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Evaluation of alternative recreational snapper MLS and bag limits for SNA 8

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EXECUTIVE SUMMARY

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Estimates of the recreational harvest provided by the 2011–12 and 2017–18 National Panel Surveys suggests that the snapper (*Chrysophrys auratus*) harvest taken by amateur fishers from the SNA 8 fish stock now exceeds the 312 t recreational catch allowance (set in 2005) by a considerable margin. The two main regulatory tools used to manage recreational harvesting levels in New Zealand are minimum legal size limits and daily bag limits.

This report provides estimates of the degree to which alternative recreational minimum legal size and daily bag limit settings would constrain the recreational harvest in SNA 8, to inform a possible review of the TAC, allowances, and TACC for SNA 8 in 2021. These estimates are based on snapper catch per fisher trip (creel survey) data reported by boat-based fishers interviewed at a small number of boat ramps in SNA 8, over a five year period spanning the 2015–16 to 2019–20 fishing years. Incrementally increasing minimum legal size limits were applied to these catch per trip compositional data, and, within each of these size increments, progressively decreasing daily bag limits were applied to the remaining catch. The remaining catch of all fishers was summed, for each combination of minimum legal size limit and daily bag limit, to estimate the proportional reduction in the SNA 8 catch that would have occurred in 2017–18, when the most recent National Panel Survey was conducted.

These analyses suggest that the current 27 cm minimum legal size limit would have to be increased significantly and the current 10 snapper daily bag limit would have to be decreased significantly, to constrain the annual SNA 8 recreational harvest to any substantive degree. This is because most of the snapper landed by recreational fishers for SNA 8 are substantially larger than 27 cm, and only a small proportion of fishers currently land their daily bag limit.

The estimates provided do not appear to be sensitive to alternative interpretations of whether or not fishers in the same boat pool their daily bag limit. Issues associated with increasing minimum legal size limits and decreasing daily bag limits are discussed, because factors such as release mortality should also be considered when assessing the effectiveness of options.

1. INTRODUCTION

Estimates for the recreational harvest of snapper (*Chrysophrys auratus*) taken from SNA 8 provided by an aerial survey conducted in 2006–07 (Hartill et al. 2011) and National Panel Surveys conducted in 2011–12 and 2017–18 (Wynne-Jones et al. 2014, 2019) indicate a substantial increase in the catch taken by this sector in recent years. This increasing recreational harvest trend reflects the increase in the SNA 8 biomass in recent years, as indicated by all model sensitivities provided by the 2020 assessment of the SNA 8 fish stock (Langley 2020). Commercial catch rates have also increased over the same period (Langley 2020).

Both the 2011–12 and 2017–18 National Panel Survey harvest estimates for SNA 8 are substantially higher than the existing 312 t recreational catch allowance for this stock that was set in 2005 before the recent biomass increase. The current recreational Minimum Legal Size Limit (MLS) for SNA 8 is 27 cm and the daily fisher bag limit is 10 snapper; these limits were set to constrain the catch taken by this sector.

This report provides an evaluation of the likely impact that different combinations of increasing MLS and decreasing daily bag limits will have on the recreational catch, based on modelling of data provided by recent boat ramp interview surveys.

Objective

To evaluate the impact that changes to recreational bag and MLS limits could have on the recreational harvest from SNA 8.

2. METHODS AND RESULTS

The following results are based on creel survey data that have been collected during interviews with recreational fishers returning to boat ramps in Fishery Management Areas (FMAs) 8 and 9. The methods used to analyse these data have closely followed those used for a similar assessment of recreational MLS and daily bag limit combinations for SNA 1 in 2013 (Hartill & Bian 2013).

2.1 Available SNA 8 recreational catch data

Creel surveys of recreational fishers returning to boat ramps have been conducted by NIWA in a consistent fashion since 1991. These surveys have been conducted for a wide variety of purposes, but almost all of the interviewing undertaken on the west coast of the North Island since 2011–12 has been undertaken as part of an ongoing camera/creel survey monitoring programme (Hartill et al. 2020a). As part of this monitoring programme, interviews with fishers have been conducted over a four hour period during the expected time of peak boat ramp traffic, on 60 days randomly pre-selected from each fishing year, on midweek and weekend/public holiday days, during the summer (1 October to 30 April) and winter (1 May to 30 September).

The location of the four boat ramps where these creel surveys have been conducted is shown in Figure 1, at Shelly Beach, Raglan, New Plymouth, and Twin Bridges. Creel survey interviewing was also conducted at Cornwallis and Wanganui in 2011–12 and 2017–18, for another purpose, but the format of those interviews followed that used for the longer term monitoring programme.

Data on the snapper length and bag composition of recreational fisher landings has therefore been collected in a consistent fashion throughout each year since 2011–12. These data can be used to characterise the SNA 8 boat-based fishery, and to inform an evaluation of the potential impact of alternative combinations of MLS and daily bag limits on the annual recreational catch landed from this fish stock.

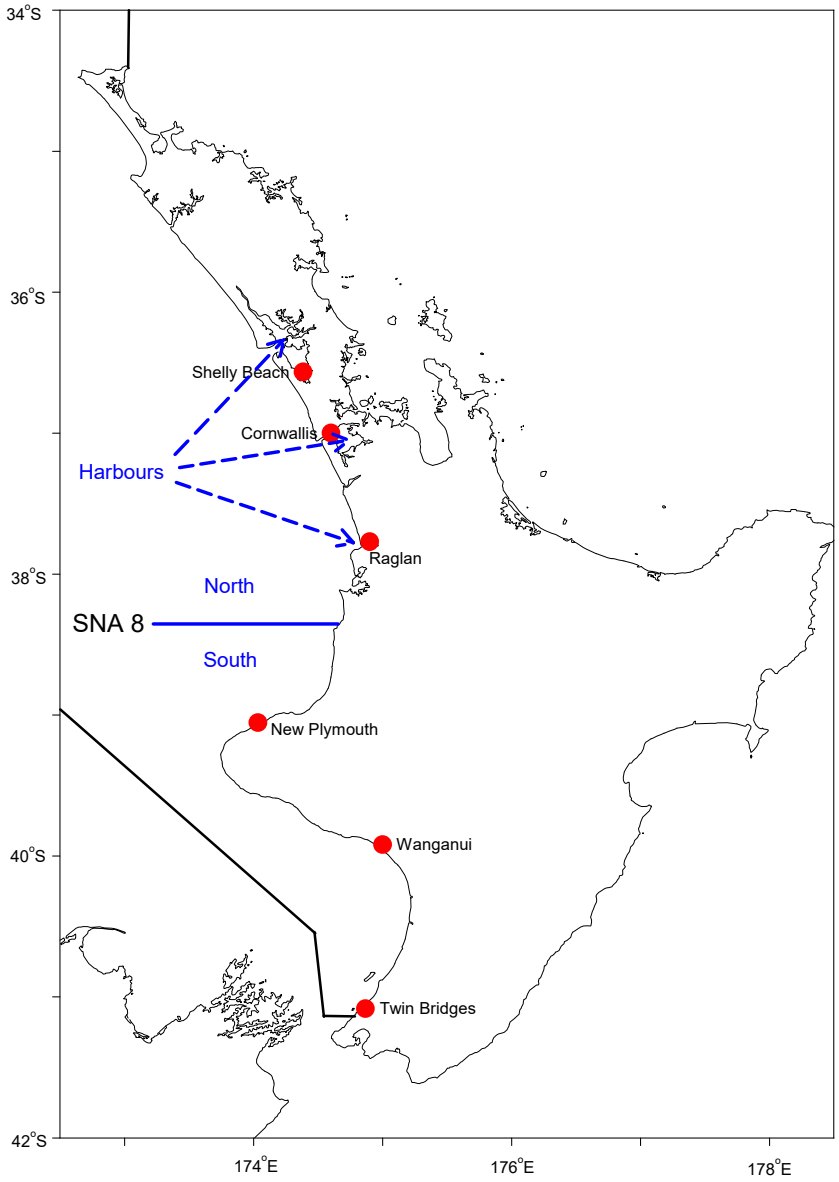

Figure 1: Location of boat ramps in SNA 8 where creel survey data have been collected on the length composition and number of snapper landed by recreational boat-based fishers. The spatial definitions for three subregions of the SNA 8 fishery are also indicated, which are for the North and South open coast fisheries, and the more sheltered combined Harbours fishery.

2.2 Characterisation of the SNA 8 recreational fishery

Previous analyses of recreational creel survey data collected from the west coast have identified distinct regional differences in both the length composition and number of snapper landed per fisher trip (Hartill et al. 2011). The size composition of snapper taken from west coast harbours is dominated by smaller fish that are less than 40 cm long, but on the open coast to the North and the South, a significant proportion of the catch is composed of larger snapper (Figure 2). Further, fewer snapper were landed per fisher trip in southern areas of SNA 8, although fisher success has increased in this area in recent years (Figure 3). Any analysis of the potential consequences of a change to recreational SNA 8 fishing regulations should therefore take these regional differences into account, in an appropriately weighted manner.

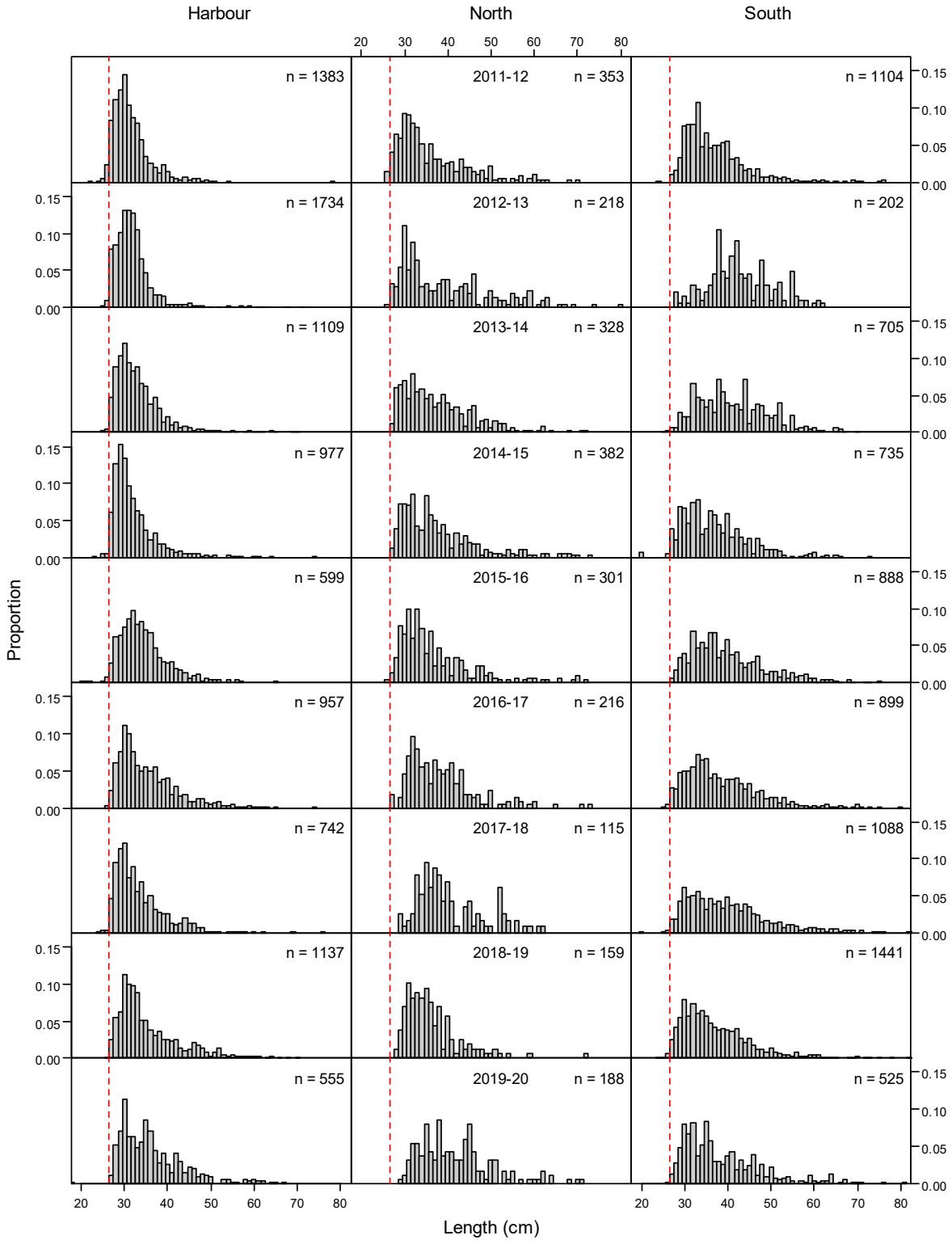

Figure 2: Length frequency distributions of snapper landed by recreational fishers in three sub-areas of SNA 8, by fishing year. The red dashed vertical line denotes the 27 cm MLS in force at the time of sampling.

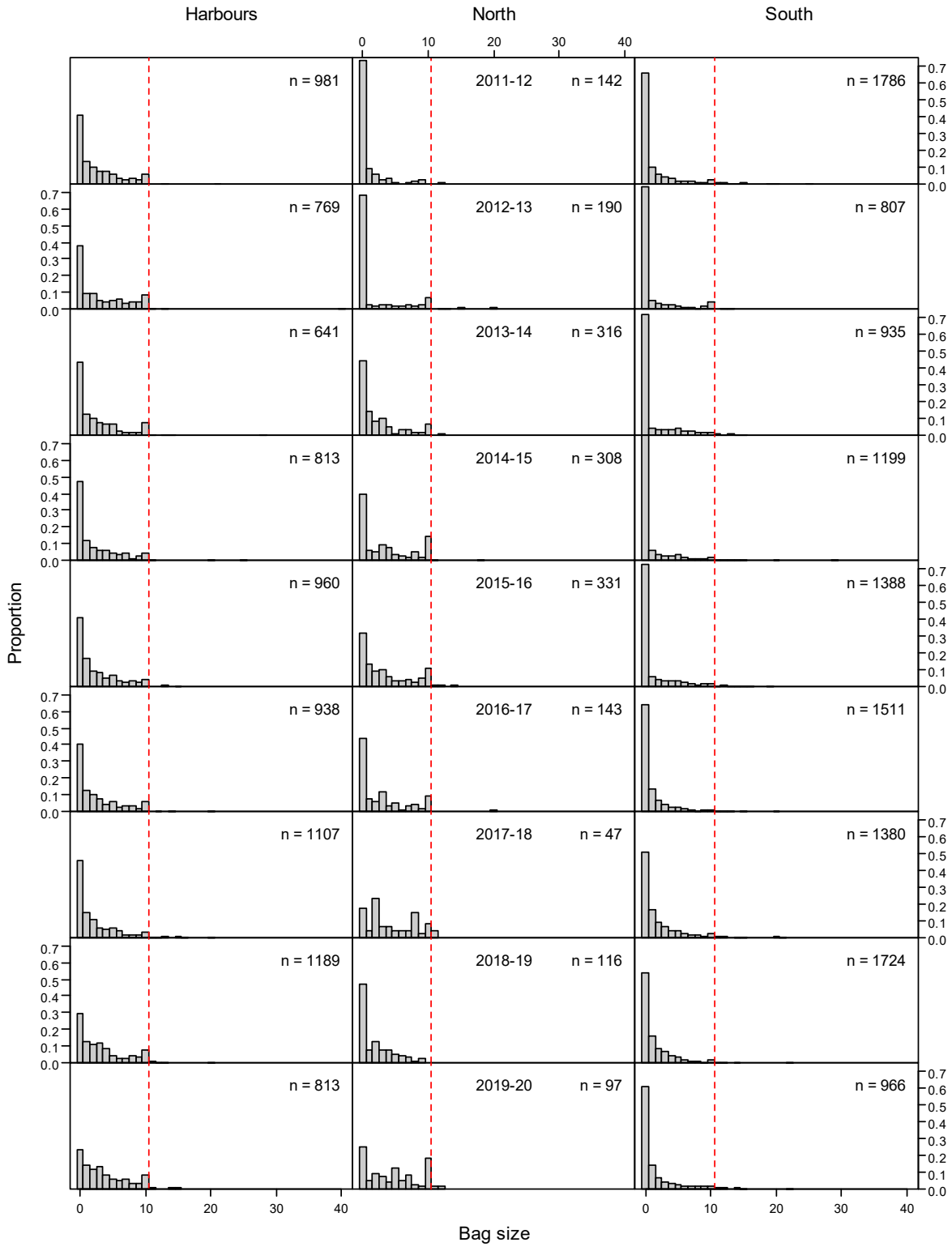

Figure 3: Number of snapper landed per trip by recreational fishers in three sub-areas of SNA 8, by fishing year. The red dashed vertical line denotes the recreational daily bag limit in force at the time of sampling.

Recreational snapper fishing in FMAs 8 & 9 has improved in recent years, as SNA 8 stock biomass has increased (Langley 2020). The recreational SNA 8 harvest was estimated to be 261 t in 2006–07 (Hartill et al. 2011) and had increased to an estimated 684 t in 2011–12 (Wynne-Jones et al. 2014), and again to 892 t in 2017–18 (Wynne-Jones et al. 2019).

Thirty year trends in four descriptors of fisher success are shown in Figure 4, for each region. The average size of the snapper landed by recreational anglers fishing in the North and from Harbours has steadily increased over the past 30 years, but there has been little change in the average length of snapper landed from the South region. The three other metrics of snapper fishing success indicate a steady improvement in all three regions off the west coast of the North Island since the early 1990s. The incidence of unsuccessful fisher (zero catch) trips has declined in all three regions, as the average number of snapper landed per trip has increased, along with an increasing but still low proportion of trips where fishers caught or exceeded the 10 snapper bag limit, which came into effect on 1 October 2005. These trends in increased recreational catch rates mirror that seen in the standardised SNA 8 commercial single trawl catch per unit effort (CPUE) index provided by Langley (2020) which also indicates a substantial increase in the SNA 8 biomass (Figure 5).

This study was restricted to creel survey data collected over a five year period since 2015–16, because the composition of trip catches has changed over time. The analysis of creel survey data was pooled over these five years. This was to ensure the analysis was based on a sufficiently large number of observations for each regional fishery (Table 1). The pooling of data was especially necessary for the North region, where there was snapper catch data for no more than 300 fisher trips per fishing year, yet over a third of the estimated 2017–18 catch was taken from this region (Wynne-Jones et al. 2019). A cursory examination of Figures 2, 3, and 4 suggests that there has been relatively little change in the composition of recreational snapper catches over the most recent five year period, given the degree of interannual variability observed.

Table 1: Summary statistics for creel survey data that are available by region of SNA 8, for the most recent five fishing years and for all five years combined.

Rergion	Fishing year	Fisher trips	Snapper bags	Snapper measured
Harbour	2015–16	960	570	599
	2016–17	938	562	957
	2017–18	1 107	596	742
	2018–19	1 189	834	1 137
	2019–20	813	622	555
	Combined	5 007	3 184	3 990
North	2015–16	331	227	301
	2016–17	143	80	216
	2017–18	47	39	115
	2018–19	116	61	159
	2019–20	97	73	188
	Combined	734	480	979
South	2015–16	1 388	384	888
	2016–17	1 511	540	899
	2017–18	1 380	678	1 088
	2018–19	1 724	794	1 441
	2019–20	966	375	525
	Combined	6 969	2 771	4 841
SNA 8	Combined	12 710	6 435	9 810

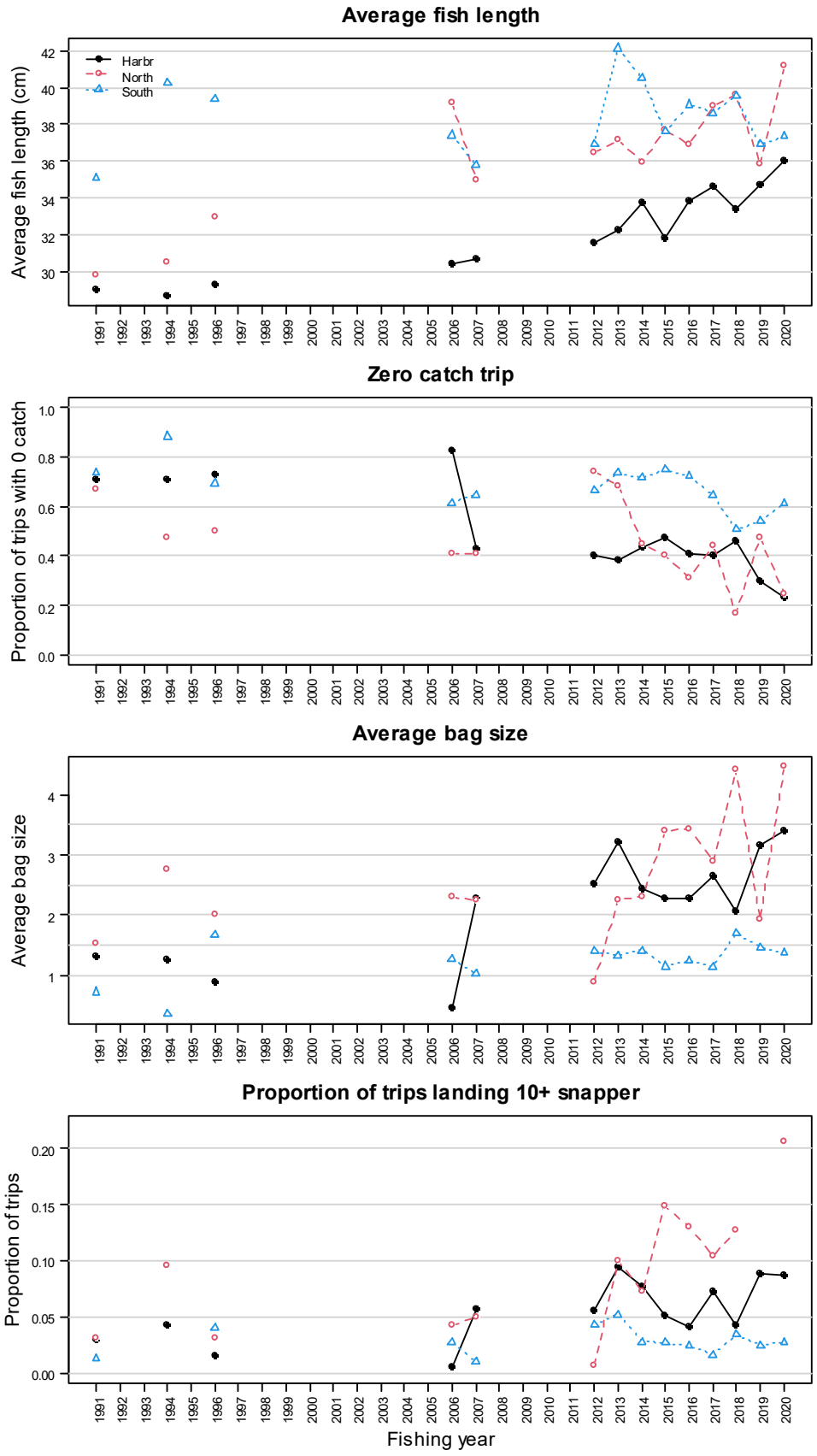

Figure 4: **Trends in SNA 8 regional recreational snapper catches since 1991, by region, by fishing year. The recreational 10 snapper daily bag limit for SNA 8 came into effect at the beginning of the 2005–06 fishing year.**

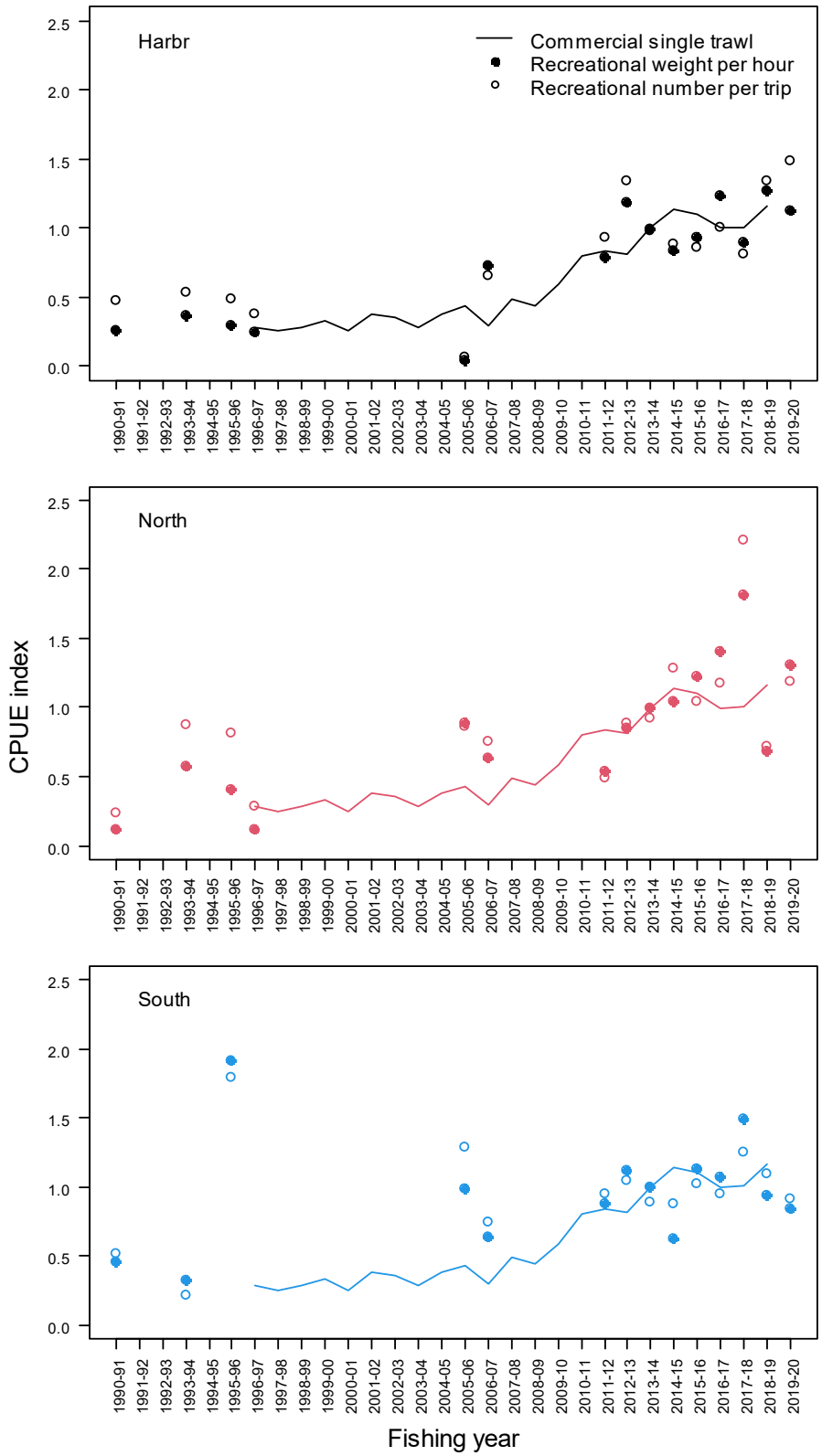

Figure 5: **Two alternative recreational catch per effort indices for each region of SNA 8, compared with a standardised commercial single trawl catch rate index that is predominantly based on fishing events taking place in the open coast North region of SNA 8 (Langley 2020). All three indices in each region have been scaled to the geometric mean calculated for each index for the period 2011–12 to 2018–19.**

The five year combined length and bag size compositional data used for all further analyses are shown in Figure 6. These data are further stratified by season, although there is very little evidence of seasonal differences in either regional length frequencies or regional bag frequencies when the data from the five years are pooled (Figures 7 & 8, respectively).

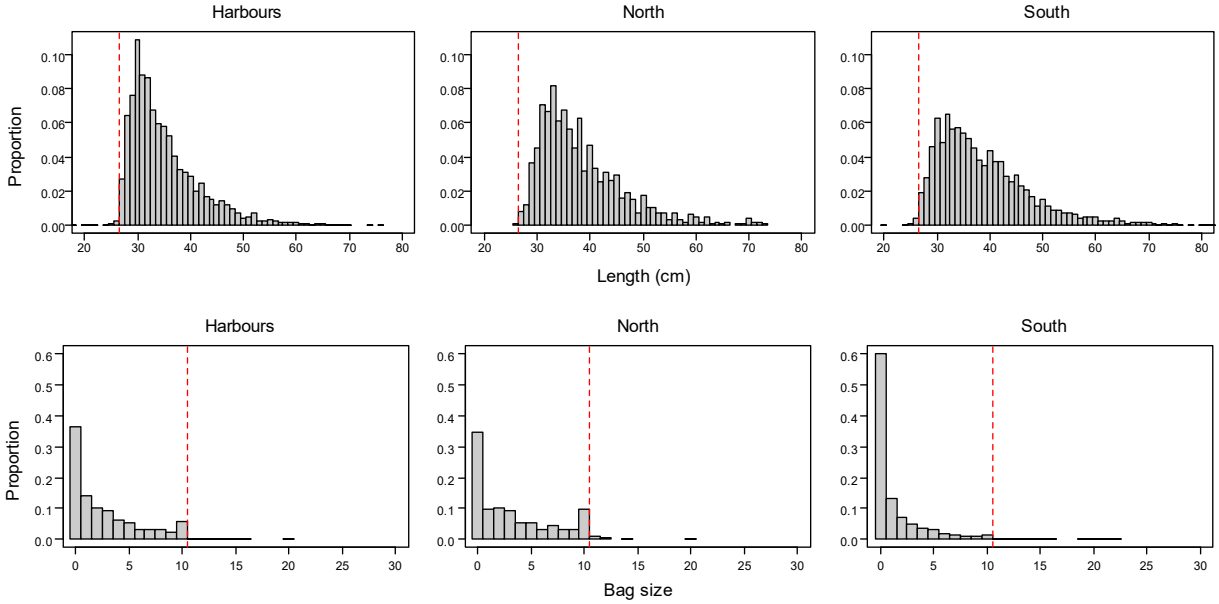

Figure 6: The length composition (upper panels) and bag size composition of snapper landed by recreational fishers in each region of SNA 8, for the combined five year 2015–16 to 2019–20 period. Vertical dashed lines indicate minimum legal size and daily fisher bag limits that were and are currently in force.

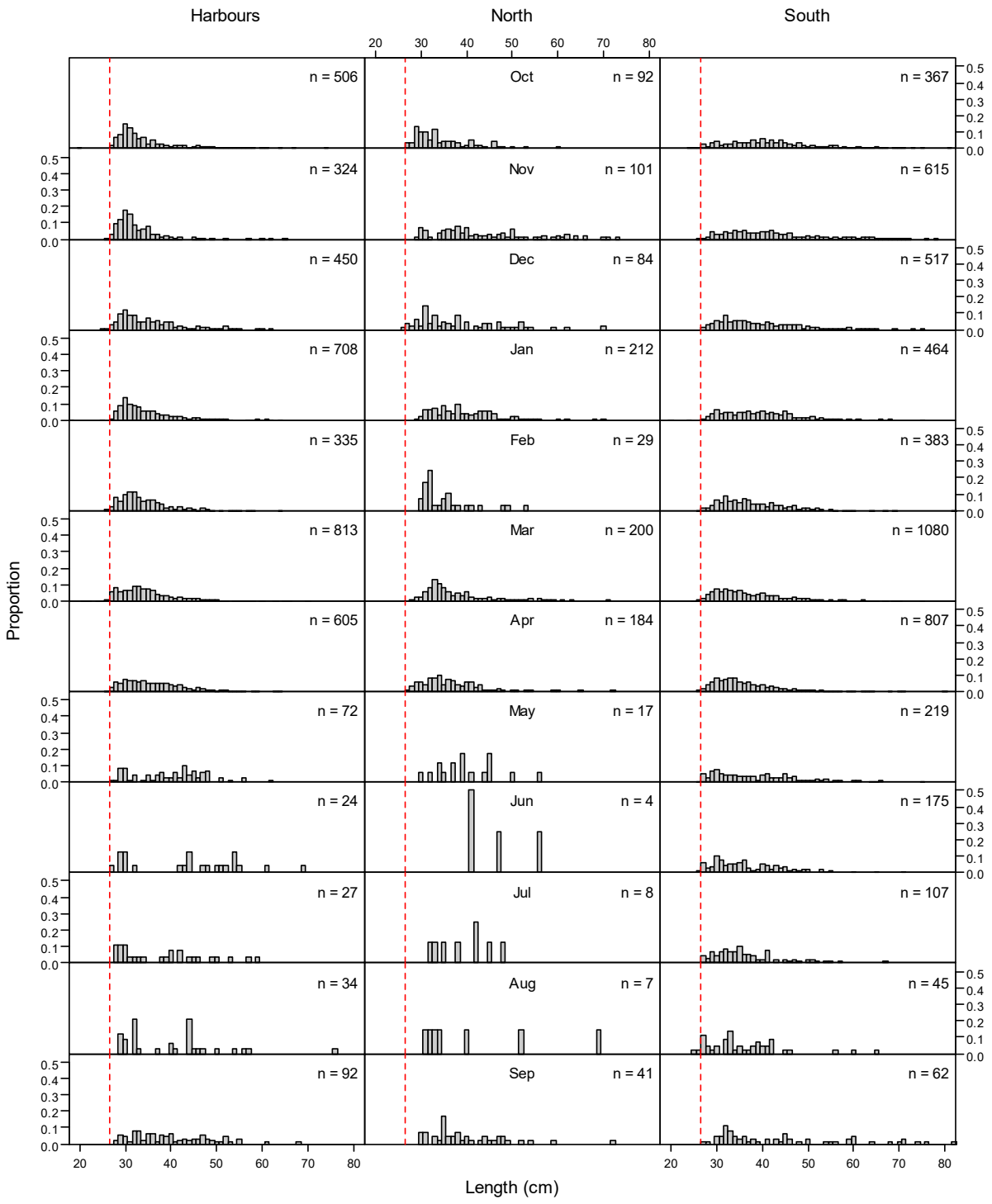

Figure 7: Length frequency distributions of snapper landed by recreational fishers in three sub-areas of SNA 8, by month, for the 2015–16 to 2019–20 fishing years combined. The red dashed vertical line denotes the 27 cm MLS at the time of sampling.

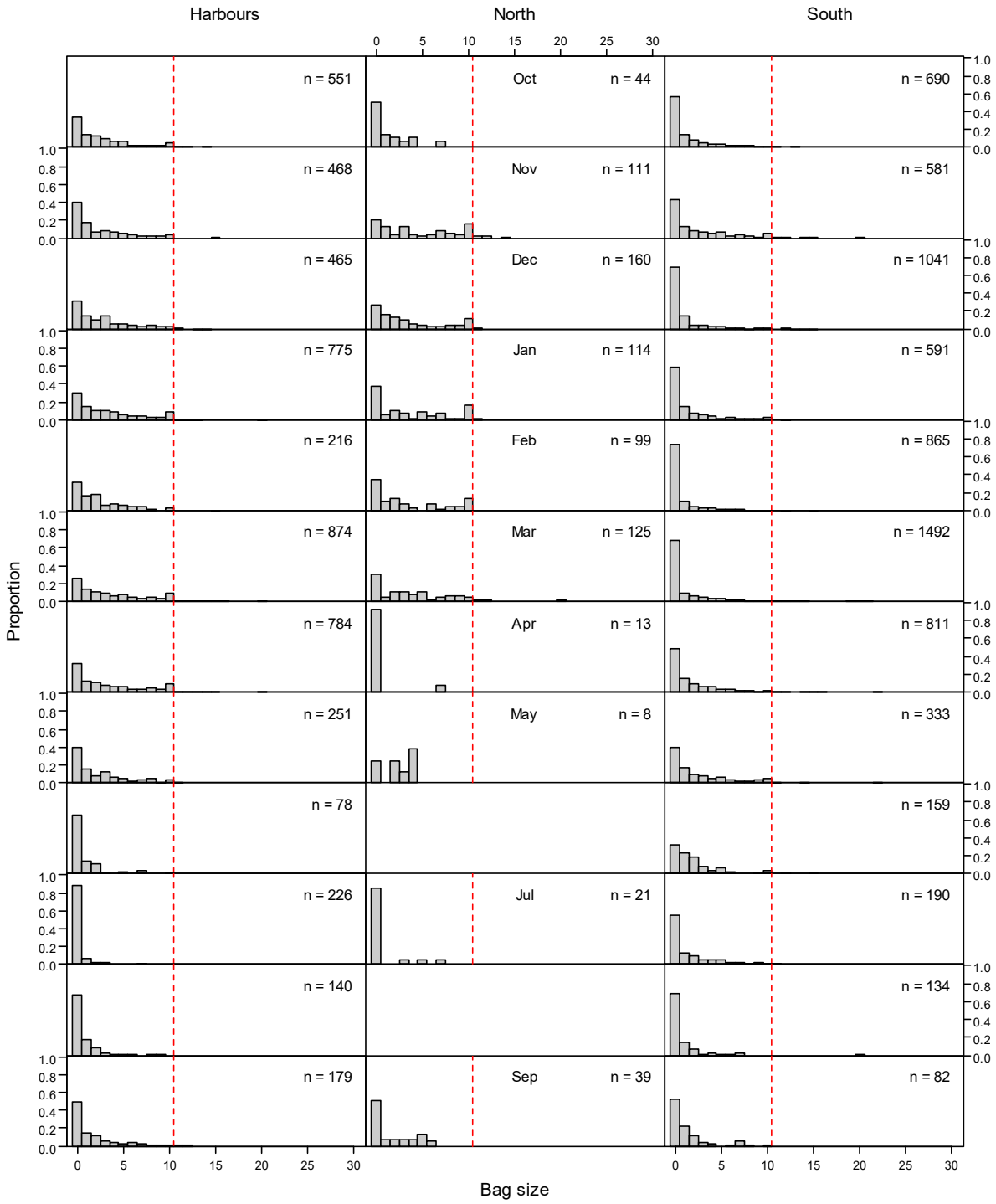

Figure 8: Distribution of fisher trip bag for snapper landed by recreational fishers in three sub-areas of SNA 8, by month, for the 2015–16 to 2019–20 fishing years combined. The red dashed vertical line denotes the 10 fish daily bag limit at the time of sampling.

Although the potential impact of any change to the recreational MLS and daily legal bag limit regulations will differ by region, these regulations are applied across all of SNA 8, and seasonal regional recreational harvest estimates are therefore required to statistically weight model outputs that are generated across regions and seasons. Spatially and seasonally stratified recreational harvest estimates were therefore calculated from the 2017–18 National Panel Survey SNA 8 catch data, which are given in Table 2, where Summer is defined as October to April and Winter is defined as May to September.

Table 2: Seasonal regional estimates of the recreational catch taken from SNA 8 by fishing platform calculated from data reported by panellists participating in the 2017–18 National Panel Survey.

	Region	Summer (t)	Winter (t)	2017–18 (t)
From boats	Harbours	160	26	186
	North	249	44	293
	South	222	26	248
From the shore	Harbours	14	1	15
	North	90	20	109
	South	37	2	40
Boat & shore	Harbours	173	28	201
	North	339	64	403
	South	259	28	288
	SNA 8	772	120	892

2.3 Method for estimating the impact of regulation change

The impact of differing combinations of reduced daily bag limits and increased minimum legal size limits was assessed by adjusting observed fisher catch data by region by season. Although boat ramp interviewers attempt to measure all fish landed by interviewed fishers, this is not always possible because fishers are sometimes reluctant to wait around for their fish to be measured, given the time that the interview had already taken. Interviewers were also instructed to just count fish when there were many fishers returning to the ramp, to maximise the number of interviews attained. There are therefore landings for which counts of fish were available, for which there were no corresponding fish lengths. It was therefore necessary to assign fish length data to these unmeasured landings, to determine the impact that any change to the minimum legal size limit would have on those landed catches. Simply removing unmeasured landings from the data set was not an option because there was a lower likelihood of a landing being measured when a greater number of fish were landed (Figure 9).

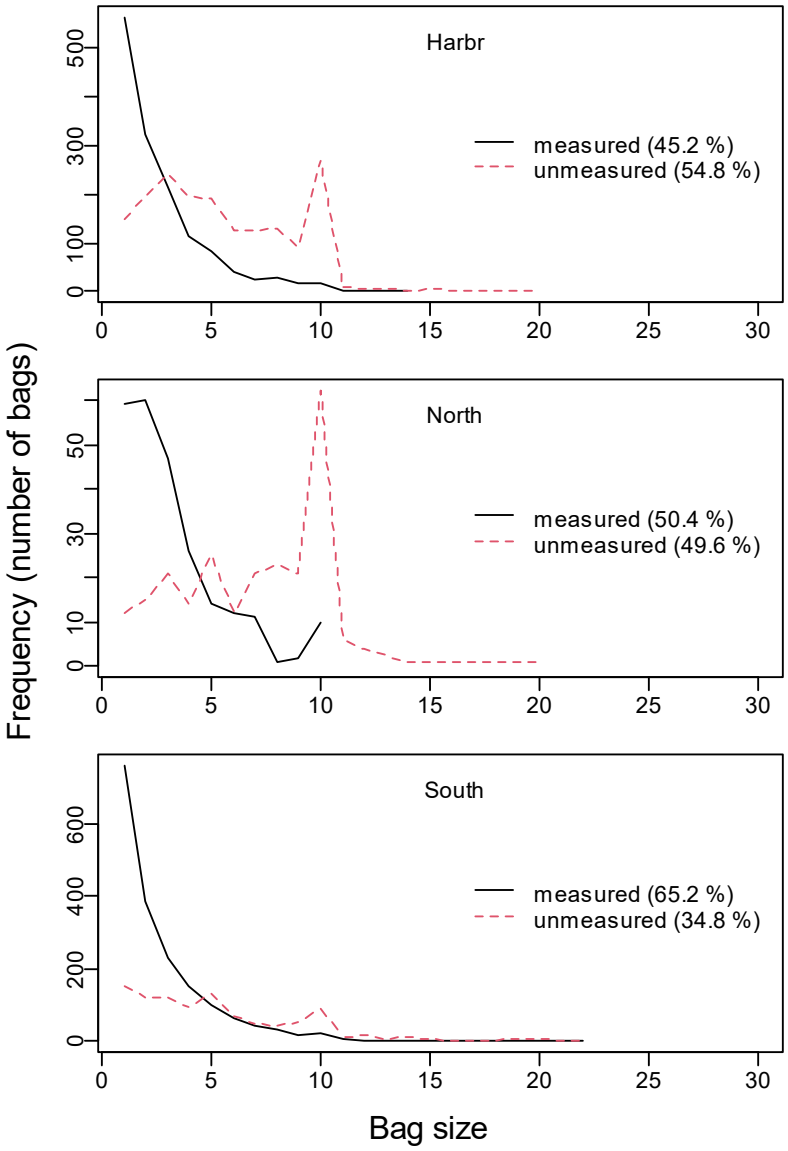

Figure 9: Frequency of landings where snapper were measured and not measured by the interviewer, by region.

Length data from measured landings were therefore sampled without replacement and assigned to unmeasured landings that were encountered within the same region and season. Sampling without replacement was used to avoid a potential oversampling of fish that were from infrequently caught length classes. Length data for unmeasured landings were only sampled from measured landings of the same bag size from the same region, because the length composition of landings of larger landings could conceivably differ from the length composition of smaller landings of fewer fish. When the number of unmeasured landings of a given bag size was greater than the number of measured landings available for the same bag size, the sampling of measured landings without replacement was repeated until imputed length data were available for all unmeasured landings.

Weights of individually measured or imputed measured fish were then estimated using the length-weight relationship:

$$Weight = 0.04467 * Length^{2.793} \qquad \text{(Paul 1976)}$$

and these estimates were used to calculate the mean weight of the fish landed by each fisher. This estimate was used for two purposes.

Firstly, because some interviewed fishers landed more than their 10 fish legal daily bag limit, and a mean weight estimate was required for each fisher to remove the weight of these excess fish in an unbiased fashion. Fish taken in excess of the current daily bag limit of 10 fish, and those that were less than the current minimum legal size limit, accounted for 1.8% of the directly observed harvest during the five year period between 2015–16 and 2019–20. These fish were removed from the data set for this analysis because it is necessary to assume that fishers will fully comply with regulatory limits when evaluating alternative scenarios, including those currently in force.

Secondly, because the annual catch allowance for the recreational sector is specified in terms of landed weight (currently 312 t), and the impact of any change in minimum legal size limits and daily bag limits should therefore be expressed in terms of weight, rather than numbers of fish caught.

The impact of changes in MLS and daily bag limits was assessed by adjusting the reported catch of each interviewed fisher so that it reflected that which would have been landed given an alternative regulatory regime. Incremental adjustments were applied to each fisher's catch, by first removing fish smaller than a revised MLS limit (increasing from 27 cm to 40 cm in 1 cm increments) and, then within each MLS limit, reducing the remaining catch if the number of fish exceeded a candidate bag limit (decreasing incrementally from 10 to 1 fish):

$$p_{s',b'} = \frac{\sum_F c_{F,s',b'}}{\sum_F c_{F,s,b}}$$

where $p_{s',b'}$ is the proportional change in total catch landed under a revised minimum legal size limit s' and daily bag limit b', and $c_{F,s,b}$ is the catch c of fisher F taken relative to the current size limit s of 27 cm given the current bag limit b of 10 fish.

These estimates of proportional harvest change were then scaled up to estimates of the recreational harvest landed in each region of SNA 8, in each season of 2017–18 (see Table 2), to estimate the harvest that would have been landed at that time had alternative MLS and daily bag limits been in force.

$$h^a_{s',b'} = p_{s',b'} \cdot h^a$$

where $h^a_{s',b'}$ is the estimated harvest taken under a revised minimum legal size limit s' and daily bag limit b', and h^a is the 2017–18 National Panel Survey harvest estimate for the same region in the same season. The total annual harvest estimate for SNA 8 taken under a candidate MLS and daily bag limit is the sum of all regional and seasonal estimates of $h^a_{s',b'}$.

2.4 Accounting for co-fishers pooling bag limits

In practice, there are two ways that fishers can regard daily bag limits when fishing in groups. In the stricter sense, a fisher can interpret the limit as a restriction on the number of snapper that they can personally land. This 'independent harvesting' behaviour is most likely in situations where fishers fish competitively, or when fishing alongside strangers from a charter boat. Although this assumption may be valid for some interviewed fishers, it is less likely to hold true when at least one fisher in a party reaches the current daily bag limit of 10 fish.

Fishers in other parties will often fish together, sharing any fish caught, and essentially pooling their daily bag limits. This 'co-fisher harvesting' behaviour is more likely when there is a strong social bond between fishers, e.g., when a family fishes together. An illustration comparing the outcome of these two behavioural scenarios is shown in Figure 10.

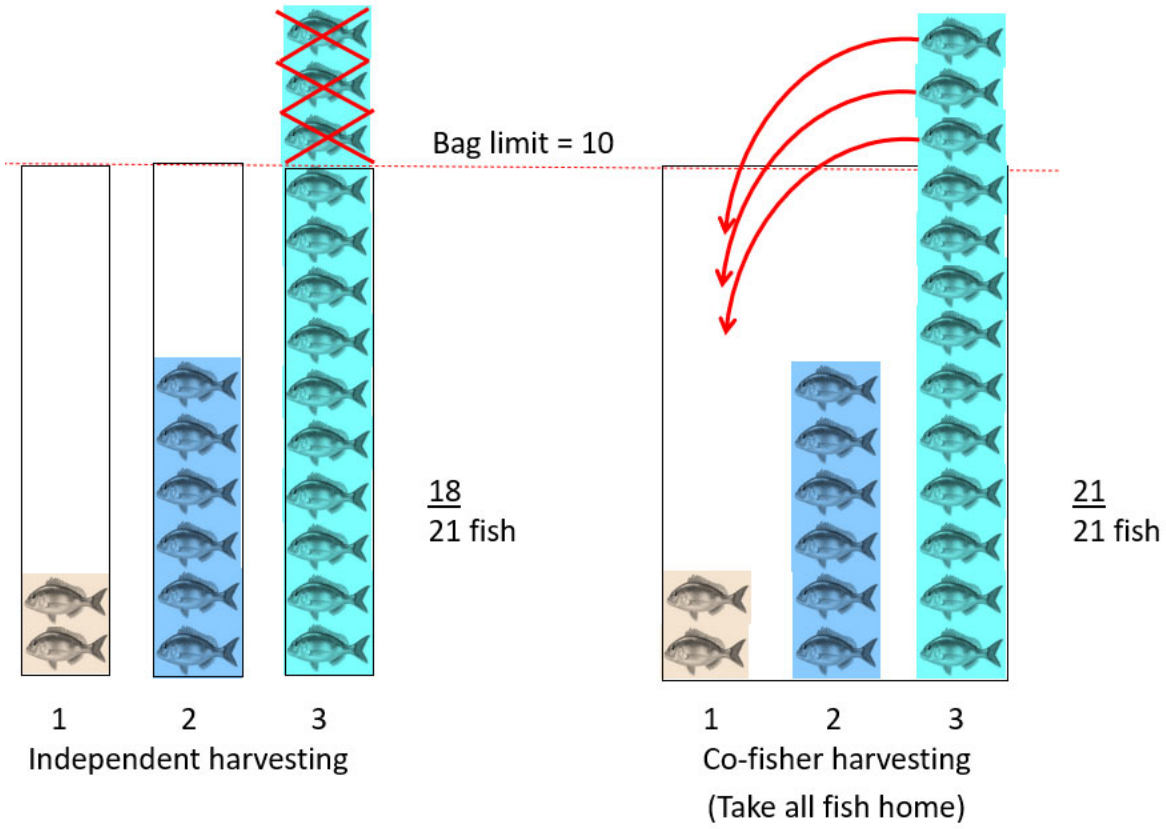

Figure 10: A schematic representation of two ways that a party of three fishers might interpret how the current daily bag limit of 10 snapper per fisher constrains their catch. Under the independent harvesting scenario, Fisher 3 discards the last 3 fish they caught (or stops fishing early), to stay within their daily bag limit. Under the co-fisher harvesting scenario, all fishers in a party can retain fish as long as they stay within their combined daily bag limit, and there is therefore no need to discard any fish in this instance.

Most fishers do not currently land their daily bag limit of 10 fish, however, and the incidence of co-fisher harvesting behaviour will therefore not be as pronounced as it would be if a lower daily bag limit was set. An example of the more pronounced impact of catch sharing by co-fishers, which would take place when a significant decrease is made to the daily bag limit, is shown in Figure 11.

The impact of alternative combinations of increased minimum legal size limits and decreased daily bag limits was therefore reassessed, by reconfiguring the catch reported by all boating parties to reflect what would have been reported if co-fishers in the same party had pooled their daily catch limits. It is likely, however, that some pooling of daily bag limits had already taken place in the unconfigured creel survey data used for the independent fisher scenario.

When the catch that would have been landed by any fisher in a boat exceeded a revised bag limit, the number of fish that exceeded that limit was selected at random from their catch and reallocated to any fishers from the same boat who had not caught the revised bag limit. Any remaining randomly drawn excess catch was removed from the catch of fishers that had exceeded the revised bag limit.

An example of this un-caught bag reallocation approach is given in Figure 11.

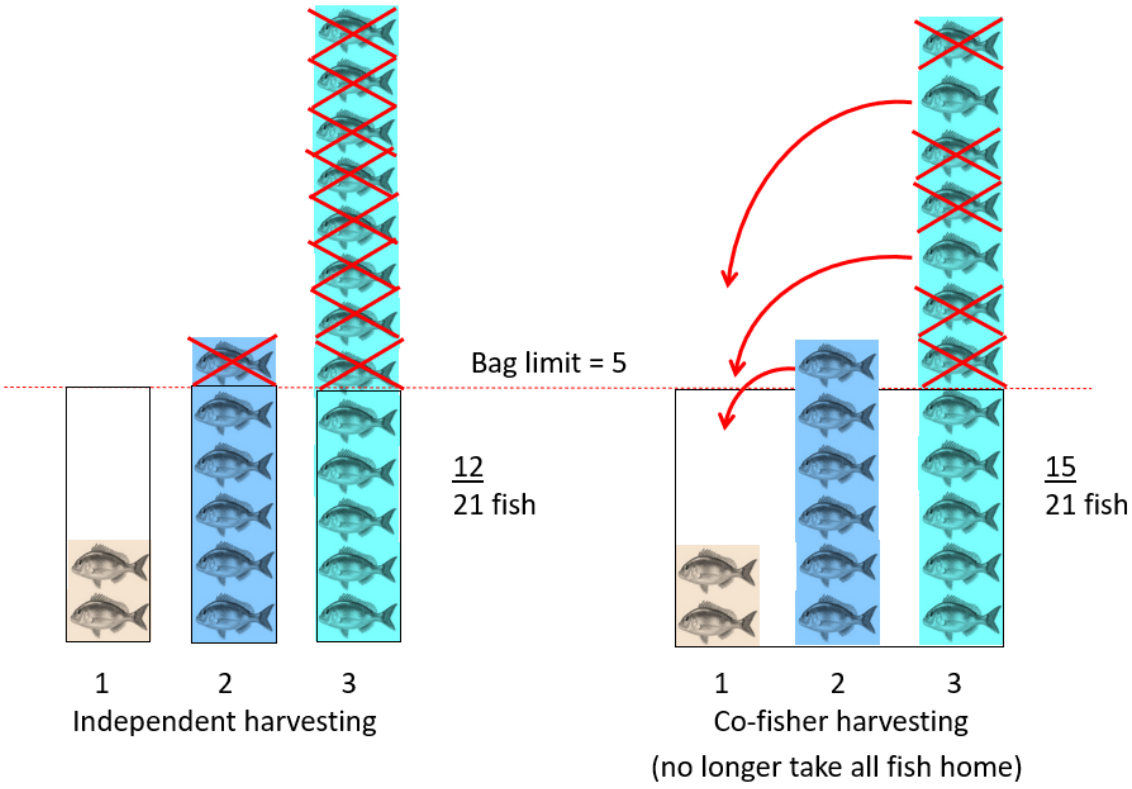

Figure 11: A schematic representation of the reallocation of a partially un-caught daily bag allowance to other fishers in the same party whose catch would have been constrained by a bag limit of five fish. With this scenario, Fisher 1 under caught their daily bag limit by three fish, and this un-caught allowance was randomly allocated to Fishers 2 and 3. Fisher 3 only had to discard part of their excess catch of the daily bag limit (by eight fish).

As stated above, Minimum Legal Size Limits were incrementally applied to each fisher's catch before any adjustments were made to the number of fish landed by fishers and co-fishers under each bag limit scenario.

The following profiles of the potential impact that regulation changes may have on the recreational harvest landed from SNA 8 are for the co-fisher scenario, because estimates produced by this scenario were the basis for advice provided to the Minister of Fisheries in 2013, when regulation changes were made for the SNA 1 recreational fishery. Similar profiles and estimates produced for the independent fishery scenario are provided as appendices.

2.5 Estimates of the potential impact of regulation change

The relative influence of changes to management controls differed by region (Figure 12, Table 3). Differences were most apparent when estimates of proportional change for the Harbour and South region fisheries were compared. Reductions in daily bag limits and increases in minimum legal sizes had a greater effect on levels of recreational harvesting for the Harbour fishery than for the South fishery, because smaller fish made up a much greater proportion of the catch in Harbours.

Changes to the daily bag limit had less effect if the minimum legal size limit was also increased, because some of the smaller fish associated with larger bag sizes in 2017–18 would no longer be retained if they were deemed to be undersize. Small increases in the MLS and reductions in daily bag limits had very little effect on the recreational harvest tonnage taken from SNA 8 when only one of these management measures was adjusted (Table 3). Even if, for example, the SNA 8 regulation limits were aligned with those currently in effect in SNA 1, by increasing the MLS to 30 cm and reducing the daily fisher bag

limit to 7 snapper, it would reduce the recreational harvest taken by boat fishers from this fish stock by only 11% or 81 t (Table 4).

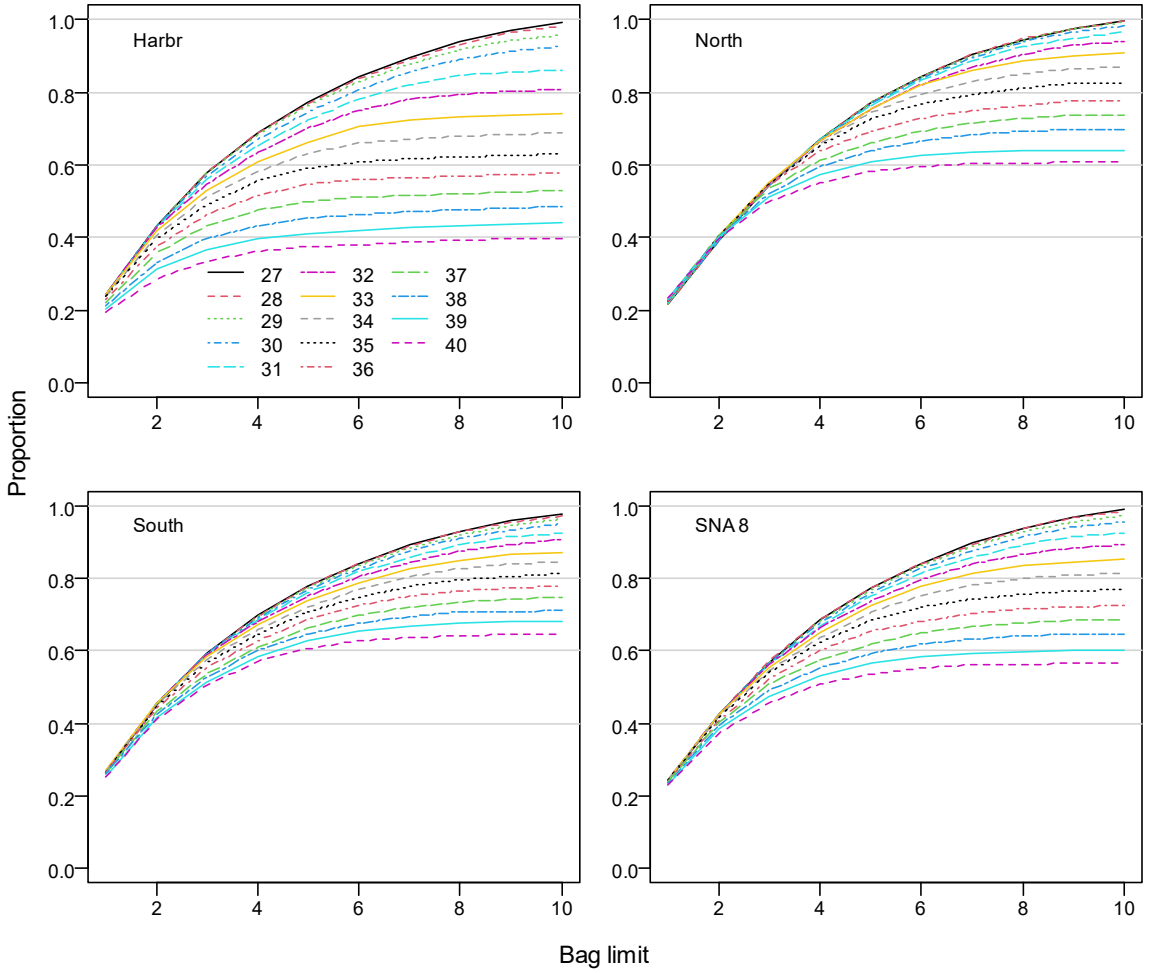

Figure 12: Estimates of the proportional change in the total weight of snapper landed in each region of SNA 8 for alternative minimum legal size limits ranging from 27 to 40 cm, for daily bag limits ranging from 1 to 10 fish, for the 'co-fisher' scenario. Seasonal estimates of proportional change for each region have been weighted together based on National Panel Survey estimates of the weight of fish landed in each season in each region during 2017–18, and the same harvest estimates have been used to weight together regional estimates.

Table 3: Estimates of the proportion of the regional recreational boat-based harvest from SNA 8 in 2017–18 that would have remained given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'co-fisher' scenario. Proportions are given to two decimal places only, but more precise estimates have been used to calculate tonnages in the following tables.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	0.24	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.22	0.21	0.21	0.20
Harbour	2	0.44	0.44	0.44	0.44	0.43	0.43	0.42	0.41	0.40	0.38	0.36	0.33	0.31	0.29
Harbour	3	0.58	0.58	0.58	0.57	0.56	0.55	0.53	0.51	0.49	0.47	0.43	0.40	0.37	0.34
Harbour	4	0.69	0.69	0.69	0.67	0.65	0.64	0.61	0.58	0.56	0.52	0.48	0.44	0.40	0.36
Harbour	5	0.78	0.77	0.77	0.75	0.73	0.70	0.67	0.63	0.60	0.55	0.50	0.46	0.41	0.38
Harbour	6	0.85	0.84	0.83	0.81	0.78	0.75	0.71	0.66	0.61	0.56	0.51	0.47	0.42	0.38
Harbour	7	0.90	0.90	0.88	0.86	0.83	0.78	0.73	0.68	0.62	0.57	0.52	0.47	0.43	0.39
Harbour	8	0.94	0.94	0.92	0.90	0.85	0.80	0.74	0.68	0.63	0.57	0.53	0.48	0.43	0.39
Harbour	9	0.98	0.97	0.95	0.92	0.86	0.81	0.74	0.69	0.63	0.58	0.53	0.48	0.44	0.40
Harbour	10	1.00	0.99	0.96	0.93	0.87	0.81	0.75	0.69	0.63	0.58	0.53	0.49	0.44	0.40
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.24	0.24	0.24
North	2	0.42	0.42	0.42	0.42	0.42	0.42	0.43	0.42	0.42	0.41	0.42	0.41	0.41	0.41
North	3	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.56	0.55	0.55	0.54	0.53	0.52	0.50
North	4	0.69	0.69	0.69	0.69	0.69	0.68	0.68	0.67	0.66	0.65	0.62	0.60	0.58	0.55
North	5	0.79	0.79	0.79	0.79	0.78	0.77	0.77	0.75	0.73	0.70	0.67	0.64	0.61	0.59
North	6	0.86	0.86	0.86	0.85	0.84	0.83	0.83	0.80	0.77	0.73	0.70	0.67	0.63	0.60
North	7	0.91	0.91	0.91	0.90	0.89	0.88	0.86	0.83	0.80	0.75	0.72	0.69	0.64	0.61
North	8	0.95	0.95	0.95	0.94	0.93	0.91	0.89	0.85	0.82	0.77	0.73	0.70	0.64	0.61
North	9	0.98	0.98	0.98	0.97	0.95	0.93	0.90	0.87	0.83	0.78	0.74	0.70	0.64	0.61
North	10	1.00	1.00	0.99	0.99	0.97	0.94	0.91	0.87	0.83	0.78	0.74	0.70	0.64	0.61
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	0.27	0.27	0.27	0.27	0.27	0.27	0.28	0.27	0.27	0.27	0.27	0.27	0.26	0.26
South	2	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.46	0.46	0.45	0.44	0.44	0.43	0.42
South	3	0.61	0.61	0.60	0.60	0.60	0.60	0.60	0.59	0.58	0.56	0.55	0.54	0.53	0.52
South	4	0.71	0.71	0.71	0.71	0.70	0.70	0.69	0.67	0.66	0.64	0.63	0.61	0.60	0.58
South	5	0.80	0.80	0.79	0.79	0.78	0.77	0.76	0.74	0.72	0.70	0.68	0.66	0.64	0.62
South	6	0.86	0.86	0.85	0.85	0.84	0.82	0.81	0.79	0.77	0.74	0.72	0.69	0.67	0.64
South	7	0.91	0.91	0.90	0.89	0.88	0.86	0.84	0.82	0.79	0.77	0.74	0.71	0.68	0.65
South	8	0.95	0.95	0.94	0.93	0.91	0.89	0.87	0.84	0.81	0.78	0.75	0.72	0.69	0.66
South	9	0.98	0.98	0.97	0.96	0.93	0.91	0.89	0.86	0.82	0.79	0.76	0.73	0.70	0.66
South	10	1.00	0.99	0.99	0.97	0.95	0.92	0.89	0.86	0.83	0.80	0.76	0.73	0.70	0.66
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24
SNA 8	2	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.43	0.43	0.42	0.41	0.40	0.39	0.38
SNA 8	3	0.58	0.59	0.58	0.58	0.58	0.57	0.57	0.56	0.55	0.53	0.52	0.50	0.48	0.46
SNA 8	4	0.70	0.70	0.70	0.69	0.68	0.68	0.66	0.65	0.63	0.61	0.59	0.56	0.54	0.52
SNA 8	5	0.79	0.79	0.79	0.78	0.77	0.75	0.74	0.72	0.69	0.66	0.63	0.60	0.57	0.54
SNA 8	6	0.85	0.85	0.85	0.84	0.83	0.81	0.79	0.76	0.73	0.69	0.66	0.63	0.59	0.56
SNA 8	7	0.91	0.91	0.90	0.89	0.87	0.85	0.82	0.79	0.75	0.71	0.67	0.64	0.60	0.57
SNA 8	8	0.95	0.95	0.94	0.93	0.90	0.88	0.84	0.81	0.77	0.72	0.69	0.65	0.61	0.57
SNA 8	9	0.98	0.98	0.97	0.95	0.92	0.89	0.86	0.82	0.78	0.73	0.69	0.65	0.61	0.57
SNA 8	10	1.00	0.99	0.98	0.97	0.94	0.90	0.86	0.82	0.78	0.73	0.70	0.66	0.61	0.57

Table 4: Estimates of the regional tonnage of snapper landed by boat-based fishers in SNA 8 in 2017–18 given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'co-fisher' scenario. Seasonal estimates of proportional change in each region have been weighted together based on National Panel Survey estimates of the weight of fish landed in each season in each region during 2017–18, and these estimates have also been used to statistically weight together regional estimates. These harvest estimates do not include any provision for harvest taken by shore-based fishers, which are included in the estimates given in Table 5 in section 2.7.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	46	46	46	46	46	46	45	45	45	43	42	40	38	36
Harbour	2	81	81	81	81	80	80	78	76	74	70	67	62	58	54
Harbour	3	108	109	108	107	105	103	99	96	92	87	81	74	69	63
Harbour	4	129	128	128	125	122	119	114	109	104	97	89	81	74	67
Harbour	5	144	144	143	140	135	131	124	118	111	102	94	85	77	70
Harbour	6	157	157	155	151	146	140	132	124	114	105	96	87	79	71
Harbour	7	167	167	164	160	153	146	136	126	115	106	97	88	80	72
Harbour	8	175	174	172	167	158	149	137	127	117	107	98	89	81	73
Harbour	9	182	181	177	171	160	150	138	128	117	108	98	90	82	74
Harbour	10	186	184	179	173	161	151	139	129	118	108	99	91	82	75
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	69	69	69	70	70	71	72	72	71	71	72	71	71	71
North	2	122	122	122	123	123	123	125	122	122	122	123	121	121	120
North	3	167	167	167	167	167	166	166	163	163	162	159	155	152	147
North	4	203	204	203	202	202	200	199	196	194	189	182	177	170	163
North	5	233	233	232	231	229	227	226	221	215	206	196	189	180	172
North	6	251	252	251	250	248	244	242	235	226	215	205	197	186	176
North	7	267	267	267	265	262	257	253	244	235	221	211	202	188	178
North	8	279	279	278	276	272	266	260	251	240	226	215	205	189	179
North	9	287	287	286	284	279	273	264	254	243	228	217	206	189	179
North	10	293	293	292	290	284	276	267	256	244	229	217	206	189	179
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	67	67	67	68	68	68	68	68	68	68	67	66	65	64
South	2	115	115	115	116	116	116	116	115	114	112	110	108	106	104
South	3	150	150	150	150	150	149	148	146	143	140	136	134	131	128
South	4	177	177	176	175	174	173	170	167	164	160	155	152	149	145
South	5	198	198	197	195	193	191	188	184	179	174	169	164	160	154
South	6	214	213	212	210	208	204	200	196	190	184	178	172	166	160
South	7	226	226	224	222	218	214	210	204	197	190	183	177	170	162
South	8	236	235	234	231	226	222	216	210	202	194	187	179	172	163
South	9	244	243	241	237	232	227	220	213	205	197	189	180	173	164
South	10	248	247	245	241	235	230	222	215	206	198	190	181	173	164
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	182	182	183	183	184	185	185	185	184	182	181	177	174	172
SNA 8	2	318	319	319	319	319	319	319	313	310	304	299	292	285	278
SNA 8	3	425	426	425	424	421	418	413	404	398	388	376	364	352	338
SNA 8	4	509	509	507	503	498	491	483	472	461	446	426	410	392	375
SNA 8	5	575	574	572	566	558	548	538	523	506	482	458	439	417	396
SNA 8	6	622	622	618	611	601	588	574	554	530	503	478	456	431	407
SNA 8	7	661	660	656	647	633	617	598	574	547	518	491	466	438	413
SNA 8	8	690	689	683	674	657	637	613	587	558	527	499	473	442	416
SNA 8	9	712	710	703	693	672	650	622	595	565	533	504	476	443	417
SNA 8	10	728	724	716	704	681	657	627	599	568	535	506	477	444	418

2.6 Comparison of co-fisher and independent fisher scenario estimates

Estimates of the degree of reduction in the recreational harvest that might be achieved when adjustments were made to minimum legal size limits and daily bag limits, when independent fisher harvesting was assumed, are given in Appendices 1 to 3.

Predicted changes in harvest levels for the independent fisher scenario were very similar to, but slightly lower, than those already provided, when co-fisher bag sharing was assumed (Figure 13). The most pronounced differences occurred at intermediate bag size limit levels, for the three minimum legal size limit settings shown here. These plots suggest that alternative interpretations of fisher harvesting behaviour would have little influence on the predicted impact of any combination of the two management controls assessed here, given the manner in which interviewed fishers reported the apportioning of their catch in 2017–18.

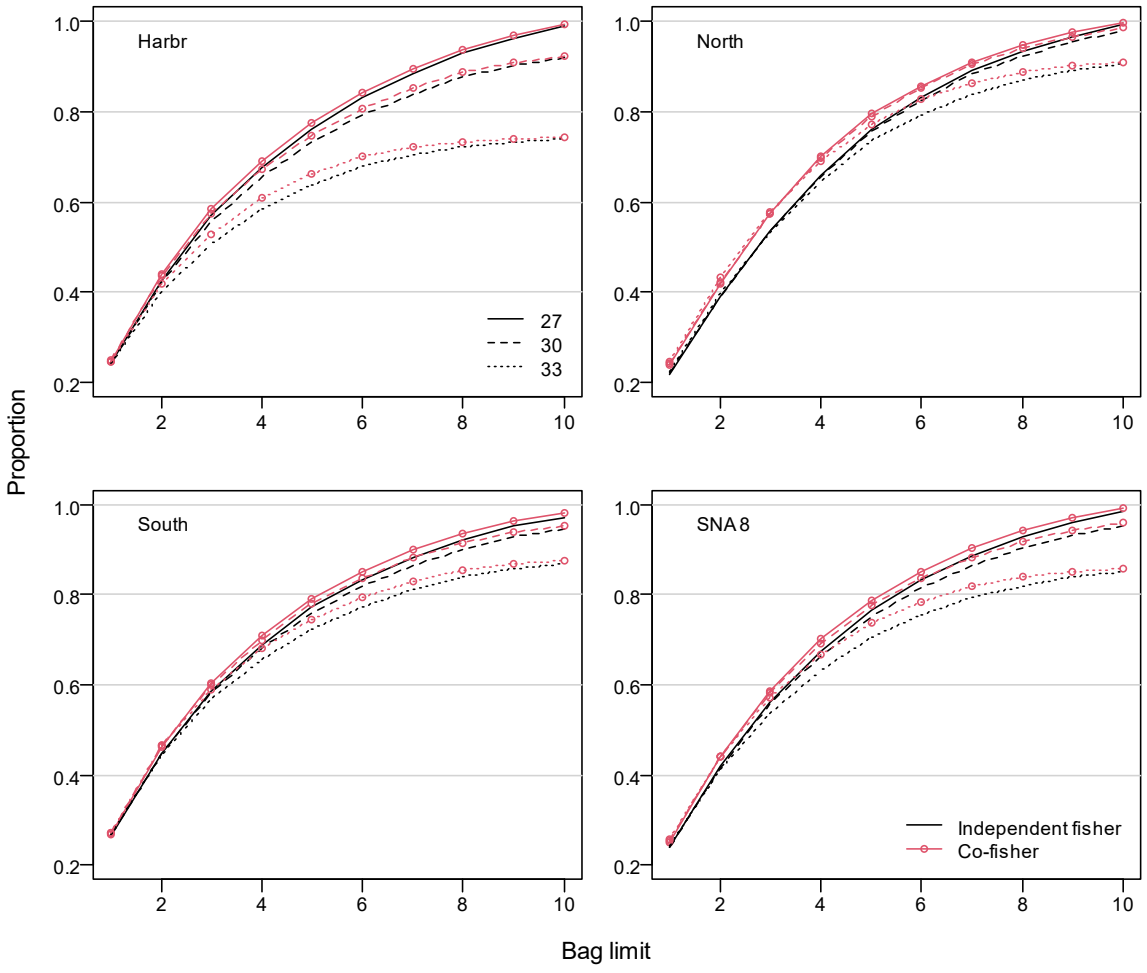

Figure 13: Comparison of 'co-fisher' and 'independent fisher' scenario estimates of the proportion of the recreational harvest tonnage landed from SNA 8 remaining, given 27 cm, 30 cm, and 33 cm minimum legal size limits, for daily bag limits ranging from 1 to 10 fish.

2.7 Including the shore-based catch

Data provided by the 2017–18 National Panel Survey (Wynne-Jones et al. 2019) indicated that boat-based fishers in that year accounted for 82% of the recreational harvest from SNA 8 (see Table 2). The harvest tonnage estimates given in Table 4 are for boat-based fishers only, because there are no available data on the size composition of the shore-based catch from this fishery. Fisheries managers also have to

take the additional 18% shore-based harvest into account when setting a recreational catch allowance for this fishery.

The only data that are available on the composition of shore-based catches come from the 2017–18 National Panel Survey, which can be used to characterise the bag compositions (Figure 14). But there are no data available on the size composition of shore-based snapper catches because these fishers are rarely encountered during boat ramp creel surveys (which is the source of all recreational length composition data).

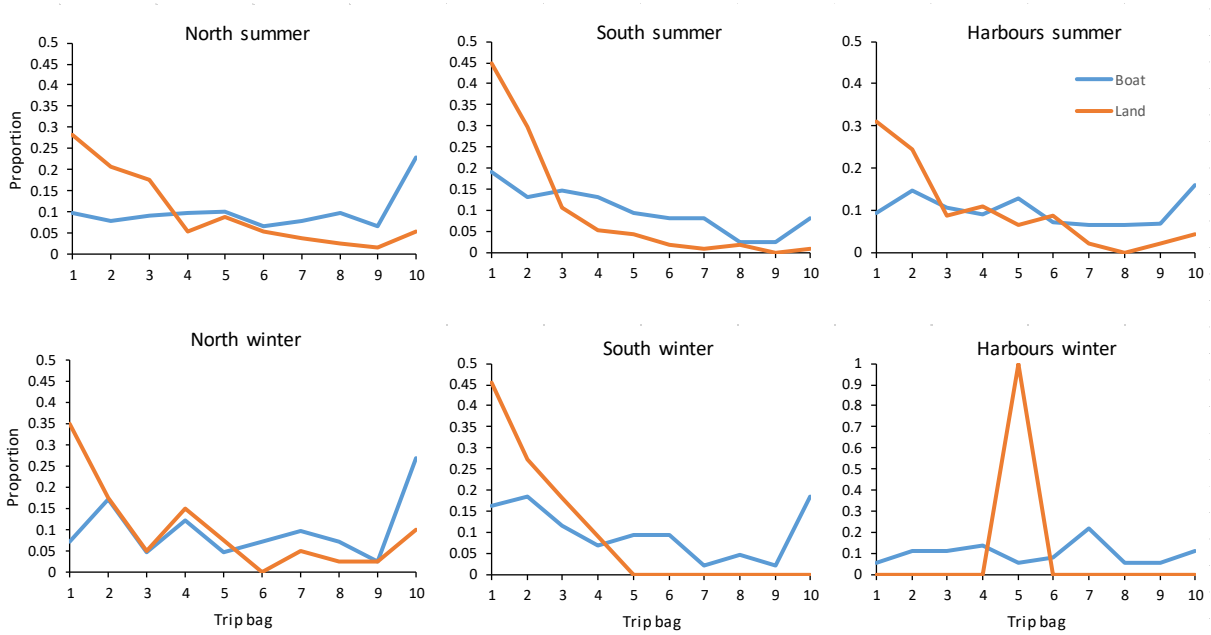

Figure 14: Comparison of bag size distributions reported by boat-based and shore-based fishers in each region of SNA 8, by season. These data were provided by a National Panel Survey conducted by the National Research Bureau in 2017–18 (Wynne-Jones et al. 2019).

Quantitative adjustments can therefore only be made for reductions in daily bag limits for the shore-based catch. This has been done by pooling the seasonal bag distribution data shown in Figure 14, to calculate the proportional reduction in the shore-based catch that would have occurred in each region, for any given daily bag limit. These proportional reductions have then been multiplied by the shore-based tonnage harvest estimates given in Table 2 for each region, to estimate the additional shore-based harvest that has not been accounted for in each scenario shown in Table 4. Estimates of the combined boat and shore-based harvest that would have occurred in 2017–18, for different combinations on MLS and daily bag limits, are given in Table 5.

Although these estimates do not make any allowance for the effect that a change in the MLS might have on the shore-based harvest, any additional reduction in the recreational harvest from SNA 8 because of this issue is probably relatively minor. This is because any concurrent bag reduction will have also partially reduced the shore-based harvest from this fishery, which only accounts for 18% of the total recreational harvest. Nonetheless, the tonnage estimates given in Table 5 will be slight overestimates because there is no way of estimating the effect that any MLS adjustment would have on the shore-based harvest taken from the SNA 8 fishery.

Table 5: Estimates of the regional tonnage of snapper that would have been landed by boat- and shore-based fishers in SNA 8 in 2017–18 given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'co-fisher' scenario.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	50	50	50	50	50	50	50	50	49	48	46	45	43	41
Harbour	2	89	89	89	89	88	88	86	84	82	78	75	70	66	62
Harbour	3	119	119	118	117	115	113	109	106	102	97	91	84	79	73
Harbour	4	140	140	139	137	134	131	125	121	116	109	101	93	86	79
Harbour	5	157	157	156	153	148	144	137	131	124	115	107	98	90	83
Harbour	6	171	170	169	165	160	154	146	138	128	118	110	101	93	85
Harbour	7	182	181	179	174	168	160	150	140	130	120	111	102	94	87
Harbour	8	190	189	186	181	173	163	152	142	131	121	112	104	95	88
Harbour	9	197	196	192	186	175	165	153	143	132	122	113	105	96	89
Harbour	10	201	199	195	188	176	166	154	144	133	123	114	106	97	90
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	100	100	100	101	101	102	103	103	102	102	103	102	103	102
North	2	175	175	175	176	176	177	178	176	175	175	176	174	174	173
North	3	235	236	236	236	236	235	235	232	231	231	228	224	221	216
North	4	283	284	283	282	282	280	279	276	274	269	262	257	250	243
North	5	322	322	321	320	318	316	315	310	304	294	285	278	269	261
North	6	346	347	347	345	343	339	338	330	322	310	300	292	281	272
North	7	367	367	367	365	362	357	353	345	335	322	311	302	288	279
North	8	383	383	382	380	376	370	364	355	344	330	319	309	293	283
North	9	394	394	393	391	386	380	371	361	350	335	324	313	296	286
North	10	403	402	401	399	394	386	376	365	353	338	326	315	298	288
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	86	86	86	86	86	87	87	87	86	86	85	85	83	83
South	2	144	144	144	144	144	144	144	143	143	141	138	137	134	133
South	3	184	184	183	183	183	182	181	179	177	173	169	167	164	161
South	4	213	213	212	211	210	209	206	203	200	196	191	188	185	180
South	5	236	235	234	233	231	228	225	221	217	212	206	202	197	191
South	6	252	252	251	249	246	242	239	234	228	222	216	210	205	198
South	7	265	265	263	261	257	253	249	243	236	229	222	216	209	201
South	8	276	275	273	270	266	262	255	249	241	234	226	219	211	202
South	9	283	282	280	277	272	267	259	252	244	236	228	220	212	203
South	10	288	287	285	281	275	269	261	254	246	238	229	220	213	203
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	236	236	237	237	238	239	239	239	238	236	235	231	229	226
SNA 8	2	408	408	408	409	409	409	408	403	400	394	389	381	375	367
SNA 8	3	537	538	537	536	533	530	525	516	510	501	488	476	464	450
SNA 8	4	636	637	635	631	625	619	611	599	589	574	554	538	520	502
SNA 8	5	714	714	711	706	697	688	677	662	645	621	598	578	556	535
SNA 8	6	770	769	766	759	749	736	722	702	678	651	625	603	578	555
SNA 8	7	814	813	809	800	787	771	752	728	701	671	644	620	591	567
SNA 8	8	848	847	841	832	814	795	771	745	716	685	657	631	600	573
SNA 8	9	873	871	865	854	833	811	783	756	726	694	665	637	605	578
SNA 8	10	892	888	880	867	845	821	791	763	732	699	670	641	608	582

3. DISCUSSION

Recreational harvest estimates provided by the 2011–12 and 2017–18 National Panel Surveys (Wynne-Jones et al. 2014, 2019) suggest that the harvest taken by this sector has now exceeded the current 312 t recreational catch allowance for SNA 8 by a considerable margin. This allowance was set in 2005 and is now probably conservative given the improved status of this fish stock (Langley 2020). Both recreational and commercial fishers have experienced increasing catch rates since recreational and commercial catch allowance/allocations were reduced at the beginning of the 2005–06 fishing year to allow for a rebuild of the fishery, that has now occurred to some degree. Ongoing trends in recreational harvesting in SNA 8 are currently being monitored as part of the Fisheries New Zealand research programme MAF2019-01, following the methods described by Hartill et al. (2020b). Preliminary estimates provided by this monitoring programme for the 2019–20 year suggest that the recreational harvest has increased further since 2017–18, which may reflect a further increase in the SNA 8 biomass since that time.

The primary regulatory measures used in New Zealand to constrain the recreational harvest to any annual catch allowance are Minimum Legal Size (MLS) and daily fisher bag limits. The analyses provided here suggest that small changes to either of these limits are unlikely to constrain current levels of recreational harvesting from SNA 8 to a substantial degree.

A modest increase in the MLS limit would only have a limited impact on levels of recreational harvesting for two reasons. Firstly, because the weight of a snapper increases exponentially with increasing length, and fish that are only slightly larger than the current MLS therefore account for a relatively low proportion of the total weight harvested in a fishery when far larger fish are also commonly caught. Secondly, because the only area of SNA 8 where an appreciable component of the recreational catch comprises smaller fish is in the harbours, where only 23% of the estimated 2017–18 recreational harvest was taken. Recreational fishers elsewhere are also more likely to release smaller legal sized snapper when larger fish are also being caught. Snapper off the west coast grow substantially faster than in neighbouring SNA 1 off the east coast, and consequently larger, heavier snapper make up a greater proportion of the landed recreational catch in SNA 8 because they grow through the smaller size classes more rapidly.

A modest reduction in the daily bag limit for the SNA 8 fishery will also have limited impact on constraining the recreational SNA 8 catch, because only a very small proportion of fishers currently catch the current 10 snapper bag limit.

Even a combined increase of the MLS and decrease of the daily bag limit will have limited effect if the degree of change to each of these regulations was limited. The adjusted empirical catch simulations provided here suggest that, for example, bringing the recreational SNA 8 regulation limits in line with those currently in force for SNA 1 (where the MLS is now 30 cm and the daily bag limit is seven snapper) would only reduce the SNA 8 recreational catch by 11%. The estimated recreational SNA 8 catch in 2017–18 was 285% of the current 312 t recreational catch allowance. However, the extent to which any change to these regulation limits might be required depends on recreational catch allowance levels that may be adjusted given the recent rebuilding of the SNA 8 fish stock.

There are also other potential issues to consider when choosing regulation settings. Any increase in the MLS limit will result in more fish being caught and released, which will lead to increased levels of incidental discard mortality. Conversely, decreasing the daily bag limit should decrease discard mortality levels, because some fishers will catch their limit sooner and stop fishing. Some fishers may change their selectivity, however, to maximise the weight of fish landed given a reduced bag limit. Any attempt to quantify the implications of assumed fisher behaviour in response to future changes in size and bag limits would be speculative, however, because fisher responses will vary to an unknown and unpredictable degree.

A recent review of recreational snapper release mortality studies conducted in New Zealand and Australia suggests, however, that a high proportion of recreationally caught snapper might survive release (Hartill et al. 2020b). The primary cause of recreational release mortality is gut hooking, but only a small proportion of recreationally released snapper are gut hooked, because they are mostly smaller sub-legal fish that are less likely to ingest a hook. Field experiments will be conducted in late 2021 and early 2022 to assess the likely degree of recreational snapper release mortality given a range of factors, as part of the Fisheries New Zealand research programme MAF2020-06. The mortality rate estimates produced by this field study could be combined with a survey of the incidence of those factors in the SNA 8 recreational fishery as part of a future study, to estimate the annual tonnage of snapper lost due to recreational release mortality.

4. ACKNOWLEDGMENTS

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APPENDIX 1: Estimates of the proportion of the regional recreational boat-based harvest from SNA 8 in 2017–18 that would have remained given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'independent' fisher scenario.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	0.25	0.25	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.22	0.21	0.20	0.19
Harbour	2	0.43	0.43	0.43	0.43	0.42	0.42	0.40	0.39	0.38	0.36	0.34	0.32	0.30	0.28
Harbour	3	0.58	0.58	0.57	0.56	0.55	0.54	0.51	0.49	0.47	0.44	0.41	0.38	0.35	0.32
Harbour	4	0.68	0.68	0.68	0.66	0.64	0.62	0.59	0.56	0.53	0.49	0.45	0.41	0.38	0.35
Harbour	5	0.77	0.77	0.76	0.74	0.71	0.69	0.64	0.61	0.57	0.52	0.48	0.44	0.40	0.36
Harbour	6	0.84	0.84	0.82	0.80	0.77	0.74	0.69	0.64	0.59	0.54	0.50	0.46	0.41	0.38
Harbour	7	0.89	0.89	0.88	0.85	0.81	0.77	0.71	0.66	0.61	0.56	0.51	0.47	0.42	0.38
Harbour	8	0.94	0.93	0.92	0.89	0.84	0.79	0.73	0.68	0.62	0.57	0.52	0.47	0.43	0.39
Harbour	9	0.97	0.97	0.94	0.91	0.86	0.80	0.74	0.69	0.63	0.57	0.53	0.48	0.44	0.40
Harbour	10	1.00	0.99	0.97	0.93	0.87	0.81	0.75	0.69	0.63	0.58	0.53	0.48	0.44	0.40
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.25	0.25	0.24	0.25	0.25	0.25	0.25
North	2	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.41	0.41	0.41	0.41	0.40	0.40	0.39
North	3	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.54	0.53	0.51	0.51	0.50	0.48
North	4	0.69	0.69	0.69	0.68	0.68	0.67	0.67	0.65	0.64	0.62	0.60	0.58	0.56	0.54
North	5	0.79	0.79	0.79	0.78	0.77	0.76	0.76	0.74	0.71	0.68	0.65	0.63	0.60	0.57
North	6	0.85	0.85	0.85	0.84	0.83	0.82	0.81	0.78	0.75	0.72	0.68	0.66	0.62	0.59
North	7	0.90	0.90	0.90	0.90	0.88	0.86	0.85	0.82	0.79	0.74	0.71	0.68	0.64	0.60
North	8	0.94	0.94	0.94	0.93	0.92	0.90	0.88	0.84	0.81	0.77	0.73	0.70	0.64	0.61
North	9	0.97	0.97	0.97	0.96	0.95	0.92	0.90	0.86	0.83	0.78	0.74	0.70	0.65	0.61
North	10	1.00	1.00	0.99	0.99	0.97	0.94	0.91	0.87	0.83	0.78	0.75	0.71	0.65	0.61
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	0.27	0.27	0.27	0.27	0.27	0.28	0.28	0.28	0.27	0.27	0.27	0.27	0.26	0.26
South	2	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.45	0.45	0.44	0.43	0.42	0.41	0.40
South	3	0.60	0.60	0.60	0.60	0.59	0.59	0.58	0.57	0.56	0.55	0.53	0.52	0.51	0.50
South	4	0.71	0.71	0.70	0.70	0.69	0.69	0.67	0.66	0.65	0.63	0.61	0.59	0.57	0.56
South	5	0.79	0.79	0.79	0.78	0.77	0.76	0.74	0.73	0.71	0.68	0.66	0.64	0.62	0.60
South	6	0.86	0.85	0.85	0.84	0.83	0.81	0.79	0.77	0.75	0.72	0.70	0.67	0.65	0.63
South	7	0.91	0.90	0.90	0.89	0.87	0.86	0.83	0.81	0.78	0.75	0.72	0.70	0.67	0.64
South	8	0.95	0.94	0.94	0.93	0.91	0.89	0.86	0.84	0.81	0.77	0.74	0.71	0.69	0.65
South	9	0.98	0.98	0.97	0.95	0.93	0.91	0.88	0.85	0.82	0.79	0.76	0.72	0.69	0.66
South	10	1.00	0.99	0.99	0.97	0.95	0.92	0.89	0.86	0.83	0.80	0.76	0.73	0.70	0.66
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	0.25	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.25	0.25	0.25	0.24	0.24	0.24
SNA 8	2	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.41	0.40	0.39	0.38	0.37
SNA 8	3	0.58	0.58	0.58	0.58	0.57	0.57	0.56	0.54	0.53	0.51	0.49	0.48	0.47	0.45
SNA 8	4	0.69	0.69	0.69	0.68	0.67	0.66	0.65	0.63	0.61	0.59	0.56	0.54	0.52	0.50
SNA 8	5	0.79	0.78	0.78	0.77	0.76	0.74	0.72	0.70	0.67	0.64	0.61	0.59	0.56	0.53
SNA 8	6	0.85	0.85	0.84	0.83	0.82	0.80	0.77	0.75	0.71	0.68	0.64	0.61	0.58	0.55
SNA 8	7	0.90	0.90	0.89	0.88	0.86	0.84	0.81	0.78	0.74	0.70	0.67	0.63	0.60	0.56
SNA 8	8	0.94	0.94	0.93	0.92	0.89	0.87	0.84	0.80	0.76	0.72	0.68	0.65	0.61	0.57
SNA 8	9	0.98	0.97	0.96	0.95	0.92	0.89	0.85	0.82	0.78	0.73	0.69	0.66	0.61	0.58
SNA 8	10	1.00	0.99	0.98	0.97	0.94	0.90	0.86	0.82	0.78	0.74	0.70	0.66	0.61	0.58

APPENDIX 2: Estimates of the regional tonnage of snapper landed by boat-based fishers in SNA 8 in 2017–18 given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'independent' fisher scenario.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	46	46	46	46	46	46	45	45	44	43	41	40	38	36
Harbour	2	80	80	80	80	79	78	75	73	71	67	63	59	56	52
Harbour	3	107	107	106	105	102	100	96	92	88	82	76	71	65	59
Harbour	4	127	127	126	123	119	116	110	104	98	91	84	77	71	64
Harbour	5	143	143	141	138	133	128	120	113	105	97	89	82	75	68
Harbour	6	156	155	153	149	143	137	128	119	110	101	93	85	77	70
Harbour	7	166	166	163	158	151	143	132	123	114	104	95	87	79	72
Harbour	8	175	174	170	165	156	147	136	126	116	106	97	88	80	73
Harbour	9	181	180	176	169	160	149	138	128	117	107	98	89	81	74
Harbour	10	186	184	180	173	161	151	139	128	118	108	99	90	82	74
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	69	69	69	70	70	71	72	72	72	71	72	72	72	72
North	2	121	122	122	122	122	122	123	121	120	119	119	117	116	113
North	3	165	166	166	165	165	163	162	160	158	155	150	149	146	140
North	4	201	201	201	200	198	196	195	191	187	181	175	171	164	157
North	5	231	231	230	229	226	223	221	216	208	199	191	185	176	167
North	6	249	249	249	247	244	239	236	230	221	210	201	193	182	173
North	7	265	265	264	263	258	253	249	240	231	218	208	200	186	176
North	8	276	276	276	273	269	263	257	248	237	225	214	205	189	178
North	9	286	286	285	282	278	271	263	254	243	229	217	207	190	180
North	10	293	293	292	289	285	277	267	256	245	230	219	207	191	180
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	68	68	68	68	68	69	68	68	68	68	67	66	65	64
South	2	115	115	114	115	114	114	113	112	111	109	106	104	102	100
South	3	150	150	149	149	148	147	145	142	140	136	133	130	126	123
South	4	176	176	175	174	172	171	168	164	160	156	151	147	143	139
South	5	197	197	196	194	191	189	185	180	175	170	164	159	154	149
South	6	213	212	211	209	206	202	197	192	186	180	173	167	162	155
South	7	225	225	223	221	217	213	207	201	194	187	180	173	167	159
South	8	235	235	233	230	225	221	214	208	200	192	185	177	170	162
South	9	243	242	240	237	231	226	219	212	204	196	188	179	172	163
South	10	248	247	245	241	235	229	222	214	206	198	189	180	173	164
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	183	183	183	184	184	185	185	185	184	182	181	177	175	172
SNA 8	2	316	317	317	316	315	314	312	307	302	295	288	281	273	265
SNA 8	3	423	423	421	418	415	410	403	394	386	373	359	349	337	323
SNA 8	4	505	504	502	497	490	482	472	459	445	427	410	395	378	360
SNA 8	5	571	570	567	561	550	539	526	510	489	466	444	426	405	384
SNA 8	6	618	617	613	606	593	578	561	542	518	491	467	446	420	398
SNA 8	7	657	655	651	641	626	609	589	565	538	509	483	460	432	407
SNA 8	8	686	685	679	668	651	631	607	581	553	523	496	470	439	413
SNA 8	9	710	708	701	689	669	647	620	593	564	531	503	475	443	417
SNA 8	10	728	724	717	703	681	657	628	599	568	535	507	478	445	418

APPENDIX 3: Estimates of the regional tonnage of snapper landed by boat- and shore-based fishers in SNA 1 in 2017–18 given alternative minimum legal size limits ranging from 27 to 40 cm, and daily bag limits ranging from 1 to 10 fish, for the 'co-fisher' scenario.

		Minimum Legal Size Limit (cm)													
Region	Bag limit	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Harbour	1	50	50	51	51	51	51	50	49	49	48	46	44	43	41
Harbour	2	88	88	88	88	86	86	83	81	79	75	71	67	64	60
Harbour	3	117	117	117	115	113	110	106	102	98	92	86	81	75	70
Harbour	4	139	139	138	135	131	128	121	116	110	102	95	89	83	76
Harbour	5	156	156	154	151	146	141	133	127	119	110	102	95	88	81
Harbour	6	170	169	167	163	157	151	142	133	124	115	107	99	91	84
Harbour	7	181	180	177	172	165	157	147	138	128	118	110	101	93	86
Harbour	8	189	188	185	179	171	162	150	141	130	120	112	103	95	87
Harbour	9	196	195	190	184	175	164	153	142	132	122	113	104	96	89
Harbour	10	201	199	195	188	177	166	154	144	133	123	114	105	97	90
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
North	1	100	100	101	101	101	102	103	103	103	102	104	103	104	103
North	2	175	175	175	175	175	175	176	174	173	172	172	170	169	166
North	3	234	235	234	234	234	232	231	229	227	224	219	218	215	209
North	4	281	282	281	280	278	276	275	271	267	261	255	251	244	237
North	5	320	320	319	318	315	312	310	305	297	288	280	274	265	256
North	6	345	345	344	343	339	335	332	325	317	305	296	289	277	268
North	7	365	365	365	363	359	353	349	341	331	318	309	300	287	276
North	8	380	380	380	377	373	367	361	352	341	329	318	309	293	282
North	9	392	392	392	389	385	378	370	361	350	336	324	313	297	286
North	10	403	402	401	399	394	386	376	365	354	339	328	317	300	289
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
South	1	86	86	86	86	87	87	87	87	86	86	85	84	83	83
South	2	143	143	143	143	143	143	142	141	139	137	135	133	130	129
South	3	183	183	182	182	181	180	178	175	173	169	166	163	159	156
South	4	212	211	211	210	208	206	203	200	196	191	187	183	179	175
South	5	235	234	233	231	229	226	222	218	213	207	201	197	192	186
South	6	251	251	249	247	244	240	236	230	224	218	211	206	200	194
South	7	264	264	262	259	256	251	246	240	233	226	219	212	206	198
South	8	275	274	272	269	265	260	254	247	239	232	224	217	209	201
South	9	283	282	280	276	271	265	259	252	243	235	227	219	211	203
South	10	288	287	285	281	275	269	261	254	245	237	229	220	212	203
		27	28	29	30	31	32	33	34	35	36	37	38	39	40
SNA 8	1	237	237	237	238	238	240	239	239	238	236	235	231	229	226
SNA 8	2	406	406	406	405	405	404	401	396	391	384	377	370	363	355
SNA 8	3	535	535	533	530	527	522	515	506	498	485	471	461	449	435
SNA 8	4	632	632	630	624	617	610	600	587	573	555	537	523	505	488
SNA 8	5	711	710	707	700	690	679	666	650	629	605	584	566	545	523
SNA 8	6	766	764	761	753	740	726	709	689	665	638	614	593	568	545
SNA 8	7	810	809	804	795	779	762	742	719	692	663	637	613	585	561
SNA 8	8	844	843	837	826	809	789	765	739	711	681	654	628	597	571
SNA 8	9	871	869	862	850	830	808	781	755	725	693	664	637	604	578
SNA 8	10	892	888	881	867	845	821	792	763	732	699	670	642	609	582