Ministry for Primary Industries
Manatū Ahu Matua

Review of QMS species for inclusion in the east coast South Island winter trawl survey reports

New Zealand Fisheries Assessment Report 2013/35

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ISSN 1179-5352 (online)

ISBN 978-0-478-41416-5 (online)

May 2013

New Zealand Government

Growing and Protecting New Zealand

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EXECUTIVE SUMMARY

Beentjes, M.P.; MacGibbon, D. (2013). Review of QMS species for inclusion in the east coast South Island winter trawl survey reports.

***New Zealand Fisheries Assessment Report 2013/35.* 102 p.**

The content of the east coast South Island (ECSI) trawl survey reports that describe the results of each of the nine surveys (up until 2012) has been determined by the specific project objectives and the target species, which have changed over time. For non-target QMS (Quota Management System) species the presentation of results (catch rates, biomass, and length frequency) has been largely *ad hoc* and based on the assumed, top 20 or so, commercially important species. The purpose of this report was to review data collected by the ECSI winter trawl surveys to determine the appropriate subset of non-target QMS species, for which relative abundance and size composition information should be documented in survey reports.

Twenty candidate QMS species were reviewed. Of these, five had inadequate data and were rejected outright (slender jack mackerel, greenback jack mackerel, yellowtail jack mackerel, southern arrow squid, and white warehou). For the other fifteen species, information from surveys on distribution, catch rates, length distribution, biomass and general life history were analysed and considered in relation to seven criteria on survey coverage. At the Southern Inshore Working Group meeting on 19 November 2012, this work was reviewed and the working group recommended eight species for inclusion in the survey reports (barracouta, lemon sole, ling, rough skate, smooth skate, school shark, rig, and silver warehou). The remaining seven species were rejected because they did not fulfil criteria for adequate survey coverage (blue cod, New Zealand sole, sand flounder, hapuku, hoki, leatherjacket, and blue warehou). Catch rates, biomass (by sex, total, and recruited), and length frequency by depth range (10–30 and 30 to 400 m) for the eight selected species will be presented for the 2012 ECSI survey and for each subsequent survey.

1. INTRODUCTION

Including 2012, there have been nine winter bottom trawl surveys carried out on east coast South Island (ECSI) in 30–400 m using R.V. *Kaharoa*. (Beentjes & Wass 1994, Beentjes 1995a, 1995b, 1998a, 1998b, Beentjes & Stevenson 2008, 2009, Beentjes et al. 2010). In the 2012 survey, red gurnard (*Chelidonichthys kumu*) and elephant fish (*Callorhinchus milii*) were added to the target species bringing the total to eight (in addition to existing targets: dark ghost shark, *Hydrolagus novaezelandiae;* giant stargazer, *Kathetostoma giganteum*; red cod, *Pseudophycis bachus*; sea perch, *Helicolenus percoides*; spiny dogfish, *Squalus acanthius*; and tarakihi, *Nemadactylus macropterus*).

In 2012, the ECSI survey was officially expanded to include four strata in the 10–30 m depth range, principally for elephant fish and red gurnard. These four shallower survey strata have been surveyed since 2007 (2007, 2008, 2009, and 2012), but before 2012 there were no specified target species, nor additional days added to the surveys to accommodate the extra stations required. Consequently, the allocated stations in 10–30 m strata were not always completed due to time and resource constraints, and because they were outside the 30–400 m core strata used in the historical winter time series, priority was low. Hence, the 2012 survey represents the first of a new time series for red gurnard and elephant fish, and potentially other shallow dwelling species in 10–400 m (i.e., core plus shallow strata).

The content of the reports that describe the results of each of the previous surveys has been determined by specific project objectives and target species. However, for the non-target QMS species the presentation of results has been largely *ad hoc* and based on the assumed, top 20 or so, commercially important species. For these species, results presented generally included distribution of catch rates, biomass, and length frequency distribution in the core strata (30–400 m).

This report fulfils specific objective 7 of INT2011-01. We examined ECSI winter trawl survey data from twenty candidate QMS species and recommend which species and outputs should be included in all future survey reports.

Specific objective 7:

To review data collected by the ECSI series to determine for which species relative abundance trends and size composition information should be provided in each survey report.

The other specific objectives (1 to 6) of INT201101 are covered in Beentjes et al. (in press).

2. METHODS

2.1 Selection of candidate species

The initial list of candidate QMS species (other than the eight target species) is shown in Table 1. These include all the main commercial QMS species that are caught by trawling on the ECSI. The number of fish of each species that have been measured on each survey was then examined (Table 2). Since nearly all QMS species caught during surveys are measured, this is an indication of the numbers encountered on the survey, and can be used to eliminate from the analysis species with low numbers measured. Criteria for determining whether sufficient fish had been measured were largely subjective and relied on species having consistently high numbers measured throughout the time series. On this basis the three jack mackerel species (JMD, JMN JMM), arrow squid (NOS), and white warehou (WWA), were dropped leaving fifteen species to be considered (Table 2). Rough skate (RSK) and smooth skate (SSK) were included, even though in the first few years they were not measured on surveys.

2.2 Distribution, biomass, length frequency, and occurrence

For each species, catch rates for each of the nine surveys are plotted on the survey strata area map to show temporal and spatial patterns in distribution.

Relative biomass and coefficients of variation were estimated by the area-swept method described by Francis (1981, 1989) using the NIWA program '*SurvCalc*" (Francis & Fu 2012). All tows for which the gear performance was satisfactory (code 1 or 2) were used for biomass estimation. The combined biomass and length frequency analysis option in *SurvCalc* was used for deriving scaled length frequency distributions and biomass estimates. All length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area.

Separate analyses of total biomass, were carried out for all species in the core strata (30–400 m), and for species where distribution overlaps with the 10 to 30 m strata, biomass was also estimated for core plus the shallow strata (10–400 m) in the 2007 and 2012 surveys. The Southern Inshore Working Group (SINS WG) noted that were insufficient tows carried out in the 10 to 30 m depth range in 2008 and 2009 to make valid size and biomass comparisons among the four years and so these two surveys were excluded from the analyses of biomass or length frequency in 10 to 30 m (SINS-WG- 2012-35). The two depth ranges are plotted on the same figures to show the contribution to biomass made by the shallow strata.

Scaled length frequency distributions are plotted for each species by depth range (10–30 m, 30–100 m, 100–200 m, 200–400 m) for all nine surveys combined. This also includes the 10 to 30 m in 2008 and 2009 where data are spurious (see introduction), but we consider this to be valid because we are using the results to look at overall depth distributions rather than the nature of the biomass estimates or length distributions.

Length-weight coefficients were determined for rig, rough skate, school shark, and smooth skate in 2012. Coefficients were determined by regressing natural log weight against natural log length ($W=aL^b$). These length weight coefficients were used to scale length frequencies. For other species, length weight coefficients in the *trawl* database were used.

For the core strata (30–400 m), time series (nine surveys) length frequency distributions are plotted to show temporal patterns in size distribution. For species common in shallow water, the length frequency data in the 10–30 m strata for 2007 and 2012 were plotted on top of (overlaid on) that from 30–400 m to identify any differences in size between depths below and over 30 m.

For the core strata (30–400 m) the percent occurrence or proportion of tows with non-zero catch of each target species was tabulated for each survey. Similarly the catch of each target species as a percentage of the catch of all species from each survey was tabulated. This was also done for the 2007 and 2012 surveys in core plus shallow strata (10 to 400 m).

Occurrence was categorised on the basis of the average percent occurrence as follows:

below 20%	low
20–39%	med-low
40–59%	medium
60–79%	med-high
over 79%	high.

Similarly the proportion catch was categorised on the basis of the average percent catch as follows:

below 1%	low
1–2%	med-low
3–4%	med
5–6%	med-high
over 6%	high.

2.3 Criteria for determining which species to include in the survey reports

The decision on whether or not to include a species in the survey report, and in what form, was partially based on the how each species met the following criteria:

1. Fish are available to the survey (all fish in the water column are below the headline height and available to the net, and are not migrating in or out of the survey area during the survey).
2. Fish are vulnerable to *Kaharoa* bottom trawl (vulnerable to capture by the trawl gear used and found on the ground that is surveyed in equal proportion to that on foul ground).
3. The distribution of the fish species falls within the survey depth range.
4. The surveys monitor pre-recruited, recruited, or the youngest cohorts (0+ 1+…).
5. The length frequency distributions are consistent among surveys and may also track cohorts (i.e., modal progression).
6. The coefficients of variation associated with biomass estimates are acceptable (on average less than about 35%).
7. The occurrence of fish on the survey is adequate (at least 20% of tows).

3. RESULTS AND DISCUSSION

The fifteen species considered are given in alphabetical order of common name.

3.1 Barracouta (BAR)

Biology

The maximum age of barracouta is about 13 years in the commercial fishery and the largest males grow to about 85 cm (fork length , FL) and females to 100 cm in Southland (Harley et al. 1999). They are known to grow to over 1.5 m FL and are thought to have a maximum age of over 30 years (Ayling & Cox 1982). Sexual maturity is at about 50–60 cm FL corresponding to about 2–3 years of age (Ministry for Primary Industries 2012). Barracouta recruit to the commercial fishery at about 40 cm, but the bulk of the catch is over 60 cm (Harley et al. 1999).

Availability

Barracouta is described as a pelagic schooling fish (Ayling & Cox 1982), but clearly spends considerable time near the bottom as it is an abundant and common catch on the ECSI *Kaharoa* trawl surveys where the headline height of the net is about 5 m. BAR 1 includes FMAs 1 to 3 (the entire east coast of the North and South Island), although barracouta fish stock boundaries are not well understood and are at best nominal. It is thought that there is considerable mixing and movement of fish between Southland and both the east and west coasts of the South Island (Ministry for Primary Industries 2012), indicating that this species may not be fully available to the survey. Spawning occurs in late winter-spring (Aug to Dec) on the east coast South Island, outside the timing of the survey. Monitoring barracouta will be more problematic if the timing and magnitude of the migrations fluctuate annually and hence availability varies between surveys. This in turn will impact biomass estimates and probably length distributions.

Vulnerability

Barracouta can be considered to be vulnerable to trawl since 99% of the commercial catch is taken by trawling. We assume that barracouta are found on the ground that is surveyed in equal proportion to that on foul ground as they are not a species known to aggregate in untrawlable foul ground.

Species depth range

The distribution of barracouta catch rates from the nine east coast South Island surveys shows that they are most commonly caught between about 30 and 200 m and for the last four surveys, largest catches have been off Timaru (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that barracouta have been caught in depths ranging from about 5 to 670 m (mean 182 m), but the vast majority of the catch is taken from about 50 to 400 m and most often in 100 to 200 m (Anderson et al. 1998). The survey depth range of 10 to 400 m is therefore acceptable for monitoring barracouta.

Length frequency distributions

The length distributions (Figure 3) show at least three clear pre-recruit modes at about 20 cm, 25 cm, and 50 cm (combined males, females, and unsexed) consistent with ages of 0+, 1+, and 2+ (Harley et al. 1999). There is a tendency for the 0+ cohort (unsexed) to be more common in 30–100 m than deeper. The largest mode (60 to 80 cm) comprises multiple year classes and is similar to the recruited size range caught by commercial fisheries (Figure 3). The survey is therefore monitoring both individual pre-recruited cohorts, and fish in the recruited size range.

Plots of time series length frequency distributions (Figure 4) are consistent, showing the presence of the pre-recruited cohorts on nearly all surveys, with indications that these could be tracked through time (modal progression). The addition of the 10–30 m depth range does not change the shape of the length distribution.

Biomass estimates

Biomass in the core strata (30–400 m) appears to be increasing and is about three-fold larger in 2009 and 2012 than the average biomass of the early 1990s (Table 3, Figure 5). Coefficients of variation are generally low ranging from 16 to 34%, but were below 20% on the last four surveys (Table 3). The additional biomass captured in the 10–30 m depth range accounts for 15% and 6% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that shallow strata should be monitored for this species (Table 3).

Occurrence and proportion catch

Barracouta average occurrence in tows is 89% from both core strata (30–400 m) and from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of barracouta in both depth ranges is high. Similarly, the average percentage of the catch in tows is 23% from core strata and 28% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as high. The high occurrence and proportion of the catch confirms that barracouta is a key species in this area. Only the target species spiny dogfish (*Squalus acanthias*) has a greater occurrence and higher proportion of the catch than barracouta on ECSI surveys (see Beentjes et al. in press).

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that barracouta be included in the survey reports for core strata (30–400 m) and core plus shallow strata (10–400 m). A summary of the results for barracouta and criteria met is given in Table 5.

3.2 Blue cod (BCO)

Biology and fishery

Blue cod are protogynous hermaphrodites with some (but not all) females changing into males as they grow and hence the largest fish in the populations are invariably males (Carbines 2004). In heavily fished blue cod populations sex ratios skewed towards males are often observed (Beentjes & Carbines 2009). The maximum age of blue cod is about 30 years in the recreational and commercial fisheries on the east coast of the South Island (Beentjes & Carbines 2009, 2011). Males at this age are about 50 to 60 cm (total length, TL), and females slightly smaller. The maximum recorded age of blue cod is 32 years (Ministry for Primary Industries 2012), but historically, before they were exploited, they may have grown larger and lived longer. Sexual maturity is at about 26–28 cm and 4–5 years of age in Southland (Ministry for Primary Industries 2012) with spawning occurring over spring/summer. Blue cod is caught commercially by potting and recreationally by lining with a minimum legal size of 30 cm in BCO 3 corresponding to an age of about 6 years. By default, the minimum legal size (MLS) is the size at recruitment to the fishery since under-size fish are returned to the water. Recreational catches in BCO 3 are not well quantified, but are known to be greater than the commercial catch (Ministry for Primary Industries 2012).

Availability and vulnerability

Blue cod is a bottom living fish that is often found over rock reef structures or on sand and cobble, close to rocky outcrops (Ayling & Cox 1982, Francis 2001, Beentjes & Carbines 2009). If blue cod are encountered by the trawl gear they are very likely to be caught as they are not fast swimmers. Blue cod are known to be territorial and tagging studies show that blue cod have a restricted home range (Mace & Johnston 1983, Mutch 1983, Carbines & McKenzie 2001). Within BCO 3 (i.e. FMA 3) there are likely to be multiple sub-populations of blue cod. Large scale movement in or out of the survey area is unlikely, particularly in early winter outside the spawning period. Blue cod are therefore available to the survey.

Blue cod cannot be considered to be fully vulnerable to trawl as much of the recreational catch is taken by lining over or near untrawlable foul ground. Given that this is the preferred habitat of blue cod it seems unlikely that this species is found on the ground that is surveyed in equal proportion to that on foul ground.

Species depth range

The distribution of blue cod catch rates from the nine east coast South Island surveys shows that they are most commonly caught between about 50 and 200 m, although catches are sporadic (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that blue cod have been caught in depths ranging from about 14 to 500 m (mean 104 m), but the vast majority of the catch is taken inside 200 m (Anderson et al. 1998). On blue cod potting surveys, blue cod are frequently caught in less than 10 m (Beentjes & Carbines 2012) suggesting that the 10 m survey shallow depth range may not be shallow enough.

Length frequency distributions

The blue cod length distributions (Figure 3) show only a single mode, characteristic of the size distribution shape in blue cod populations, except that overall the blue cod caught on the ECSI trawl surveys tend to have more larger and older fish. The single mode will comprise multiple cohorts from about 6 to possibly 30 years of age. The size distributions in the 30 to 100 m depth range tend to have more small fish than in 100 to 200 m. The survey is monitoring both pre-recruited fish (less than 30 cm) and recruited fish, although individual cohorts are not distinguishable.

Plots of time series length frequency distributions (Figure 4) are inconsistent because of the paucity of fish caught on each survey, but the size range is similar throughout the series, showing the presence of the pre-recruited and recruited fish on all surveys. The addition of the 10–30 m depth range has not changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) shows no trend although the biomass in 2012 is considerably greater than all previous estimates (Table 3, Figure 5). Coefficients of variation are medium to high, ranging from 28 to 93% (mean 48%) (Table 3). The additional biomass captured in the 10–30 m depth range is negligible, indicating that the core strata time series is appropriate for monitoring this species (Table 3).

Occurrence and proportion catch

Blue cod average occurrence in tows from core strata (30–400 m) and core plus shallow strata (10–400 m) is low (17% and 21%, respectively) (Table 4). Similarly, the average percentage of the catch in tows from both depth ranges is low (0.1%). The low occurrence and proportion of the catch confirms that blue cod is a minor component of the non-target QMS species in this area.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that blue cod should not be included in the survey reports for core strata (30–400 m) or the core plus shallow strata (10–400 m). A summary of the results for blue cod and criteria met is given in Table 5.

3.3 Blue warehou (WAR)

Biology

The maximum age of blue warehou was 22 years for a 65 cm (FL) female and 23 years for a 63 cm male sampled from research tows (Bagley et al. 1998). They are known to grow to about 75 cm FL (Ayling & Cox 1982), but growth is negligible after about age 15, so a maximum age cannot be estimated from growth curves. They become sexually mature at about 36 cm (Hurst et al. 2000) which corresponds to an age of about 3 years from the growth curves of Bagley et al. (1998). The smaller immature fish tend to be found in shallow water (Ayling & Cox 1982), and recruit to the commercial fishery at 50 cm (FL) (Bagley et al. 1998).

Availability and vulnerability

Blue warehou is a schooling fish with a body shape and diet that indicates both a pelagic and demersal existence. It feeds on shrimps, mollusc, crabs, squid, and the pelagic schooling sprats and pilchards (Ayling & Cox 1982), and stomachs from blue warehou caught on the ECSI trawl survey often contain salps. They clearly spend considerable time near the bottom, however, as it is an abundant and common catch on the ECSI *Kaharoa* trawl surveys as well as a common catch of commercial bottom trawling (Ministry for Primary Industries 2012). WAR 3 is equivalent to FMAs 3 to 6 although blue warehou fish stock boundaries are not well understood and are at best nominal. Little is known of their movements although their body shape would suggest that they are good swimmers capable of extensive movements. Migrations have been described as extensive and temperature dependent (Gavrilov 1979). Further, seasonal patterns in commercial fisheries suggest that blue warehou move up and down the coast (Bagley et al. 1998). There are thought to be four spawning areas: Southland- Canterbury Bight, north east South Island–south east North Island including Cook Strait, West coast South Island, and Tasman Bay to New Plymouth (Bagley et al. 1998). Timing of spawning varies between areas, but the Southland-Canterbury Bight stock spawns in shallow waters in November near Stewart Island (Bagley et al. 1998). The origin of the strong 0+ fish modes on the ECSI surveys is unknown but the local current regimes would suggest that they come from the Stewart Island spawning ground and drift north on the Southland current. The timing of the east coast South Island trawl survey is unlikely to be an issue for mature spawning blue warehou, but in general the survey tends to sample juvenile immature blue warehou which are more common on the continental shelf.

Blue warehou can be considered to be vulnerable to trawl as most of the commercial catch is bycatch from bottom trawling. We assume that blue warehou is found on the ground that is surveyed in equal proportion to that on foul ground as they are not a species known to aggregate in untrawlable foul ground.

Species depth range

The distribution of blue warehou catch rates from the nine east coast South Island surveys shows that they are caught from 10 m to about 200 m and while catch rates are generally low, there is the occasional very large catch taken (see 2007 and 2008 distribution maps) (Figures 1 and 2). Few fish were caught deeper than 100 m (Figure 3). Analyses of depth distributions from 292 research trawls around New Zealand show that blue warehou have been caught in depths ranging from about 6 to 987 m (mean 135 m), but the vast majority of the catch is taken from a few metres to about 200 m (Anderson et al. 1998). The survey depth range of 10 to 400 m is deep enough to adequately monitor blue warehou.

Length frequency distributions

The length distributions (Figure 3) show two clear modes at about 10 cm and 20 cm (combined males, females, and unsexed) consistent with ages of 0+ and 1+ (Bagley et al. 1998) (Figures 3 and 4). The 0+ cohort (unsexed) is more prominent in the shallow 10 to 30 m strata. Blue warehou caught in the commercial fishery are mature fish (range 40 to 65 cm), whereas virtually all fish caught on the ECSI survey are immature (i.e., smaller than 36 cm) (Figure 3). The survey is therefore monitoring pre-recruited fish and cohorts, but not fish in the recruited size range.

Plots of time series length frequency distributions (Figure 4) consistently show the presence of the pre-recruited cohorts on nearly all surveys, but distributions are inconsistent because of variation in recruitment strength of cohorts among the surveys, as well as changes in annual modal growth. The addition of the 10–30 m depth range has significantly changed the shape of the length frequency distributions.

Biomass estimates

Biomass in the core strata (30–400 m) shows no clear trends with high estimates for 2007 and 2008 associated with very large c.v.s. (Table 3, Figure 5). Coefficients of variation range from 28 to 90% (mean 60%), and can be regarded as high (Table 3). The additional biomass captured in the 10–30 m depth range accounted for 4% and 66% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that the shallow strata may be important for this species (Table 3).

Occurrence and proportion catch

Blue warehou average occurrence in tows is 19% from core strata (30–400 m) and 32% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4) and by definition occurrence of blue warehou is low and med-low, respectively. Similarly, the average percentage of the catch in tows is 0.5% from core strata and 0.9% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. This suggests that although blue warehou is a reasonably common species in this area, it is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that blue warehou should not be included in the survey reports. A summary of the results for blue warehou and criteria met is given in Table 5.

3.4 Hapuku (HAP)

Biology

The oldest hapuku, estimated from ageing otoliths, was 63 years old at a length of about 120 cm (TL) (Francis et al. 1999). They are known to grow to over 1.8 m (Ayling & Cox 1982) and therefore the maximum age is likely to be considerably older than 63 years. Hapuku reach sexual maturity at about 85 cm and 88 cm for males and females, respectively (Johnston 1983) corresponding to an estimated age of about 10 years using the von Bertalanffy growth curve of Francis et al. (1999). Hapuku recruit to the commercial fishery at about 50 cm (Francis et al. 1999).

Availability and vulnerability

Juvenile hapuku are pelagic, becoming demersal at about 50 cm length and 3–4 years of age (Francis et al. 1999). Adults often shoal close to rocky reefs (Ayling & Cox 1982) and are targeted mainly by lining and setnetting methods (Paul 2002). Clearly hapuku also spend time over flat bottom since they are a common catch on the ECSI *Kaharoa* trawl surveys and other research trawl surveys. HPB 3 (hapuku bass) is equivalent to FMA 3, but it not known whether biological stocks conform to the fish stock boundaries. It has been shown that hapuku from the south east coast of the South Island migrate northward in April into Cook Strait for spawning which takes place in about July, after which groper return to their feeding ground (Beentjes & Francis 1999). The timing of the migration overlaps with the trawl survey, and hence may affect availability. This in turn will impact biomass estimates and probably length distributions.

Hapuku cannot be considered to be fully vulnerable to trawl since most of the commercial catch is taken by setnet and lining (Paul 2002) near non-trawlable ground. We cannot assume that hapuku is found in the survey area on trawlable ground in equal proportion to that on foul ground as larger fish aggregate over untrawlable foul ground.

Species depth range

The distribution of hapuku catch rates from the nine east coast South Island surveys shows that they are most often caught between about 30 and 200 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that hapuku have been caught in depths ranging from about 14 to 582 m, (mean 205 m), but the vast majority of the catch is taken from about 100 to 300 m, (Anderson et al. 1998). The survey depth range of 10 to 400 m is therefore acceptable for monitoring hapuku.

Length frequency distributions

The length distributions (Figure 3) have a single mode comprised of multiple year classes. The modal peak is at about 50 cm, the size of recruitment to the commercial fishery. Depth does not appear to affect the length range which is from about 40 to 90 cm and includes mostly immature fish (Figure 3). Hapuku caught in the commercial fishery are considerably larger than those caught on the ECSI survey as are those from trawl surveys of Southland (Bagley & Hurst 1996). The survey is not monitoring pre-recruited cohorts or fish in the recruited size range particularly well.

Plots of time series length frequency distributions (Figure 4) are spiky because of the low numbers caught, but the size range is reasonably consistent among surveys. The addition of the 10–30 m depth range has not changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) shows no strong trends, but the two highest biomass estimates have been in more recent surveys (2007 and 2012). (Table 3, Figure 5). Coefficients of variation are generally medium to low ranging from 19 to 35% (mean 27%) (Table 3). The additional biomass captured in the 10–30 m depth range account for 3% and 2% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that the core survey area is appropriate for this species (Table 3).

Occurrence and proportion catch

Hapuku average occurrence in tows is medium-low (39%) from core strata (30–400 m), whereas the average percentage of the catch in tows is low (0.2%) (Table 4). The high occurrence confirms that hapuku is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that hapuku should not be included in the survey reports for either core strata (30–400 m) or core plus shallow strata (10–400 m). A summary of the results for hapuku and criteria met is given in Table 5.

3.5 Hoki (HOK)

Biology

The maximum age of hoki is 20–25 years in the commercial fishery with the largest males growing to about 115 cm (TL) and females to 130 cm (Ministry for Primary Industries 2012). Sexual maturity is at 60–65 cm and 3–4 years for males and about 65–70 cm for females (Ministry for Primary Industries

2012). Hoki recruit to the commercial fishery at about 40 cm and 2 years of age (Horn & Sullivan 1996). The 0+, 1+, and 2 + modes are generally clearly discernible in research survey length distributions. Modes equivalent to 2, 3, and 4 year old fish are centred around 45–50 cm, 60–65 cm and 70–75 cm, depending on the time of year

Availability and vulnerability

Hoki is predominantly a demersal species, but catches have been made in mid-water on the Chatham Rise (Livingston et al. 2004). HOK 1 includes all FMAs except FMA 10, a reflection of a well dispersed stock. It is thought that there are two main dispersed stocks, the Chatham Rise and the Southern Plateau (Ministry for Primary Industries 2012) and two main spawning stocks, the western and eastern stocks. The western stock includes the west coast of the North and South Islands and the area south of New Zealand including Puysegur, Snares, and the Southern Plateau. The eastern stock includes the area of the ECSI, Mernoo Bank, Chatham Rise, Cook Strait, and the east coast North Island to North Cape (Ministry for Primary Industries 2012). Spawning occurs from June to mid-September, overlapping with the timing of the ECSI survey and so we would expect mature spawning fish to have migrated to the Chatham Rise or Cook Strait where they spawn.

Hoki can be considered to be vulnerable to trawl since virtually all the commercial catch is taken by trawling. We assume that hoki is found on the ground that is surveyed in equal proportion to that on foul ground as they are not a species known to aggregate in untrawlable foul ground.

Species depth range

The distribution of hoki catch rates from the nine east coast South Island surveys shows that they are virtually all caught between 200 and 400 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that hoki have been caught in depths ranging from about 15 to 1400 m (mean 651 m), but the vast majority of the catch is taken from about 400 to 1000 m (Anderson et al. 1998). The survey depth range of 10 to 400 m for the ECSI survey is at the shallow margin of their distribution.

Length frequency distributions

The length distributions (Figure 3) show two distinct modes centred at about 28 cm and 45 cm, and a third less distinct mode at about 60 cm (combined males, females, and unsexed) consistent with ages of 1+, 2+, and 3+. The right hand tail of the distribution larger than 70 cm comprises multiple year classes and comprises considerably smaller and younger fish than those from the commercial fishery (Horn & Sullivan 1996) (Figure 3). The survey is therefore monitoring individual pre-recruited cohorts, but not fish in the recruited size range.

Plots of time series length frequency distributions (Figure 4) indicate that the pre-recruited modes appear sporadically throughout the series, depending on annual abundance and recruitment variation. The addition of the 10–30 m depth range has not changed the shape of the distribution and the existing core strata time series in 30–400 m is suitable, but the core plus shallow strata (10–400 m) is not.

Biomass estimates

Biomass in the core strata (30–400 m) shows no trend and is variable in recent years (Table 3, Figure 5). Coefficients of variation are also variable ranging from 10 to 93%, (mean 48%) and overall can be regarded as high (Table 3). The biomass in the 10–30 m depth range was zero.

Occurrence and proportion catch

Hoki average occurrence in tows is low (12%) from core strata (30–400 m) and the average percentage of the catch in tows is also low (0.9%) (Table 4). The low occurrence and proportion of the catch confirms that hoki is not a key species in this area.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that hoki should not be included in the survey reports for either core strata (30–400 m) or core plus shallow strata (10–400 m). A summary of the results for hoki and criteria met is given in Table 5.

3.6 Leatherjacket (LEA)

Biology

No ageing has been carried out for leatherjacket but it is believed that they live to about 6 to 7 years growing very quickly, reaching 20 cm after the first year and full adult size after only two years (Ayling & Cox 1982). They are sexually mature at 19–22 cm and mature at 2 years of age (Francis 2001). Maximum size is between 35 cm (Ayling & Cox 1982) and 45 cm (Francis 2001). Leatherjacket probably recruit to the commercial fishery at about 20 cm.

Availability and vulnerability

Leatherjacket is primarily a reef dwelling species feeding on sponges and ascidians, but can sometimes be found on sand and in mid-water (Ayling & Cox 1982, Francis 2001). Given their body shape and ecology it is doubtful that they move far from their spawning and feeding areas. Spawning occurs from August to November outside the timing of the survey. Leatherjacket is mainly a bycatch species of commercial trawling, but it is likely to be more abundant over foul ground that cannot be trawled by *Kaharoa* and hence this species cannot be regarded as fully vulnerable to trawling.

Species depth range

The distribution of leatherjacket catch rates from the nine east coast South Island surveys shows that they are most common between about 10 and 40 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that leatherjacket have been caught in depths ranging from about 9 to 159 m (mean 54 m), but the vast majority of the catch is taken below about 80 m (Anderson et al. 1998). The 10 m minimum trawl survey depth is probably acceptable for leatherjacket.

Length frequency distributions

The length distributions (Figure 3) show at least three clear modes at about 10 cm, 16 cm, and 23 cm (combined males, females, and unsexed). If they reach 20 cm after one year, as described by Ayling & Cox (1982), then the 16 cm mode represents the 0+ cohort turning one in August to November, and the 23 cm mode is comprised of multiple age classes (2 to 7 years). However, this does not explain the presence of the smaller mode at 10cm which seems more likely to be 0+ fish. The survey is therefore monitoring both pre-recruited cohorts, and fish in the recruited size range.

Plots of time series length frequency distributions (Figure 4) show that they were not caught in significant numbers until 2007 when the shallow strata were included in the surveys. Very few fish were sexed on any of the surveys. The two larger modes are consistently represented and overall the distributions show the presence of the pre-recruited cohorts, with 2012 having a larger proportion of recruited fish. The addition of the 10–30 m depth range has changed the shape of the distribution significantly and only the core plus shallow strata (10–400 m) time series that includes 2007 and 2012 is acceptable.

Biomass estimates

Biomass in the core strata (30–400 m) are not valid given that so few fish were caught (Table 3, Figure 5), and coefficients of variation are generally high ranging from 36 to 66% (mean 55%) (Table 3). The additional biomass captured in the 10–30 m depth range accounted for 93% and 79% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that the core plus shallow strata (10–400 m) (Table 3) is the only valid depth range within which to monitor leatherjacket biomass.

Occurrence and proportion catch

Leatherjacket average occurrence in tows is 12% from core strata (30–400 m), and 26% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of leatherjacket on both depth ranges is low and med-low, respectively. Similarly, the average percentage of the catch in tows is 0.1% from core strata and 0.3% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. The low occurrence and proportion of the catch confirms that leatherjacket is not a key species within the entire survey area, although it is more important shallower than 50 m.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that leatherjacket should not be included in the survey reports for core strata (30–400 m) and core plus shallow strata (10–400 m). However, the Working Group noted that the leatherjacket data may be more informative after a few more surveys in the shallow strata have been completed and hence this species should be reassessed sometime in the future. A summary of the results for leatherjacket and criteria met is given in Table 5.

3.7 Lemon sole (LSO)

Biology

The flounders and soles are fast growing short-lived species and the fisheries are thought to be comprised of only a few year classes. Some ageing work on lemon sole has been carried out, but has not been published– there is reference to this in the plenary report (Ministry for Primary Industries 2012). In the absence of age and growth information for lemon sole we assume they have growth parameters and life history characteristics similar to New Zealand sole, but probably only live to about 5 years of age given their smaller maximum size. Commercial catches of lemon sole from SeaFIC Industry log books show that the catch ranges in size from about 10 to 45 cm, but the bulk of the catch is between 25 and 40 cm (Beentjes & Manning 2010). As for New Zealand sole, the MLS for the commercial fishery for lemon sole is 25 cm, which is also the most appropriate value for size at recruitment to the fishery.

Availability and vulnerability

Lemon sole is most abundant in FLA 3, (FMAs 3–6) particularly in Otago and Canterbury Bight (Beentjes 2003) and it is also the most commonly landed flatfish species in FLA 3. Like New Zealand sole, lemon sole is a bottom living species most often found on sand or mud bottoms where they nestle into the substrate. Apart from inshore and offshore spawning migrations, there is unlikely to be any significant movements in or out of the survey area.

Flatfish are caught in either standard multispecies trawls, or specialised flatfish target trawls. For target flatfish bottom trawling, specialised gear is required in which the heavy roller and bobbin ground rope of standard trawls is replaced by a chain fitted with short drop chains (Beentjes & Manning 2010). A lighter chain known as the “tickler chain” in front of the chain ground rope disturbs flatfish from the bottom and herds them into the mouth of the net. The wings of flatfish trawls tend to have smaller mesh sizes compared to standard trawl nets. Flatfish fishing also requires a low headline height of about 1 m (standard trawl is several metres), achieved by adjusting the flotation of the headline. Flatfish are most commonly targeted between about 8 to 15 m depth, and not deeper than 50 m (Beentjes & Manning 2010) which suggests that lemon sole may be landed from operations using a combination of standard trawls and the specialised flatfish trawl, given their preferred depth range (see below). This species appears to be at least partly vulnerable to the *Kaharoa* trawl gear.

Species depth range

The distribution of lemon sole catch rates from the nine east coast South Island surveys shows that they are most commonly caught between about 30 and 200 m (Figures 1 and 2). New Zealand sole have been caught in depths ranging from about 5 to 653 m (mean 187 m), but the vast majority of the catch is taken between about 50 and 400 m (Anderson et al. 1998). The 10 m minimum trawl survey depth is probably acceptable for lemon sole.

Length frequency distributions

Lemon sole length distributions (Figure 3) show single modes in both 30 to 100 m and 100 to 200 m depths, with lengths ranging from about 10 to 40 cm, and overall smaller than the commercial catch. The single mode probably comprises several year classes. Females are caught in much larger numbers that males (Figure 3). The survey does not monitor pre-recruited fish (less than 25 cm) well, and recruited fish do not appear to be well represented compared to the commercial catch.

Plots of time series length frequency distributions (Figure 4) are consistent among surveys showing a single mode with similar size ranges. The addition of the 10–30 m depth range does not change the shape of the length frequency distribution to any extent.

Biomass estimates

Biomass in the core strata (30–400 m) shows no trend (Table 3, Figure 5). Coefficients of variation are moderate to low, ranging from 18 to 33% (mean 24%) (Table 3). The additional biomass captured in the 10–30 m depth range accounted for only 4% and 1% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012, respectively, indicating that the existing core strata time series in 30–400 m is the most important, but that shallow strata should also be monitored.

Occurrence and proportion catch

Lemon sole average occurrence in tows from core strata (30–400 m) and from core plus shallow strata (10–400 m) is medium (48% and 43%, respectively) (Table 4), but the average percentage of the catch in tows from both depth ranges is low (0.1%). The medium occurrence suggests that this species is common, but is not very abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that lemon sole should be included in the survey reports for core strata (30–400 m) and the core plus shallow strata (10–400 m). A summary of the results for lemon sole and criteria met is given in Table 5.

3.8 Ling (LIN)

Biology

The maximum recorded age of ling is 39 years, and in the commercial fishery the largest males range from about 97 to 130 cm total length (27 to 33 years of age) depending on the area caught, and females from 120 to 150 cm (30 to 35 years) (Horn 1993). Sexual maturity (proportion at 50% maturity) is at 8 years for males and 12 years for females (Ministry for Primary Industries 2012) which corresponds to about 80 cm and 90 cm respectively. Ling recruit to the commercial fishery at about 40 cm which corresponds to about 3 years of age. Pre-recruited or recruited cohort modes are not distinguishable in either commercial or ECSI trawl survey length distributions.

Availability and vulnerability

Ling are mainly a demersal species feeding on crustaceans and fish, but are known to move into mid water to feed on spawning hoki (Ministry for Primary Industries 2012). LIN 3 is equivalent to FMA 3 but may not reflect biological stock boundaries. There are thought to be at least five stocks of ling: Cook Strait, west coast South Island, Chatham Rise, Bounty Plateau, and Stewart-Snares Shelf (Ministry for Primary Industries 2012) and the southeast South Island ling are likely to be part of the

Chatham Rise stock. Spawning time is area dependent, but is in July to November on the Chatham Rise which is outside the timing of the ECSI survey.

Ling can be considered to be vulnerable to trawl since a large proportion of the commercial catch is taken by trawling (Ministry for Primary Industries 2012). We assume that ling is found on the ground that is surveyed in equal proportion to that on foul ground as they are not a species known to aggregate in untrawlable foul ground.

Species depth range

The distribution of ling catch rates from the nine east coast South Island surveys shows that they are caught between about 40 and 400 m, but the largest catches are generally from 200 to 400 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that ling have been caught in depths ranging from about 16 to 1300 m (mean 481 m), but the vast majority of the catch is taken from about 200 to 700 m (Anderson et al. 1998). The survey depth range of 10 to 400 m for the ECSI survey is at the shallow margin of their distribution.

Length frequency distributions

The length distributions (Figure 3) show two distinct modes, particularly in the shallower depths, centred at about 50 cm and 90 cm (combined males, females, and unsexed). Both modes will comprise multiple year classes (Figure 3). The survey is therefore not monitoring individual pre-recruited cohorts, or the full extent of the recruited fish typical in commercial catches from the Chatham Rise (Horn 1993).

Plots of time series length frequency distributions (Figure 4) are generally consistent among surveys with indications of fewer larger fish (mode around 90 cm) in recent years. The addition of the 10–30 m depth range has not changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) is consistently lower in recent surveys compared to that in the 1990s (Table 3, Figure 5). Coefficients of variation are also variable ranging from 17 to 35%, (mean 23%) and overall can be regarded as low (Table 3). The additional biomass captured in the 10–30 m depth range is negligible.

Occurrence and proportion catch

Ling average occurrence in tows is medium-high (60%) from core strata (30–400 m) and the average percentage of the catch in tows is low (1.2%) (Table 4). The medium occurrence and low proportion of the catch confirms that ling is a common, but not an abundant species in this area.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that ling should be included in the survey reports for the core strata (30–400 m). A summary of the results for ling and criteria met is given in Table 5.

3.9 New Zealand sole (ESO)

Biology

The flounders and soles are fast growing short-lived species and the fisheries are thought to be comprised of only a few year classes. Ageing on New Zealand sole (also known as common sole) indicates a maximum age of 7 to 10 years at about 50 to 55 cm total length (Stevens et al. 2004). They reside in sheltered estuaries and harbours until 2 to 3 years of age after which they move offshore. Spawning occurs in winter-spring and, although unknown, maturity it is likely to be at 2 to 3 years of age similar to sand flounders (Colman 1994). Commercial catches of New Zealand sole from Seafood Industry Council (SeaFIC) log books show that the catch ranges in size from about 15 to 64 cm, but the bulk of the catch is between 25 and 50 cm (Beentjes & Manning 2010). The MLS for the commercial fishery for New Zealand sole is 25 cm, which is also the most appropriate value for size at recruitment to the fishery.

Availability and vulnerability

New Zealand sole is most abundant in FLA 3, (FMAs 3–6) particularly in Otago and Canterbury Bight (Beentjes 2003). New Zealand sole is a bottom living species most often found on sand or mud bottoms where they nestle into the substrate, but are also known to be move into mid-water in search of food (Francis 2001). Apart from inshore and offshore spawning migrations, there is unlikely to be any significant movements in or out of the survey area.

Flatfish are caught in either standard multispecies trawls, or specialised flatfish target trawls (see Section 3.7). Flatfish are most commonly targeted between about 8 to 15 m depth, and not deeper than 50 m which suggests that New Zealand sole may be landed from operations using both standard trawls and the specialised flatfish trawl. This species appears to be at least partly vulnerable to the *Kaharoa* trawl gear.

Species depth range

The distribution of New Zealand sole catch rates from the nine east coast South Island surveys shows that they are most commonly caught between about 10 and 30 m (Figures 1 and 2). New Zealand sole have been caught in depths ranging from about 6 to 200 m (mean 40 m), but the vast majority of the catch is taken inside 100 m (Anderson et al. 1998). The 10 m minimum trawl survey depth is probably marginally too deep, but acceptable for New Zealand sole.

Length frequency distributions

New Zealand sole length distributions (Figure 3) show a single mode in 30 to 100 m and bi-modal in 10 to 30 m, with lengths ranging from about 10 to 50 cm, and overall smaller than the commercial catch. The two modes are probably the 1 and 2 year old fish. The survey is monitoring pre-recruited fish (less than 25 cm), but recruited fish do not appear to be well represented compared to the commercial catch.

Plots of time series length frequency distributions (Figure 4) are spiky and inconsistent because of the paucity of fish caught on each survey, but the size range is similar throughout the series showing the presence of the mostly pre-recruited fish on all surveys. The addition of the 10–30 m depth range changes the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) shows no trend although 1991 biomass is considerably greater than all subsequent estimates (Table 3, Figure 5). Coefficients of variation are moderate to high, ranging from 38 to 82% (mean 54%) (Table 3). The additional biomass captured in the 10–30 m depth range accounted for 80% and 54% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012, respectively, indicating that the shallow strata are very important for this species.

Occurrence and proportion catch

New Zealand sole average occurrence in tows from core strata (30–400 m) and core plus shallow strata is low (7% and 16%, respectively) (Table 4). Similarly, the average percentage of the catch in tows from both depth ranges is also low (less than 0.1%). The low occurrence and proportion of the catch confirms that this species is a minor component of the non-target QMS species in this area.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that New Zealand sole should not be included in the survey reports for core strata (30–400 m) or the core plus shallow strata (10–400 m). However, the Working Group noted that the New Zealand sole data may be more informative after a few more surveys in the shallow have been completed and hence this species should be reassessed sometime in the future. A summary of the results for New Zealand sole and criteria met is given in Table 5.

3.10 Rig (SPO)

Biology

Longevity of rig is estimated to exceed 20 years (Francis & Ó Maolagáin 2000) with the largest recorded rig 126 cm (TL) for males and 152 for females (Francis 1997a). Rig reach sexual maturity at about 85 and 100 cm for males and females respectively, corresponding to about 5 and 7.5 years of age. Historically, rig recruited to the setnet commercial fishery at about 60 cm (Francis & Smith 1988), but this size is probably smaller for trawling where a 100 mm codend is used.

Availability and vulnerability

Rig are probably neither fully demersal or pelagic as they are targeted by set netting methods and are a common bycatch of trawling (Ministry for Primary Industries 2012). Rig biological stock boundaries are not well understood and SPO 3 includes FMAs 1 to 6. Tagging of rig indicated that there may be separate east and west coast South Island stocks and that most movement of rig was generally within the confines of the QMA in which they were tagged (Francis 1988). More than half of the tagged rig were recaptured 200 km or more from the tagging site and of those tagged in the ECSI survey area, recaptures were common outside the survey area. Rig aggregate in shallow coastal areas over the spring-summer period for mating and pupping, but the exact locations of these events are not well understood (Francis 1988). The timing of rig inshore reproductive migrations does not overlap with the trawl survey, and hence should not affect availability. The extensive movements of rig in and out of the survey area, however, may affect availability of rig to the survey.

Rig cannot be considered to be fully vulnerable to trawl since a considerable proportion of the commercial catch is taken by setnet, indicating that they may be off the bottom. Further, they are known to be very fast swimmers capable of evading or swimming ahead of the *Kaharoa* trawl gear.

Species depth range

The distribution of rig catch rates from the nine east coast South Island surveys shows that they are most often caught between about 10 and 100 m, with few fish caught deeper than 100 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that rig have been caught in depths ranging from about 4 to 1000 m, (mean 140 m), but the vast majority of the catch is taken from a few metres to about 200 m (Anderson et al. 1998). Despite their wide depth range, the survey depth range of 10 to 400 m appears to be acceptable for monitoring rig in winter given that they were not caught deeper than 200 m on any of the ECSI surveys.

Length frequency distributions

The length distributions (Figure 3) have two clear modes centred round 40 cm and 60 cm, most pronounced in the shallow 10 to 30 m depth range. These two modes correspond to pre-recruit rig of ages 1+ and 2+ from the age at length curves of Francis & Ó Maolagáin (2000). Rig tends to be larger overall in the 30 to 100 m depth range. Rig caught in the commercial fishery are probably larger overall than those caught on the ECSI survey which are mainly immature rig (smaller than 85 cm for males and 100 cm for females). The survey appears to be monitoring pre-recruited cohorts (1+ and 2+) reasonably well, but probably not the full extent of the recruited size distribution.

Plots of time series length frequency distributions (Figure 4) are spiky because of the low numbers caught, but the size range is reasonably consistent among surveys. The addition of the 10–30 m depth range has changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) is generally higher in recent years compared with the 1990s. (Table 3, Figure 5). Coefficients of variation are highly variable ranging from 18 to 62% (mean 32%)

(Table 3), but overall are medium. The additional biomass captured in the 10–30 m depth range accounts for 30% and 46% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that it is necessary to monitor the shallower strata as well as the core area for these species (Table 3).

Occurrence and proportion catch

Rig average occurrence in tows is 25% from core strata (30–400 m), and 28% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of rig on both depth ranges is med-low. Similarly, the average percentage of the catch in tows is 0.2% from core strata, and core plus shallow strata 0.4%, and the proportion of the catch in both depth ranges is categorised as low.
This indicates that rig is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that rig should be included in the survey reports for both core strata (30–400 m) and core plus shallow strata (10–400 m). A summary of the results for rig and criteria met is given in Table 5.

3.11 Rough skate (RSK)

Biology

Longevity of rough skate is unknown but the oldest aged fish in the sample used for ageing by Francis et al. (2001) was 9 years for a skate 70 cm (pelvic length, PL), although this has not been validated. Francis et al. (2001) estimate longevity at about 15 years. The largest recorded rough skate caught was a 98 cm female from a Snares shelf research tow, but this was potentially a misidentified smooth skate and the realistic maximum size is thought to be about 69 cm for males and 79 cm for females (Francis 1997b). The maximum sized rough skate caught from the east South Island surveys is about 80 cm and the size range is likely to be similar to that caught commercially as all sizes are marketable, but recruitment is likely to be around 40 cm. Males reach 50% sexual maturity at about 52 cm and 4 years, and females at 59 cm and 6 years (Francis et al. 2001).

Availability and vulnerability

Rough skate are primarily a demersal species known to inhabit soft muddy bottom substrates, but are suspected of migrating into mid-water on occasions to feed on sprats (Francis 1997b, Francis 2012). They are caught mainly as bycatch of trawling, but are also caught by lining (Ministry for Primary Industries 2012). Their distribution is known to range from shallow out to about 500 m and most of the commercial catch comes from the east coast South Island in RSK 3 (Ministry for Primary Industries 2012). Rough skate biological stock boundaries are not well understood and RSK 3 includes FMAs 3 to 6. Opportunistic tagging of rough skate from the ECSI trawl surveys have yielded only six tag returns from several hundred tagged skate. Only two of these had recapture locations and both were recaptured close to the tagging site. Rough skate deposits two leathery egg cases at a time in spring-summer on the sea floor (Francis 1997b, Francis 2012). It is not known where they mate or lay egg cases so it is not possible to comment on whether their reproductive behaviour would have any effect on availability of rough skate to the survey, but it seems unlikely. Their general movements, as shown by tagging, showed very limited movement in or out of the survey area suggesting that they are available to the survey

Rough skate are likely to be fully vulnerable to trawl since most of the commercial catch is taken by this method and they are primarily a bottom dwelling species.

Species depth range

The distribution of rough skate catch rates from the nine east coast South Island surveys shows that they are caught across the entire survey depth range from 10 to 400 m (Figures 1 and 2). They are most common in 30–100 m, although as more surveys are carried out in shallow strata, the 10 to 30 m depth range may be equally as important. Analyses of depth distributions from 292 research trawls around New Zealand show that rough skate have been caught in depths ranging from about 14 to 1465 m, (mean 370 m), although this probably includes the deeper water skates *Bathyraja* spp. and *Pavoraja* spp. (Anderson et al. 1998). The vast majority of the catch that is likely to be correctly identified as rough skate is taken from a few metres to about 400 m (Anderson et al. 1998). The survey depth range of 10 to 400 m appears to be acceptable given that relatively few fish were caught deeper than 200 m on any ECSI survey.

Length frequency distributions

The length distributions have no clear modes, comprise multiple year classes, and there are no small skate in the deep 200 to 400 m strata (Figure 3). Rough skate caught in the commercial fishery in the survey area are probably of similar size to those from the ECSI survey in which more than half of the skates are immature (i.e., smaller than 52 cm for males and 59 cm for females). The survey appears to be monitoring pre-recruited lengths down to 1+ age and the full recruited distribution, but no individual cohorts are discernible.

Plots of time series length frequency distributions (Figure 4) are reasonably consistent among surveys with no lengths measured before 1996. The addition of the 10–30 m depth range has changed the shape of the length frequency distribution slightly.

Biomass estimates

Biomass in the core strata (30–400 m) in recent years is about double that of the 1990s (Table 3, Figure 5). Coefficients of variation are variable ranging from 19 to 30% (mean 22%) (Table 3), but overall are low to medium. The additional biomass captured in the 10–30 m depth range accounted for 30% and 20% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it essential to monitor the core plus shallow strata (10–400 m) (Table 3).

Occurrence and proportion catch

Rough skate average occurrence in tows is 43% from core strata (30–400 m), and 61% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of rough skate on both depth ranges is medium and medium-high, respectively. Similarly, the average percentage of the catch in tows is 0.8% from core strata, and 1.1% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. This indicates that rough skate is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that rough skate should be included in the survey reports for both core strata (30–400 m) and core plus shallow strata (10–400 m). A summary of the results for rough skate and criteria met is given in Table 5.

3.12 Sand flounder (SFL)

Biology

The flounders and soles are fast growing short-lived species and the fisheries are thought to be comprised of only a few year classes. Sand flounder grow to a maximum length of about 45 cm and reach a maximum age of about 4 years (Colman 1994) with the fishery comprising mostly two and three year old fish. A maximum age of eight years, however, is suggested by Ayling & Cox (1982) and a maximum length of 45 cm. They are sexually mature at age 2 and about 25 cm when they first spawn (Colman 1974, Ayling & Cox 1982). Commercial catches of sand flounder from SeaFIC Industry log books show that the catch ranges in size from about 10 to 62 cm (considerably larger than the maximum size suggested by Colman (1974) and Ayling & Cox (1982)), but the bulk of the catch is between 25 and 45 cm (Beentjes & Manning 2010). Sand flounder MLS for the commercial fishery is 23 cm, which is also the most appropriate value for size at recruitment to the fishery.

Availability and vulnerability

Sand flounder is most abundant in FLA 7 followed by FLA 3 (FMAs 3–6) where it is particularly abundant in Otago and Canterbury Bight (Beentjes 2003). It is also the third most commonly landed flatfish species in FLA 3 after lemon sole and New Zealand sole. Sand flounder is a bottom living species most often found on sand or mud bottoms and at river mouths where they nestle into the substrate. Colman (1978) found that sand flounders tagged within the harbours of Banks Peninsula tended to disperse from the nursery grounds out into Pegasus Bay and southward into the Canterbury Bight, moving further from the tagging sites with time and as they grew larger. Spawning is also thought to take place in winter-spring with two main spawning grounds off Akaroa and Timaru in about 30 to 45 m depth — the eggs and larvae are then carried by the northward flowing currents settling in, among other areas, the harbours of Banks Peninsula. Apart from inshore and offshore spawning migrations, there is unlikely to be any significant movements in or out of the survey area.

Flatfish are caught in either standard multispecies trawls, or specialised flatfish target trawls (see Section 3.7). Flatfish are most commonly targeted between about 8 to 15 m depth, and not deeper than 50 m (Beentjes & Manning 2010). This species appears to be at least partly vulnerable to the *Kaharoa* trawl gear.

Species depth range

The distribution of sand flounder catch rates from the nine east coast South Island surveys shows that they are most commonly caught between about 10 and 30 m (Figures 1 and 2). The relatively large numbers of fish measured from the 30–100 m depth range (Figure 3) is misleading because the surveys did not begin surveying the shallow 10–30 m strata until 2007, and most catches are close to the 30 m contour (Figure 2). Sand flounder from research trawl surveys have been caught in depths ranging from about 4 to 102 m (mean 28 m), but the vast majority of the catch is taken in less than about 30 m (Anderson et al. 1998). The 10 m minimum trawl survey depth is probably not shallow enough for monitoring sand flounder.

Length frequency distributions

Sand flounder length distributions (Figure 3) show two modes in both 10 to 30 m and 30 to 100 m, with lengths ranging from about 13 to 49 cm, and overall smaller than the commercial catch. The smaller modes may be the 2+ fish, and the larger mode probably comprises several year classes, depending on the true maximum age. Females are caught in much larger numbers that males (Figure 3). The survey does not monitor pre-recruited fish (less than 23 cm) well, and recruited fish do not appear to be well represented compared to the commercial catch. Sand flounder is likely to be caught in less than 10 m which is probably why the commercial catch has larger fish than the *Kaharoa*.

Plots of time series length frequency distributions (Figure 4) are inconsistent among surveys because of low numbers, particularly in the earlier surveys. The addition of the 10–30 m depth range changes the shape of the distribution, accentuating the bimodal pattern.

Biomass estimates

Biomass in the core strata (30–400 m) shows no strong trends, but overall biomass is greater in recent years and 2012 is more than twice that of the next highest biomass in 2009 (Table 3, Figure 5). Coefficients of variation are high, ranging from 49 to 100% (mean 66%) (Table 3). The additional biomass captured in the 10–30 m depth range accounted for 66% and 41% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, it is essential to monitor the core plus shallow strata (10–400 m).

Occurrence and proportion catch

Sand flounder average occurrence in tows from core strata (30–400 m) and from core plus shallow strata is low (5% and 17% respectively) (Table 4). The average percentage of the catch in tows from core strata and core plus shallow strata is also low (less than 0.1%). The low occurrence and proportion of the catch confirms that sand flounder is not a major species within the entire survey area, although it is more important shallower than 50 m.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that sand flounder should not be included in the survey reports for core strata (30–400 m) or the core plus shallow strata (10–400 m). A summary of the results for sand flounder and criteria met is given in Table 5.

3.13 School shark (SCH)

Biology

Longevity of school shark is unknown. The oldest aged fish in the sample used for ageing by Francis & Mulligan (1998) was 25 years, but tagging studies in Australia indicate that they live to at least 45 years (Moulton et al. 1989). The maximum size fish caught from the west coast inshore trawl surveys was about 160 cm (Francis & Mulligan 1998) and commercially they range between about 90 to 170 cm (Ministry for Primary Industries 2012), but they may grow as large as large 2.5 m (Ayling & Cox 1982). School shark reach sexual maturity at about 12–17 years for males and 13–15 for females, corresponding to about 130 cm for both sexes based on the growth curves of Francis & Mulligan (1998).

Availability and vulnerability

School shark are probably neither fully demersal or pelagic as they are targeted by set netting methods, but are also caught by lining and as a trawl bycatch (Ministry for Primary Industries 2012). Their distribution is known to range from shallow inshore to well off the coast of New Zealand past the continental slope (Ministry for Primary Industries 2012). School shark biological stock boundaries are not well understood and SCH 3 is equivalent to FMA 3. Opportunistic tagging of school shark from research trawl surveys indicate that they are a mobile species with some individuals travelling to Australia (Hurst et al. 1999). Of those school shark tagged in SCH 3, about half were recaptured outside of QMA 3 including three that travelled to South Australia. School shark aggregate in shallow coastal areas over the spring-summer period for pupping, but the exact locations of these events are not well understood (Paul 1988). Mating is thought to takes place in deep water in winter time (Ministry for Primary Industries 2012). The timing of school shark inshore migrations for pupping does not overlap with the trawl survey, and hence should not affect availability. However, school shark may leave the survey grounds in winter for mating which could affect availability as well as the general extensive movements of school shark in and out of the survey area unrelated to reproduction.

School shark cannot be considered to be fully vulnerable to trawl since most of the commercial catch is taken by setnet, notwithstanding the inshore setnet bans, indicating that they may be off the bottom. Further, they are known to be very fast swimmers, more than capable of evading or swimming ahead of the *Kaharoa* trawl gear.

Species depth range

The distribution of school shark catch rates from the nine east coast South Island surveys shows that they are most often caught between about 10 and 200 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that rig have been caught in depths ranging from about 4 to 1000 m, (mean 207 m), but the vast majority of the catch is taken from a few metres to about 300 m (Anderson et al. 1998). Despite their wide depth range, the survey depth range of 10 to 400 m appears to be acceptable given that few fish were caught deeper than 200 m on any ECSI survey.

Length frequency distributions

The length frequency distributions plotted by depth range show that school shark are most common in 30–100 m with a tendency for the smallest cohorts to be in the shallower depth ranges (Figure 3). The three modes at 35, 50, and 60 cm are all pre-recruited school shark and correspond to ages of 0+, 1+, and 2+ from the age at length curves of Francis & Mulligan (1998). School shark caught in the commercial fishery are larger overall than those caught on the ECSI survey which are virtually all immature (i.e., smaller than 130 cm). The survey appears to be monitoring pre-recruited cohorts 0+, 1+, 2+ (and possibly a few more older cohorts) reasonably well, but not the recruited school shark size distribution.

Plots of time series length frequency distributions (Figure 4) are spiky because of the low numbers caught, but the size range is reasonably consistent among surveys. The addition of the 10–30 m depth range has changed the shape of the length frequency distribution slightly.

Biomass estimates

Biomass in the core strata (30–400 m) is variable, but generally higher in recent years compared with the 1990s (Table 3, Figure 5). Coefficients of variation are variable ranging from 18 to 42% (mean 25%) (Table 3), but overall are low to medium. The additional biomass captured in the 10–30 m depth range accounted for only 2.5% and 6% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012, respectively.

Occurrence and proportion catch

School shark average occurrence in tows is 40% from core strata (30–400 m), and 51% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of school shark on both depth ranges is medium. Similarly, the average percentage of the catch in tows is 0.3% from core strata, and 0.4% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. This indicates that school shark is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that school shark should be included in the survey reports for both core strata (30–400 m) and core plus shallow strata (10–400 m). A summary of the results for school shark and criteria met is given in Table 5.

3.14 Silver warehou (SWA)

Biology

The maximum age of silver warehou sampled from research tows was 23 years for a 54 cm (FL) female and 19 years for a 54 cm male (Horn & Sutton 1995). They are known to grow to about 65 cm (Ayling & Cox 1982), but growth is negligible after about age 10 (Horn & Sutton 1995) so a maximum age cannot be estimated from growth curves. They become sexually mature at about 47 cm (Hurst et al. 2000) which corresponds to an age of about 5 years from the growth curves of Horn and Sutton (1995). The larger mature silver warehou tend be found in deeper water (Ayling & Cox 1982), and probably recruit to the commercial fishery at lengths over 40 cm.

Availability and vulnerability

Silver warehou is a schooling fish with a body shape and diet that indicates a pelagic existence. It feeds on shrimps and small fish including the mid-water lantern fish (Ayling & Cox 1982), and stomachs from silver warehou caught on the ECSI trawl survey often contain salps. They clearly spend considerable time near the bottom, however, as they are an abundant and common catch on the ECSI *Kaharoa* trawl surveys as well as a common catch of commercial bottom trawling (Ministry for Primary Industries 2012). SWA 3 is equivalent to FMAs 3 (the east coast of the South Island), although silver warehou fish stock boundaries are not well understood and are at best nominal. Little is known of their movements although analyses of growth and reproductive data showed no differences between fish from the Chatham Rise, Southern Plateau, and west coast South Island (Horn et al. 2001), which would suggest that mixing may occur among these areas. Further, their body shape would suggest that they are good swimmers capable of extensive movements. There are thought to be at least five spawning areas: west coast South Island, southern South Island, eastern North Island, western Chatham Rise, and Chatham Islands – timing of spawning is in late winter for all but the Chatham Islands where it is late spring to early summer (Livingston 1988). The origin of the strong 0+ fish modes on the ECSI surveys is unknown but the local current regimes would suggest that they are from the postulated southern South Island spawning stock that drift north on the Southland current. The timing of the east coast South Island trawl survey may be an issue for mature spawning silver warehou which could be spawning elsewhere in winter, but in general the survey tends to sample juvenile immature fish that are more common on the continental shelf.

Silver warehou can be considered to be vulnerable to trawl as most of the commercial catch is bycatch from bottom trawling. We assume that silver warehou is found on the ground that is surveyed in equal proportion to that on foul ground as they are not a species known to aggregate in untrawlable foul ground.

Species depth range

The distribution of silver warehou catch rates from the nine east coast South Island surveys shows that they are caught across the full survey depth range of 10 to 400 m, but highest catch rates were in the 200 to 400 m strata off Timaru (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that silver warehou have been caught in depths ranging from about 16 to 1377 m (mean 322 m), but the vast majority of the catch is taken from about 100 to 500 m (Anderson et al. 1998). The survey depth range of 10 to 400 m is probably not deep enough to adequately monitor mature silver warehou, but is likely to be suitable for immature fish.

Length frequency distributions

The length distributions (Figure 3) show two clear modes at about 17 cm and 28 cm, and potentially a third at 39 cm (combined males, females, and unsexed) consistent with ages of 0+, 1+, and 2+ (Horn & Sutton 1995) (Figures 3 and 4). There is a tendency for the 0+ cohort (unsexed) to be more common in shallow and the 1+ and 2+ and older fish to be more common in deeper strata. Silver warehou caught in the commercial fishery are almost certainly larger overall than those caught on the ECSI survey which are virtually all immature fish (i.e., smaller than 47 cm) (Figure 3). The survey is therefore monitoring individual pre-recruited cohorts, but not fish in the recruited size range.

Plots of time series length frequency distributions (Figure 4) consistently show the presence of the pre-recruited cohorts on nearly all surveys, with indications that these could be tracked through time (modal progression). The variation in recruitment strength of the 0+ cohort among the surveys is evident. The addition of the 10–30 m depth range has not changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) in recent years is higher overall than in the 1990s by about two-fold (Table 3, Figure 5). Coefficients of variation range from 21% to 46% (mean 34%), but overall are medium (Table 3). The additional biomass captured in the 10–30 m depth range accounted for only 1.3% and 0.9% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, only the existing core strata time series in 30–400 m needs to be monitored (Table 3).

Occurrence and proportion catch

Silver warehou average occurrence in tows is 61% from core strata (30–400 m) and 65% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4) and by definition occurrence of silver warehou on both depth ranges is med-high. Similarly, the average percentage of the catch in tows is 0.6% from core strata and 0.7% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. This indicates that silver warehou is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that silver warehou should be included in the survey reports for core strata only (30–400 m). A summary of the results for silver warehou and criteria met is given in Table 5.

3.15 Smooth skate (SSK)

Biology

Longevity of smooth skate is unknown but the oldest aged fish in the sample used for ageing by Francis et al. (2001) was 24 years for a 133 cm female (pelvic length), although this has not been validated. The largest smooth skate caught was a 160 cm female from a Chatham Rise research tow (Francis 1997b) and based on the growth curve, would have a corresponding age of at least 40 years as suggested by Francis et al. (2001). The maximum sized smooth skate caught from the ECSI surveys is about 140 cm and the size range is likely to be smaller overall than those from the commercial fishery which operates deeper than the survey. Recruitment is likely to be around 40 cm. Males reach 50% sexual maturity at about 93 cm and 8 years, and females at 112 cm and 13 years (Francis et al. 2001).

Availability and vulnerability

Smooth skate are primarily a demersal species known to inhabit soft muddy bottom substrates, but are suspected of migrating into mid-water at night (Francis 2012). They are caught mainly as bycatch of trawling, but are also caught by lining (Ministry for Primary Industries 2012). Their distribution is known to range from the continental shelf and slope to about 800 m and most of the commercial catch comes from the east coast South Island in SSK 3 (Ministry for Primary Industries 2012).Smooth skate biological stock boundaries are not well understood and SSK 3 includes FMAs 3 to 6. Opportunistic tagging of smooth skate from the ECSI trawl surveys have yielded only one tag return of several hundred tagged skate and there was no recapture location provided. Smooth skate deposit two leathery egg cases at a time in spring-summer on the sea floor (Francis 1997b, Francis 2012). It is not known where they mate or lay egg cases so it is not possible to comment on whether their reproductive behaviour would have any effect on availability of smooth skate to the survey, but it seems unlikely. Their general movements are unknown, but they are not known for large scale migrations and any movement in or out of the survey area is likely to be inshore/offshore suggesting that they are not always available to the survey (i.e., if they move deeper than 400 m).

Smooth skate are likely to be fully vulnerable to trawl since most of the commercial catch is taken by this method and they are primarily a bottom dwelling species.

Species depth range

The distribution of smooth skate catch rates from the nine east coast South Island surveys shows that they are caught across the entire survey depth range from 10 to 400 m, but are most common in 30–200 m (Figures 1 and 2). Analyses of depth distributions from 292 research trawls around New Zealand show that smooth skate have been caught in depths ranging from about 13 to 1444 m, (mean 412 m), although this may include the deeper water skates *Bathyraja* spp. and *Pavoraja* spp. The vast majority of the catch that is likely to be correctly identified as smooth skate is taken from about 30 m to 600 m (Anderson et al. 1998). The survey depth range of 10 to 400 m is probably not deep enough to adequately monitor smooth skate.

Length frequency distributions

The length distributions have no clear modes and comprise multiple year classes with the possibility of a juvenile mode centred about 20 cm corresponding to 0+ fish in shallower depths (Figure 3). The rest of the distribution includes multiple year classes from about 1 to 25 years. The 30–100 m strata tend to have more larger skates than the deeper strata (Figure 3). Smooth skate caught in the commercial fishery in the survey area are probably larger overall than those from the ECSI survey in which most fish are immature (i.e., smaller than 93 cm for males and 112 cm for females). The survey appears to be monitoring pre-recruited lengths down to 0+ age, but probably not the full extent of the recruited distribution.

Plots of time series length frequency distributions (Figure 4) are reasonably consistent among surveys with differences among surveys mainly confined to recruitment of the first few year classes. No lengths were measured before 1996. The addition of the 10–30 m depth range has not changed the shape of the length frequency distribution.

Biomass estimates

Biomass in the core strata (30–400 m) in recent years is higher overall than in the 1990s (Table 3, Figure 5). Coefficients of variation are variable ranging from 18 to 35% (mean 21%) (Table 3), but overall are low to medium. The additional biomass captured in the 10–30 m depth range accounted for 0% and 3% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, indicating that in terms of biomass, only the existing core strata time series in 30–400 m should be monitored (Table 3).

Occurrence and proportion catch

Smooth skate average occurrence in tows is 48% from core strata (30–400 m), and 46% from core plus shallow strata (10–400 m) in 2007 and 2012 (Table 4). By definition occurrence of smooth skate on both depth ranges is medium. Similarly, the average percentage of the catch in tows is 0.8% from core strata, and 1.0% from core plus shallow strata, and the proportion of the catch in both depth ranges is categorised as low. This indicates that smooth skate is a common species in this area, but is not abundant.

Selection of species

The information described above was presented to the SINS WG meeting on 19th November 2012 and based on this and the criteria met, the Working Group recommended that smooth skate should be included in the survey reports for core strata (30–400 m). A summary of the results for smooth skate and criteria met is given in Table 5.

4. CONCLUSIONS

Of the initial twenty candidate QMS species that were reviewed for inclusion in the ECSI trawl survey reports (see Table 1), five had inadequate data and were not considered in terms of the criteria set out in Section 2.3. The remaining fifteen species were presented to the Southern Inshore Working Group (SINS-WG-2012-35) on the 19th November 2012, and based on survey coverage and life history, eight species were recommended for inclusion in the survey reports (BAR, LSO, LIN, RSK, SSK, SCH, SPO, and SWA). The other seven species did not qualify for inclusion in the reports (BCO, ESO, SFL, HAP, HOK, LEA, WAR), although the Working Group noted that survey data for leatherjacket and New Zealand sole in the shallow strata may be more informative after a few more surveys have been carried out. A summary of the results for each species and criteria met is given in Table 5.

For the eight species to be included in reports¸ results should be presented on catch rates, biomass (by sex, total, and recruited), and length frequency by depth range (10–30 and 30 to 400 m) for the 2012 and subsequent surveys. Time series (all surveys) of catch rates (for each tow), total biomass, and length frequency for the winter survey core strata (30–400 m) should be presented for all nine surveys, whereas for core plus shallow strata (10–400 m) this should only include 2007, 2012, and subsequent surveys.

5. ACKNOWLEDGMENTS

This research was funded by Ministry for Primary Industries (MPI) (Project INT2011-01, specific objective 7). Thanks to all NIWA scientific staff and crew on board *Kaharoa* for their contribution to the 2012 and all previous surveys dating back to 1991. Thanks to MPI Southern Inshore Working Group for the discussions that led to the final recommendations on species to include in the survey reports. Thanks to Richard O'Driscoll (NIWA), Steve Brouwer (MPI) for reviewing the draft document, and Marianne Vignaux for editorial comments.

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Table 1: Twenty candidate non-target QMS species considered for inclusion in the east coast South Island winter trawl survey reports. Species are listed in order of common name.

Species code	Common Name	Scientific Name
BAR	Barracouta	*Thyrsites atun*
BCO	Blue cod	*Parapercis colias*
WAR	Blue warehou	*Seriolella brama*
HAP	Hapuku	*Polyprion oxygeneios*
HOK	Hoki	*Macruronus novaezelandiae*
JMD	Jack mackerel (*declivis*)	*Trachurus declivis*
JMM	Jack mackerel (Peruvian)	*Trachurus symmrtricus murphyi*
JMN	Jack mackerel (yellowtail)	*Trachurus novaezelandiae*
LEA	Leatherjacket	*Parika scaber*
LSO	Lemon sole	*Pelotretis flavilatus*
LIN	Ling	*Genypterus blacodes*
ESO	New Zealand sole	*Peltorhamphus novaezeelandiae*
NOS	NZ southern arrow squid	*Nototodarus sloanii*
SPO	Rig	*Mustelus lenticulatus*
RSK	Rough skate	*Zearaja nasuta*
SFL	Sand flounder	*Rhombosolea plebeia*
SCH	School shark	*Galeorhinus galeus*
SWA	Silver warehou	*Seriolella punctata*
SSK	Smooth skate	*Dipturus innominatus*
WWA	White warehou	*Seriolella caerulea*

Table 2: Number of candidate non-target QMS species measured on the nine ECSI winter trawl surveys from core strata (30–400 m). Species are listed in order of species-code. Species considered to have sufficient numbers of fish measured to be eligible for assessment are in bold.

	KAH9105	KAH9205	KAH9306	KAH9406	KAH9606	KAH0705	KAH0806	KAH0905	KAH1207
BAR	2 582	4 509	3 553	4 354	7 542	7 298	9 250	6 000	7 353
BCO	89	71	72	460	104	170	101	337	209
ESO	0	47	22	33	45	31	35	13	84
HAP	60	42	75	38	58	120	57	104	99
HOK	83	133	527	288	747	417	713	947	517
JMD	95	109	151	143	239	42	48	72	61
JMM	59	258	216	262	1 278	13	25	114	24
JMN	5	228	44	34	82	9	23	2	1
LEA	0	0	0	0	17	479	426	352	592
LIN	483	675	658	881	1 003	423	675	735	610
LSO	0	207	387	677	257	415	428	371	361
NOS	109	0	1 600	2 659	2 194	0	0	0	0
RSK	0	0	0	0	83	409	388	392	580
SCH	69	97	144	96	157	282	214	138	186
SFL	0	11	13	5	13	44	47	5	133
SPO	150	84	45	59	56	78	136	126	145
SSK	0	0	0	0	35	300	277	406	366
SWA	244	291	535	502	1 348	1 038	1 335	652	1 018
WAR	79	217	76	127	453	451	594	422	98
WWA	0	1	105	136	6	6	10	4	70

Table 3: Estimated biomass (t) and coefficient of variation (c.v.) for fifteen non-target QMS species for the nine ECSI winter surveys from the core strata in 30–400 m) (A), and core plus shallow strata in 10–400 m (B). Biomass estimates for 1991 have been adjusted to allow for non-sampled strata (7 and 9 – equivalent to current strata 13, 16 and 17). Species are listed in order of common name. *, rough and smooth skates not separated in 1991; Biom., biomass; c.v., coefficient of variation.

A (30–400 m)

	1991		1992		1993		1994		1996		2007		2008		2009		2012	
Species code	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)	Biom. (t)	c.v. (%)
BAR	8 361	29	11 672	23	18 197	22	6 965	34	16 848	19	21 132	17	25 544	16	33 360	16	34 325	17
BCO	80	72	37	36	54	42	111	56	49	93	94	37	44	28	82	34	156	39
WAR	104	90	116	43	50	39	165	78	238	64	1 418	79	507	87	103	28	34	35
HAP	186	24	104	35	177	31	54	32	102	19	249	28	109	21	188	23	267	32
HOK	61	93	108	75	413	32	125	49	460	32	134	62	837	53	1 333	10	281	27
LEA	44	57	14	76	7	58	29	60	10	58	96	44	40	36	414	70	400	37
LSO	85	27	57	18	121	19	77	21	49	33	74	26	116	25	55	27	65	18
LIN	1 009	35	525	17	651	27	488	19	488	21	283	27	351	22	262	19	265	21
ESO	39	47	10	55	5	61	2	53	9	53	5	51	6	38	2	48	15	82
SPO	175	30	66	18	67	30	54	29	63	37	134	37	280	23	125	26	171	62
RSK	*	*	224	24	340	21	517	20	177	20	878	22	858	19	1 029	30	1 133	20
SFL	4	53	6	70	7	63	0	100	7	49	16	61	9	52	2	74	43	71
SCH	100	30	104	21	369	42	155	36	202	18	538	22	411	20	254	18	292	20
SWA	29	21	32	22	256	44	35	28	231	32	445	44	319	32	446	42	434	46
SSK	*	*	609	18	670	24	306	25	385	24	709	20	554	18	736	23	1 025	35

Table 3 – *continued*

(B) 10–400 m

Species code	2007 Biom. (t)	2007 c.v. (%)	2012 Biom. (t)	2012 c.v. (%)
BAR	24 939	19	36 526	16
BCO	94	37	157	39
WAR	1 482	76	103	38
HAP	257	27	272	31
HOK	134	62	281	27
LEA	1 327	56	1 942	31
LSO	76	25	65	18
LIN	283	27	266	21
ESO	24	59	32	43
SPO	192	30	315	37
RSK	1 261	16	1 414	16
SFL	46	47	73	44
SCH	552	21	310	19
SWA	451	43	438	46
SSK	709	20	1 053	35

Table 4: Percent occurrence (% of stations where species was caught) and percent total catch (% of all species caught on the survey) for each non-target QMS species for the nine ECSI winter surveys from core strata in 30–400 m (A), and core plus shallow strata in 10–400 m for 2007 and 2012 surveys (B). Species are listed in order of common name. NA, not applicable (see Table 3); % occc., percent occurrence.

(A) 30–400 m

	1991		1992		1993		1994		1996		2007		2008		2009		2012	
Species code	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch	% occ.	% catch
BAR	95	17.8	90	26.8	88	27.1	82	9.2	92	14.7	88	25.6	89	25.0	87	30.8	86	31.2
BCO	22	0.1	16	0.1	16	0.1	19	0.4	3	0.1	22	0.1	19	0.1	25	0.2	26	0.1
WAR	16	0.2	28	0.2	19	0.1	8	0.2	14	0.5	34	1.7	14	1.1	22	0.1	14	0.0
HAP	69	0.4	29	0.3	38	0.3	23	0.1	31	0.1	50	0.3	29	0.2	43	0.2	39	0.2
HOK	15	0.2	10	0.3	22	1.5	10	0.6	11	0.7	6	0.3	11	1.7	13	2.6	11	0.4
LEA	18	0.1	8	0.0	7	0.0	7	0.1	3	0.0	18	0.2	16	0.1	14	0.4	18	0.4
LSO	56	0.2	55	0.1	55	0.2	59	0.2	27	0.1	40	0.1	46	0.1	44	0.1	51	0.1
LIN	82	2.5	76	1.6	73	1.8	67	1.3	60	1.4	43	0.6	55	0.6	45	0.7	39	0.4
ESO	16	0.1	8	0.0	5	0.0	4	0.0	8	0.0	7	0.0	9	0.0	6	0.0	7	0.0
SPO	40	0.5	35	0.1	23	0.1	21	0.1	19	0.1	21	0.1	26	0.3	17	0.1	21	0.2
RSK	NA	NA	29	0.5	32	0.4	53	1.1	25	0.2	52	1.1	49	1.0	48	0.9	58	1.1
SFL	9	0.0	5	0.0	5	0.0	1	0.0	5	0.0	6	0.0	7	0.0	3	0.0	8	0.0
SCH	42	0.2	41	0.2	39	0.5	24	0.2	41	0.3	45	0.6	45	0.4	37	0.2	50	0.2
SWA	62	0.1	61	0.1	68	1.0	43	0.1	69	0.6	69	0.8	70	0.7	46	1.4	62	0.6
SSK	NA	NA	51	1.5	59	1.0	33	0.6	25	0.4	52	0.9	51	0.9	59	0.9	54	1.1

Table 4 – *continued*

(B) 10–400 m

	2007		2012	
	% occ.	% catch	% occ.	% catch
BAR	90	25.6	88	31.2
BCO	20	0.1	23	0.1
WAR	39	1.7	25	0.0
HAP	48	0.3	35	0.2
HOK	6	0.3	10	0.4
LEA	24	0.2	29	0.4
LSO	41	0.1	45	0.1
LIN	38	0.6	34	0.4
ESO	12	0.0	20	0.0
SPO	23	0.1	33	0.2
RSK	57	1.1	66	1.1
SFL	11	0.0	24	0.0
SCH	46	0.6	56	0.2
SWA	68	0.8	62	0.6
SSK	47	0.9	46	1.1

Table 5: Summary table of species characteristics from east coast South Island winter trawl surveys. The table should be read in conjunction with the methods. Species are listed in alphabetical order of species code. Where occurrence has two entries, the first is for core strata (30–400m) and the second for core plus shallow strata (10–400 m), otherwise it is the same for both. See Table 1 for species common names. c.v.s, coefficients of variation.

						Size range monitored				Species in report		
Species	Species is available	Species is vulnerable	Survey depth range is adequate	Occurrence	% catch	Cohorts	Pre-recruits	Recruits	Biomass c.v.s	Accept	10–400 (m)	30–400 (m)
BAR	Partially	Yes	Yes	High	High	0+, 1+, 2+	Yes	Yes	Low	Yes	Yes	Yes
BCO	Yes	Partially	Partially	Low	Low	No	Yes	Yes	Med-high	No	–	–
ESO	Yes	Partially	Yes	Low	Low	No	Yes	No	Med-high	No	Yes	Yes
LSO	Yes	Partially	Yes	Med	Low	No	No	No	Low	Yes	Yes	Yes
SFL	Partially	Partially	Partially	Low	Low	2+ ?	No	No	High	No	–	–
HAP	Partially	Partially	Yes	Med-low	Low	No	No	No	Med-low	No	–	–
HOK	Partially	Yes	Partially	Low	Low	1+, 2+, 3+	Yes	No	High	No	–	–
LEA	Partially	Partially	Yes	Low	Low	0+, 1+	Yes	Yes	High	No	–	–
LIN	Partially	Yes	Partially	Med-high	Low	No	No	Partially	Low	Yes	No	Yes
RSK	Yes	Yes	Yes	Med and Med-high	Low	No	Yes	Yes	Med-low	Yes	Yes	Yes
SSK	Partially	Yes	Partially	Med	Low	0+ ?	Yes	No	Med-low	Yes	No	Yes
SCH	Partially	Partially	Yes	Med	Low	0+, 1+, 2+	Yes	No	Med-low	Yes	Yes	Yes
SPO	Partially	Partially	Yes	Med-low	Low	1+, 2+	Yes	Partially	Med	Yes	No	Yes
SWA	Partially	Yes	Partially	Med-high	Low	0+ ,1+, 2+	Yes	No	Med	Yes	No	Yes
WAR	Partially	Yes	Yes	Low and med-low	Low	0+	Yes	No	High	No	–	–

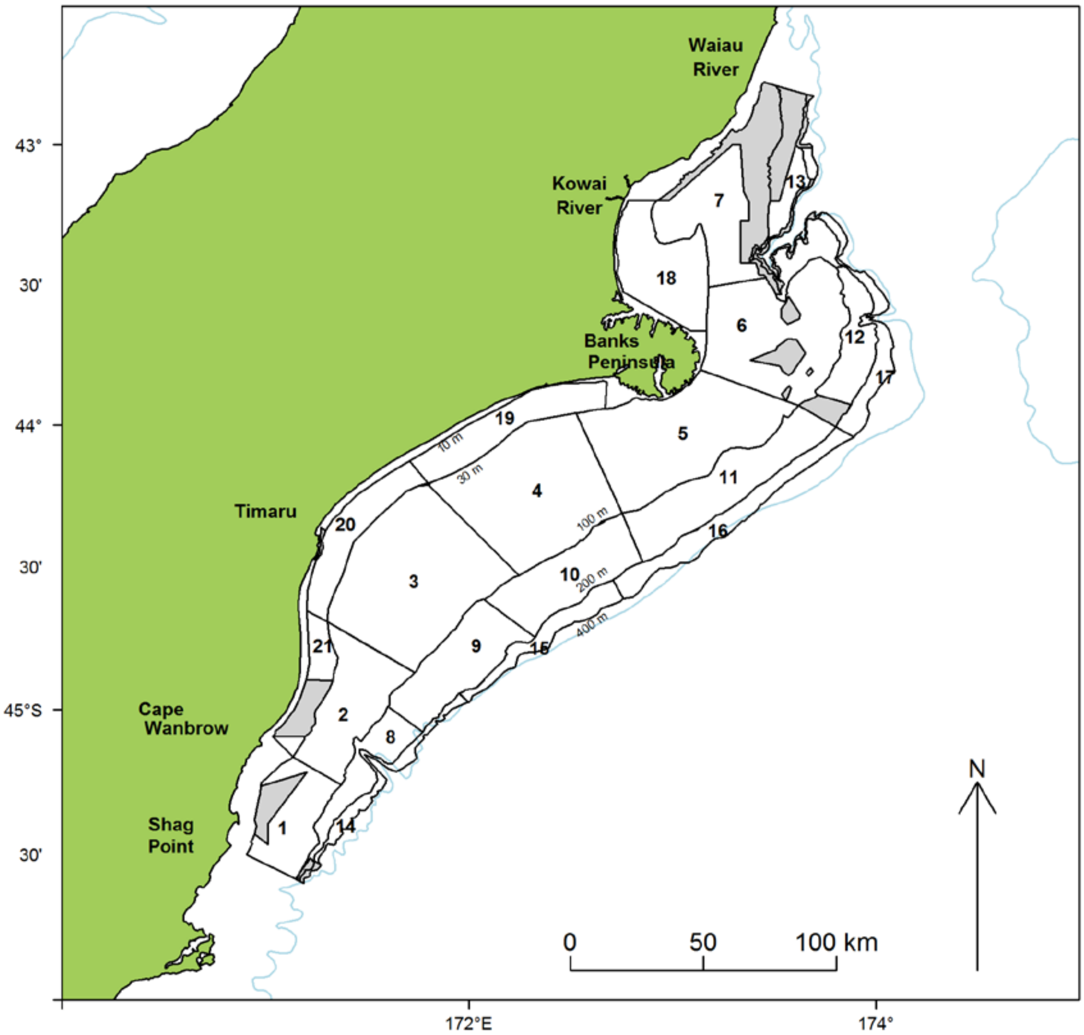


Figure 1: Strata used in the ECSI trawl survey showing core strata (30–400 m) and shallow strata (10–30 m). Shaded areas are foul ground.

Barracouta (1991 to 1996)

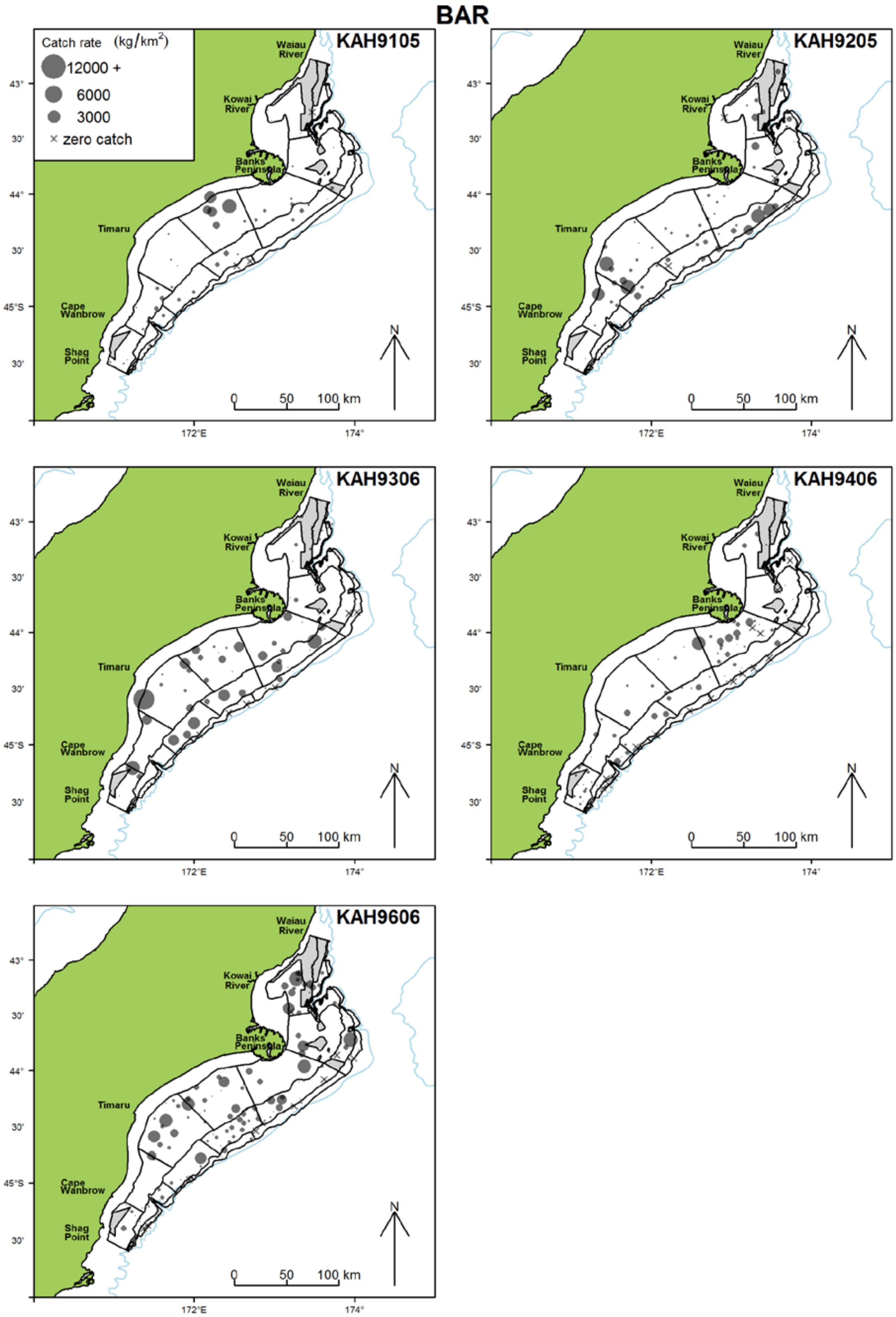


Figure 2: Catch rates (kg.km^{-2}) of non target QMS species for the nine ECSI winter trawl surveys.

Barracouta (2007 to 2012)

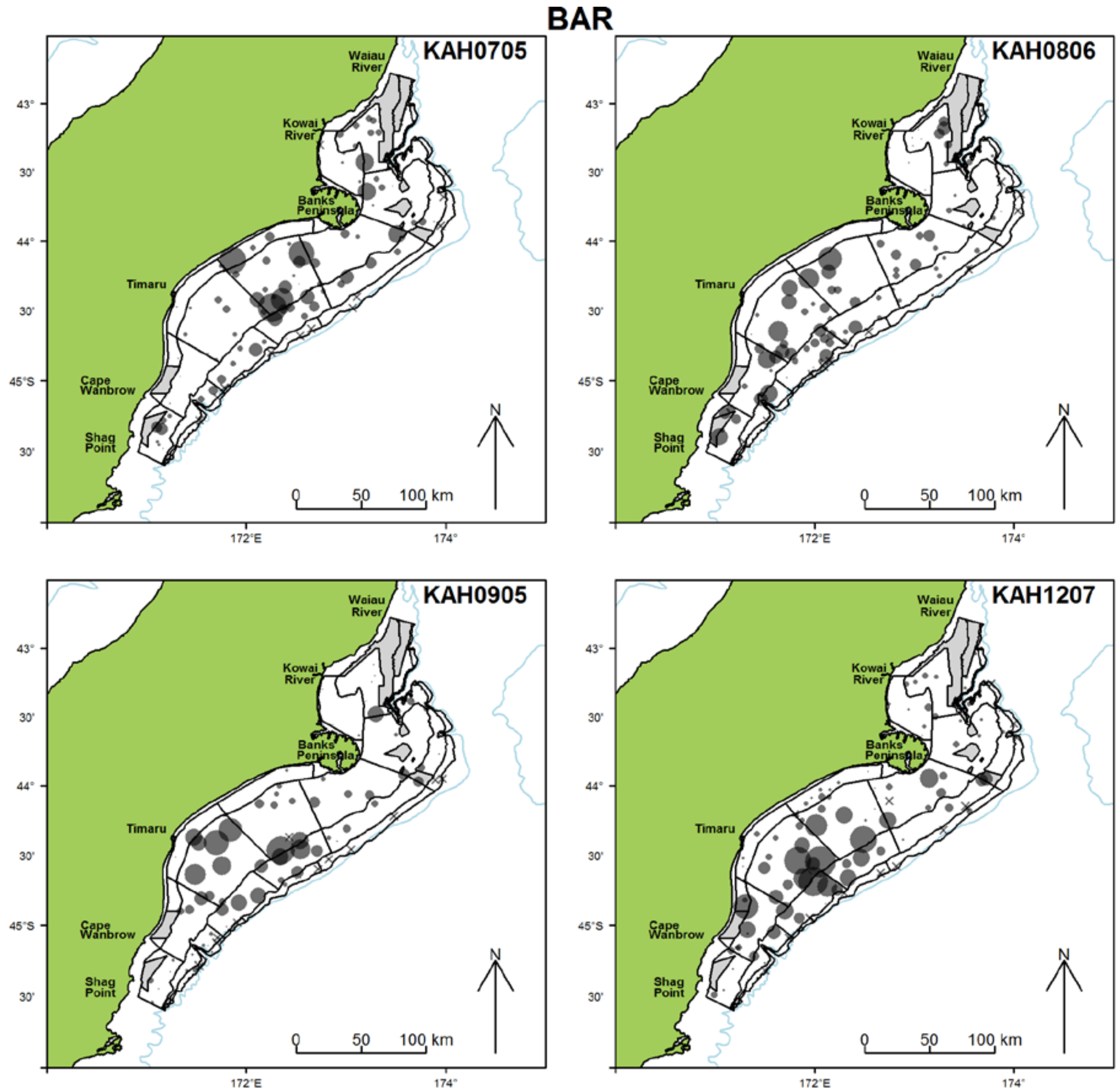


Figure 2 – *continued*

Blue cod (1991 to 1996)

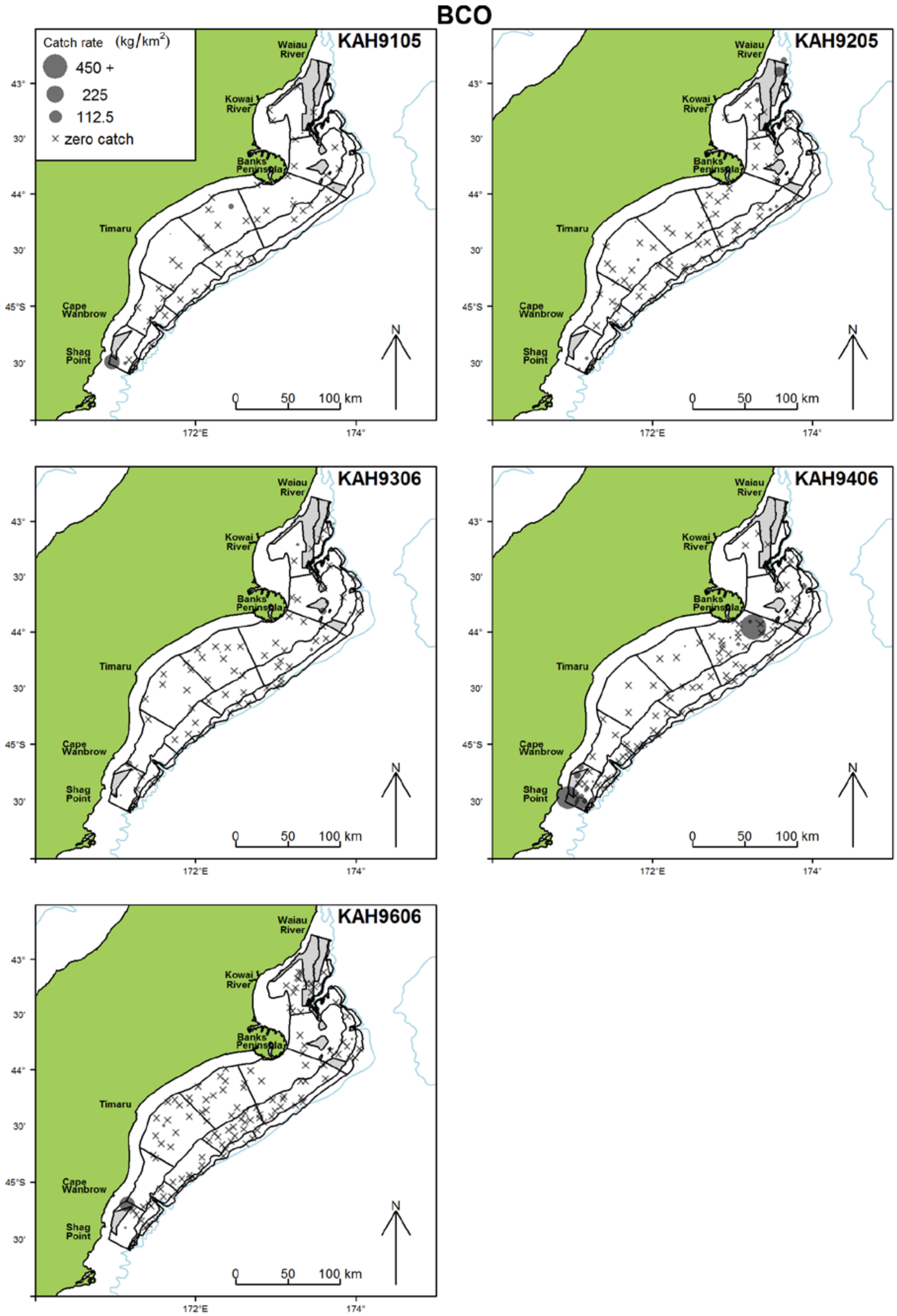


Figure 2 – ***continued***

Blue cod (2007 to 2012)

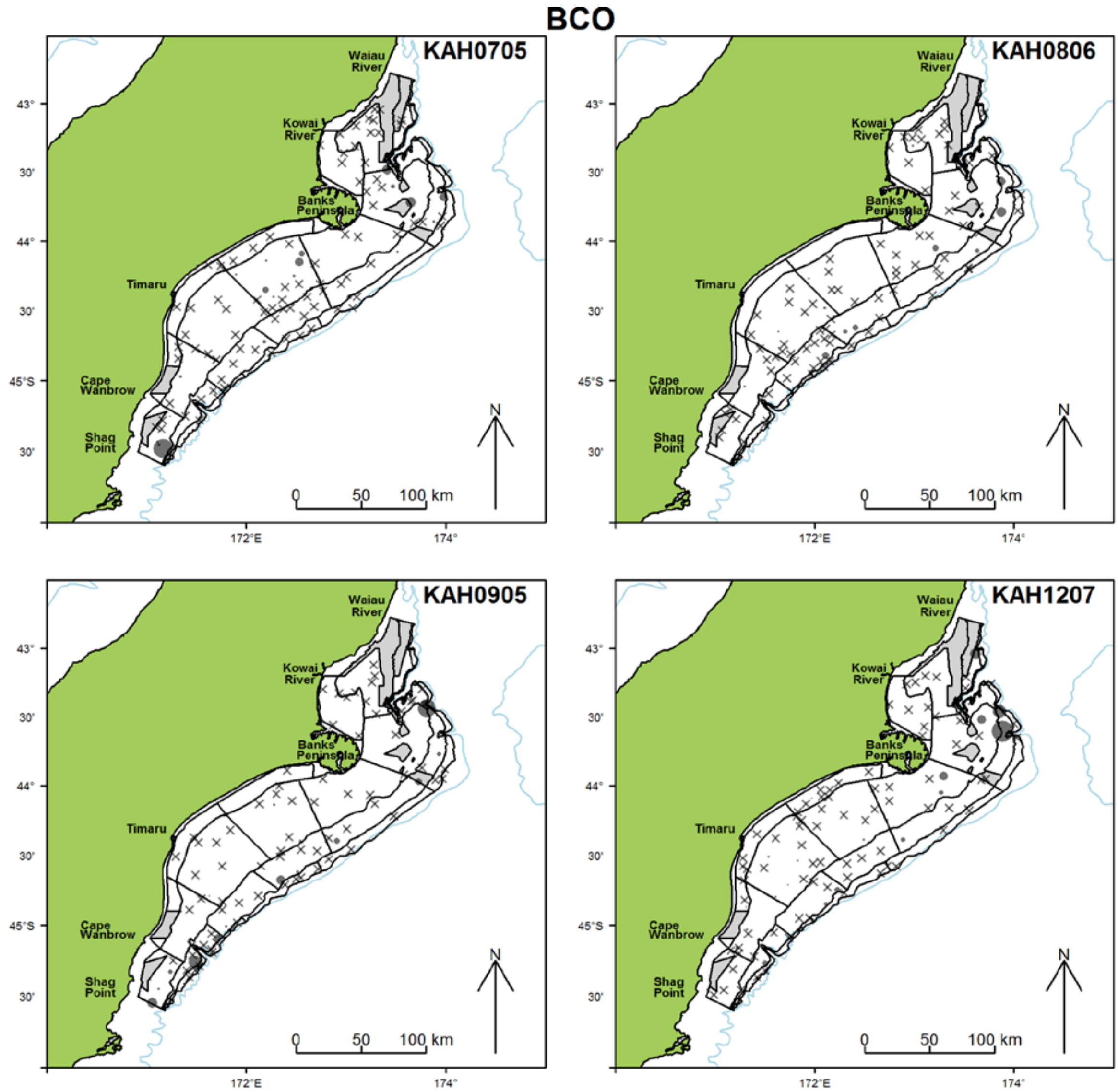


Figure 2 – ***continued***

Blue warehou (1991 to 1996)

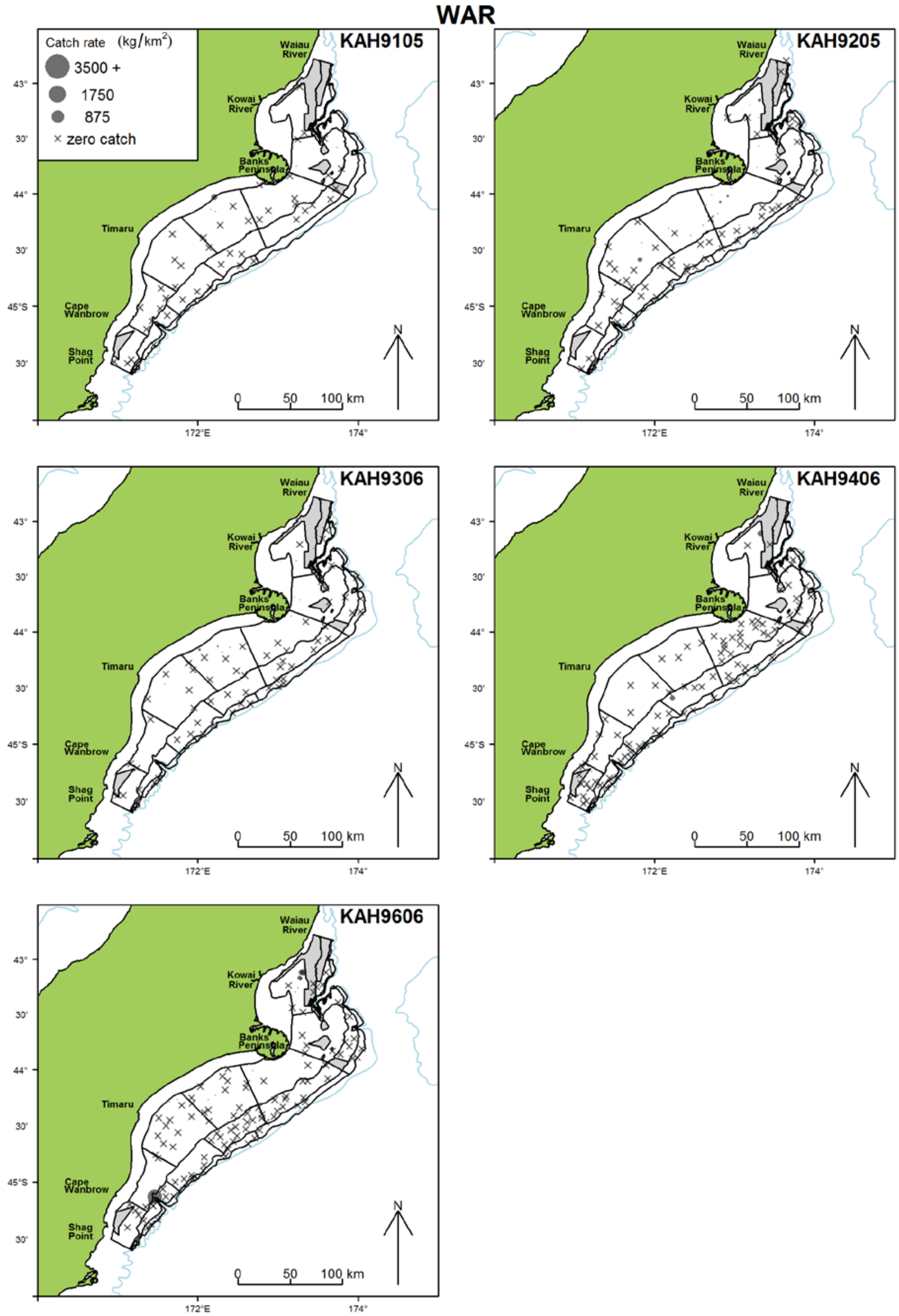


Figure 2 – *continued*

Blue warehou (2007 to 2012)

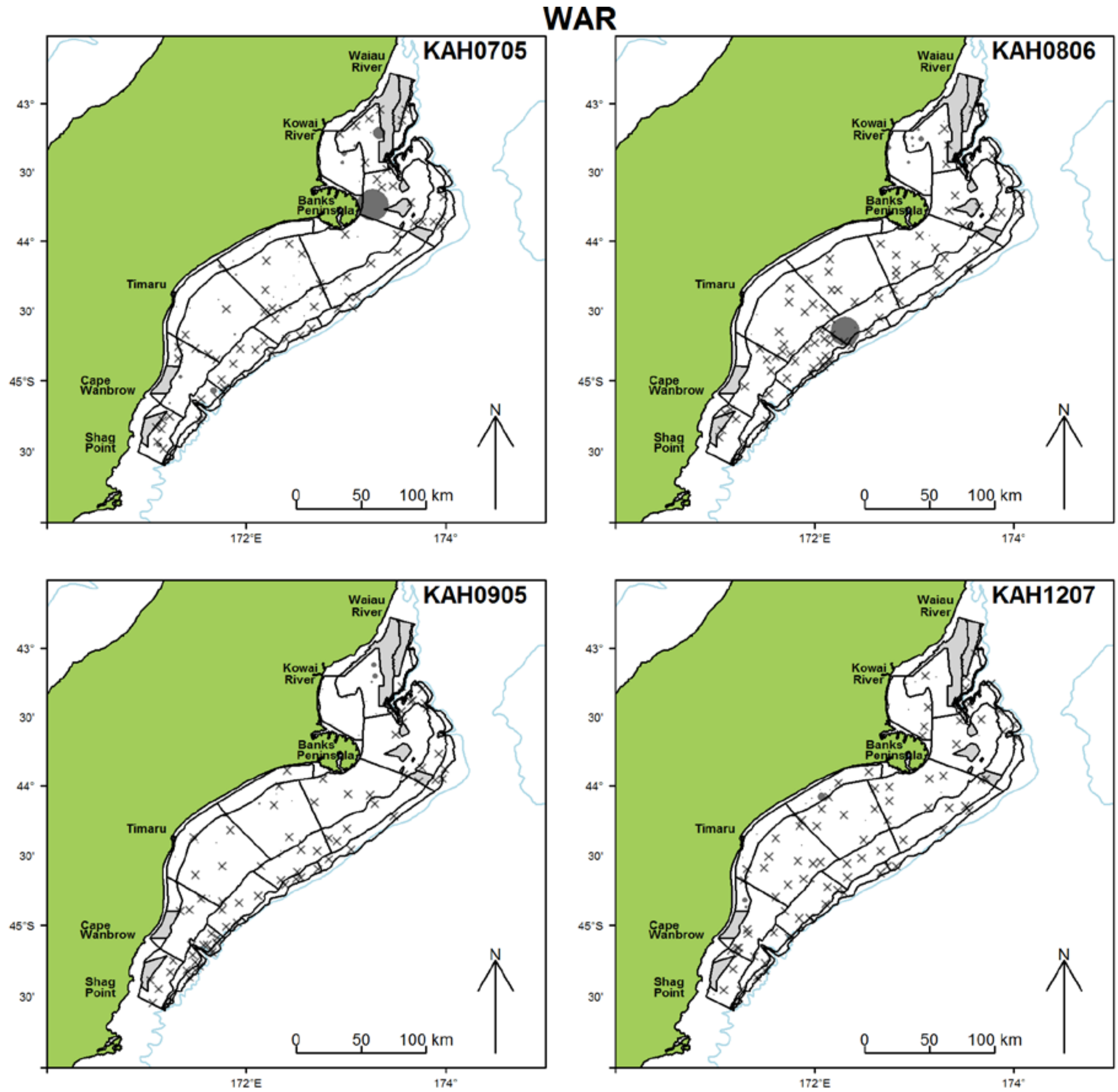


Figure 2 – ***continued***

Hapuku (1991 to 1996)

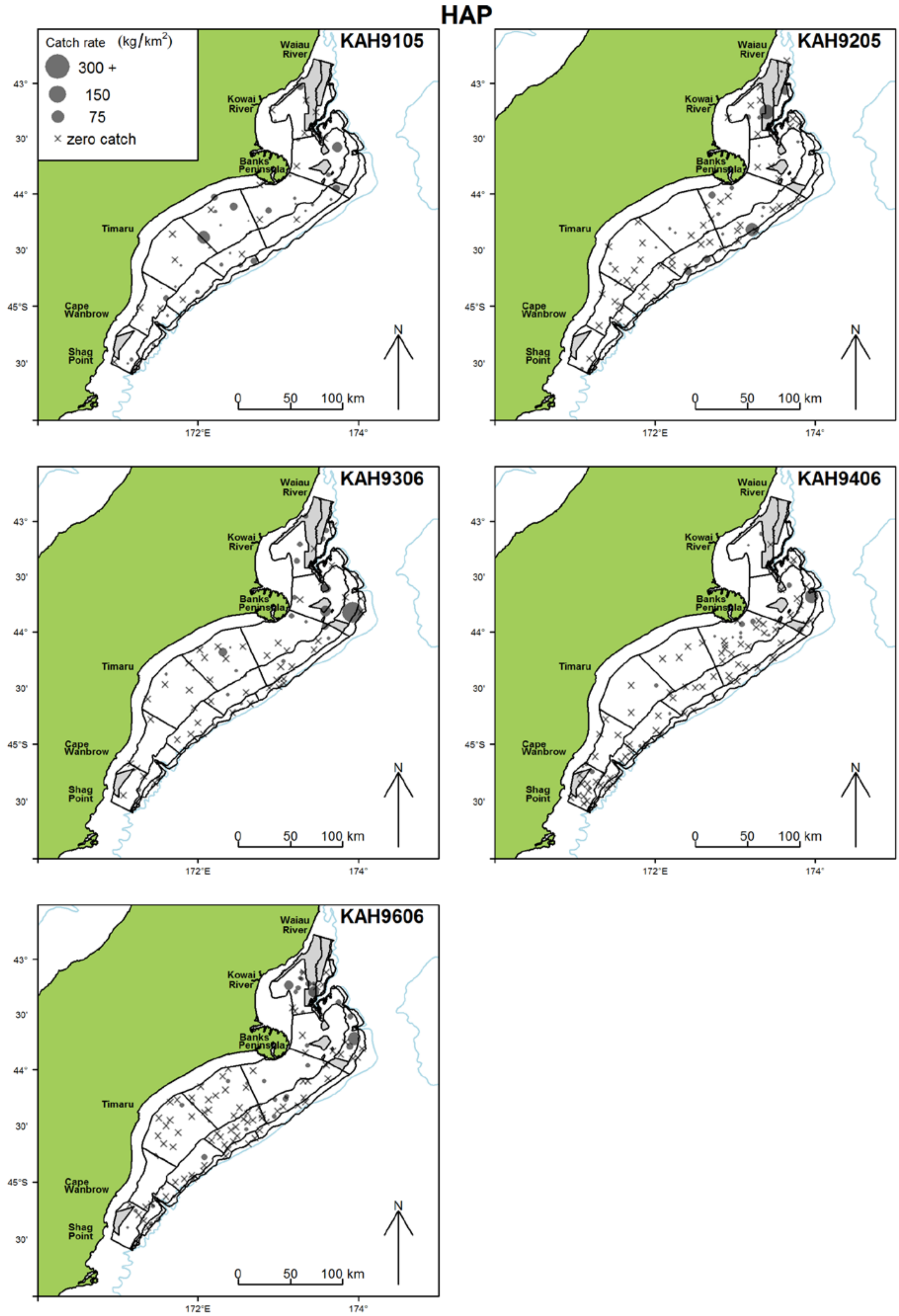


Figure 2 – ***continued***

Hapuku (2007 to 2012)

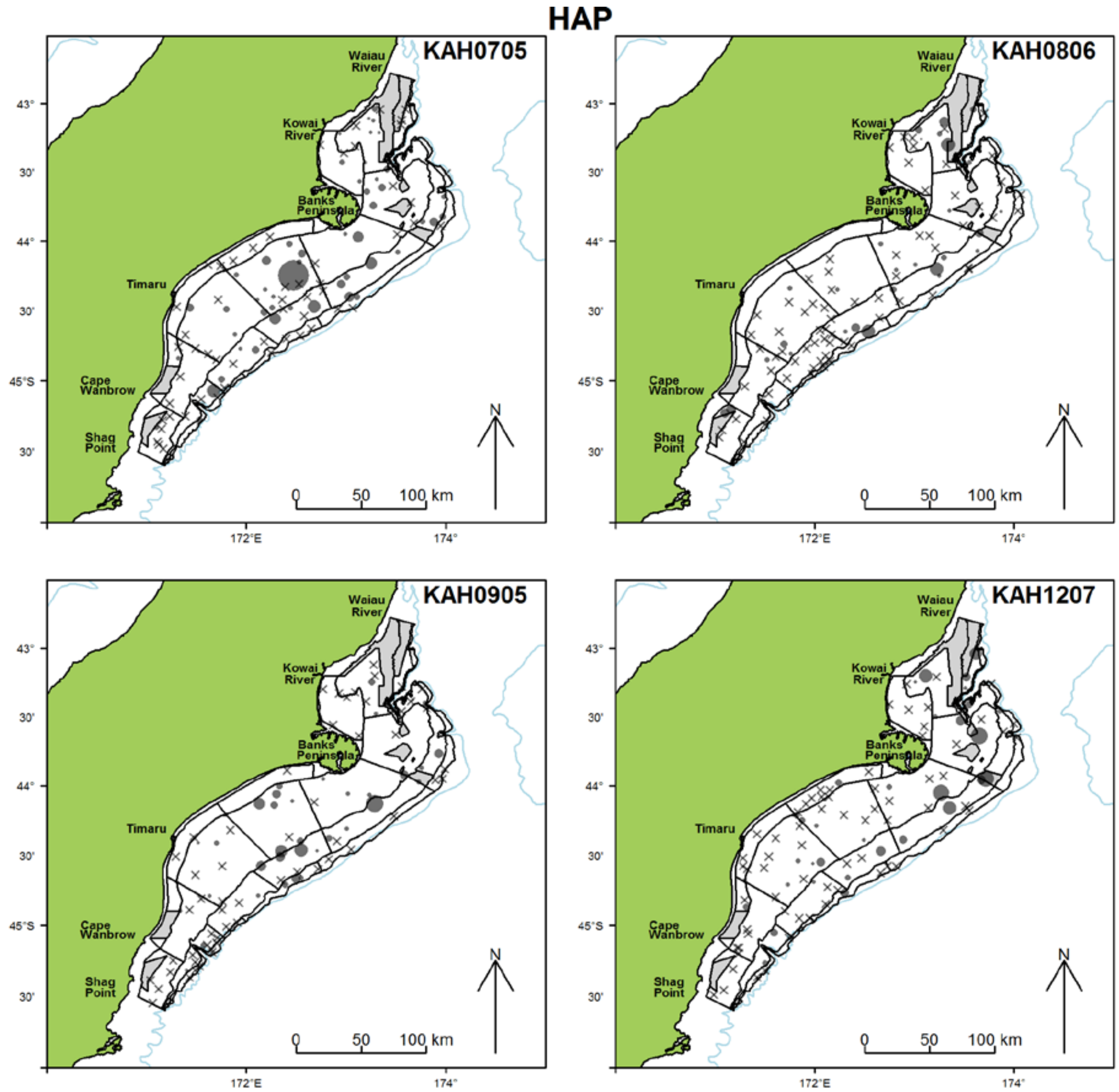


Figure 2 – ***continued***

Hoki (1991 to 1996)

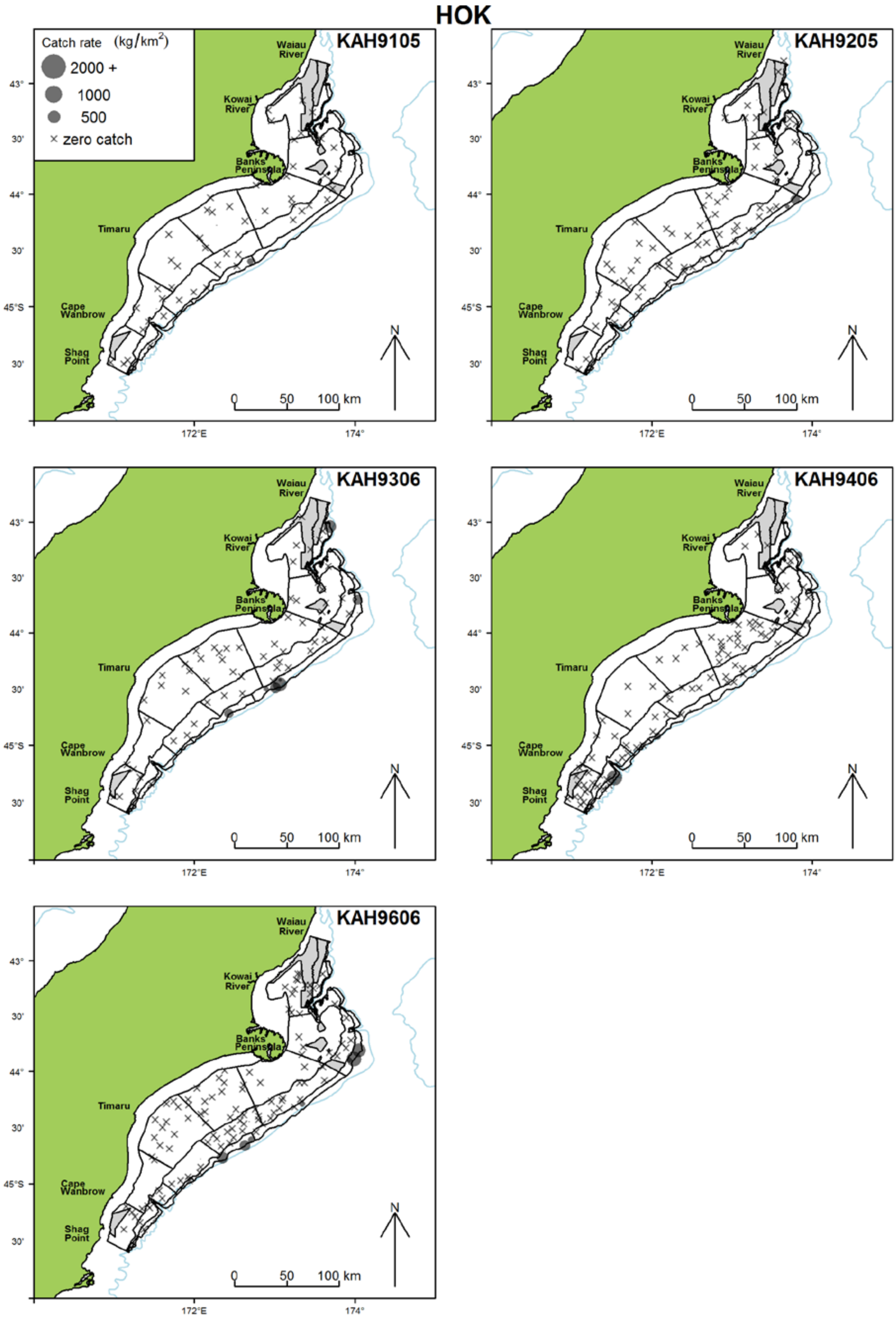


Figure 2 – *continued*

Hoki (2007 to 2012)

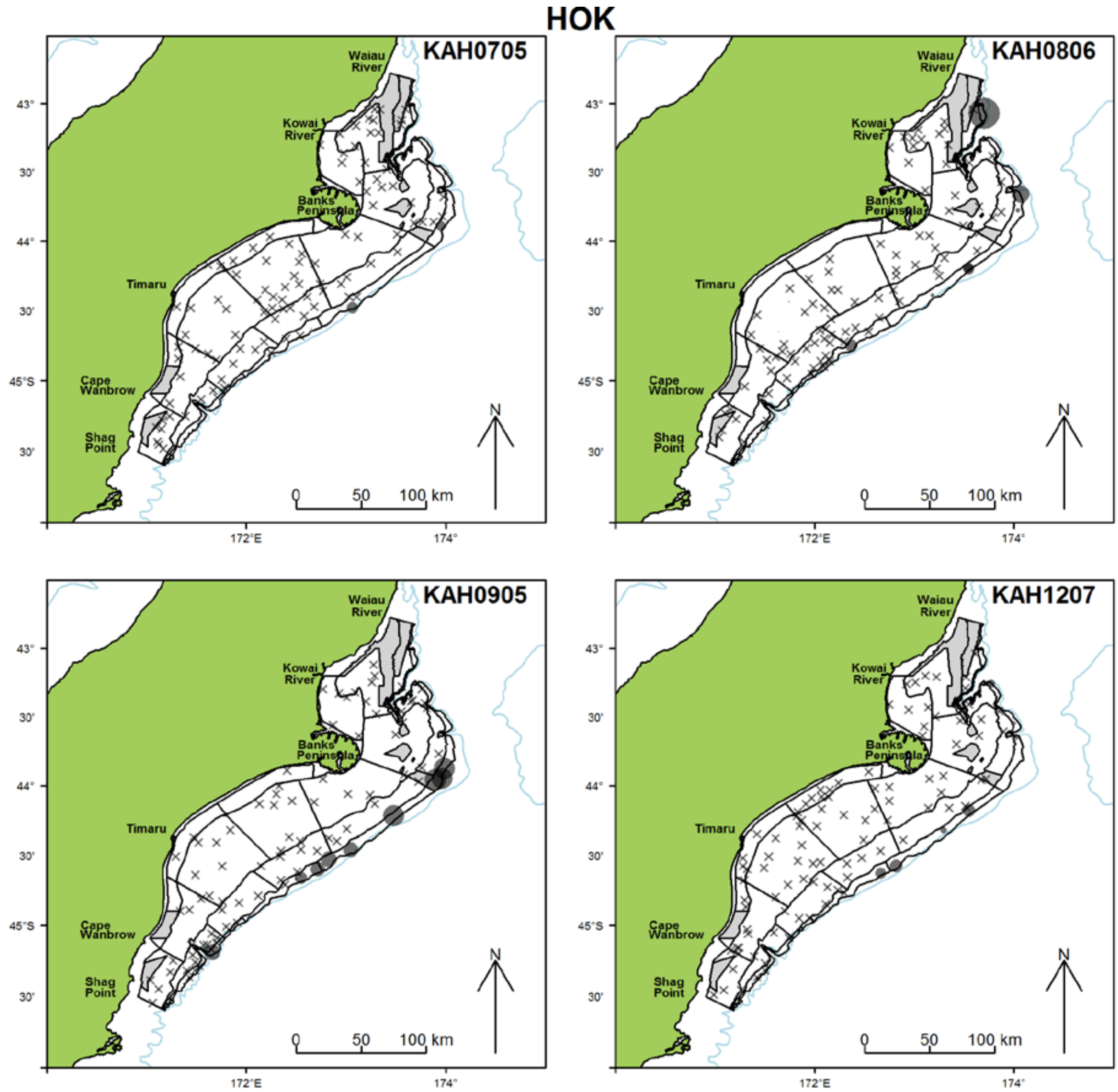


Figure 2 – ***continued***

Leatherjacket (1991 to 1996)

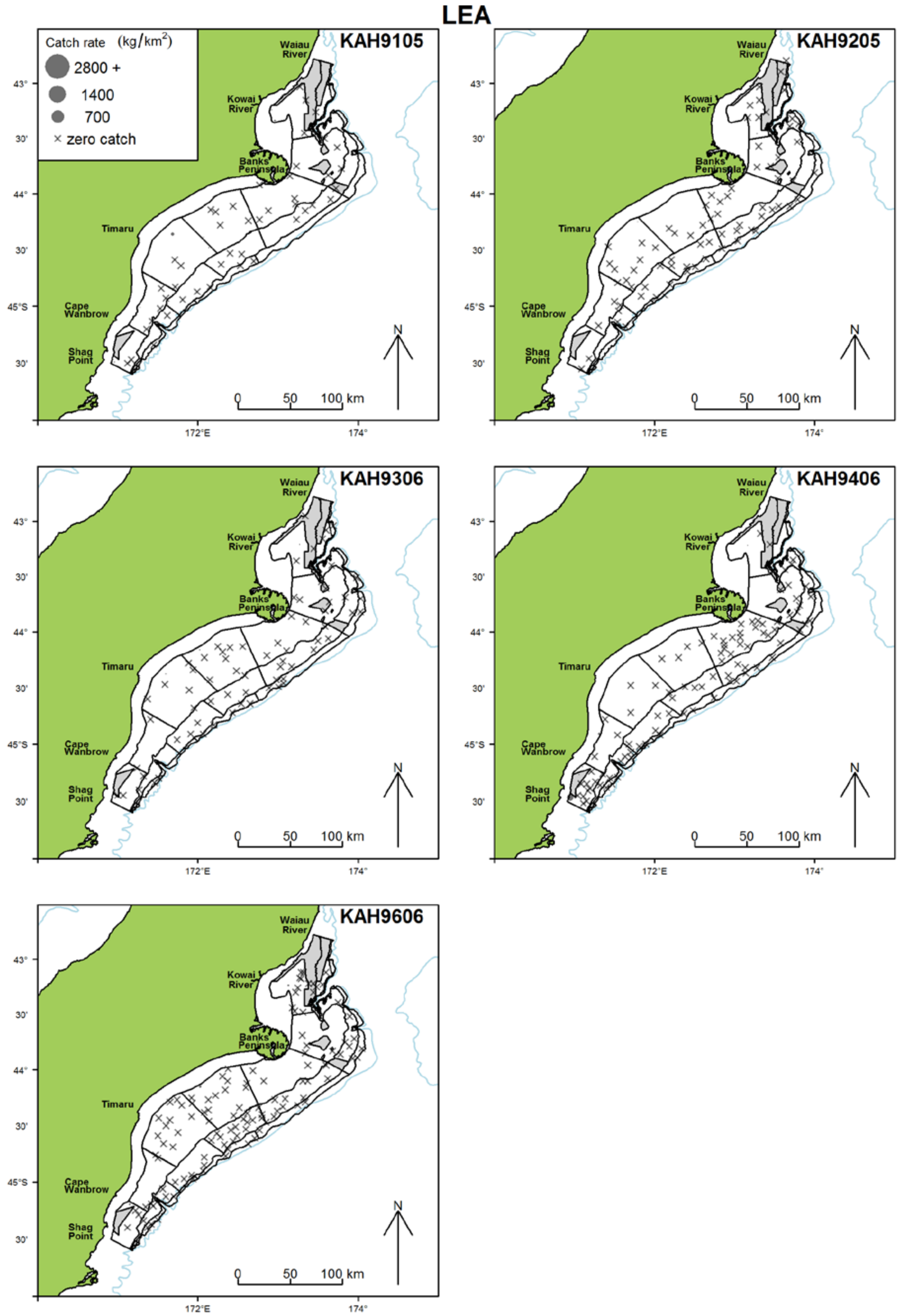


Figure 2 – ***continued***

Leatherjacket (2007 to 2012)

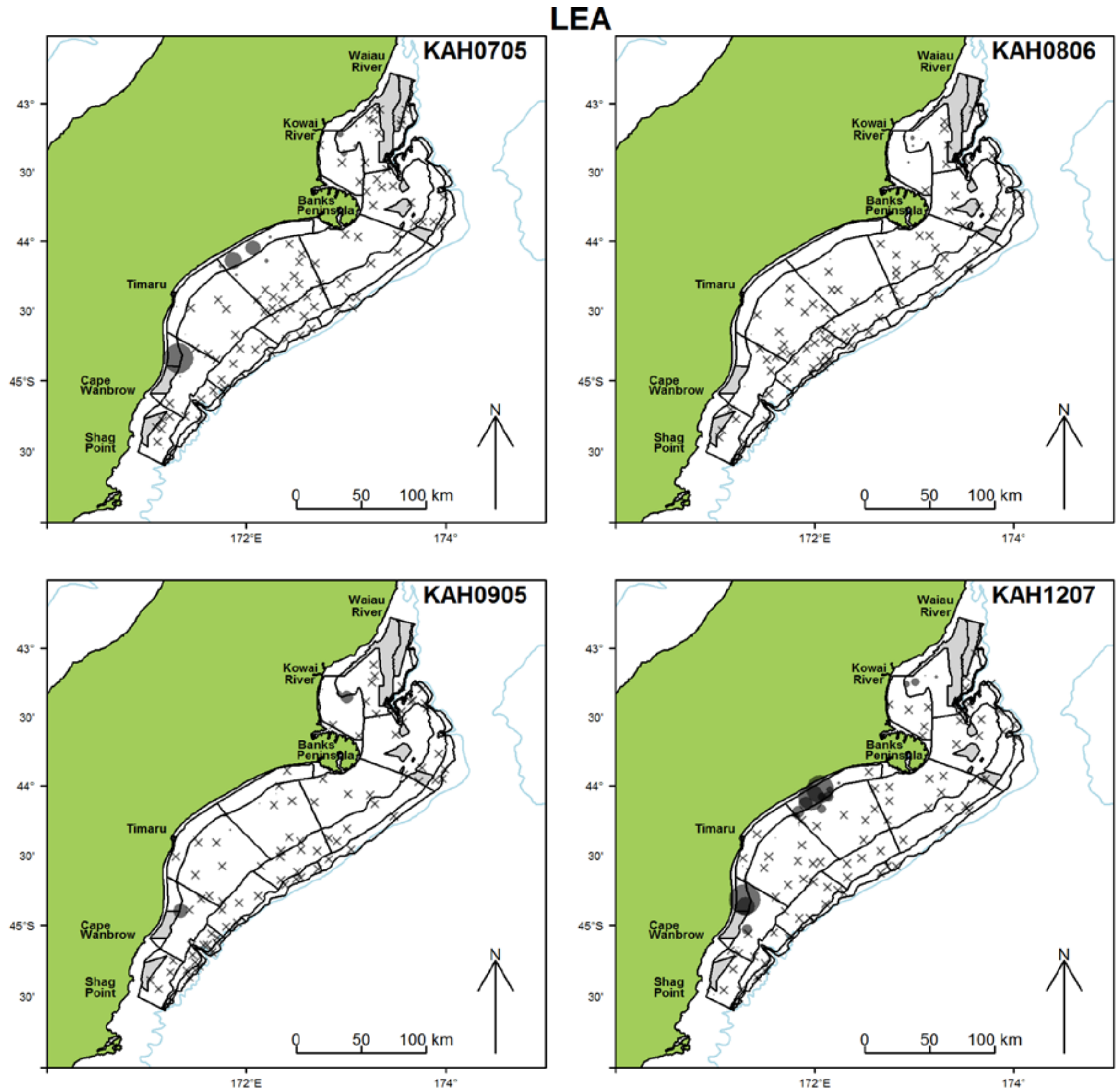


Figure 2 – ***continued***

Lemon sole (1991 to 1996)

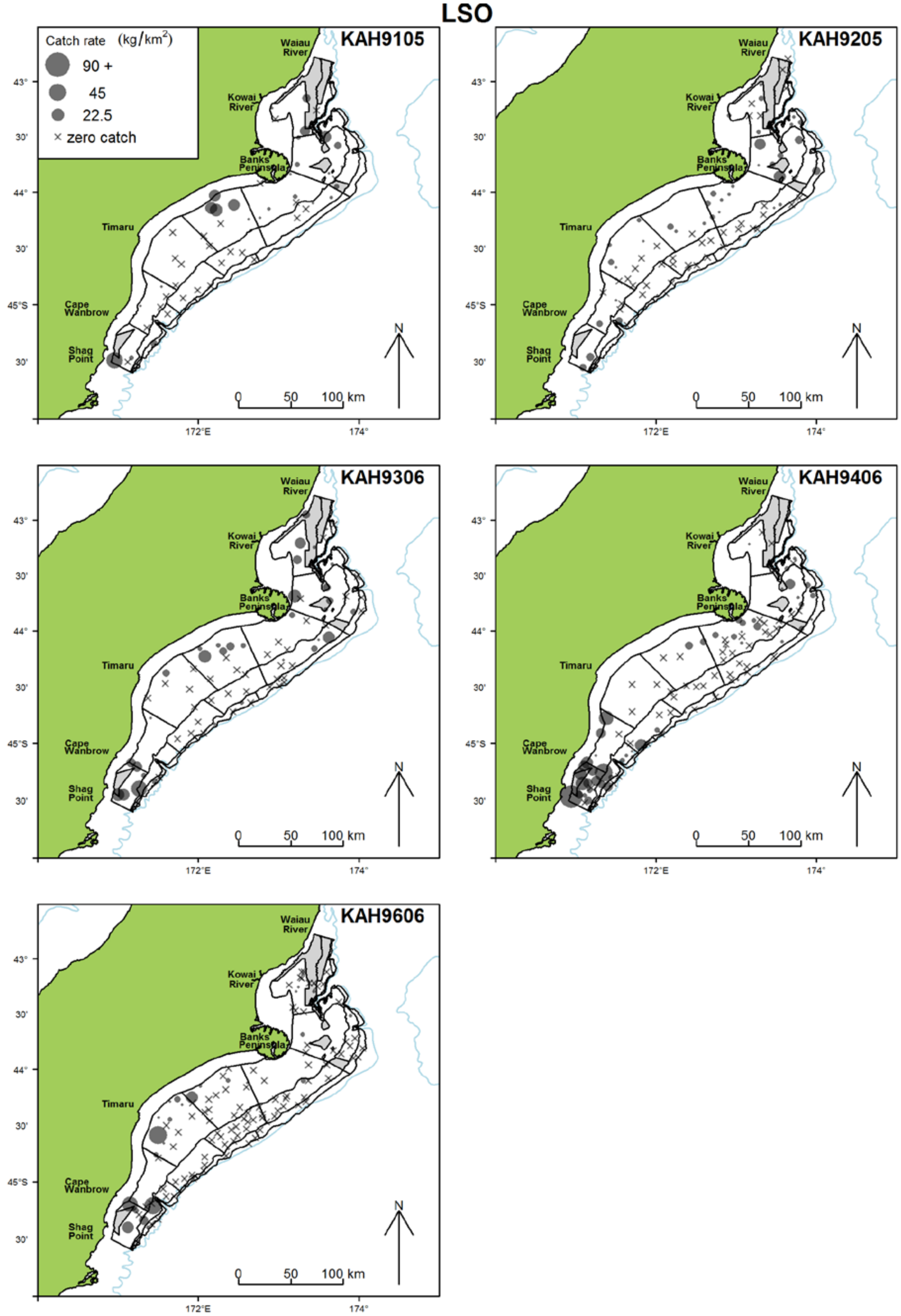


Figure 2 – ***continued***

Lemon sole (2007 to 2012)

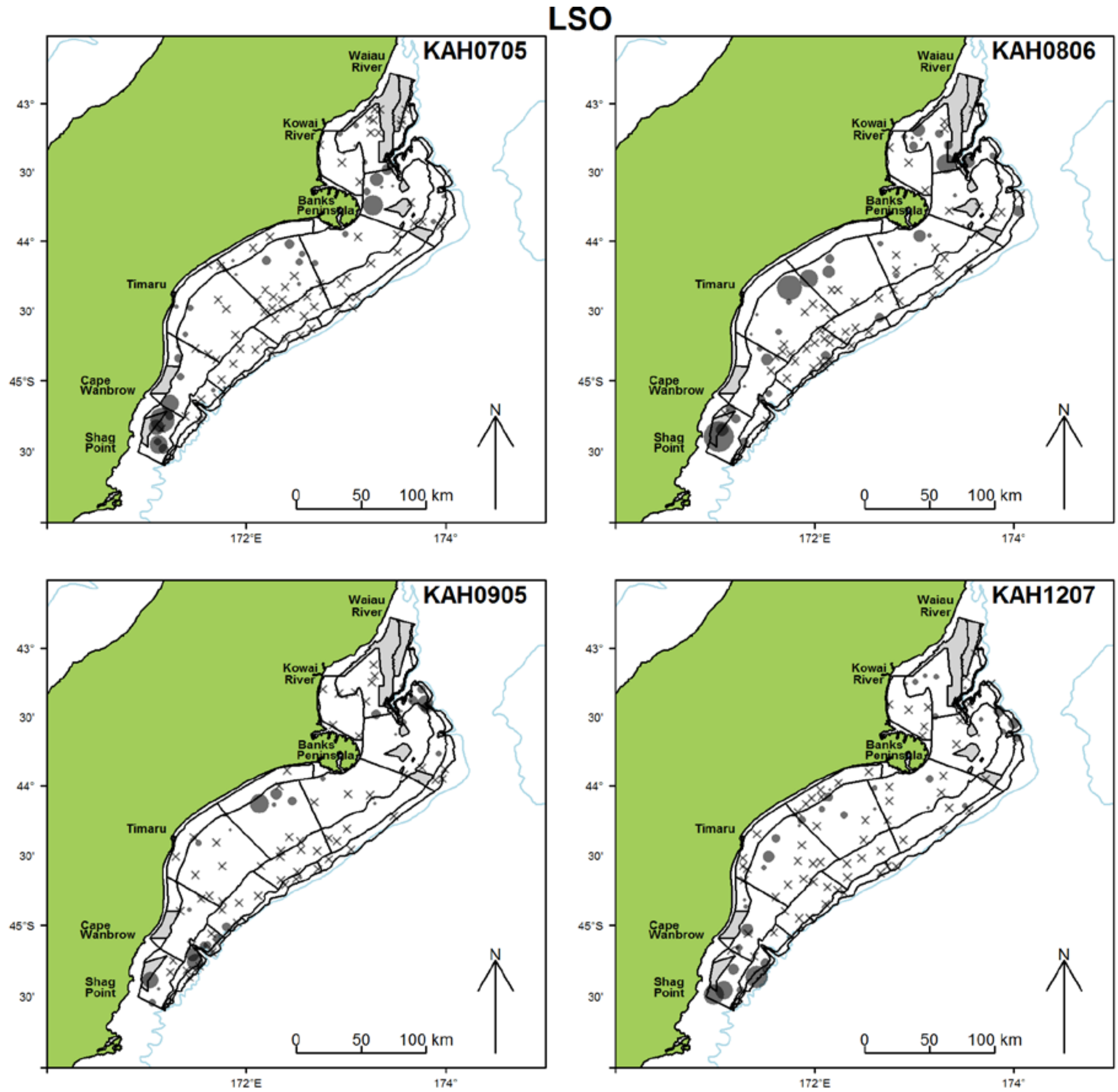


Figure 2 – *continued*

Ling (1991 to 1996)

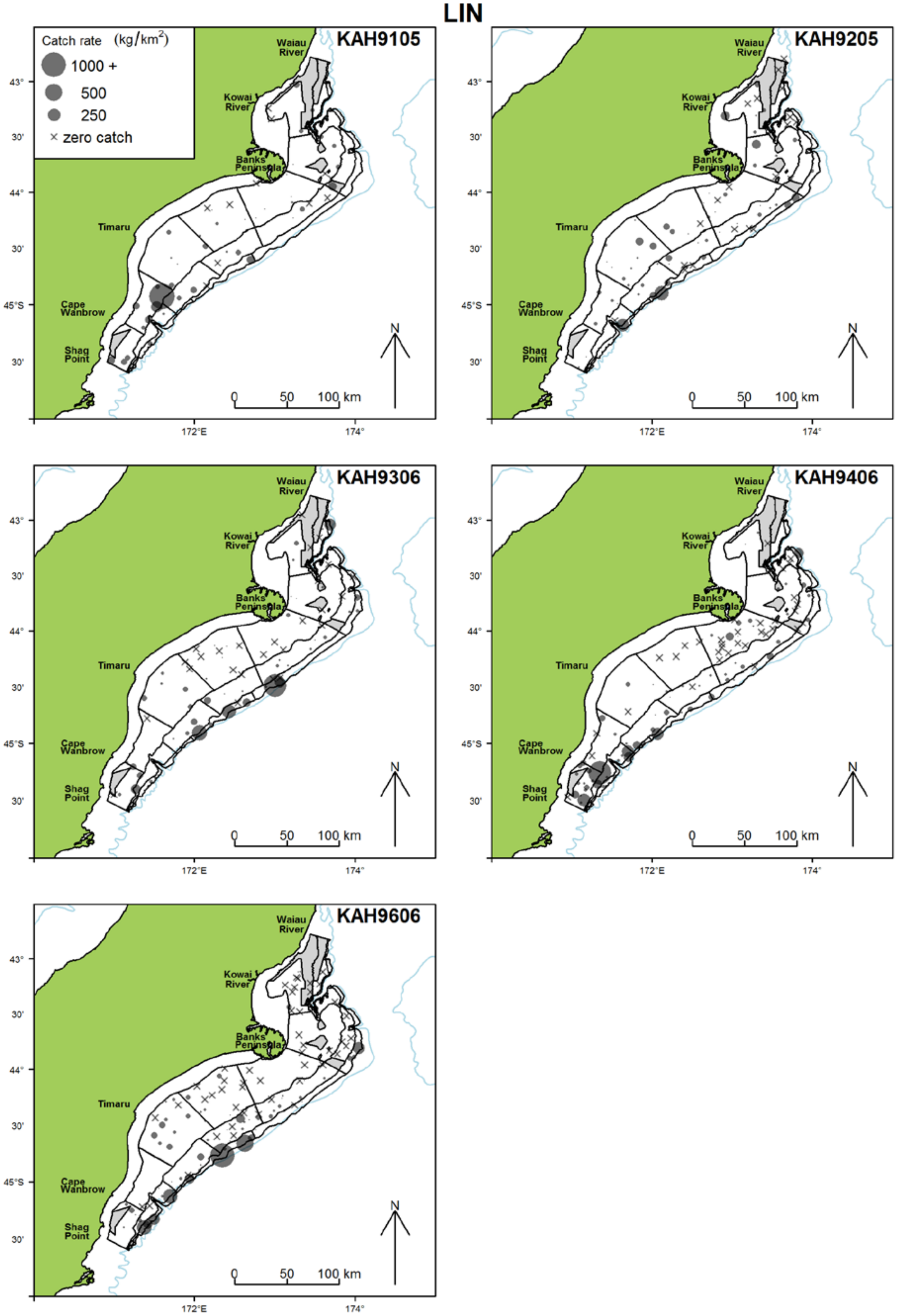


Figure 2 – ***continued***

Ling (2007 to 2012)

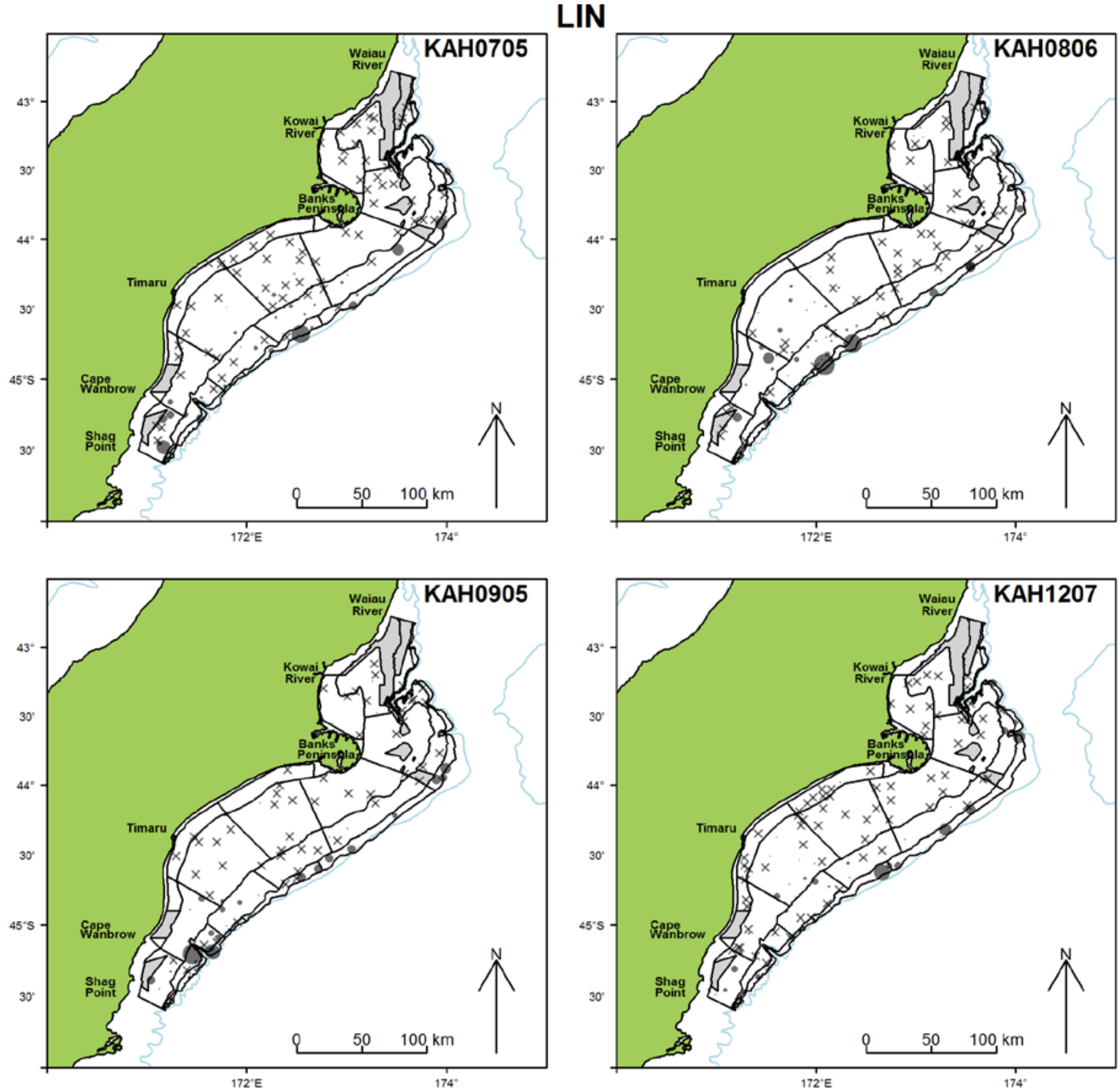


Figure 2 – *continued*

New Zealand sole (1991 to 1996)

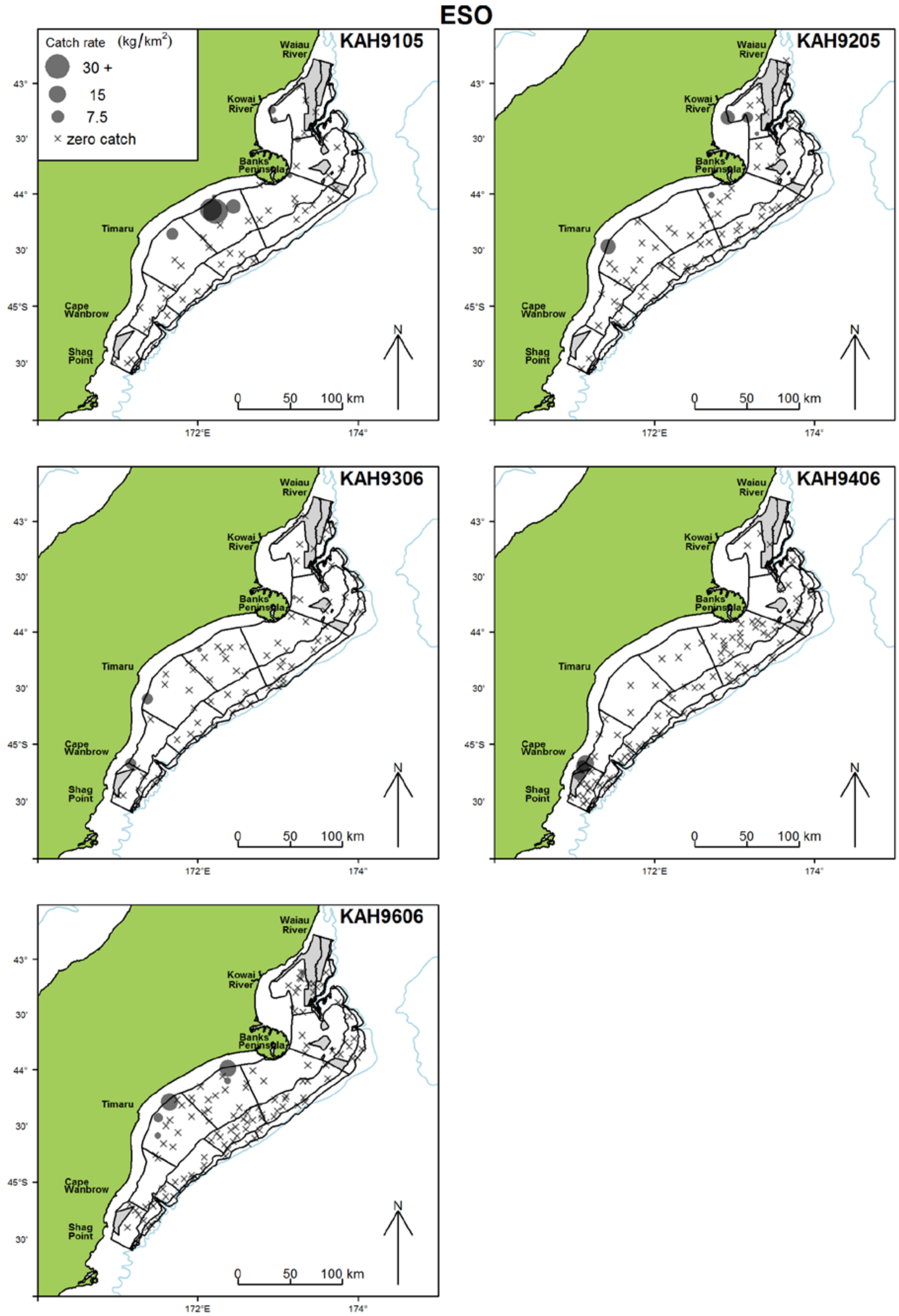


Figure 2 – ***continued***

New Zealand sole (2007 to 2012)

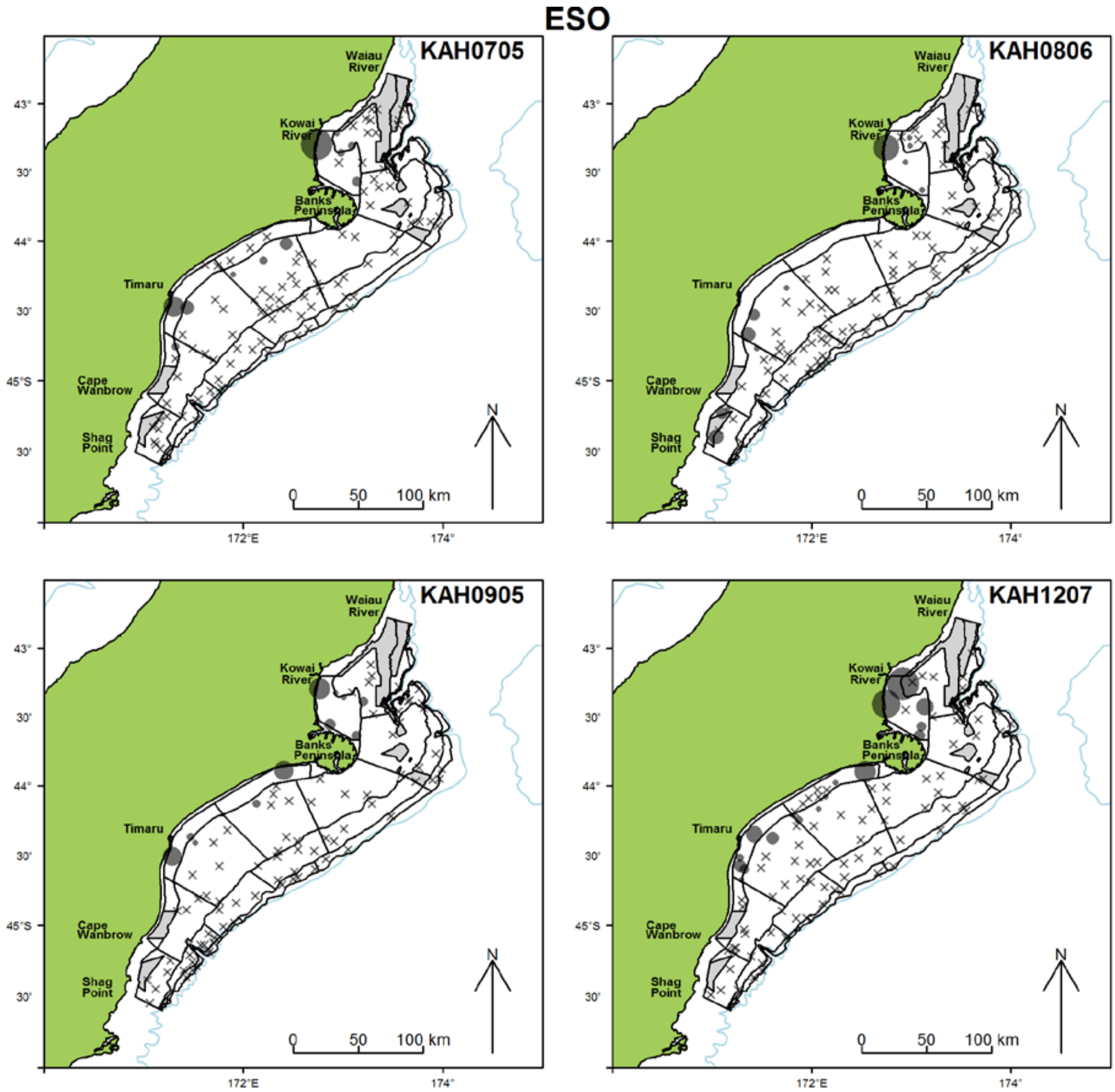


Figure 2 – *continued*

Rig (1991 to 1996)

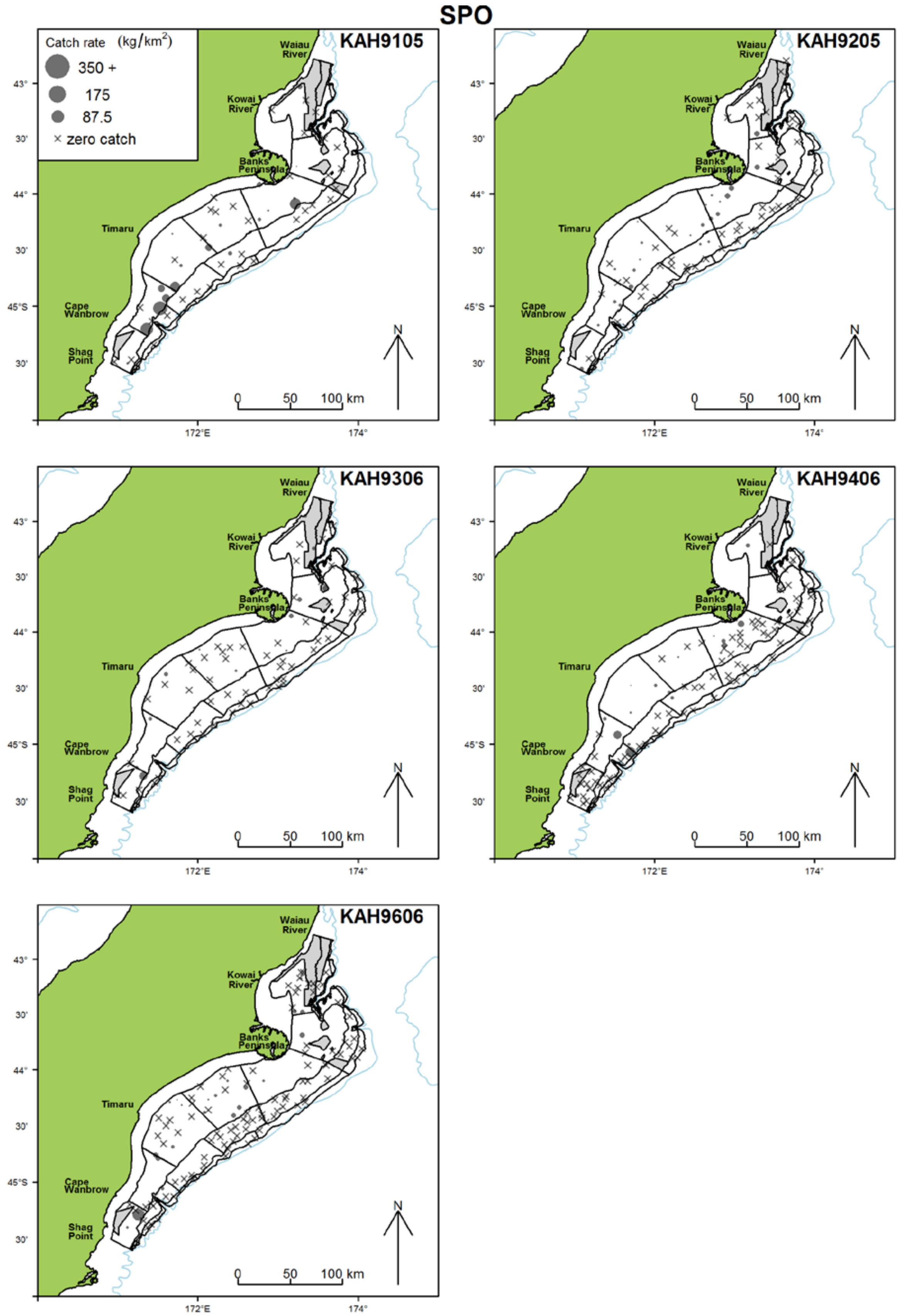


Figure 2 – *continued*

Rig (2007 to 2012)

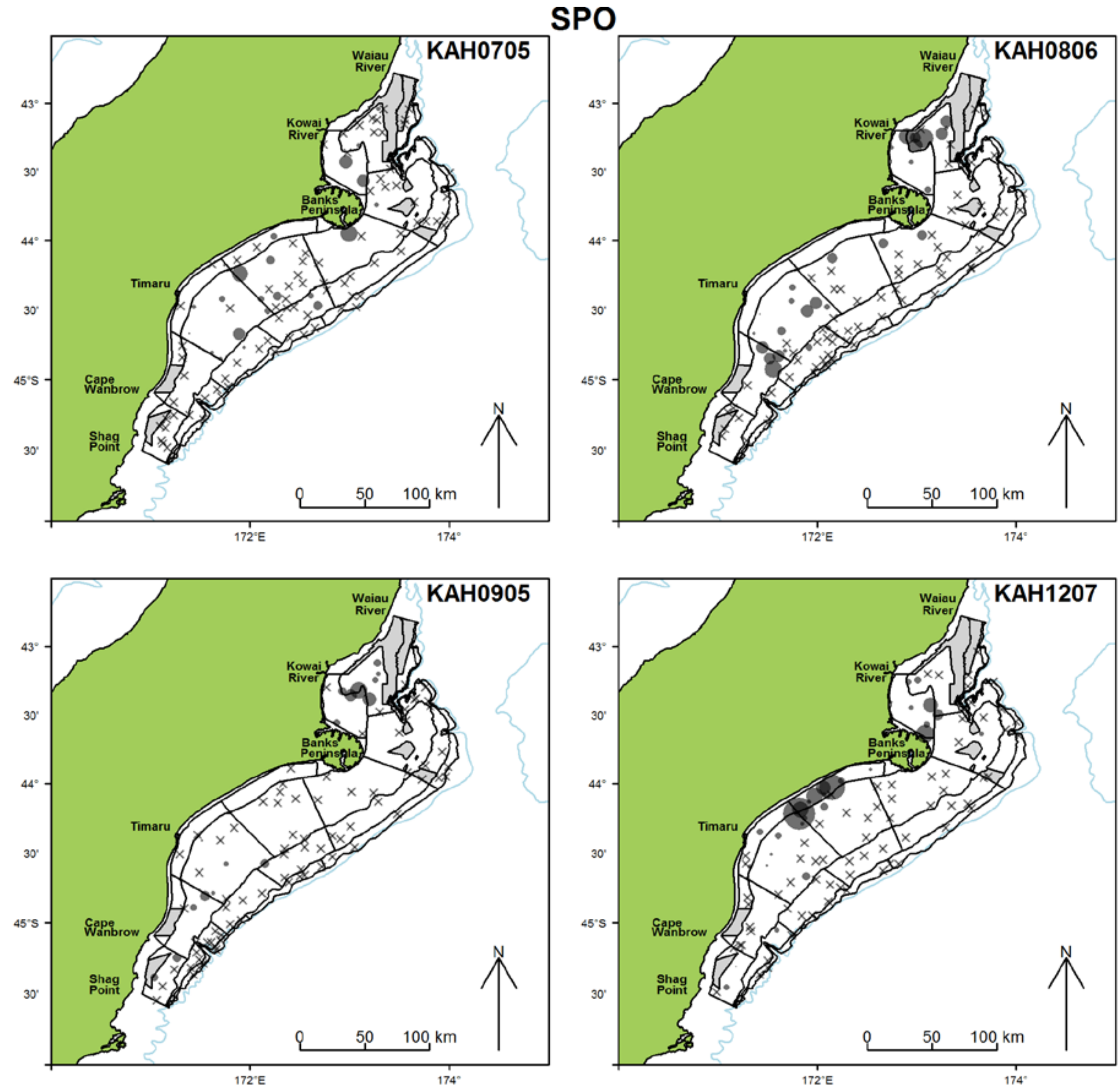


Figure 2 – ***continued***

Rough skate (1991 to 1996)

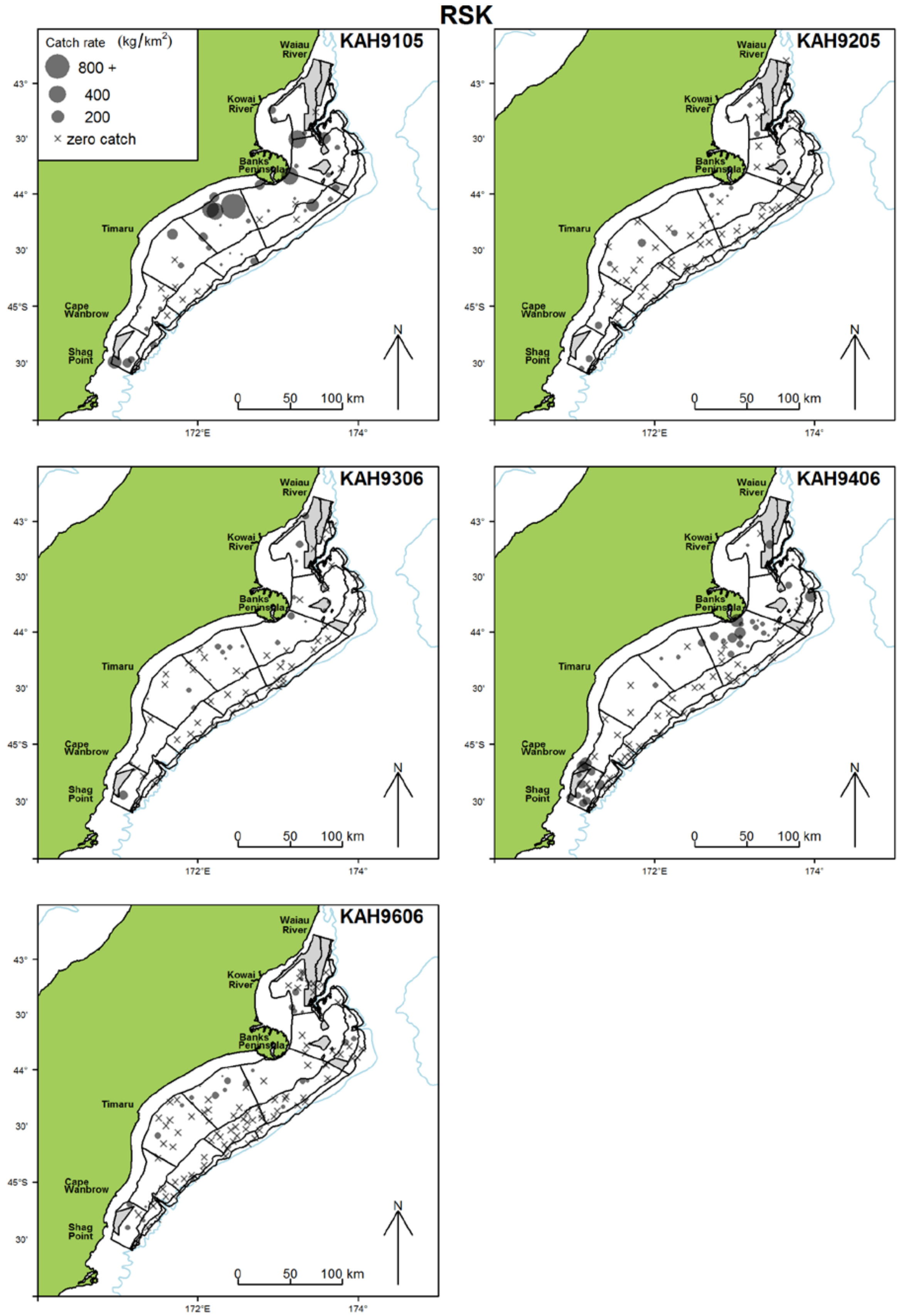


Figure 2 – *continued*

Rough skate (2007 to 2012)

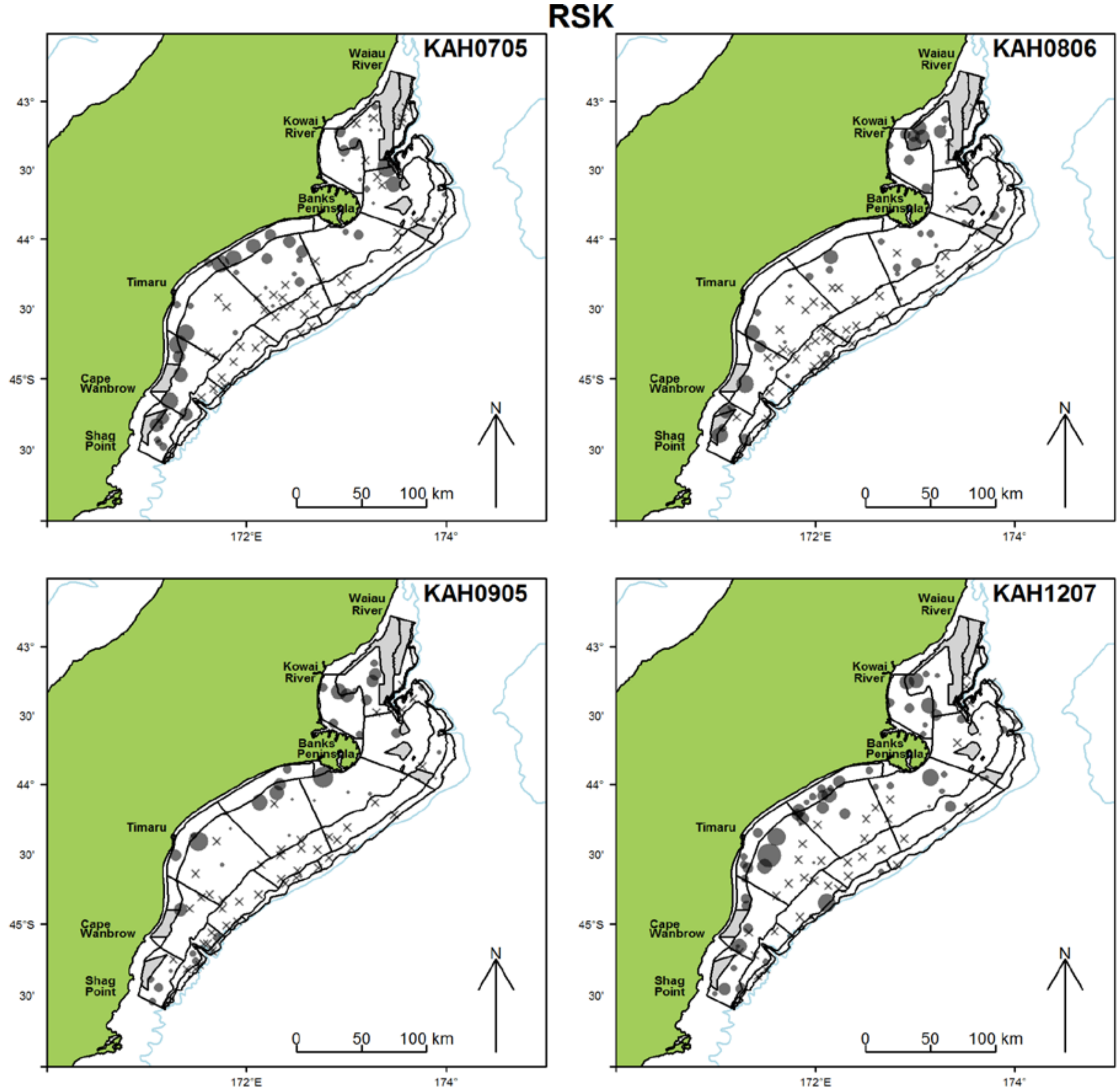


Figure 2 – *continued*

Sand flounder (1991 to 1996)

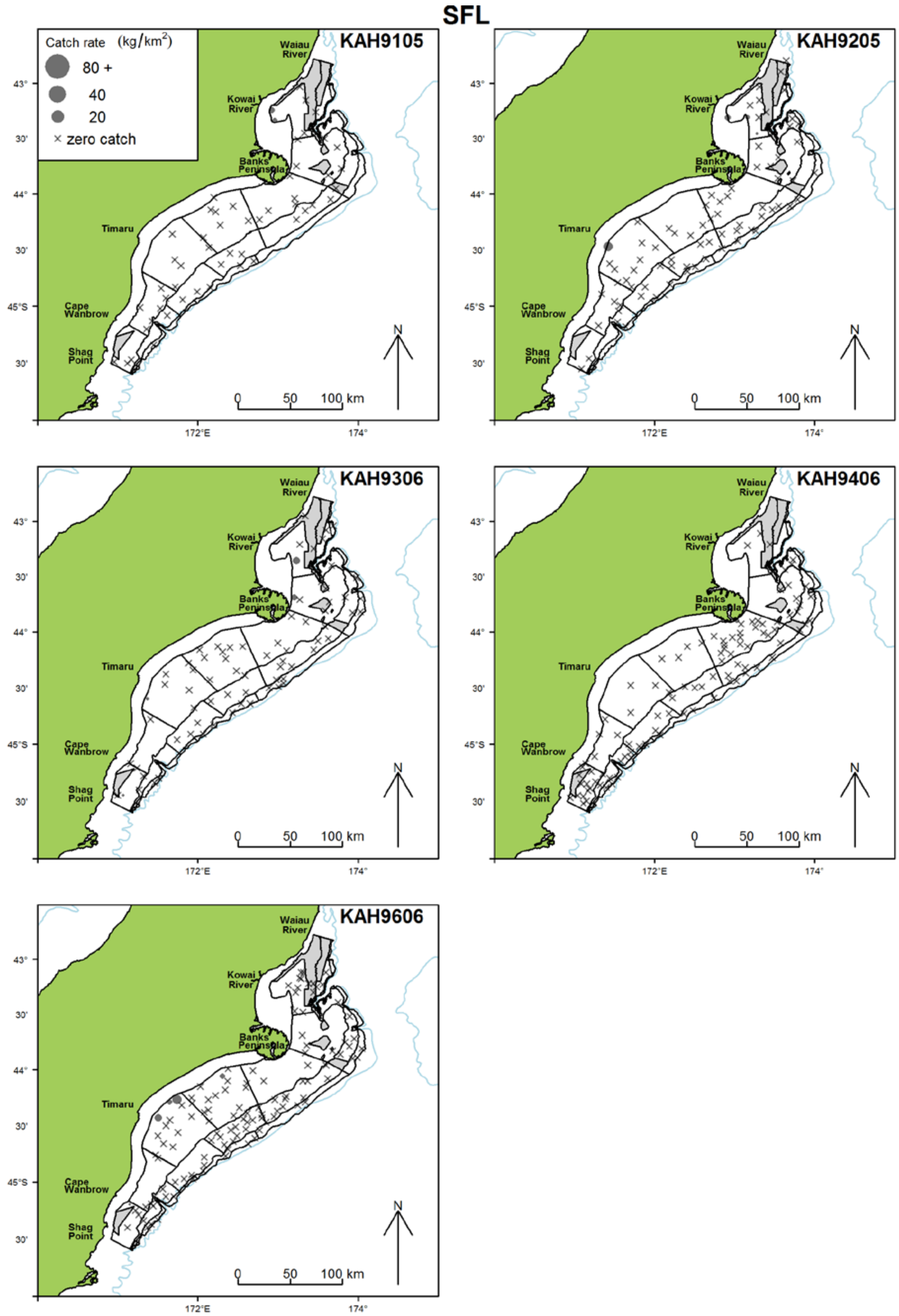


Figure 2 – ***continued***

Sand flounder (2007 to 2012)

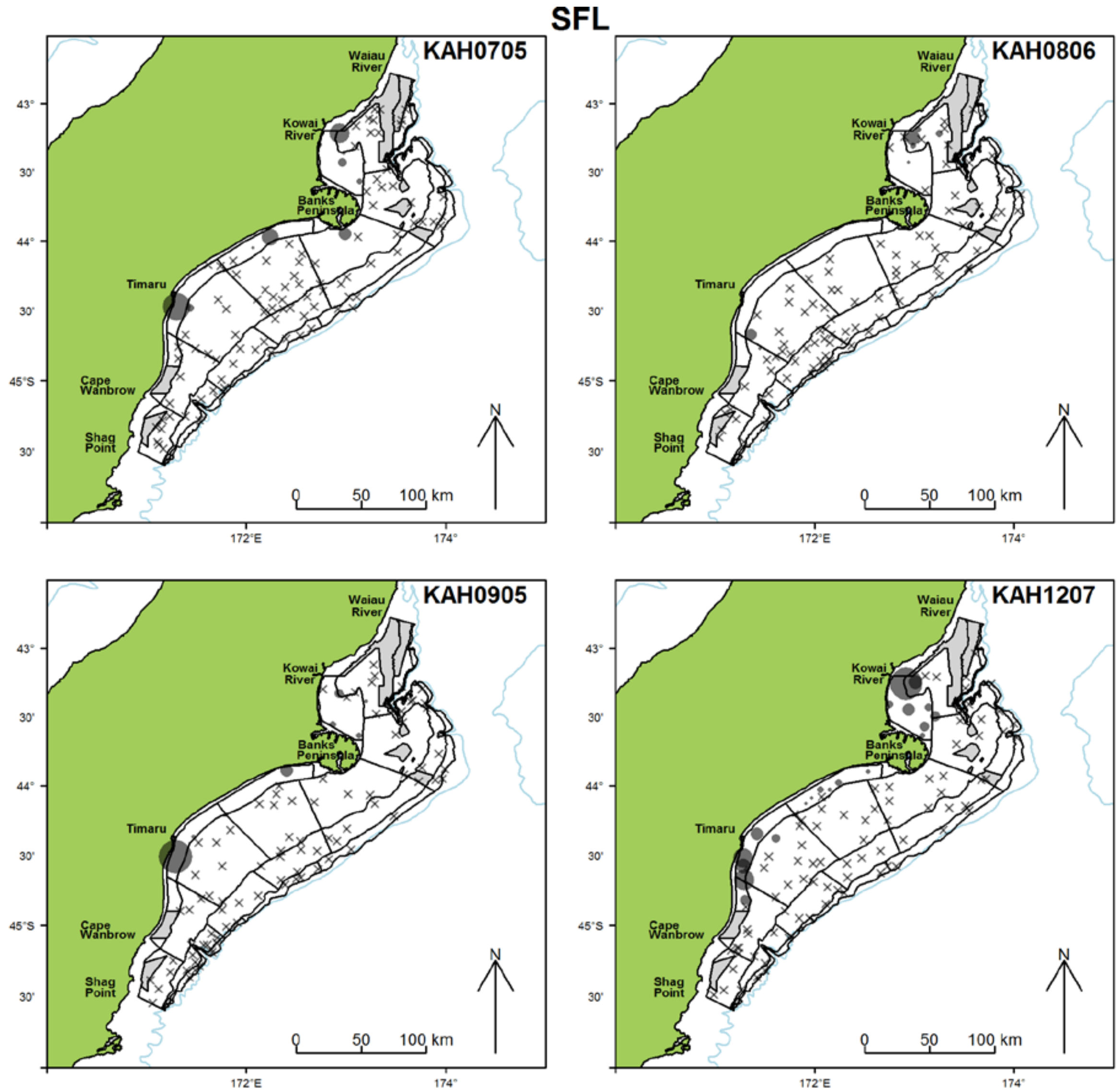


Figure 2 – ***continued***

School shark (1991 to 1996)

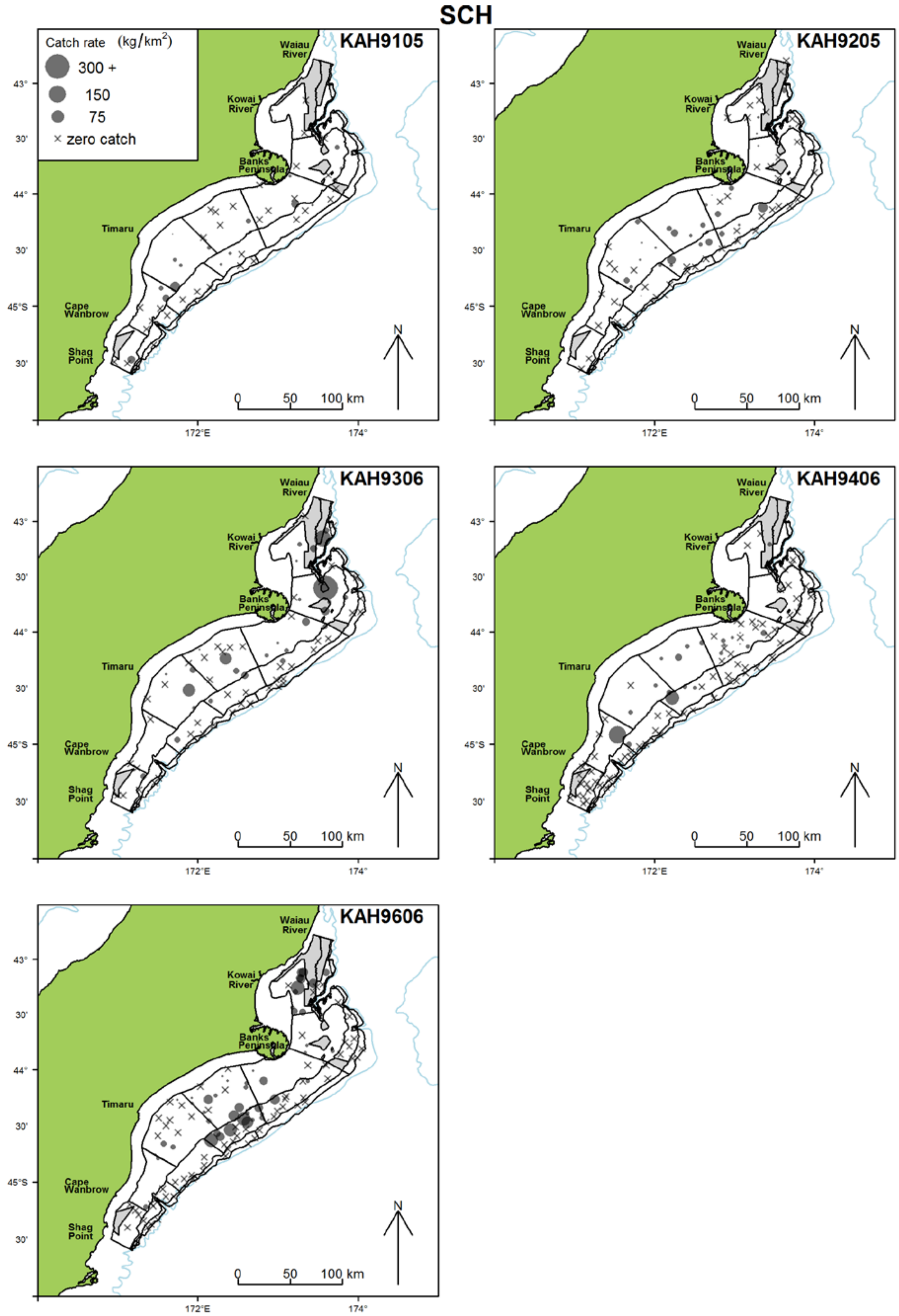


Figure 2 – ***continued***

School shark (2007 to 2012)

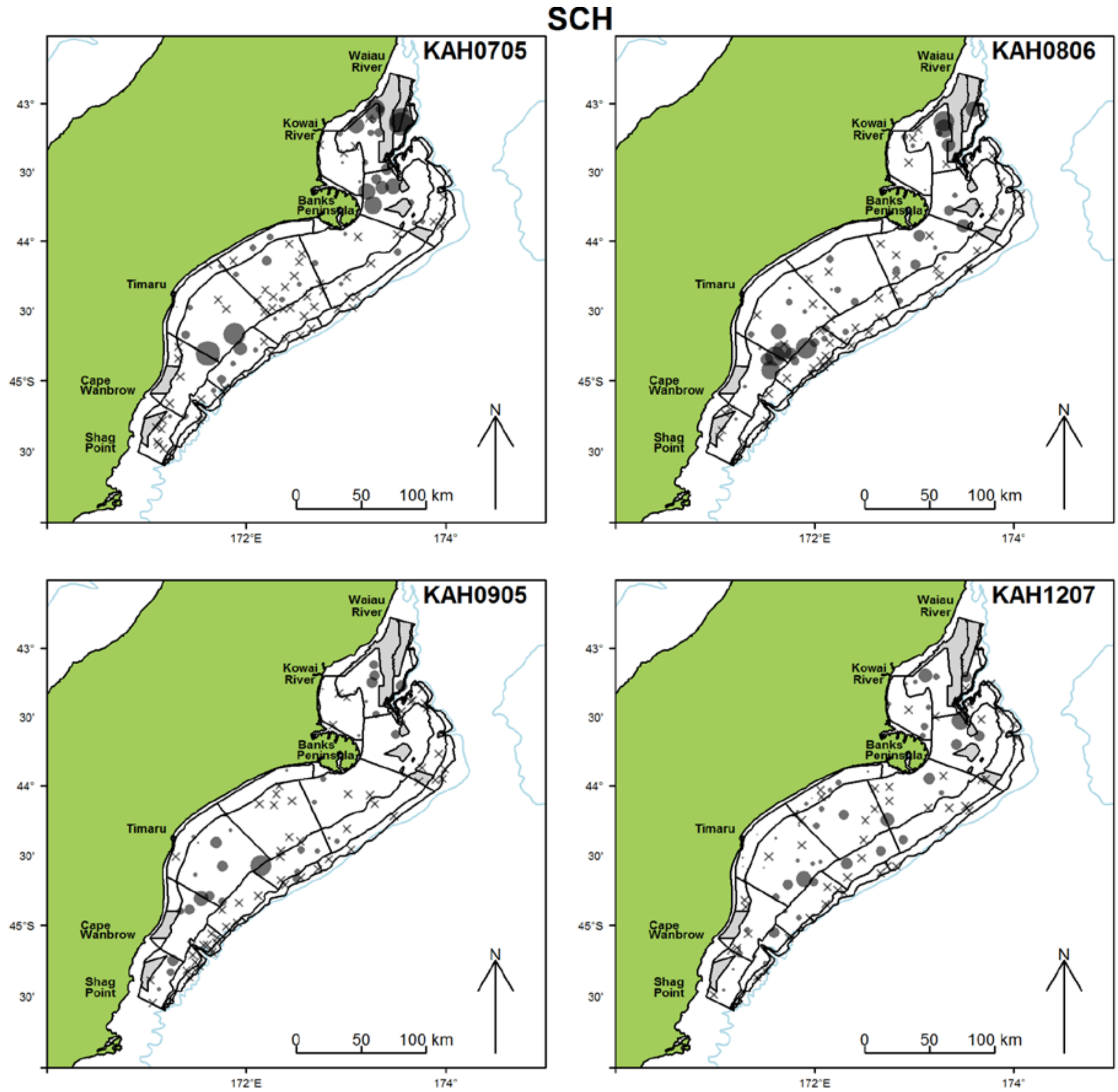


Figure 2 – *continued*

Silver warehou (1991 to 1996)

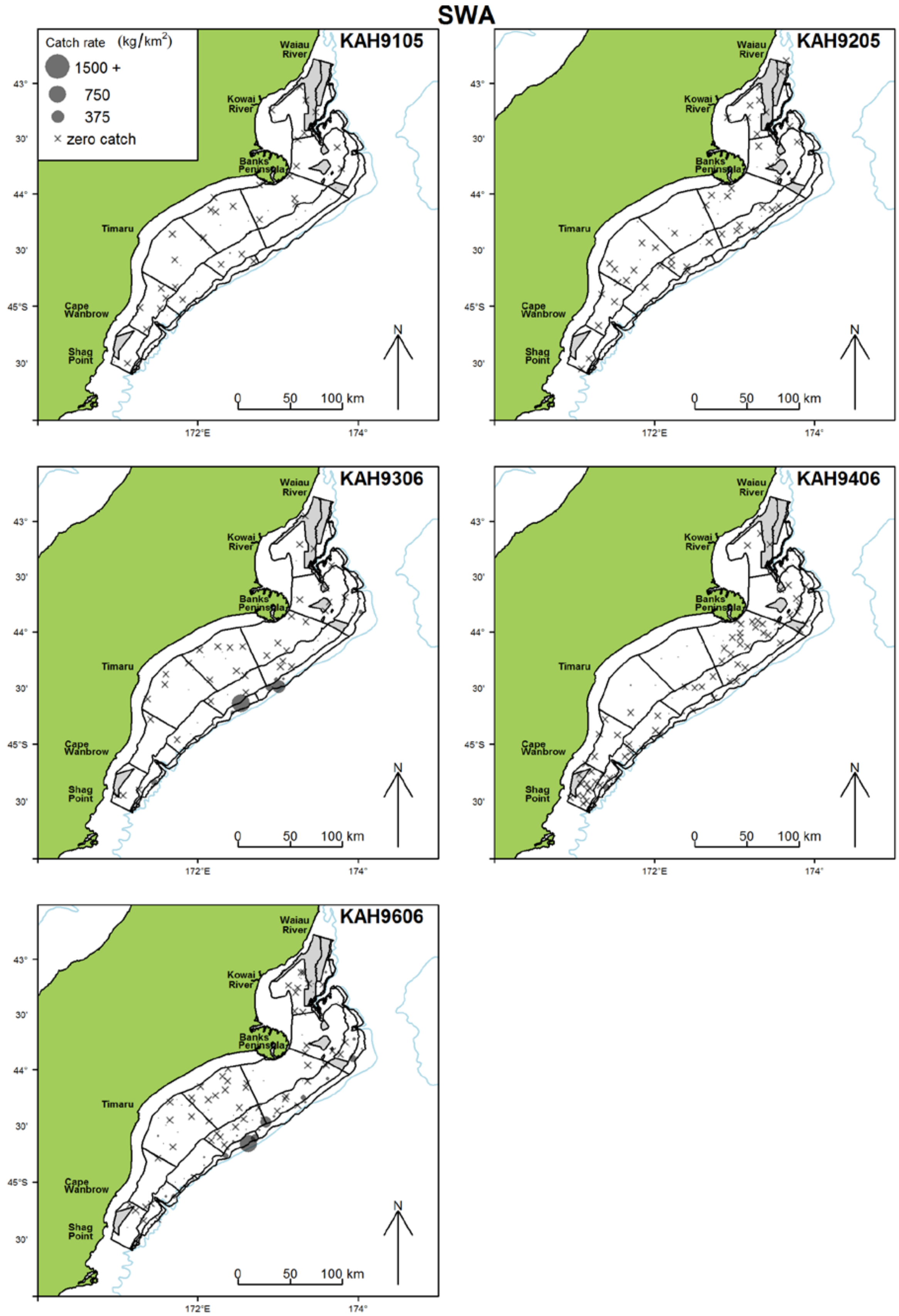


Figure 2 – ***continued***

Silver warehou (2007 to 2012)

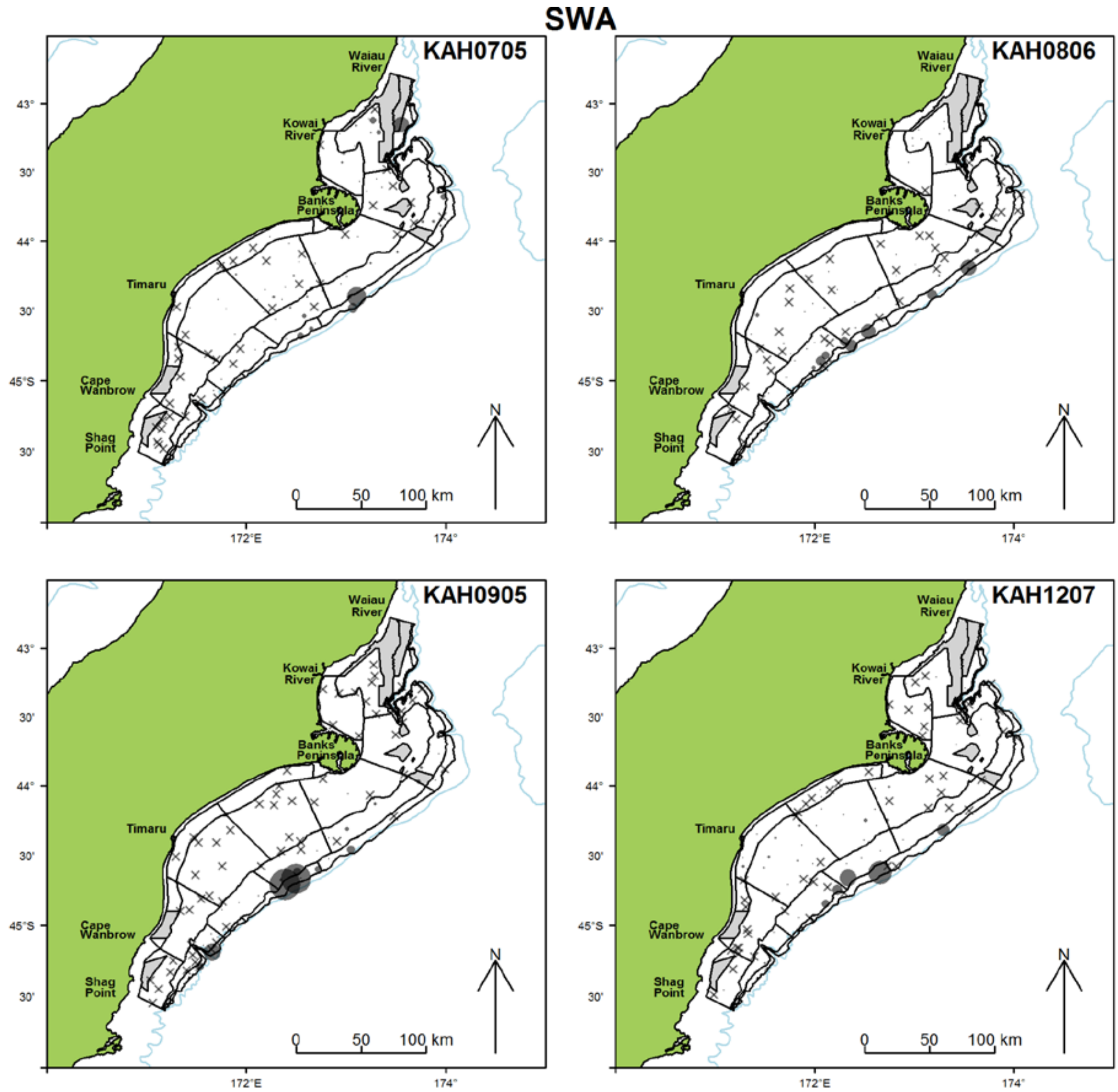


Figure 2 – ***continued***

Smooth skate (1991 to 1996)

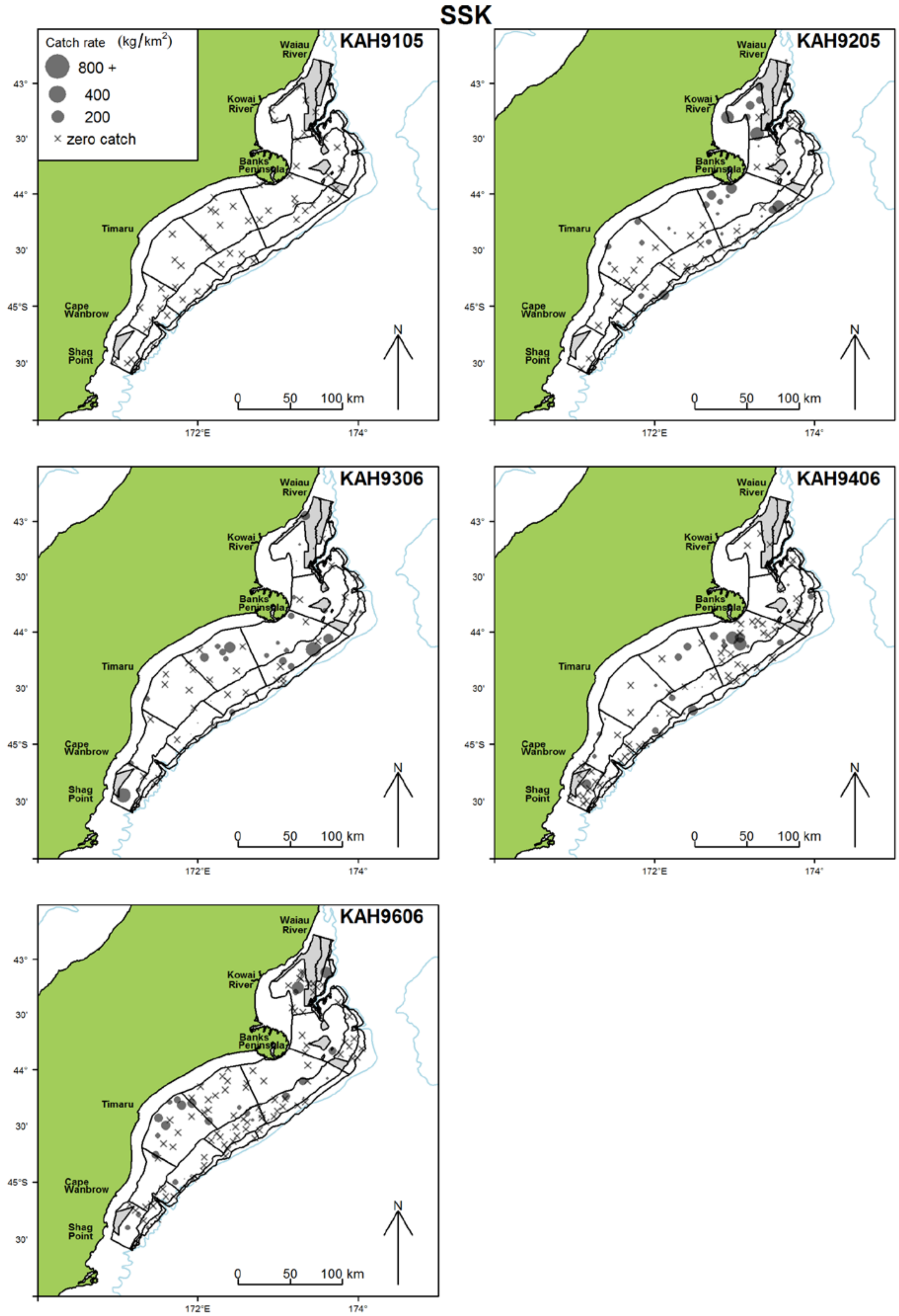


Figure 2 – *continued*

Smooth skate (2007 to 2012)

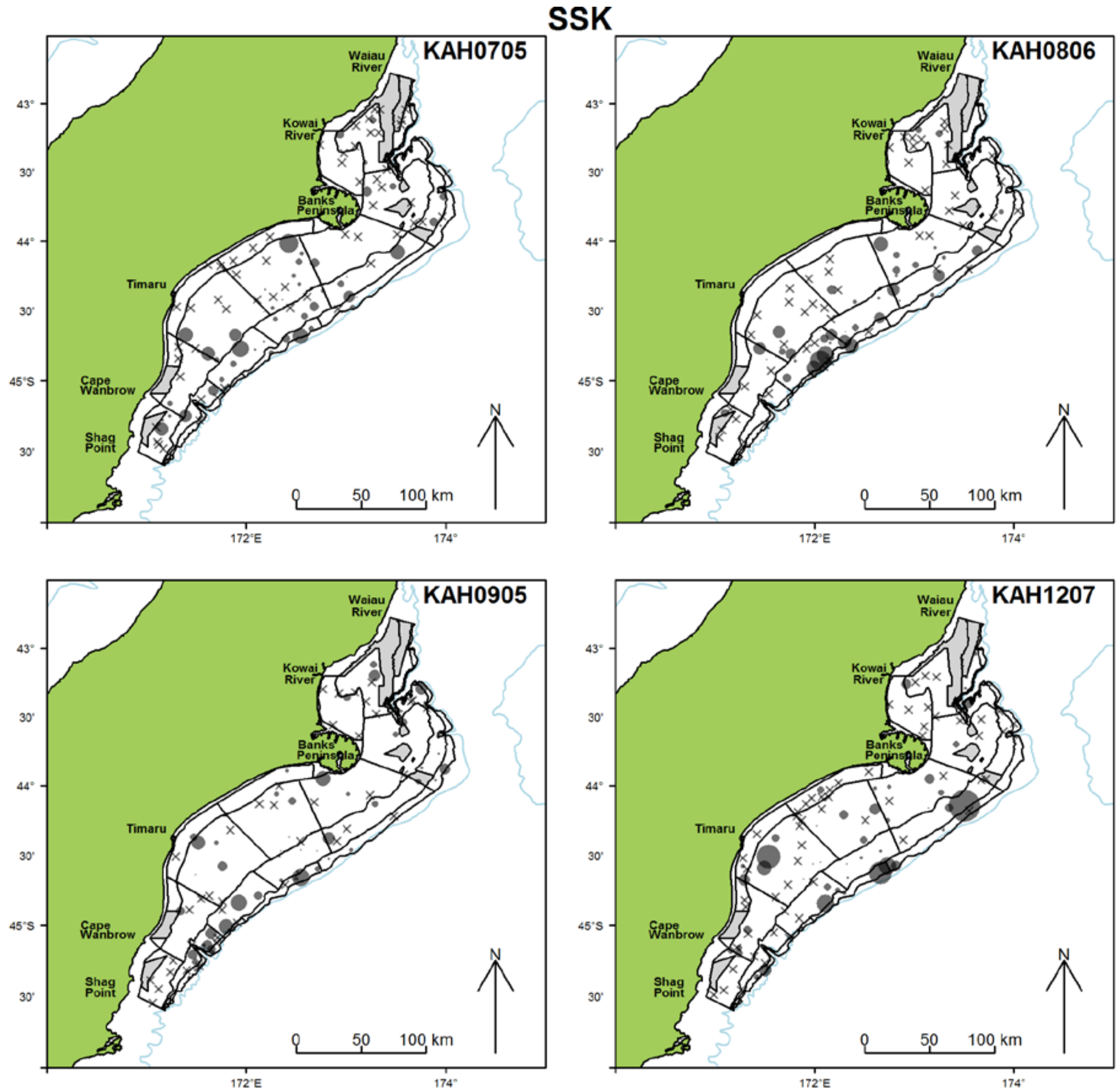


Figure 2 – ***continued***

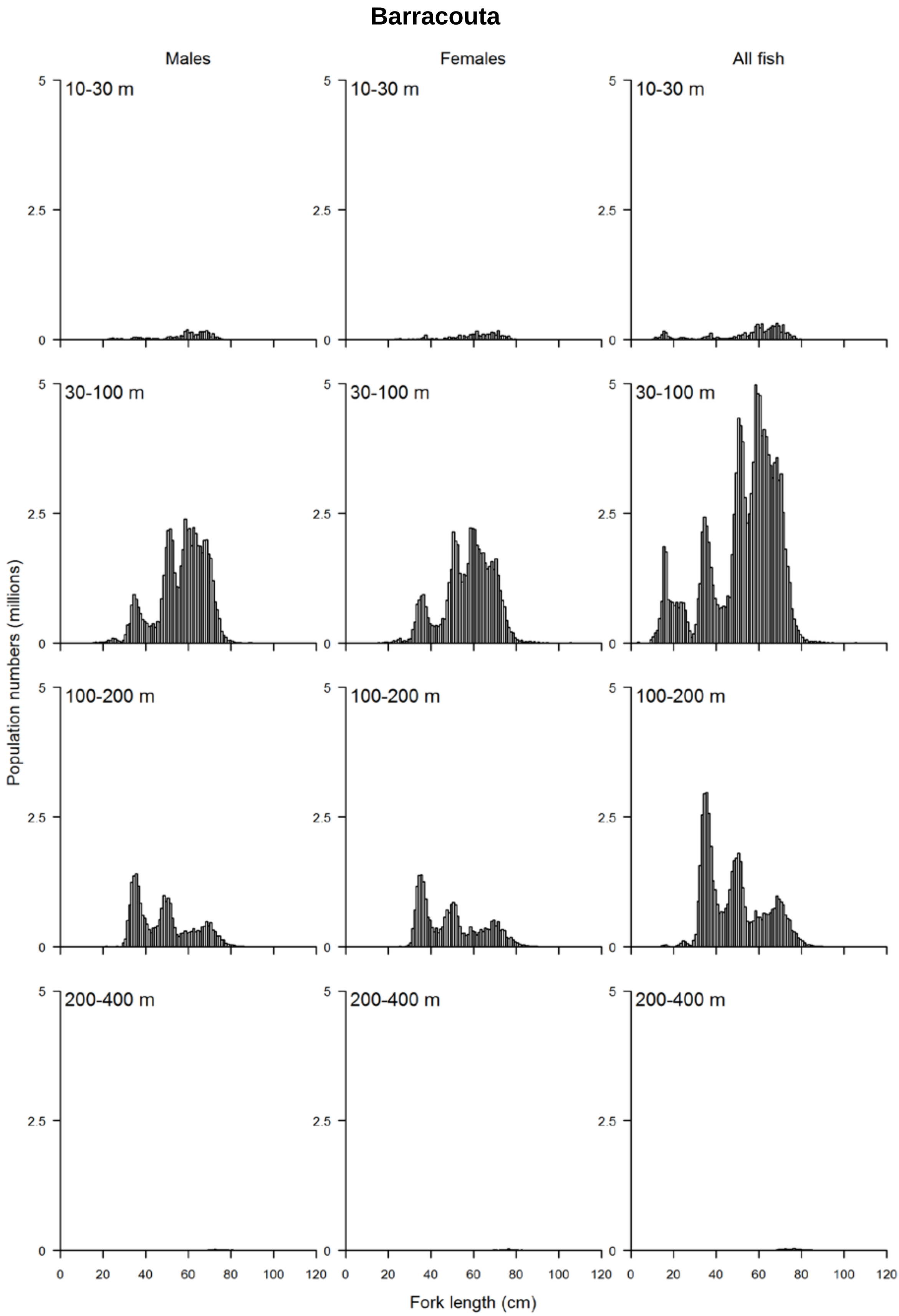


Figure 3: Scaled length frequency distributions for the non-target key QMS species by depth range for all nine east coast South Island winter surveys combined. The 10–30 m depth range includes fish from only the last four surveys (2007, 2008, 2009, and 2012).

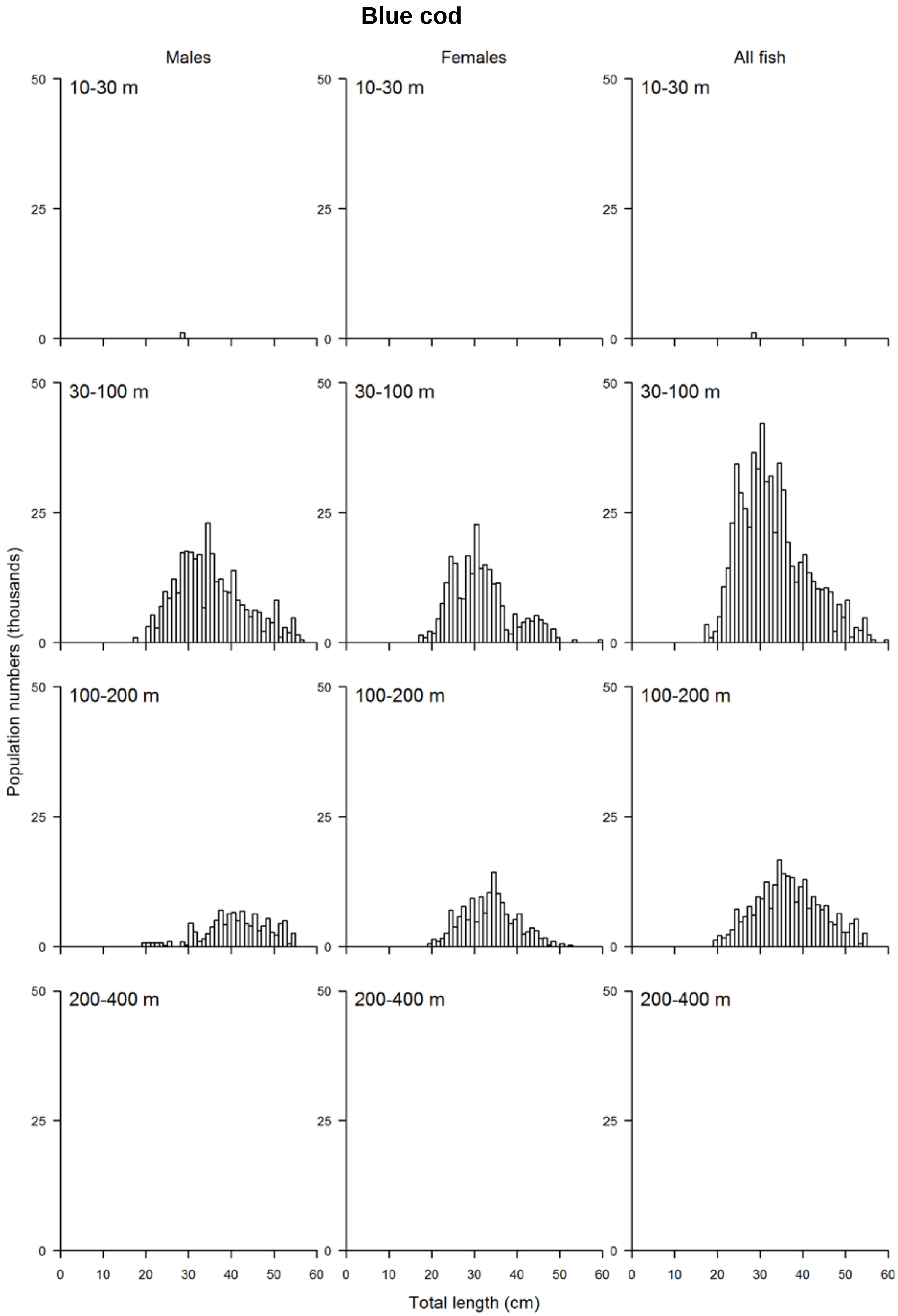


Figure 3 – *continued*

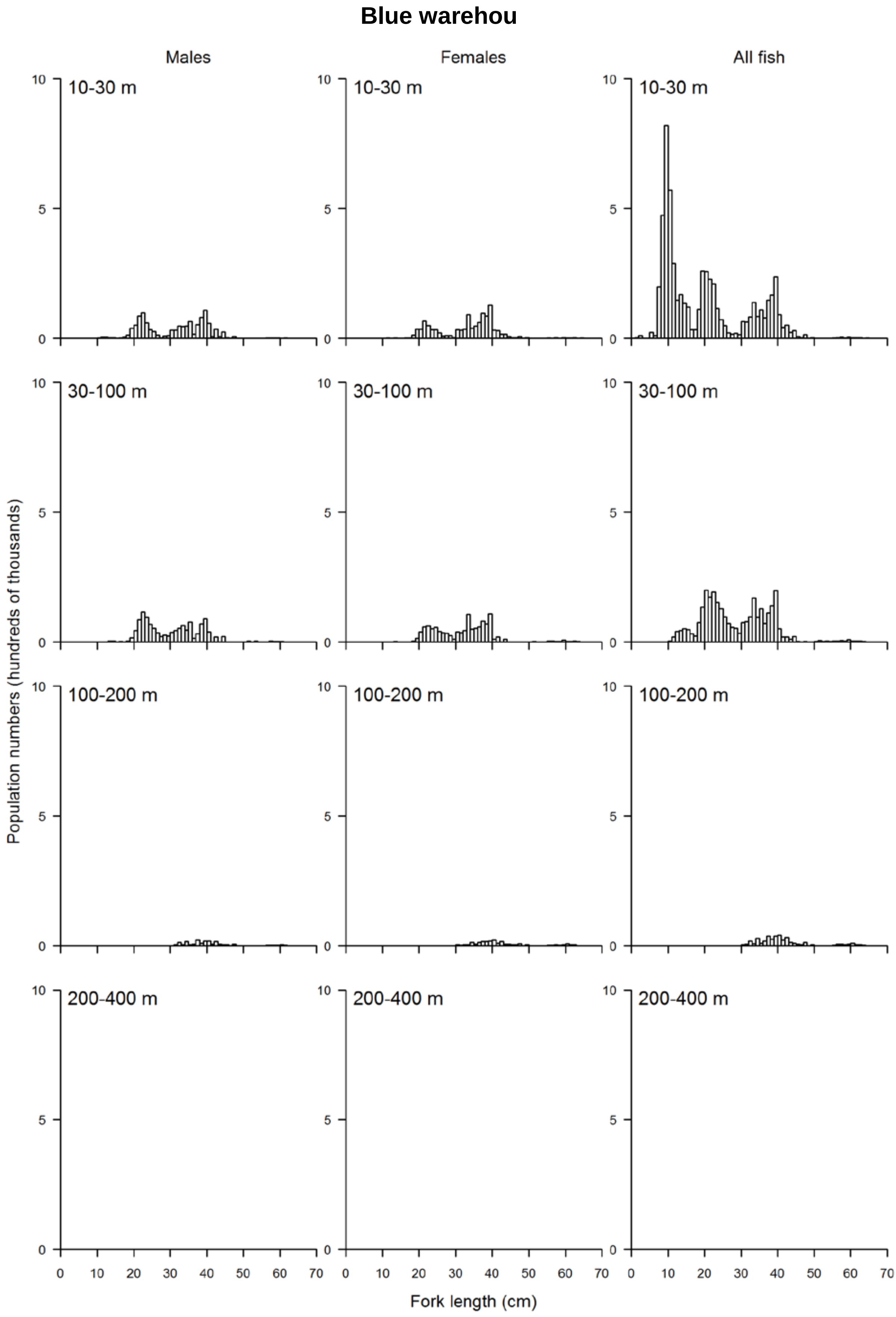


Figure 3 – ***continued***

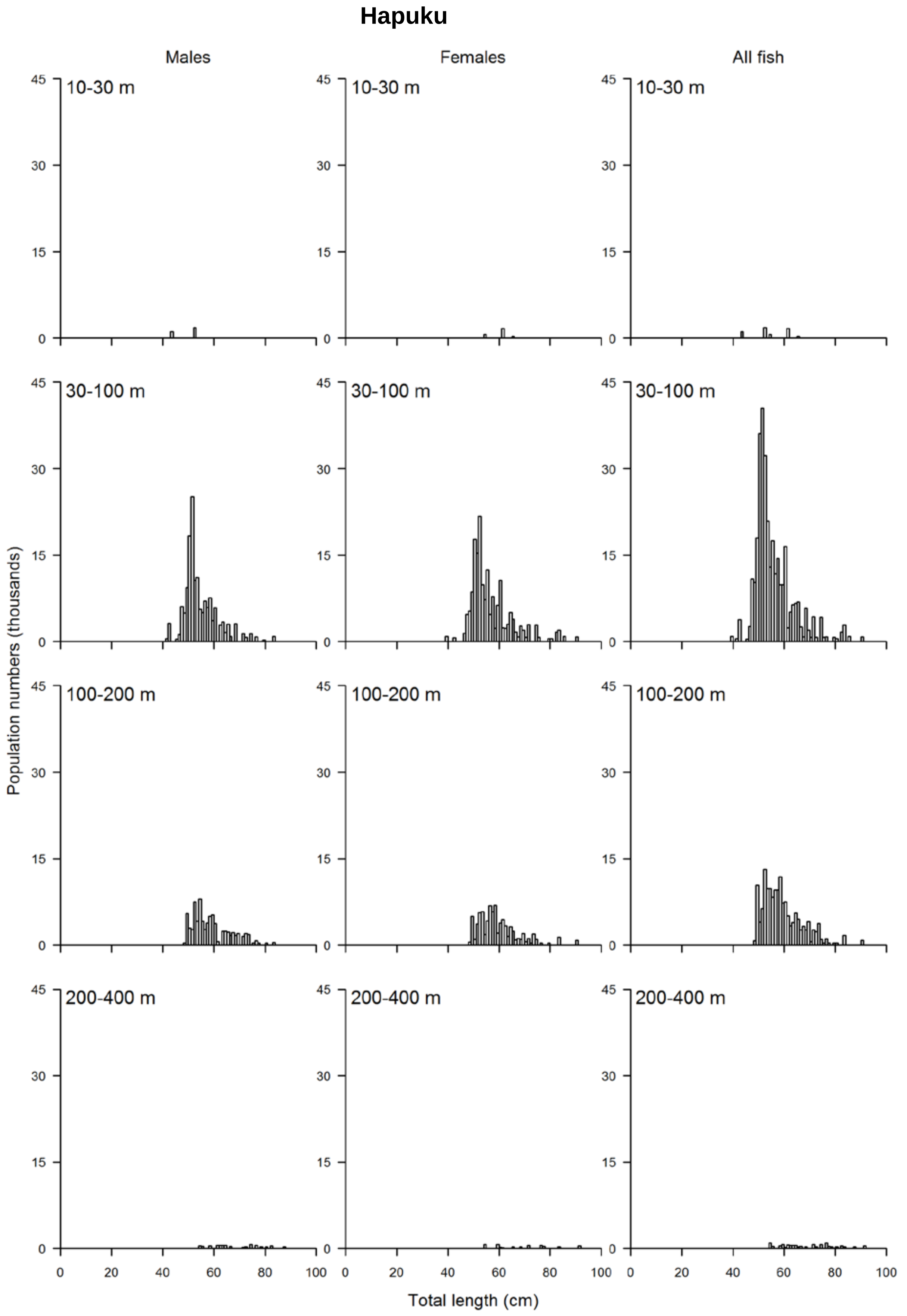


Figure 3 – *continued*

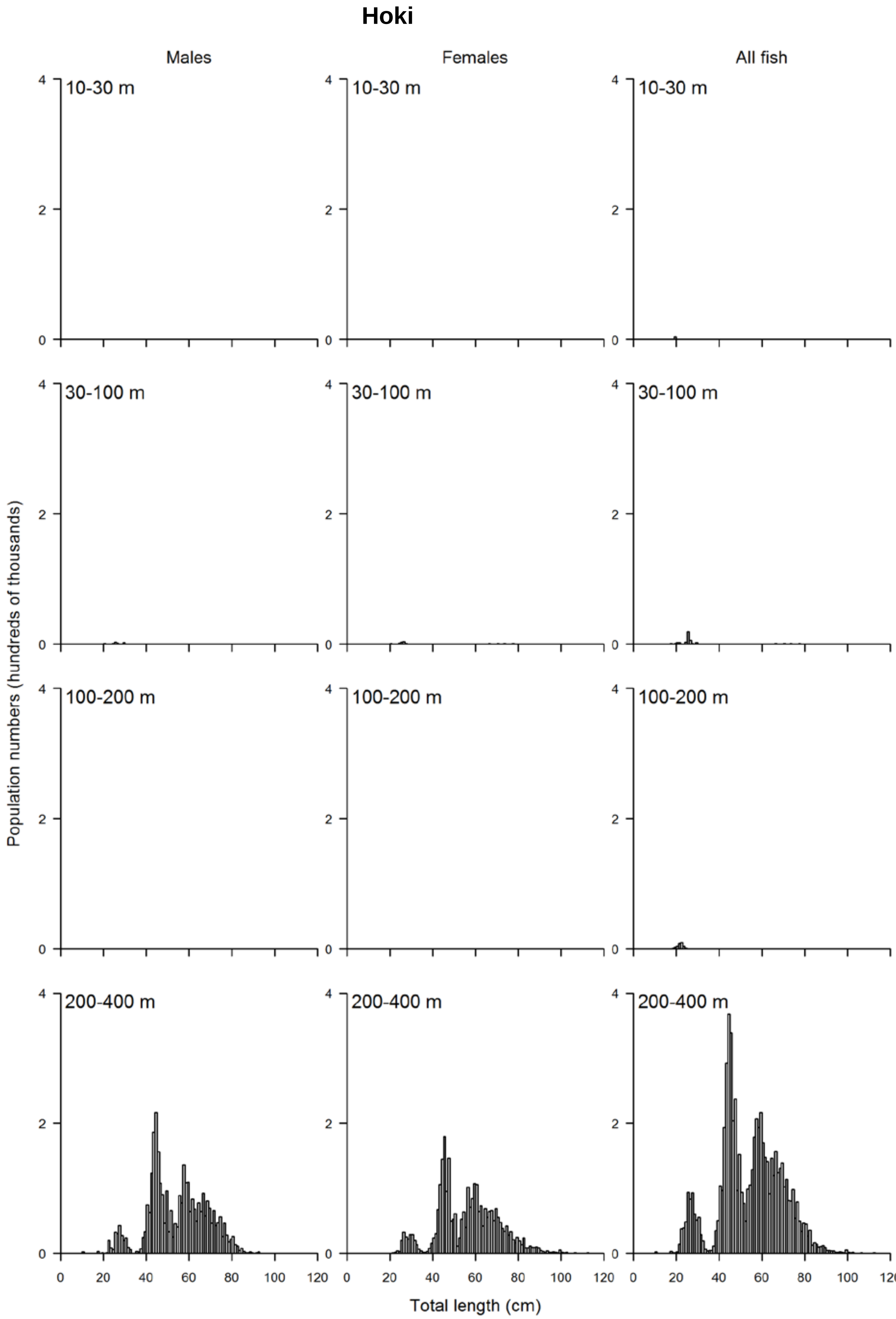


Figure 3 – ***continued***

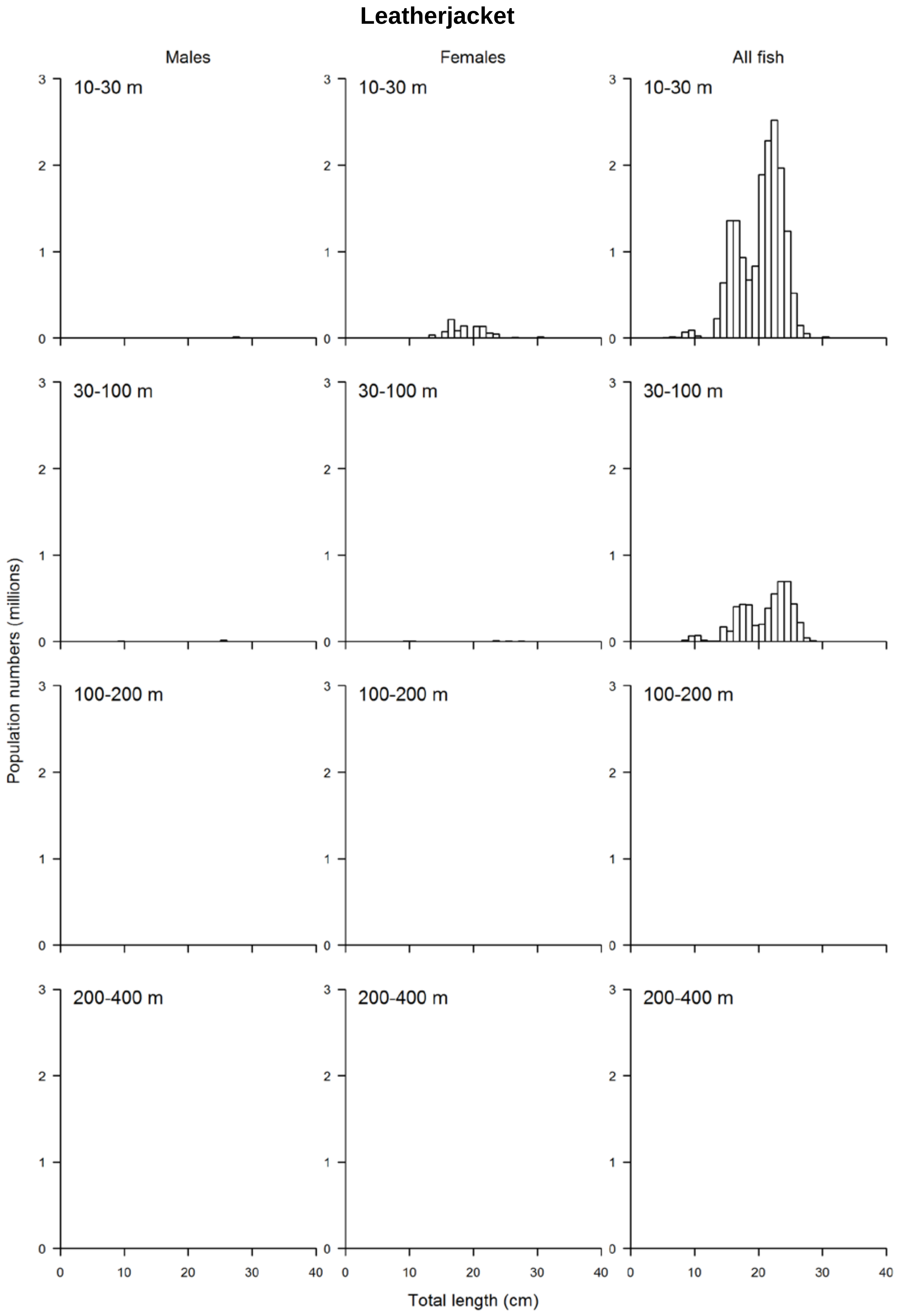


Figure 3 – ***continued***

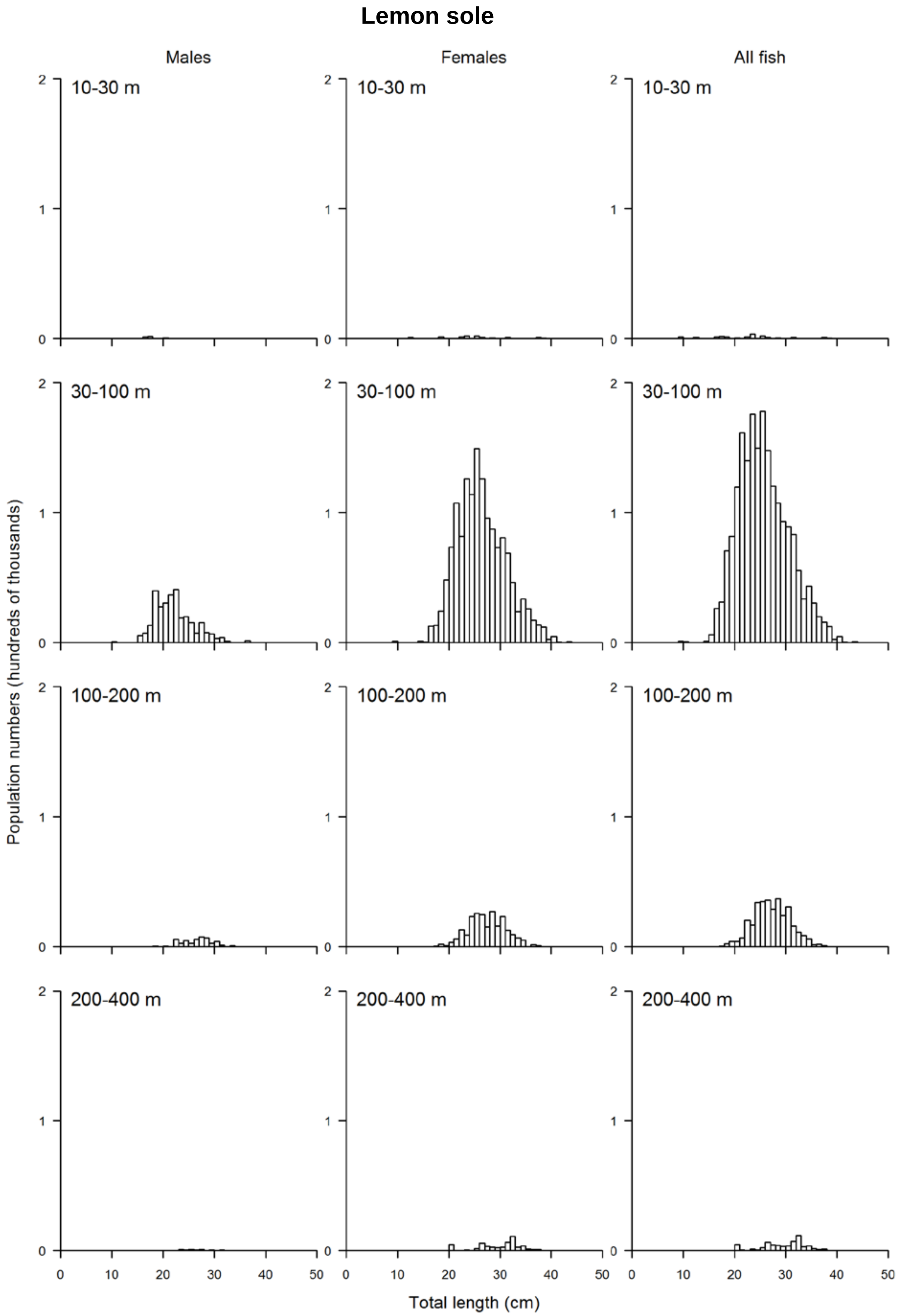
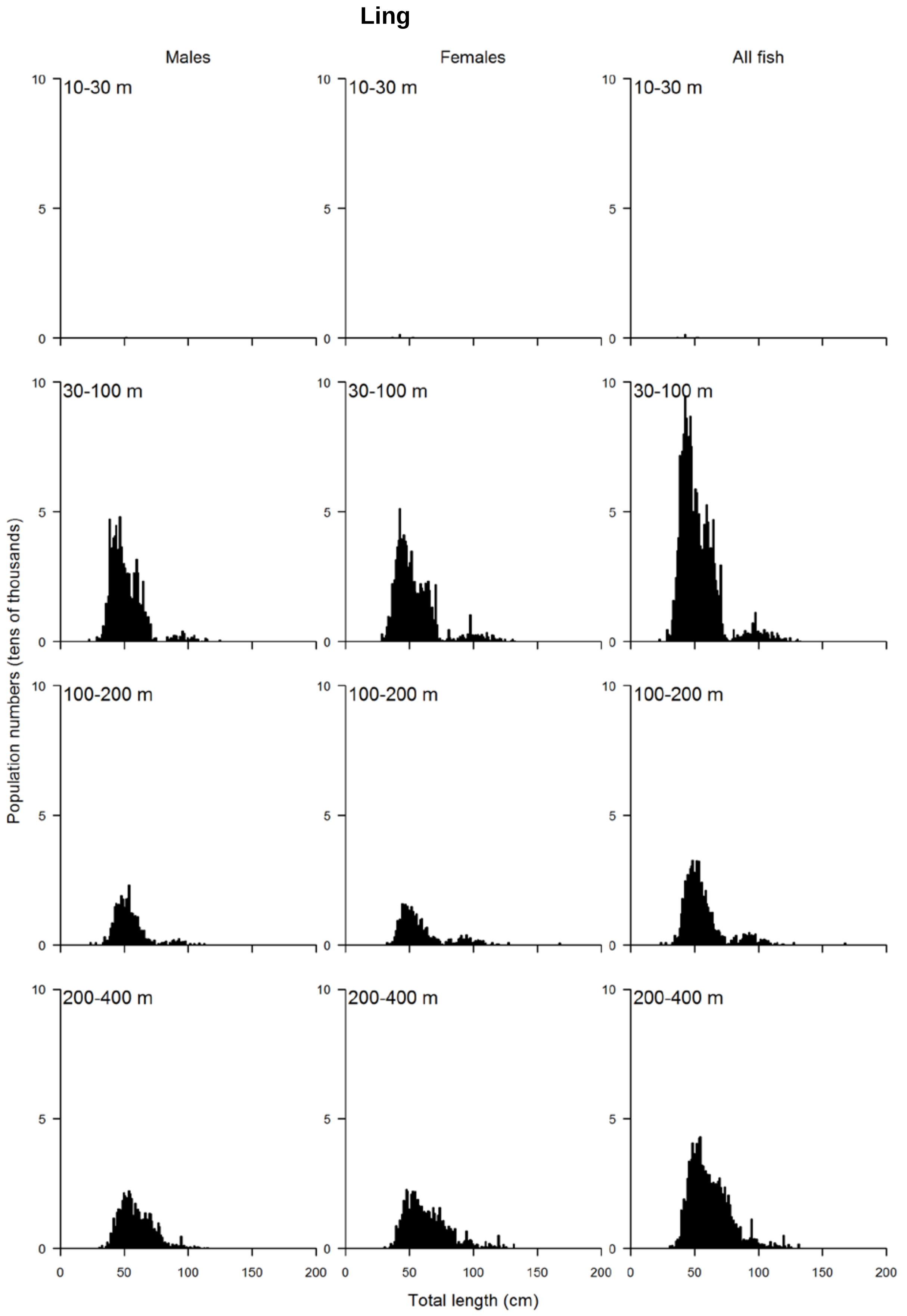


Figure 3 – *continued*



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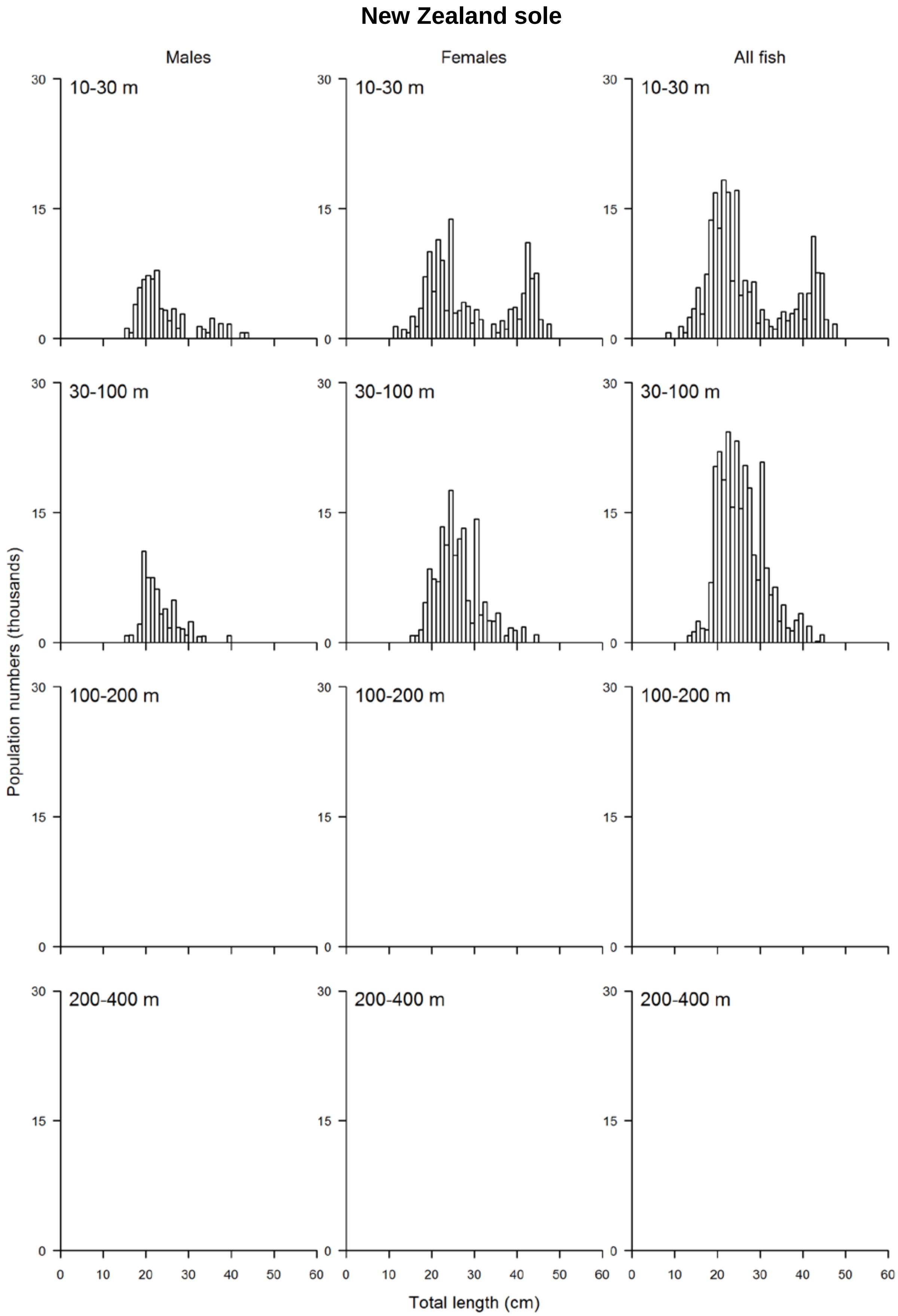

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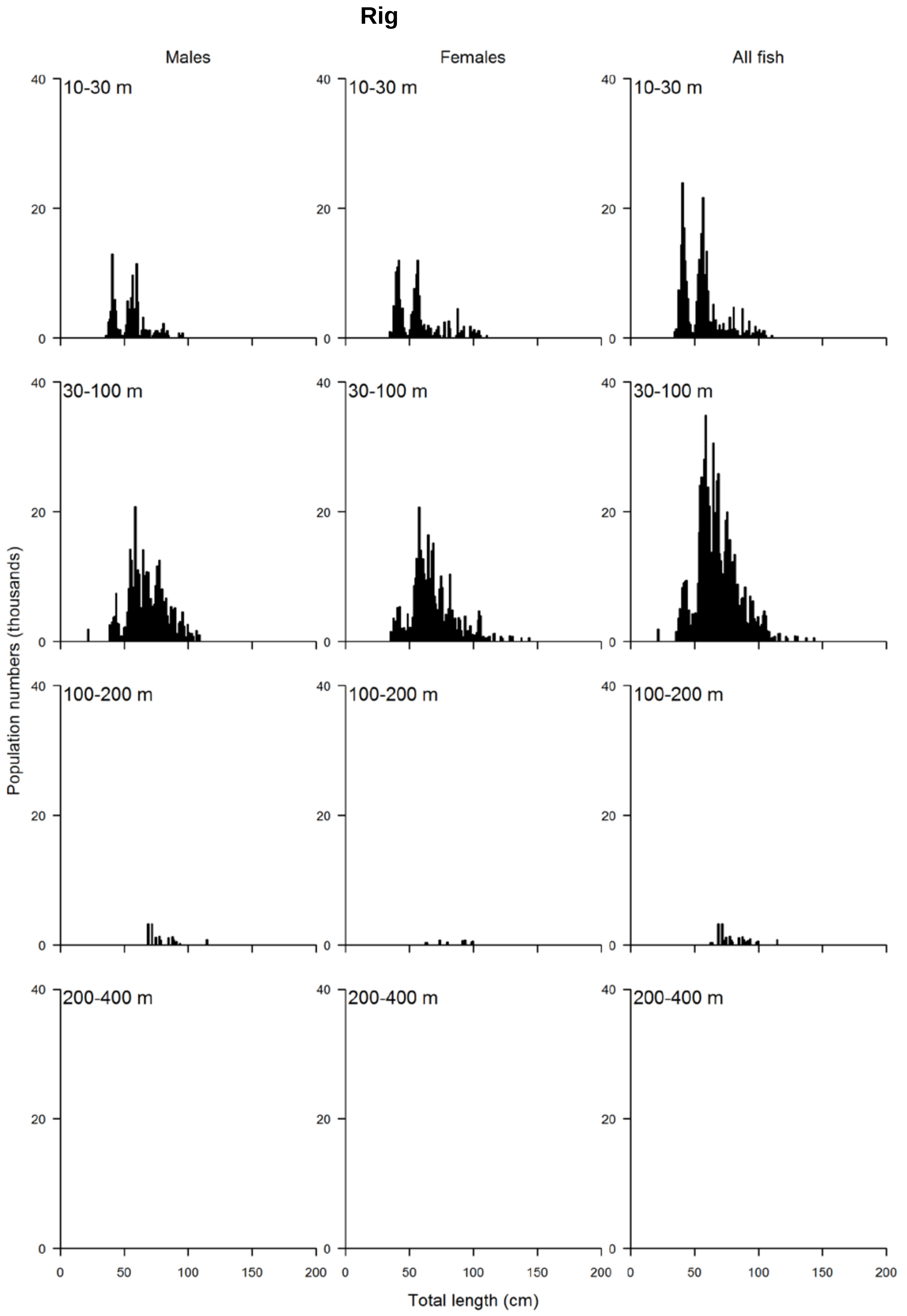

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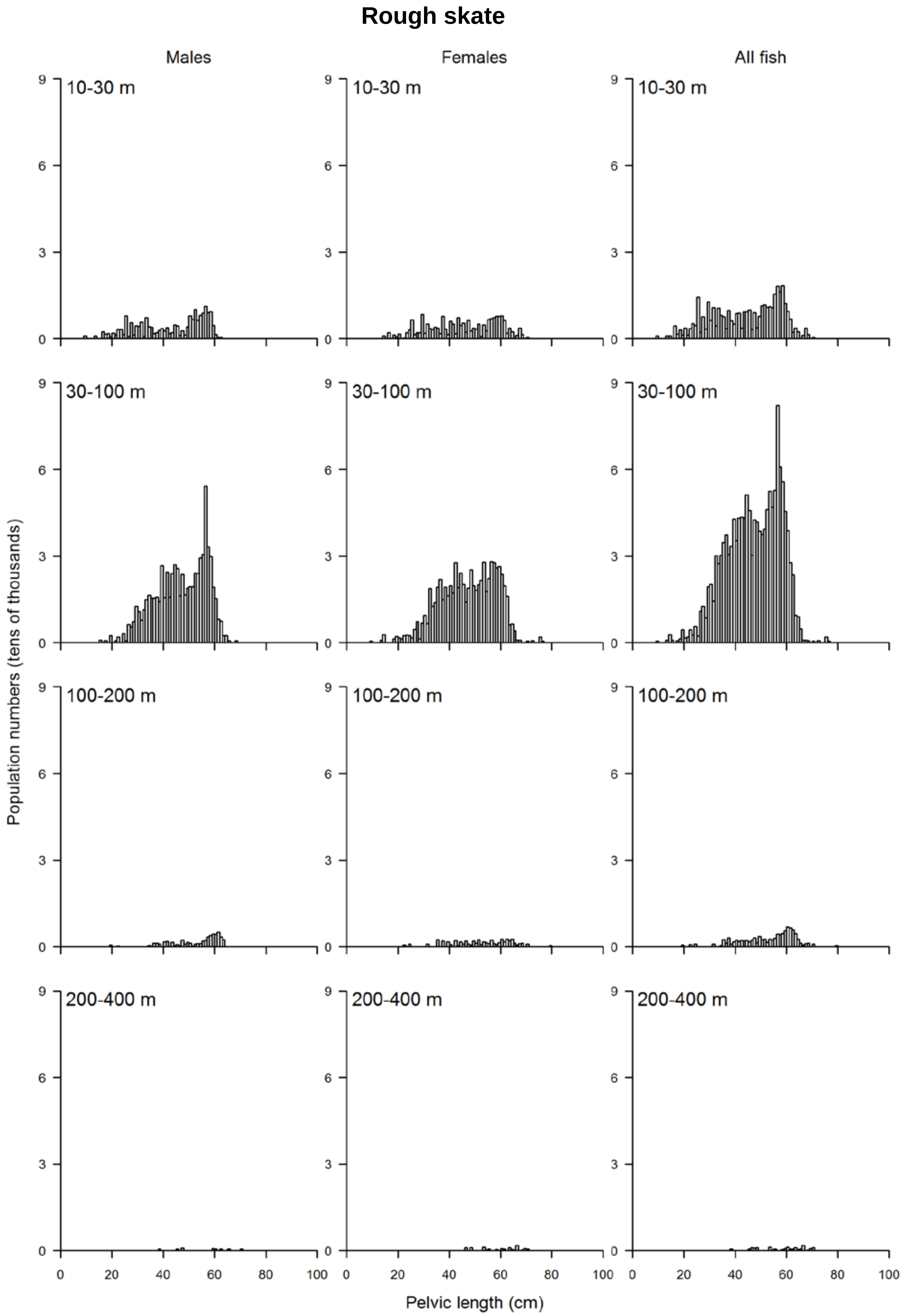
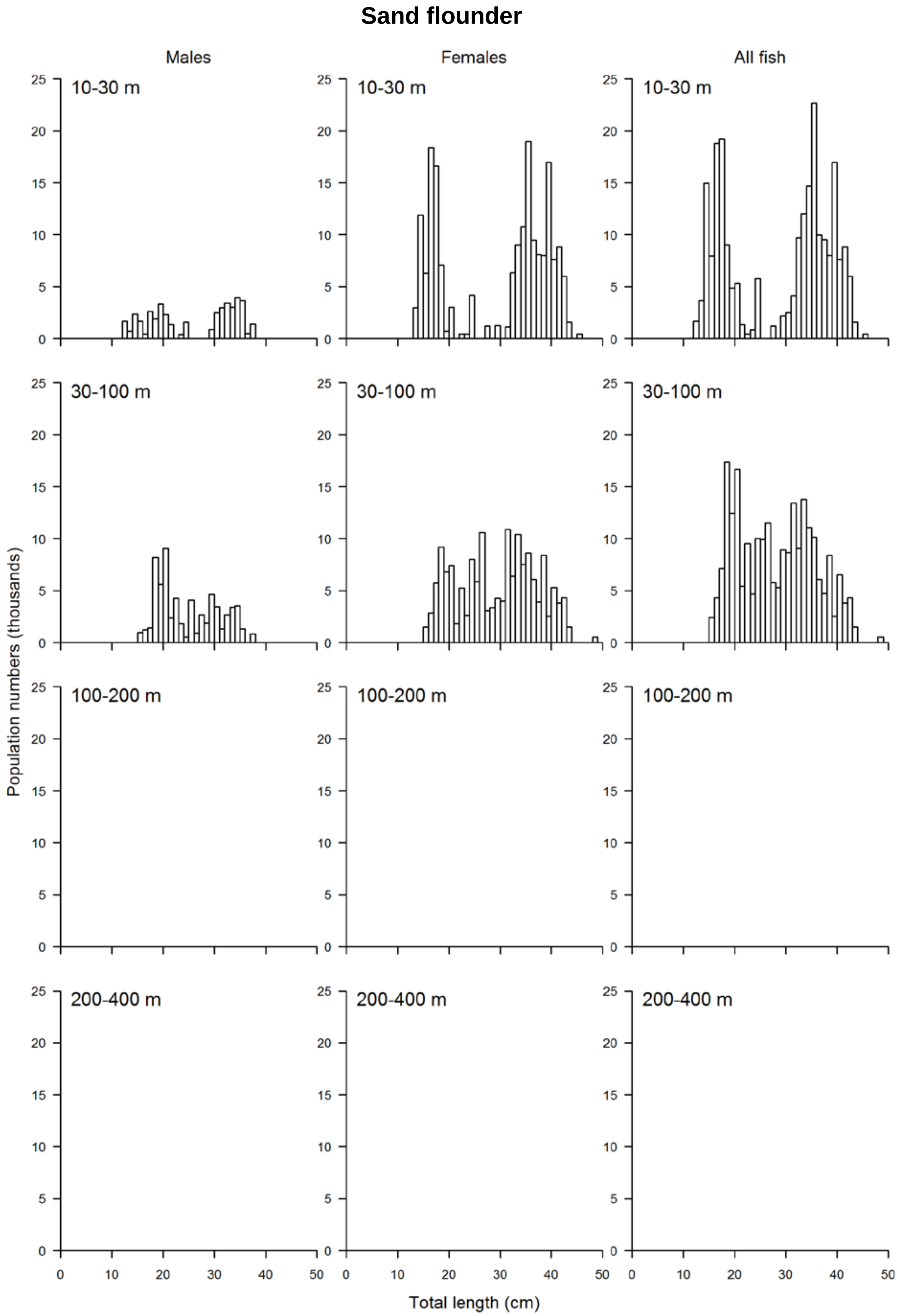


Figure 3 – ***continued***



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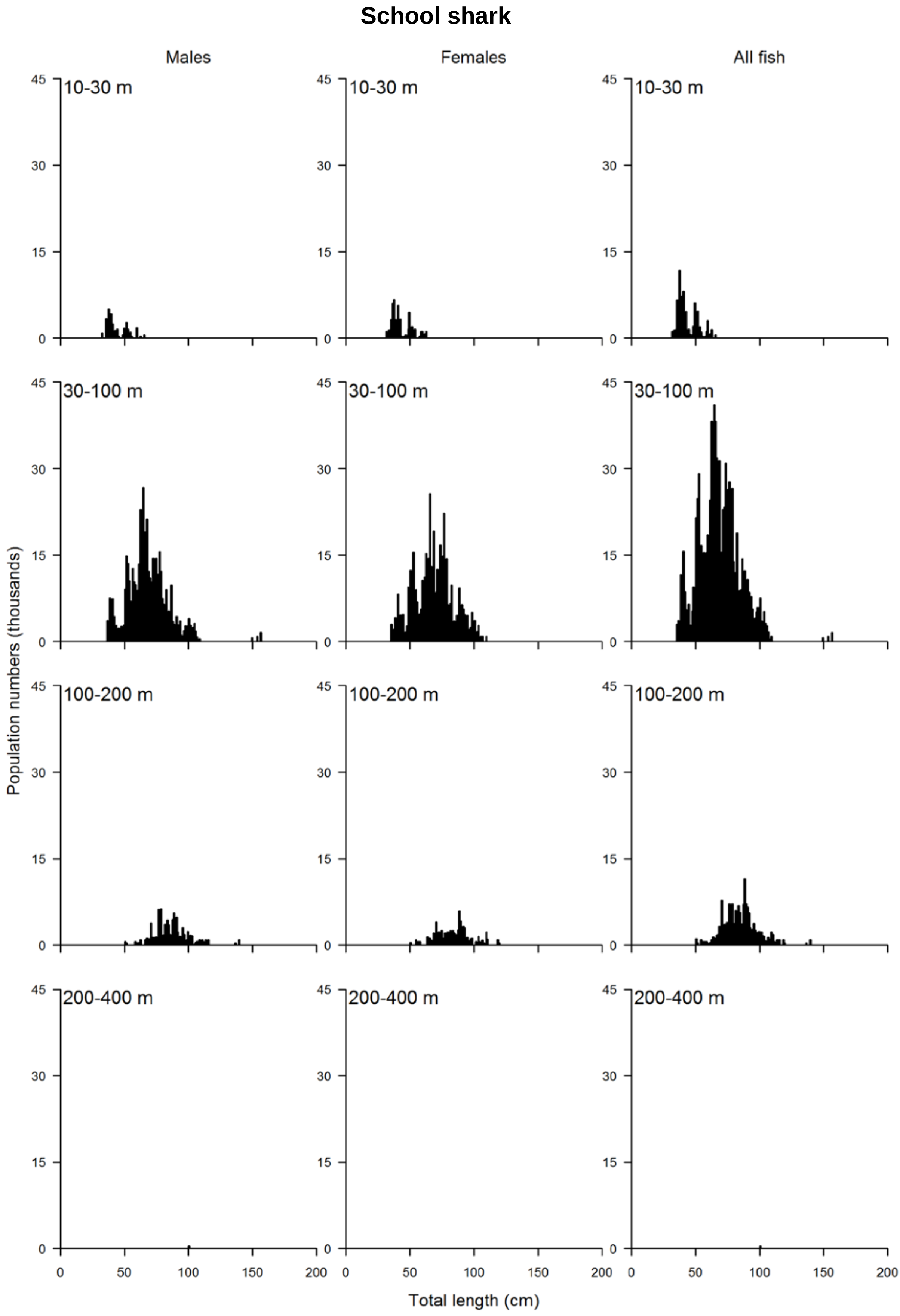

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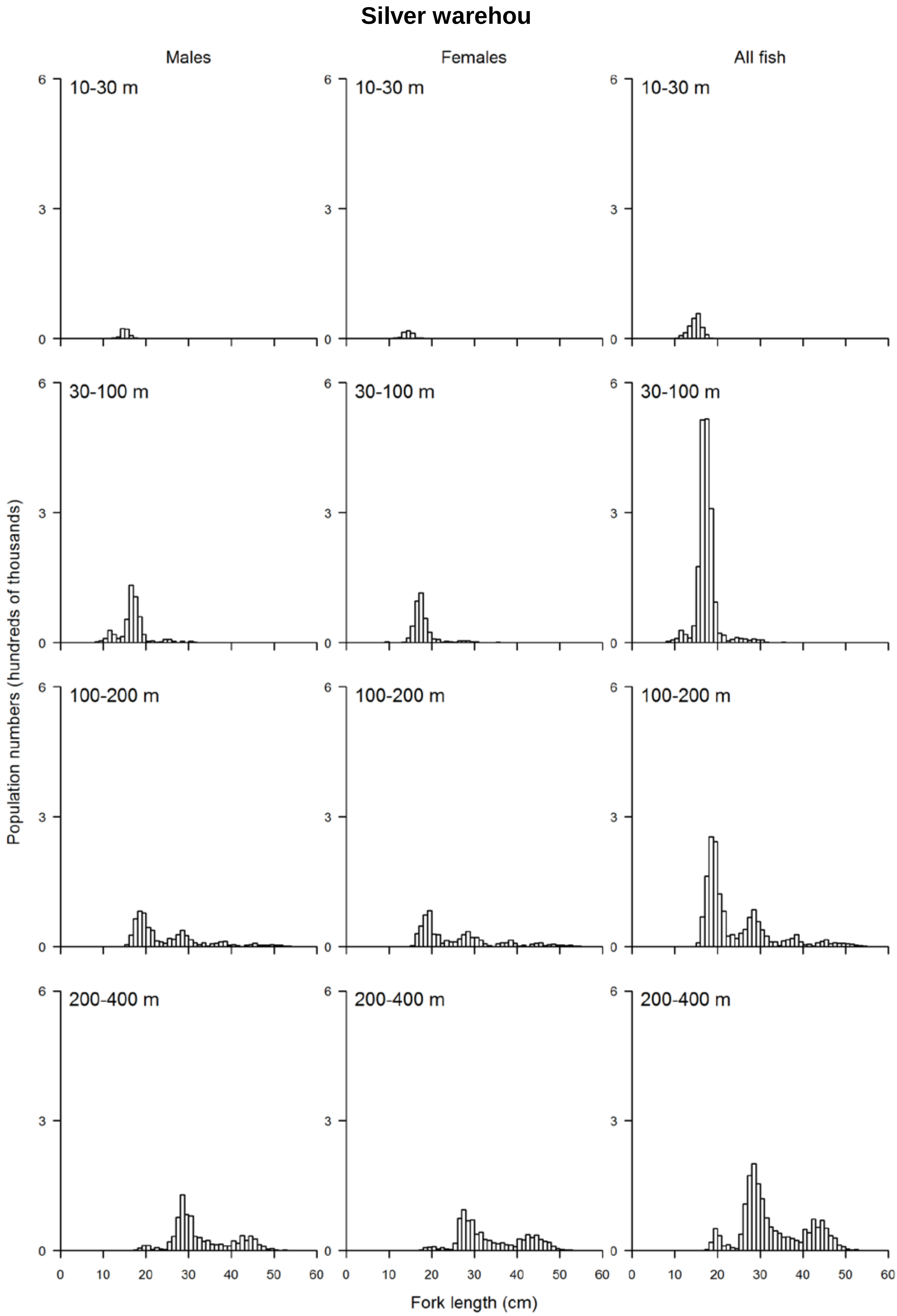

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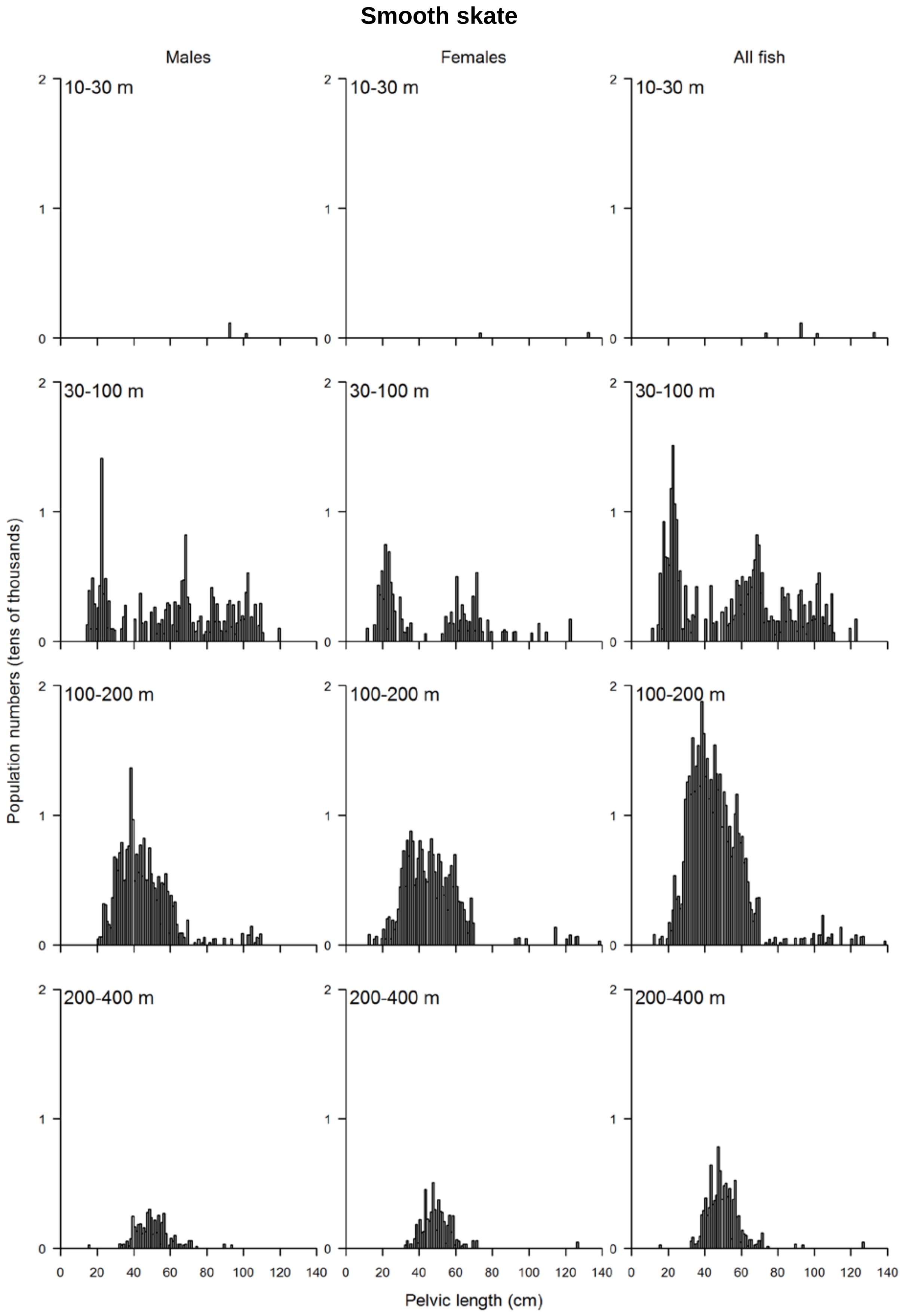


Figure 3 – ***continued***

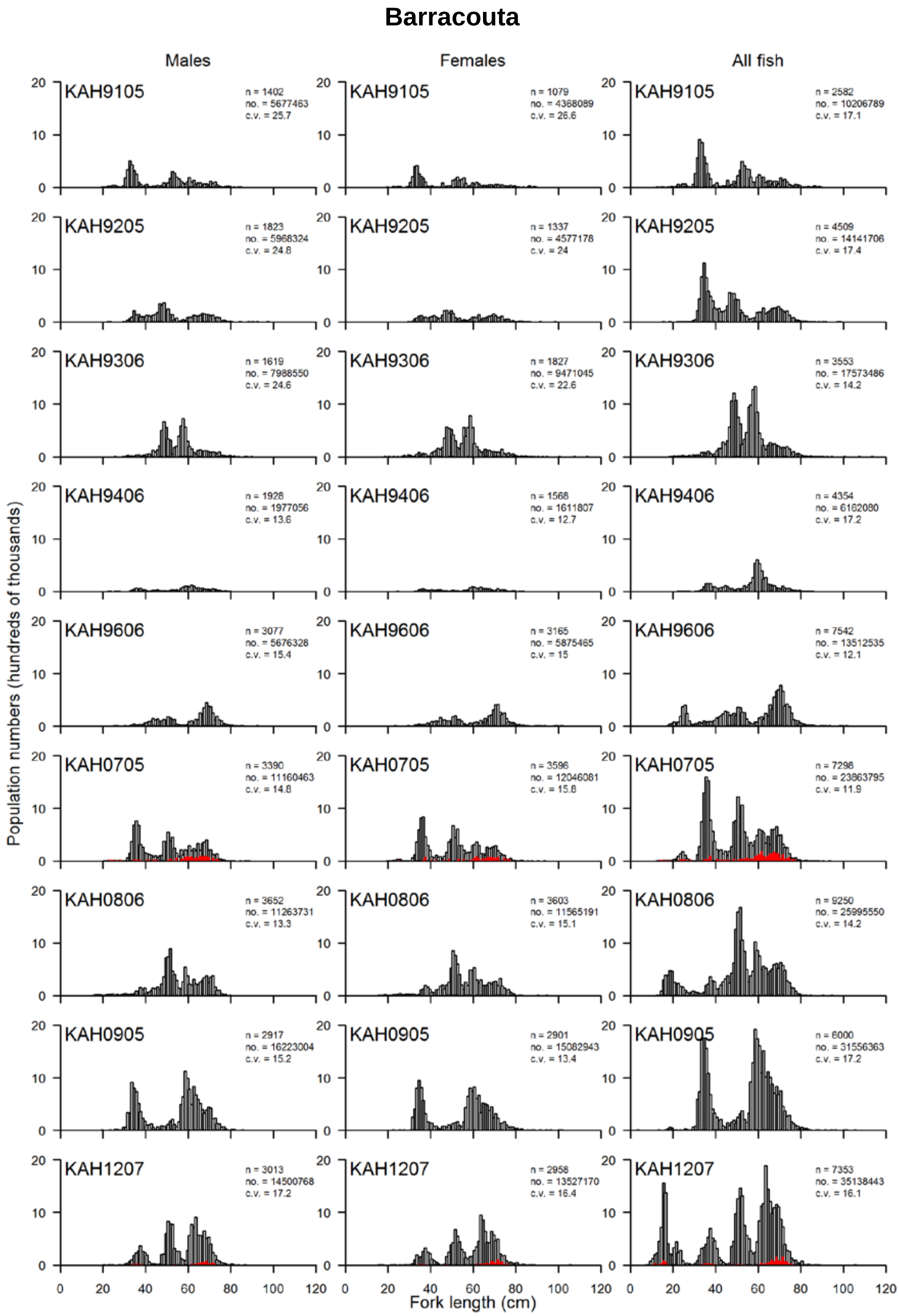


Figure 4: Scaled length frequency distributions for the non-target key QMS species in core strata (30–400 m) for all nine ECSI winter surveys. The length distribution is also shown in the 10–30 m depth strata for the 2007 and 2012 surveys overlaid in red for species with many length classes, otherwise in light grey (not stacked). Population estimates are for the core strata only. n, number of fish measured; no., population number; c.v., coefficient of variation.

Blue cod

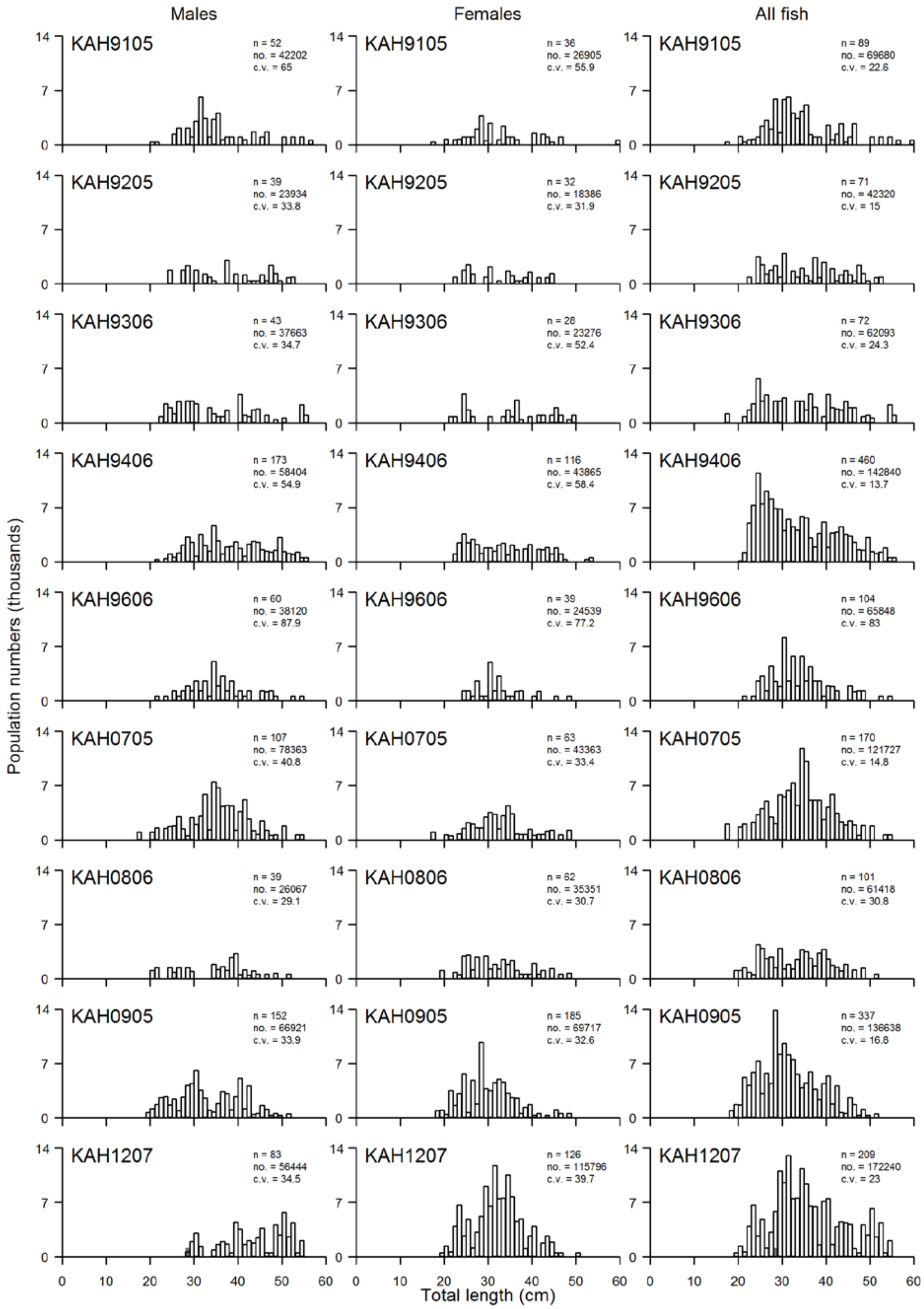


Figure 4 – ***continued***

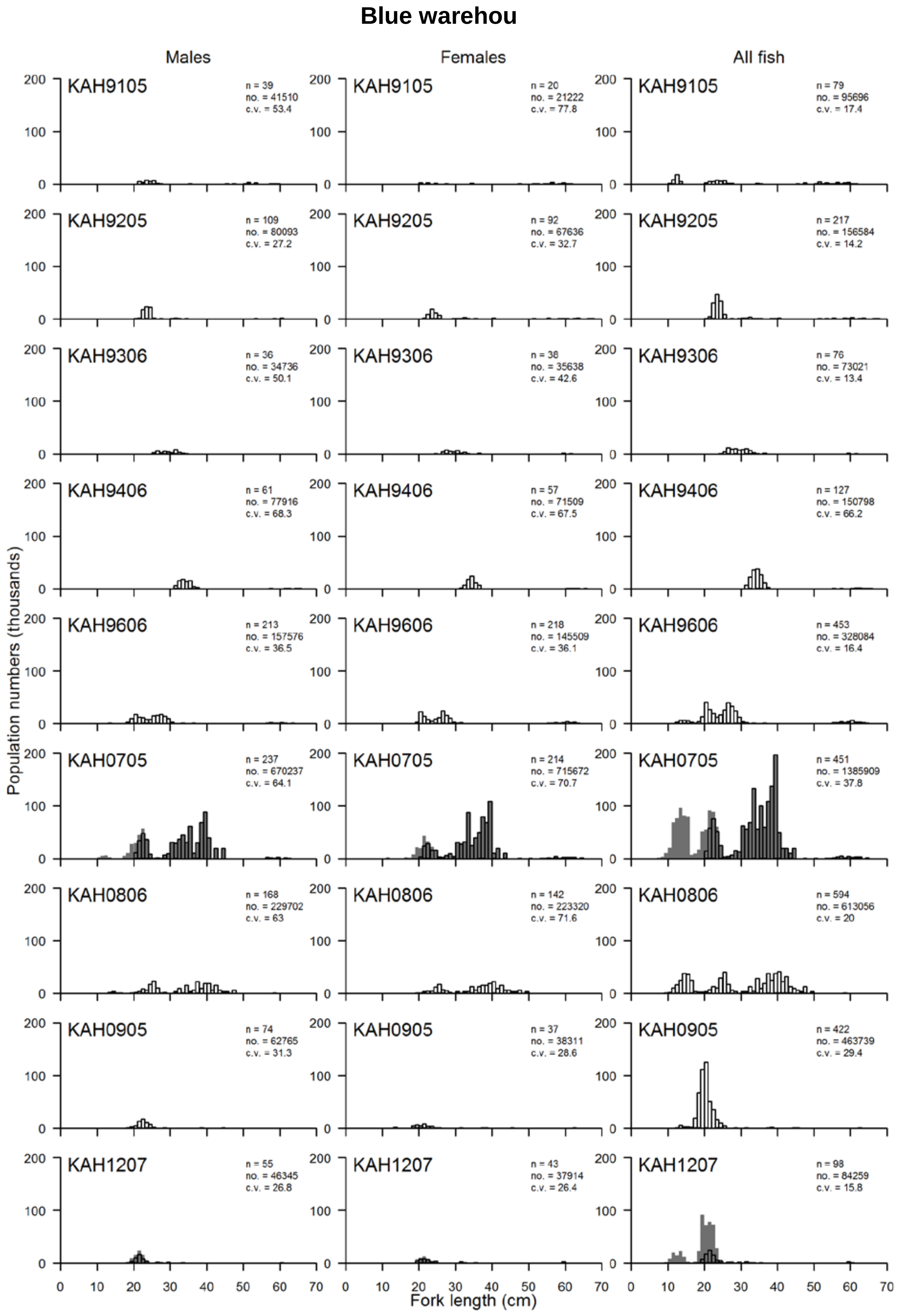


Figure 4 – ***continued***

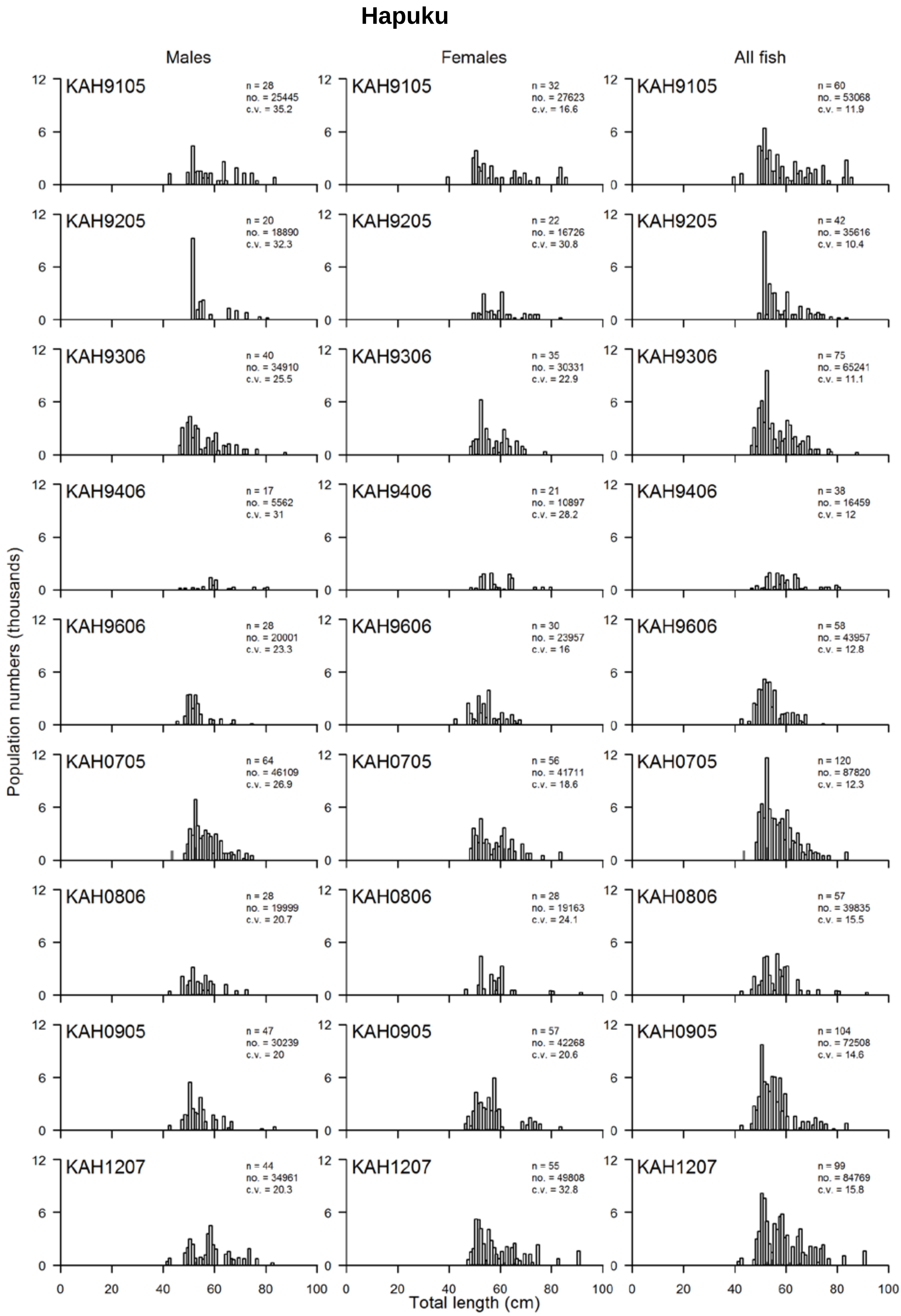


Figure 4 – ***continued***

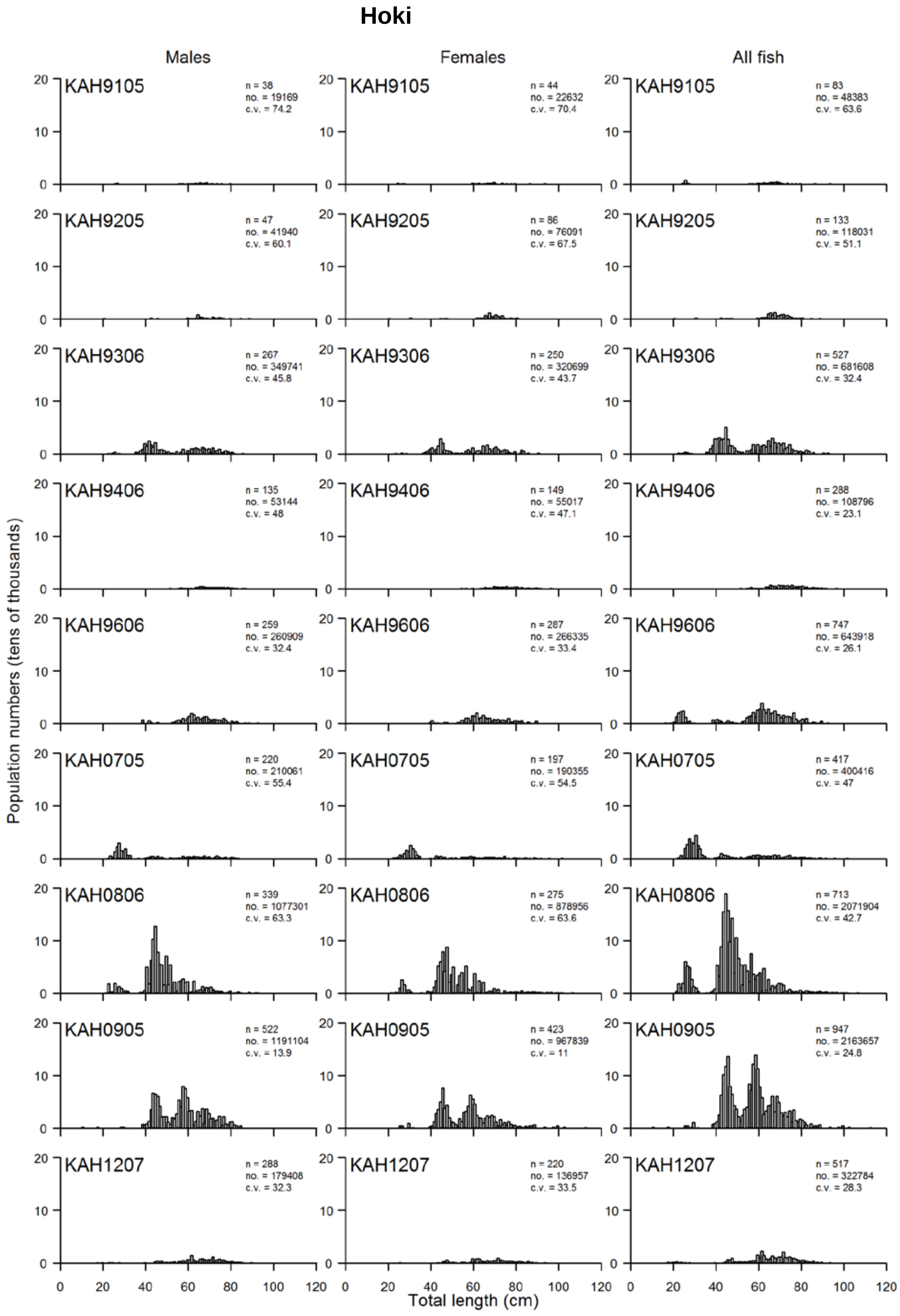


Figure 4 – ***continued***

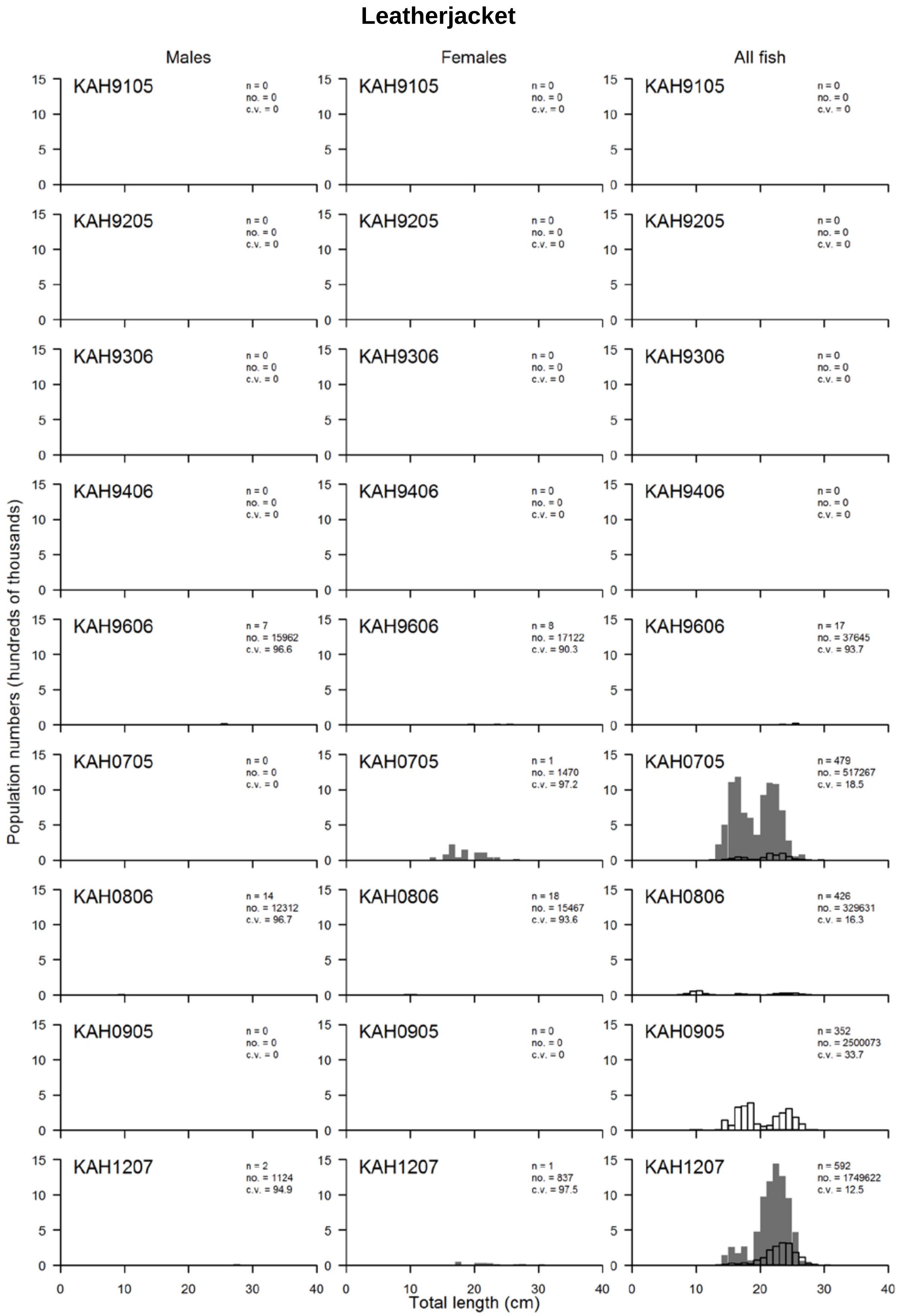


Figure 4 – ***continued***

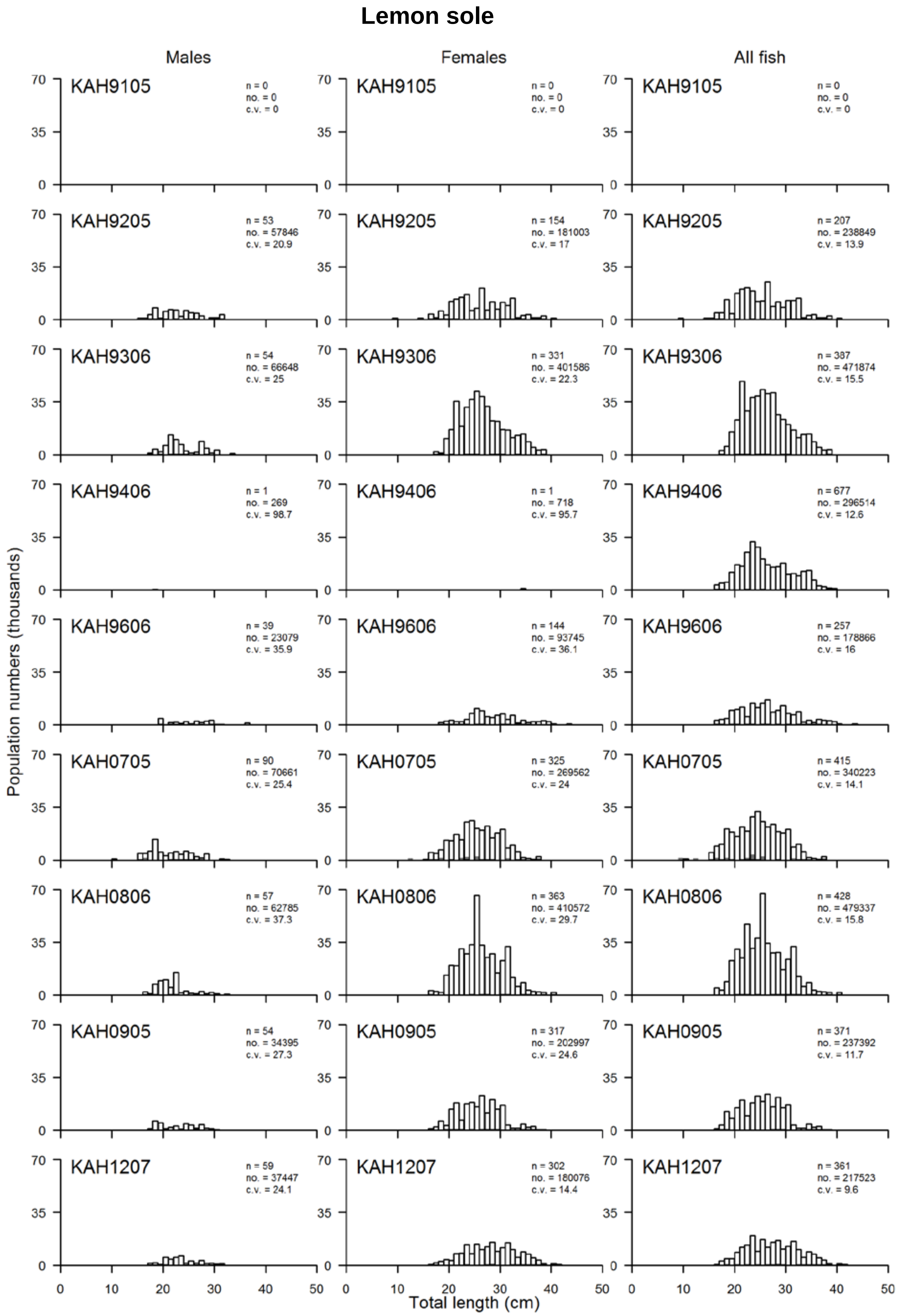


Figure 4 – ***continued***

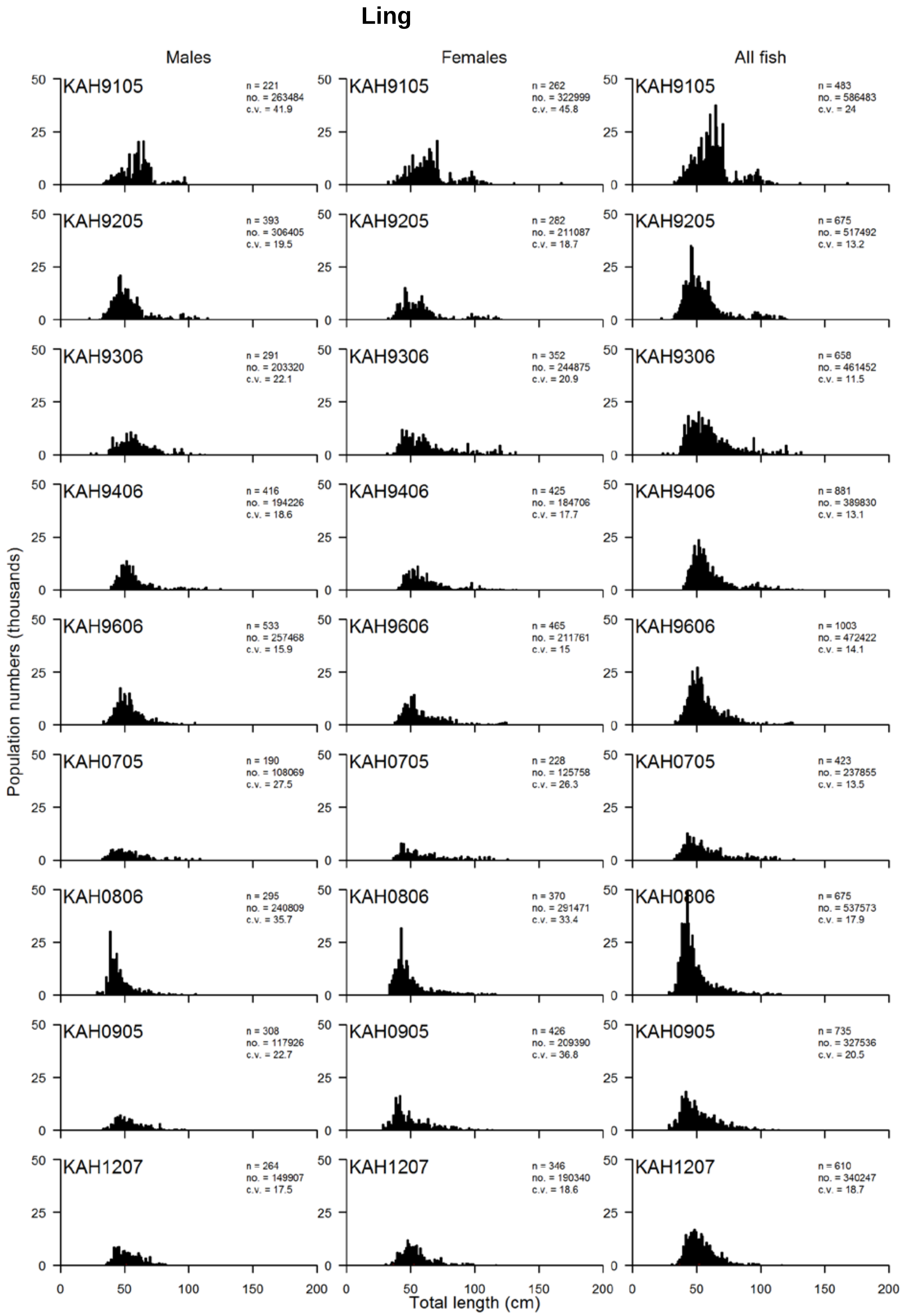


Figure 4 – ***continued***

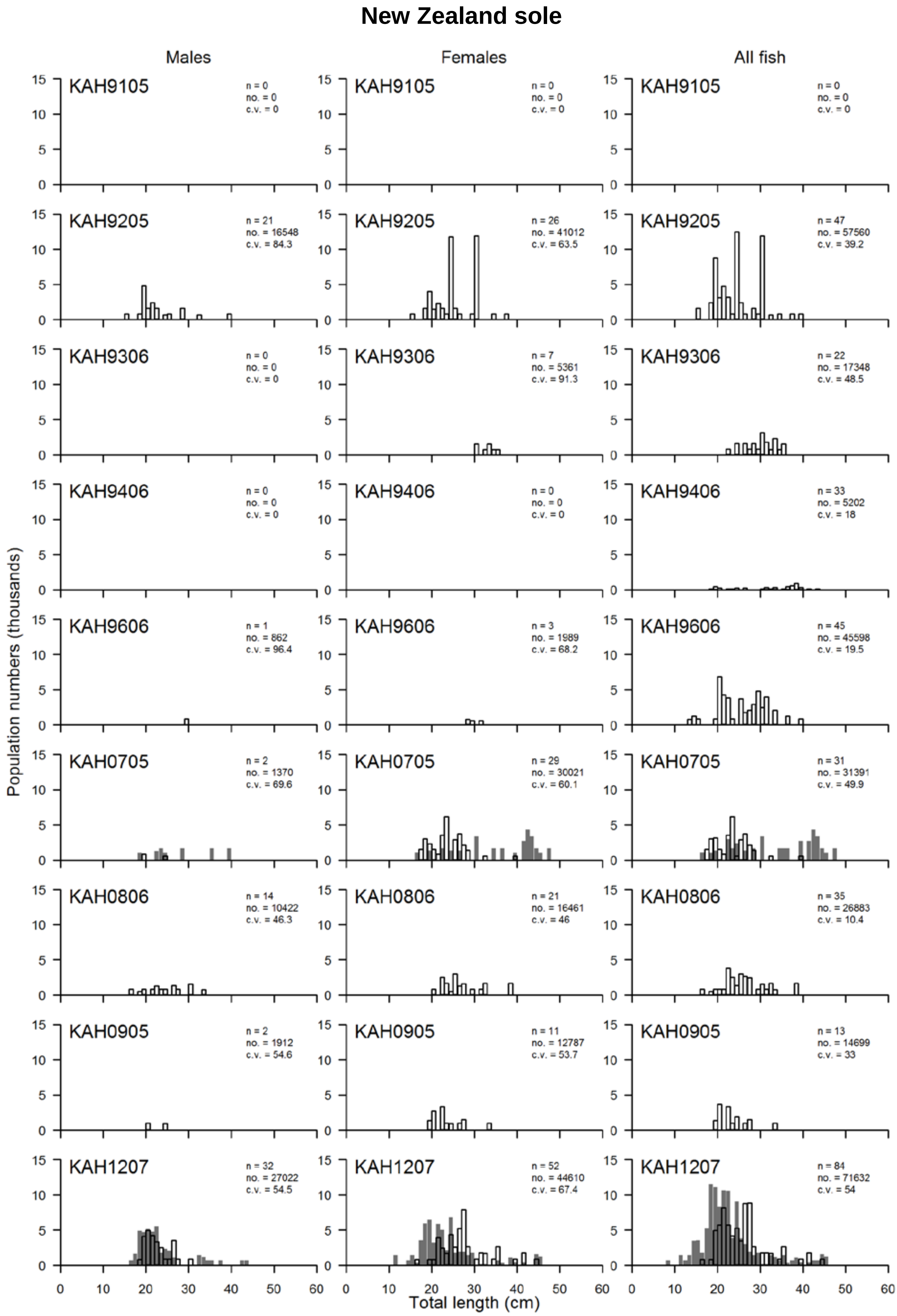


Figure 4 – ***continued***

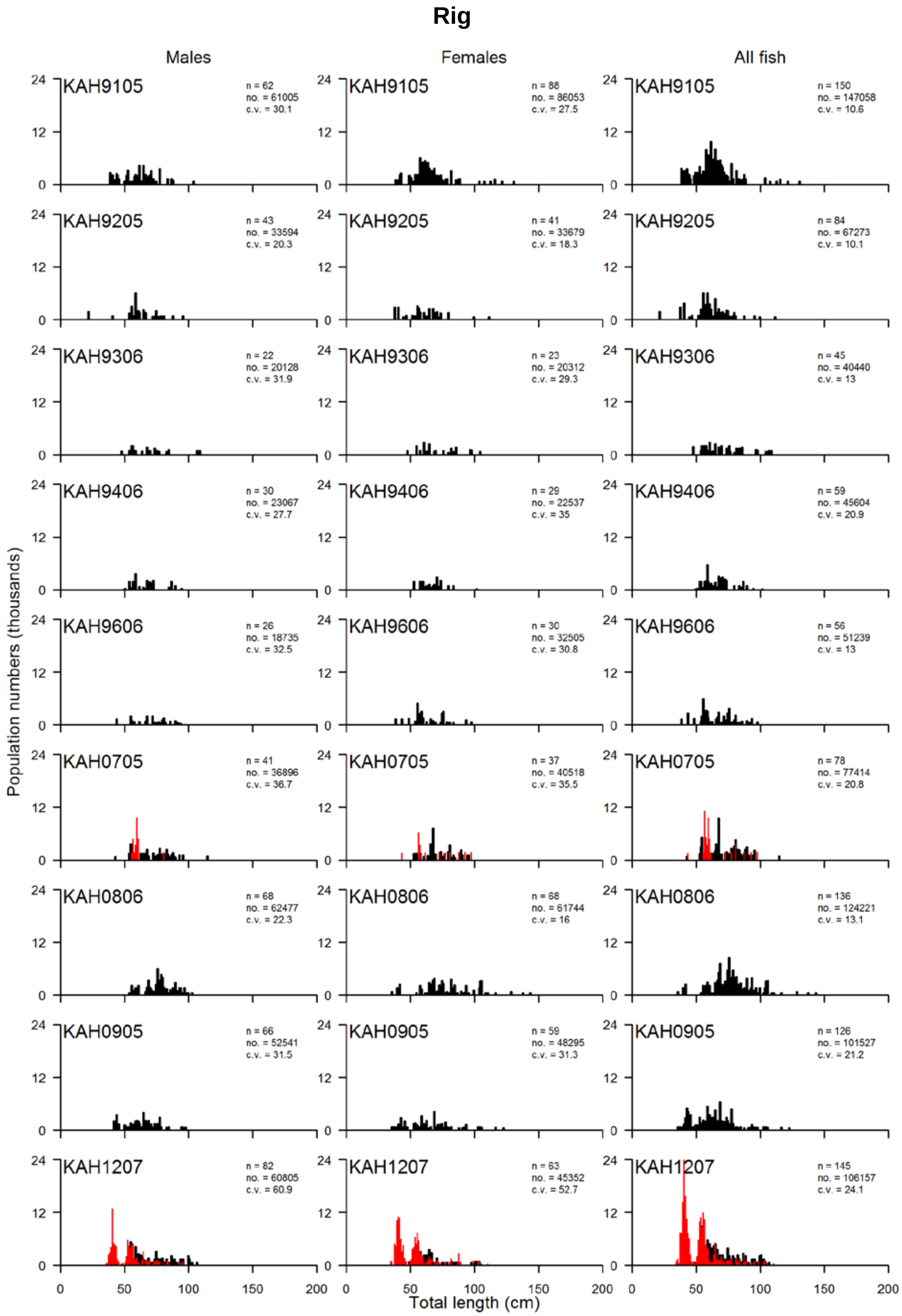


Figure 4 – ***continued***

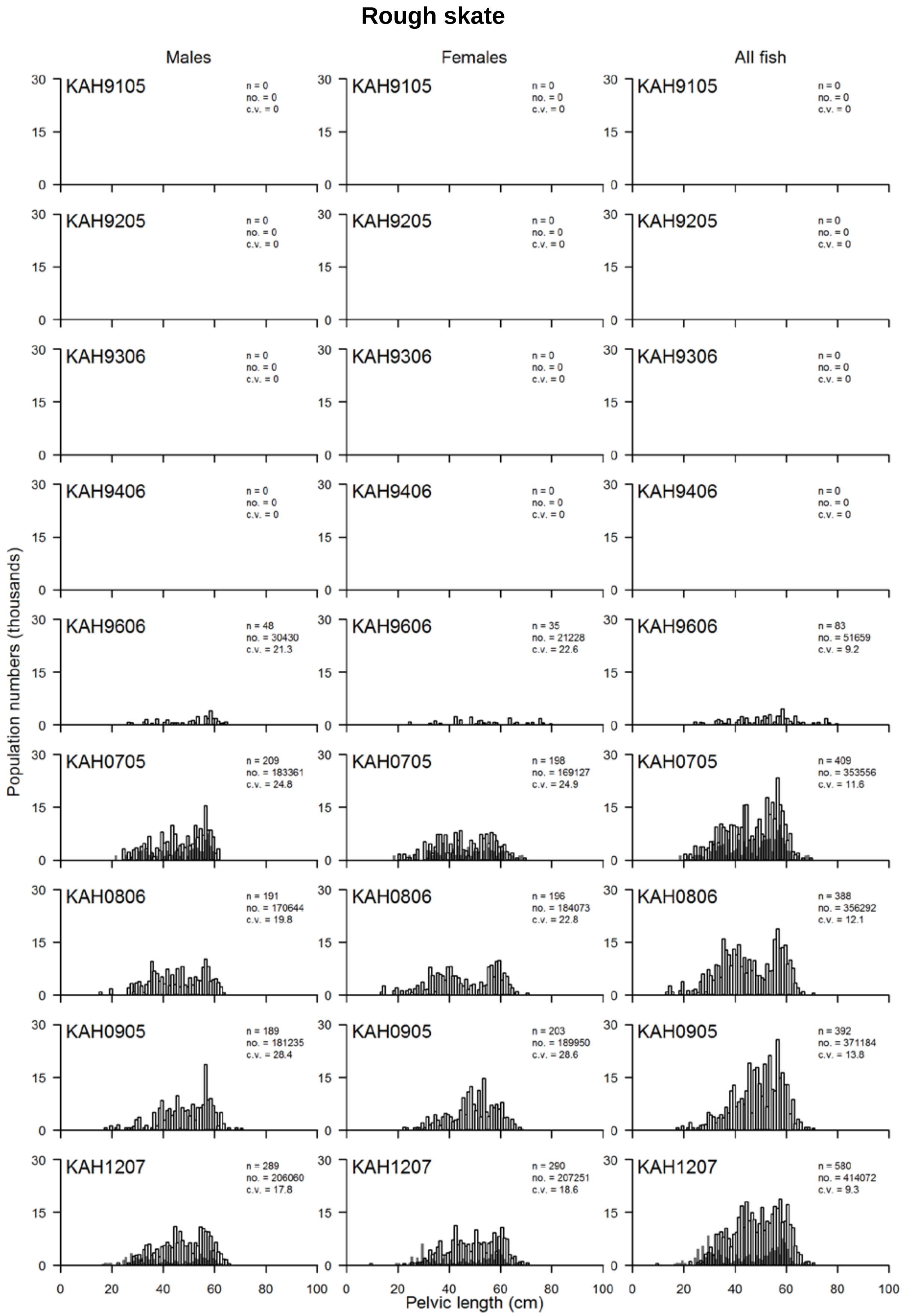


Figure 4 – *continued*

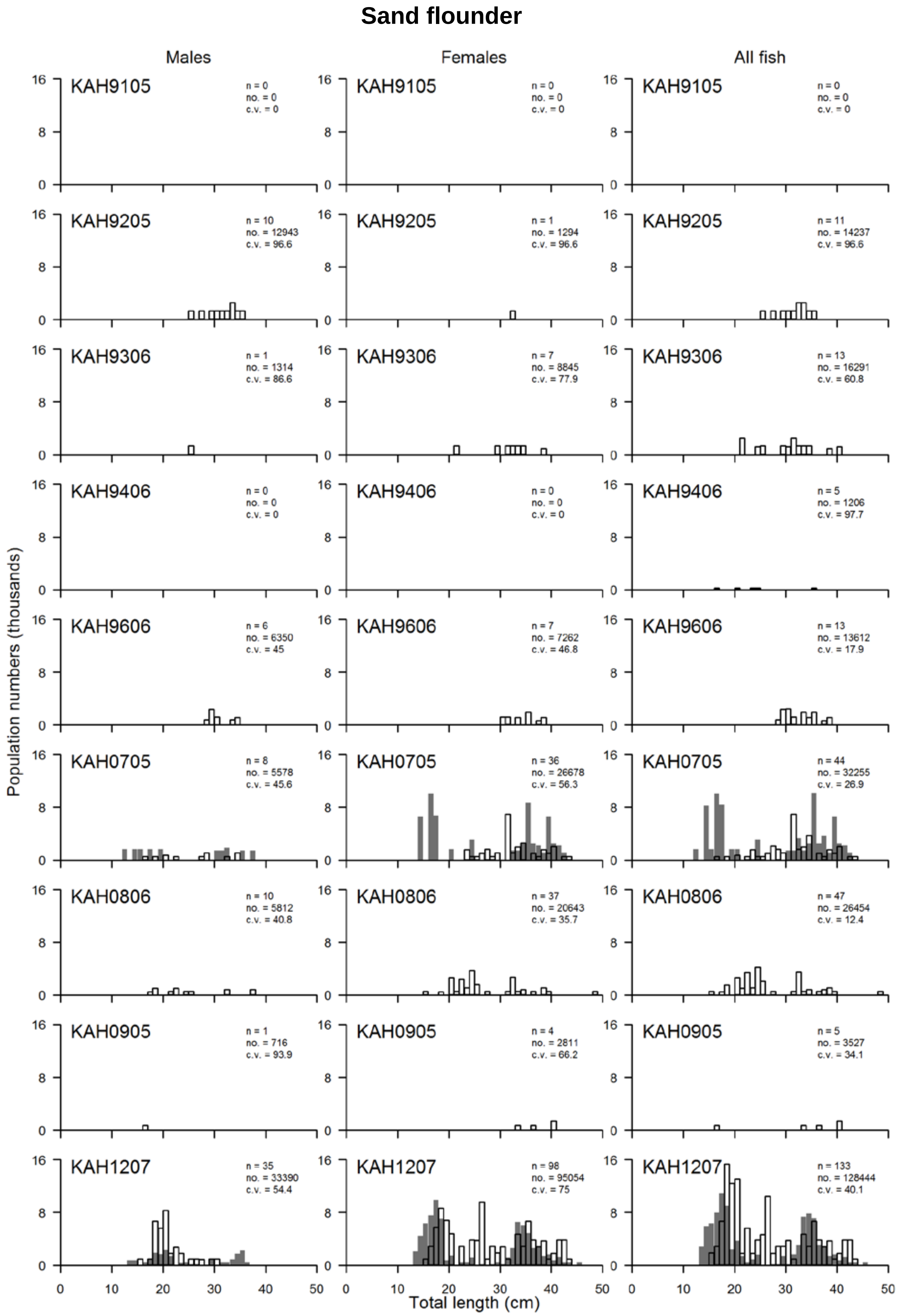


Figure 4 – ***continued***

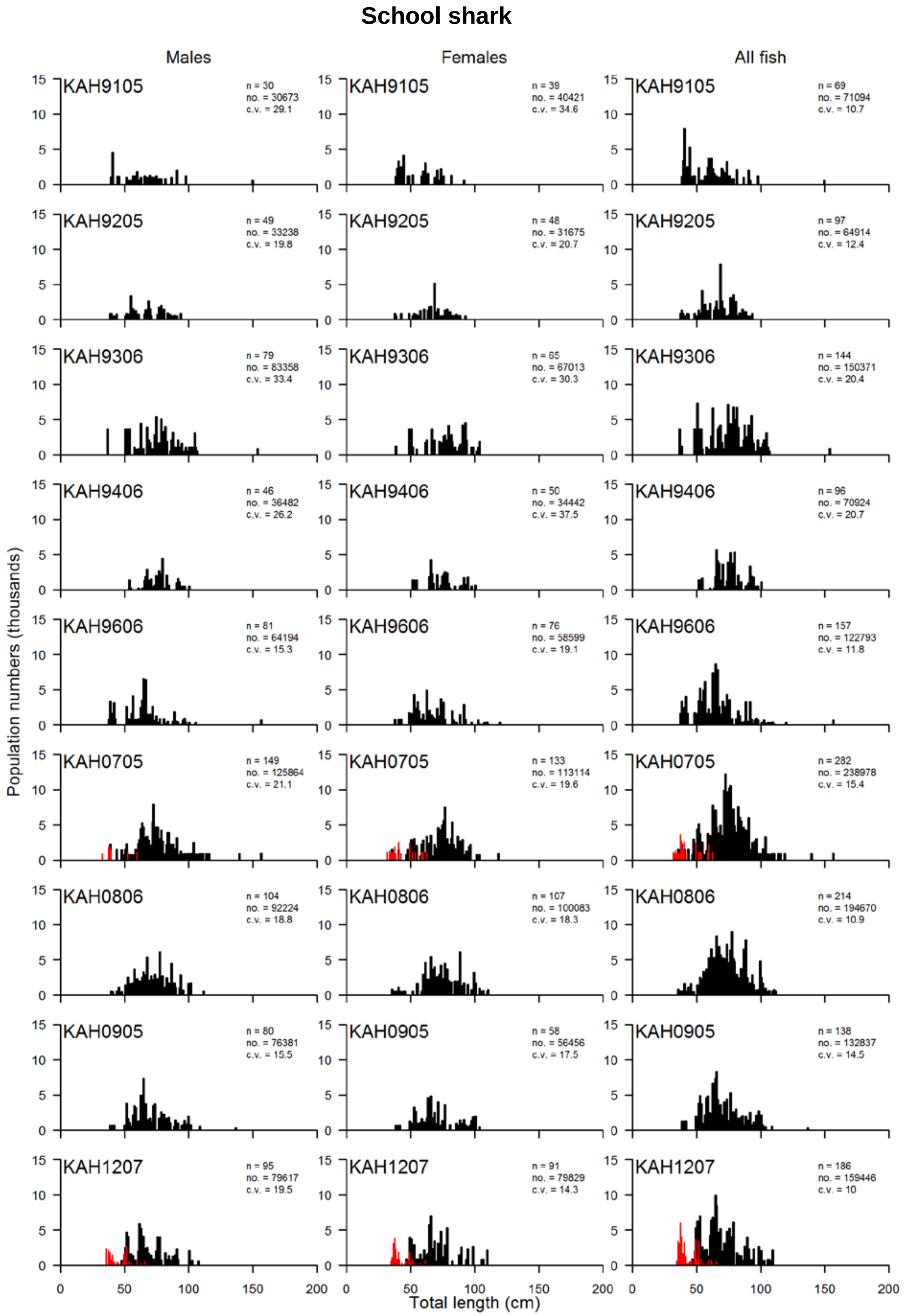


Figure 4 – ***continued***

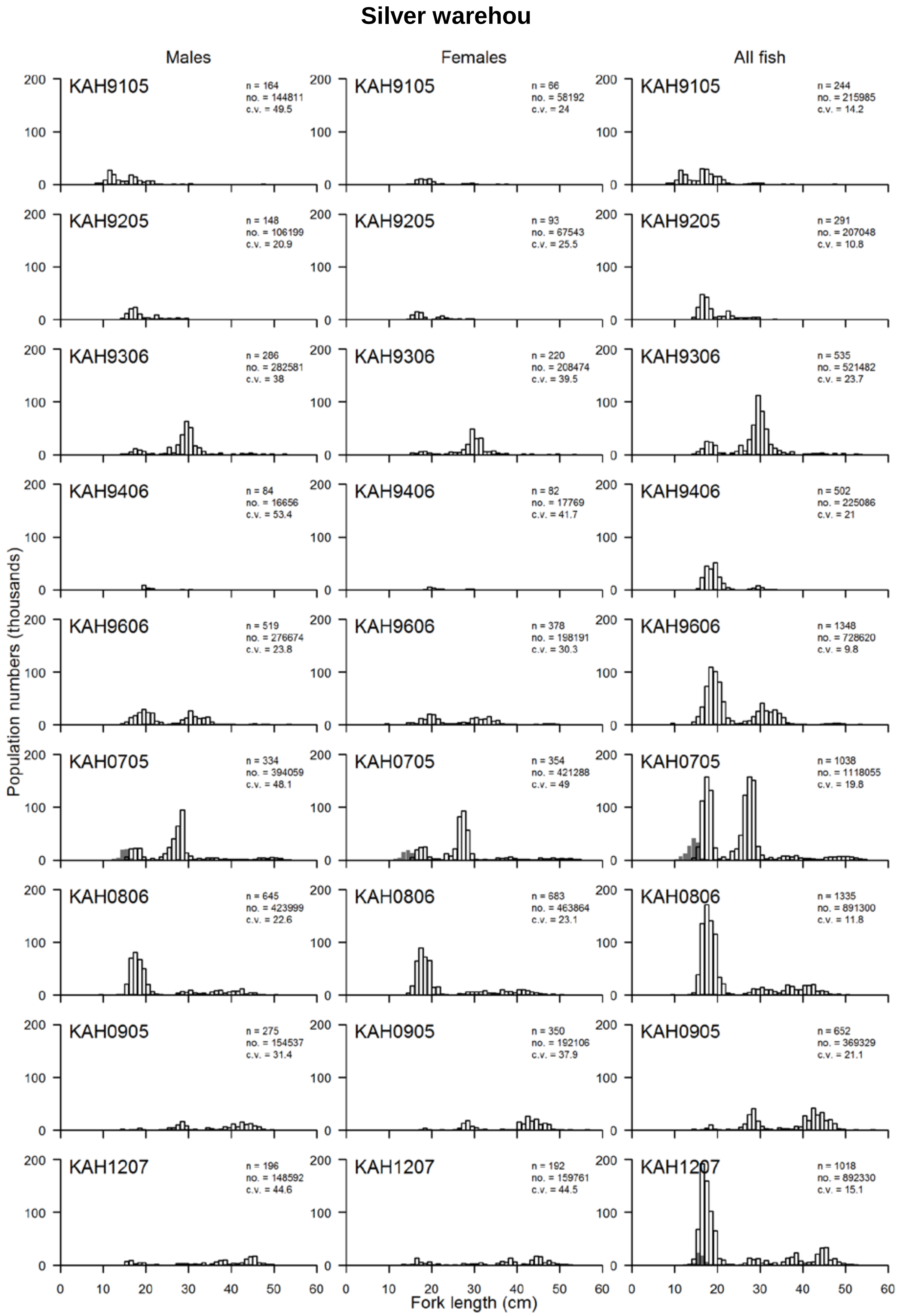


Figure 4 – ***continued***

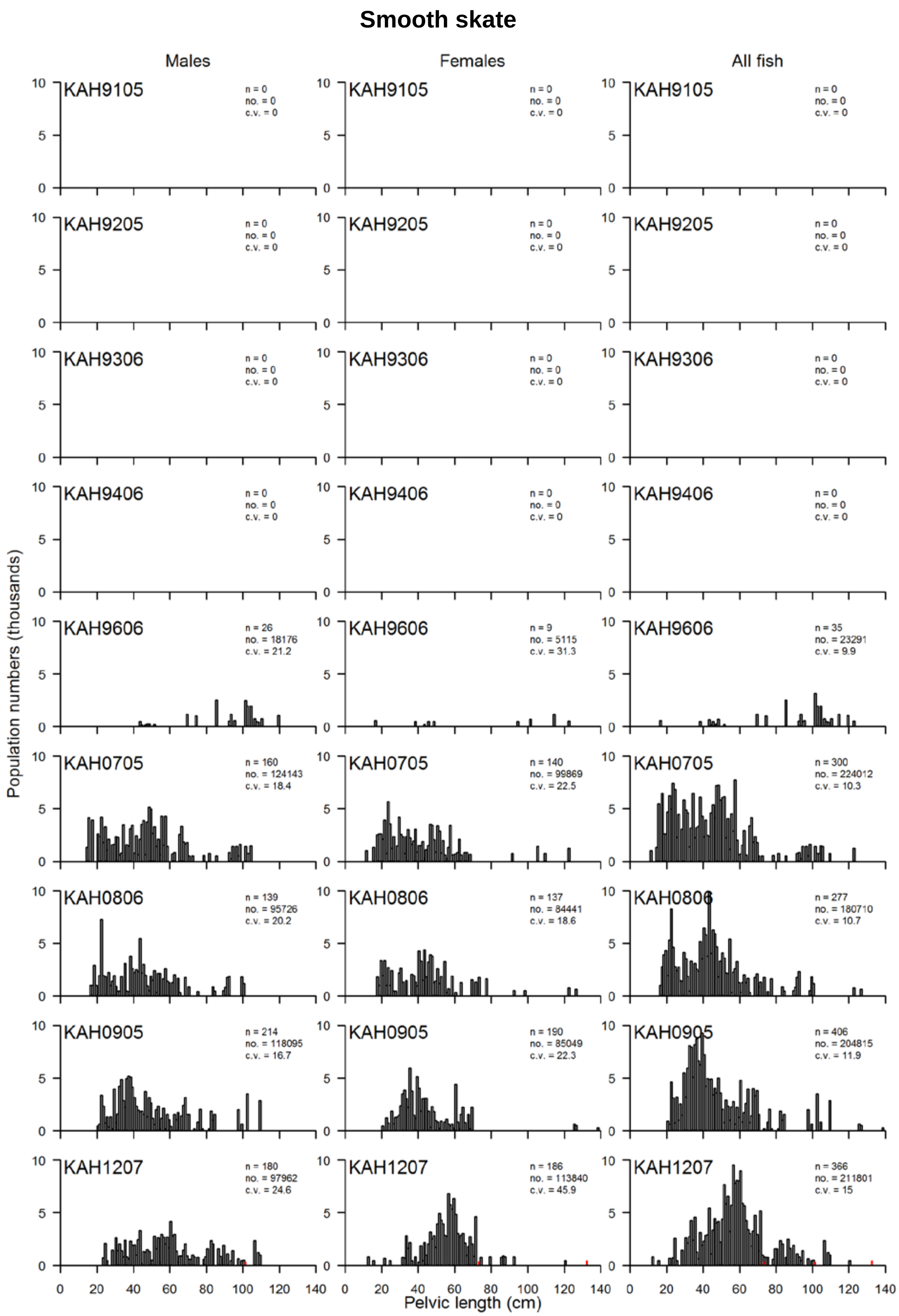


Figure 4 – *continued*

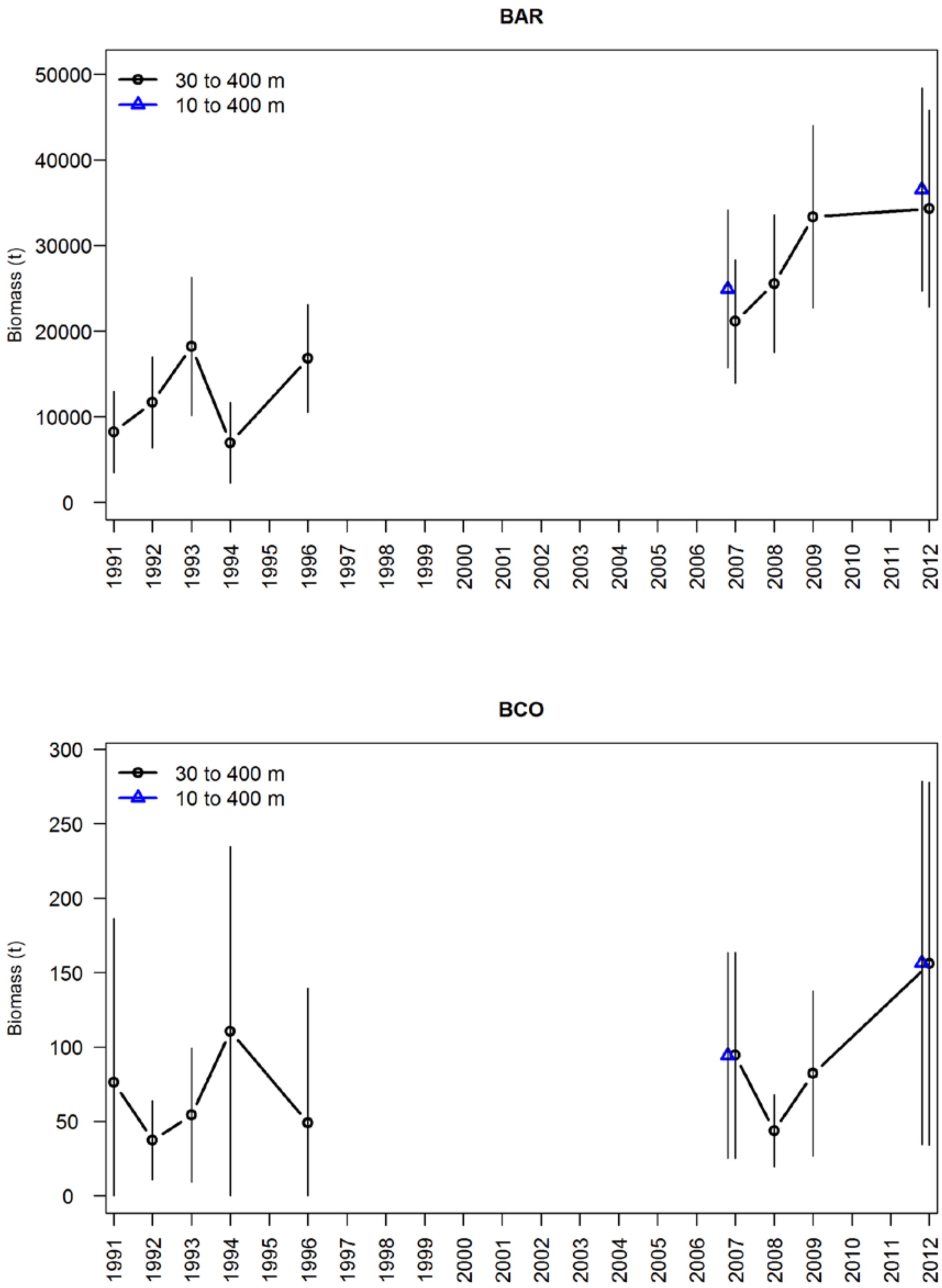


Figure 5: Biomass and 95% confidence intervals (total biomass only) for the ECSI trawl survey core strata (30–400), and core plus shallow strata (10–400 m).

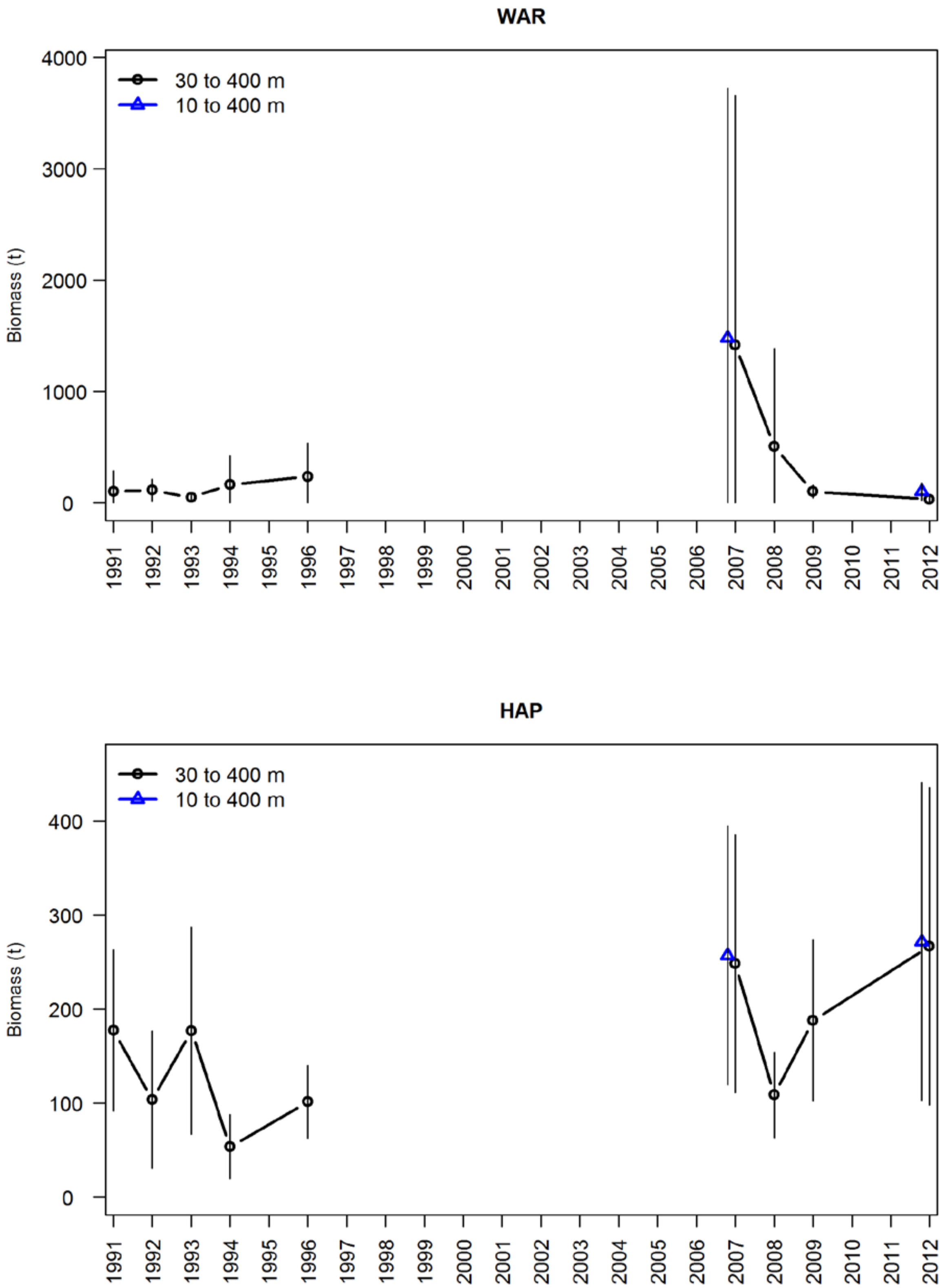
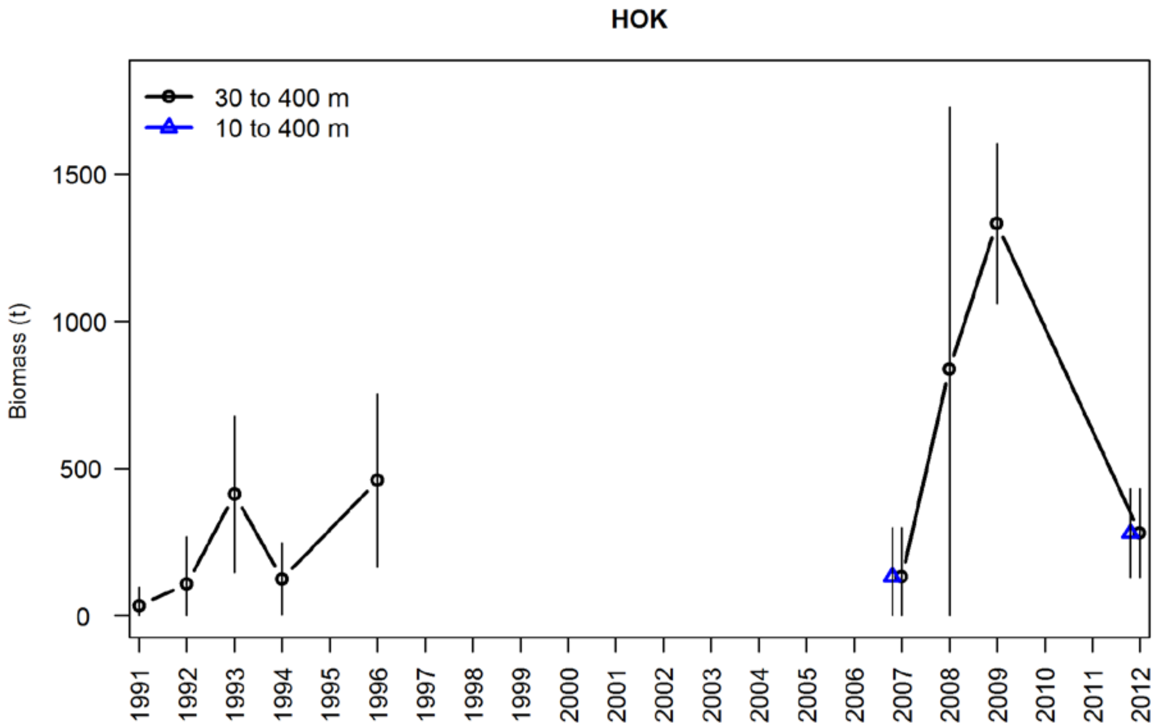


Figure 5– ***continued***



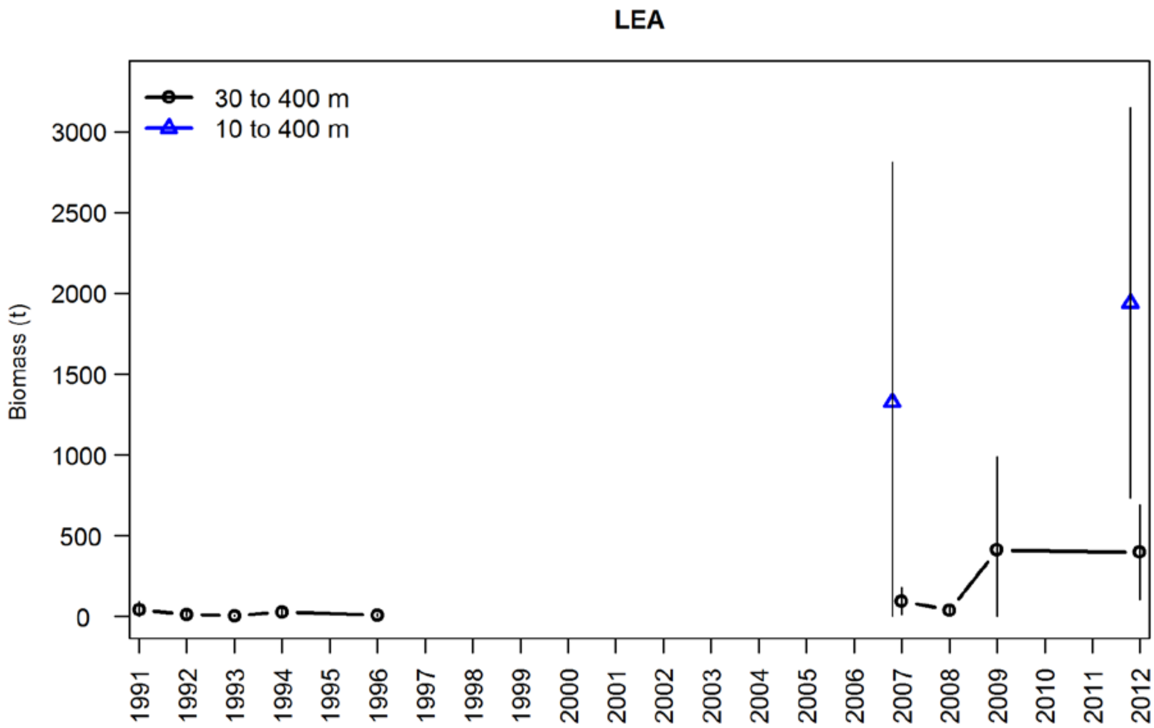
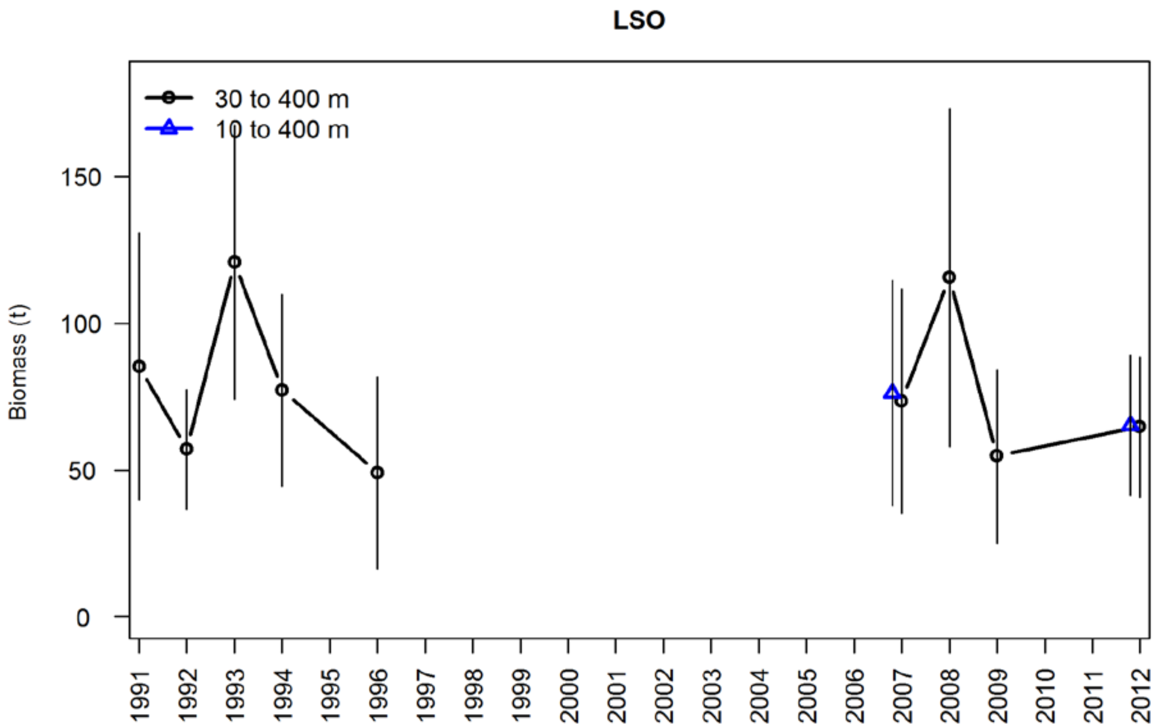


Figure 5– ***continued***



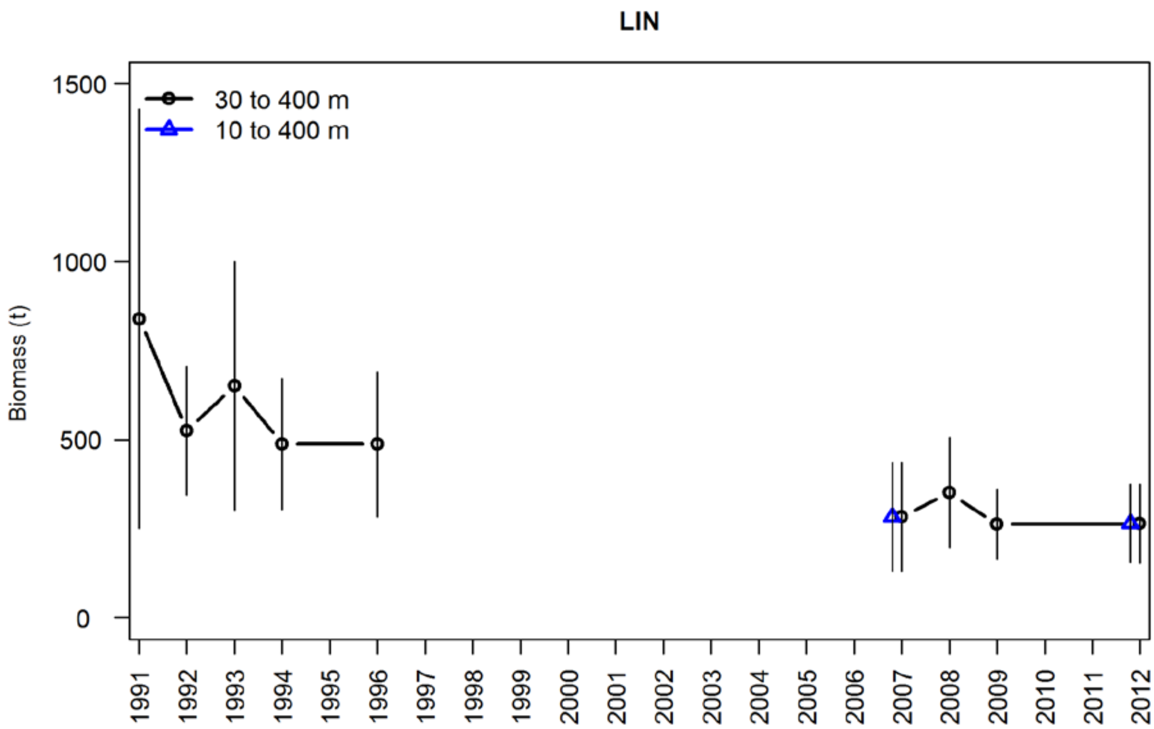
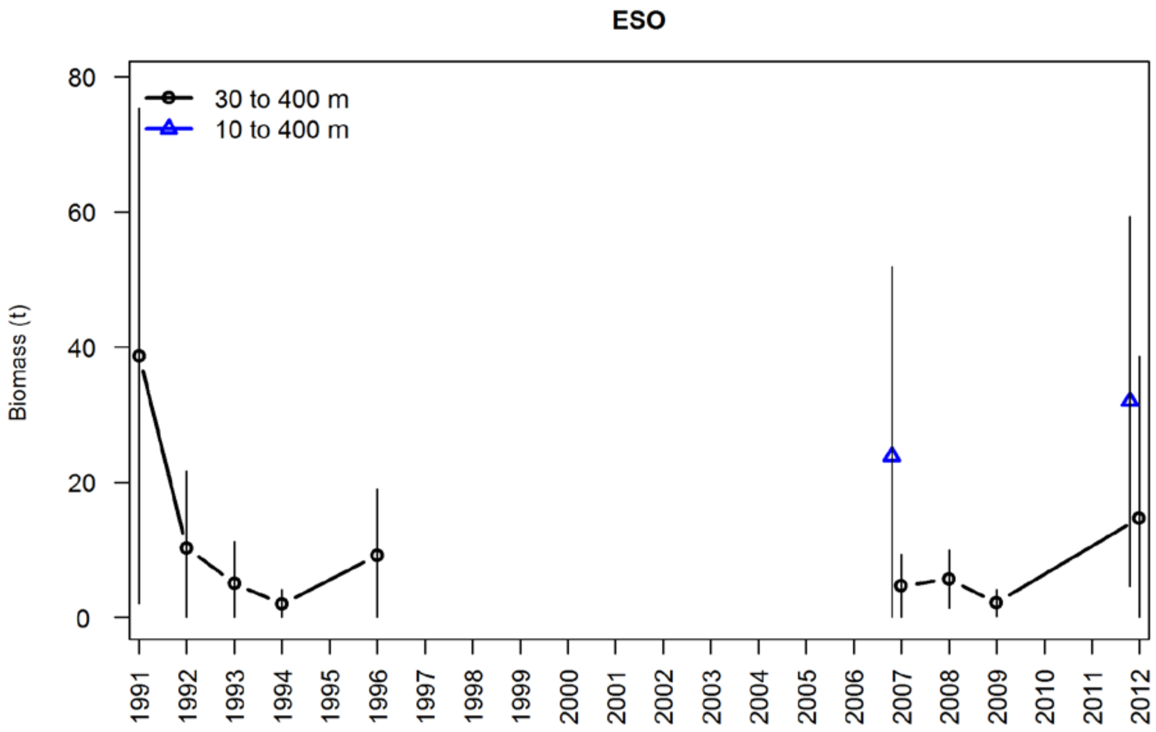


Figure 5– ***continued***



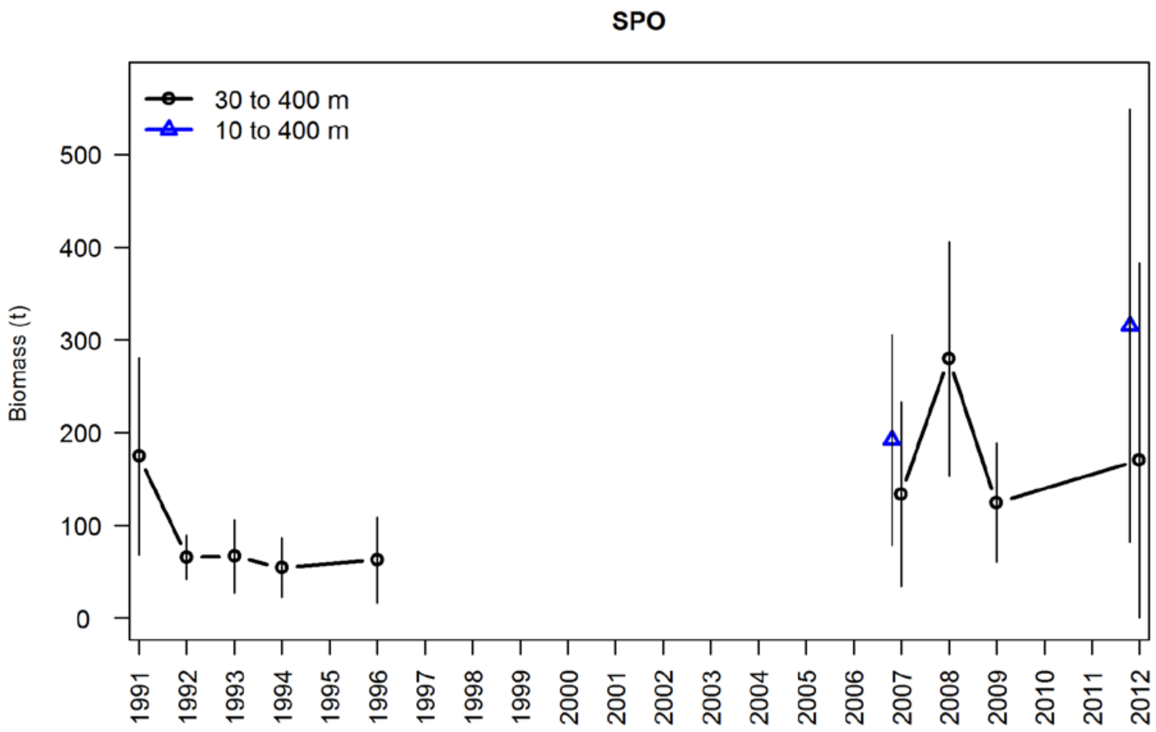
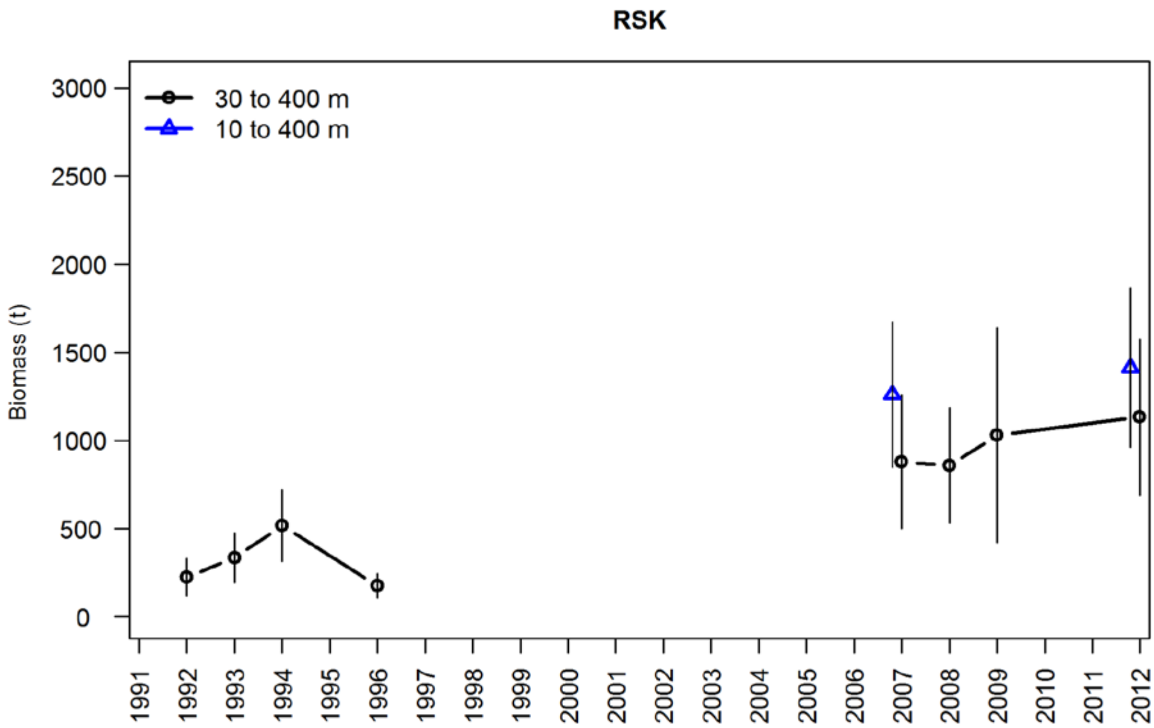


Figure 5– ***continued***



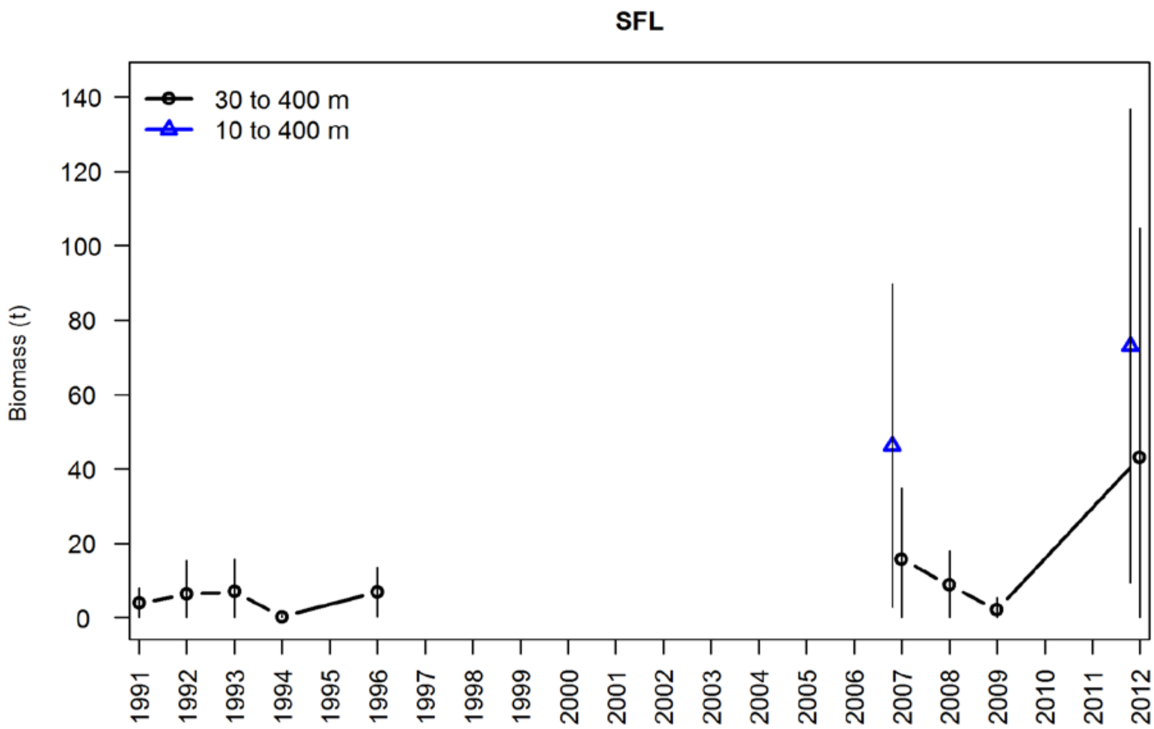
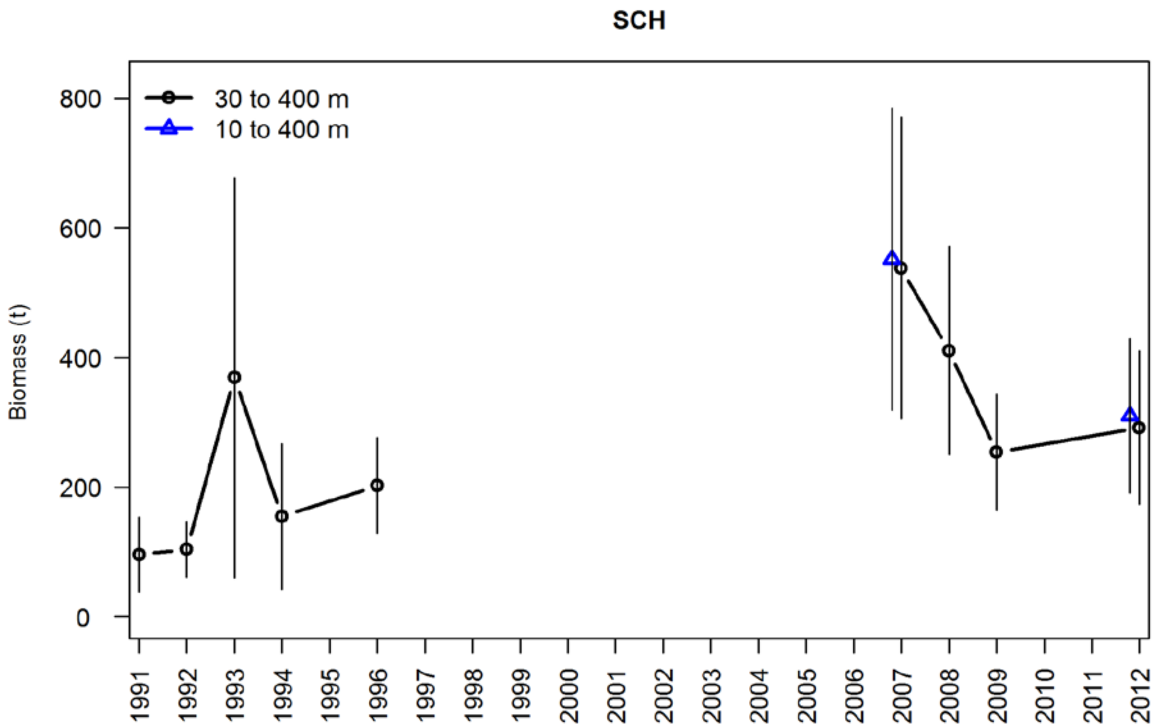


Figure 5– *continued*



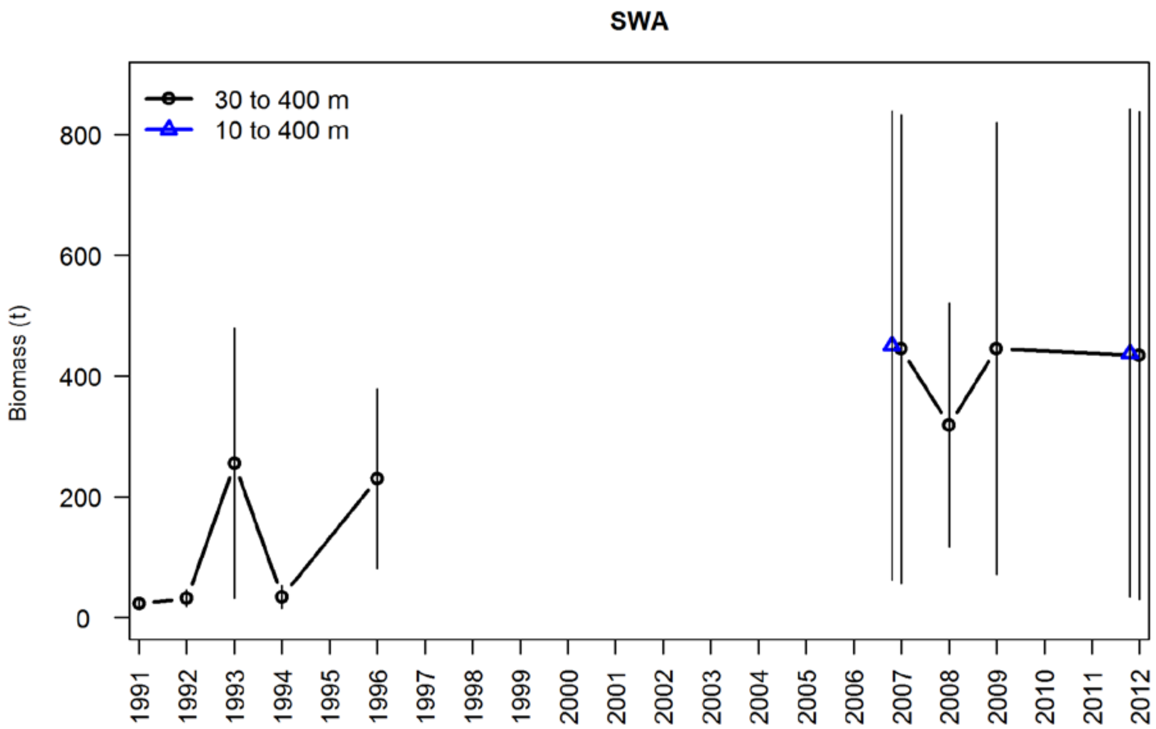


Figure 5– ***continued***

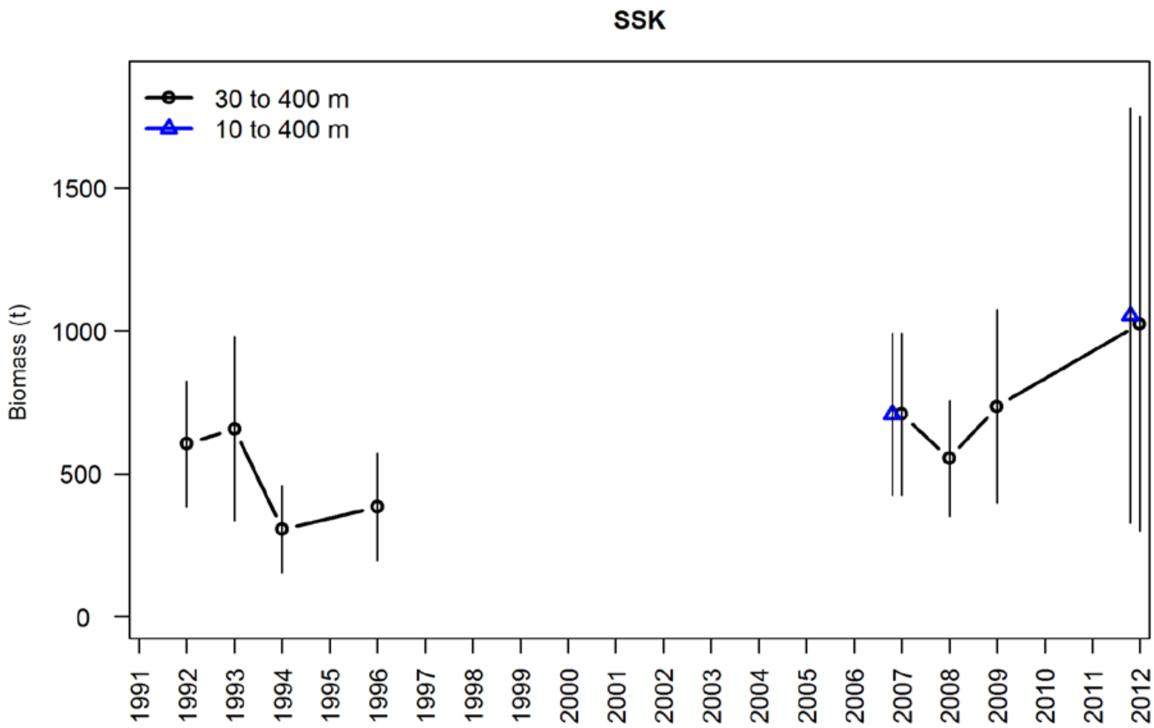


Figure 5– ***continued***