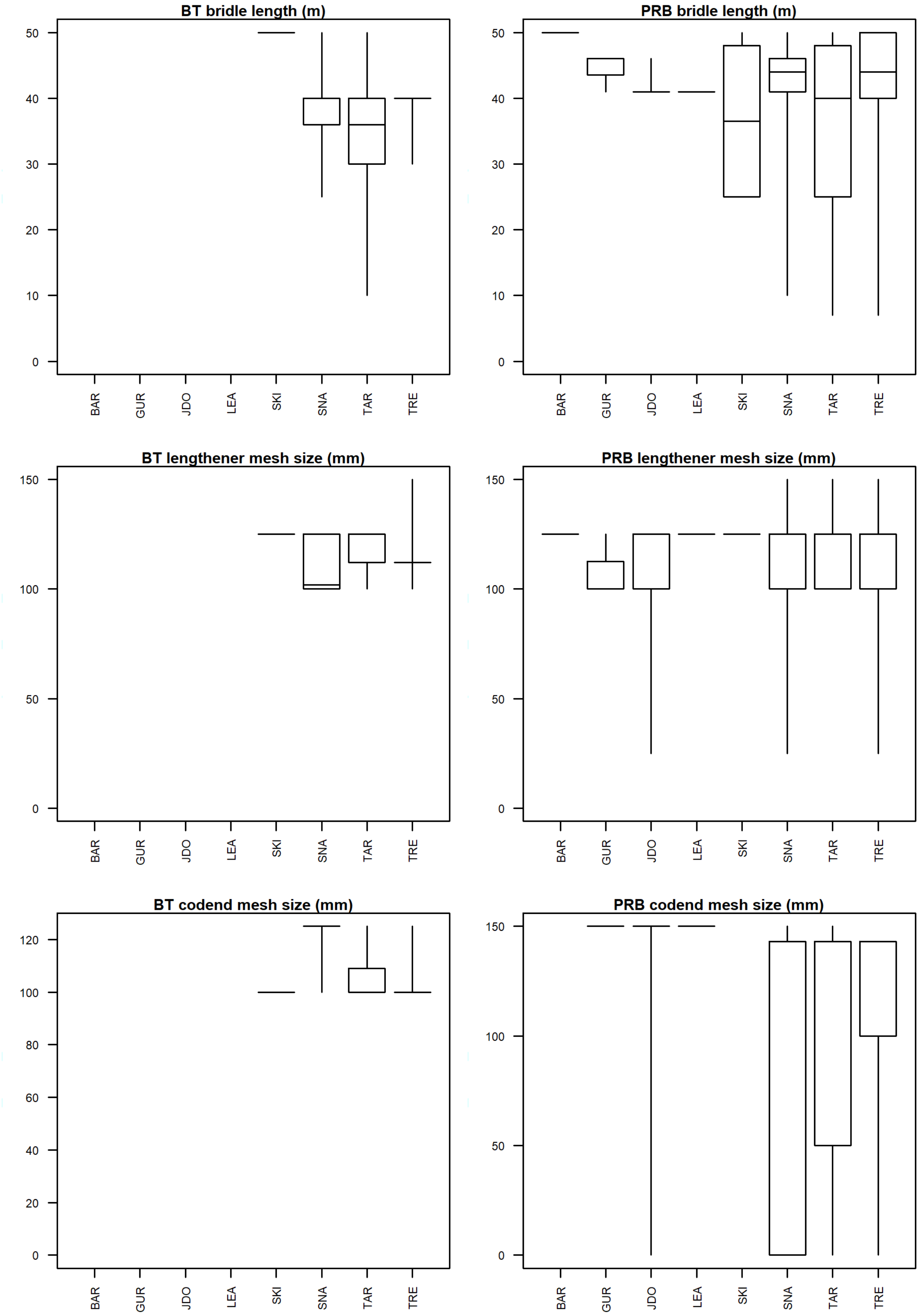


Figure 6-19: Box plots of bridle length, lengthener mesh, and codend mesh by target species for FMA 1 for the 2016–17 fishing year from observer data. Target species codes are defined in Table 1.

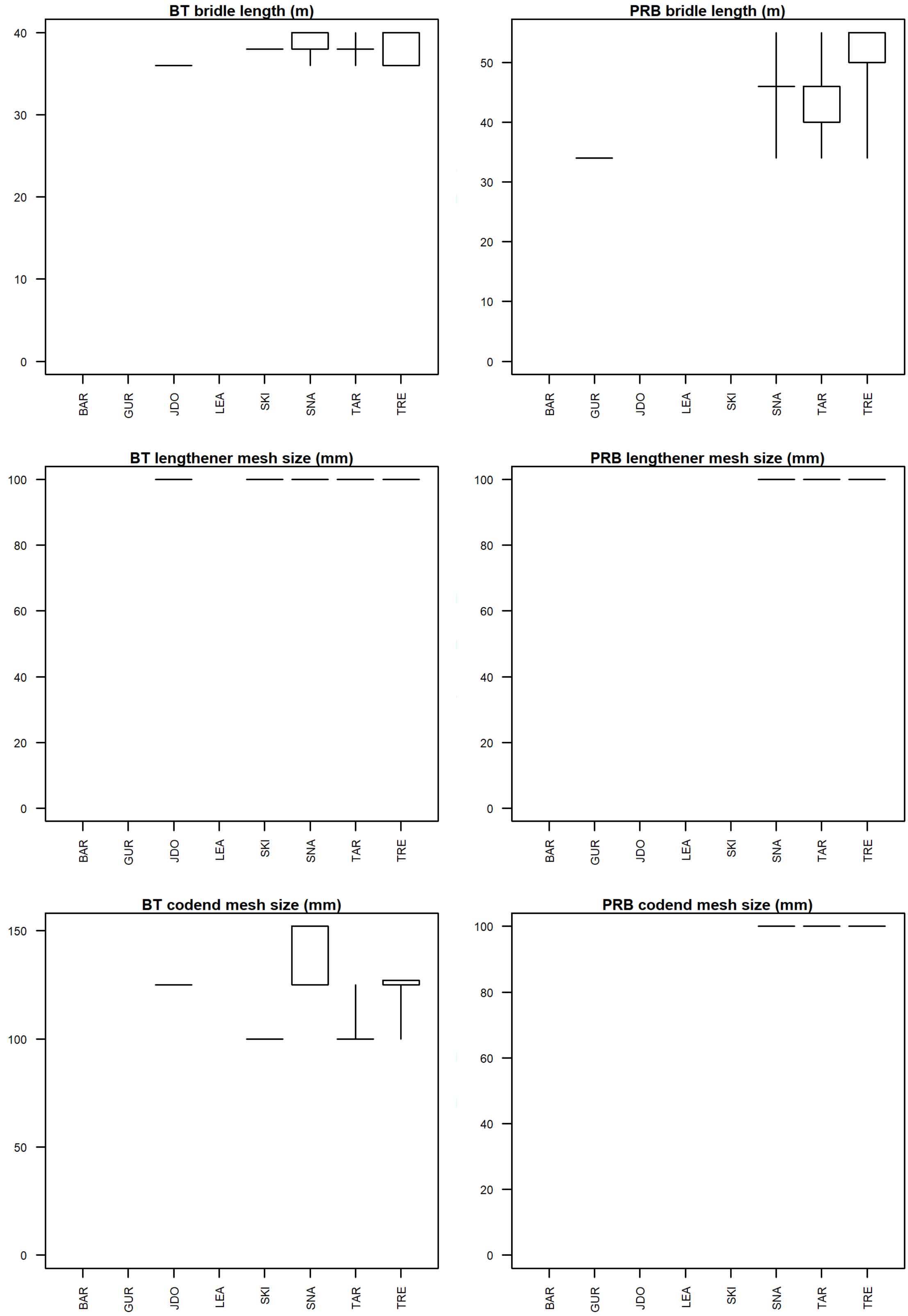


Figure 6-20: Box plots of bridle length, lengthener mesh, and codend mesh by target species for FMA 1 for the 2017–18 fishing year from observer data. Target species codes are defined in Table 1.

APPENDIX 7: WORKSHOP ATTENDANCE LIST

Name	Organisation
Josh Barclay	New Zealand Sports Fishing Council
Curly Brown	Commercial fisher, FMA 8 & 9
Austin Burgess	Fisheries New Zealand (Fisheries Observer Programme)
Mark Chambers	Trident
Phil Clow	Commercial fisher, FMA 1
Martin Cryer	Fisheries New Zealand (Fisheries science)
Glen Curtis	Motueka Nets
Kim George	Fisheries Inshore New Zealand (Data management)
Mark Geytenbeek	Fisheries Inshore New Zealand (Fisheries management)
Trude Hellesland	Department of Conservation
Rosemary Hurst	NIWA
Emma Jones	NIWA
Pamela Mace	Fisheries New Zealand (Fisheries science)
Jeremy McKenzie	NIWA
Alicia McKinnon	Fisheries New Zealand (Fisheries management)
John Moriarty	Fisheries New Zealand (Data management)
Pat Nyhon	Commercial fisher, FMA 5
Nathan Reid	Moana, NZ
Kevin Saunders	Commercial fisher, FMA 8
Carol Scott	Southern Inshore Fisheries Management
Tony Threadwell	Commercial fisher, FMA 3, Fishermen's Federation
Ian Tuck	NIWA
Karen Tunley	Fisheries New Zealand (Fisheries science)
Richard Wells	Fisheries Inshore New Zealand
Oliver Wilson	Fisheries Inshore New Zealand

APPENDIX 8: WORKSHOP AGENDA

Trawl Gear use in New Zealand's Inshore Fisheries - Expert Workshop

When	**Wednesday 26th June** **9:30 – 16:00**
Where	NIWA Allen Board room Greta Point, 301 Evans Bay Parade, Hataitai, Wellington.

Agenda

09:30 Opening Remarks & Introduction; project rationale and scope of workshop

09:45 Scene-setting: Background presentations on where trawl gear information is relevant:
- Trawl gear selectivity
- Stock monitoring & abundance estimation
- Estimating benthic footprint of fisheries

Discussion

10:30 Coffee Break

11:00 Assessment of trawl gear used across New Zealand's inshore trawl fisheries based on data currently collected – preliminary results.

Discussion

12:00 Lunch

12:50 Intro to afternoon session

13:00 Break out groups to discuss:
- what attributes could be collected from fishers to better understand trawl gear selectivity and feed into fisheries science & management?
- how to define these attributes?
- how practical are they to record?

14:00 Re-group to discuss and draw up combined list of attributes, definitions, uses and practicality

15:00 Coffee Break

15:30 Final Summing up session

16:00 Meeting close