Monitoring the private vessel recreational fishery for blue cod and sea perch off Kaikoura and North Canterbury; second boat ramp survey, 2009

T. H. Kendrick
A. Hart
G. Hanley

Trophia Limited
PO Box 60
Kaikoura 7340

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EXECUTIVE SUMMARY

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A survey of recreational fishing for the Kaikoura – North Canterbury area was undertaken during the period January to April 2009. Boat ramp and charter vessel based fishing was surveyed. The objective of the survey was to monitor harvest rates and sizes of blue cod *(Parapercias colias*) and sea perch (*Helicolenus percoides*). The design of the survey was informed by the results of a similar survey in 2003 that concluded that at least 300 harvest rate estimates would be required to detect a 20% decline in harvest rate (in numbers), and a minimum of 150 measured fish (per species) would be required to detect changes of 1 cm or more in mean fish size. Over 42 randomly allocated sampling days, interviews were initiated for 833 vessel retrievals observed at six boat ramps in Kaikoura (using a bus route survey design) and one ramp in Motunau. Blue cod and/or sea perch were the target species on 434 of the fishing trips, and length measurements for 860 fish (451 blue cod; 409 sea perch) were taken. Logbooks were completed by five charter vessel operators, and data obtained for 107 fishing trips, from which 1977 length measurements were obtained (972 blue cod; 1005 sea perch).

The results of the 2009 survey are presented and compared with those from the earlier comparable 2003 survey. Harvest rate and fish size are compared between the two surveys, and additional perspective is provided from estimates of total private vessel effort from trailer counts and the associated removals of blue cod and sea perch.

Total private vessel effort increased by 100% at Kaikoura and by 20% at Motunau between 2003 and 2009. There was a shift towards more weekday fishing at Kaikoura. Effort expanded into a third boat ramp at Kaikoura in 2009 (two boat ramps accounted for 80% of effort in 2003), and the overflow from parking areas meant that more trailers were removed off-site, with a specific correction required to be made for this (which was not necessary in 2003).

The mean size of fish retained from private vessels at Kaikoura in 2009 was smaller (significant at $p=0.05$) by about 4 cm for blue cod and by over 3 cm for sea perch. There was no change in fish size at Motunau. In 2003, retained blue cod from Kaikoura were considerably larger than those from Motunau, but that differential has now disappeared. In both areas, the proportion of legal blue cod in the harvest was greater in 2009 by about 10%. In Kaikoura this compensated fishers somewhat for a decline in the total catch per trip, and in Motunau it manifested as a significant increase in the catch rate of legal-sized fish despite no significant change in total catch.

The size structure of the harvest of both species suggests that harvest rates have been maintained by recent good recruitment to the fishery, but that recruitment has not been maintained at that level, exploitation rates are high and there is little accumulation of larger size classes to provide bigger fish to anglers.

Harvest rates and fish size distributions from charter vessel logbooks generally supported the observations made from private vessel catches; with harvest rates of blue cod remaining at close to 2003 levels in both areas but consisting of smaller fish. However, the catch rates of sea perch at Kaikoura by charter vessels were greater, and the fish larger in 2009 than in 2003, which may have more to do with the high turnover of operators than with any changes in the underlying population of sea perch.

The estimates of total harvest retained by the private vessel fishers during the four month period January to April 2009 were not precise but comparison with the 2003 estimates of total removals suggests there was a 60% increase in the number of blue cod taken between 2003 and 2009, corresponding closely with the estimated increase in effort, and converting to a 40% increase in biomass because of the decline in fish size at Kaikoura. The number of sea perch taken increased by 30% and equated to a 10% decrease in the biomass removed because of the smaller fish size in Kaikoura in 2009.

Logbook data collected in 2009 does not reflect the increased effort by charter vessels that was evident to surveyors and therefore coverage and representativeness must be considered to be inadequate, particularly for Kaikoura operators. No estimates of total effort or total removals by charter vessels can be made.

1. INTRODUCTION

National diary surveys of marine recreational fishing have found blue cod (*Parapercis colias*) to be the third most frequently landed species nationally (behind snapper and kahawai), and the most important recreational finfish in the South Island (Ministry of Fisheries, 2010). Surveys undertaken in 1992 and 1996 put the recreational harvest along the east coast of the South Island, in BCO 3, at between 175 and 245 t (Bradford et al. 1998). In addition, commercial fishers in this area land about 150 to 180 t of blue cod annually. Blue cod is also an important species for Maori customary fishers. About 80% of the recreational blue cod harvest in BCO 3 is taken in Otago waters off Moeraki, Karitane and Taieri Mouth; however, blue cod is still a very important species in the northern part of BCO 3. Although blue cod is distributed throughout New Zealand, tagging studies have shown it to exhibit little movement from home ranges (Carbines 2001). Consequently, there are likely to be many, largely independent sub-stocks of blue cod, potentially rendering this species susceptible to localised depletion.

Commercial fishing

This is a shared fishery with both species also taken commercially. Blue cod in BCO 3 is largely caught by potting, and sea perch in SPE 3 is a target and bycatch of the mixed species inshore bottom trawl fishery. BCO 3 catches have consistently exceeded the TACC of 163 t by about 5% since 2002–03. Commercial sea perch catches have declined from over 1000 t in 1995–96 to 328 t in 2008–09 and have not been constrained by the TACC of 1000 t (Ministry of Fisheries 2010).

A standardised CPUE analysis was conducted in 2010 on the target blue cod potting fishery operating in BCO 3 and showed a declining trend in commercial CPUE since 2002/03 after a relatively long period of stability (Starr & Kendrick 2010). However, as the bulk of the total BCO 3 commercial catch (74%) was taken from Statistical Areas 024 and 026, the Southern Inshore Working Group agreed that the CPUE trend may not be applicable to those parts of BCO 3 north of Area 024 (Ministry of Fisheries 2010).

The commercial fishery for blue cod in Northern BCO 3 is monitored using potting surveys. Fishery independent surveys of blue cod in North Canterbury (part of BCO 3) in 2004–05 (Carbines & Beentjes 2006a) and in 2008 (Carbines & Beentjes 2009) used standardised cod pots, and described an overall 44% decline in catch rates of legal sized blue cod in Motunau between 2005 and 2008.

Abundance of sea perch in SPE 3 was monitored under an Adaptive Management Programme (AMP) in trawl tows targeted at sea perch, red cod, barracouta or tarakihi (Ministry of Fisheries 2010). A target bottom trawl fishery centred on Kaikoura effectively ceased when the main participant withdrew from the fishery in 2002–03. Since then, the fishery has largely operated further south in Statistical Areas 020 and 022. Annual indices of commercial catch rate of SPE from a lognormal model of successful catches in SPE 3 declined by more than 50% between 1998–99 and 2006–08. The probability of catching SPE (binomial model) also declined in a similar manner. (Starr et al. 2008).

Recreational fishing

Some recreational fishers are concerned about the stocks of blue cod in the northern part of BCO 3. The area of reef is limited by a narrow continental shelf, and a series of troughs and canyons that come close inshore at Kaikoura. As a consequence of anecdotal information given to the Ministry of Fisheries Review of Sustainability Measures for 2000–01, the recreational bag limit for blue cod was lowered in December 2000 for the northern part of BCO 3 (from the Waimakariri River to Clarence Point). The current amateur fisheries regulations for Kaikoura – North Canterbury include a Minimum Legal Size (MLS) of 30 cm and a Maximum Daily Limit (MDL) of 10 fish. In 2003, the MDL in an adjacent Fishtock, BCO 7 (Marlborough Sounds), was reduced to 3 fish due to

sustainability concerns and from 1 October 2008 the enclosed waters of Marlborough Sounds were temporarily closed to all recreational fishing for blue cod (expiring on 1 October 2012 unless removed earlier). Kaikoura is only 90 minutes away by road from Blenheim and is a viable alternative for fishers so that the closure is considered to have increased pressure on the Kaikoura fishery.

There are also concerns about the stocks of sea perch (*Helicolenus percoides*) in the northern part of SPE 3. Fishing pressure is said to have increased in the Kaikoura area, partly due to an increase in the number of charter boats and partly from perceived shifts in recreational effort from Motunau, and more recently from the Marlborough Sounds, to Kaikoura. Sea perch are seldom targeted by recreational fishers, but are caught in large numbers. Some are used for bait, and most have historically been discarded, but they are gaining favour as a table fish. There is no amateur fisheries regulated MDL for sea perch in this area.

Blue cod and sea perch are caught almost exclusively by line fishing from vessels. The Kaikoura area is serviced by six main boat ramps and the North Canterbury area by one ramp at Motunau, so there is considerable potential for monitoring a significant proportion of the total recreational effort and harvest using boat ramp surveys. Many of the locals from Kaikoura are retired and fish when the weather is suitable whatever the day of the week, but at Motunau there is a more pronounced difference with higher effort recorded on weekends than on weekdays. The tidal bar at Motunau concentrates returning boats over a short time period so the timing of sampling at that ramp needs to be determined by tide times rather than being allocated randomly. A considerable proportion of private vessel boat trips target rock lobster and that needs to be accounted for when estimating relevant total effort.

Previous work

In this research, changes in harvest rates and lengths of the two key target species; sea perch and blue cod, are monitored by repeating a survey designed and carried out in 2003 (Hart & Walker 2004).

The 2003 survey undertook boat ramp surveys on 45 sample days and analysed logbooks from six charter vessels. The results included estimates of total recreational effort and of total harvest for the four months January to April 2003 as well as estimates of harvest rate (kg/hour) and size distribution for blue cod and for sea perch in four parts of the fishery; Kaikoura private vessels, Kaikoura charter vessels, Motunau (North Canterbury) private vessels and Motunau charter vessels. This study provided the first baseline statistics for this fishery and established a repeatable design suitable for monitoring any changes in the patterns of exploitation or in the availability or average size of the key species.

For charter vessels, the 2003 study was able to compare harvest rates and fish lengths with results from a previous small-scale programme that ran from October 1999 to February 2001, and which obtained data from 388 trips on three vessels. Tentative comparisons of blue cod harvest rates and sizes were also able to be made with the national diary surveys of marine recreational fishing undertaken in 1992 and 1996 (Bradford et al. 1998) but those surveys failed to provide good estimates of the recreational sea perch harvest due to problems with species identification and incomplete records.

The 2003 study also characterised angler demographics and presented a power analysis describing the sampling effort required to achieve each estimate at various levels of precision. It concluded that monitoring the recreational blue cod and sea perch fishery in the Kaikoura – North Canterbury area with a bus route/access sampling design of 35 sample days (between January and April) would yield at least 300 estimates of harvest rate required to detect a 20% decline in harvest rate (numbers per vessel-hour), and would yield more than the minimum 150 measured fish (per species) required to detect changes of 1 cm or more in mean fish size.

The main result of note from the 2003 survey was the significant difference in mean size of blue cod for private vessels between Kaikoura and Motunau. On average, blue cod caught from Kaikoura weighed 1.1 kg, compared with 0.7 kg from Motunau. The size frequency distribution for blue cod caught by Motunau private vessels was knife-edged above the MLS, which can be a sign of a heavily exploited stock. The net result of this is that even though it was estimated that almost twice as many blue cod were harvested from Motunau compared with Kaikoura, the estimated harvest in tonnes was very similar. This size difference was also observed in the 1996 surveys, suggesting that exploitation could have been quite high for some time in Motunau, although the alternative hypothesis of differences in growth between these populations could not be discounted. Hart & Walker (2004) noted that if exploitation at Kaikoura continued to increase, as was quite likely, a similar response in Kaikoura blue cod populations might be detected in the future.

The overall objective of this project was to monitor the recreational blue cod and sea perch fishery in the North Canterbury – Kaikoura area. There were two specific objectives;

1. To monitor changes in recreational catch rates of key target species in the North Canterbury – Kaikoura area.

2. To monitor changes in the size of key target species in recreational catches in the North Canterbury – Kaikoura area.

2. METHODS

The boat ramp surveys carried out for this study (and for a comparable four month period in 2003 as described in Hart & Walker 2004) aimed to achieve comprehensive coverage of private vessel recreational fishing in the Kaikoura and north Canterbury regions for January to April inclusive. The restricted access points along these coastlines makes it possible to survey all boat ramps, and the bus route method (Pollock et al. 1994) was employed to monitor the six boats ramps in Kaikoura randomly within a day in proportion to the effort expended from them. Sampling at the more remote Motunau ramp (North Canterbury) was done over the entire day, or at least over the tidal range for which the bar makes it accessible.

Surveyors initiated an interview for each boat retrieved. They obtained catch rate measures, both total and retained (harvested), for all species caught, and length measurements of the harvest for the two key species (blue cod and sea perch) along with ancillary information to describe fishing effort. Harvest rates, fish size, and total removals are based on retained catch which could be seen by the surveyors, while estimates of total catch, legal catch, and discards (both legal and sub-legal) are based on fisher recall and are subject to bias.

The survey also included counts of trailers and observations of vessel launches and recoveries at each ramp to estimate total daily effort (vessel-hours) in the area stratum. A correction for trailers that were removed off-site (for lack of parking space) was necessary in 2009. Total daily effort was also corrected upwards for trips that started earlier in the day than sampling did, and downwards to account for the proportion of boats launched for reasons other than line fishing for blue cod (BCO) or sea perch (SPE). Average daily effort was scaled up to estimate the total relevant effort (vessel-hours targeted on BCO or SPE) for the four months, and multiplied by the average retained catch per vessel-hour (ratio of means) in each stratum to obtain estimates of total removals in the four month period. No assumptions are made about annual levels of effort or catch.

Estimates from the 2003 survey were re-worked to ensure consistency and differ slightly from those reported in Hart & Walker (2004). This mostly involved applying corrections as above, that were not considered necessary in 2003 but which had considerable effect on 2009 results, but also correction to

the calculation of confidence limits around the estimates of total effort. Where tables and figures differ from similar summaries reported in Hart & Walker (2004) this is identified in the caption.

Catch and harvest rates and fish measurements were also obtained from charter vessel operators who filled out logbooks. Because the number of fishers on these boats (up to ten) is greater than for the typical private vessels, they are not included in the strata used for daily effort estimates. The catch and harvest rates achieved, and the average size of fish retained also determine that charter fishing belongs to a separate strata from private vessel fishing.

2.1. Spatial and temporal stratification

Estimates of catch rates and fish size were required from each fleet for the two key species in two distinct areas (Kaikoura and Motunau). Total effort and total catch were also estimated for the private vessel fleet over the whole region. Sampling effort was stratified by day type (weekends and weekdays) and by boat ramp in proportion to the fishing effort expended in each. Total targeted effort estimated from the previous survey was used to stratify sampling by area and by weekends and weekdays (Table 1). Weekdays in the first week of January and Easter Friday and Monday were included in weekend strata due to their holiday status. Competition days were avoided, as they make up a stratum of their own.

Hart & Walker (2004) accessed data from the 1992 and 1996 Recreational Surveys from the MFish database "rec_dat" that suggested that a sampling effort allocation of 23% at Kaikoura and 77% at Motunau would have best reflected fishing effort at that time (during the 1990s). The allocation they actually used in 2003 was 60% Kaikoura and 40% Motunau to better reflect the larger area fished by vessels operating along the Kaikoura coastline.

Analysis of the total effort estimates from the 2003 survey (Table 1) confirmed that there had been a marked shift in effort into northern areas with 72% of recreational effort for the region estimated to have been expended from Kaikoura, and the decision was made to concentrate even more of the sampling effort on Kaikoura in 2009 than was done in 2003, increasing the allocation from 60% to 73%.

Proportional allocation between weekends and weekdays was retained at near the 60% weekends, 40% weekdays, distribution that was reported in 2003 for Kaikoura, and 85% and 15% respectively for Motunau. The final sampling allocation by location and day type is given in Table 1. Days in each strata were assigned dates randomly.

Assuming similar intercept rates (number of relevant interviews per hour of wait time) to the 2003 survey, we estimated that 45 days of survey would yield about 332 samples of catch rates (Table 1). This is more than the number of days suggested by Hart & Walker (2004) and the difference was due to the proposed reduction in effort at Motunau on weekends compared with that study. The tidal bar at Motunau concentrates returning boats over a short time period so intercept rates are higher than those experienced at Kaikoura. For each day of sampling at Kaikoura, the wait times at each boat ramp were set proportional to the number of relevant interviews obtained per hour of sampling during the 2003 survey and given in Table 2 of Hart & Walker (2004). The sampling effort allocation was about 80% split between the two South Bay ramps with the remaining 20% divided over the remaining four ramps (Table 2).

Table 1: Effort weighting (percent vessel-hours), based on distribution of recreational fishing effort in 2003, proportionate allocation of days in 2009, intercept rates (relevant interviews per day) achieved in 2003, from Hart & Walker (2004), and the anticipated number of harvest rates estimates for 2009.

Day Type	Area	Private Vessel Effort in 2003 % of Relevant Vessel-hours	Sampling Allocation in 2009 (days)	2003 Intercept Rate BCO/SPE interviews/day	Anticipated Number of Interviews In 2009
Weekend	Kaikoura	44%	20	8	164
Weekday	Kaikoura	28%	13	2	22
Weekend	Motunau	24%	11	13	141
Weekday	Motunau	4%	2	2	5
Total		100%	45		332

Table 2: Effort weighting (proportion) based on relevant (BCO/SPE) interviews per hour obtained during the 2003 survey, from Hart & Walker (2004) and proportionate allocation (minutes) in 2009 of sampling (wait) time among boat ramps at Kaikoura.

Boat Ramp	2003 Effort Weighting	2009 Wait time (minutes)
Boat Harbour	0.02	8
Pier Slipway	0.02	8
Armers Beach	0.08	33
Public Ramp	0.45	185
Boat Club	0.35	144
Barney's Rock	0.08	33
	1.00	410

The boat ramp survey logbook and session cover sheet designed for this project is attached in Appendix 2. The design closely follows the *rec_dat* database format. Appendix 3 lists the cross-references of the elements of the Trophia BCO/SPE survey logbook with the tables and attributes of the *rec_dat* database.

An interview was initiated for each vessel-retrieval observed, and then coded depending on the outcome. Whether or not the trailer had been kept off-site was noted. Vessels that were not relevant to the survey were noted (e.g. those used for water skiing).

2.2. Estimation of total effort

A survey design using the bus route method (Pollock et al. 1994) was used to sample the six Kaikoura boat ramps, and schedules were constructed according to Jones & Robson (1991). This sampling method provides logistical efficiency while still allowing the daily schedule to be randomised. The equations used to estimate total daily effort for each stratum and total effort and catch for the four month period, are given in Appendix 5 and are reproduced from Sumner et al. (2002).

For each Kaikoura survey day, the starting location and direction of travel (North or South) was chosen randomly using an Excel worksheet routine similar to that developed by Sumner et al. (2002). Daily interview schedules for each access point were constructed using data on wait time and travelling time. Wait time is the time spent at a ramp counting boat trailers and interviewing anglers, and travelling time is the time required (by car and/or walking) to travel between each access point. A

prototype schedule that maps the interview route in terms of cumulative time (waiting + travel time) is shown in Appendix 1. At Motunau a simple access point design was utilised for the single boat ramp that launches onto a tidal bar.

Each sampling session encompassed the entire fishing day. In Kaikoura, sampling sessions ran from 10am to 7pm during January and February, and 10am to 6pm during March and April. The previous survey, done in 2003, started earlier in the morning but established that most vessels that returned before 10 am were rock lobster fishers who were retrieving pots that had been set overnight (Hart & Walker, 2004). Sampling at the Motunau boat ramp occurred over the high tide each survey day, as the majority of fishing trips are three to four hours in duration with boats getting out over the bar prior to high tide and returning no later than two hours after high tide.

Estimates of total daily effort on sampling days were based on the duration that trailers spent parked at each ramp and were adjusted for effort missed because trips began before sampling did, for trailers parked elsewhere and not included in the census, and for the proportion of vessels that were launched for other purposes (potting or diving for rock lobsters for example).

Total daily effort in each area/day type stratum was scaled up to the number of days in the stratum to get estimates of total relevant effort in vessel-hours for the four month period.

2.2.1. Correction to number of trailers parked at start of session for off-site parking

Daily effort based on boat ramp parking area trailer counts will be underestimated when a vessel is launched but the trailer is removed off-site. The incidence of off-site parking varies among ramps depending on proximity to residential areas, whether or not the ramp is part of a camping ground (as for Boat Harbour), and the degree of security provided. The proportion of trailers that were kept off-site was calculated from observed retrievals using off-site parked trailers, and was used to adjust upwards the number of parked trailers counted at the start of the session. Off-site launches could have been used to calculate this proportion instead but we had better observation of boats retrieved than of boats launched (because of the 10:00 a.m. start time).

2.2.2. Correction to daily effort estimates for proportion of vessels fishing for blue cod or sea perch

The proportion of vessels that line fished for blue cod or sea perch was determined for each area from boat ramp interviews, and was used to modify the estimates of average daily effort. The number of vessels targeting either blue cod or sea perch was divided by the total number of vessel retrievals rather than successful interviews to take account of vessels that were launched for purposes other than line fishing (e.g. lobster potting, skiing) or that were charter vessels and therefore were not approached by surveyors.

2.2.3. Correction to daily effort estimates for effort prior to sampling

At Kaikoura, the proportion of effort that occurred before the sampling start time of 10:00 a.m. was established from boat ramp interviews and used to scale up the daily effort estimates based on observed launches and retrievals. Surveyors stayed at the last ramp until the last trailer was retrieved and no correction was therefore required for effort occurring after the hours surveyed. Multipliers based on the ratio of effort before survey start time to the rest of the effort were calculated for each area separately and were greater in 2009 than in 2003 for Kaikoura. The reason for this was the later start time of 10:00 a.m. at Kaikoura in 2009. In 2003, the day started at 7:00 a.m. and a greater proportion of the launches were therefore observed. The decision to shift the start time was made

because it is more important to observe retrievals than launches, and the relatively few retrievals that were noted earlier than 10:00 a.m. in 2003 tended to be rock lobster fishers who had left pots out overnight and were retrieving them as early as possible the next morning.

At Motunau, the ratio of effort before and after the arrival time of the surveyor was used to adjust the daily effort estimates.

2.3. Catch rates and fish lengths

Estimation of vessel harvest rates and variances followed the methods of Hoenig et al. (1997), Jones et al. (1995) and Pollock et al. (1994, 1997). Anglers were asked to participate in a two minute prepared questionnaire to identify the target species, and to differentiate between fish caught and kept (including for bait), and fish caught and released.

The observations of catch per trip collected from interviews describe the total catch per species, and in the case of blue cod, the legal catch. Because fish of any size can be returned to the water, both of these estimates require the fisher to recall the number of fish that were released. Catch rates can only be monitored accurately at sea, but in boat ramp surveys they rely on fisher recall and are therefore subject to bias. They are collected to describe the experience of the fisher and are distinct from harvest rates, which can be verified at the boat ramp and which reflect the removals from the population.

The estimates of total catch were based on harvest rates (fish retained) and therefore represent actual removals.

Length measurements were taken of all blue cod and sea perch landed when time allowed, and a sample (minimum of five fish) when interviewers were very busy. Catch and harvest rates for blue cod and sea perch were calculated from those fishing trips that targeted either of the species by line fishing.

2.4. Charter vessel logbooks

A charter vessel logbook designed for this project is shown in Appendix 4. It is a modification of a previous logbook and associated database that Trophia designed, and comes with a fully functional and documented database (Walker 1999). The logbooks were distributed to vessel operators in November for the peak fishing season from mid-December 2008 to April 30th 2009. There has been a high turnover of charter boat operators since the previous survey was done, particularly at Kaikoura.

3. RESULTS

3.1. Boat ramp survey: sampling achieved

Sampling began on the 27th December, and included four days in late December 2008 that were outside of the survey period (January–December 2009). Where tables and figures include December data this is identified in the caption as ‘whole period’. In each survey, some days were not used in the calculation of catch rates and total effort because they were anomalous in some way. For example, in 2003 the 20 April was a competition day that constituted a stratum in its own right and was subsequently discarded from all but the length frequency calculations. In both years the number of valid days sampled for January to April including days of bad weather when no fishing was observed was 42.

The actual coverage of the temporal strata is given in (Table 3) and 78% of weekend days and 16% of weekdays in the four month period were sampled.

Table 3: Coverage of temporal strata (weekdays and weekend days between 1 January and 30 April) in 2009; number of days in strata, number of days sampled, percent coverage.

Strata	Days in strata	Days sampled	% coverage
Weekends	37	29	78.4
Weekdays	82	13	15.9

An attempt was made to approach all vessels, however a few in each year were missed (coded N) when interviewers were particularly busy (5.5% in 2003 and 3.1% in 2009), and a few refused to be interviewed (coded R) (0.1% and 2.7%). Full interviews were coded "I" and were achieved for 90% (in 2003) and 74.6% (in 2009) of the vessel retrievals (Table 4). The difference is explained by the increase in the number of vessels launched for other than recreational fishing (coded O) (from 3.2% in 2003 to 16.9% in 2009) or identified as charter vessels (coded X) and therefore not approached.

The total number of full interviews done in 2009 was 754, an increase on the 673 achieved in 2003 (Table 4). This includes interviews done on days outside of the survey strata, for example; the competition day in 2003 and the days sampled in December 2008. These data were used in the description of demographics, and for fish length frequencies.

Table 4: Comparison of interview outcomes for the 2003 and 2009 surveys; all days and boat ramps included. An interview was initiated for each observed boat retrieval, but only "I" interviews yielded catch rate estimates or fish lengths. "O" outcome includes commercial or charter vessels counted in the first few days of the survey but not counted thereafter.

Interview			2003		2009
Outcome	Description of vessel retrieval	Number	%	Number	%
I	Interview	**673**	90.0	**754**	74.6
O	Other (Boats used for skiing etc.)	24	3.2	171	16.9
N	Not interviewed (Missed)	41	5.5	31	3.1
R	Refused to be interviewed	1	0.1	27	2.7
X	Charter boat operators (not interviewed)	4	0.5	27	2.7
Z	Other	5	0.7	3	0.1
	Total Initiated	**748**		**1013**	

When the dataset was trimmed to days valid for catch rate and total effort estimates (January to April) the number of total interviews (observed boat retrievals) was reduced to 833, of which 434 were full "I" coded interviews that reported line fishing for blue cod or sea perch (Table 5).
The number of measurements obtained of blue cod and sea perch (451 and 409 respectively) obtained from the whole period exceeded, in each area, the 150 of each species recommended in Hart & Walker (2004) as necessary to detect a 1 cm change in mean size (Table 6).

The intercept rates (number of relevant interviews per hour) achieved in Kaikoura in 2009 are also given for each boat ramp (Table 7) to inform the design for the next survey. The main difference from the allocation used, which was based on the 2003 intercept rates, was the increased use of Boat Harbour, and the higher effort weighting for that ramp in 2009 suggests that it should be assigned about a quarter of the wait time on Kaikoura sampling days next survey, although it should be noted that use of this ramp is somewhat tide and weather (swell) dependent.

Similarly, the advice given in Hart & Walker (2004) that the Pier Slipway might best be dropped from the bus route is reiterated this study.

Table 5: Valid harvest rate estimates obtained from boat ramp interviews for the survey period January–April 2009. Interviews are total boat retrievals observed (not just "I" interviews), BCO/SPE is the number of boats that had been line fishing and targeted blue cod or sea perch. The ratio of the two was applied to trailer counts to apportion relevance to daily effort estimates.

2009		Days	Interviews (Retrievals)	BCO/SPE Interviews	BCO/SPE Ratio	2009 Intercept rate BCO/SPE interviews /day
Kaikoura	weekends	18	404	164	0.41	9.1
	weekdays	11	182	71	0.39	6.5
Motunau	weekends	11	244	197	0.81	17.9
	weekdays	2	3	2	0.67	1.0
Total harvest rate estimates				434		

Table 6: Number of boat ramp interviews for the whole period December 2008 – April 2009 and numbers of blue cod and sea perch measured.

2009		Days	Total Interviews	BCO measured	SPE measured
Kaikoura	weekends	20	546	199	279
	weekdays	11	182	53	97
Motunau	weekends	13	282	194	33
	weekdays	2	3	5	0
Total harvest rate estimates			1013	451	409

Table 7: Distribution of interviews by ramp at Kaikoura in 2009. Total interviews initiated (vessel retrievals), number of vessels that targeted BCO or SPE, intercept rate (BCO/SPE interviews per hour), revised (future) effort weighting by boat ramp in Kaikoura.

Boat ramp	Strata	Hours sampled	Total number of interviews	BCO/SPE target interviews	BCO/SPE interviews per hour	Revised effort weighting
Armers Beach	Weekend	9.22	17	4	0.43	0.06
	Weekday	6.83	10	1	0.15	
Boat Club	Weekend	34.57	137	42	1.22	0.27
	Weekday	24.15	66	29	1.20	
Boat Harbour	Weekend	3.68	3	2	0.54	0.25
	Weekday	1.80	3	3	1.67	
Barney's Rock	Weekend	8.37	6	1	0.12	0.01
	Weekday	4.38	2	0	0.00	
Public Ramp	Weekend	46.17	241	115	2.49	0.40
	Weekday	33.58	101	38	1.13	
Pier Slipway	Weekend	1.73	0	0	0.00	0.00
	Weekday	1.37	0	0	0.00	
Total		175.85	586	235		1.00

3.2. Charter vessels: sampling achieved

Logbooks were filled out for 107 charter vessels trips in 2009 (Table 8) which is fewer than in 2003. This does not imply a similar change in total effort, and probably the reverse is true. In 2009, despite

good intentions, charter operators carrying up to 10 customers found themselves too busy to fill out logbooks, and measuring catch was often out of the question.

Table 8: Description of charter vessel logbook data for the whole period 2009 (includes some trips in late December 2008): number of charter vessel operators, trips, fishers, percentage of fishers that were New Zealanders, and the number of fish measurements for blue cod and sea perch.

Location	Operators	Trips	Fishers	% NZ Fishers	BCO measured	SPE measured
Kaikoura	3	61	417	69	512	565
Motunau	2	46	463	100	460	440
Total					972	1005

3.3. Descriptive analysis

3.3.1. Private vessel recreational fishing

In 2009, about 80% of private vessel fishers interviewed were male, and the proportion of female participants was slightly greater at Kaikoura than at Motunau (Table 9). This is almost the same as was observed in 2003. About half of the fishers in 2009 were aged 31 to 50 and almost another 20% were in the age bracket 50 to 60 (Table 10). Less than 10% of anglers were over 60. The average experience was 20 days fished in the last year, considerably less than the 31 days reported in 2003.

Line fishing trips tended to be targeted at blue cod, potting trips were targeted at rock lobster, and diving trips at rock lobster or paua. It was common for more than one method to be used on a trip. Most trips from Motunau were line fishing trips (65%), with dive trips accounting for much of the remainder (21%). This is a high proportion of diving compared with Kaikoura (12%) where there is more shore access to dive sites. Potting was a more common method on vessels from Kaikoura (24%) than from Motunau (9%) and line fishing accounted for 46% of Kaikoura trips (Table 11).

Line fishing trips that targeted blue cod or sea perch makes up the effective effort for the statistics presented in this report. Those trips generally carried an average of just over three fishers with slightly fewer lines than fishers, and stayed on the water for about three and one quarter hours (including travel time). There is some suggestion of small increases in those statistics between 2003 and 2009 (

Table 12) that might be consistent with larger and more comfortable boats, although no data on vessel size are included.

The catches were dominated by sea perch in Kaikoura, followed by rock lobster and blue cod. This contrasted with Motunau where blue cod was the main catch, followed by rock lobster and sea perch. Other species among the top ten in both areas included dogfish, barracouta, red cod, paua, and kina. Butterfish was an important part of the catch at Kaikoura but not at Motunau, and blue moki was more commonly included in catches at Motunau than at Kaikoura (Table 13).

Table 9: Distribution of sex of recreational anglers on private vessels by area in 2009 (whole period).

2009	%	
Location	Male	Female
Kaikoura	79	21
Motunau	83	17
Overall	81	19

Table 10: Distribution of age of recreational anglers on private vessels by area in 2009 (whole period).

2009						Age groups (%)		Number
Location	<15	15-20	21-30	31-40	41-50	51-60	61+	Total
Kaikoura	6	11	10	20	30	16	7	841
Motunau	10	5	9	23	28	20	6	709
Overall	8	8	9	21	29	18	6	1550

Table 11: Percentage of private vessel trips in each area (from successful interviews, whole period) that used the main fishing methods (diving, lining, and potting), targeted at the target species (blue cod, sea perch, and lobster). Other includes trips where no target species was specified. Some trips fished more than one method and these trips are double-counted. Percentages sum to 100 in each area.

Fishing method	% of trips			
	Kaikoura (566 trips)			
Target species	Dive	Line	Pot	Other
Blue cod	0	46	0	0
Sea perch	0	4	0	0
Rock lobster	6	0	24	0
Other	6	12	1	0
	Motunau (343 trips)			
Blue cod	0	65	0	0
Sea Perch	0	0	0	0
Rock lobster	19	0	9	0
Other	2	4	1	0

Table 12: Average effort on trips by private vessels targeting blue cod or sea perch in the period January to April (excluding competition day in 2003).

Private vessels	Survey year	Mean number fishers per trip	Mean number hours per trip	Mean number lines per trip
Kaikoura	2003	2.87	3.15	2.27
	2009	3.01	3.22	2.57
Motunau	2003	3.35	3.21	2.43
	2009	3.34	3.41	2.86

Table 13: Total catch (numbers of fish caught), and % retained, for the top 10 species by area from boat ramp survey interviews of private vessel fishing in 2009.

Location	Species	Total # caught	% of catch retained
Kaikoura	Sea perch	5545	64
	Rock lobster	1744	59
	Blue cod	1304	66
	Spiny dogfish	315	24
	Butterfish	314	95
	Barracouta	86	66
	Red cod	80	94
	Paua	56	88
	Parore	38	95
	Kina	28	54
Motunau	Blue cod	5657	51
	Rock lobster	1464	84
	Sea perch	914	51
	Spiny dogfish	108	6
	Paua	63	68
	Red cod	19	74
	Barracouta	15	53
	Blue moki	15	100
	Kina	12	100
	Wrasse spp.	11	82

3.3.2. Charter vessel fishing

Most charter boat customers were New Zealanders; almost 100% of those departing from Motunau and about 70% of customers taken out from Kaikoura (Table 8). Trips tended to be slightly longer duration on average than private vessel fishing trips around Kaikoura, and much longer at Motunau, averaging just under six hours in 2009 (Table 14).

Charter skippers were asked to identify the zone in which they fished and the distribution of areas fished is compared for 2003 and 2009 in Table 15. The southernmost zones, 518 and 520, were not as well represented in 2009 as in 2003 although coverage of Motunau charter fishing is considered to have been almost complete in 2009. Charter vessel operators from both areas (but particularly from Motunau) will sometimes travel long distances to fish relatively inaccessible reefs in areas 522 where there are larger blue cod. The greater geographical range of effort by charter vessels is reflected in the greater range of catch rate estimates and of fish sizes.

Catch composition may not have been correctly recorded by Kaikoura operators as it included only blue cod and sea perch, with the later making up 72% of the catch (although that is similar to the percent reported for private vessel fishing). In contrast, catches by Motunau operators consisted mainly of blue cod (62%) followed by sea perch (24%), with the balance including school shark, hapuku, trumpeter, tarakihi and ling, indicating that a different and possibly deeper habitat was being fished compared to private vessel fishers (Table 16). The logbook data are used with caution to compare catch rates and sizes with private vessels and with previous years, but not for any estimates of total catch or effort.

Although it should have been possible to cover charter vessel effort completely (because operators were keen to cooperate), their workload in 2009 when looking after large numbers of often inexperienced fishers at any one time meant that only a small proportion of their catch/ effort data was in fact recorded. Observed retrievals of these vessels at boat ramps in 2009 suggest that there was a

large increase in charter effort at Kaikoura relative to 2003, but this was not reflected in the logbook data.

Table 14: Average effort in trips by charter vessels. Whole period (includes some December 2008 days).

Charter vessels	Survey year	Mean number fishers per trip	Mean number hours per trip	Mean number lines per trip
Kaikoura	2003	8.60	3.77	5.74
	2009	6.83	3.63	6.87
Motunau	2003	8.68	6.45	8.94
	2009	10.07	5.78	10.07

Table 15: Spatial distribution of charter boat effort reported on logbooks in 2003 and in 2009.

Year	Operator base	Zone	Description	Number of trips
2003	Kaikoura	518	Clarence to Kerengu River	9
		520	Kahutara to Hapuku River	101
		522	Waiau to Conway River	9
	Motunau	523	Hurunui to Waiau River	4
		524	North of the Motunau river mouth to the Hurunui River	21
2009	Kaikoura	520	Kahutara to Hapuku River	61
	Motunau	-	Not recorded	6
		523	Hurunui to Waiau River	5
		524	North of the Motunau river mouth to the Hurunui River	35

Table 16: Total catch (numbers of fish caught), and % retained, for all species reported in charter vessel logbooks in 2009 by area.

Location	Species	Total number caught	% of catch retained
Kaikoura	Sea perch	2871	79
	Blue cod	1117	78
Motunau	Blue cod	5246	60
	Sea perch	2003	71
	Hapuku	487	100
	Rock Lobster	501	61
	School shark	98	96
	Barracouta	19	100
	Trumpeter	16	100
	Red cod	24	54
	Tarakihi	1	100
	Ling	1	100
	Kahawai	1	100

3.4. Total effort (private recreational vessels)

Estimates of total daily effort on sampling days were based on the duration that trailers spent parked at each ramp and were adjusted for effort missed because trips began before sampling did, for trailers parked elsewhere and not included in the census, and for the proportion of vessels that were launched for other purposes (potting or diving for rock lobsters for example).

Total daily effort in each area/day type stratum was scaled up to the number of days in the stratum to get estimates of total relevant effort in vessel-hours for the four month period.

Even before these adjustments were made it was evident that the average daily effort had increased in every strata, except Motunau weekdays, between 2003 and 2009. A positive adjustment for trailers kept off-site is needed given the observed overflow from full boat ramp parking areas.

3.4.1. Correction to number of trailers parked at start of session for off-site parking

This correction was calculated for each boat ramp and was greatest for the Public Ramp at Kaikoura (1.37) and least (1.00) for both Piers Slipway and Motunau (Table 17).

Table 17: The proportion of trailers kept off-site as observed during vessel retrievals in 2009. The multiplier applied to the trailer counts at start of a session by boat ramp. In 2003 there was only one instance recorded of a trailer kept off-site, and this correction was not deemed necessary.

Boat ramp	Proportion of trailers kept off-site	Multiplier used to correct number of trailers at start of session
Armers Beach	0.09	1.09
Boat Club	0.08	1.08
Boat Harbour	0.13	1.13
Barney's Rock	0.00	1.00
Motunau	0.02	1.02
Public Ramp	0.37	1.37
Pier Slipway	0.00	1.00

3.4.2. Correction to daily effort estimates for proportion of vessels fishing for blue cod or sea perch

The proportion of vessels that targeted blue cod or sea perch was almost 40% at Kaikoura ramps and closer to 80% at Motunau (Table 18). This represented little change from the 2003 survey.

Table 18: Proportion of vessels that line fished for blue cod or sea perch in 2003 and in 2009 as ascertained from interviews, but expressed as a proportion of total vessel retrievals (Jan –April not including competition day). Other vessels included vessels that fished for lobster, were launched for skiing, and charter fishing vessels.

Survey year	Proportion of vessels targeting BCO/SPE	
	Kaikoura	Motunau
2003	0.392	0.788
2009	0.397	0.806

3.4.3. Correction to daily effort estimates for effort prior to sampling

Although the later start meant that some trips may have been missed altogether, the distribution of finish times at Kaikoura boat ramps suggests that there would have been few of them (Figure 1). The result of the shift in start time was that fewer launches were observed, and the correction made for 'early launches' was greater (Table 19).

Table 19: Comparison of the corrections used in the two surveys to adjust for effort prior to the start of sampling.

Location	Survey year	Ratio of effort prior to start to other effort	Correction for boats launched early
Kaikoura	2003	0.016	1.016
	2009	0.139	1.139
Motunau	2003	0.410	1.410
	2009	0.036	1.036

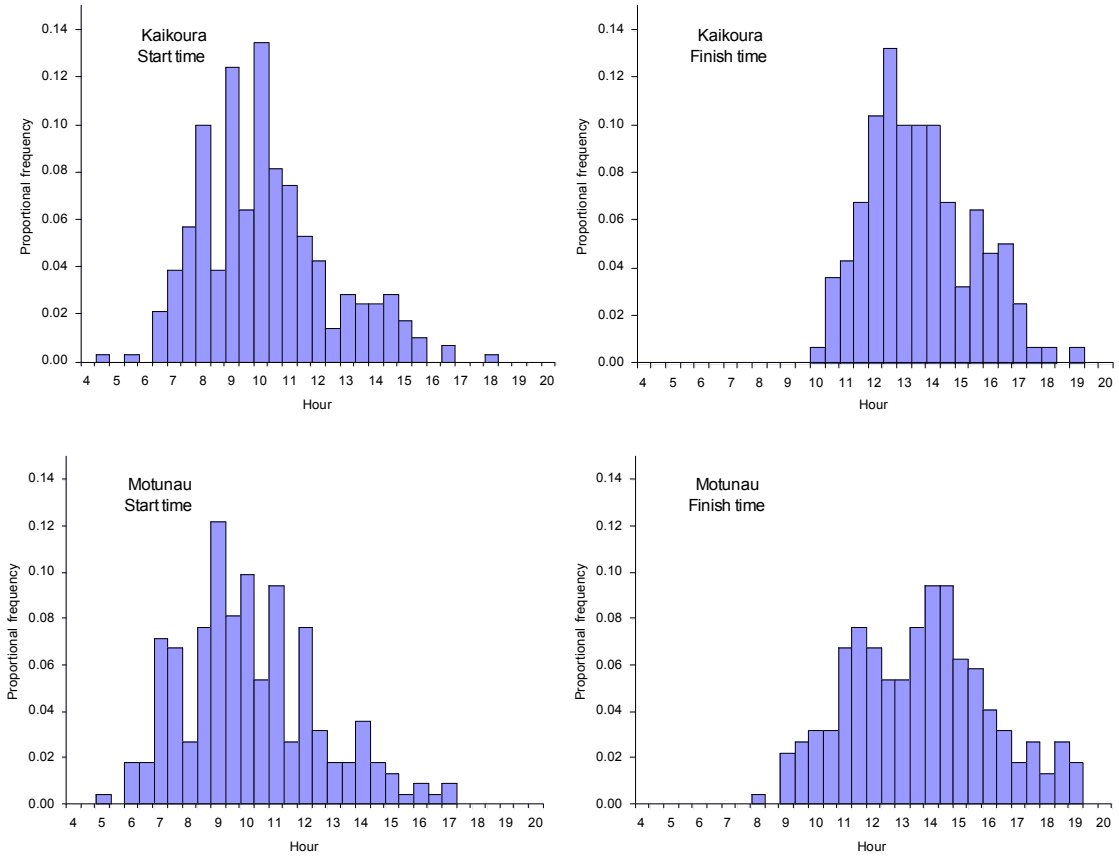


Figure 1: The distribution of trip start and finish times at Kaikoura and Motunau boat ramps established from interviews. Trips that finished before 10:00 would have been missed as surveyors began their day at 10:00 at Kaikoura. Start time at Motunau was determined by the tide.

Effort targeted at blue cod or sea perch in 2009 is estimated to have increased by 70% overall, from 5019 (SE 571) vessel-hours in 2003 to 8684 (SE 1459) vessel-hours in 2009. Most of the increase occurred in Kaikoura with that area accounting for 74% of the total relevant effort in 2009 compared to 62% in 2003 (Figure 2, Table 20). The greatest increase was an almost threefold increase in effort expended during weekdays in Kaikoura (Table 20).

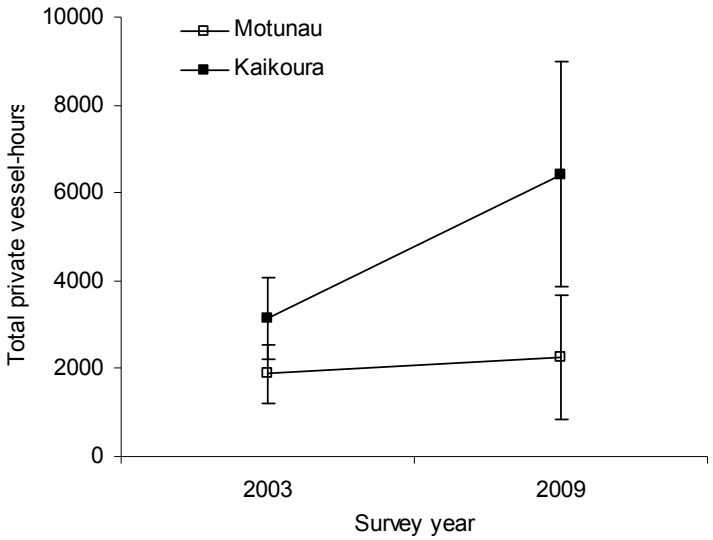


Figure 2: Comparison of total relevant effort (vessel-hours± 2 SE) by area for January to April in 2003 (re-worked), and in 2009.

Table 20: Comparison of total relevant effort (vessel-hours) by stratum for January to April in 2003 (re-worked), and in 2009, the percentage of total BCO/SPE effort (vessel-hours) by area and by day type within area for each survey year.

Survey year	Area	Day Type	BCO/SPE effort vessel-hours (SE)	% of BCO/SPE fishing effort by area	% of BCO/SPE Fishing effort by area/daytype
2003	Kaikoura	Weekend	1 931 (280)		62
		Weekday	1 201 (371)	62	38
	Motunau	Weekend	1 618 (320)		86
		Weekday	2 695 (90)	38	14
2009	Kaikoura	Weekend	2 889 (558)		45
		Weekday	3 536 (1150)	74	55
	Motunau	Weekend	1 915 (617)		85
		Weekday	344 (339)	26	15

3.5. Changes in fish size

3.5.1. Blue cod (BCO)

The average size of blue cod retained by private vessel fishers declined significantly (at p=0.001) in Kaikoura between 2003 and 2009 by over 4 cm, but did not change at Motunau (Figure 3, Table 21). The charter fleet experienced a similar decline in the average size of blue cod at Kaikoura as well as a smaller decline at Motunau. In 2003, blue cod caught at Kaikoura by the private vessel fleet were considerably larger than those caught at Motunau (over 1 kg on average compared with 0.6 kg). In 2009, there was not such a marked difference, with the average size for Kaikoura blue cod having declined to almost the same as the Motunau caught fish.

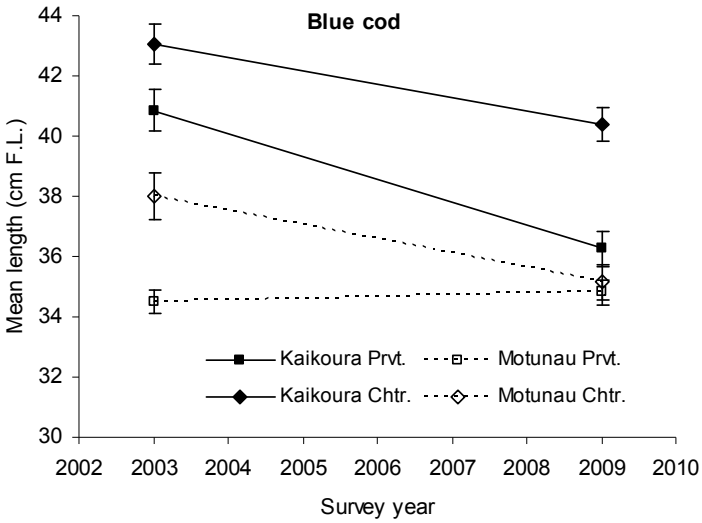
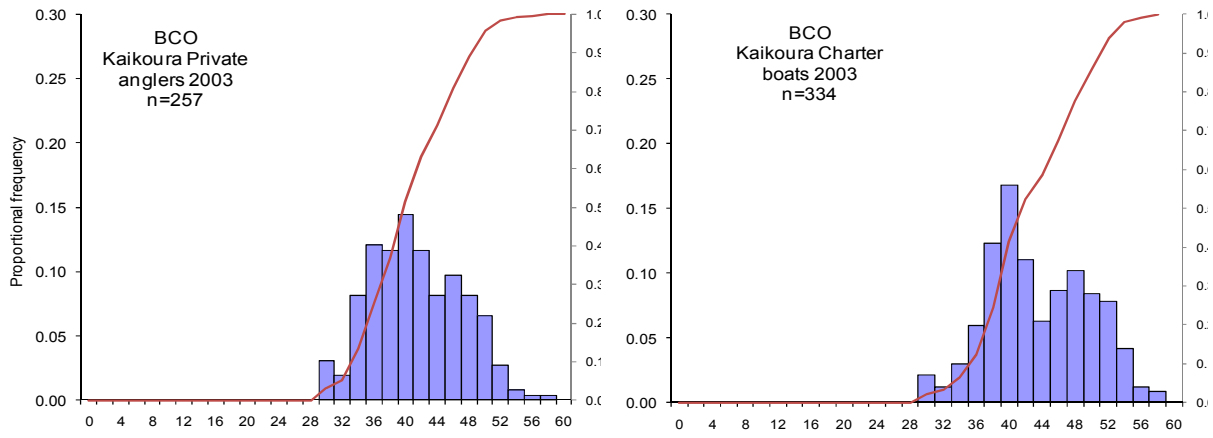


Figure 3: Comparison of mean lengths (± 2 SE) in 2003 and 2009 of blue cod retained by the private vessel fleet and the charter fleet in Kaikoura and Motunau.

Table 21: Comparison of mean weight (kg) and mean length (cm F. L.) of the retained catch of blue cod by fleet and area in 2003 and 2009. SE is standard error of mean length, p is Pr(>|t|) students-t difference between years, significance code, * =0.001. % Sub-legal is the percentage of the catch reported to have been smaller than MLS (30 cm) and released.**

Blue cod Fleet	Location	Survey year	Mean weight (kg)	Mean length (F.L) cm	SE	p	Signif.	% Sub-legal
Private vessel	Kaikoura	2003	1.097	40.848	0.353			39.6
		2009	0.756	36.254	0.295	<0.001	***	27.7
	Motunau	2003	0.647	34.491	0.191			56.1
		2009	0.667	34.824	0.204	0.234	n.s.	42.7
Charter								
	Kaikoura	2003	1.293	43.057	0.334			5.8
		2009	1.061	40.406	0.281	<0.001	***	8.9
	Motunau	2003	0.875	37.996	0.378			16.4
		2009	0.686	35.141	0.281	<0.001	***	27.8



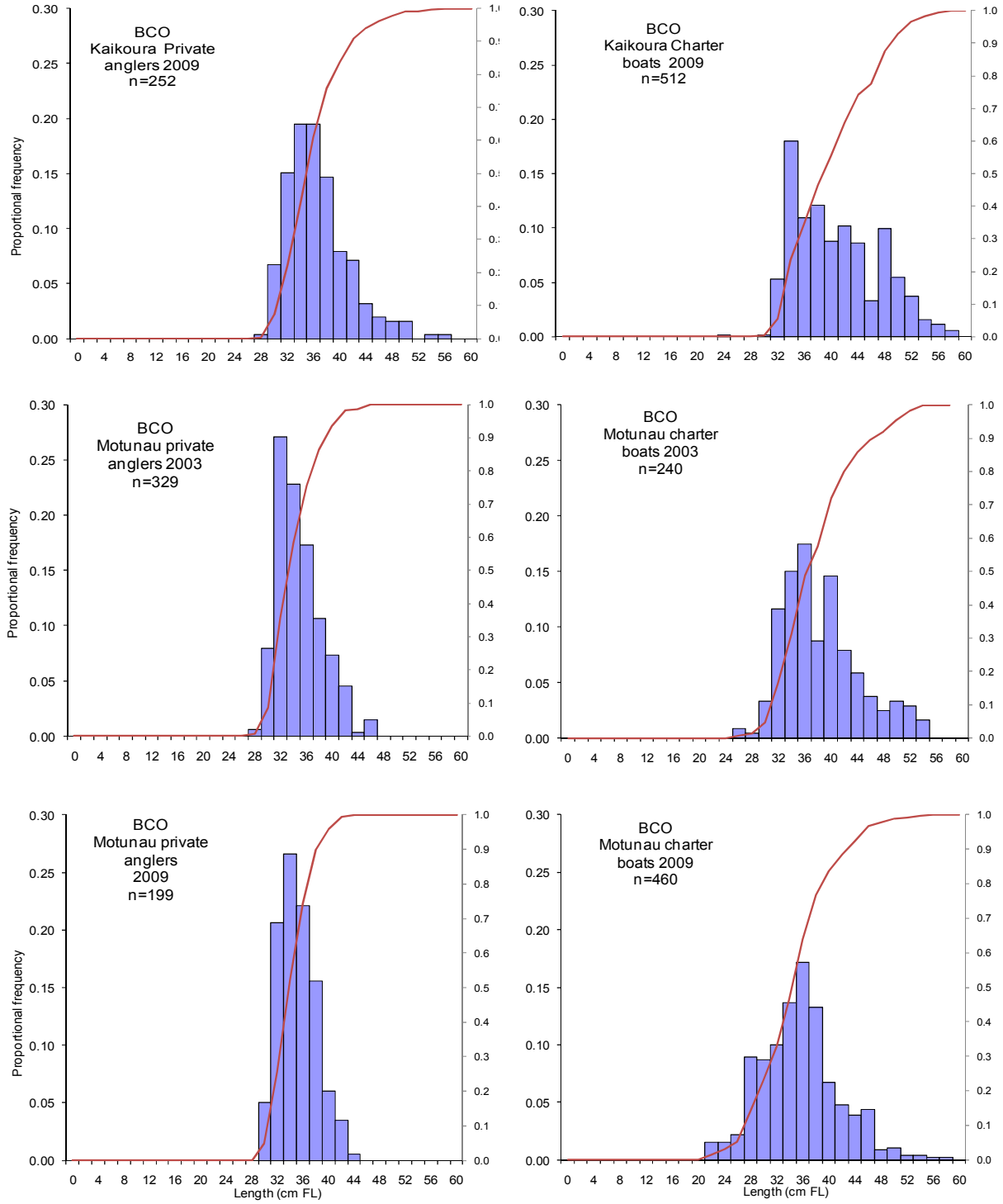


Figure 4: Length distributions (proportions and cumulative proportions) of retained blue cod from private vessels [left] and charter boats [right] fishing from Kaikoura in 2003 [top panel], and in 2009 [second panel], Motunau in 2003 [third panel], and in 2009 [bottom panel]. The minimum legal size for blue cod in these areas is 30 cm.

The changes in length structure of the retained catch for private vessels at Kaikoura between 2003 and 2009 (Figure 4) shows the loss of two distinct modes of larger fish (centred around 40 cm and 46 cm) that were present in 2003, and a new peak of fish in 2009 that were more recently recruited to the fishery (centred around 34 cm). In combination with the reported decline in the proportion of sub-legal fish in the catch this represents a marked contraction of the length distribution. In 2009, the charter fleet were still able to access larger blue cod, with a mode at 48 cm, but their retained catch

was similarly dominated by a mode of smaller fish centred at 34 cm. The size structure of the private vessel harvest of blue cod at Motunau was described as knife edged in 2003 (Hart & Walker 2004) and looked very similar in 2009, with no accumulation of large fish evident (Figure 4). The composition of the charter fleet retained catch was different from that of the private vessel fleet in 2003 with larger numbers of big fish represented, and this also was the case in 2009.

3.5.2. Sea perch (SPE)

The average size of sea perch retained by private vessel fishers declined significantly (at p=0.001) by more than 3 cm between 2003 and 2009 in Kaikoura, but did not change significantly at Motunau (Figure 5, Table 22). The charter fleet experienced no similar decline and maybe a slight increase in both areas. In 2003, sea perch retained by the charter fleet at Kaikoura were considerably larger than those retained from Motunau. In 2009, the difference was even greater (over twice the greenweight). The numbers of sea perch kept by private vessel anglers at Motunau were too few to make any useful comparisons.

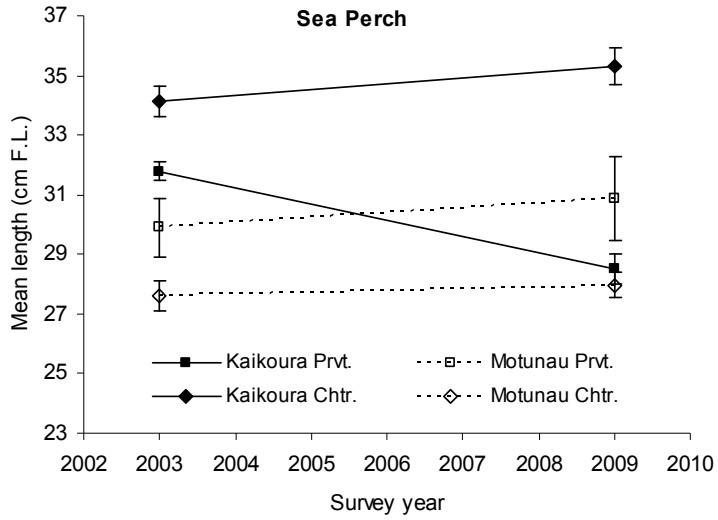
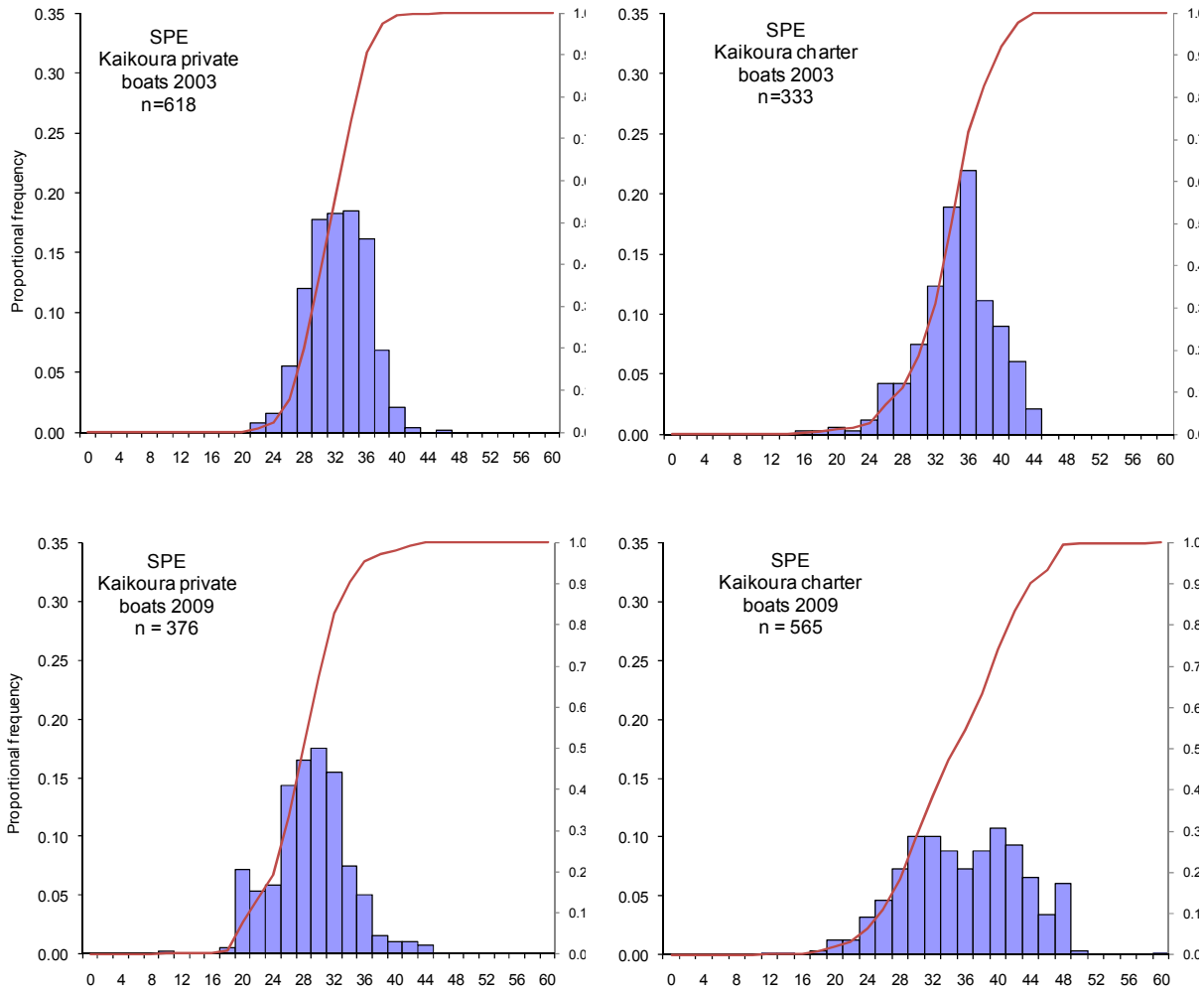


Figure 5: Comparison of mean length (± 2 SE) in 2003 and 2009 of sea perch retained by the private vessel and charter fleets in Kaikoura and Motunau.

Table 22: Comparisons of mean weight (kg) and mean length (cm F. L.) of the retained catch of sea perch by fleet and area in 2003 and 2009. SE is standard error of mean length, p is Pr(>|t|) students-t difference between years, significance code, * =0.001; **=0.01.**

Sea perch Fleet	Location	Survey year	Mean weight (kg)	Mean length (F.L) c.m	SE	p	Signif.
Private vessel	Kaikoura	2003	0.532	31.788	0.150		
		2009	0.377	28.556	0.255	<0.001	***
	Motunau	2003	0.437	29.902	0.493		
		2009	0.485	30.879	0.711	0.263	n.s.
Charter	Kaikoura	2003	0.669	34.123	0.253		
		2009	0.746	35.306	0.303	0.003	**
	Motunau	2003	0.339	27.622	0.249		
		2009	0.352	27.950	0.212	0.316	n.s.

The changes in length structure of the harvest of sea perch at Kaikoura between 2003 and 2009 (Figure 6) shows a shift of the whole distribution to the left, and a new mode of fish being kept in 2009 that was centred around 20 cm. The difference in the size structure of harvest by the charter fleet showed a similar shift despite there being little change in the mean length; whereas in 2003 it described a uni-modal distribution centred around 36 cm, in 2009 two modes were obvious, centred at 30 cm and at 40 cm. At Motunau, the private vessel harvest of sea perch was too small in either year to be able to make comparisons. The charter fleet catches looked very similar in 2009 to 2003. Although the median had shifted 1 cm smaller, there was an accumulation of larger (30–36 cm) fish evident that accounted for the slightly greater average size in 2009 (Figure 6). It is not possible to speculate whether the percentage of the catch of sea perch that was kept relates in any way to the size of the fish, as fish of any size may legally be kept, and sea perch is commonly used for bait.



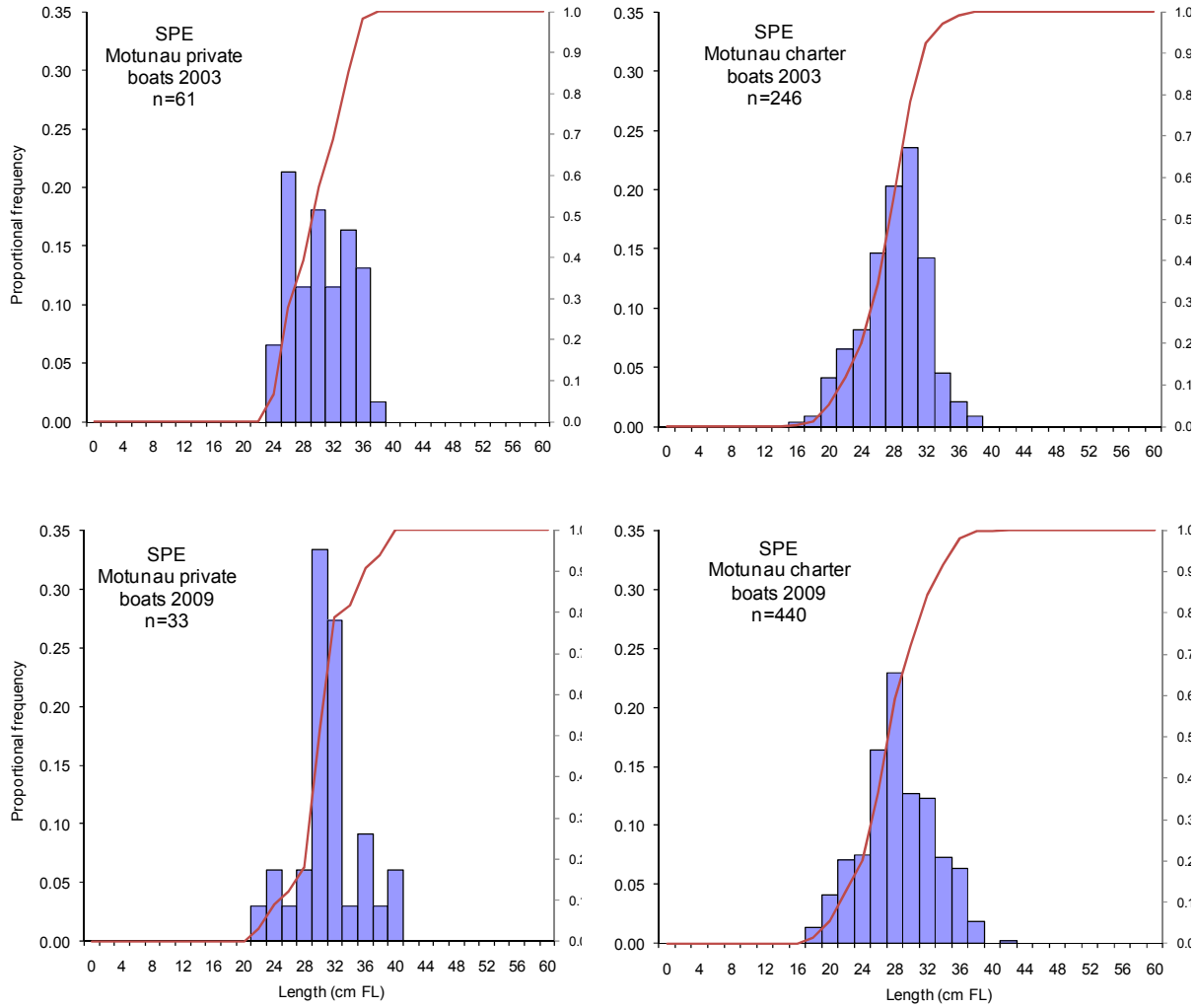


Figure 6: Length distributions (proportions and cumulative proportions) of retained sea perch on private vessels [left] and charter boats [right] fishing from Kaikoura in 2003 [top panel], and in 2009 [second panel], from Motunau in 2003 [third panel] and in 2009 [bottom panel].

3.6. Catch-rates

The observations of catch per trip collected from interviews are described alternatively as total catch per species, and in the case of blue cod, of legal catch. Because fish of any size can be returned to the water, these estimates include both fish retained and fish released and are therefore partly based on fisher recall rather than on verified harvest. These are encounter rates and describe the experience of the fisher, as distinct from harvest rates, which reflect the removals from the population. Harvest rates were used to calculate total catch.

3.6.1. Blue cod

The observations of catch per trip collected from interviews are compared between years for each stratum in Table 23 where they are described alternatively as mean catch of blue cod, and the mean catch of legal-sized blue cod caught (whether kept or released). The standard deviation of the mean legal catch per trip is greater than, or similar to, the mean in most strata and the high variance of catches understandably compromises any analysis of catch rates and catches. Catch per unit of effort (CPUE) is described by the ratio of means (average catch per trip divided by average trip duration) for

legal fish caught (whether kept or released), and the distributions of those values in each strata are plotted in Figure 7 and Figure 8. The distributions are highly skewed with the long right hand tails that are typical of catch rate data, but show distinctive differences between areas and fleets, with little difference between survey years within strata.

Catch rates of blue cod are greater at Motunau than at Kaikoura, and are also considerably greater for charter vessels than for private vessels, which is not surprising given the greater number of fishers onboard these larger vessels.

Catch rates of legal-sized blue cod from private vessels were distributed similarly in both years at Kaikoura, averaging about 0.9 per vessel-hour (Table 23), but generally less than 2 fish per hour, and reported as zero in 70% of trips (Figure 7). At Motunau, catch rates were dispersed more widely, generally reported to be between 1 and 5 fish per hour but not uncommonly up to 10 per hour. Catch rates at Motunau were 36% greater in 2009 than in 2003 (4.2 in 2009 compared with 3.1 per hour in 2003), and there were more reports of catch rates exceeding 10 fish per hour and up to 20 fish per hour. The proportion of zero catches at Motunau also declined from 30% in 2003 to less than 25% in 2009.

Legal-sized fish made up a higher proportion of the private vessel catch of blue cod in 2009 than in 2003 in both areas (Table 24) and somewhat masked a 20% decline in the total catch per trip at Kaikoura (Table 23). At Motunau there was only a slight increase in the total catch of blue cod per trip reported in 2009, but the component of the catch was that was legal-sized increased markedly (Table 23). In 2009, when fish were smaller, fishers in private vessels also reported releasing considerably more blue cod than they were legally required to do. This is in contrast to their behaviour in 2003 when most of the legal catch was retained (Table 24).

The charter fleet generally accesses larger fish and reported relatively fewer sub-legal blue cod than the private vessel fleet (Table 24), although the proportion of sub-legals increased in both areas between 2003 and 2009 in contrast to the experience of the private vessel fleet. There was very little difference between years in the average catch rates of legal-sized fish for either area, but the incidence of zero catches at Kaikoura was lower in 2009 than in 2003. The charter fleet released considerable numbers of legal fish in both years.

Analysis of the differences between years was done in log space using quasi-poisson GLMs with a log link function and described no significant declines in catch rate of legal sized fish in either area for either fleet, but confirmed the significance of the increase at Motunau of the number of legal blue cod per hour caught by private vessels.

Table 23: Comparison between years and between areas of the mean number of fish caught per vessel-trip (total and legal) by private vessel recreational vessels targeting blue cod or sea perch between January and April (competition day in 2003 not included). Std. dev. is the standard deviation of the mean catch of legal blue cod, catch rate estimate is number of legal blue cod per vessel hour (ratio of means). Results of one-way quasi-poisson GLM models with log-link, p is Pr(>t), significance of difference between years * =0.001.**

Blue cod Fleet		Survey	Mean catch (Number of fish per vessel-trip)			Catch rate (Number of fish per vessel-hour (ratio of means))		
Private	Location	Year	All fish caught	Legal fish	(Std. dev.)	Legal fish	p	Signif.
	Kaikoura	2003	4.80	2.90	(5.13)	0.92		
		2009	3.88	2.80	(5.68)	0.87	0.48	n.s
	Motunau	2003	22.57	9.87	(9.69)	3.12		
		2009	25.22	14.44	(12.78)	4.24	<0.001	***
Charter	Kaikoura	2003	22.1	20.85	(39.0)	5.42		
		2009	24.1	21.93	(17.3)	6.04	0.09	n.s.
	Motunau	2003	119.5	99.92	(58.2)	15.49		
		2009	117.2	84.65	(53.8)	14.63	0.85	n.s

Table 24: Proportion of reported catch of blue cod that was below the MLS of 30 cm, and the proportion of the total catch that was released for fleet, area and survey year.

Blue cod Fleet/Location		Survey Year	% Sub-legal	% Released
Private				
	Kaikoura	2003	40	40
		2009	28	36
	Motunau	2003	56	57
		2009	43	49
Charter				
	Kaikoura	2003	6	29
		2009	9	23
	Motunau	2003	16	38
		2009	28	39

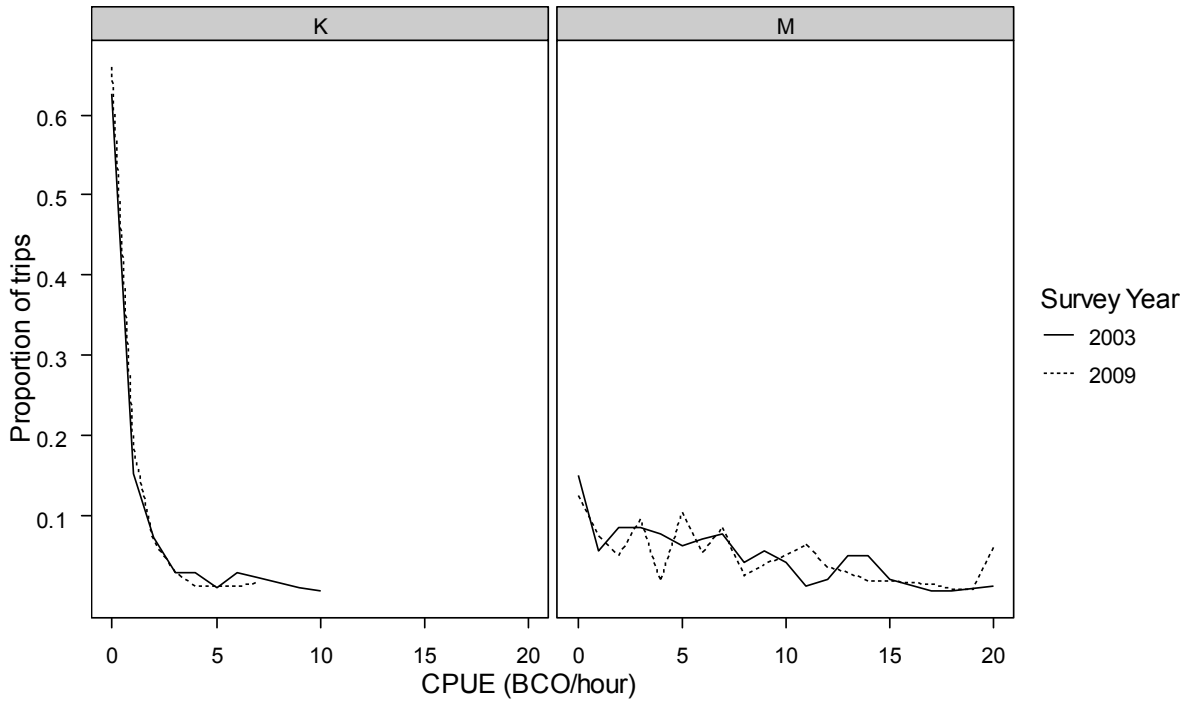


Figure 7: Distribution of catch rates (number of legal blue cod per vessel-hour) from boat ramp surveys of the private vessel fleet at Kaikoura [left] and at Motunau [right] in 2003 and 2009.

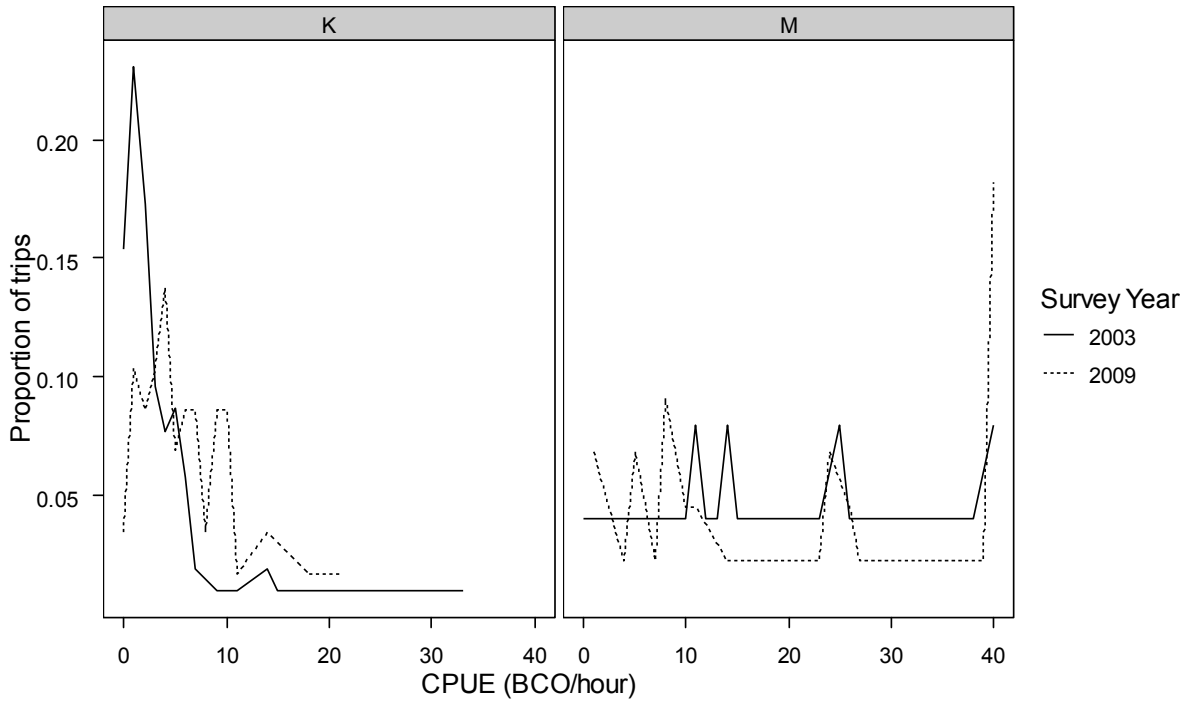


Figure 8: Distribution of catch rates (number of legal blue cod per vessel-hour) from charter vessel logbooks at Kaikoura [left] and Motunau[right] in 2003 and 2009.

3.6.2. Sea perch

The converse spatial distribution for sea perch is evident with catch rates on private vessels not uncommonly 10 or more fish per vessel-hour at Kaikoura but generally less than 2 fish per hour at Motunau (Figure 9). A higher incidence of zero catches of sea perch by the private vessel fleet at Kaikoura in 2009 than in 2003 (25% compared to 13%) drove down the mean catch from 6.1 to 5.1 fish per vessel-hour (significant at p=0.01), but the distributions of catch rates were otherwise similar between years in each area (Figure 9).

Catch rates were greater on charter vessels, and zero catches were rare (Figure 10). In contrast to the experience of the private vessel fleet, the charter fleet experienced an increase in average catch rate at Kaikoura from 8.8 in 2003 to 15.5 sea perch per hour in 2009 (Table 25). The 75% increase (significant at p=0.001) may reflect newer operators who are less able to avoid sea perch.

It is not possible to speculate whether the percentage of the catch of sea perch that was kept relates in any way to the size of the fish, as fish of any size may legally be kept for bait, and sea perch is commonly used for lobster bait (Table 26).

Table 25: Comparison between years and between areas of the mean number of sea perch caught per vessel-trip (total) by private vessels targeting blue cod or sea perch between January and April, standard deviation of the mean catch of sea perch, catch rate estimate (number of sea perch per vessel hour: ratio of means). Results of one-way quasi-poisson GLM models with log-link, Pr(>t), significance of difference between years.

Sea Perch			Mean catch (number of fish per vessel-trip)			Catch rate (number of fish per vessel-hour (ratio of means))		
Fleet		Survey						
Private	Location	Year	All fish caught	(Std. dev.)		All fish caught	p	Signif.
	Kaikoura	2003	19.0	(15.24	)	6.05		
		2009	16.6	(15.58	)	5.15	0.007	**
	Motunau	2003	5.3	(9.10	)	1.65		
		2009	4.0	(7.50	)	1.17	0.165	n.s.
Charter								
	Kaikoura	2003	32.9	(35.39	)	8.82		
		2009	56.3	(34.31	)	15.48	<0.001	***.
	Motunau	2003	50.9	(30.64	)	8.54		
		2009	43.7	(35.64	)	7.55	0.819	n.s.

Table 26: Proportion of reported catch of sea perch that was sublegal (there is no MLS for sea perch), and the proportion of the total catch that was released for fleet, area and survey year.

Sea perch Fleet/Location		Survey		
Private		Year	% sub-legal	% Released
	Kaikoura	2003	-	30.6
		2009	-	36.0
	Motunau	2003	-	54.2
		2009	-	3.3
Charter				
	Kaikoura	2003	-	21.4
		2009	-	21.6
	Motunau	2003	-	8.7
		2009	-	28.8

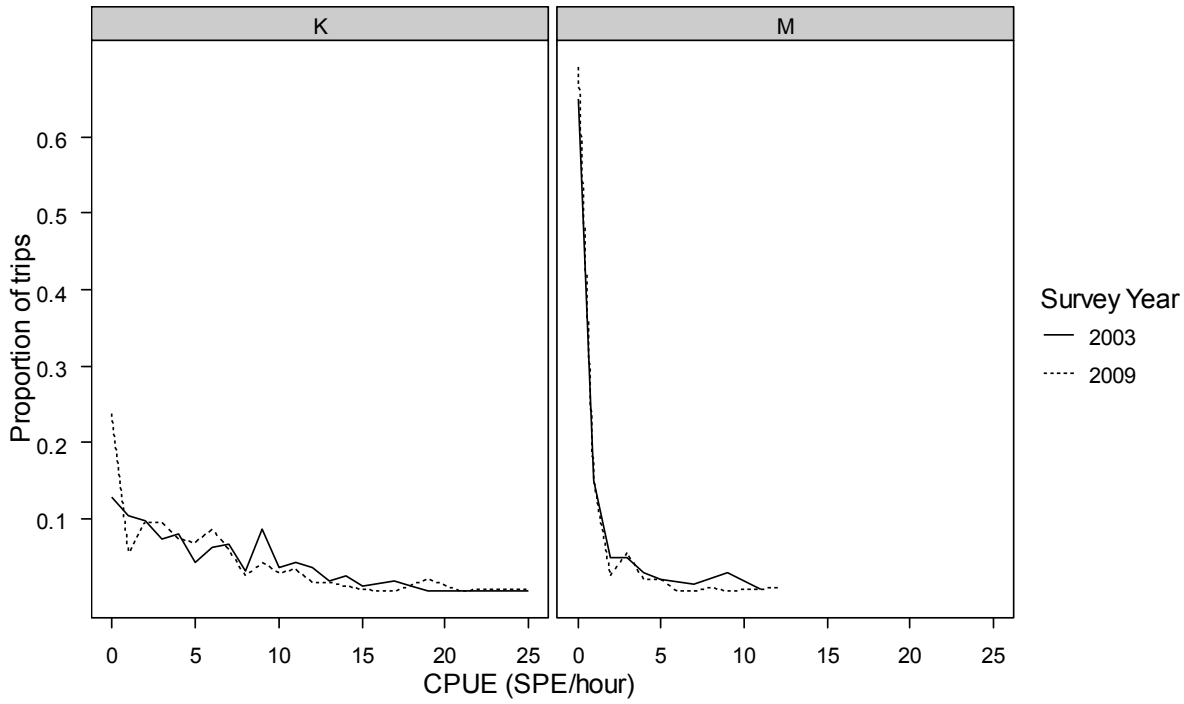


Figure 9: Distribution of catch rates (total number of sea perch per vessel-hour) of sea perch from boat ramp surveys of the private vessel fleet at Kaikoura [left] and at Motunau [right] in 2003 and 2009.

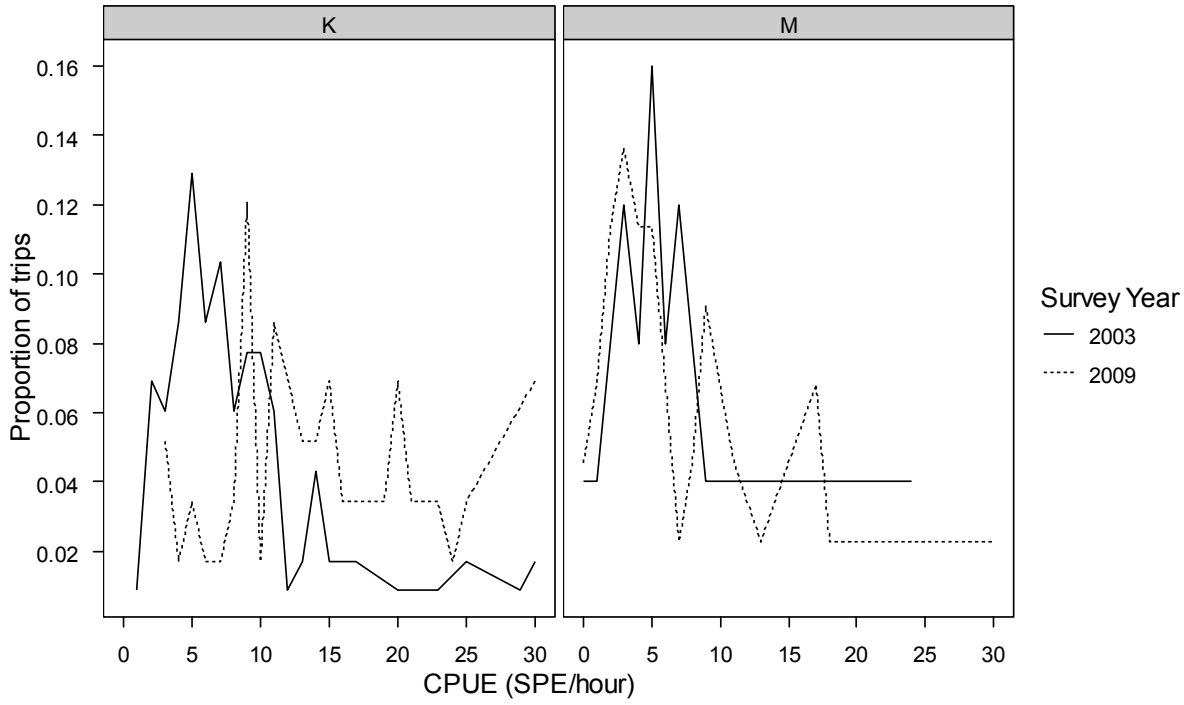


Figure 10: Distribution of catch rates (total number of sea perch per vessel-hour) of sea perch from charter vessel logbooks at Kaikoura [left] and Motunau[right] in 2003 and 2009.

3.7. Effectiveness of catch limits for blue cod

Information about the catch that was released is necessarily based on the recall of fishers and charter operators at the end of the trip. It is presented here for completeness, and because it raises some questions about the effectiveness of catch limits. These data should be interpreted with some caution.

In both 2003 and 2009 a substantial proportion (52% and 40% respectively) of the private vessel catch was returned to the water as under-sized (Figure 11). This suggests that the MLS is an effective control on landed blue cod but also implies considerable potential for handling mortalities with as many sub-legal fish being handled and released as are kept. The charter fleet released a smaller proportion of their total catch as undersized in both years reflecting the larger size of fish that these operators access. In 2003, charter vessels voluntarily returned 18% of their legal-sized fish catch as the main operator exercised his own size limit. That operator was no longer in the fishery in 2009 and the behaviour of the charter fleet changed accordingly (Figure 11).

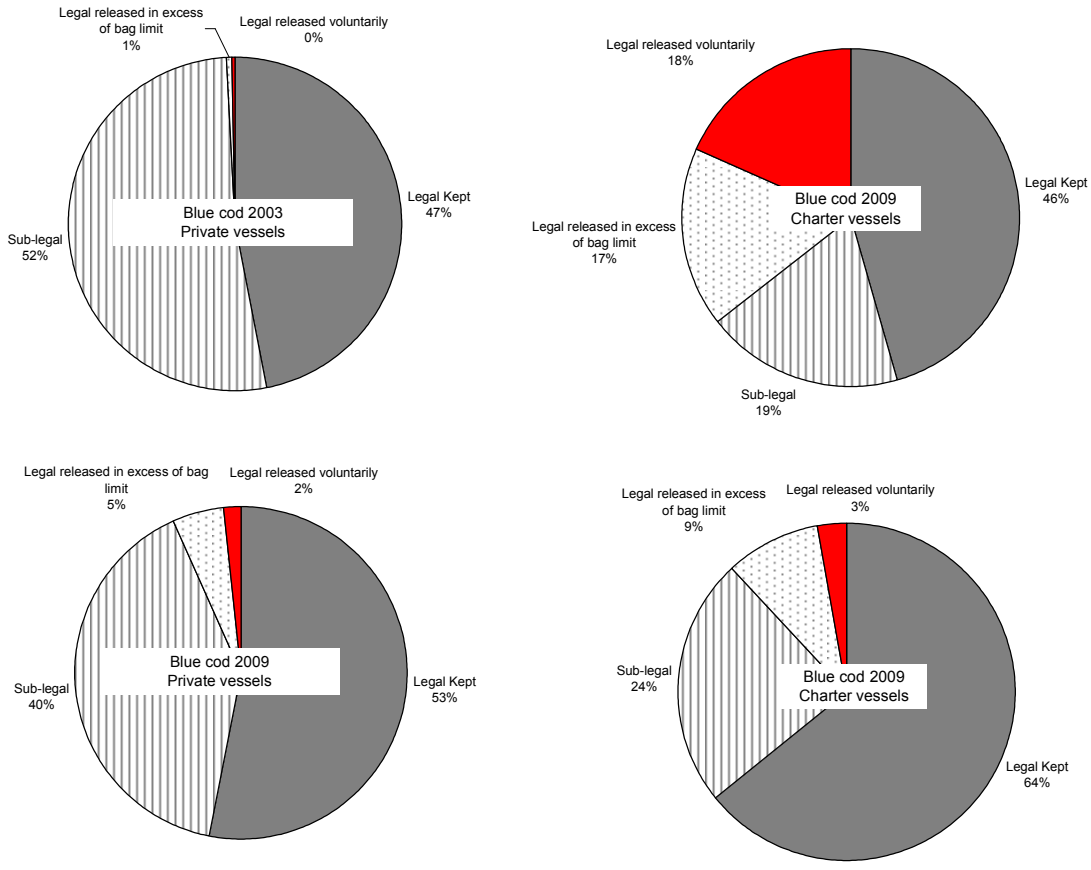


Figure 11: Proportions of blue cod kept [dark area], and released [other areas], from private vessels [left], and charter vessels [right], in 2003 [upper] and in 2009 [lower]. Fish released included undersized (sub-legal), legal fish in excess of the bag limit, and legal fish released voluntarily from vessels that retained less than the bag limit. Private vessels 2003, n=4351; charter vessels 2003, n= 5289; private vessels 2009, n=6961; charter vessels 2009, n= 6363.

A larger proportion of the catch of blue cod was legal in 2009 than in 2003 with the effect that the bag limit was invoked on a greater proportion of trips (Figure 12) and that there were some voluntary releases of legal-sized fish. These have been further defined according to whether they were in excess

of the bag limit or not, although this distinction may not describe different behaviours. Both of these aspects were almost non-existent for the private vessel fleet in 2003. The difference in proportions kept and released between 2003 and 2009 for the charter fleet probably reflects the change in operators between years.

The bag limit constrained removals in fewer than 10% of private vessel vessel-trips, slightly higher in 2009 than in 2003 (Figure 12). Charter operators achieved the vessel bag limit (10 per fisher) on 10 to 20% of trips and also returned a greater proportion of their legal catch than did private vessel anglers. This may partly explain the larger average size of their retained catch. The risk associated with high-grading is that dead fish may be returned to the water, and the effectiveness of the bag limit therefore depends on the ethic of the fisher (when the decision is made to keep or release a fish). Both MLS and MDL controls have demonstrably negative consequences when fish are small as is the case in this fishery.

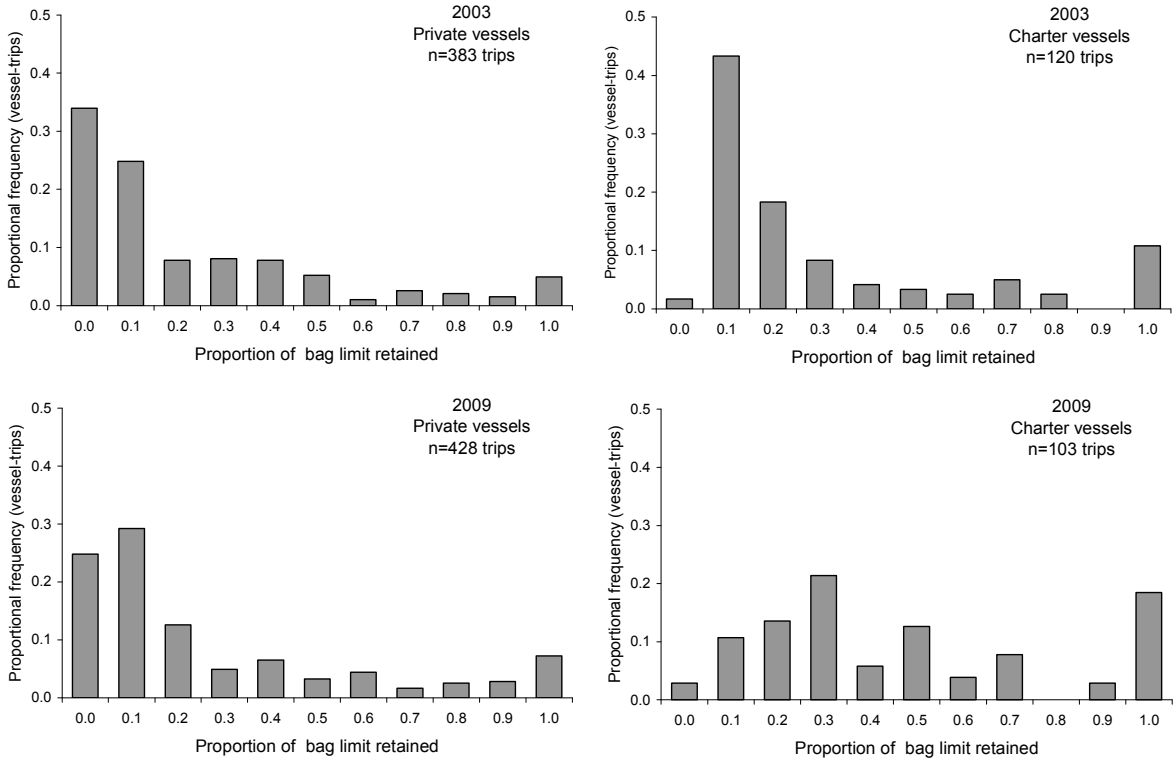


Figure 12: Distributions of harvested catch of blue cod as a proportion of vessel bag limits for private vessel [left] and charter vessels [right] in 2003 [upper] and in 2009 [lower].

3.8. Total catch (private recreational vessels)

Total removals (number of fish retained) were estimated using harvest rates obtained from boat ramp interviews, and the estimates of total effort established from trailer counts in each strata (Table 27). Precision was poor due to the variance of the daily catches (see Table 24). Mean size of the retained catch and published length-weight relationships (Appendix 6) also allowed estimates to be made of the total weight of removals (kg greenweight).

Comparison with the 2003 estimates of total removals suggests there was a 60% increase in the number of blue cod taken between 2003 and 2009, corresponding closely with the estimated increase in effort, and converting to a 40% increase in biomass because of the decline in fish size at Kaikoura.

The number of sea perch taken increased by 30% and equated to a 10% decrease in the biomass removed because of the smaller fish size in Kaikoura in 2009 (Table 28).

Table 27: Calculation of total catch retained in private vessel recreational fishing during January–April 2009: mean number of fish kept per vessel trip, mean number of hours per trip, and total vessel-hours in each stratum. Total removals (numbers of fish ± SE, and estimated greenweight kg) of blue cod and of sea perch by area.

2009		Mean fish kept per trip	Mean hours per trip	Ratio of means harvest rate (number of fish kept per vessel-hour)	Total effort (vessel-hours)	Total catch kept (numbers fish) (± SE)	Estimated Total catch kept (kg fish)
BCO (kept)	Stratum						
Kaikoura	Weekend	2.40	3.13	0.768	2 889		
	Weekday	2.72	3.45	0.788	3 536	5 008 (7 299)	3 785
Motunau	Weekend	12.95	3.41	3.804	1 915		
	Weekday	3.00	3.88	0.774	344	7 550 (6 927)	5 033
SPE (kept)							
Kaikoura	Weekend	10.04	3.13	3.207	2 889		
	Weekday	12.00	3.45	3.480	3 536	21 570 (17 490)	8 128
Motunau	Weekend	2.07	3.41	0.607	1 915		
	Weekday	0.00	3.88	0.00	344	1 162 (2 432)	563

Table 28: Estimated total removals of blue cod and sea perch by private vessel recreational fishing in January–April for 2003 (reworked), and in 2009. Relevant effort ± SE, numbers of fish kept ± SE, estimated greenweight removed (kg).

Species	Survey year	Total effort (vessel-hours ± SE)	Number of fish kept (± SE)	Estimated Greenweight of fish kept (kg)
BCO	2003	5 021 (571)	7 781 (5 917)	5 999
	2009	8 684 (1 459)	12 558 (10 062)	8 818
SPE	2003	5 021 (571)	17 501 (12 504)	9 181
	2009	8 684 (1 459)	22 732 (17 658)	8 691

4. DISCUSSION

This survey monitored changes in recreational catch rates and changes in harvest size distribution for blue cod and sea perch in the North Canterbury – Kaikoura area by surveying boat ramps at Motunau and Kaikoura.

The emphasis of the survey design was on obtaining total coverage of line fishing effort along the coast targeted at blue cod and/or sea perch, as well as obtaining length measurements for the harvest of both species. Harvest rate estimates were used to estimate total removals for each species.

While harvest rates can be verified by counting the catch retained at the boat ramp, this statistic does not tell us much about the fishery in a fishery where fishers are voluntarily releasing part of their legal catch. Interviews were used to obtain estimates of actual catch rate, and of the proportion of catch that was legal-sized (in the case of blue cod). The bias associated with fisher recall was not evaluated.

4.1. Survey results

Sampling of 42 days covered more than 78% of weekend effort and almost 16% of weekday effort for the period January to April 2009 and the anticipated number of relevant interviews (targeted BCO or SPE) was exceeded by 30%. The recommended number of fish measured (150 of each species) was exceeded in both Kaikoura and Motunau.

The estimates of total effort describe a large (more than 100%) increase between 2003 and 2009 in private vessel effort targeted at blue cod or sea perch at Kaikoura, and a smaller increase at Motunau (20%). The relative importance of the two areas (74% and 26% respectively) confirms a continuing shift in the relative importance of effort towards Kaikoura. The distribution of effort by day type at Kaikoura had shifted to a higher proportion of weekday effort in 2009 than in 2003 but was unchanged at Motunau.

The increase in private vessel effort was also evident in boat ramp usage at Kaikoura which changed from being dominated by two main ramps (Boat Club and Public Ramp) to the increased use of a third ramp at Boat Harbour (accounting for 25% of effort in 2009). There was also a higher number of vessel retrievals observed, and more trailers removed off-site as parking space became saturated. This required that a correction be made to the trailer counts used for total effort that was not deemed necessary in 2003. The proportion of vessels that were launched for purposes other than fishing for blue cod or sea perch (for example potting for rock lobster or skiing) was also greater in 2009 and was adjusted out of the daily effort estimates.

The average size of retained blue cod at Kaikoura declined significantly by 4 cm between 2003 and 2009. This represents the difference between a fish of over 1 kg greenweight in 2003 to 0.75 kg in 2009. There was no similar decline at Motunau, but the distinction observed in 2003 of blue cod at Kaikoura being considerably larger on average than those from Motunau has been lost with the decline in fish size at Kaikoura. The length distributions show some loss of large size classes, and a pulse of more recently recruited fish that was available to fishers in 2009. There is little evidence of any previous recruitments having accumulated to provide larger fish to anglers.

The mean size of the retained catch of sea perch also declined significantly by about 3 cm in Kaikoura and was unchanged at Motunau. There is no minimum legal size for sea perch and small fish are often retained for bait, but the length frequencies suggest that there has been a shift of the whole size distribution towards smaller fish available and smaller fish being retained.

Catch rates were not estimated with precision and are subject to bias because they are based on fisher recall, but the proportion of the catch of blue cod that was above legal-size appears to have increased (despite the average size of the retained catch having declined) and that is corroborated by a decline in zero catches, an increase in the number of trips that caught the bag limit, and an increase in the proportion of legal fish reported to have been released by fishers on private vessels. The increase in the number of legal (albeit small) fish, when considered alongside the decline in the total catch per hour, points to a recent recruitment to the fishery that has maintained catch rates but that may not continue to sustain them in the near future.

The estimates of total catch were based on harvest rates (fish retained) and therefore represent actual removals, however the calculation of confidence intervals around the estimate is large and the statistic for the lower limit is less than zero, which is obviously unrealistic.

Catch rates and size distributions from charter vessel logbooks were contradictory in some aspects to the boat ramp survey results but this is understandable given the underlying differences in catch by fleet, and the large turnover of operators between survey years. For example, a significant increase in the catch rate of legal sized blue cod at Motunau by private vessels largely consisted of fish around 34 cm F.L. The charter fleet catch was made up of larger fish and no similar increase was detected.

Conversely, an increase in the number and size of sea perch caught by charter vessels at Kaikoura was in contrast to the experience of the private vessel fleet, but was more likely to reflect different fishing practices due to the almost complete turnover of operators, than a change in the underlying population of sea perch.

Logbook data collected in 2009 do not reflect the increased effort by charter vessels in 2009 that was evident to surveyors and coverage and representativeness of this sector must be considered to be inadequate.

4.2. Implications

It appears that catch rates of blue cod have been maintained, despite the large increase in effort, by recent good recruitment. However, almost half of the catch by private anglers was made up of sub legal fish, much of the legal catch likewise was made up of small fish, and there is no evidence of any accumulation of larger fish from earlier recruitments. Recreational catch limits for blue cod (MLS and MDL) each have biologically deleterious effects in a fishery consisting mostly of small fish. The MLS means that almost half the catch is returned to the water and is therefore subject to handling mortality (which could be as high as 100%, although it is probably much lower), and the MDL is either not constraining the fishery because it is rarely achieved (as in 2003), or, when abundance increases (as at Motunau in 2009), encourages high grading that may see dead fish returned to the water.

If recruitment is not maintained at previous high levels, it is likely that catch rates; of both total and legal-sized fish will decline. There is not a large range of alternative species available to line fishers on this coast and this is likely to erode the experience of the amateur fisher.

4.3. Recommendations for future surveys

Advice from the previous study (that 35 days sampling would be adequate to obtain 300 relevant interviews necessary to detect a 20% change in catch rate) was based on treating the survey area as a single area, but the results of this study suggest that changes in catch rate need to be monitored separately for Kaikoura and for Motunau. Based on 2009 intercept rates, at least 37 days sampling at Kaikoura and 20 days at Motunau would have been necessary to obtain 300 relevant interviews for each area. This may have compromised the ability to detect changes in catch rate as the variance of catches was large, however, a 36% increase in legal blue cod catch per hour by private vessels at Motunau (significant at $p=0.001$), and a 17% decline in average catch per vessel-hour of sea perch at Kaikoura (significant at $p=0.01$) were detected.

The actual intercept rates achieved in Kaikoura in 2009 are given for each boat ramp (Table 7) to inform the design for the next survey. The main difference from the 2003 intercept rates, was the increased use of Boat Harbour in 2009. Results suggest that it should be assigned about a quarter of the wait time on Kaikoura sampling days next survey, although it should be noted that use of this ramp is somewhat tide and weather (swell) dependent. Also, the advice given in Hart & Walker (2004) that the Pier Slipway might best be dropped from the bus route is reiterated this study.

A positive adjustment for trailers kept off-site is needed given the observed overflow from full boat ramp parking areas and future surveys should revert to an earlier start time if the survey is to be considered suitable for estimating recreational catch of rock lobster.

A review of the methods led to some changes being made retrospectively to the 2003 estimates of effort, in particular the way the correction was done for effort prior to survey start, and to the confidence intervals around total effort estimates. Some statistics reported in this report may therefore

differ slightly from what was reported in Hart & Walker (2004). However, the resultant confidence bounds around estimates of total catch are unrealistic (in that the lower bound is less than zero), and it may be worthwhile to explore appropriate asymmetrical error distributions in future studies.

The Working Group discussed how changes in gear (specifically with respect to the increased use of soft baits) may have under, or over estimated catch and concluded that future surveys should also endeavour to collect information on gear type/gear changes through time.

5. ACKNOWLEDGMENTS

Thanks to our team of surveyors who were consistent and reliable for the entire survey period, and to the charter operators who took part despite an already impressive workload. Thanks to members of the Marine Amateur Fisheries Working Group who made useful suggestions, particularly David Middleton, and to Nokome Bentley who gave helpful advice and reviewed a previous version of this report.

6. REFERENCES

Blackwell, R.G. (1997). Abundance, size composition, and sex ratio of blue cod in the Marlborough Sounds, September 1995. New Zealand Fisheries Data Report No. 39. 79 p. (Unpublished report held in NIWA library, Wellington.)

Bradford, E.; Fisher, D.; Bell, J. (1998). National marine recreational fishing survey 1996: snapper, kahawai, and blue cod length distributions from boat ramp and diary surveys. NIWA Technical Report 19. (Unpublished report held in NIWA library, Wellington.)

Carbines, G.D. (2001). Movement patterns and stock mixing of the blue cod in Southland. Final report to the Ministry of Fisheries for project BCO9702. (Unpublished report held by Ministry of Fisheries, Wellington.)

Carbines, G.; Beentjes, M.P. (2006a). Relative abundance of blue cod in North Canterbury in 2004 and 2005. *New Zealand Fisheries Assessment Report 2006/30*. 26p.

Carbines, G.D.; Beentjes, M.P. (2009). Relative abundance, size and age structure, and mortality of blue cod in north Canterbury (BCO 3) in 2007/08. *New Zealand Fisheries Assessment Report 2009/37.*

Hart, A.M.; Walker, N.A. (2004). Monitoring the recreational blue cod and sea perch fishery in the Kaikoura – North Canterbury area. *New Zealand Fisheries Assessment Report 2004/45*. 30 p.

Hoenig, J.M.; Jones, C.M.; Pollock, K.H.; Robson, D.S.; Wade, L.W. (1997). Calculation of catch rate and total catch in roving surveys of anglers. *Biometrics 53:* 306–317.

Jones, C.M.; Robson, D.S. (1991). Improving precision in angler surveys: traditional access design versus bus route design. *In:* Guthrie, D.; Hoenig, J.M.; Holliday, M.; Jones, C.M.; Mills, M.J.; Moberly, S.A.; Pollock, K.H.; Talhelm, D.R. (eds). Creel and angler surveys in fisheries management. *American Fisheries Society Symposium. 12*: 177–188.

Jones, C.M.; Robson, D.S.; Lakkis, H.D.; Kressel, J. (1995). Properties of catch rates used in analysis of angler surveys. *Transactions of the American Fisheries Society 124*: 911–928.

Kendall, M. G.; Stuart, A. (1969).The Advanced Theory of Statistics, Vol. 1. Distribution Theory. P.232. Charles Griffin, London.

Ministry of Fisheries (2010). Report for the Fishery Assessment Plenary, May 2010: stock assessments and yield estimates. Ministry of Fisheries 1158 p. (Unpublished report held in NIWA library, Wellington.)

Neter, J.; Wasserman, W.; Whitmore, G.A. (1988). Applied Statistics. 3rd edition. Allyn and Bacon, Boston. 1006 p.

Pollock, H.K.; Hoenig, J.M.; Jones, C.E.; Robson, D.S.; Greene, C.J. (1997). Catch rate estimation for roving and access point surveys. *North American journal of Fisheries Management 17*: 11–19.

Pollock, H.K.; Jones, C.E.; Brown, T.L. (1994). Angler survey methods and their application in fisheries management. *American Fisheries Society Special Publication 25*.

Schofield, K.A.; Livingston, M.E. (1996) Trawl surveys of hoki and middle depth species on the Chatham Rise, January 1996 (TAN9601). NZ Fisheries Data Report No 71. 50 p. (Unpublished report held in NIWA library, Wellington.)

Starr, P.J.; Kendrick, T.H. (2010). Report to Southeast Finfish Management LTD: Review of the BCO 3 fishery characterisation and CPUE analysis for BCO 3. 56 p. (Unpublished report held by NZ Seafood Industry Council, Wellington).

Starr, P.J.; Kendrick, T.H.; Bentley, N.; Lydon, G. (2008). Report to the Adaptive Management Programme Fishery Assessment Working Group: Review of the SPE 3 Adaptive Management Programme: AMP WG/08/08 82 p. Unpublished manuscript available from the NZ Seafood Industry Council, Wellington.

Sumner, N.R.; Williamson, P.C.; Malseed, B.E. (2002). A 12 month survey of recreational fishing in the Gascoyne bioregion of Western Australia during 1998–99, Fisheries Research Report no. 139, Department of Fisheries, Western Australia, 54p.

Walker, N. (1999). Charter Operator Logbook Database DIN: P099010/07: Unpublished Technical Document held by Trophia Limited.

7. APPENDICES

APPENDIX 1: EXAMPLE BUS ROUTE SCHEDULE

Direction: 0=down
1=up

					Travel Times		
Identifier	Boat Ramp	Effort Weighting	Minutes	**Time spent at Boat Ramp**	Identifier	Times North	Times South
1	Boat Harbour	0.02	8	0:08	1	0:25:00	0:10:00
2	Pier Slipway	0.02	8	0:08	2	0:05:00	0:25
3	Armers Beach	0.08	33	0:32	3	0:10:00	0:05:00
4	Public Ramp	0.45	185	3:04	4	0:05:00	0:10:00
5	Boat Club	0.35	144	2:23	5	0:15:00	0:05:00
6	Barney's Rock	0.08	33	0:32	6	0:10:00	0:15:00
		1.00	410.00	6:47		1:10:00	1:10:00

Sample Day		**Direction***	**Start Boat Ramp**	**Start times**	**Depart Times**
31	Sunday, 8 March 2009	0	2	10:00 a.m.	10:08 a.m.
			1	10:33 a.m.	10:41 a.m.
			6	10:51 a.m.	11:23 a.m.
			5	11:38 a.m.	2:01 p.m.
			4	2:06 p.m.	5:10 p.m.
			3	5:20 p.m.	6:00 p.m.

APPENDIX 2: SESSION AND INTERVIEW QUESTIONNAIRES USED IN THE BOAT RAMP SURVEYS

Session sheet

BCO/SPE Boat ramp survey

Session cover sheet

Survey Code

Interviewer

Date:	

Start time:	
Finish time:	

Ramp:	WB	R	AB	PB	BC	GB	
Vantage Point:			KP	RL	HB		
Vantage Point Counts		1					
		2					

 # boat trailers at:

Session Start | Middle of Session | Session Finish

Tides and Moon

	Time	Level
Low tide	: am/pm	.
High tide	: am/pm	.
Moon phase		

Weather conditions

Sea state:	1	0.1–0.5	2	0.5–1.0
	3	1.0–2.5	4	2.5–4.0
Rain:	1	Nil	2	Light, continuous
	3	Light, scattered	4	Medium, scattered
Overhead:	1	Sunny, continuous	2	Mainly sunny
	3	Mainly cloudy	4	Cloudy, continuous
Wind speed	1	Nil	2	Light (1-10 knots)
	3	Medium (11-20 knots)	4	Strong (21+ knots)

Wind direction: N, NE, E, SE, S, SW, W, NW, Nil, Variable

Boat Launches				**Boat Retrievals**			
Time	**Time**	**Time**	**Time**	**Time**	**Time**	**Time**	**Time**

Boat Trailers Removed off site (Y/N)				**Boat Trailers Retrieved off site (Y/N)**			

Interview sheet

BCO/SPE Boat ramp survey **Session #**

INTERVIEW ONE	INTERVIEW TWO
Intercept time : am/pm	Intercept time : am/pm
Outcome I R N O Z X	Outcome I R N O Z X
# Fishers # males # females	# Fishers # males # females
Age group 1 15-20, 2 21-30, 3 31-40, 4 41-50, 5 51-60, 6 61+	Age group 1 15-20, 2 21-30, 3 31-40, 4 41-50, 5 51-60, 6 61+
Days fished in last year	Days fished in last year
Fishing zone	Fishing zone
Target species	Target species
Method	Method
# rods	# rods
#hooks per rod	#hooks per rod
Burley Yes No	Burley Yes No
Fishfinder Yes No	Fishfinder Yes No
Fish start time : am/pm	Fish start time : am/pm
Fish finish time : am/pm	Fish finish time : am/pm
Time not fishing (hrs) .	Time not fishing (hrs) .

Catch

Species Code	# Retained	# Legal Released	# Not Legal Released
B C O / S P E			

LENGTHS

B C O Length (cm)	S P E Length (cm)

Catch

Species Code	# Retained	# Legal Released	# Not Legal Released
B C O / S P E			

LENGTHS

B C O Length (cm)	S P E Length (cm)

APPENDIX 3: CROSS-REFERENCES OF THE ELEMENTS OF THE TROPHIA BCO/SPE SURVEY LOGBOOK WITH THE TABLES AND ATTRIBUTES OF THE *REC_DATA* DATABASE

Trophia Survey Logbook	MFish *rec_dat* database	
	Primary table	Attribute(s)
Session Cover Sheet		
Session #	t_session	sess_no
Survey code		Survey
Date	"	sess_date
Start time	"	sess_time_s
Finish time	"	sess_time_f
Boat trailers (start, middle, finish)	"	trailer_s, trailer_m, trailer_f
Tides and Moon (low, high, moon phase)	"	low_tide, high_tide,moon
Weather conditions	"	"various"
Boat launches, Boat retrievals	"	boats_not_iv
Boat Ramp Survey Sheet		
Intercept time	t_group	time_i
Number of fishers (total, male, female)	"	no_fishers, no_males, no_females
Age group	t_interview	age_gp
Days fished in previous year	"	days_per_period
Fishing zone (as used in KAI99 survey)	"	fish_zone
Target Species	"	target_spp
Methods (codes from t_fish_methods)	"	fish_meth
# rods, hooks, burley, fishfinder	"	"various"
Fish start time	"	fish_time_s
Fish finish time	"	fish_time_f
Time not fishing	"	not_fish_t
Catch - Species code	t_length	species
- # retained, legal released, not legal released (add together = TOTAL)	"	no_fish
Lengths	"	lgth

APPENDIX 4: CHARTER OPERATOR LOGBOOK

Charter Operator Logbook

Operator Number

Fill in a new column for each new trip, each new zone fished within a trip, and each method used (catch from each trip, zone, and method to be separated). Always enter the Date, Zone, Trip time, Methods used and Catch. Enter the sizes of retained catch where time permits.

TRIP		ZONE		METHOD			
Date				L	LL	N	
				N	P	D	
day	month	year					
Trip time	Start		am/pm				
	End		am/pm				
Total # of fishers	NZ		Overseas				
Effort	# Rods						
Line (L)	# Hooks per rod						
	Fishing time (hrs)						
Longline (LL)	# Hooks						
	Fishing time (hrs)						
Net (N)	Length (m)						
	Fishing time (hrs)						
Pots (P)	# pots						
	Pot time (hrs per pot)						
Diving (D)	# divers						
	Time (hrs per diver)						
Other (describe)							
	(hrs)						

Catch Species Code	# Retained	# Legal Released	# Not Legal Released

TRIP		ZONE		METHOD			
Date				L	LL	N	
				N	P	D	
day	month	year					
Trip time	Start		am/pm				
	End		am/pm				
Total # of fishers	NZ		Overseas				
Effort	# Rods						
Line (L)	# Hooks per rod						
	Fishing time (hrs)						
Longline (LL)	# Hooks						
	Fishing time (hrs)						
Net (N)	Length (m)						
	Fishing time (hrs)						
Pots (P)	# pots						
	Pot time (hrs per pot)						
Diving (D)	# divers						
	Time (hrs per diver)						
Other (describe)							
	(hrs)						

Catch Species Code	# Retained	# Legal Released	# Not Legal Released

Measure as many retained Blue Cod (BCO) and Sea Perch (SPE) as possible. Measure fish in cm or mm from the tip of the nose to the tail fork (or tail tip if no fork).

TRIP ONE SIZES

B C O Length (cm)	S P E Length (cm)

TRIP TWO SIZES

B C O Length (cm)	S P E Length (cm)

APPENDIX 5: EFFORT, CATCH, AND CATCH RATE EQUATIONS

Estimation of total effort

The fishing effort (vessel hours) for sample day *m* in Kaikoura was estimated by the method of Jones & Robson (1991) as follows:

$$e_m = fT\sum_i^n \left[\left(\frac{1}{w_i} \right) \sum_j X_{ij} \right] \tag{1}$$

where T is the time taken to complete the bus route, (varied depending on weather, but generally between 9 and 11 hours), n is the number of boat ramps (6), w_i is the interviewer wait time at boat ramp i, X_{ij} is the time trailer j spends at boat ramp i during the sample session.

A correction factor (Sumner et al. 2002) was used to adjust the effort for fishing that occurred before the morning shift commenced at time t:

$$f = \frac{\sum_j \left(r_j - L_j \right)}{\sum_j b_j} \tag{2}$$

where

$$b_j = \begin{cases} r_j - t, & L_j < t \\ r_j - L_j, & L_j \geq t \end{cases}$$

r_j is the retrieval time for boat j and L_j is the launch time for boat j.

The fishing effort (vessel hours) for sample day *m* in Motunau was estimated as follows:

$$e_m = \sum_i^n L_i \tag{3}$$

where L_i is the effort (in hours) of fishing trip i, and n is the total number of fishing trips.

The estimated variance $V(\bar{e}_k)$ within stratum k (k = 4; 2 locations x weekend/weekday) is calculated as follows (Pollock et al. 1994):

$$s_k^2 = \frac{1}{n_k - 1} \sum_{m=1}^{n_k} \left(e_{km} - \bar{e} \right)^2 \tag{4}$$

where n_k is the sample size (days) for stratum k, e_{km} is the effort for stratum k on day m and $\bar{e}_k$ is the mean daily fishing effort (in hours and fishing trips) for stratum k.

The variance associated with the estimate of the mean, with finite population correction (Neter et al. 1988) is:

$$V(\bar{e}_k) = \frac{s_k^2}{n_k}\left(\frac{N_k - n_k}{N_k}\right) \tag{5}$$

where is N_k is the total number of days in stratum k.

The total effort for stratum k is estimated as:

$$\hat{E}_k = \frac{N_k}{n_k}\sum_{m=1}^{n_k} e_{km} \tag{6}$$

The variance associated with $\hat{E}_k$ is estimated by:

$$V(\hat{E}_k) = N_k^2 V(\bar{e}_k) \tag{7}$$

The standard error is calculated by the usual method:

$$SE(\hat{E}_k) = \sqrt{V(\hat{E}_k)} \tag{8}$$

The total effort is estimated by summing the effort for each strata as follows:

$$\hat{E} = \sum_{k=1}^{n} \hat{E}_k \tag{9}$$

where n is the number of strata.

Similarly, the variance of $\hat{E}$ is estimated as:

$$V(\hat{E}) = \sum_{k=1}^{n} V(\hat{E}_k) \tag{10}$$

The standard error of $\hat{E}$ is calculated by the usual method:

$$SE(\hat{E}) = \sqrt{V(\hat{E})} \tag{11}$$

Estimation of catch rate and total catch

The ratio-of-means catch rate for each stratum ($\hat{H}_k$) is estimated as:

$$\hat{H}_k = \frac{\bar{c}_k}{\bar{L}_k} = \frac{\sum_{j=1}^{n_k} c_{kj}/n_k}{\sum_{j=1}^{n_k} L_{kj}/n_k} \tag{12}$$

where n_k is the number of vessels in stratum k where the catch was recorded, c_{jk} is the catch for boat j in stratum k, and L_{jk} the effort, in hours, for boat j in stratum k.

The variances for $\bar{c}_k$ and $\bar{L}_k$ can be calculated by the usual method described in (4) and (5) without the finite population correction factor.

Variance of $\hat{H}_k$ is estimated using the formulae of Kendall & Stuart (1969):

$$\hat{V}(\hat{H}_k) = \hat{H}_k^2 \left(\frac{s_y^2}{\bar{y}^2} + \frac{s_x^2}{\bar{x}^2} - \frac{2Cov(\bar{y},\bar{x})}{\bar{y}\bar{x}} \right) \quad (13)$$

The covariance term was assumed to be zero. The total catch for stratum *k* is estimated as:

$$\hat{C}_k = \hat{E}_k \hat{H}_k \quad (14)$$

The variance was estimated using the formula described in Kendall & Stuart (1969):

$$V\left(\hat{C}_k\right) \approx \hat{C}_k^2 \left(\frac{V(\hat{E}_k)}{\hat{E}_k^2} + \frac{V(\hat{H}_k)}{\hat{H}_k^2} + \frac{2Cov(\hat{E}_k,\hat{H}_k)}{\hat{E}_k \hat{H}_k} \right) \quad (15)$$

where the covariance term is assumed to be 0.

The total catch was estimated by summing the catch for each strata as follows:

$$\hat{C} = \sum_{k=1}^{n} \hat{C}_k \quad (16)$$

The variance of $\hat{C}$ is estimated as:

$$V(\hat{C}) = \sum_{k=1}^{n} V(\hat{C}_k) \quad (17)$$

The standard error of $\hat{C}$ is estimated by the usual method:

$$SE(\hat{C}) = \sqrt{V(\hat{C})} \quad (18)$$

APPENDIX 6: LENGTH (CM) –WEIGHT (G) RELATIONSHIPS FOR BLUE COD AND SEA PERCH

Common name	Scientific name	Equation	Source for equation
Blue cod	*Parapercias colias*	$W=1.02\times10^{-2}L^{3.123}$	Blackwell (1997)
Sea Perch	*Helicolenus percoides*	$W=7.767\times10^{-3}L^{3.219}$	Schofield & Livingston (1996)