Ministry for Primary Industries
Manatū Ahu Matua

# Report from the Fisheries Assessment Plenary, May 2012: stock assessments and yield estimates

## Part 3: Red Gurnard to Yellow-eyed Mullet

Compiled by

Ministry for Primary Industries
Fisheries Science Group

May 2012

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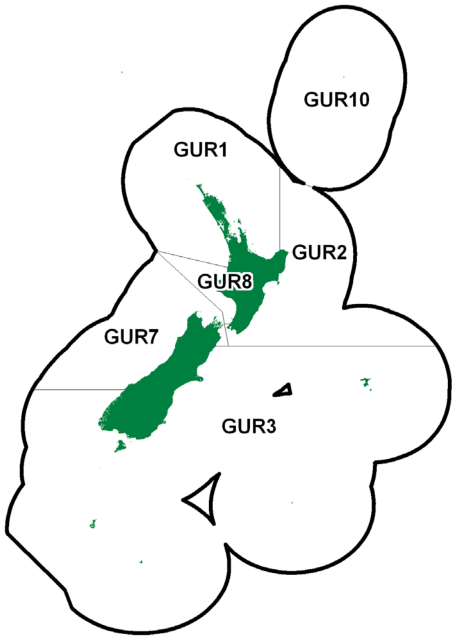
**Ministry for Primary Industries**
**May 2012**

# RED GURNARD (GUR)

(*Chelidonichthys kumu*)
Kumukumu




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

Red gurnard are a major bycatch of inshore trawl fisheries in most areas of New Zealand, including fisheries for red cod in the southern regions and flatfish on the west coast of the South Island (WCSI) and in Tasman Bay. They are also directly targeted in some areas. Some minor target fisheries for red gurnard are known in Pegasus Bay, off Mahia and off the west coast South Island. Red gurnard is also a minor bycatch in the jack mackerel trawl fishery in the South Taranaki Bight. Up to 15% of the total red gurnard catch is taken by bottom longline and setnet.

Red gurnard was introduced into the Quota Management System (QMS) in 1986. The 1986 TACCs were based on 1984 landings for Southland and 1983 landings for other regions. TACCs for GUR 3 and 7 were increased by 76 t (14%) and 137 t (20%) respectively for the 1991-92 fishing year under the Adaptive Management Programme (AMP), to 600 t in GUR 3 and to 815 t in GUR 7. The GUR 7 TACC was reduced to 678t, in 1997-98. For the 2009-10 fishing season, the TACC in GUR 7 was increased from 681 t to 715 t, including an allocation of 10 t for customary, 20 t for recreational use, and 14 t allocation for other sources of mortality. The TACC for GUR 3 was increased, by 300 t (50%) to 900 t, for the 1996-97 fishing year under the AMP, but decreased to 800 t in 2002-03. For the 2009-10 fishing season, the TACC for GUR 3 was increased from 800 t to 900 t, including a 3 t, 5 t, and 45 t allocation for customary, recreational, and other sources of mortality respectively. All AMP programmes ended on 30 September 2009.

Recent reported landings and actual TACCs by Fishstock are shown in Table 1, while Figure 1 depicts the historical landings and TACC values for the main GUR stocks.

Annual landings of GUR 1 have been relatively stable since 1986-87, generally ranging between 900 and 1300 t; substantially lower than the 2287 t TACC. About 60% of the GUR 1 total is taken from FMA 1, as a bycatch of a number of fisheries including inshore trawl fisheries for snapper, John dory and tarakihi. The remaining 40% is taken from FMA 9, mainly as a bycatch of the snapper and trevally inshore trawl fisheries.

GUR 2 landings have fluctuated within the range of 400-700 t since 1991-92, typically well below the TACC. In addition to the target fishery off Mahia, red gurnard are taken as a bycatch of the tarakihi, trevally and snapper inshore trawl fisheries.

**Table 1: Reported landings (t) of red gurnard by Fishstock from 1983-84 to 2010-11 and actual TACCs (t) from 1986-87 to 2010-11. The QMS data is from 1986-present.**

| Fishstock | GUR 1 | | GUR 2 | | GUR 3 | | GUR 7 | |
|---|---|---|---|---|---|---|---|---|
| QMA (s) | 1 & 9 | | 2 | | 3, 4, 5 & 6 | | 7 | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84* | 2 099 | - | 782 | - | 366 | - | 468 | - |
| 1984-85* | 1 531 | - | 665 | - | 272 | - | 332 | - |
| 1985-86* | 1 760 | - | 495 | - | 272 | - | 239 | - |
| 1986-87 | 1 021 | 2 010 | 592 | 610 | 210 | 480 | 421 | 610 |
| 1987-88 | 1 139 | 2 081 | 596 | 657 | 386 | 486 | 806 | 629 |
| 1988-89 | 1 039 | 2 198 | 536 | 698 | 528 | 489 | 479 | 669 |
| 1989-90 | 916 | 2 283 | 451 | 720 | 694 | 501 | 511 | 678 |
| 1990-91 | 1 123 | 2 284 | 490 | 723 | 661 | 524 | 442 | 678 |
| 1991-92 | 1 294 | 2 284 | 663 | 723 | 539 | 600 | 704 | 815 |
| 1992-93 | 1 629 | 2 284 | 618 | 725 | 484 | 601 | 761 | 815 |
| 1993-94 | 1 153 | 2 284 | 635 | 725 | 711 | 601 | 469 | 815 |
| 1994-95 | 1 054 | 2 287 | 559 | 725 | 685 | 601 | 455 | 815 |
| 1995-96 | 1 163 | 2 287 | 567 | 725 | 633 | 601 | 382 | 815 |
| 1996-97 | 1 055 | 2 287 | 503 | 725 | 641 | 900 | 378 | 815 |
| 1997-98 | 1 015 | 2 287 | 482 | 725 | 477 | 900 | 309 | 678 |
| 1998-99 | 927 | 2 287 | 469 | 725 | 395 | 900 | 323 | 678 |
| 1999-00 | 944 | 2 287 | 521 | 725 | 411 | 900 | 331 | 678 |
| 2000-01 | 1 294 | 2 287 | 623 | 725 | 569 | 900 | 571 | 678 |
| 2001-02 | 1 109 | 2 287 | 619 | 725 | 717 | 900 | 686 | 681 |
| 2002-03 | 1 256 | 2 287 | 552 | 725 | 888 | 800 | 793 | 681 |
| 2003-04 | 1 225 | 2 287 | 512 | 725 | 725 | 800 | 717 | 681 |
| 2004-05 | 1 354 | 2 287 | 708 | 725 | 854 | 800 | 688 | 681 |
| 2005-06 | 1 113 | 2 287 | 542 | 725 | 957 | 800 | 604 | 681 |
| 2006-07 | 1 180 | 2 287 | 575 | 725 | 1 004 | 800 | 714 | 681 |
| 2007-08 | 1 198 | 2 287 | 517 | 725 | 842 | 800 | 563 | 681 |
| 2008-09 | 1 060 | 2 287 | 621 | 725 | 939 | 800 | 595 | 681 |
| 2009-10 | 1 075 | 2 287 | 853 | 725 | 1 018 | 900 | 603 | 715 |
| 2010-11 | 1 046 | 2 288 | 587 | 725 | 929 | 900 | 545 | 715 |

| Fishstock | GUR 8 | | GUR 10 | | | |
|---|---|---|---|---|---|---|
| QMA (s) | 8 | | 10 | | Total | |
| | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84* | 251 | - | 0 | - | 3 966 | - |
| 1984-85* | 247 | - | 0 | - | 3 047 | - |
| 1985-86* | 163 | - | 0 | - | 2 929 | - |
| 1986-87 | 159 | 510 | 0 | 10 | 2 403 | 4 230 |
| 1987-88 | 194 | 518 | 0 | 10 | 3 121 | 4 381 |
| 1988-89 | 167 | 532 | 0 | 10 | 2 749 | 4 596 |
| 1989-90 | 173 | 538 | 0 | 10 | 2 745 | 4 730 |
| 1990-91 | 150 | 543 | 0 | 10 | 2 866 | 4 762 |
| 1991-92 | 189 | 543 | 0 | 10 | 3 390 | 4 975 |
| 1992-93 | 208 | 543 | 0 | 10 | 3 700 | 4 978 |
| 1993-94 | 174 | 543 | 0 | 10 | 3 142 | 4 978 |
| 1994-95 | 217 | 543 | 0 | 10 | 2 969 | 4 982 |
| 1995-96 | 182 | 543 | 0 | 10 | 2 927 | 4 982 |
| 1996-97 | 219 | 543 | 0 | 10 | 2 796 | 5 281 |
| 1997-98 | 249 | 543 | 0 | 10 | 2 532 | 5 143 |
| 1998-99 | 170 | 543 | 0 | 10 | 2 284 | 5 143 |
| 1999-00 | 222 | 543 | 0 | 10 | 2 429 | 5 143 |
| 2000-01 | 291 | 543 | 0 | 10 | 3 348 | 5 143 |
| 2001-02 | 302 | 543 | 0 | 10 | 3 429 | 5 143 |
| 2002-03 | 342 | 543 | 0 | 10 | 3 831 | 4 993 |
| 2003-04 | 329 | 543 | 0 | 10 | 3 508 | 4 993 |
| 2004-05 | 370 | 543 | 0 | 10 | 3 974 | 4 993 |
| 2005-06 | 373 | 543 | 0 | 10 | 3 589 | 4 993 |
| 2006-07 | 349 | 543 | 0 | 10 | 3 822 | 4 993 |
| 2007-08 | 223 | 543 | 0 | 10 | 3 344 | 4 993 |
| 2008-09 | 274 | 543 | 0 | 10 | 3 489 | 4 993 |
| 2009-10 | 239 | 543 | 0 | 10 | 3 789 | 5 181 |
| 2010-11 | 182 | 543 | 0 | 10 | 3 289 | 5 181 |

*FSU data.

GUR 3 landings regularly exceeded the TACC between 1988-89 and 1995-96. Ageing of fish collected during the east coast South Island trawl (ECSI) surveys suggests there were 1 or 2 relatively strong year classes moving through the fishery, which may help explain the overcatches. GUR 3 has been consistently overcaught since 2004.

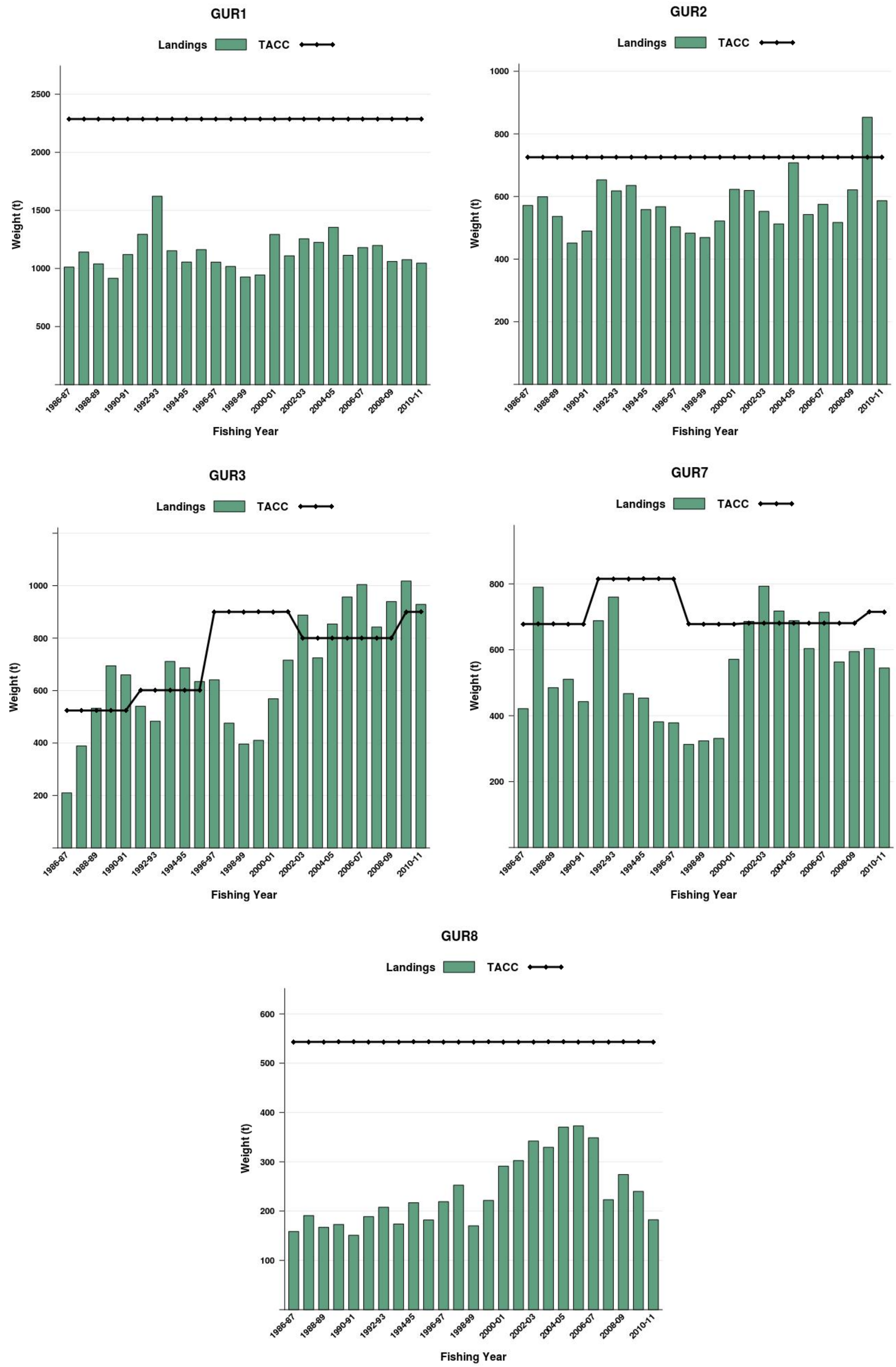



**Figure 1: Historical landings and TACC for the five main GUR stocks. From top left: GUR1 (Auckland East), GUR2 (Central East), GUR3 (South East Coast), GUR7 (Challenger), and GUR8 (Central Egmont). Note that these figures do not show data prior to entry into the QMS.**

GUR 7 landings declined steadily from 761 t in 1992-93, to 309 t in 1997-98, but then increased to a peak of 793 t in 2002-03. The TACC has not been caught in the last two years. Landings in GUR 8 have remained well below the levels of the TACC since 1986-87.

## 1.2 Recreational fisheries

Red gurnard is, by virtue of its wide distribution in shallow coastal waters, an important recreational species. Vulnerable to recreational fishing methods, it is often taken by snapper and tarakihi anglers, particularly in the Northern Region.

Recreational harvest estimates were obtained from national telephone diary surveys undertaken in 1996 and 2001. Regional diary surveys were undertaken from 1991 to 1994. The Recreational Technical Working Group concluded that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and, c) the 2000 and 2001 estimates are implausibly high for many important fisheries. The 1999-2000 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation. Recreational catch estimates are given in Tables 2-4.

**Table 2: Estimated number and weight of red gurnard harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991-92, Central in 1992-93 and North in 1993-94 (Teirney *et al.* 1997). The estimated Fishstock harvest is indicative and was made by combining estimates from the different years.**

| | | Total | | |
|---|---|---|---|---|
| Fishstock | Survey | Number | CV(%) | Survey harvest (t) |
| GUR 1 | North | 349 000 | 14 | 155-245 |
| GUR 2 | North | 2 000 | - | - |
| GUR 2 | Central | 156 000 | 31 | 50-125 |
| GUR 7 | Central | 21 000 | 23 | 5-20 |
| GUR 8 | Central | 157 000 | 37 | 50-110 |

**Table 3: Results of a national diary survey of recreational fishers in 1996. Estimated number of red gurnard harvested by recreational fishers by Fishstock and the corresponding harvest tonnage. The mean weights used to convert numbers to catch weight are considered the best available estimates. Estimated harvest is presented as a range to reflect the uncertainty in the estimates (from Bradford 1998).**

| Fishstock | Number caught | CV (%) | Harvest Range (t) | Harvest Point |
|---|---|---|---|---|
| GUR 1 | 262 000 | 7 | 100-120 | 108 |
| GUR 2 | 38 000 | 18 | 10-20 | 16 |
| GUR 3 | 1 000 | - | - | - |
| GUR 7 | 26 000 | 15 | 10-15 | 12 |
| GUR 8 | 67 000 | 15 | 25-35 | 28 |

**Table 4: Results of the 1999-00 national diary survey of recreational fishers (Dec 1999 - Nov 2000). Estimated number of red gurnard harvested by recreational fishers by Fishstock and the corresponding harvest tonnage. Estimated harvest is presented as a range to reflect the uncertainty in the estimates (Boyd & Reilly 2002).**

| Fishstock | Number caught | CV (%) | Harvest Range (t) | Harvest Point |
|---|---|---|---|---|
| GUR 1 | 465 000 | 16 | 188-256 | 223 |
| GUR 2 | 209 000 | 37 | 80-173 | 127 |
| GUR 3 | 11 000 | 70 | 2-9 | 5 |
| GUR 7 | 36 000 | 23 | 9-14 | 11 |
| GUR 8 | 99 000 | 36 | 26-55 | 40 |

Owing to the limitations of diary surveys a combined aerial overflight/boat ramp survey was undertaken in FMA 1 during 2005 (1 December 2004 to 30 November 2005), primarily targeting snapper (Hartill *et al*. 2007). The GUR 1 recreational harvest was estimated by this survey to be 127 t (CV 14%).

### 1.3 Customary non-commercial fisheries
Red gurnard is an important species for customary non-commercial fishing interests, by virtue of its wide distribution in shallow coastal waters. However, no quantitative estimates of customary non-commercial catch are currently available.

### 1.4 Illegal catch
No quantitative information is available.

### 1.5 Other sources of mortality
No quantitative information is available.

## 2. BIOLOGY

Gurnard growth rate varies with location, and females grow faster and are usually larger at age than males. Maximum age ($A_{MAX}$) is about 16 years and maximum size is 55+ cm. Red gurnard reach sexual maturity at an age of 2-3 years and a fork length (FL) of about 23 cm, after which the growth rate slows. An analysis of the age and growth of red gurnard in FMA 7 revealed that young fish 1-4 years old tend to be most common in Tasman and Golden Bays. Three to six year old fish are found on the inshore areas of the West coast South Island and the older fish are predominantly found further offshore (Lyon and Horn 2011).

*M* was estimated using the equation $M = \log_e 100$/maximum age, where maximum age is the age to which 1% of the population survives in an unexploited stock. Samples from the ECSI suggested an $A_{MAX}$ of about 16 years for males and 13 years for females, giving estimates for *M* of 0.29 and 0.35 respectively. Samples from the WCSI indicate an $A_{MAX}$ of about 15 years for both sexes, giving an estimate of 0.31 for *M*. These samples were not from virgin populations, so *M* may be slightly overestimated.

Red gurnard have a long spawning period which extends through spring and summer with a peak in early summer. In the Hauraki Gulf, ripe adults can be found throughout the year. Spawning grounds appear to be widespread, although perhaps localised over the inner and central shelf. Egg and larval development takes place in surface waters, and there is a period of at least eight days before feeding starts. Small juveniles (< 15 cm FL) are often caught in shallow harbours, but rarely in commercial trawls.

Biological parameters relevant to the stock assessment are shown in Table 5.

**Table 5: Estimates of biological parameters for red gurnard.**

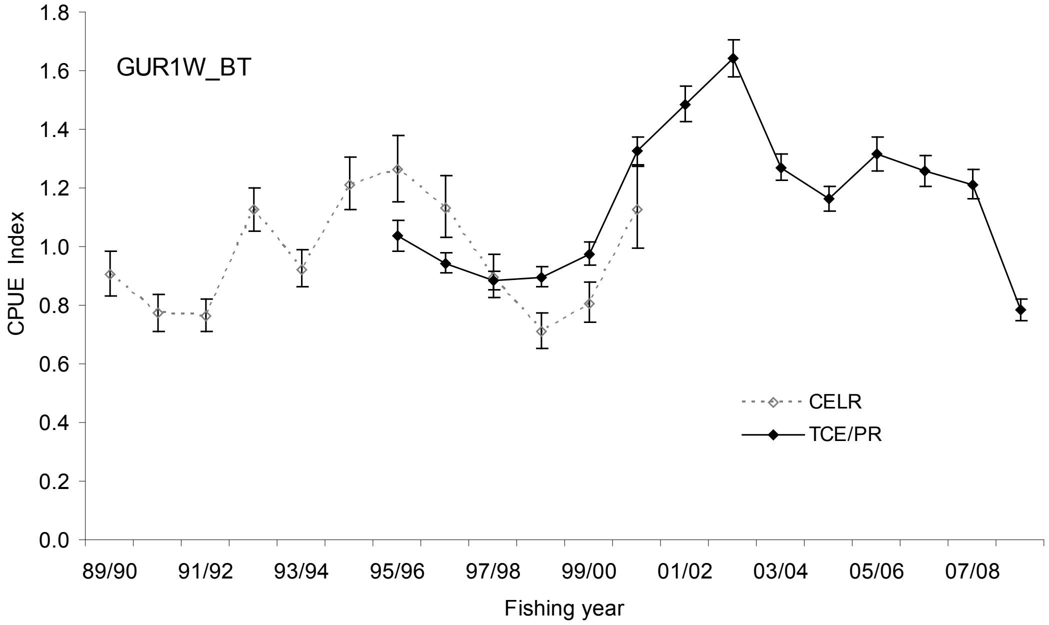
| **Fishstock** | | | | | | **Estimate** | **Source** |
|---|---|---|---|---|---|---|---|
| 1. Natural mortality (*M*) | | | | | | | |
| | | | Female | | | Males | |
| GUR 1W & 1E | | | 0.30 | | | 0.35 | Stevenson (2000) |
| GUR 3 | | | 0.29 | | | 0.35 | Sutton (1997) |
| GUR 7 | | | 0.31 | | | 0.31 | Sutton (1997) |
| 2. Weight = a(length)$^b$ (Weight in g, length in cm fork length). | | | | | | | |
| | | | | | | Both Sexes | |
| | | | a | | | b | |
| GUR 1 | | | 0.00998 | | | 2.99 | Elder (1976) |
| GUR 1W & 1 E | | | 0.026 | | | 2.775 | Stevenson (2000) |
| GUR 2 | | | 0.0053 | | | 3.19 | Stevenson (2000) |
| 3. von Bertalanffy growth parameters | | | | | | | |
| | | | Females | | | Males | |
| | $L_\infty$ | $k$ | $t_0$ | $L_\infty$ | $k$ | $t_0$ | |
| GUR 1 | 36.4 | 0.641 | 0.189 | 28.8 | 0.569 | -0.552 | Elder (1976) |
| GUR 1W | 45.3 | 0.25 | -0.88 | 36.5 | 0.45 | -0.30 | Stevenson (2000) |
| GUR1E | 44.5 | 0.28 | -0.76 | 35.2 | 0.49 | -0.24 | Stevenson (2000) |
| GUR 3 | 48.2 | 0.44 | 0.1 | 42.2 | 0.49 | -0.26 | Sutton (1997) |
| GUR 7 | 45.7 | 0.40 | -0.36 | 40.3 | 0.37 | -0.96 | Sutton (1997) |

## 3. STOCKS AND AREAS

There are no data that would alter the current stock boundaries. No information is available on stock separation of red gurnard. For GUR 3 the Working Group noted that spatial information from the CPUE analyses indicated that separate stocks or sub-stocks may exist between the East and South coasts of the South Island.

## 4. STOCK ASSESSMENT

There are no new data which would alter the yield estimates given for the GUR stocks in the 1997 Plenary Report. Those yield estimates were based on commercial landings data only and have not changed since the 1992 Plenary Report.



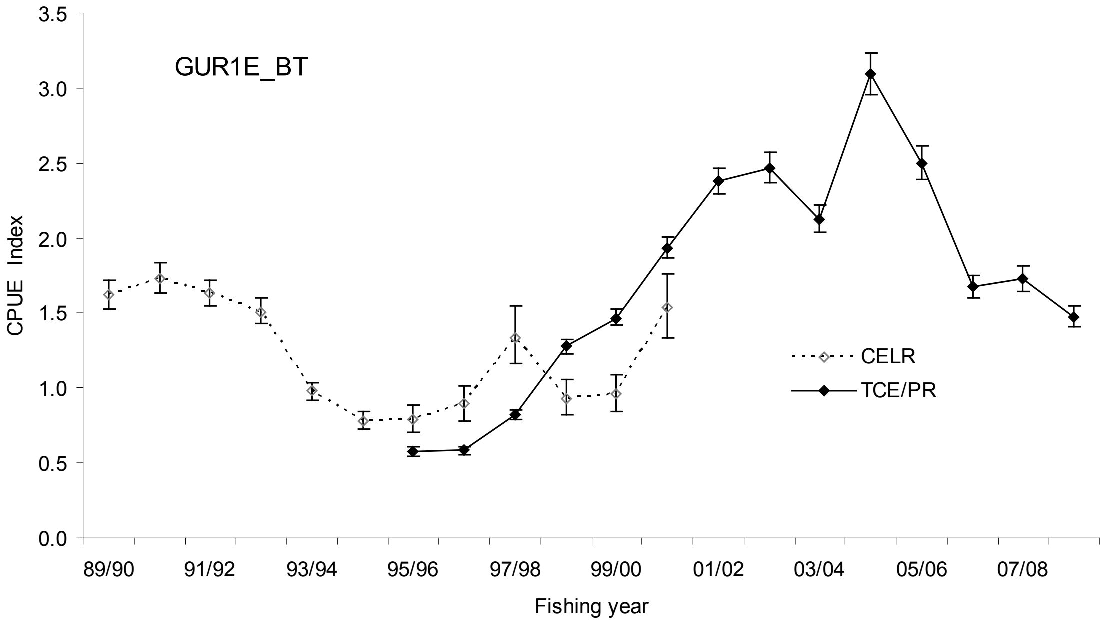




**Figure 2: Comparison of indices for GUR 1E and GUR 1W. Lognormal indices for bottom trawl based on CELR format data, and the lognormal series based on TCEPR/ TCE format data (Kendrick & Bentley 2010).**

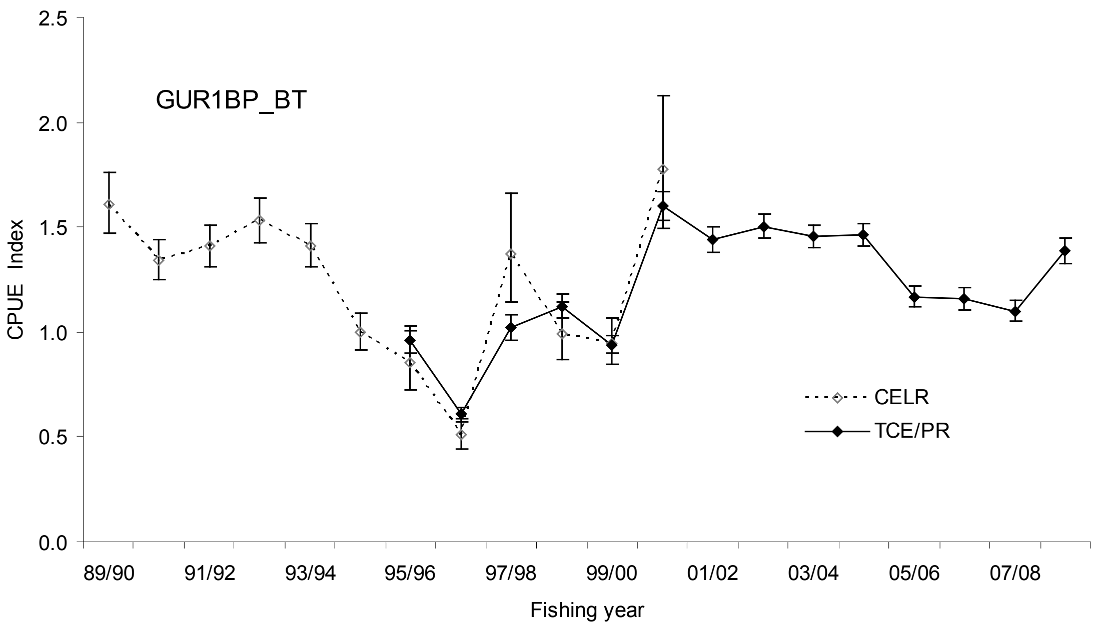



**Figure 3: Comparison of indices for and GUR 1BP. Lognormal indices for bottom trawl based on CELR format data, and the lognormal series based on TCEPR/ TCE format data (Kendrick & Bentley 2010).**

In 2010, Kendrick & Bentley (2010) updated CPUE analyses for GUR 1W, GUR 1E, and GUR 1BP (Figures 2 & 3). In each substock positive catches from single bottom trawl targeted at gurnard, snapper, trevally, tarakihi or John dory were standardised using lognormal models. Separate analyses were done for each of the two main form types (CELR and TCEPR/TCE) and the data were analysed in their original resolution (daily and tow-by-tow respectively) This was done because of concern that the systematic shift in this fishery from reporting on daily CELR forms to reporting tow-by-tow on TCEPRs may potentially confound the year effects and yield overly-optimistic trajectories.

For each substock, there appears to have been an increase in abundance from a low in the mid-1990s to a peak in the early to mid-2000s followed by a subsequent decline. GUR 1W has returned to around the level observed in 1997-98, while GUR 1E and GUR 1 BP are currently above the mean for the series.

**GUR 2**

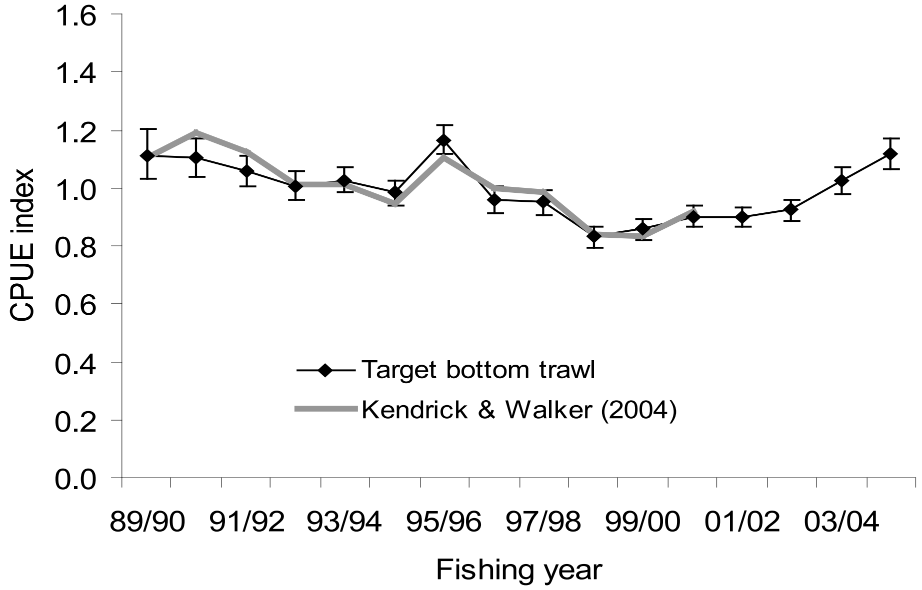
In 2006, Kendrick (2009b) updated CPUE analyses for GUR 2 (Figure 4). Presently GUR 2 is monitored using the bottom trawl target fishery and standardised CPUE is based on a lognormal model of positive estimated catches from statistical areas 011-014.

For contrast or corroboration the bycatch of red gurnard from tows targeted at tarakihi in the same areas is also monitored. Whilst the lognormal model of positive estimated catches shows no trend up or down, analyses that include unsuccessful effort were markedly more optimistic.

Aside from a decline in the early part of the bycatch CPUE series and an increase in the later part of the target series, there have been no drastic changes in CPUE with current levels similar to that from the early 1990s.

**GUR 3**

Two standardised CPUE series for GUR 3 were prepared for 2012, with both series based on the bycatch of red gurnard in bottom trawl fisheries defined by different target species combinations. The Working Group concluded in 2009 that trends in the BT(RCO) indices north and south of Banks Peninsula were virtually identical, with no indication of separate stocks in these areas as were similar analyses for the Canterbury Bight and Southland BT(FLA) indices. The Working Group recommended that these analyses be combined to provide two independent indices: targeted RCO, STA, BAR, TAR, GUR and targeted FLA indices, each applicable to all GUR 3 statistical areas.



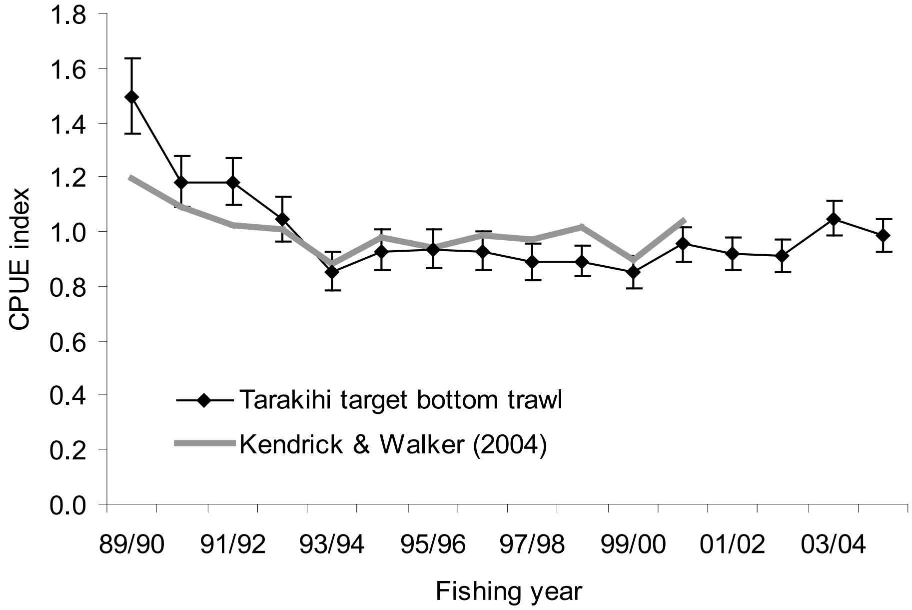




**Figure 4: Comparison of lognormal models of successful catches of red gurnard in the target GUR 2 fishery (top) and bycatch from the TAR target fishery (bottom); this study and previous series from Kendrick & Walker (2004). Both series rescaled relative to the geometric mean of the years in common (1989-90 to 2000-01) (Kendrick 2009b).**

These analyses were based on data which had been amalgamated into "trip-strata" (Starr 2007), defined as the sum of the catch and effort within a trip characterised by unique statistical areas, target species and method of capture. This approach loses much of the detailed information available in tow-by-tow records, but reduces all data to a common level of stratification, allowing the calculation of linked year coefficients. Unfortunately, the "trip-stratum" approach ignores problems associated with shifts in reporting behaviour associated with changes in form type requirements, while relying on the model parameterisation to adjust for potential biases. The Working Group was concerned in 2009 whether the shift to the new TCER forms in October 2007 may have affected the indices in the 2007–08 fishing year. As a further three years of catch/effort data have now been collected using the new, more detailed, TCER forms, a further standardised analysis was run on data which had been summarised to the level of a complete “trip” to test the sensitivity of the annual coefficients to the level of amalgamation. The presumption being that amalgamating the data to the level of a “trip” would minimise the effect of the change in form type, with the definition of a “trip” unaffected by form requirements.

Each series was modelled in the same manner, with log(catch) offered as the dependent variable and a range of explanatory variables offered, including duration and number of tows as continuous polynomials, and statistical area, target species, vessel and month as categorical explanatory variables. In every case, year was forced into the model as the first variable and was considered to be a proxy for relative annual abundance. Data were restricted to vessels which had participated for a specified number of years at a minimum level of participation (expressed as number of trips in a year). This filtering of the data was done to reduce the number of vessels in the data set without overly reducing the amount of catch represented in the model.

Trial models based on five alternative distributional assumptions were fitted to a reduced set of explanatory variables, with the distribution giving the best log-likelihood fit selected for the final stepwise model fit. Table 6 lists the distribution giving the best fit for each model. A logit model which modelled the probability of success was also fit to the same data using a binomial distribution. This model was generated as a diagnostic but is not presented.

**Table 6: Names and descriptions of the three red gurnard GUR 3 bottom trawl CPUE series accepted by the Working Group in 2012. Also shown is the error distribution that had the best fit to the distribution of standardised residuals for the fitted model.**

| Name | Code | Statistical areas | Target species | Best distribution |
|---|---|---|---|---|
| GUR 3 bottom trawl mixed target species | BT(MIX) | 018, 020, 022,024, 026, 025, 030 | RCO, STA, BAR, TAR, GUR | Weibull |
| GUR 3 bottom trawl flatfish target | BT(FLA) | 018, 020, 022,024, 026, 025, 030 | FLA | Weibull |
| GUR 3 bottom trawl trip-based | BT(MIX)-trip | 018, 020, 022,024, 026, 025, 030 | N/A | Weibull |

**BT(MIX):** This series showed a generally declining trend to the late 1990s, when it reached a nadir at about one-half of the long-term mean (Figure 5, left panel). The indices then increased steadily until 2007-08, when they peaked at around 1.8 times the long-term mean. The series has since declined to about 1.5 times the long-term mean.

**BT(FLA):** This series has a trajectory similar to the BT(MIX) series, also reaching a nadir in the late 1990s slightly above one-half of the long-term mean (Figure 5, right panel). The indices then increased steadily until 2009-10, when they peaked at around 1.9 times the long-term mean, where it has remained.

**BT(MIX)-trip:** This series was run as a diagnostic sensitivity to test whether the change in form type in October 2007 introduced a bias into the analysis. This series was nearly identical the BT(MIX) series (Figure 6), leading to the conclusion that, for GUR 3, the form type change did not introduce strong bias. This conclusion is further advanced by the strong similarity of the BT(FLA) series with the BT(MIX) series because there is much less evidence in the data of a “form type” effect in the former series.

**BT(MIX+FLA):** This series, plotted in Figure 6, is the mean of the BT(MIX) and BT(FLA) series in each year, beginning with the 1990-91 fishing year.

The Working Group accepted the BT(MIX+FLA) series as an index of the abundance of gurnard in GUR 3. These fisheries cover different aspects of gurnard distribution, both by depth and spatially, but still have very similar trajectories, providing some confidence that these series are likely to be tracking abundance.

**Establishing $B_{MSY}$ compatible reference points**

The mean from 1997-98 to 1999-00 of BT(MIX+FLA) was selected as the Soft Limit because it was a well-defined low point in the series, along with the observations that both catch and CPUE increased simultaneously from that point. The Working Group accepted the default Harvest Strategy Standard definitions that the target "$B_{MSY}$ compatible proxy" for GUR 3 would be twice the Soft Limit and the Hard Limit was one-half the Soft Limit.

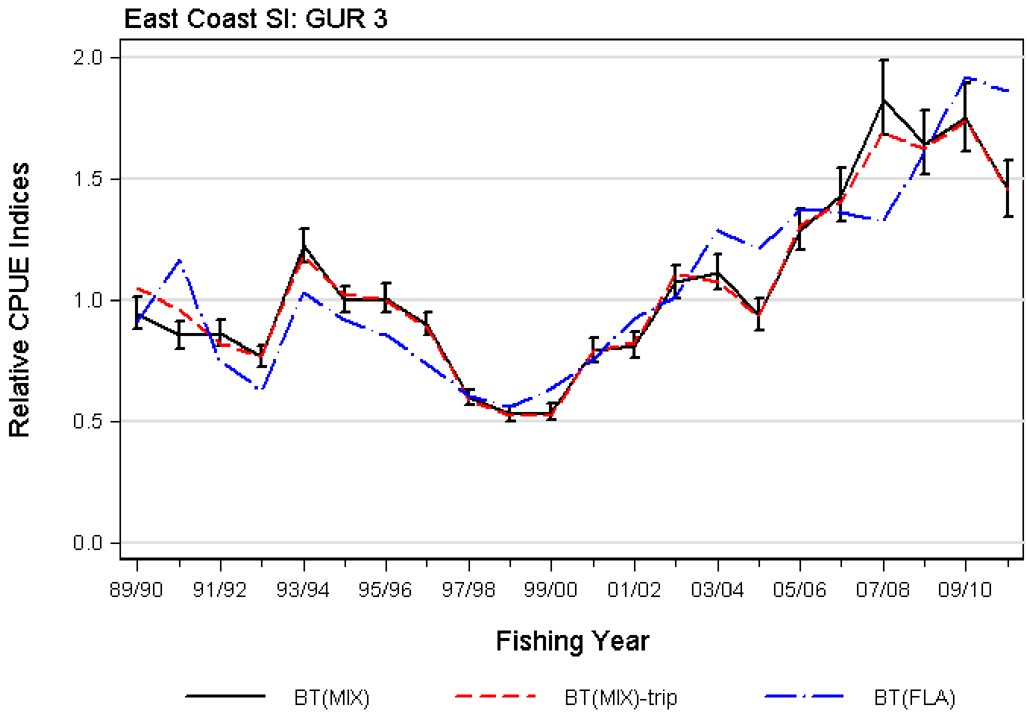



**Figure 5: Standardised CPUE indices for three east coast South Island bottom trawl fisheries [BT(MIX), BT(MIX)-trip and BT(FLA)]; Table 6) These series have been normalised to a geometric mean=1.0. Error bars show ±97.5% confidence intervals.**

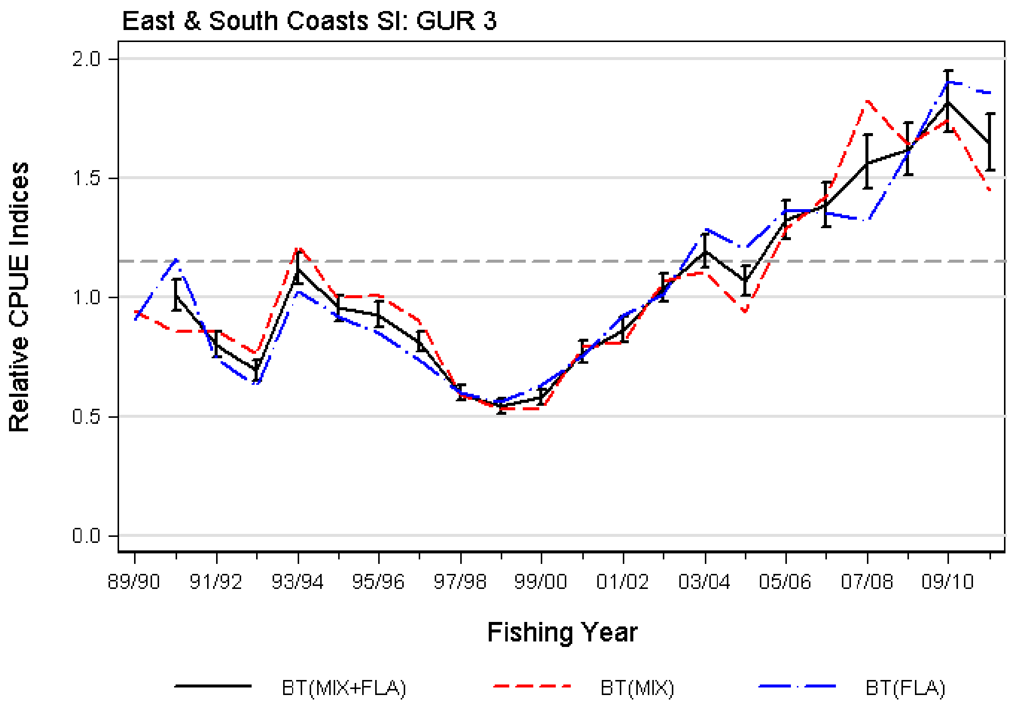



**Figure 6: Standardised CPUE indices for two east coast South Island bottom trawl fisheries [BT(MIX) and BT(FLA)]; plotted along with the mean of these two series [BT(MIX+FLA)], which is proposed as the "$B_{MSY}$ compatible proxy". Error bars show ±97.5% confidence intervals.**

**GUR 7**

The relative biomass index calculated for the whole stock (West coast and Tasman Bay combined) declined from 1995 to 2000 and has increased steadily from 2003 to the highest level in the series in 2009, the 2009 estimate is preliminary.

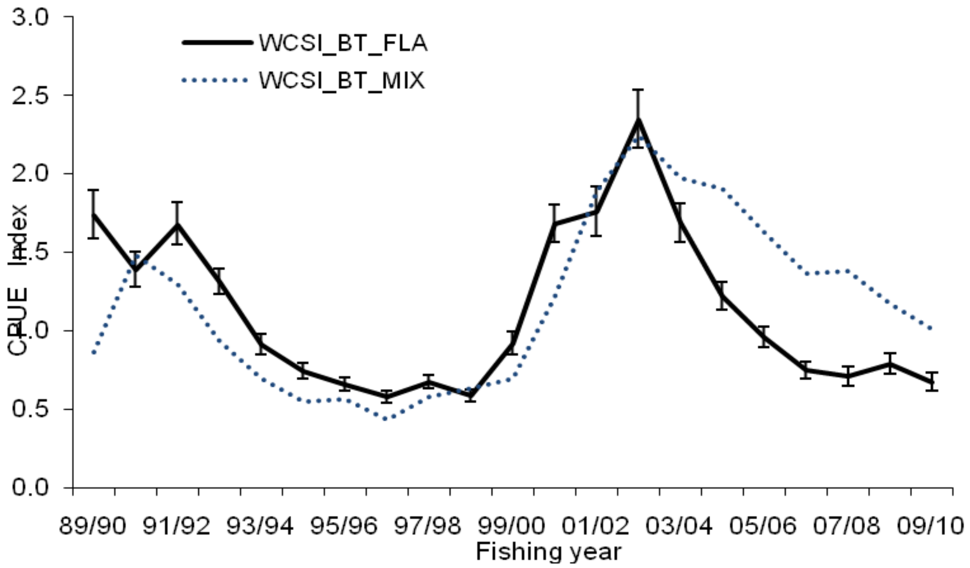



**Figure 7: Comparison of the lognormal indices from two independent CPUE series for GUR 7 in statistical areas (033, 034, 035, and 036); a) WCSI_BT_FLA: bottom trawl, target FLA or RCO; b) WCSI_BT_MIX: bottom trawl, target, BAR, TAR, WAR.**

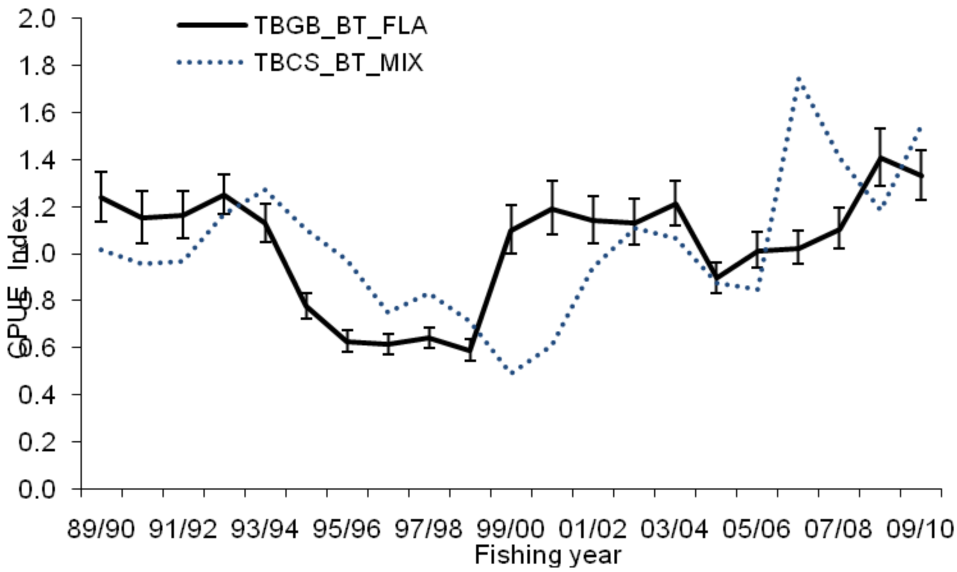
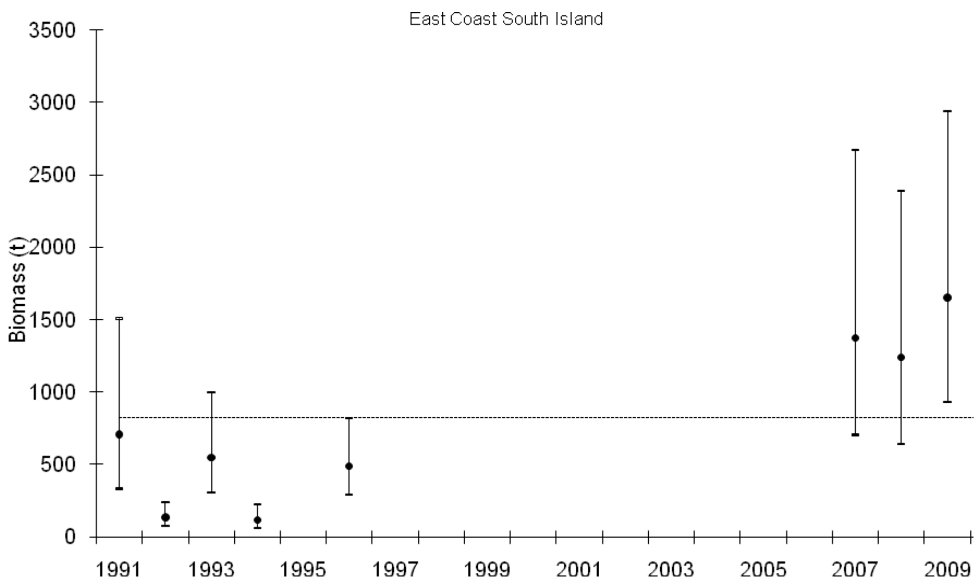



**Figure 8: Comparison of the lognormal indices from two independent CPUE series for GUR 7 ; a) TBGB_BT_FLA: bottom trawl in statistical areas 38, and 17, target FLA or RCO ; b) TBCS_BT_MIX: bottom trawl in statistical areas 38,39, 17 and 18, target, BAR, TAR, WAR.**

Relative abundance indices have been obtained from trawl surveys of the Bay of Plenty, west coast North Island and Hauraki Gulf within the GUR 1 Fishstock and the South Island west coast and Tasman/Golden Bays combined (GUR 7) (Table 7). The biomass trends from the west and east coast South Island trawl surveys are shown in Figure 5.

CPUE indices were developed for four bottom trawl fisheries as described by Langley (2011), that operate in different depth ranges and substock areas and account for most of the catch of GUR 7. Standardised CPUE analyses were based on lognormal models of positive (allocated) landed catches at trip-stratum resolution, using the Starr (2007) methodology (Kendrick *et al.* 2011).



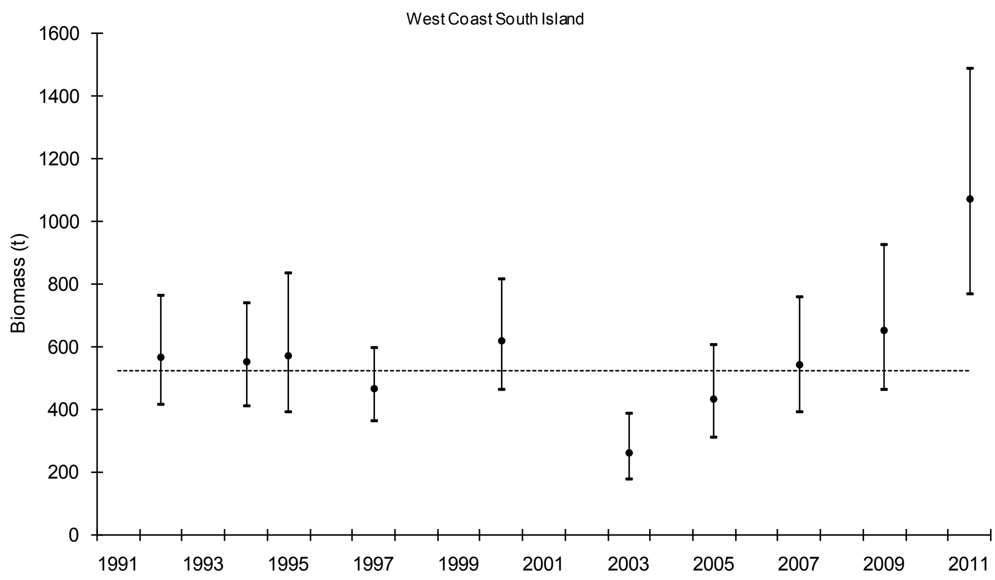




**Figure 9: Biomass trends ± 95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) from the West (top) and East (bottom) Coast South Island trawl surveys.**

The series show similar patterns for target fisheries (BT_FLA or BT_MIX) within each substock area, but markedly different trends between the substock areas, with both West Coast series declining from a peak in 2002-03 to a low in 2009-10 that equals the lowest for the series (Figure 7). The Tasman Bay/Golden Bay/Cook Strait series (BT_FLA or BT_MIX) (Figure 8) show broadly similar peaks and troughs as those on the West Coast up to 2004-05 thereafter the indices diverge and the West coast indices decline while those on in Tasman/Golden Bay increase. The West Coast South Island trawl survey (Figure 9) indices previously used to monitor GUR 7 resemble CPUE in Tasman Bay/ Golden Bay more closely than off the west coast.

**Table 7: Estimates of red gurnard biomass (t) from *Kaharoa* trawl surveys.**

| Year and location | Trip Code | Biomass | CV (%) |
|---|---|---|---|
| Bay of Plenty | | | |
| 1983 | KAH8303 | 380 | 23 |
| 1985 | KAH8506 | 57 | 17 |
| 1987 | KAH8711 | 410 | 28 |
| 1990 | KAH9004 | 432 | 12 |
| 1992 | KAH9202 | 290 | 9 |
| 1996 | KAH9601 | 332 | 14 |
| 1999 | KAH9902 | 364 | 14 |
| North Island west coast (QMA 9) | | | |
| 1986 | KAH8612 | 1 763 | 16 |
| 1987 | KAH8715 | 2 022 | 24 |
| 1989 | KAH8918 | 1 013 | 12 |
| 1991 | KAH9111 | 1 846 | 23 |
| 1994 | KAH9410 | 2 498 | 30 |
| 1996 | KAH9615 | 1 820 | 14 |
| North Island west coast (QMA 8) | | | |
| 1989 | KAH8918 | 628 | 15 |
| 1991 | KAH9111 | 817 | 9 |
| 1994 | KAH9410 | 685 | 22 |
| 1996 | KAH9615 | 370 | 37 |
| 1999 | KAH9915 | (QMAs 8 & 9 combined) 2099 | 13 |
| Hauraki Gulf | | | |
| 1984 | KAH8421 | 595 | 15 |
| 1985 | KAH8517 | 49 | 44 |
| 1986 | KAH8613 | 426 | 36 |
| 1987 | KAH8716 | 255 | 15 |
| 1988 | KAH8810 | 749 | 19 |
| 1989 | KAH8917 | 105 | 29 |
| 1990 | KAH9016 | 141 | 16 |
| 1992 | KAH9212 | 330 | 9 |
| 1993 | KAH9311 | 177 | 17 |
| 1994 | KAH9411 | 247 | 19 |
| 1997 | KAH9720 | 242 | 14 |
| 2000 | KAH0012 | 24 | 46 |
| South Island west coast and Tasman/Golden Bays | | | |
| 1992 | KAH9204 | 572 | 15 |
| 1994 | KAH9404 | 559 | 15 |
| 1995 | KAH9504 | 584 | 19 |
| 1997 | KAH9704 | 471 | 13 |
| 2000 | KAH0004 | 625 | 15 |
| 2003 | KAH0304 | 270 | 20 |
| 2005 | KAH0503 | 442 | 17 |
| 2007 | KAH0704 | 553 | 17 |
| 2009 | KAH0904 | 651 | 18 |
| 2010 | KAH1004 | 1 070 | 17 |
| North Island east coast | | | |
| 1993 | KAH9304 | 439 | 44 |
| 1994 | KAH9402 | 871 | 16 |
| 1995 | KAH9502 | 178 | 26 |
| 1996 | KAH9605 | 708 | 29 |
| South Island east coast (winter) | | | |
| 1991 | KAH9105 | 763 | 40 |
| 1992 | KAH9205 | 142 | 30 |
| 1993 | KAH9306 | 576 | 31 |
| 1994 | KAH9406 | 112 | 34 |
| 1996 | KAH9606 | 505 | 27 |
| 2007 | KAH0705 | 1 453 | 35 |
| 2008 | KAH0806 | 1 309 | 35 |
| 2009 | KAH0905 | 1 725 | 30 |
| South Island east coast (summer) | | | |
| 1996/97 | KAH9618 | 765 | 13 |
| 1997/98 | KAH9704 | 317 | 16 |
| 1998/99 | KAH9809 | 493 | 13 |
| 1999/00 | KAH9917 | 202 | 20 |
| 2000/01 | KAH0014 | 146 | 34 |

Length frequency trends for the West Coast South Island red gurnard catch are presented in Figure 10. These data show that there were substantial numbers of 20-25 cm fish in 1997 and 2000. These size fish did not appear in large numbers in 2003 or 2005 but high numbers were landed again in 2007.

## 4.1 Estimation of Maximum Constant Yield (*MCY*)

The level of risk to the stock by harvesting the population at the estimated *MCY* value cannot be determined.

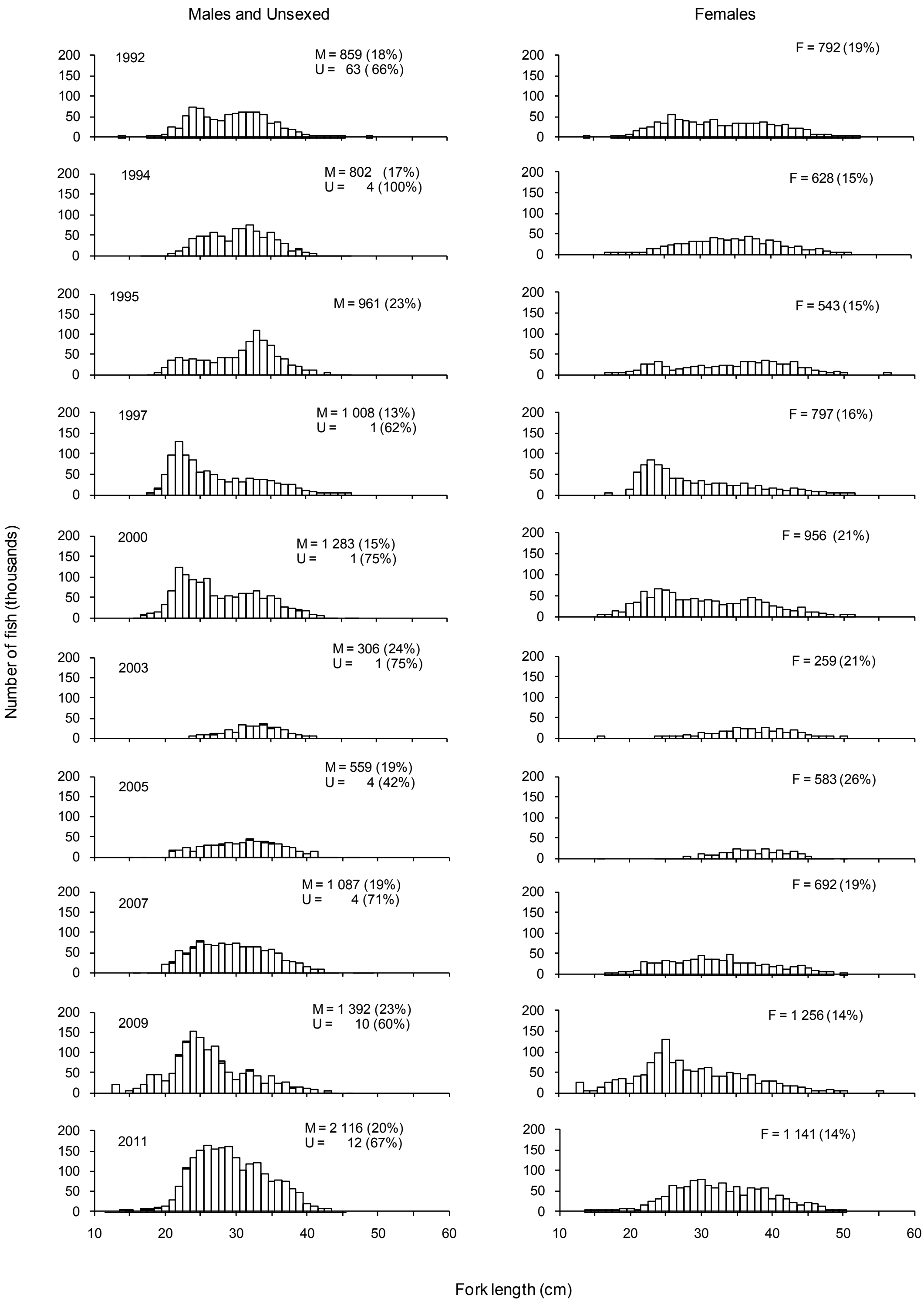



**Figure 10: Scaled length frequency distributions for red gurnard in 30-400 m, for all WCSI surveys. M, males; F, females; (CV%) (Stevenson in press).**

### 4.2 Estimation of Current Annual Yield (*CAY*)
No estimate of *CAY* is available for red gurnard.

### 4.3 Other yield estimates and stock assessment results
Other yield estimates and stock assessment results are not available.

### 4.4 Other factors
Red gurnard is a major bycatch of target fisheries for several different species, such as snapper and flatfish. The target species may differ between areas and seasons. The recorded landings are influenced directly by changes in the fishing patterns of fisheries for these target species and indirectly by the abundance of these target species. Some target fishing for gurnard also occurs. Therefore, *MCY* estimates based on catch data are subject to a great deal of uncertainty.

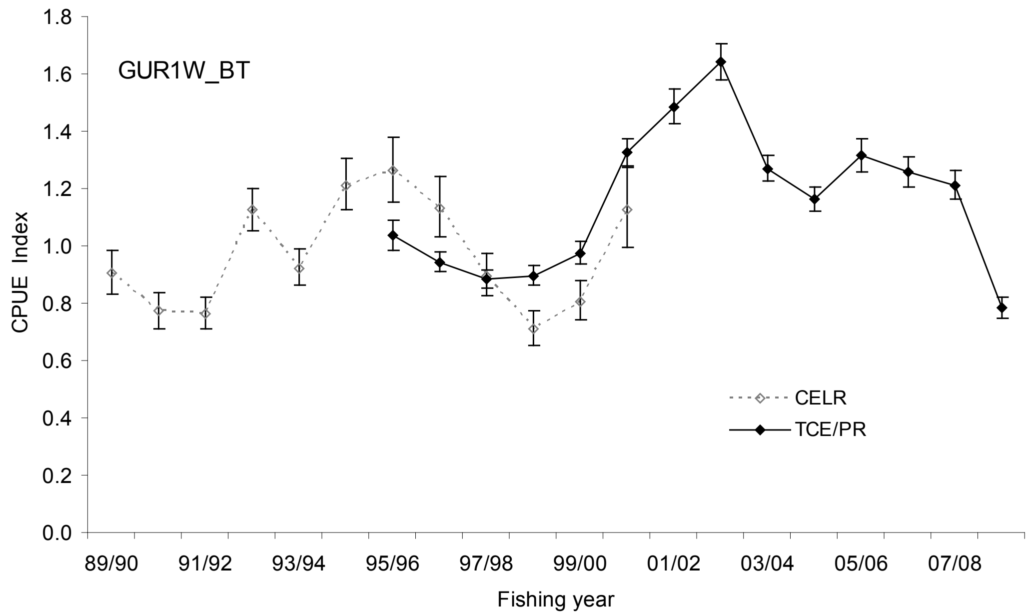
## 5. STATUS OF THE STOCKS

**Stock Structure Assumptions**
For the purpose of this summary GUR1 is considered to be a single stock with three sub-stocks.

**GUR 1W**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 |
| Assessment Runs Presented | |
| Reference Points | Target: Not established<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

**Historical Stock Status Trajectory and Current Status**




**Standardised CPUE indices for red gurnard in GUR 1W from lognormal models of catch rate in successful bottom trawl trips done separately by the two main data formats (Kendrick & Bentley 2010).**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or | The lognormal CPUE indices depict a trend that cycles over a 4-8 |

| | |
|---|---|
| Proxy | year period that is consistent with what one would expect from a short lived species with variable recruitment. Indices of abundance suggest that stock size has fluctuated around the long-term average since 1989-90. An increase that was sustained over five consecutive years peaked in 2002-03 and then declined, suggesting that the stock is now in a downward part of the cycle. |
| Recent Trend in Fishing Mortality or Proxy | Unknown |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Without corroborating information on recruitment from a trawl survey, it is not possible to predict how the stock is going to respond in the next few years. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2 - Partial quantitative stock assessment | |
| Assessment Method | Standardised CPUE based on lognormal error distribution and positive catches. | |
| Main data inputs | Catch and effort data | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2014 |
| Changes to Model Structure and Assumptions | Improvements in the analysis of the daily CELR data have made the two CPUE series more comparable. | |
| Major Sources of Uncertainty | Uncertainty in the stock structure<br>Relationship between CPUE and biomass. | |

| **Qualifying Comments** |
|---|
| As the red gurnard fishery in FMAs 1 and 9 has a long history, it is not possible to infer stock status from abundance trends from only the last 20 years. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in at least two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed over the last 23 years have been relatively consistent (averaging 1100 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch is unlikely to affect the long-term viability of this stock.<br><br>As the TACC is substantially higher than the current catch, it is not possible to evaluate catches at the level of the TACC. |

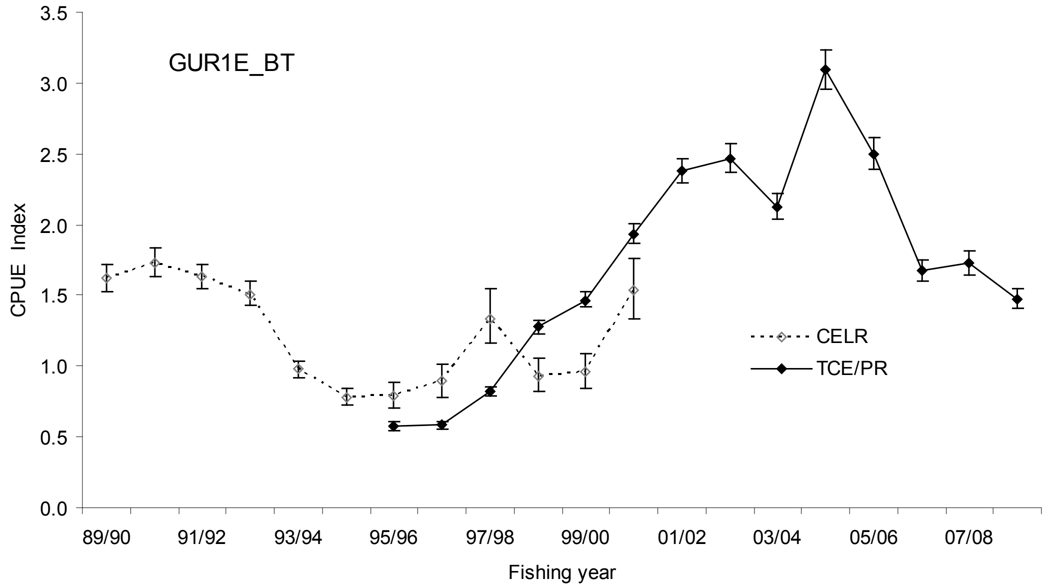
| **Fishery Interactions** |
|---|
| Red gurnard is taken on the west coast by bottom trawl targeted at snapper and trevally.<br><br>Incidental captures of seabirds occur and there is a risk of incidental capture of Maui's dolphins. |

**GUR 1E**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 |
| Assessment Runs Presented | |
| Reference Points | Target: Not established |

| | |
|---|---|
| | Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

**Historical Stock Status Trajectory and Current Status**




**Standardised CPUE indices for red gurnard in GUR 1E from lognormal models of catch rate in successful bottom trawl trips done separately by the two main data formats (Kendrick & Bentley 2010).**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | An increase in CPUE was sustained over six consecutive years, peaked in 2004-05 and has since declined. The most recent years are currently near the mean for the TCE/PR series. The lognormal CPUE indices depict a trend that cycles over a period that is consistent with what one would expect from a short lived species with variable recruitment. |
| Recent Trend in Fishing Mortality or Proxy | |
| Other Abundance Indices | |
| Trends in Other Relevant Indicators or Variables | |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Without corroborating information on recruitment from a trawl survey, it is not possible to predict how the stock is going to respond in the next few years. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2 - Partial quantitative stock assessment | |
| Assessment Method | Standardised CPUE based on lognormal error distribution and positive catches. | |
| Main data inputs | Catch and effort data | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2014 |
| Changes to Model Structure and Assumptions | Improvements in the analysis of the daily CELR data have made the two CPUE series more comparable. | |

| | |
|---|---|
| Major Sources of Uncertainty | Uncertainty in the stock structure<br>Relationship between CPUE and biomass. |

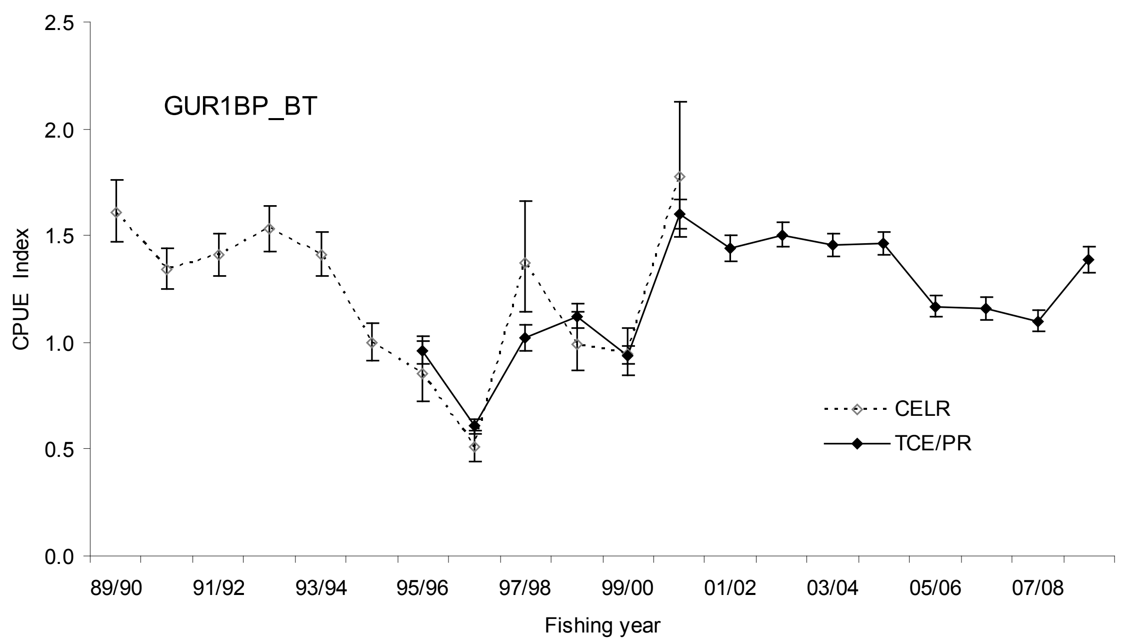
| **Qualifying Comments** |
|---|
| As the red gurnard fishery in FMAs 1 and 9 has a long history, it is not possible to infer stock status from abundance trends from only the last 20 years. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in at least two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed over the last 23 years have been relatively consistent (averaging 1100 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch is unlikely to affect the long-term viability of this stock.<br>As the TACC is substantially higher than the current catch, it is not possible to evaluate catches at the level of the TACC. |

| **Fishery Interactions** |
|---|
| Red gurnard is taken as a bycatch on the east coast mainly by bottom longline targeted at snapper, with the balance taken almost equally by bottom trawl and Danish seine targeting snapper and John dory.<br><br>Incidental captures of seabirds occur and there is a risk of incidental capture of Maui's dolphins. |

**GUR 1 - BoP**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 |
| Assessment Runs Presented | |
| Reference Points | Target: Not established<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below |

**Historical Stock Status Trajectory and Current Status**




**Standardised CPUE indices for red gurnard in GUR 1BP from lognormal models of catch rate in successful bottom trawl trips done separately by the two main data formats (Kendrick & Bentley in prep).**

| Fishery and Stock Trends | |
|---|---|
| Recent Trend in Biomass or Proxy | Biomass increased from a low in 1996-97 to a peak in 2000-01 and has been relatively stable at the new level. |
| Recent Trend in Fishing Mortality or Proxy | Unknown |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| Projections and Prognosis | |
|---|---|
| Stock Projections or Prognosis | Without corroborating information on recruitment from a trawl survey, it is not possible to predict how the stock is going to respond in the next few years. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) (current catch only) |

| Assessment Methodology | | |
|---|---|---|
| Assessment Type | Level 2 - Partial quantitative stock assessment | |
| Assessment Method | Standardised CPUE based on lognormal error distribution and positive catches. | |
| Main data inputs | Catch and effort data | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2014 |
| Changes to Model Structure and Assumptions | Improvements in the analysis of the daily CELR data have made the two CPUE series more comparable. | |
| Major Sources of Uncertainty | Uncertainty in the stock structure<br>Relationship between CPUE and biomass. | |

| Qualifying Comments |
|---|
| As the red gurnard fishery in FMAs 1 and 9 has a long history, it is not possible to infer stock status from abundance trends from only the last 20 years. The abundance of all three sub-stocks appears to be cyclical, probably in response to recruitment variation, and in at least two sub-stocks trends are currently downward. This makes it difficult to predict future trends without recruitment information. Given that the catch levels observed over the last 23 years have been relatively consistent (averaging 1100 t for all of GUR 1) and that red gurnard are mainly taken as bycatch, current catch is unlikely to affect the long-term viability of this stock.<br><br>As the TACC is substantially higher than the current catch, it is not possible to evaluate catches at the level of the TACC. |

| Fishery Interactions |
|---|
| Red gurnard is taken as a bycatch on the east coast mainly by bottom longline targeted at snapper, with the balance taken almost equally by bottom trawl and Danish seine targeting snapper and John dory.<br><br>Incidental captures of seabirds occur and there is a risk of incidental capture of Maui's dolphins. |

**GUR 2**

**Stock Structure Assumptions**

For the purpose of this summary GUR2 is considered to be a single stock with three sub-stocks.

A stock assessment of GUR2 was attempted in 1997-98, but rejected by the Inshore Working Group. CPUE analyses suggest that GUR2 abundance remained fairly stable between 1989/90 and 2004/05. Reported landings were also reasonably stable during this period, fluctuating between 450 t and 708

t. These results suggest that catches in this time period and the TACC are probably sustainable, at least in the short-term.

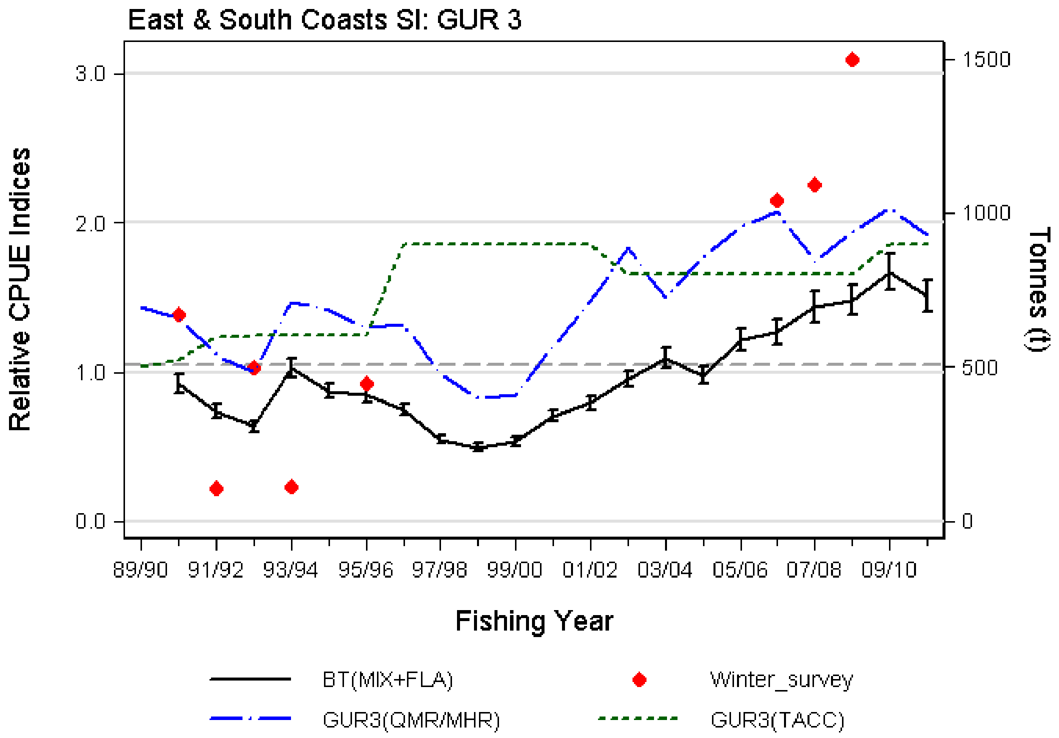
**GUR 3**

**Stock Structure Assumptions**

No information is available on the stock separation of red gurnard. The Fishstock GUR 3 is treated in this summary as a unit stock.

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2012 |
| Reference Points | Target: $B_{MSY}$-compatible proxy based on CPUE is twice the mean from 1997-98 to 1999-00 of BT(MIX+FLA) series, as defined in Starr and Kendrick (2012)<br>Soft Limit:Mean from 1997/98 to 1999/00 of BT(MIX+FLA) series, as defined in Starr and Kendrick (2012).<br>Hard Limit: 50% of soft limit |
| Status in relation to Target | Very Likely (> 90%) to be above the target |
| Status in relation to Limits | Soft Limit: Very Unlikely (< 10%) to be below<br>Hard Limit: Very Unlikely (< 10%) to be below |

| **Fishery and Stock Trends** | |
|---|---|
| Trend in Biomass or Proxy | Two bottom trawl CPUE series (one targeted at flatfish and the other at red cod), which are considered to be an index of stock abundance, have been increasing steadily since the late 1990s.<br>The resumed east coast South Island trawl survey has returned three biomass indices in 2007, 2008 and 2009 which are greater than equivalent estimates from the early 1990s. |
| Trend in Fishing Mortality or Proxy | Unlikely (< 40%) that overfishing is occurring. Catches and relative abundance are both increasing. |

| **Historical Stock Status Trajectory and Current Status** | |
|---|---|
| East coast South Island winter trawl survey, CPUE, Catch and TACC Trajectories<br><br><br>**Comparison of three available biomass series (east coast South Island winter trawl survey and two bottom trawl CPUE series, one targeted at flatfish and the other at red cod) with the trajectories of catch and TACCs from 1989-90 to 2007-08. The three biomass series have been standardised to the mean of each series for the survey years (90-91 to 93-94, 95-96 and 06-07 to 08-09).** | |
| Other Abundance Indices | ECSI summer survey - not used |
| Trends in Other Relevant Indicator or Variables | N/A |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Quantitative stock projections are unavailable. |
| Probability of Current Catch / TACC causing decline below Limits | Soft Limit: Unlikely (< 40%)<br>Hard Limit: Unlikely (< 40%) |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index and a trawl survey, | |
| Assessment Method | Evaluation of agreed standardised CPUE indices which reflect changes in abundance as well as the trawl survey biomass indices. | |
| Period of Assessment | Latest assessment: 2012 | Next assessment: 2015 |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs (rank) | -Trawl survey biomass indices and associated length frequencies<br>- Catch and effort data derived from the MPI compulsory logbooks. | 1- High Quality<br><br>1- High Quality |

| | |
|---|---|
| Data not used (rank) | N/A |
| Changes to Model Structure and Assumptions | None |
| Major Sources of Uncertainty | Prior to 2007 the ECSI trawl survey did not cover the entire depth range for red gurnard. Uncertainty in stock structure assumptions and the relationship between CPUE and biomass. |

| **Qualifying Comments** |
|---|
| Red gurnard are relatively short-lived and reasonably productive. They exhibit strong interannual fluctuations and were at apparent low levels in the mid-1990s. Stock size appears to have increased substantially since then and commercial fishers indicate that they find it difficult to stay within the TACC despite the low level of targeting on this species.<br><br>Two independent CPUE series and the trawl survey corroborate that stock size for GUR 3 has increased since the late 1990s.<br><br>There are potentially enough data to undertake a quantitative stock assessment for GUR 3. This would allow the estimation of $B_{MSY}$ and other reference points. |

| **Fishery Interactions** |
|---|
| Red gurnard in GUR 3 are taken almost entirely by bottom trawl in fisheries targeted at red cod, barracouta and flatfish. Some gurnard are also taken in the target tarakihi and stargazer bottom trawl fisheries. The level of targeting on this species is low, averaging less than 10% of the total landed catch since 1989-90.<br><br>Incidental captures of seabirds occur and there is a risk of incidental capture of Hector's dolphins. |

**GUR 7**

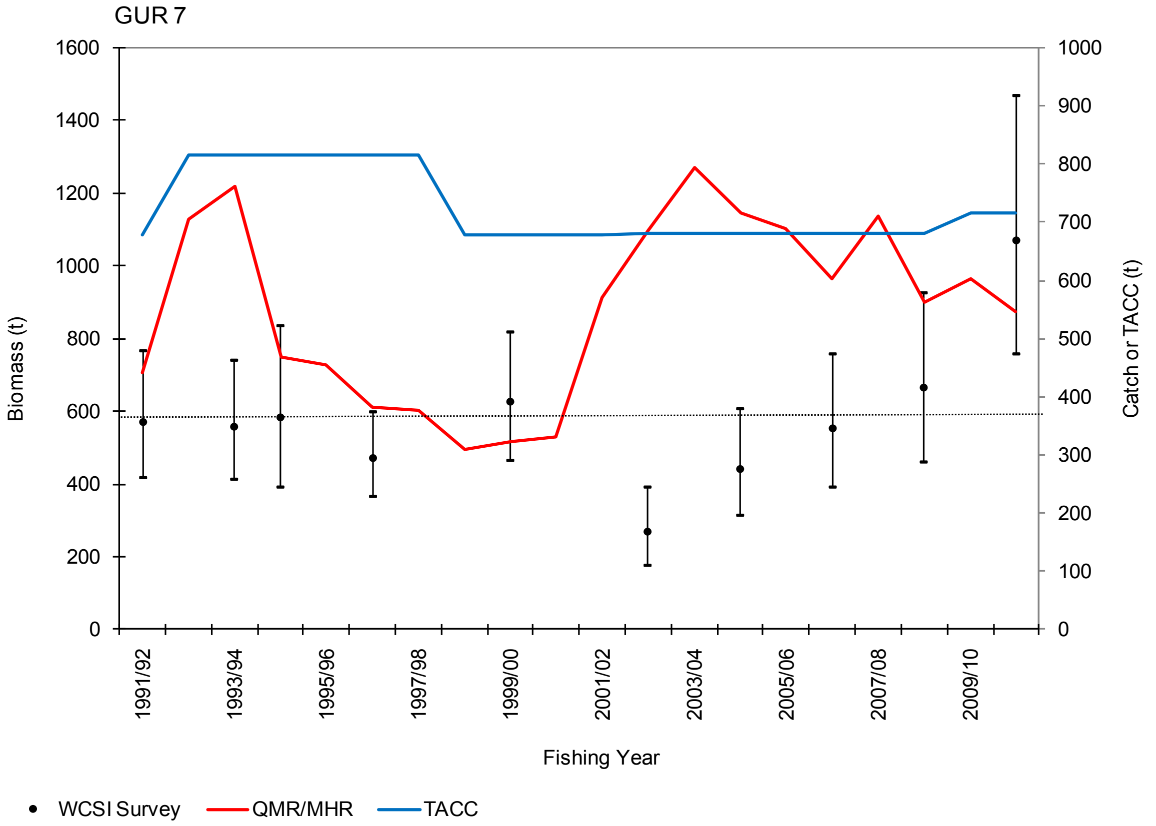
**Stock Structure Assumptions**

Stock boundaries are unknown, but for the purpose of this summary, GUR 7 is considered to be a single management unit.

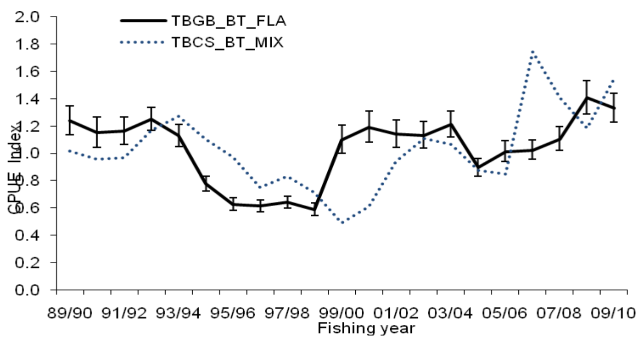
| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 (West Coast South Island trawl survey); 2011 CPUE analysis |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft limit: Unlikely (< 40%) to be below<br>Hard Limit: Unlikely (< 40%) to be below |

| **Fishery and Stock Trends** | |
|---|---|
| Trend in Biomass or Proxy | The West Coast South Island trawl survey relative biomass index declined from 1995 to 2000 and has increased steadily from 2003 to the highest level in the series in 2011.<br>The CPUE analysis suggests that the index has increased steadily since 2004-05 in Tasman and Golden Bays (probably a juvenile index). But on the West Coast (possibly an adult index) the index has declined steadily since 2002-03 and is now almost half the long-term mean. |
| Trend in Fishing Mortality or Proxy | Unlikely (< 40%) that overfishing is occurring. Catches have increased since 2000-01 coincident with an apparent increase in the survey biomass indices. |

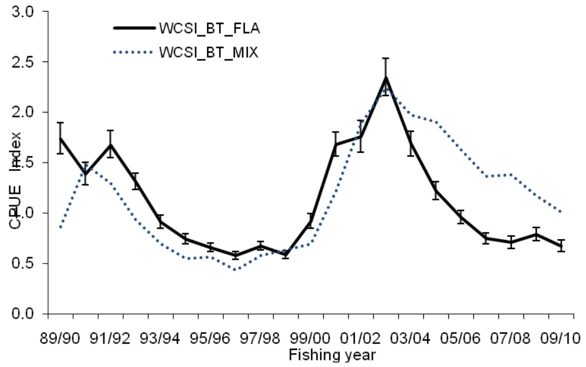
**Historical survey biomass, Catch and TACC Trajectories**




**West Coast South Island survey biomass (points) commercial catch (red line) and TACC (blue line) for the period 1990 to 2007. Horizontal dashed line is the mean biomass index, 1992-2011.**




**Comparison of the lognormal indices from two independent CPUE series for GUR 7 ; a) TBGB_BT_FLA: bottom trawl in statistical areas 38, and 17, target FLA or RCO ; b) TBCS_BT_MIX: bottom trawl in statistical areas 38,39, 17 and 18, target, BAR, TAR, WAR.**




**Comparison of the lognormal indices from two independent CPUE series for GUR 7 in statistical areas (033, 034, 035, and 036); a) WCSI_BT_FLA: bottom trawl, target FLA or RCO; b) WCSI_BT_MIX: bottom trawl, target, BAR, TAR, WAR.**

| | |
|---|---|
| Other Abundance Indices | - |
| **Projections and Prognosis** | |
| Stock Projections or Prognosis | Recent catches and the TACC are probably sustainable, at least in the short-term. Quantitative stock projections are unavailable. |
| Probability of Current Catch / TACC causing decline below Limits | Soft Limit: Unlikely (< 40%)<br>Hard Limit: Unlikely (< 40%) |

| | | |
|---|---|---|
| **Assessment Methodology** | | |
| Assessment Type | Level 2: Agreed abundance index | |
| Assessment Method | West Coast South Island Trawl survey biomass<br>- Survey length frequency. | |
| Main data inputs | Survey biomass and length frequencies. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | N/A | |
| Major Sources of Uncertainty | | |

| |
|---|
| **Qualifying Comments** |
| Red gurnard are a survey target of the West Coast South Island trawl survey and the Southern Inshore Working Group regards the series as a reliable index of abundance. |

| |
|---|
| **Fishery Interactions** |
| Red gurnard are primarily taken in conjunction with the following QMS species: barracouta, stargazer, red cod, tarakihi and other species in the West Coast South Island target bottom trawl fishery.<br><br>Incidental captures of seabirds occur and there is a risk of incidental capture of Hector's dolphins. |

**GUR 8**

It is not known if recent catch levels or the current TACC are sustainable.

Yields estimates, TACCs, and reported landings for red gurnard for the most recent year are summarised in Table 8.

**Table 8: Summary of yield estimates (t), TACCs (t) and reported landings (t) of red gurnard for the most recent fishing year.**

| Fishstock | QMA | | 2010-11 Actual TACC | 2010-11 Reported landings |
|---|---|---|---|---|
| GUR 1 | Auckland (GUR 1W & GUR 1E) | 1 & 9 | 2 288 | 1 046 |
| GUR 2 | Central (east) | 2 | 725 | 587 |
| GUR 3 | South-East, Southland and Sub-Antarctic | 3, 4, 5, & 6 | 900 | 929 |
| GUR 7 | Challenger | 7 | 715 | 545 |
| GUR 8 | Central (west) | 8 | 543 | 182 |
| GUR 10 | Kermadec | 10 | 10 | 0 |
| Total | | | 5 181 | 3 289 |

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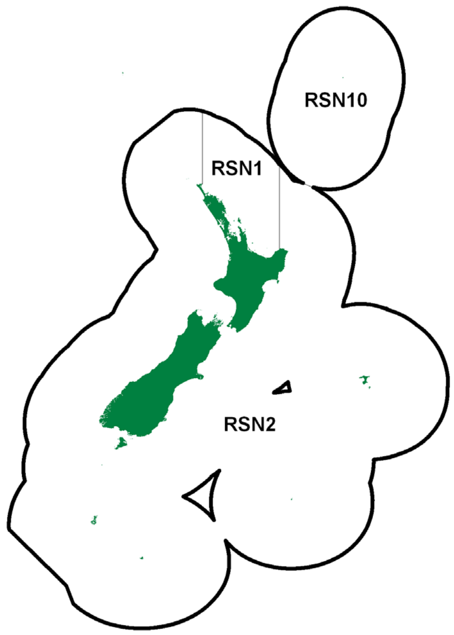
# RED SNAPPER (RSN)

*(Centroberyx affinis)*
Kaorea




## 1. FISHERY SUMMARY

Red snapper was introduced into the Quota Management System on 1 October 2004 with the TAC, TACC and allowances as shown in Table 1. These have not changed.

**Table 1: Recreational and customary non-commercial allowances, TACCs and TACs of red snapper.**

| Fishstock | Recreational Allowance | Customary non-commercial Allowance | Other sources of mortality | TACC | TAC |
|---|---|---|---|---|---|
| RSN 1 | 13 | 2 | 1 | 124 | 140 |
| RSN 2 | 2 | 1 | 1 | 21 | 25 |
| RSN 10 | 1 | 1 | 1 | 1 | 4 |
| Total | 16 | 4 | 3 | 146 | 169 |

### 1.1 Commercial fisheries

Small commercial catches of red snapper in New Zealand have almost certainly been made for decades, but would have been included among "assorted minor species" in reported landings. Annual landings peaked at 112 t from 1989-90 to 1994-95, and have continued to increase to a peak of 197 t in 2000-2001. Landings then dropped to 51 t in 2003-04 and have remained near this level since 2004-05 (Tables 2 & 3).

Red snapper is mostly taken as a bycatch of 1) the longline fishery for snapper off east Northland, 2) the trawl fisheries for tarakihi off east and west Northland, and 3) the setnet fishery for snapper and trevally in the Bay of Plenty.

### 1.2 Recreational fisheries

The National Marine Recreational Fishing surveys in 1994, 1996, and 2000 do not provide an estimate of the recreational catch of red snapper. However, it is likely that recreational fishers will periodically catch red snapper while line fishing on deep reefs in Northland, the outer Hauraki Gulf, and Bay of Plenty.

### 1.3 Customary non-commercial fisheries

There is no quantitative information available to allow the estimation of the amount of red snapper taken by customary non-commercial fishers.

**Table 2: Reported landings (t) by commercial fishers of red snapper by FMA from 1989-90 to 2003-04. Data are derived from the landing section of CELRs and CLRs.**

| | FMA 1 | FMA 2 | FMA 3 | FMA 4 | FMA 7 | FMA 8 | FMA 9 | FMA 10 | Unknown | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1989-90 | 67.9 | 3 | 3.1 | 0 | 1.8 | 0.9 | 0 | 0 | 0.0 | 76.7 |
| 1990-91 | 107.3 | 1.2 | 2.8 | 0 | 0.6 | 0.7 | 0 | 0 | 0.0 | 112.7 |
| 1991-92 | 89.1 | 0.7 | 1.1 | 0 | 0 | 1.6 | 0 | 0.6 | 0.0 | 93.2 |
| 1992-93 | 98.2 | 2.1 | 0.4 | 0 | 0 | 0.6 | 0 | 0 | 0.3 | 101.6 |
| 1993-94 | 78.2 | 2.6 | 0.3 | 0.1 | 0.4 | 0.4 | 0.2 | 0 | 0.0 | 82.4 |
| 1994-95 | 78.2 | 1.8 | 0.3 | 0 | 0.2 | 0.6 | 0.5 | 0 | 1.0 | 82.6 |
| 1995-96 | 126.7 | 2.1 | 0.8 | 0.2 | 1.2 | 0.2 | 1 | 0 | 1.3 | 133.4 |
| 1996-97 | 186.4 | 17.4 | 0.9 | 0 | 1 | 0.3 | 2.9 | 0.2 | 2.8 | 211.8 |
| 1997-98 | 159.1 | 3.4 | 0.3 | 0 | 0.2 | 0.7 | 3.6 | 0 | 0.8 | 168.2 |
| 1998-99 | 134.4 | 1.5 | 0.4 | 0.1 | 0.3 | 1 | 4.7 | 0 | 0.4 | 142.8 |
| 1999-00 | 108.1 | 1.3 | 0.8 | 0 | 0.1 | 21.3 | 25.4 | 0 | 0.7 | 157.7 |
| 2000-01 | 140.0 | 1.1 | 2.3 | 0.8 | 0 | 0.8 | 51.5 | 0 | 0.0 | 196.5 |
| 2001-02 | 109.7 | 1.5 | 2.2 | 0.1 | 0 | 0.4 | 12.3 | 0 | 0.6 | 126.7 |
| 2002-03 | 117.5 | 2.2 | 0.3 | 0 | 0 | 0.6 | 37.5 | 0 | 14.2 | 172.5 |
| 2003-04 | 40.9 | 1.8 | 0.2 | 0 | 0.3 | 1.3 | 6.7 | 0 | 0 | 51.3 |

**Table 3: Reported domestic landings (t) of red snapper Fishstock and TACC from 2004-05 to 2010-11.**

| | RSN 1 FMA 1 | | RSN 2 FMA 2-9 | | RSN 10 FMA 10 | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 2004-05 | 43 | 124 | 11 | 21 | 0 | 1 | 54 | 146 |
| 2005-06 | 41 | 124 | 8 | 21 | 0 | 1 | 49 | 146 |
| 2006-07 | 44 | 124 | 10 | 21 | 0 | 1 | 53 | 146 |
| 2007-08 | 70 | 124 | 17 | 21 | 0 | 1 | 87 | 146 |
| 2008-09 | 30 | 124 | 12 | 21 | 0 | 1 | 42 | 146 |
| 2009-10 | 22 | 124 | 9 | 21 | 0 | 1 | 31 | 146 |
| 2010-11 | 27 | 124 | 8 | 21 | 0 | 1 | 35 | 146 |

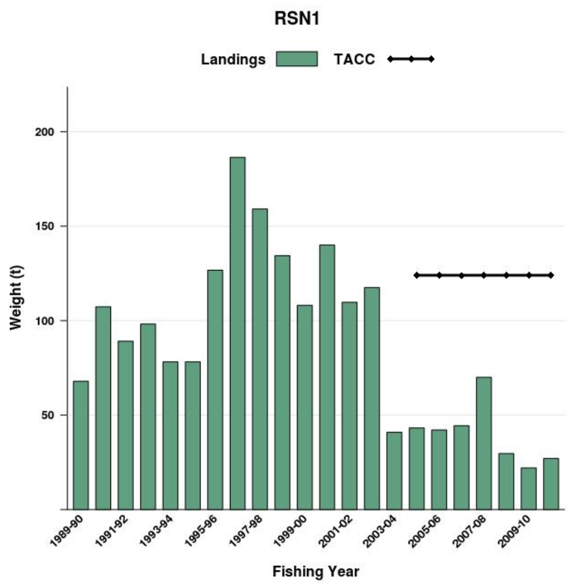



**Figure 1: Historical landings and TACC for the main RSN stock, RSN1 (Auckland).**

## 2. BIOLOGY

The red snapper (*Centroberyx affinis*) is present throughout New Zealand coastal waters, but is generally rare south of East Cape and Cape Egmont. In southeastern Australia (known as redfish) it occurs from Brisbane to Melbourne, and off northern Tasmania.

Red snapper occur in association with deep coastal reefs, in particular caves and overhangs, as well as in open water, to depths of about 400 m. Their relative abundance within this depth range is unknown. The southeastern Australian target fishery operates at depths of 100-250 m (Rowling 1994).

There have been no formal aging studies of New Zealand red snapper, but Leachman *et al*. (1978) reported a maximum ring count of 80, based on examination of a few broken and burned otoliths. These rings were not, however, validated. Work in Australia, based on tagging and thin otolith sections suggest unvalidated ages of at least 35 (Rowling 1994) and 40 years (Smith & Robertson 1992). Radiocarbon analysis supported an age of at least 37 years (Kalish 1995).

Red snapper attain 55 cm in New Zealand but average 30-40 cm. Nothing is known of their reproductive biology.

## 3. STOCKS AND AREAS

There has been no research to determine if there are separate biological stocks of red snapper.

## 4. STOCK ASSESSMENT

There has been no scientific stock assessment of the biomass that can support the Maximum Sustainable Yield (*MSY*) for red snapper.

## 5. STATUS OF THE STOCK

The reference or current biomass is not known for any red snapper stock. It is not known if the recent catch levels are sustainable. The status of RSN 1, 2 and 10 relative to $B_{MSY}$ is unknown.

TACCs and reported landings by Fishstock, for the 2010-11 fishing year, have been summarised in Table 4.

**Table 4: Summary of TACCs (t) and reported landings (t) of red snapper for 2010-11 fishing year.**

| Fishstock | | FMA | 2010-11 Actual TACC | 2010-11 Reported landings |
|---|---|---|---|---|
| RSN 1 | Auckland (East) | 1 | 124 | 27 |
| RSN 2 | Auckland (West), South east, Southland, Sub-Antarctic, Central, Challenger | 2,3,4,5,6, 7,8&9 | 21 | 8 |
| RSN 10 | Kermadec | 10 | 1 | 0 |
| Total | | | 146 | 35 |

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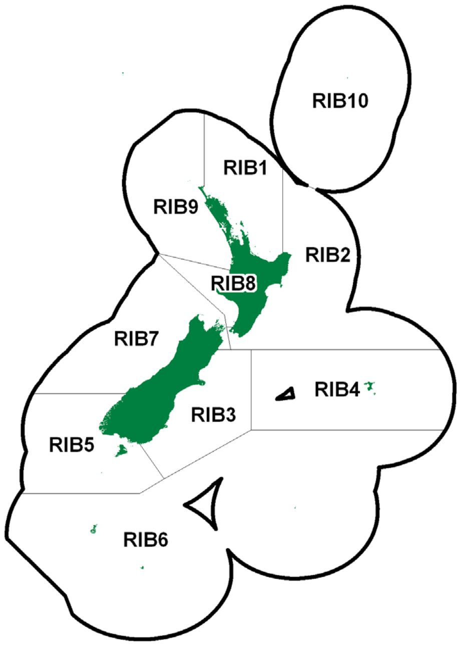
# RIBALDO (RIB)

(*Mora moro*)




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

In New Zealand ribaldo is caught mainly on bottom longlines and as a bycatch of trawling. Up to 4500 t were reported in 1977 by Japanese and Korean longline vessels target fishing for ling on the Chatham Rise and east coast of the South Island in the 1970s. Since 1982-83, overall reported catch has been mainly from the Chatham Rise and east coast South Island (QMAs 3 & 4) but has declined somewhat from these areas since being introduced into the QMS in the 1998-99 fishing year. Since entering the QMS, a similar decline in reported ribaldo catch is seen in other QMAs with the exception of RIB 7 where reported catches have been increasing. RIB 7 now has the highest reported catch of any QMA. The reasons for these changes in catch levels are not well understood as ribaldo is mainly taken as bycatch. Levels of discarding and unreported catch are likely to have changed with the introduction of ribaldo into the QMS. Ribaldo are caught throughout the New Zealand Exclusive Economic Zone by a variety of fishing methods in different target fisheries but mainly as bycatch in bottom trawls targeting hoki (*Macruronus novaezelandiae*), hake (*Merluccius australis*) and ling (*Genypterus blacodes*) and bottom longlines for ling.

There is no seasonality of catch other than on the west coast South Island which is related to target fishing of hoki and hake during the winter spawning season. Catches by Japanese and Korean longliners in the mid 1970s are shown in Table 1. Landings from 1982-83 onwards are shown in Table 2, while Figure 1 shows the historical landings and TACC values for the main RIB stocks.

**Table 1: Japanese and Korean longline catch (t) of ribaldo ("deep-sea cod[1]") from New Zealand waters, probably mostly Chatham Rise and east coast South island, by calendar year from 1975-77.**

| Year | 1975 | 1976 | 1977 |
|---|---|---|---|
| Japan | 2 417 | 4 920 | 4 283 |
| Korea | - | - | 2 86 |

1. Reported as "cods" but considered to be mainly ribaldo. The Korean fleet began fishing in April 1977.

Ribaldo was introduced into the QMS from 1 October 1998, no customary, recreational or other mortality allowances have been given. Historical catch limits up to the most recent fishing year (2009-10) are shown in Table 2. TACCs were increased from 1 October 2006 in RIB 6 to 231 t and in RIB 7 to 330 t. In these stocks landings were above the TACC for a number of years and the TACCs have been increased to the average of the previous 7 years plus an additional 10%. Current levels of reported catch are well below TACCs apart from in RIB 7 where they have continued to exceed the TACC, with the exception of the most recent fishing year.

**Table 2: Reported landings (t) of ribaldo by QMA for fishing years 1983-84 to 2010-11 and TACCs (t). QMA 10 has no catches and a TACC of 0. Total includes catches from outside the NZ EEZ.**

| | QMA 1 | | QMA 2 | | QMA 3 | | QMA 4 | | QMA 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1982-83 | 0 | | 8 | | 15 | | 33 | | 111 | |
| 1983-84 | 0 | | 3 | | 24 | | 21 | | 68 | |
| 1984-85 | 0 | | 4 | | 17 | | 61 | | 21 | |
| 1985-86 | 1 | | 1 | | 26 | | 13 | | 35 | |
| 1986-87 | 4 | | 1 | | 44 | | 20 | | 41 | |
| 1987-88 | 19 | | 4 | | 65 | | 31 | | 56 | |
| 1988-89 | 1 | | 2 | | 33 | | 41 | | 6 | |
| 1989-90 | 8 | | 9 | | 23 | | 28 | | 6 | |
| 1990-91 | 15 | | 15 | | 177 | | 119 | | 34 | |
| 1991-92 | 95 | | 40 | | 160 | | 169 | | 73 | |
| 1992-93 | 131 | | 54 | | 217 | | 228 | | 67 | |
| 1993-94 | 87 | | 70 | | 217 | | 186 | | 23 | |
| 1994-95 | 116 | | 136 | | 437 | | 303 | | 68 | |
| 1995-96 | 121 | | 168 | | 286 | | 253 | | 26 | |
| 1996-97 | 114 | | 188 | | 365 | | 843 | | 64 | |
| 1997-98 | 78 | | 122 | | 141 | | 375 | | 80 | |
| 1998-99 | 24 | 121 | 55 | 176 | 161 | 394 | 290 | 357 | 71 | 52 |
| 1999-00 | 22 | 121 | 89 | 176 | 264 | 394 | 347 | 357 | 80 | 52 |
| 2000-01 | 5 | 121 | 107 | 176 | 269 | 394 | 306 | 357 | 78 | 52 |
| 2001-02 | 7 | 121 | 53 | 176 | 198 | 394 | 370 | 357 | 62 | 52 |
| 2002-03 | 12 | 121 | 98 | 176 | 211 | 394 | 183 | 357 | 50 | 52 |
| 2003-04 | 12 | 121 | 120 | 176 | 175 | 394 | 299 | 357 | 50 | 52 |
| 2004-05 | 28 | 121 | 127 | 176 | 156 | 394 | 379 | 357 | 44 | 52 |
| 2005-06 | 49 | 121 | 137 | 176 | 126 | 394 | 202 | 357 | 47 | 52 |
| 2006-07 | 39 | 121 | 125 | 176 | 149 | 394 | 312 | 357 | 49 | 52 |
| 2007-08 | 53 | 121 | 135 | 176 | 134 | 394 | 173 | 357 | 43 | 52 |
| 2008-09 | 45 | 121 | 74 | 176 | 216 | 394 | 216 | 357 | 31 | 52 |
| 2009-10 | 28 | 121 | 63 | 176 | 213 | 394 | 162 | 357 | 27 | 52 |
| 2010-11 | 42 | 121 | 67 | 176 | 348 | 394 | 137 | 357 | 30 | 52 |

| | QMA 6 | | QMA 7 | | QMA 8 | | QMA 9 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1982-83 | 0 | | 58 | | 0 | | 0 | | 225 | |
| 1983-84 | 1 | | 25 | | 0 | | 0 | | 142 | |
| 1984-85 | 13 | | 18 | | 0 | | 0 | | 134 | |
| 1985-86 | 2 | | 37 | | 0 | | 0 | | 115 | |
| 1986-87 | 10 | | 6 | | 0 | | 0 | | 126 | |
| 1987-88 | 12 | | 68 | | 0 | | 0 | | 255 | |
| 1988-89 | 6 | | 69 | | 1 | | 10 | | 169 | |
| 1989-90 | 13 | | 21 | | 0 | | 0 | | 108 | |
| 1990-91 | 106 | | 55 | | 0 | | 0 | | 521 | |
| 1991-92 | 98 | | 40 | | 0 | | 0 | | 675 | |
| 1992-93 | 96 | | 106 | | 0 | | 0 | | 899 | |
| 1993-94 | 92 | | 42 | | 1 | | 0 | | 718 | |
| 1994-95 | 122 | | 39 | | 2 | | 6 | | 1 231 | |
| 1995-96 | 109 | | 62 | | 0 | | 0 | | 1 025 | |
| 1996-97 | 158 | | 77 | | 1 | | 0 | | 1 824 | |
| 1997-98 | 262 | | 110 | | 1 | | 1 | | 1 214 | |
| 1998-99 | 223 | 124 | 243 | 55 | 1 | 1 | 0 | 2 | 1 081 | 1 282 |
| 1999-00 | 237 | 124 | 300 | 55 | < 1 | 1 | < 1 | 2 | 1 359 | 1 282 |
| 2000-01 | 191 | 124 | 275 | 55 | < 1 | 1 | < 1 | 2 | 1 242 | 1 282 |
| 2001-02 | 322 | 124 | 254 | 55 | 0 | 1 | < 1 | 2 | 1 311 | 1 282 |
| 2002-03 | 172 | 124 | 338 | 55 | < 1 | 1 | 1 | 2 | 1 209 | 1 282 |
| 2003-04 | 205 | 124 | 364 | 55 | < 1 | 1 | 2 | 2 | 1 302 | 1 282 |
| 2004-05 | 105 | 124 | 307 | 55 | < 1 | 1 | 2 | 2 | 1 240 | 1 282 |
| 2005-06 | 62 | 124 | 336 | 55 | 0 | 1 | 4 | 2 | 1 018 | 1 282 |
| 2006-07 | 61 | 231 | 404 | 330 | 0 | 1 | 9 | 2 | 1 162 | 1 664 |
| 2007-08 | 80 | 231 | 356 | 330 | < 1 | 1 | 14 | 2 | 992 | 1 664 |
| 2008-09 | 63 | 231 | 456 | 330 | < 1 | 1 | 10 | 2 | 1 111 | 1 664 |
| 2009-10 | 104 | 231 | 137 | 330 | < 1 | 1 | 21 | 2 | 755 | 1 664 |
| 2010-11 | 67 | 231 | 198 | 330 | 2.7 | 1 | 20 | 2 | 913 | 1 664 |

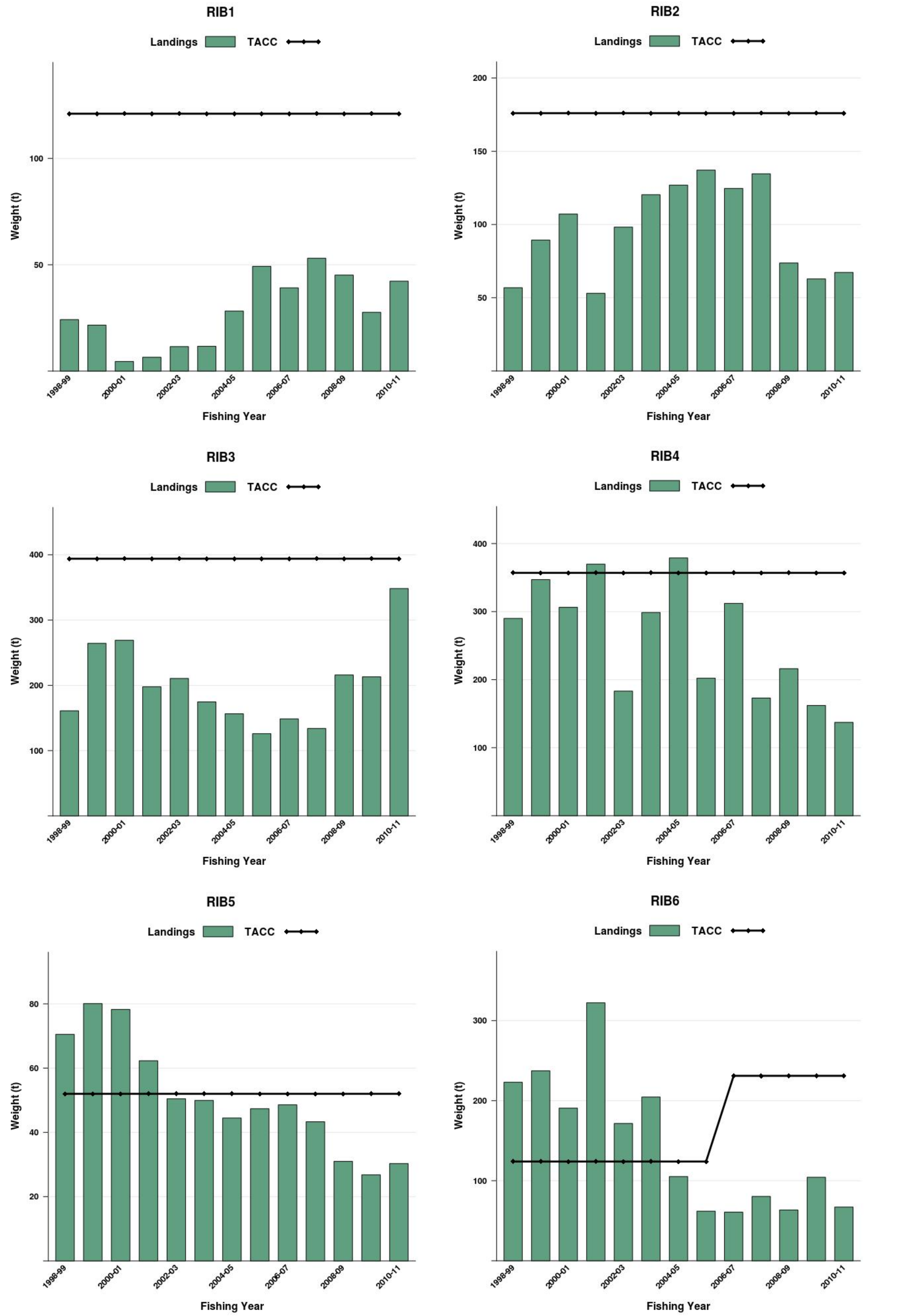



**Figure 1: Historical landings and TACC for the seven main RIB stocks. From top left: RIB1 (Auckland East), RIB2 (Central East), RIB3 (South East Coast), RIB4 (South East Chatham Rise), RIB5 (Southland), RIB6 (Sub-Antarctic). [Continued on next page].**

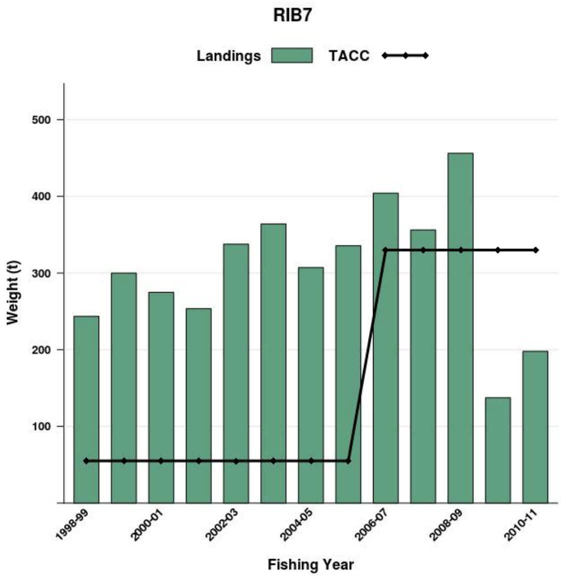



**Figure 1 [Continued]: Historical landings and TACC RIB7 (Challenger). Note that these figures do not show data prior to entry into the QMS.**

In RIB 1, ribaldo are taken as bycatch primarily in the ling and to lesser extent bluenose bottom longline fisheries. There is also some direct targeting of ribaldo by bottom longline. In RIB 2, ribaldo are taken as bycatch primarily in the ling and bluenose bottom longline fisheries and to a lesser extent the hoki and orange roughy bottom trawl fisheries. There is also some direct targeting of ribaldo by bottom longline. In RIB 8 very small catches (< 1 t) of ribaldo are reported mainly in bottom trawl and bottom longline fisheries for a variety of target species. There is no reported targeting of ribaldo in RIB 8 and since entering the QMS in the 1998-99 fishing year the TACC of one tonne has never been caught. In RIB 9 very small amounts of ribaldo are taken as bycatch in orange roughy, cardinal and alfonsino target trawl fisheries and in the ling bottom longline fishery. In all areas, a variety of other fishing methods and target fisheries also report catching ribaldo but only in negligible amounts. The majority of the ribaldo catch is taken in RIB 3-7. Fisheries interactions for these areas are described in the Status of the Stocks tables in Section 5.

### 1.2 Recreational fisheries
There are no known recreational fisheries for ribaldo.

### 1.3 Customary non-commercial fisheries
There is no known customary non-commercial fishing for ribaldo.

### 1.4 Illegal catch
Estimates of illegal catch are not available.

### 1.5 Other sources of mortality
There is no quantitative information on the level of other sources of mortality.

## 2. BIOLOGY

Ribaldo is known from the North Atlantic Ocean from Iceland to West Africa, the western Mediterranean Sea, the Indian Ocean south of Madagascar and the Pacific Ocean from Australia, New Zealand and Chile. In New Zealand it is widespread and has been caught by research trawl at depths of about 200-1300 m. It appears to be most common at 500-1000 m. The relatively high catch by bottom longline suggests that it favours rough bottom habitats.

Ribaldo reaches fork lengths (FL) of about 75 cm and 65 cm for females and males respectively. Most research trawls have caught fish ranging from 30 to 70 cm FL. The 50% length at sexual maturity has been estimated at 45 cm total length for New Zealand ribaldo (O'Driscoll *et al.* 2003). Analyses of data on female gonad development, collected by the Ministry of Fisheries Observer Programme, indicates a winter/early spring spawning season. Fish do not appear to form large spawning aggregations. Locations at which spawning fish have been observed are the upper North Island (extending outside the EEZ), north-east and west Chatham Rise, the area between the Snares and Auckland Islands shelves, and west coast of the South Island. Early life history is largely unknown but a few individuals less than 10 cm FL were captured in plankton nets in the upper 200 m of the water column over bottom depths of about 1000 m at the south west end of Chatham Rise. The distribution of juveniles < 28 cm is similar to that of observed spawning females. Juveniles up to 35 cm have been observed in all fished areas of the EEZ except for the Bounty Islands.

Ageing by zone counts of otoliths has been validated using radiometric techniques (Sutton *et al.* 2010) using ribaldo caught on Chatham Rise trawl surveys by *Tangaroa* from 2001 to 2005. Maximum observed ages were 37 and 39 years for females and males respectively. Von Bertalanffy growth parameters are presented in Table 3, estimates of natural mortality (*M*) are presented in Table 4 and length-weight parameters in Table 5.

Ribaldo are caught in low numbers both in research trawl surveys and in observed commercial fisheries making tracking of cohorts by length frequencies difficult. Collection of otoliths is required to construct catch-at-age series for any fishing areas. Analyses of trawl survey and observer data has shown that biomass of females is usually greater than that of males on the Chatham Rise although sex ratios are about 1:1. In the SubAntarctic the biomass and numbers of females are significantly greater than males, often over 10:1. Sex ratios elsewhere in the EEZ are less clear.

**Table 3: Von Bertalanffy growth parameter values for ribaldo. Source: Sutton *et al.* 2010.**

| Von Bertalanffy growth parameters | $K$ | $t_0$ | $L\infty$ |
|---|---|---|---|
| RIB 3 & 4 females | 0.135 | 0.221 | 67.526 |
| RIB 3 & 4 males | 0.072 | -5.246 | 61.444 |
| RIB 3 & 4 combined sexes | 0.14 | -0.287 | 60.47 |

**Table 4: Estimates of natural mortality (*M*). Source: Sutton *et al.* 2010.**

| | Females | Males |
|---|---|---|
| Natural mortality (*M*) | 0.106 | 0.112 |

**Table 5: Length-weight parameter values for ribaldo.**

| Fishstock | | | | Estimate | Source |
|---|---|---|---|---|---|
| Weight = a(length)b (Weight in g, length in cm total length) | | | | | |
| | Females | | Males | | |
| | a | b | a | b | |
| RIB 3 & 4 | 0.0037 | 3.27 | 0.0053 | 3.18 | Sutton *et al.* (2010) |
| RIB 5 & 6 | - | - | - | - | |
| | | | Sexes combined | | |
| | | | a | b | |
| RIB 3 & 4 | | | 0.004289 | 3.237753 | Sutton *et al.* (2010) |
| RIB 5 & 6 | | | 0.0039 | 3.15 | Bagley *et al.* (unpublished data) |

## 3. STOCKS AND AREAS

It is not known whether different regional stocks of ribaldo occur in New Zealand waters but it is possible that there are separate stocks based on natural bathymetric boundaries. The Working Group had previously agreed on five fishstocks based on the four main fishing areas plus the Kermadec area, i.e., the east coast of the North Island (QMAs 1 and 2), Chatham Rise and east coast South Island (QMAs 3 and 4), Southland and Sub-Antarctic (QMAs 5 and 6), the west coast of New Zealand (QMAs 7, 8 and 9) and QMA 10. A review of all available information in 2010 indicated that the main fishing areas are still as found previously. The review also indicated spawning activity in all areas, except RIB 8 and RIB 10 (for which there is no information). This is not inconsistent with the management of the fishery by the current 10 FMAs. Highly skewed sex ratios in the SubAntarctic have unknown implications for stock structure.

## 4. STOCK ASSESSMENT

The Middle Depths Working Group agreed in February 2011 that relative biomass estimates of ribaldo from middle depth trawl surveys on the Chatham Rise and the SubAntarctic were suitable for monitoring major changes in ribaldo abundance for RIB 3 & 4 and RIB 5 & 6 respectively. Standardised CPUE indices from the spawning hoki and hake target fisheries in RIB 7 were not accepted although this could possibly be revisited in future using daily processed catch of ribaldo instead of estimated catch at the tow by tow level. There are no stock monitoring indices available for RIB 1, 2, 8 & 9

### 4.1 Estimates of fishery parameters and abundance

No estimates of fishery parameters have been made. Analyses of research trawl survey abundance estimates on the Chatham Rise and Sub-Antarctic suggest they may be suitable for monitoring major changes in abundance. While the Sub-Antarctic survey does not fully cover the depth range of ribaldo the Chatham Rise survey has been extended down to 1300 m since 2010. Biomass from the deep strata (800-1300 m) accounted for 23% of the total ribaldo biomass in 2010.

Dunn (2006) described the fishery up to 2002-03 but found that interpreting CPUE data was difficult because ribaldo are taken mainly as by-catch of other fisheries and the CPUE may reflect changes in those fisheries rather than ribaldo abundance. MacGibbon & Hurst (2011) carried out a standardised trawl CPUE analysis of hoki and hake in RIB 7 from 1999-2009. The index was problematic for the same reasons listed above. The trend showed a slight decline from 1999 to 2002 and was fairly steady thereafter.

### 4.2 Biomass estimates

Estimates of biomass are given in Table 6.

### 4.3 Estimation of Maximum Constant Yield (*MCY*)

*MCY* cannot be estimated.

### 4.4 Estimation of Current Annual Yield (*CAY*)

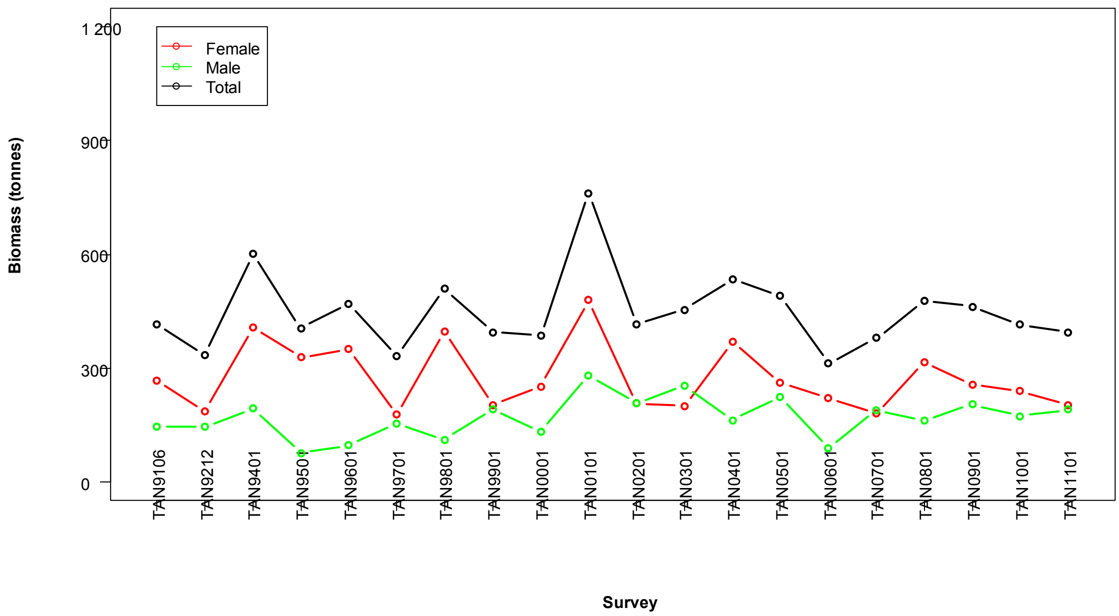
*CAY* cannot be estimated.

### 4.5 Other yield estimates and stock assessment results

No information is available.

**Table 6: Biomass indices (t) and coefficients of variation (CV) of ribaldo from *Tanagroa* trawl surveys (Assumptions: areal availability, vertical availability and vulnerability = 1). NB: estimates are for the core strata only for the respective time series.**

| Vessel | Trip code | Date | Biomass (t) | %CV |
|---|---|---|---|---|
| Chatham Rise (RIB 3 & 4) | | | | |
| *Tangaroa* | TAN9106 | Dec 91-Feb 92 | 417 | 12.2 |
| | TAN9212 | Dec 92-Feb 93 | 336 | 17.2 |
| | TAN9401 | Jan-94 | 602 | 10.8 |
| | TAN9501 | Jan-Feb 95 | 406 | 19.7 |
| | TAN9601 | Dec 95-Jan 96 | 470 | 18.2 |
| | TAN9701 | Jan-Jan 97 | 333 | 21.3 |
| | TAN9801 | Jan-Jan 98 | 510 | 14.3 |
| | TAN9901 | Jan-Jan 99 | 395 | 18 |
| | TAN0001 | Dec 99-Jan 00 | 387 | 20.8 |
| | TAN0101 | Dec 00-Jan 01 | 762 | 18.3 |
| | TAN0201 | Dec 01-Jan 02 | 417 | 13.2 |
| | TAN0301 | Dec 02-Jan 03 | 455 | 18.1 |
| | TAN0401 | Dec 03-Jan 04 | 535 | 15.6 |
| | TAN0501 | Dec 04-Jan 05 | 491 | 14.2 |
| | TAN0601 | Dec 05-Jan 06 | 313 | 16.9 |
| | TAN0701 | Dec 06-Jan 07 | 380 | 15 |
| | TAN0801 | Dec 07-Jan 08 | 479 | 14.3 |
| | TAN0901 | Dec 08-Jan 09 | 463 | 12.7 |
| | TAN1001 | Jan-10 | 416 | 19.9 |
| | TAN1101 | Jan-11 | 396 | 16.7 |
| SubAntarctic (summer, RIB 5 & 6) | | | | |
| *Tangaroa* | TAN9105 | Nov-Dec 91 | 1035 | 11.2 |
| | TAN9211 | Nov-Dec 92 | 389 | 18.6 |
| | TAN9310 | Nov-Dec 93 | 996 | 12.8 |
| | TAN0012 | Nov-Dec 00 | 873 | 14 |
| | TAN0118 | Nov-Dec 01 | 1 017 | 17.2 |
| | TAN0219 | Nov-Dec 02 | 656 | 17.5 |
| | TAN0317 | Nov-Dec 03 | 653 | 18.9 |
| | TAN0414 | Nov-Dec 04 | 951 | 16.5 |
| | TAN0515 | Nov-Dec 05 | 721 | 14.6 |
| | TAN0617 | Nov-Dec 06 | 780 | 16.4 |
| | TAN0714 | Nov-Dec 07 | 1 062 | 13.5 |
| | TAN0813 | Nov-Dec 08 | 658 | 18 |
| | TAN0911 | Nov-Dec 09 | 1 056 | 13.4 |
| | TAN1117 | Nov-Dec 11 | 1 017 | 17.2 |
| *Tangaroa* | TAN9204 | Apr-May 92 | 768 | 17.1 |
| | TAN9304 | May-Jun 93 | 1 162 | 15.1 |
| | TAN9605 | Mar-Apr 96 | 989 | 16.7 |
| | TAN9805 | Apr-May 98 | 837 | 14.2 |



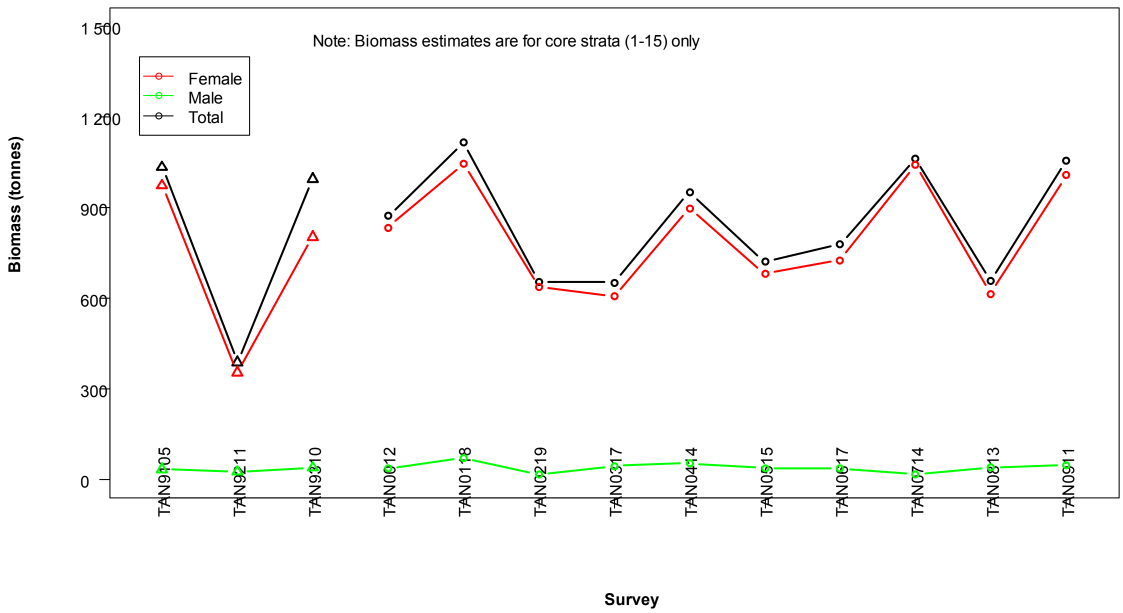




**Figure 2: Doorspread biomass estimates of ribaldo by sex from the Chatham Rise 1991 to 2011 (upper) and Sub-Antarctic 1991 to 1993 and 2000 to 2009 (lower), from *Tangaroa* trawl surveys.**

# 5. STATUS OF THE STOCKS

## RIB 1, 2, 7, 8 and 9

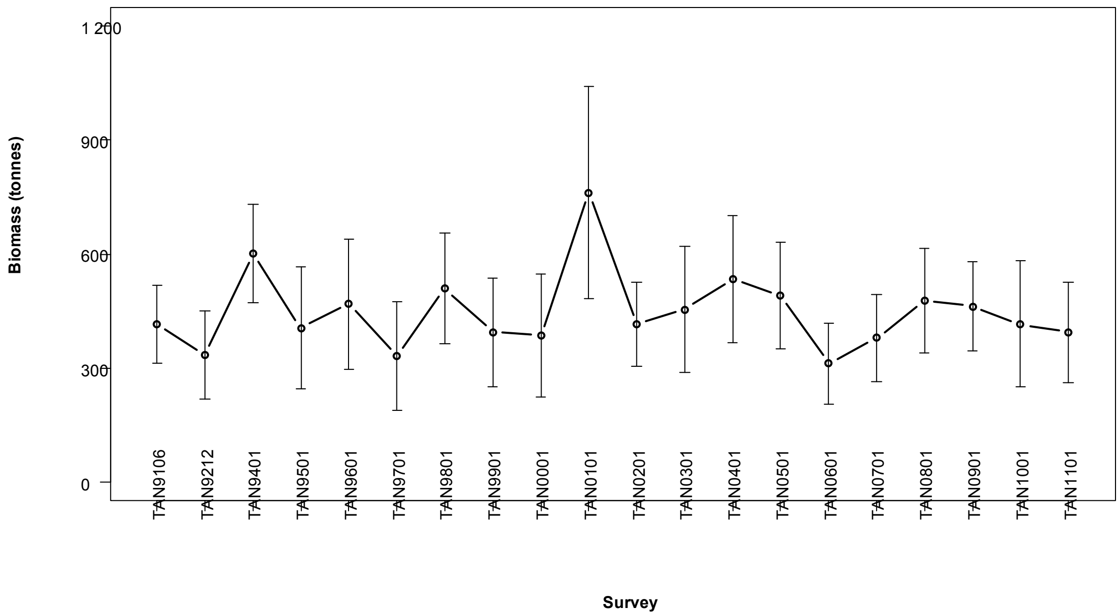
There are no accepted stock monitoring indices available for RIB 1, 2, 7, 8 & 9.

## RIB 3 & 4

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Reference Points | Target: Not established but 40% $B_0$ assumed<br>Soft Limit: 20% $B_0$ |

| | |
|---|---|
| | Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Unlikely (< 40%) to be below soft limit.<br>Unlikely (< 40%) to be below hard limit |

**Historical Stock Status Trajectory and Current Status**




**Doorspread biomass estimates of ribaldo (error bars are ± two standard deviations) from the Chatham Rise, from *Tangaroa* surveys from 1991 to 2011.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The relative biomass index of ribaldo from summer middle depth trawl surveys of the Chatham Rise is relatively flat. Precision is generally good in this time series (< 20%). Although numbers of individual ribaldo caught are low the Working Group considered this index to be suitable to monitor major trends in this stock. |
| Recent Trend in Fishing Mortality or Proxy | |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Stock size is Likely (> 60%) to remain near current levels under current catches. |
| Probability of Current Catch or TACC causing decline below Limits | Soft limit: Unlikely (< 40%) for current catches<br>Hard limit: Unlikely (< 40%) for current catches |

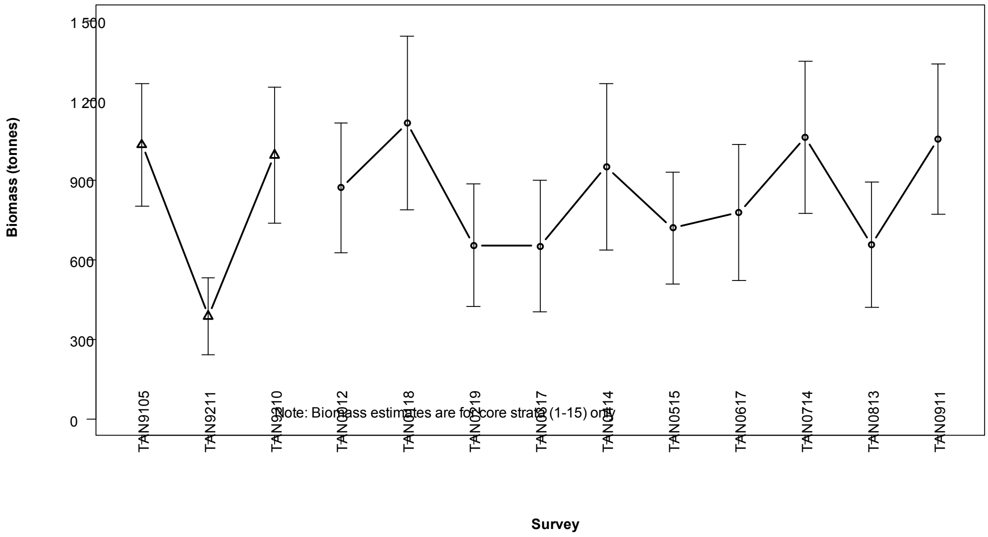
| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2: Partial quantitative stock assessment | |
| Assessment Method | Evaluation of agreed trawl survey indices thought to index RIB 3 & 4 abundance. | |
| Main data inputs | Data collected on trawl surveys. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2012 |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | Low numbers of individuals caught on trawl surveys; proportion of biomass deeper than 800 m (not surveyed in core strata) | |
| **Qualifying Comments** | | |
| - | | |

| **Fishery Interactions** |
|---|
| In RIB 3 & 4, ribaldo are taken as bycatch primarily in the ling and hoki bottom trawl fisheries and ling bottom longline fishery. |

**RIB 5 & 6**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Reference Points | Target: Not established but 40% $B_0$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Unlikely (< 40%) to be below soft limit<br>Unlikely (< 40%) to be below hard limit |

**Historical Stock Status Trajectory and Current Status**




**Doorspread biomass estimates of ribaldo (error bars are ± two standard deviations) from the Sub-Antarctic, from *Tangaroa* surveys from 1991 to 1993, and 2000 to 2009.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | Relative biomass estimates of ribaldo from summer middle depth surveys of the SubAntarctic show a relatively flat index. CVs are consistently low in this time series (< 20%). Although numbers of individual ribaldo caught are low the Working Group considered this index to be suitable to monitor major trends in this stock. |

| | |
|---|---|
| Recent Trend in Fishing Mortality or Proxy | Unknown |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Stock size is Likely (> 60%) to remain near current levels under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Soft limit: Unknown<br>Hard limit: Unlikely (< 40%) |
| **Assessment Methodology** | |
| Assessment Type | Level 2: Partial quantitative stock assessment |
| Assessment Method | Evaluation of agreed trawl survey indices thought to index RIB 5 & 6 abundance. |
| Main data inputs | Data collected on trawl surveys. |

| Period of Assessment | Latest assessment: 2011 | Next assessment: 2012 |
|---|---|---|
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | Low numbers of individuals caught on trawl surveys; proportion of biomass deeper than 800 m (not surveyed in core strata); and unknown implications of highly skewed sex ratios (females usually make up > 90% of biomass) for stock structure. Observer data also shows skewed sex ratios in favour of females. | |

| **Qualifying Comments** |
|---|
| - |

| **Fishery Interactions** |
|---|
| In RIB 5 & 6, ribaldo are mainly caught as bycatch in hoki and ling bottom trawl fisheries and ling bottom longline fisheries. |

TACCs and reported landings for the 2010-11 fishing year are summarised in Table 7.

**Table 7: Summary of TACCs (t) and reported landings (t) of ribaldo for the most recent fishing year.**

| Fishstock | | QMA | 2010-11 Actual TACC | 2010-11 Estimated landings |
|---|---|---|---|---|
| RIB 1 | Auckland (East) | 1 | 121 | 42 |
| RIB 2 | Central (East) | 2 | 176 | 67 |
| RIB 3 | South-east (Coast) | 3 | 394 | 348 |
| RIB 4 | South-east (Chatham) | 4 | 357 | 137 |
| RIB 5 | Southland | 5 | 52 | 30 |
| RIB 6 | Sub-Antarctic | 6 | 231 | 67 |
| RIB 7 | Challenger | 7 | 330 | 198 |
| RIB 8 | Central (West) | 8 | 1 | 3 |
| RIB 9 | Auckland (West) | 9 | 2 | 20 |
| RIB 10 | Kermadec | 10 | 0 | 0 |
| Total | | | 1 664 | 913 |

## 6. FOR FURTHER INFORMATION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Dunn M.R. 2006. Descriptive and catch per unit effort analyses for New Zealand ribaldo fisheries for the fishing years 1988-78 to 2002-03> New Zealand Fisheries Assessment Document 2006/22. 55p.

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MacGibbon D.J., Hurst R.J. 2011. Fishery characterisation and standardised CPUE analyses for ribaldo, *Mora moro*, (Risso, 1810) (Moridae), 1989-90 to 2008-09. New Zealand Fisheries Assessment Report 2011/XX

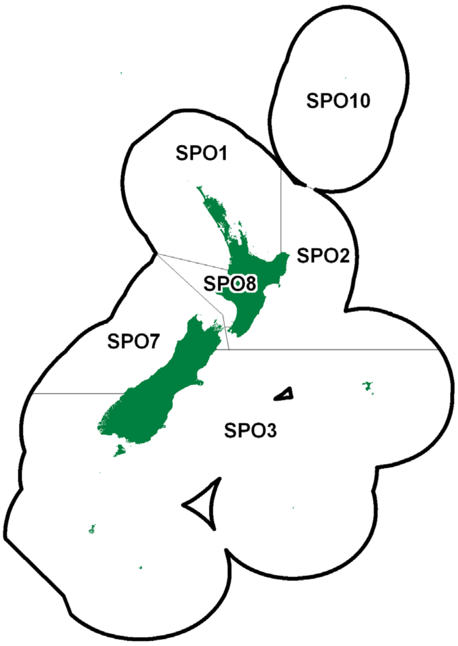
McMillan P.J., Hart A.C. 1998. Summary of biology and commercial landings, and a stock assessment of ribaldo *Mora moro* (Risso, 1810), in New Zealand waters. New Zealand Fisheries Assessment Research Document 1998/9. 16p.

O'Driscoll R.L., Booth J.D., Bagley N.W., Anderson O.F., Griggs L.H., Stevenson M.L., Francis M.P. 2003. Areas of importance for spawning, pupping or egg-laying, and juveniles of New Zealand deepwater fish, pelagic fish, and invertebrates. NIWA Technical Report 119. 377 p.

Sutton C.P., Tracey D.M., Andrews A.H., Hart A.C., MacGibbon D.J. 2010. Validated age and growth of ribaldo (*Mora moro*). *New Zealand Fisheries Assessment Report 2010/24.*26 p.

# RIG (SPO)

*(Mustelus lenticulatus)*
Pioke, Makoo




## 1. FISHERIES SUMMARY

### 1.1 Commercial fisheries

Rig are caught in coastal waters throughout New Zealand. Most of the catch is taken in water less than 50 m deep during spring and summer, when rig aggregate inshore. Before the introduction of the QMS in 1986, 80% of the commercial catch was taken by bottom setnet and most of the remainder by trawl. Total reported landings of rig increased rapidly during the 1970s, and averaged about 3200 t per year during the late 1970s and early 1980s (Table 1). Since then, a larger proportion has been taken by trawlers as bycatch, but the exact split by method is unknown (because method data were available only for a portion of the rig catch in the CELR database). The most important bottom setnet fisheries are at 90-Mile Beach, Kaipara Harbour, Manukau Harbour, South Taranaki Bight – Tasman/Golden Bay, Canterbury Bight, Kaikoura and Hauraki Gulf. Due to a decline in CPUE the TACC for SPO 7 was decreased to 221 t on the 1st October 2006. Figure 1 shows the historical landings and TACC values for the main SPO stocks.

**Table 1: Reported total New Zealand landings (t) of rig for the calendar years 1965 to 1985. Sources: MAF and FSU data.**

| Year | Landings | Year | Landings | Year | Landings | Year | Landings | Year | Landings |
|---|---|---|---|---|---|---|---|---|---|
| 1965 | 723 | 1970 | 930 | 1975 | 1 841 | 1980 | 3 000 | 1985 | 3 222 |
| 1966 | 850 | 1971 | 1 120 | 1976 | 2 610 | 1981 | 3 006 | | |
| 1967 | 737 | 1972 | 1 011 | 1977 | 3 281 | 1982 | 3 425 | | |
| 1968 | 677 | 1973 | – | 1978 | 3 300 | 1983 | 3 826 | | |
| 1969 | 690 | 1974 | 2 040 | 1979 | 2 701 | 1984 | 3 562 | | |

Following the introduction of rig to the QMS in 1986, landings declined to less than half those of the previous decade in response to the TACCs. Since 1986–87, landings have generally increased in response to TACC increases (Table 2). TACCs for all Fishstocks except SPO 10 were increased by 20% for the 1991–92 fishing year under the Adaptive Management Programme (AMP). Another TACC increase (from 454 t to 600 t) was implemented in SPO 3 for the 2000–01 fishing year. The TACCs for SPO 1, SPO 2 and SPO 8 reverted to the pre-AMP levels in the 1997–98 fishing year, when these Fishstocks were removed from the AMP in July 1997. The TACC for SPO 2 was increased from 72 t to 86 t from 1 October 2004 under the low knowledge bycatch framework (Table 4).

In October 1992, the conversion factors for headed and gutted, and dressed, rig were both reduced from 2.00 to 1.75. They were each further reduced to 1.55 in 2000-01. Landings prior to 2000-01 have not been adjusted for the changes in the conversion factor. All AMP programmes ended on 30 September 2009.

Commercial landings of rig in SPO 1 have declined consistently since 1991-92. Although changes to the conversion factors mean that landings prior to 2000-01 are overestimated, catches since that time have continued to decline.

The Banks Peninsula Marine Mammal Sanctuary was established in 1988 by the Department of Conservation under the Marine Mammal Protection Act 1978, for the purpose of protecting Hector's dolphins. The sanctuary extends 4 nautical miles from the coast from Sumner Head in the north to the Rakaia River mouth in the south. Prior to 1 October 2008, no setnets were allowed within the sanctuary between 1 November to the end of February. For the remainder of the year, setnets were allowed; but could only be set from an hour after sunrise to an hour before sunset, be no more than 30 metres long, with only one net per boat which was required to remain tied to the net while it was set.

Voluntary setnet closures were implemented by the SEFMC from 1 October 2000 to protect nursery grounds for rig and elephantfish and to reduce interactions between commercial setnets and Hector's dolphins in shallow waters. The closed area extended from the southern most end of the Banks Peninsula Marine Mammal Sanctuary to the northern bank of the mouth of the Waitaki River. This area was closed permanently for a distance of 1 nautical mile offshore and for 4 nautical miles offshore for the period 1 October to 31 January.

From 1 October 2008, a suite of regulations intended to protect Maui's and Hector's dolphins was implemented for all of New Zealand by the Minister of Fisheries.

For SPO 1, there have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island. The first was a closure to setnet fishing from Maunganui Bluff to Pariokariwa Point for a distance of 4 nautical miles on 1 October 2003. This closure was extended by the Minister to 7 nautical miles on 1 October 2008. An appeal was made by affected fishers who were granted interim relief by the High Court, allowing setnet fishing beyond 4 nautical miles during daylight hours between 1 October to 24 December.

For SPO 3, commercial and recreational set netting was banned in most areas to 4 nautical miles offshore of the east coast of the South Island, extending from Cape Jackson in the Marlborough Sounds to Slope Point in the Catlins. Some exceptions were allowed, including an exemption for commercial and recreational set netting to only one nautical mile offshore around the Kaikoura Canyon, and permitting setnetting in most harbours, estuaries, river mouths, lagoons and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour and Timaru Harbour. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SPO 5, commercial and recreational setnetting was banned in most areas to 4 nautical miles offshore, extending from Slope Point in the Catlins to Sandhill Point east of Fiordland and in all of Te Waewae Bay. An exemption which permitted setnetting in harbours, estuaries and inlets was allowed. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SPO 7, both commercial and recreational setnetting were banned to 2 nautical miles offshore, with the recreational closure effective for the entire year and the commercial closure restricted to the period 1 December to the end of February. The closed area extends from Awarua Point north of Fiordland to the tip of Cape Farewell at the top of the South Island. There is no equivalent closure in SPO 8, with the southern limit of the Maui's dolphin closure beginning north of New Plymouth at Pariokariwa Point. There have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island.

**Table 2: Reported landings (t) of rig by Fishstock from 1985–86 to 2010–11 and actual TACCs (t) from 1986–87 to 2010-11. QMS data from 1986–present.**

| Fishstock | SPO 1 | | SPO 2 | | SPO 3 | | SPO 7 | | SPO 8 | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA (s) | 1 & | | 2 | | 3,4,5, & 6 | | 7 | | 8 | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1985–86* | 845 | – | 96 | – | 921 | – | 367 | – | 465 | – |
| 1986–87 | 366 | 540 | 55 | 60 | 312 | 330 | 233 | 240 | 125 | 240 |
| 1987–88 | 525 | 614 | 66 | 68 | 355 | 347 | 262 | 269 | 187 | 261 |
| 1988–89 | 687 | 653 | 68 | 70 | 307 | 352 | 239 | 284 | 212 | 295 |
| 1989–90 | 689 | 687 | 61 | 70 | 292 | 359 | 266 | 291 | 206 | 310 |
| 1990–91 | 656 | 688 | 63 | 71 | 284 | 364 | 268 | 294 | 196 | 310 |
| 1991–92 | 878 | 825 | 105 | 85 | 352 | 430 | 290 | 350 | 145 | 370 |
| 1992–93 | 719 | 825 | 90 | 86 | 278 | 432 | 324 | 350 | 239 | 370 |
| 1993–94 | 631 | 829 | 96 | 86 | 327 | 452 | 310 | 350 | 255 | 370 |
| 1994–95 | 666 | 829 | 88 | 86 | 402 | 454 | 341 | 350 | 273 | 370 |
| 1995–96 | 603 | 829 | 107 | 86 | 408 | 454 | 400 | 350 | 330 | 370 |
| 1996–97 | 681 | 829 | 99 | 86 | 434 | 454 | 397 | 350 | 277 | 370 |
| 1997–98 | 621 | 692 | 85 | 72 | 442 | 454 | 325 | 350 | 287 | 310 |
| 1998–99 | 553 | 692 | 86 | 72 | 426 | 454 | 336 | 350 | 235 | 310 |
| 1999–00 | 608 | 692 | 86 | 72 | 427 | 454 | 330 | 350 | 219 | 310 |
| 2000–01 | 554 | 692 | 81 | 72 | 458 | 600 | 338 | 350 | 174 | 310 |
| 2001–02 | 436 | 692 | 86 | 72 | 391 | 600 | 282 | 350 | 216 | 310 |
| 2002–03 | 477 | 692 | 86 | 72 | 417 | 600 | 264 | 350 | 209 | 310 |
| 2003–04 | 481 | 692 | 81 | 72 | 354 | 600 | 293 | 350 | 203 | 310 |
| 2004–05 | 429 | 692 | 108 | 86 | 366 | 600 | 266 | 350 | 208 | 310 |
| 2005–06 | 345 | 692 | 110 | 86 | 389 | 600 | 288 | 350 | 163 | 310 |
| 2006–07 | 400 | 692 | 101 | 86 | 423 | 600 | 265 | 221 | 176 | 310 |
| 2007–08 | 297 | 692 | 104 | 86 | 472 | 600 | 231 | 221 | 220 | 310 |
| 2008–09 | 297 | 692 | 106 | 86 | 328 | 600 | 233 | 221 | 222 | 310 |
| 2009-10 | 302 | 692 | 114 | 86 | 371 | 600 | 229 | 221 | 246 | 310 |
| 2010-11 | 311 | 692 | 106 | 86 | 395 | 600 | 229 | 221 | 220 | 310 |

| Fishstock | SPO 10 | | | |
|---|---|---|---|---|
| FMA (s) | 10 | | Total | |
| | Landings | TACC | Landings§ | TACC |
| 1985–86* | 0 | – | 2 906 | – |
| 1986–87 | 0 | 10 | 1 091 | 1 420 |
| 1987–88 | 0 | 10 | 1 395 | 1 569 |
| 1988–89 | 0 | 10 | 1 513 | 1 664 |
| 1989–90 | 0 | 10 | 1 514 | 1 727 |
| 1990–91 | 0 | 10 | 1 467 | 1 737 |
| 1991–92 | 0 | 10 | 1 770 | 2 070 |
| 1992–93 | 0 | 10 | 1 650 | 2 072 |
| 1993–94 | 0 | 10 | 1 619 | 2 097 |
| 1994–95 | 0 | 10 | 1 769 | 2 098 |
| 1995–96 | 0 | 10 | 1 848 | 2 098 |
| 1996–97 | 0 | 10 | 1 888 | 2 098 |
| 1997–98 | 0 | 10 | 1 760 | 1 888 |
| 1998–99 | 0 | 10 | 1 635 | 1 888 |
| 1999–00 | 0 | 10 | 1 670 | 1 888 |
| 2000–01 | 0 | 10 | 1 607 | 2 034 |
| 2001–02 | 0 | 10 | 1 411 | 2 034 |
| 2002–03 | 0 | 10 | 1 453 | 2 034 |
| 2003–04 | 0 | 10 | 1 412 | 2 034 |
| 2004–05 | 0 | 10 | 1 377 | 204 8 |
| 2005–06 | 0 | 10 | 1 295 | 2 048 |
| 2006–07 | 0 | 10 | 1 365 | 1 919 |
| 2007–08 | 0 | 10 | 1 324 | 1 919 |
| 2008–09 | 0 | 10 | 1 186 | 1 919 |
| 2009-10 | 0 | 10 | 1 262 | 1 919 |
| 2010-11 | 0 | 10 | 1 260 | 1 919 |

*FSU data.

§Includes landings from unknown areas before 1986-87

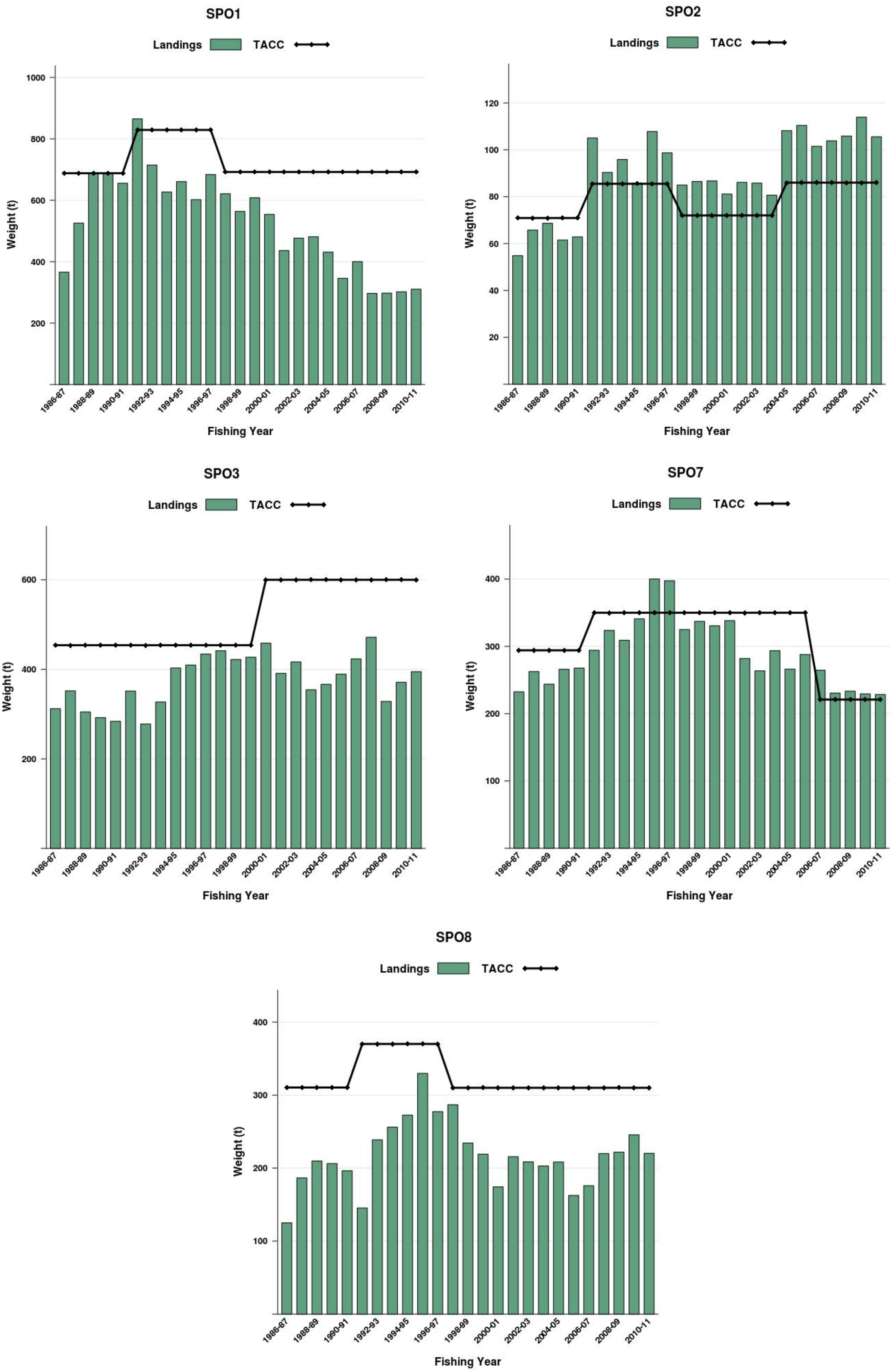



**Figure 1: Historical landings and TACC for the five main SPO stocks. From top left: SPO1 (Auckland East), SPO2 (Central East), SPO3 (South East Coast), SPO7 (Challenger), and SPO8 (Central Egmont). Note that these figures do not show data prior to entry into the QMS.**

SPO 7 is managed under a stakeholder led fisheries plan. This fisheries plan was developed by the Challenger Finfisheries Management Company Limited on behalf of quota owners and includes details of rebuild goals and objectives for the rig fishery in quota management area 7 (SPO 7). It represents part of the commitment made by 93% of the rig quota owners towards improving the value of their property rights and ensuring the future utilisation of the fishery for future generations. This plan was submitted to the Minister of Fisheries for approval pursuant to Section 11(a) of the Fisheries Act 1996. The plan seeks to improve the productivity of the SPO 7 fishstock through implementing area closures and catch reductions.

### 1.2 Recreational fisheries

Rig are caught by recreational fishers throughout New Zealand. Less that 3% of the recaptures of rig tagged around the South Island and Manawatu coasts in 1982–84 were returned by recreational fishers. Estimates of recreational landings obtained from three surveys, 1991–92 to 1993–94, 1996 and 1999–00 are given in Table 3. Recreational landings between 1991 and 1994 comprised only a small proportion (< 15%) of the total rig harvest in all Fishstocks.

**Table 3: Estimated number and weight of rig harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991–92, Central in 1992–93, North in 1993–94 (Teirney *et al.* 1997) and nationally in 1996 (Bradford 1998) and 1999–00 (Boyd & Reilly 2002). Survey harvests are presented as a range to reflect the uncertainty in the estimates.**

| Fishstock | Survey | Number | CV% | Harvest Range (t) | Point estimate (t) |
|---|---|---|---|---|---|
| 1991–92 | | | | | |
| SPO 3 | South | 12 000 | 22 | 15–30 | - |
| | | | | | |
| 1992–93 | | | | | |
| SPO 2 | Central | 5 000 | - | 5–15 | - |
| SPO 7 | Central | 8 000 | 39 | 10–25 | |
| SPO 8 | Central | 18 000 | 43 | 20–60 | - |
| | | | | | |
| 1993–94 | | | | | |
| SPO 1 | North | 11 000 | 21 | 5–25 | - |
| SPO 8 | North | 1 000 | - | 0–5 | |
| | | | | | |
| 1996 | | | | | |
| SPO 1 | National | 28 000 | 31 | 25–45 | 35 |
| SPO 2 | National | 4 000 | - | - | - |
| SPO 3 | National | 12 000 | 20 | 10–20 | 15 |
| SPO 7 | National | 19 000 | 20 | 20–30 | 24 |
| SPO 8 | National | 7 000 | - | - | - |
| | | | | | |
| 1999–00 | | | | | |
| SPO 1 | National | 13 000 | 30 | 12–23 | 17 |
| SPO 2 | National | 16 000 | 58 | 9–33 | 21 |
| SPO 3 | National | 43 000 | 32 | 39–75 | 57 |
| SPO 7 | National | 33 000 | 38 | 21–46 | 33 |
| SPO 8 | National | 7 000 | 48 | 5–13 | 9 |

The Recreational Technical Working Group concluded that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and, c) the 2000 and 2001 estimates are implausibly high for many important fisheries.

### 1.3 Customary non-commercial fisheries

Maori fishers traditionally caught large numbers of "dogfish" during the last century and early this century. Rig was probably an important species, though spiny dogfish and school shark were also taken. The historical practice of having regular annual fishing expeditions, during which thousands of dogfish were sun-dried on wooden frames, is no longer prevalent. However, rig are still caught in small quantities by customary non-commercial fishers in parts of the North Island, especially the harbours of the Auckland region. Quantitative information on the current level of customary non-commercial take is not available.

### 1.4 Illegal Catch

Quantitative information on the level of illegal catch is not available.

### 1.5 Other sources of mortality

Unknown quantities of juvenile rig are caught by setnets placed in harbours and shallow bays. Quantitative information on the level of other sources of mortality is not available.

**Table 4: Total Allowable Catch (TAC, t), Total Allowable Commercial Catch (TACC, t), and recreational, non-commercial customary, and other fishing mortality allowances (t) declared for SPO as of October 2010.**

| Fishstock | TAC | TACC | Customary Non-Commercial Catch | Recreational | Other Mortality |
|---|---|---|---|---|---|
| SPO 1 (FMA 1 & 9) | 752 | 692 | 20 | 25 | 15 |
| SPO 2 | 122 | 86 | 20 | 10 | 6 |
| SPO 3 (FMA 3-6) | 710 | 600 | 20 | 60 | 30 |
| SPO 7 | 270 | 221 | 15 | 29 | 5 |
| SPO 8 | 401 | 310 | 0 | 0 | 0 |
| SPO 10 | 10 | 10 | 0 | 0 | 0 |

## 2. BIOLOGY

Rig are born at a total length (TL) of 25–30 cm. On the South Island male and female rig attain maturity at 5–6 yrs (~ 85 cm) and 7–8 yrs (~ 100 cm), respectively (Francis & O'Maolagain 2000). Rig in the Hauraki Gulf mature earlier – 4 yrs for males and 5 yrs for females – and at smaller sizes (Francis & Francis 1992). Longevity is not known because few large fish have been aged, however, a male rig that was mature at tagging was recaptured after nearly 14 years of liberty, suggesting a longevity of 20 years or longer. Females reach a maximum length of 151 cm and males 126 cm TL.

Rig give birth to young during spring and summer following a 10–11 month gestation period. Most females begin a new pregnancy immediately after parturition, and therefore breed annually. The number of young produced increases exponentially with the length of the mother, and ranges from 2 to 37 (mean ~ 11). Young are generally born in shallow coastal waters, especially in harbours and estuaries, throughout North and South Islands. They grow rapidly during their first summer, and then disappear as water temperatures drop in autumn-winter. They presumably move into deeper water.

Rig make extensive coastal migrations, with one tagged female moving a least 1160 km. Over half of the tagged rig that were recaptured had moved over 50 km, and over half of the females had moved more than 200 km. Females travel further than males, and mature females travel further than immature females.

Biological parameters relevant to stock assessment are shown in Table 5.

**Table 5: Estimates of biological parameters for rig.**

| Fishstock | | | | | | Estimate | Source |
|---|---|---|---|---|---|---|---|
| 1. Natural mortality (*M*) | | | | | | | |
| All | | | | | | 0.2–0.3 | Francis & Francis (1992a) |
| 2. Weight = a(length) (Weight in g, length in cm fork length). | | | | | | | |
| | | | Females | | | Males | |
| | | a | b | | a | b | |
| SPO3 | | $3.67 \times 10^{-7}$ | 3.54 | | $1.46 \times 10^{-6}$ | 3.22 | Francis (1979) |
| SPO 7&8 | | $9.86 \times 10^{-7}$ | 3.32 | | $3.85 \times 10^{-}$ | 3.01 | Blackwell (unpubl. data) |
| 3. von Bertalanffy growth parameters | | | | | | | |
| | | | Females | | | Males | |
| | $L_\infty$ | k | $t_o$ | $L_\infty$ | k | $t_o$ | |
| SPO 1 | 90.7 | 0.42 | -0.77 | 118.7 | 0.16 | -2.02 | Francis & Francis (1992a) |
| SPO3 | 87.0 | 0.40 | -0.68 | 161.1 | 0.11 | -1.91 | Francis & Francis (1992a) |
| | | | | | | Both Sexes | |
| | | | | L | k | $t_o$ | |
| SPO 3 &7 | | | | 147.2 | 0.119 | -2.35 | Francis & Ó Maolagáin (2000) |

## 3. STOCKS AND AREAS

Information relevant to determining rig stock structure in New Zealand was reviewed in 2009 (Smith 2009, Blackwell & Francis 2010, Francis 2010). These reviews concluded that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. Insufficient tagging occurred in SPO 1 to determine whether division of that stock into separate 1E and 1W stocks is warranted.

Genetic, biological, fishery and tagging data were all considered, but the evidence available for the existence and geographical distribution of biological stocks is poor. Some differences were found in CPUE trends at a small spatial scale but stock separation at the indicated spatial scales seems unlikely, and the CPUE differences may have resulted from processes acting below the stock level, such as localised exploitation of different sexes or different size classes of sharks. Genetic and morphological evidence indicate that a separate undescribed species of *Mustelus* occurs at the Kermadec Islands, but it is not known if rig also occurs there.

The most useful source of information was a tagging programme undertaken mainly in 1982–84 (Francis 1988). However, most tag releases were made around the South Island, so little information was available for North Island rig. Male rig rarely moved outside the release QMA, even after more than 5 years at liberty. Female rig were more mobile than male rig, with about 30% of recaptures reported beyond the release QMA boundaries within 2–5 years of release. The proportion reported beyond the release QMA increased steadily with time. However, few females moved more than one QMA away from the release point. Because males move shorter distances than females, a conservative management approach is to set rig QMAs at a size appropriate for male stock ranges.

## 4. STOCK ASSESSMENT

There are no new data which would alter the yield estimates given in the 1997 Plenary Report. The yield estimates are based on commercial landings data only.

### 4.1 Estimates of fishery parameters and abundance

**SPO 1 and SPO 8**

Standardised CPUE indices were calculated for SPO 8 and for five sub-areas in SPO 1 by modelling (GLM) non-zero catches by core vessels targeting rig with setnets between 1989–90 and 2009-10 (Kendrick & Bentley 2011). The SPO 1 analyses were complicated by the fact that up to 50% of catches were accumulated ashore for subsequent landing to Licensed Fish Receiver, breaking the link between effort and the landing. Estimated catches are unreliable in rig fisheries because many fishers report the processed weight rather than the expected green weight. A standardised CPUE analysis which attempted to correct this bias by calculating an annual correction factor for each vessel was rejected by the NINSWG, which suggested that this new methodology required further detailed investigation before acceptance. CPUE standardisations based on SPO 1 bottom trawl data were accepted as indices of abundance by the NINSWG, which noted that the landing behaviour which characterised the setnet fishery was not active in the bottom trawl fishery.

Similarly, the SPO 8 landing data, regardless of the method of capture, did not exhibit the behaviour of landing to temporary holding receptacles. Consequently, the NINSWG accepted the standardized set net CPUE for SPO 8 which fluctuated without trend, and recent indices are near the long-term average (Figure 2). The SPO 8 bottom trawl CPUE indices were not considered to be reliable as they were based on very small data sets

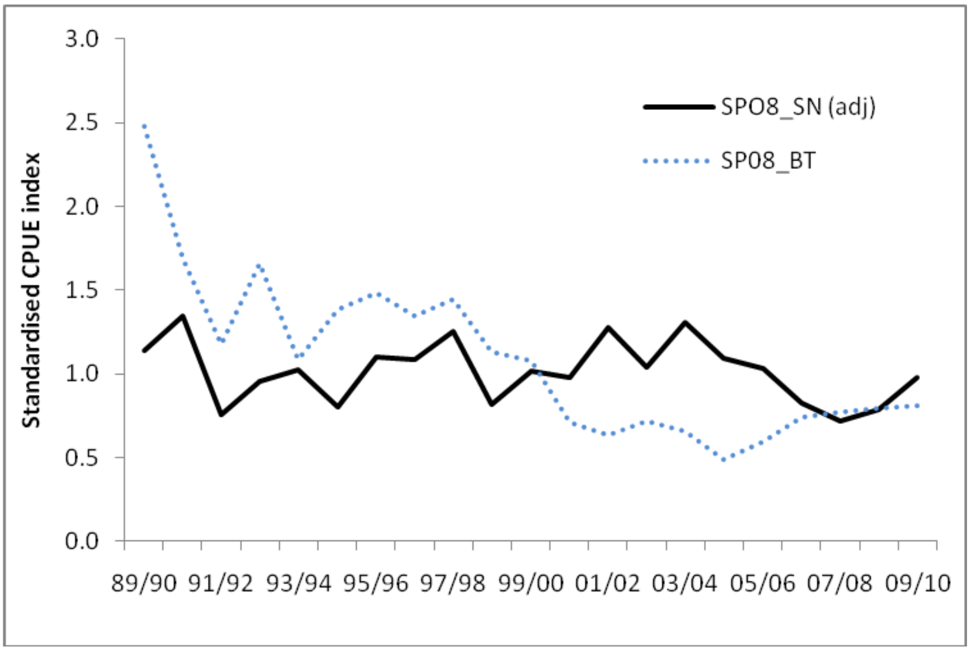



**Figure 2: Comparison of standardised CPUE for SPO8 in target shark (SPO, SCH, SPD or NSD) setnet (bold line) and bycatch of bottom trawl (target SNA, GUR, TRE, TAR) in areas 037, 039, 040, and 041.**

**SPO 2**

The standardised CPUE analysis conducted on SPO 2 in 2009 (Starr & Kendrick 2009) was extended by two years (Bentley *et.al* 2011). This analysis was based on complete trips which landed SPO 2 using the bottom trawl or setnet methods from 1989–90 to 2009–108, adjusted for changes in conversion factors. The use of complete trips was necessary because of the large proportion of trips which landed SPO 2 but did not report any estimated catch (26% by weight for the dataset). In addition, estimated catches severely underestimated landings (median estimated catch by trip was 2/3 the landed catch). The use of complete trips limited the number of explanatory factors that could be applied in the analysis. However, no difference was found between analyses which adjusted for zone of capture or target species category compared to the analyses which only corrected for year, month and vessel. The indices presented in this report are those corrected for year, month and vessel as they are based on the greatest amount of available data. The bottom trawl index is based on 18 434 trips representing 912 t of landings while the setnet index is based on 5 458 trips representing 326 t of landings. The SPO 2 landing data, regardless of the method of capture, did not exhibit the behaviour observed in SPO 1 of landing to temporary holding receptacles.

The SPO 2 series constructed from bottom trawl data shows a gradually increasing trend from 1989–90 to 2002–03 after which the series remains reasonably stable through to 2009–10 with three consecutive high years from 2001–02 to 2003-04 (Figure 3). A series based on setnet data is reasonably similar to the bottom trawl series until the mid-2000s when the setnet series goes into a steep decline. The WG agreed that the setnet series was less credible than the bottom trawl series due to fewer available data, poor vessel overlap, and the fact that the set net fishery largely targets blue moki and blue warehou.

**SPO 3**

Rig in SPO 3 are mostly landed in the shark setnet and bottom trawl fisheries, with additional small amounts landed by Danish seine vessels. The commercial catch in SPO 3 has never achieved the TACC. Two CPUE standardisations were accepted by the WG, one based on a shark target setnet fishery and the other based on a mixed target (barracouta, red cod, tarakihi, and stargazer) bottom trawl fishery. Both CPUE analyses are extensions of equivalent analyses which have been previously reviewed by the WG (SeaFIC 2005; Starr *et al.* 2008). These two fisheries are modelled separately because they operate at different depth ranges, with rig in the trawl fishery taken strictly as a bycatch while the species is targeted by the setnet fishery. These fisheries will clearly have different selectivities, harvesting a different size range of rig, with the setnet fishery taking larger fish while the trawl fishery takes sub-adults. The SPO 3 landing data, regardless of the method of capture, did not exhibit the behaviour observed in SPO 1 of landing to temporary holding receptacles.

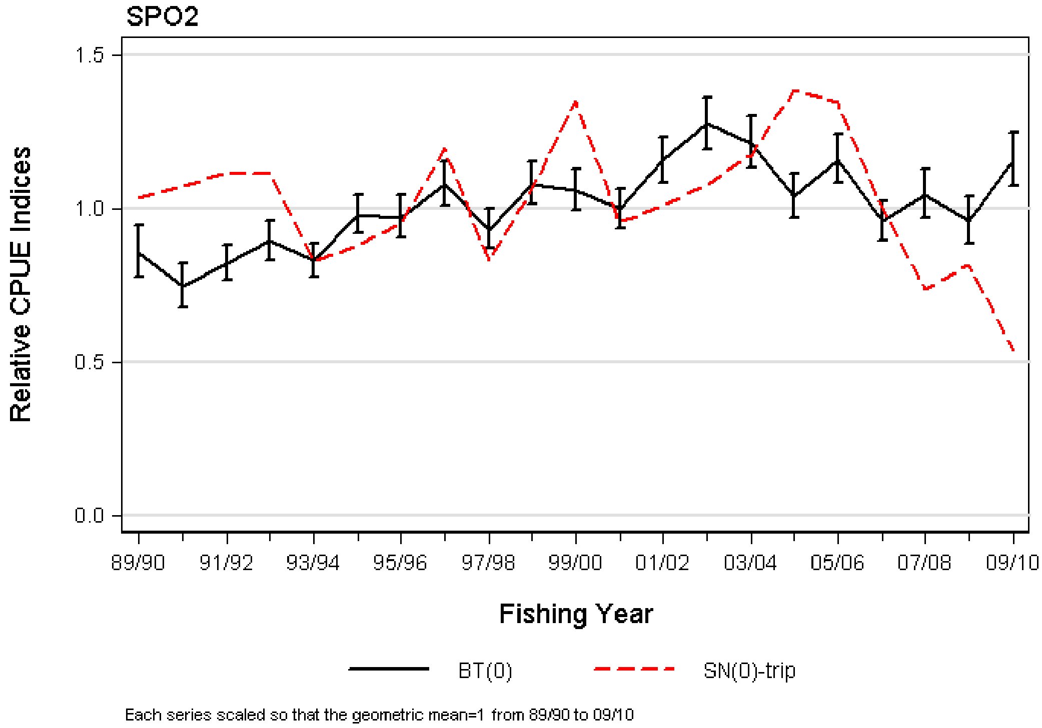



**Figure 3: Comparison of two lognormal standardised CPUE series for SPO 2 based on all valid bottom trawl and setnet trips which landed to SPO 2 up to 2009-10**

Each CPUE analysis was performed in the same manner. The effort data were matched with the landing data at the trip level to avoid relying on the estimated catch information in the effort part of the form and the resulting biases that exist in the reporting of estimated catches of rig. Core vessels which participated consistently in the fishery for a reasonably long period were identified within each data set so that the analysis could be confined to these vessels. Two standardised analyses using a stepwise selection of explanatory variables were performed: a lognormal regression on non-zero catch records and a binomial regression on the presence/absence of rig by trip stratum. The explanatory variables offered to each model included fishing year (forced), month, vessel, statistical area, target species, duration of fishing, and length of net set (for the setnet analysis). These two analyses were then combined into a single series using the delta method (Vignaux 1994) but only the lognormal analysis is reported. The landing information used in this CPUE analysis has been corrected for changes in conversion factors that have occurred over the history of the dataset (Starr & Kendrick 2011).

The two indices fluctuate about the long-term mean up to the mid-2000s (Figure 4). The SN(SHK) series increased consistently from a low in 2002–03, and then stabilises about the long term mean, while the BT(MIX) series clearly is trending upward. The SN(SHK) series shows a slight decline after TACC and catches increased in 2004/05. The WG accepted these indices as indices of abundance and considered the trend based on the SN(SHK) data to be more reliable because it should be indexing adult fish. Given the known vulnerability of shark species, these series should be repeated on a regular basis so that the trend can be evaluated.

**SPO 7**

CPUE analyses using lognormal standardisation of non-zero setnet catches for core vessels were undertaken to assess relative abundance of SPO 7. These analyses were updates of analyses previously accepted by the Working Group in 2006. The 2010 analyses used the same fishery definitions as the previous analysis: 1) setnet fishery in Statistical Areas 032–037 targeting rig, school shark and spiny dogfish [SN(WC)]; 2) setnet fishery in Statistical Area 038 targeting rig, spiny dogfish and school shark [SN(038)]; and 3) bottom trawl fishery in Statistical Areas 016–018, 032–037, 038, and 039 targeting flatfish, red cod and rig [BT(All)].

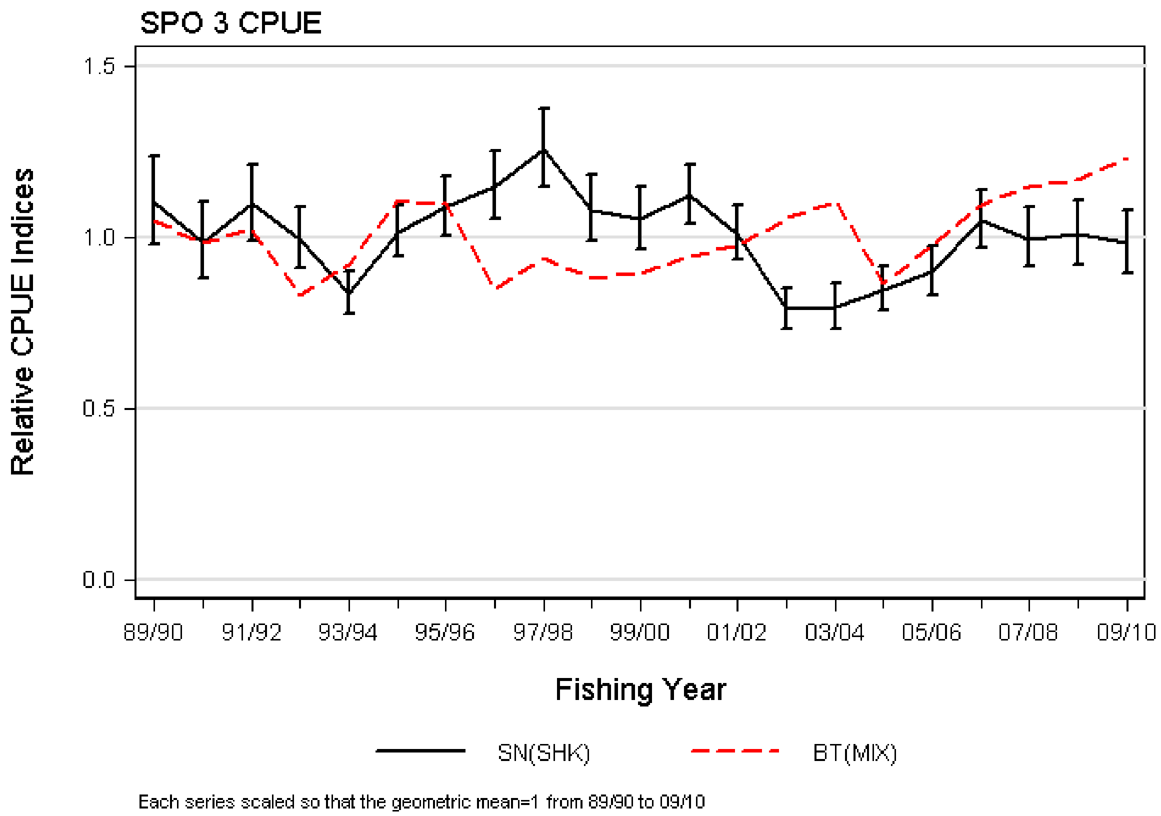



**Figure 4: Comparison of the lognormal indices from the two CPUE series for SPO 3: a) SN[SHK]: target shark species setnet fishery; b) BT[MIX]: mixed target species bottom trawl fishery.**

The analysis of each fishery/area was performed in the same manner (Starr *et al.* 2010). The effort data were matched with the landing data at the trip level. Each analysis was confined to a set of core vessels which had participated consistently in the fishery for a reasonably long period. The explanatory variables offered to each model included fishing year (forced), month, vessel, statistical area, target species, duration of fishing, and length of net set (for the setnet analysis). The Working Group had previously concluded that the SN(038) index was the most credible index of SPO 7 abundance. Concerns were raised in 2010 about the continued reliability of the SN(WC) index which may have been compromised by fleet behaviour changes in response to setnet closures on the west coast of the South Island designed to protect Hector's dolphins.

The SN(038) index showed a continuous declining trend from the beginning of the series to a low in the mid-2000s. It is this series which led to the decision to reduce the SPO 7 TACC to 221 t. That index has now increased four years in succession to 2008–09. The BT(All) series mirrored the SN(038) from the late-1990s and it too has shown an increasing trend since the mid-2000s. In 2006, the SN(WC) series was the most optimistic of the three series, showing little trend up to the mid-2000s. However, this index has since declined, although the Working Group thought it was likely that this may be in part be the result of other factors. Examination of the distribution of setnet effort on the west coast of the South Island shows that there has been a substantial decline in the number of vessels operating there since 2005–06.

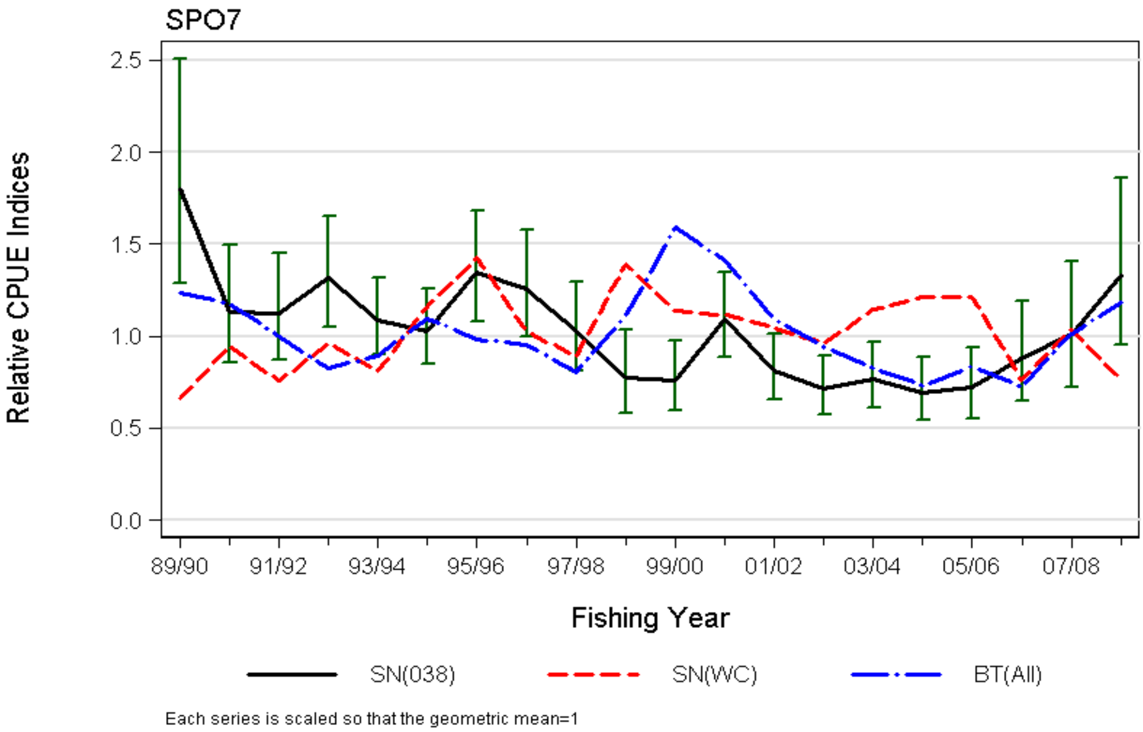



**Figure 5: Comparison of three SPO 7 standardised CPUE series: i) setnet fishery (shark target and west coast South Island) [SN(WC)]; ii) setnet fishery (shark target and Tasman/Golden Bays) [SN(038)];iii) bottom trawl fishery (mix target and all SPO 7) [BT(All)].**

Although large rig are not effectively targeted with bottom trawl gear, the WCSI trawl survey is believed to provide reliable indices of the relative biomass of males and younger females in SPO 7. Relative biomass indices declined by more than 50% between 1995 and 2005 but have since increased toward the long-term mean (Figure 5).

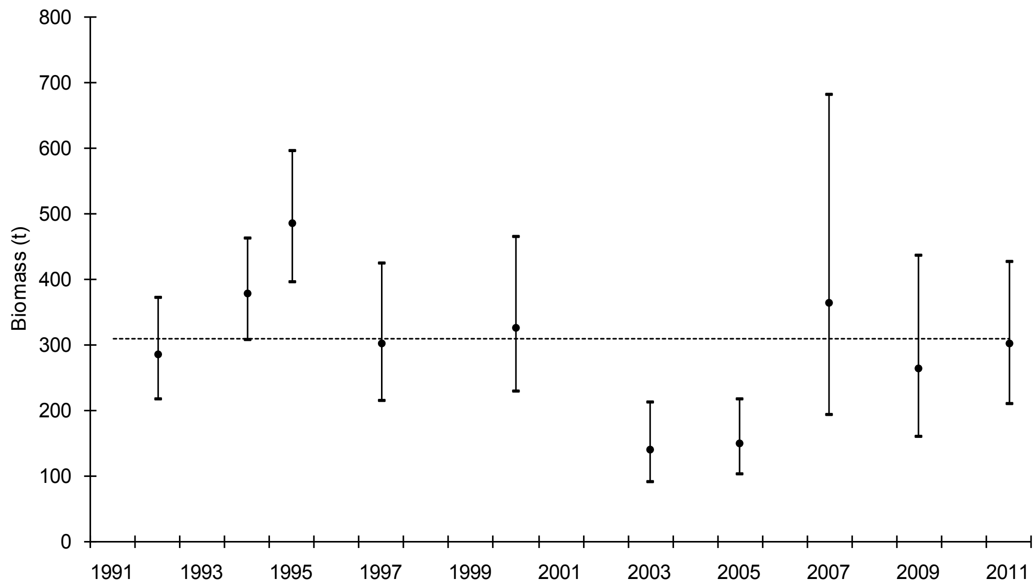



**Figure 6: Plots of biomass estimates (t) for rig from the west coast South Island trawl survey by year. Error bars are approximated from the CVs assuming a lognormal distribution dashed line is the series mean.**

**SPO 7 Stock Assessment**
A stock assessment for SPO 7 was presented to the AMP Working Group in 2006 (AMP-WG-06/24, AMP-WG-06/25). This assessment was an age-structured model fitted to setnet CPUE indices from two areas: Tasman/Golden Bays (Statistical Area 038) and the west coast South Island biomass indices from the WCSI survey (Figure 6), commercial length frequency data (setnet and trawl fisheries), length frequency data from the WCSI survey, and age-length data (for estimating the growth model). Historical catches were reconstructed back to 1965, which were assumed to be the beginning of the model, starting with an unfished biomass at equilibrium. The model had two sexes, with growth models for each sex estimated in the model and a plus group at age 23 to accommodate the largest females in the length frequency data. Sex-specific commercial and survey selectivities were estimated. Descending right-hand limbs were allowed in the commercial trawl and survey selectivity functions to account for an assumed reduction in catchability associated with large rig by trawl nets. Natural mortality (*M*) was fixed at 0.25 and steepness (*h*) at 0.5 (Francis & Francis 1992). This latter value was consistent with values used for low productivity shark species. Bayesian methods were used to estimate uncertainty.

The Working Group noted that this assessment was the first stock assessment completed within an AMP programme and was also the first chondrichthyan assessment completed in New Zealand. The Working Group accepted the methods, including data preparation steps and model structure and considered the results satisfactory.

The Working Group made the following conclusions based on this stock assessment:
- The SPO 7 stock was almost certainly below $B_{MSY}$. There was however some uncertainty as to where the stock was in relation to $B_0$. It was therefore not possible to produce reliable stock projections necessary to derive an assessment based TACC.
- Based on declining indices of abundance, current catches and the TACC (which has been substantially under caught for the last five years) were not sustainable.

The Working Group requested that the stock assessment should be repeated in 2008. The next assessment should include the following:
- sensitivity runs based on larger historical catches prior 1975 to account for probable dumping by trawlers;
- additional length-age data, particularly for large females; more rig would therefore need to be aged;
- new length composition data from the commercial catch (trawl and setnet);
- appropriate stock recruit relationships for sharks;
- 5-year stock projections;
- an understanding of the relationship of rig stocks between areas: what is the appropriate relationship of sub-areas within SPO 7 or with SPO 3 or SPO 8? The Working Group agreed that there was uncertainty in this issue and that information should be collected to address this problem.

### 4.2 Biomass estimates
Absolute estimates of current biomass are not available for any rig stocks. Relative biomass estimates are available for the West and East Coast South Island, however, the Working Group does not consider that these surveys monitor the full size range of these populations.

### 4.3 Estimation of Maximum Constant Yield (*MCY*)
No estimates of *MCY* are available for these stocks. This conclusion has not changed since the 2008 Plenary Report. Yield estimates are summarised in Table 6.

### 4.4 Estimation of Current Annual Yield (*CAY*)
*CAY* cannot be determined with available data.

**Table 6: Yield estimates (t) of rig by stock.**

| Paramet | Fishstock | Estimates |
|---|---|---|
| *MCY* | SPO 1 (WCNI + NECNI) | 630* |
| | SPO 2 (SECNI) | < 70 |
| | SPO 3 (ECSI) | Cannot be determined |
| | SPO 7 (WCSI) | Cannot be determined |
| | SPO 8 (WCNI) | 270* |
| | SPO 10 | Cannot be determined |
| *CAY* | All | Cannot be determined |

* *MCY* estimate for the WCNI stock was apportioned pro-rata between SPO 1 and SPO 8 Fishstocks on the basis of historical catches.

### 4.5 Other factors

Stock mixing occurs in the South Taranaki Bight to the Cook Strait and South Westland regions, and probably elsewhere. Some regional fisheries therefore exploit more than one stock. Also, biological stock boundaries do not always coincide with Fishstock boundaries. Consequently, management by quota within Fishstocks is likely to be sub optimal for individual stocks.

The use of small mesh commercials setnets (125 mm) in the Auckland FMA probably results in a large proportion of the rig catch being immature fish. Elsewhere, the minimum size is 150 mm.

There have been several changes to the rig conversion factors over the period that SPO has been managed within the QMS. The trend has been towards lower conversion factors. While researchers correct catches for these changes in undertaking CPUE analyses, this has not been done for total landings reported in this Working Group Report. These changes have the effect of reducing the effect of catches in recent years compared to early years, e.g. if actual catch had been constant it would appear to be declining. This has implication for historically set TACCs and any yield estimates (e.g. *MCY*).

## 5. STATUS OF THE STOCKS

No estimates of current and reference biomass are available.

**SPO 1**

For SPO 1, reported landings have consistently declined since 1991–92.

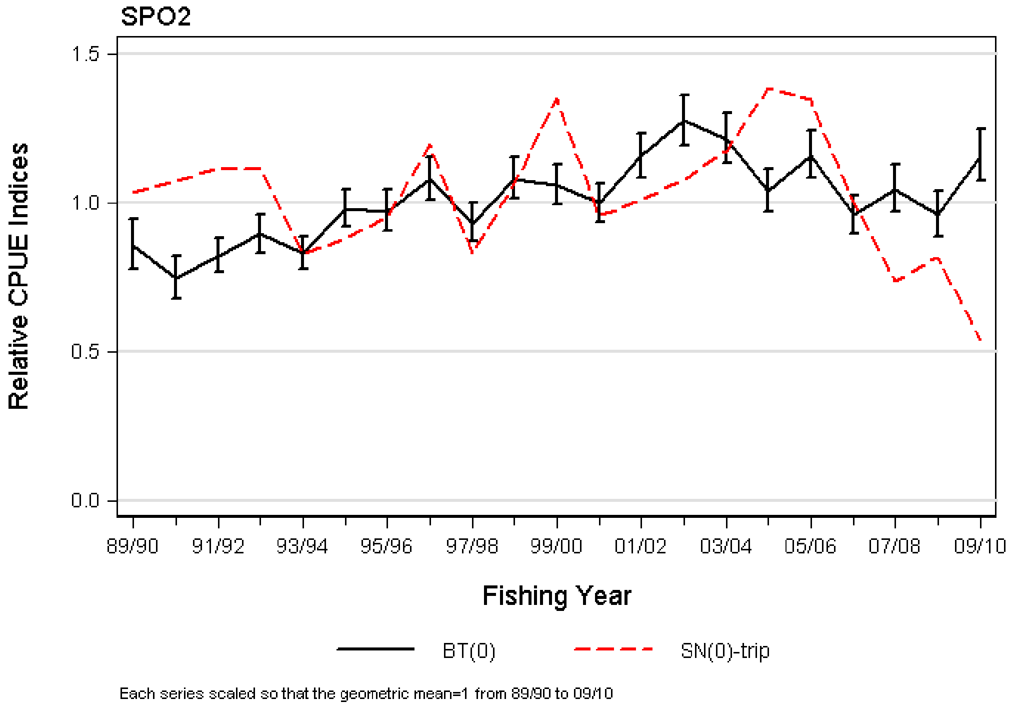
As there is currently no accepted index of abundance for SPO 1, it is not known whether current catches or the TACC will cause the stock to decline.

**SPO 2**

**Stock Structure Assumptions**

Recent reviews in 2009 conclude that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. For the purposes of this summary SPO2 is treated as a discrete stock.

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Assessment Runs Presented | |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below |

| **Historical Stock Status Trajectory and Current Status** |
|---|
|  |
| **Comparison of two lognormal standardised CPUE series for SPO 2 based on all valid bottom trawl and setnet trips which landed to SPO 2 up to 2009–10** |

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The SPO 2 CPUE series constructed from bottom trawl data shows a gradually increasing trend from 1989–90 to 2002–03 after which the series remains reasonably stable through to 2009–10 with three consecutive high years from 2001–02 to 2003-04 (Figure 3). A series based on setnet data is reasonably similar to the bottom trawl series until the mid-2000s when the setnet series goes into a steep decline. The WG agreed that the setnet series was less credible than the bottom trawl series due to fewer available data, poor vessel overlap, and the fact that the set net fishery largely targets blue moki and blue warehou. |
| Recent Trend in Fishing Mortality or Proxy | It is Unknown whether overfishing is occurring. |
| Other Abundance Indices | |
| Trends in Other Relevant Indicators or Variables | |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Current catches are Unlikely (< 40%) to cause the stock to decline. |
| Probability of Current Catch or TACC causing decline below Limits | While current catches are Unlikely (< 40%) to cause the stock to decline below the hard limit, it is Unknown whether they will cause it to decline below the soft limit.<br>Since current catches are above the TACC, it is Unlikely (< 40%) that the TACC will cause the stock to decline. |

| **Assessment Methodology** | |
|---|---|
| Assessment Type | Level 2 |
| Assessment Method | Fishery characterisation and CPUE analysis |

| | | |
|---|---|---|
| Main data inputs | Setnet and bottom trawl catch and effort data. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | Relationship between CPUE and abundance | |

| **Qualifying Comments** |
|---|
| The WG agreed that the setnet series was less credible than the bottom trawl series due to fewer available data, poor vessel overlap , and the fact that the set net fishery largely targets blue moki and blue warehou. |

| **Fishery Interactions** |
|---|
| Rig is largely a bycatch of both mixed trawl and set net fisheries (add main species later). |

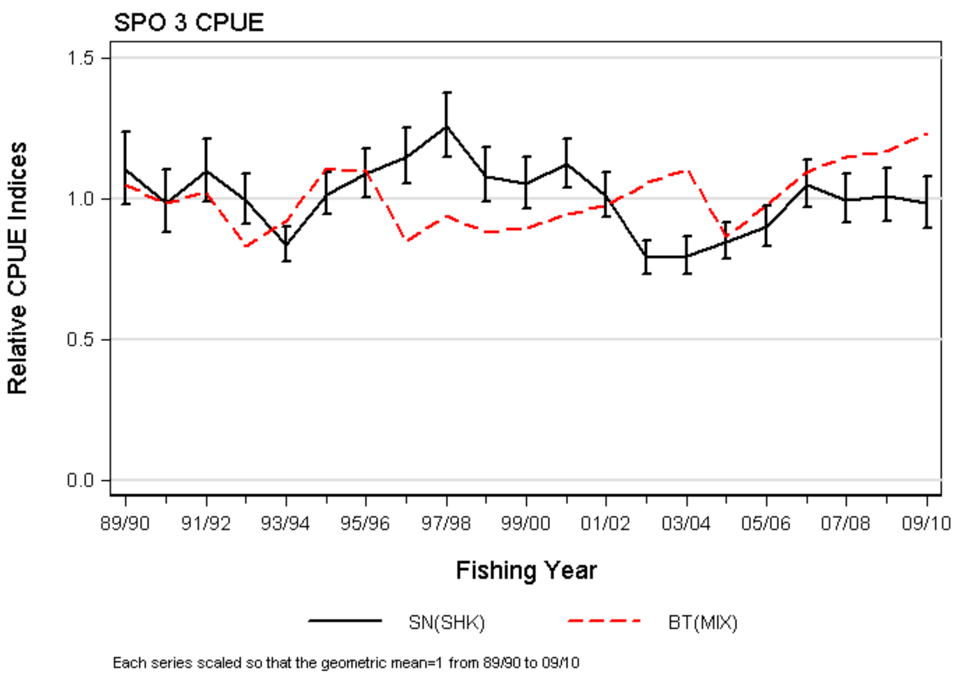
**SPO 3**

**Stock Structure Assumptions**

Recent reviews in 2009 conclude that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. For the purposes of this summary SPO3 is treated as a discrete stock.

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Assessment Runs Presented | |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below |

**Historical Stock Status Trajectory and Current Status**




**Comparison of the lognormal indices from the two CPUE series for SPO 3: a) SN[SHK]: target shark species setnet fishery; b) BT[MIX]: mixed target species bottom trawl fishery.**

| Fishery and Stock Trends | |
|---|---|
| Recent Trend in Biomass or Proxy | The two indices fluctuate about the long-term mean up to the mid-2000s (Figure 4). From 2003-03, the SN(SHK) series increases consistently from a low in 2002-03, and then stabilises about the long term mean, while the BT(MIX) series is trending upward. |
| Recent Trend in Fishing Mortality or Proxy | It is Unknown whether overfishing is occurring. |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| Projections and Prognosis | | |
|---|---|---|
| Stock Projections or Prognosis | Current catches are Unlikely (< 40%) to cause the stock to decline. | |
| Probability of Current Catch or TACC causing decline below Limits | While current catches are Unlikely (< 40%) to cause the stock to decline below the hard limit, it is Unknown whether they will cause it to decline below the soft limit.<br>Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline below Hard or Soft limits. | |
| **Assessment Methodology** | | |
| Assessment Type | Level 2 | |
| Assessment Method | Fishery characterisation and CPUE analysis | |
| Main data inputs | Setnet and bottom trawl catch and effort data. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | - | |
| **Qualifying Comments** | | |
| - | | |

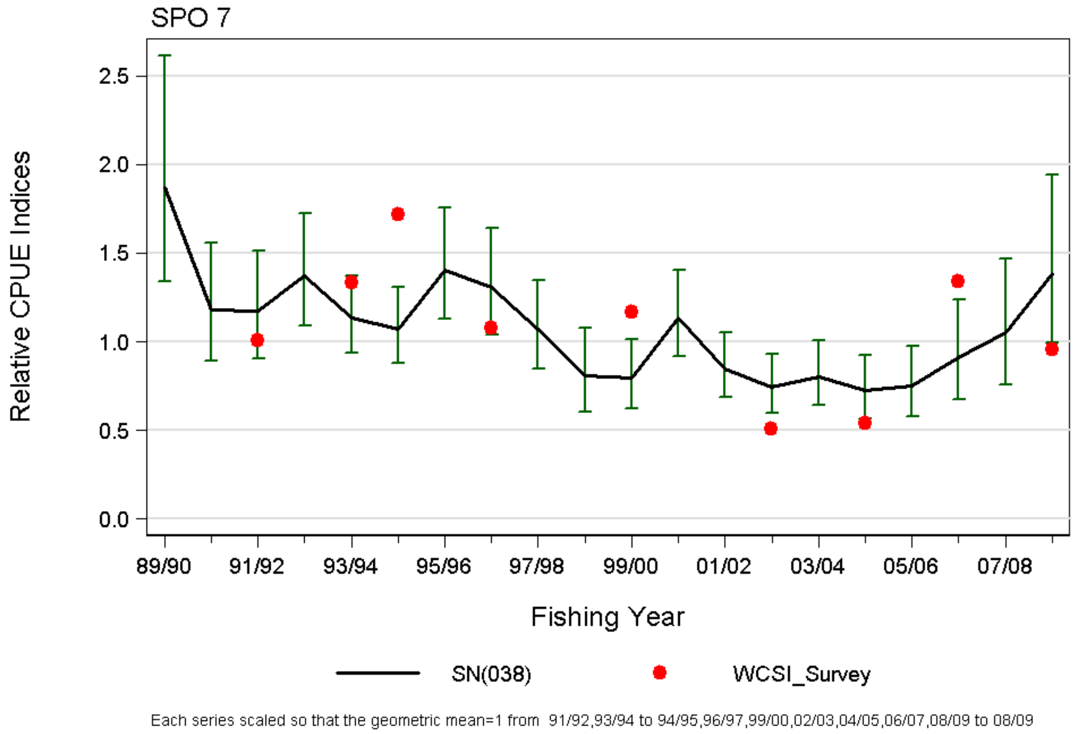
| Fishery Interactions |
|---|
| There is a 4 nm setnet closure that has been in place since October 2008 for the entire area.<br>Rig are largely targeted but they are also caught as bycatch in target fisheries for school shark, flatfish, red cod, spiny dogfish and elephant fish in setnet, botton trawl and bottom longline fisheries. |

**SPO 7**

**Stock Structure Assumptions**

Recent reviews in 2009 conclude that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. For the purposes of this summary SPO7 is treated as a discrete stock.

| Stock Status | |
|---|---|
| Year of Most Recent Assessment | 2010 |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | The SPO 7 stock was assessed in 2006 to be Very Unlikely (< 10%) to be at or above $B_{MSY}$ but has since increased. The stock is Unlikely (< 40%) to be above the target. |
| Status in relation to Limits | Soft limit: About as Likely as Not (40-60%) to be below (< 40%)<br>Hard limit: Unlikely (< 40%) to be below |

| **Historical Stock Status Trajectory and Current Status** |
|---|
|   |
| **Comparison of SPO 7 CPUE index series with the west coast South Island Kaharoa trawl survey. The survey index has been assigned to the final calendar year of the fishing year pair.** |

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | Available indices suggest an increase in recent years from a low point in 2004-05, to levels possibly near the long-term average. |
| Recent Trend in Fishing Mortality or Proxy | Reduced landings and evidence of increased recruitment suggest reduced levels of fishing mortality in recent years. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | The increasing trends in abundance and evidence of improved recruitment suggest that the stock is Likely (> 60%) to increase under current catch and TACC. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

| **Assessment Methodology** | |
|---|---|
| Assessment Type | Level 1: 2006 Quantitative stock assessment<br>Level 2: 2010 Standardised CPUE abundance index and West Coast South Island trawl survey index and length frequency analysis. |
| Assessment Method | 2006: Bayesian statistical catch-at-age model<br>2010: Evaluation of agreed standardised CPUE indices, and length frequency analysis. |

| | | |
|---|---|---|
| Main data inputs | 2006:<br>• West Coast South Island trawl survey index<br>• Setnet CPUE from area 38 and the west coast<br>• Length data from SN (38), SN(WC) and bottom trawl(WC)<br>• Age/length data<br>2010:<br>• Catch and effort data derived from the Ministry of Fisheries catch reporting.<br>• Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.<br>• Abundance indices derived from the West Coast South Island trawl surveys. | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | In 2006: SPO 7 stock status was evaluated using an age-structured model fitted to setnet CPUE indices, biomass indices from the WCSI survey, length frequency data and age-length data.<br><br>In 2010, updated CPUE standardisations were conducted, including on the two series used in the 2006 assessment, and using similar standardisation models to those used previously. | |
| Major Sources of Uncertainty | | |

| **Qualifying Comments** |
|---|
| - |

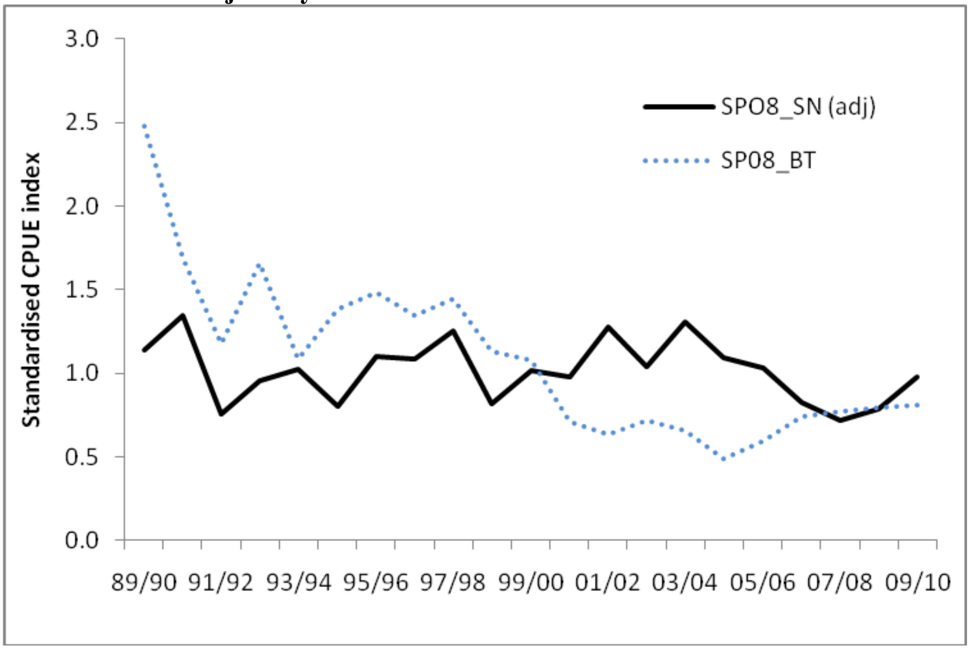
| **Fishery Interactions** |
|---|
| SPO 7 are mainly caught in a targeted setnet fishery (61%), which also targets school shark and spiny dogfish. This fishery has historically been particularly focussed in statistical area 038 (Tasman and Golden Bays). The remaining catch is taken by a bottom trawl fishery targeting flatfish, barracouta, red cod and tarakihi. |

**SPO 8**

**Stock Structure Assumptions**

Recent reviews in 2009 conclude that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. For the purposes of this summary SPO8 is treated as a discrete stock.

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft limit: Unknown<br>Hard limit: Unlikely (< 40%) to be below |

| Historical Stock Status Trajectory and Current Status |
|---|
|   |
| Comparison of standardised CPUE for SPO8 in target setnet (bold line) and bycatch of bottom trawl (target SNA, GUR, TRE, TAR) in areas 037, 039, 040, and 041. |

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | Setnet CPUE has fluctuated without trend and recent indices are near the longterm average. |
| Recent Trend in Fishing Mortality or Proxy | It is Unknown whether overfishing is occurring |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Current catches are Unlikely (< 40%) to cause the stock to decline. |
| Probability of Current Catch or TACC causing decline below Limits | While current catches are Unlikely (< 40%) to cause the stock to decline below the hard limit, it is Unknown whether they will cause it to decline below the soft limit.<br>Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline below Hard or Soft limits. |

| **Assessment Methodology** | |
|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index. |
| Assessment Method | - |

| | | |
|---|---|---|
| Main data inputs | Catch and effort data derived from the Ministry of Fisheries catch reporting. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | - | |
| Major Sources of Uncertainty | - | |

| **Qualifying Comments** |
|---|
| |

| **Fishery Interactions** |
|---|
| SPO 8 are mainly caught in a targeted setnet fishery which also targets school shark and spiny dogfish. The remaining catch is taken by a bottom trawl fishery targeting snapper, gurnard, trevally and tarakihi. |

Yield estimates, TACCs and reported landings of rig are summarised in Table 7.

**Table 7: Summary of yield estimates (t), TACCs (t) and reported landings (t) of rig for the most recent fishing year.**

| Fishstock | | FMA | *MCY* | 2010-11 Actual TACC | 2010-11 Reported landings |
|---|---|---|---|---|---|
| SPO 1 | Auckland (East) (West) | 1 & 9 | 630 | 692 | 311 |
| SPO 2 | Central (East) | 2 | < 70 | 86 | 106 |
| SPO 3 | South-East (Coast) (Chatham), Southland and Sub-Antarctic | 3, 4, 5 & 6 | – | 600 | 395 |
| SPO 7 | Challenger | 7 | – | 221 | 229 |
| SPO 8 | Central (West) | 8 | 270 | 310 | 220 |
| SPO 10 | Kermadec | 10 | – | 10 | 0 |
| Total | | | | 1 919 | 1 260 |

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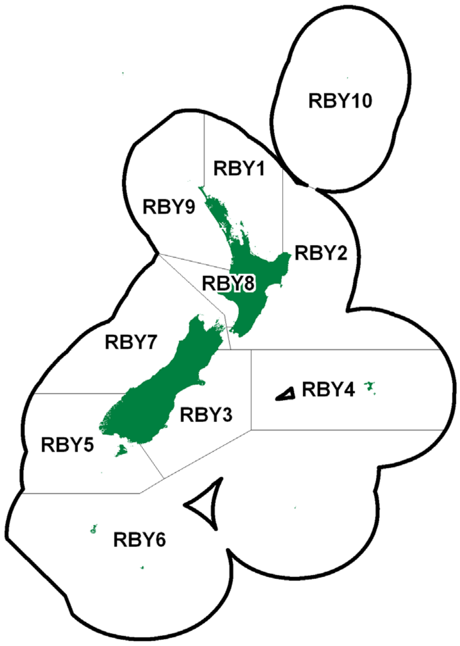
# RUBYFISH (RBY)

(*Plagiogeneion rubiginosum*)




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

Rubyfish catches were first reported in 1982-83. In 1990-91, 245 t were landed, mainly as bycatch in the trawl fisheries for alfonsino, gemfish, barracouta, hoki, and jack mackerel. In the following year landings doubled, and from 1992-93 to 1994-95 landings were about 600 t. In 1995-96, landings peaked at 735 t and in subsequent years catches fluctuated between 200 t and 500 t (Tables 1 & 2). The level of direct targeting on rubyfish has increased over the history of the fishery. At least one third of recent annual catches were taken by targeted mid-water trawling with gear usually fished close to the bottom.

The main rubyfish grounds (target species and alfonsino bycatch) are the banks or "hills" off the east coast of the North Island in QMA 2. Rubyfish is also targeted in the Bay of Plenty. The areas where rubyfish is predominantly taken as bycatch (with the target fisheries) are: Westland (hoki and barracouta); north-western South Island (jack mackerel); North Taranaki Bight (jack mackerel). Rubyfish have also been reported as an intermittent bycatch with bluenose, black cardinalfish, orange roughy, silver warehou, tarakihi, trevally and scampi. Commercial concentrations of rubyfish probably also exist in areas that have not been fished in appropriate depths, especially in the northern half of New Zealand. Since 1990-91, on average about 70% of total landings are from QMA 2, and 20% are from QMA 1.

Rubyfish was introduced into the QMS on 1 October 1998. Allowances were not made for non commercial catch. The historical landings and TACC values for the two main RCO stocks are shown in Figure 1.

In the 2002-03 fishing year, the TACC for RBY 1 was increased under the adaptive management programme (AMP) to 300 t. At the same time a customary allowance of 1 t, a recreational allowance of 2 t and an allowance of 15 t for fishing-related mortality took the TAC to 318 t. All AMP programmes ended on 30th September 2009.

In these stocks landings were above the TACC for a number of years and the TACCs have been increased to the average of the previous 7 years plus an additional 10%. From the 1st October 2006 the TACCs for RBY 4, 7 and 8 were increased to 6, 33 and 5 t respectively. Landings continued to exceed the TACC after 2006, resulting in a TACC increase to 18 t for RBY 4 from the first of October 2010. An allowance of 1 t was allocated to RBY 4 at the same time, bringing the TAC to 19 t.

**Table 1: Reported landings (t) of rubyfish by QMA and fishing year, 1983-84 to 1997-98. The data in this table has been updated from that published in previous Plenary Reports by using the data through 1996-97 in table 35 on p. 270 of the "Review of Sustainability Measures and Other Management Controls for the 1999-00 Fishing Year - Final Advice Paper" dated 6 August 1998.**

| | QMA 1 | QMA 2 | QMA 3 | QMA 4 | QMA 5 | QMA 6 | QMA 7 | QMA 8 | QMA 9 | QMA 10 | Other | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990-91 | 66 | 159 | 5 | 3 | 0 | 0 | 9 | 0 | 3 | 0 | | 245 |
| 1991-92 | 147 | 390 | 0 | 0 | 0 | 0 | 20 | 1 | 6 | 0 | | 564 |
| 1992-93 | 90 | 491 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | | 612 |
| 1993-94 | 116 | 379 | 3 | 0 | 0 | 0 | 72 | 0 | 5 | 0 | | 575 |
| 1994-95 | 43 | 500 | 3 | 12 | 0 | 0 | 13 | 0 | 10 | 0 | | 581 |
| 1995-96 | 106 | 595 | 2 | 0 | 0 | 0 | 9 | 0 | 23 | 0 | | 735 |
| 1996-97 | 128 | 297 | 2 | 1 | < 1 | 0 | 14 | < 1 | 21 | < 1 | 1 | 463 |
| 1997-98 | 50 | 308 | < 1 | 1 | 0 | 0 | 6 | < 1 | 13 | < 1 | < 1 | 380 |

† QMS data.

**Table 2: Reported landings (t) of rubyfish by Fishstock and TACCs from 1998-99 to 2010-11.**

| Fishstock | RBY 1 | | RBY 2 | | RBY 3 | | RBY 4 | | RBY 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA | | 1 | | 2 | | 3 | | 4 | | 5 |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1998-99 | 55 | 104 | 180 | 433 | < 1 | 2 | < 1 | 2 | 0 | 0 |
| 1999-00 | 138 | 104 | 321 | 433 | 6 | 2 | < 1 | 2 | 0 | 0 |
| 2000-01 | 39 | 109 | 433 | 433 | < 1 | 3 | 2 | 3 | 0 | 0 |
| 2001-02 | 36 | 109 | 414 | 433 | 1 | 3 | 8 | 3 | 1 | 0 |
| 2002-03 | 21 | 300 | 233 | 433 | < 1 | 3 | 11 | 3 | 1 | 0 |
| 2003-04 | 19 | 300 | 343 | 433 | < 1 | 3 | 2 | 3 | < 1 | 0 |
| 2004-05 | 109 | 300 | 217 | 433 | < 1 | 3 | 10 | 3 | 1 | 0 |
| 2005-06 | 135 | 300 | 303 | 433 | < 1 | 3 | 33 | 3 | 0 | 0 |
| 2006-07 | 293 | 300 | 198 | 433 | 4 | 3 | 37 | 6 | 0 | 0 |
| 2007-08 | 120 | 300 | 427 | 433 | < 1 | 3 | 11 | 6 | < 1 | 0 |
| 2008-09 | 192 | 300 | 467 | 433 | < 1 | 3 | 19 | 6 | 0 | 0 |
| 2009-10 | 351 | 300 | 309 | 433 | 2 | 3 | 11 | 6 | < 1 | 0 |
| 2010-11 | 297 | 300 | 435 | 433 | < 1 | 3 | 9 | 18 | < 1 | 0 |

| Fishstock | RBY 6 | | RBY 7 | | RBY 8 | | RBY 9 | | RBY 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA | | 6 | | 7 | | 8 | | 9 | | 10 |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1998-99 | 0 | 0 | 4 | 27 | < 1 | 0 | 7 | 9 | < 1 | 0 |
| 1999-00 | 0 | 0 | 13 | 27 | < 1 | 0 | 15 | 9 | 0 | 0 |
| 2000-01 | < 1 | 0 | 7 | 27 | 0 | 1 | 16 | 19 | 0 | 0 |
| 2001-02 | 0 | 0 | 35 | 27 | < 1 | 1 | 3 | 19 | 0 | 0 |
| 2002-03 | < 1 | 0 | 32 | 27 | 2 | 1 | 2 | 19 | 0 | 0 |
| 2003-04 | < 1 | 0 | 9 | 27 | 8 | 1 | 1 | 19 | 0 | 0 |
| 2004-05 | < 1 | 0 | 99 | 27 | < 1 | 1 | 3 | 19 | 0 | 0 |
| 2005-06 | < 1 | 0 | 8 | 27 | 8 | 1 | 20 | 19 | 0 | 0 |
| 2006-07 | 0 | 0 | 13 | 33 | < 1 | 55 | 1 | 19 | 0 | 0 |
| 2007-08 | < 1 | 0 | 4 | 33 | 1 | 6 | 1 | 19 | 0 | 0 |
| 2008-09 | < 1 | 0 | 14 | 33 | < 1 | 6 | 2 | 19 | 0 | 0 |
| 2009-10 | 0 | 0 | 4 | 33 | < 1 | 6 | < 1 | 19 | 0 | 0 |
| 2010-11 | 0 | 0 | 5 | 33 | < 1 | 6 | < 1 | 19 | 0 | 0 |

| | Total | |
|---|---|---|
| | Landings | TACC |
| 1998-99 | 247 | 577 |
| 1999-00 | 493 | 577 |
| 2000-01 | 358 | 595 |
| 2001-02 | 498 | 595 |
| 2002-03 | 302 | 595 |
| 2003-04 | 382 | 595 |
| 2004-05 | 439 | 595 |
| 2005-06 | 507 | 786 |
| 2006-07 | 546 | 849 |
| 2007-08 | 564 | 800 |
| 2008-09 | 694 | 800 |
| 2009-10 | 677 | 800 |
| 2010-11 | 747 | 812 |

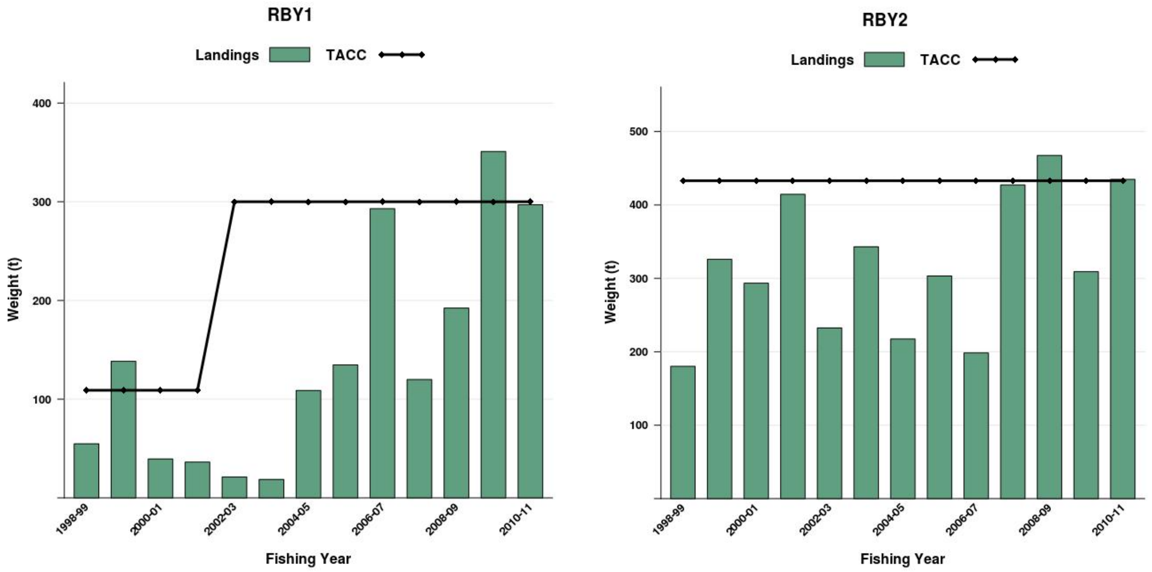



**Figure 1: Historical landings and TACC for the two main RBY stocks. Left to right: RBY1 (Auckland East) and RBY2 (Central East). Note that these figures do not show data prior to entry into the QMS.**

### 1.2 Recreational fisheries
There is no reported recreational catch.

### 1.3 Customary non-commercial fisheries
There is no quantitative information on the current level of customary non-commercial take.

### 1.4 Illegal catch
There is no quantitative information on the level of illegal catch.

### 1.5 Other sources of mortality
There is no quantitative information on the level of other sources of mortality.

## 2. BIOLOGY

Rubyfish are recorded from southern Australia, South Africa and from banks in the southern Indian and south-east Atlantic oceans. They occur in the subtropical water around northern and central New Zealand, but are absent from the southern Chatham Rise and Campbell Plateau. Rubyfish occur at depths ranging from 50 to at least 800 m. Commercial catch data suggests the species is most abundant between 200 and 400 m.

Rubyfish have been recorded up to 58 cm in length. Small catches by research trawling have all been of similar-sized fish, suggesting schooling by size. Ageing research based on simple counts of otolith structures appeared to indicate that rubyfish are a slow-growing and long-lived species (Paul *et al*. 2000). Paul *et al*. (2003) used radiocarbon dating techniques on otoliths from 10 rubyfish to determine whether the sudden 1960s increase in atmospheric/oceanic radiocarbon ($^{14}C$) levels, resulting from nuclear testing, could be detected in these otoliths. Based on the low levels of radioactive $^{14}C$ measured in the core of these otoliths, they concluded that the oldest fish in this sample were born prior to the beginning of the period of atmospheric testing and therefore were at least 45 years old (calculated from the date of otolith collection).

There is no information on rubyfish spawning cycles or areas. Observations on gut contents show that rubyfish feed on mid-water crustaceans, salps and myctophid fishes.

**Table 3: Estimates of biological parameters for rubyfish.**

| Fishstock | Estimate | | | Source |
|---|---|---|---|---|
| 1. Natural mortality ($M$) | | | | |
| All | $M$ = 0.03 - 0.1* | | | Paul *et al.* (2000, 2003) |
| 2. Weight = a (length)$^b$ (Weight in g, length in cm fork length) | | | | |
| | Both sexes | | | |
| | a | b | | |
| RBY 2 | 0.0255 | 2.9282 | | NIWA (unpub. Data) |
| 3. von Bertalanffy growth parameters | | | | |
| | Both sexes | | | |
| | $L_\infty$ | $K$ | $t_0$ | |
| QMA 2 | 48.68 | 0.045 | -16.53 | Paul *et al.* (2002) |

*revised range from 2002; see text.

# 3. STOCKS AND AREAS

It is not known whether different regional stocks of rubyfish occur in New Zealand waters.

Although landings are reported by Fishstocks which equal the standard QMAs, for stock assessment purposes it may be more appropriate to consider Fishstocks RBY 1 and RBY 9 as one (northern) unit, Fishstock RBY 2 (the main fishery) as an eastern unit, Fishstocks RBY 3–5 as a minor southern unit, and Fishstocks RBY 7 and RBY 8 as a western unit.

# 4. STOCK ASSESSMENT

## 4.1 Estimates of fishery parameters and abundance

A biomass index derived from a standardised CPUE (log linear, kg/day) analysis of the target trawl fishery represented by 10 main vessels (Blackwell 2000) was calculated for RBY 2. However, the results were highly uncertain, mainly due to the limited amount of data available, and were not accepted by the Inshore Working Group.

## 4.2 Biomass estimates

No information is available.

## 4.3 Estimation of Maximum Constant Yield (*MCY*)

*MCY* cannot be determined.

## 4.4 Estimation of Current Annual Yield (*CAY*)

*CAY* cannot be determined.

## 4.5 Other yield estimates and stock assessment results

No information is available.

## 4.6 Other factors

A substantial catch of rubyfish has been taken in conjunction with alfonsino by the trawl fishery off the North Island east coast. Future quotas and catch restraints imposed on rubyfish could, in turn, constrain the alfonsino fishery. Rubyfish is taken in smaller, irregular quantities in other target trawl fisheries and these fisheries could also be affected by future rubyfish management policy.

Catch sampling has occurred in RBY 2 for four years 1998-99 to 2000-01, and 2006-07 and 2007-08 though data for the recent years are of little value. It is likely that the age composition of RBY vary across features and exact location of the samples is not known so it is unclear if the samples have come from the areas that have been consistently fished over time. The earlier catch sampling data show that the fishery is comprised of a large number of age classes with a reasonable proportion of the catch coming from fish of greater than 50 years old (Horn & Sutton 2009).

## 5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new Adaptive Management Programme Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

**RBY 1**
The TACC for RBY 1 was increased from 109 t to 300 t under the Adaptive Management Programme (AMP) in October 2002.

**Full-term Review of RBY 1 AMP in 2007**
In 2007 the AMP FAWG reviewed the performance of the AMP (Starr *et al*. 2007). The WG noted:

**Fishery characterisation**

- Fish are landed as green weight, so there are no conversion factor issues.
- Historical landings have been primarily taken as a bycatch of the bottom trawl fishery targeted at gemfish in the Bay of Plenty. These landings have nearly disappeared as a result of the decline in that fishery.
- The main target fishery has been a mid-water trawl fishery associated with features in the Bay of Plenty which has operated in 2004-05 and 2005-06.
- It was noted that there may be some merit in considering management options like feature limits in this fishery.

**CPUE analysis**

- There are insufficient data to use for a standardised analysis so four unstandardised analyses were presented, three from bycatch trawl fisheries for gemfish, tarakihi and hoki and one from a bycatch bottom longline fishery directed at hapuku and bluenose. No series was constructed from the target rubyfish fishery as there were sufficient data in only three years. The CPUE trends in the four bycatch fisheries showed variable trends which appeared to reflect effort trends in the respective fisheries rather than RBY biomass trends.

**Logbook programme**

- There are no logbook data in the database, except 1 trip and 4 tows. There is a problem in obtaining samples as it is difficult to sample the fish, as they are directly dumped into sea water tanks on the ship.
- Recommend a shed sampling programme, or a similar approach to obtain biological data, but the programme will endeavour to collect data that will allow the fish to be linked to a tow.

**Environmental effects**

- Catch has never exceeded the TACC over the term of the AMP. The target gemfish fishery, the primary bycatch fishery for this species, has diminished considerably in recent years.
- No code of practice in RBY fishery.

**Conclusion**

- If the AMP continues, there is a need to improve the collection of information. There is a need for more biological data, such as otoliths and lengths from every large landing of this species.
- There is also a need for improved fine-scale catch and effort information for smaller areas.
- The Working Group indicated that a catch curve analysis approach is likely to be the most effective way to monitor this Fishstock.

## 6. STATUS OF THE STOCKS

### RBY 1

In 2002, RBY 1 was included in the AMP on the basis that the stock had been lightly fished and it seemed likely that the stock was above $B_{MSY}$.

### RBY 2

Catch sampling between 1998-99 and 2000-01 indicated that the fishery is comprised of a large number of age classes with a reasonable proportion of the catch coming from fish of greater than 50 years old. Although relatively high catches were made prior to this period there is no obvious truncation of the age distribution that would occur under high and unsustainable levels of fishing mortality.

Most of the current RBY catch comes from QMA 2. It is not known whether the level of recent commercial catches in this QMA is sustainable. The status of RBY 2 relative to $B_{MSY}$ is unknown.

### Other areas

For most other areas it is not known if recent catches are sustainable. Commercial concentrations of rubyfish probably also exist in areas that have not been fished. The status of other RBY stocks relative to $B_{MSY}$ is unknown.

TACCs and reported landings are summarised in Table 4.

**Table 4: Summary of TACCs (t) and reported landings (t) of rubyfish for the most recent fishing year.**

| Fishstock | | FMA | 2010-11 Actual TACC | 2010-11 Reported Landings |
|---|---|---|---|---|
| RBY 1 | Auckland (East) | 1 | 300 | 297 |
| RBY 2 | Central (East) | 2 | 433 | 435 |
| RBY 3 | South-east (Coast) | 3 | 3 | 0.152 |
| RBY 4 | South-east (Chatham) | 4 | 18 | 9 |
| RBY 5 | Southland | 5 | 0 | 0.921 |
| RBY 6 | Sub-Antarctic | 6 | 0 | 0 |
| RBY 7 | Challenger | 7 | 33 | 5 |
| RBY 8 | Central (West) | 8 | 6 | 0.502 |
| RBY 9 | Auckland (West) | 9 | 19 | 0.297 |
| RBY 10 | Kermadec | 10 | 0 | 0 |
| Total | | | 812 | 747 |

## 7. FOR FURTHER INFORMATION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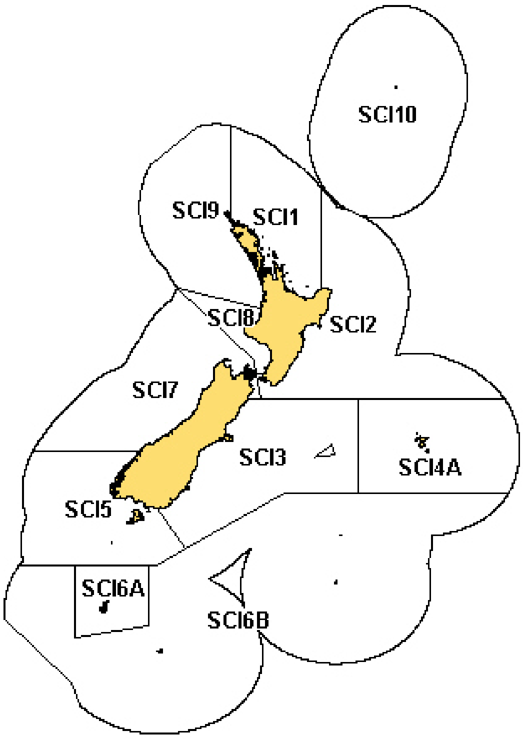
# SCAMPI (SCI)

(*Metanephrops challengeri*)




## 1. FISHERY SUMMARY

Scampi were introduced to the QMS on 1 October 2004. At this time management protocols for scampi and man0agement areas on the Chatham Rise (SCIs 3 and 4) and in the SubAntarctic (SCIs 6A and 6B) were substantially modified. TACs and TACCs by Fishstock are shown in Table 1.

**Table 1: Total allowable catches (TAC, t) allowances for customary fishing, recreational fishing, and other sources of mortality (t) and Total Allowable Commercial Catches (TACC, t) declared for scampi on introduction to the QMS in October 2004. These limits are still in force. * Details of components of 'Other' allowances provided in section 1.5.**

| | | Allowances | | | |
|---|---|---|---|---|---|
| **Stock** | **TAC** | **Customary** | **Recreational** | **Other*** | **TACC** |
| SCI 1 | 126 | 0 | 0 | 6 | 120 |
| SCI 2 | 210 | 0 | 0 | 10 | 200 |
| SCI 3 | 357 | 0 | 0 | 17 | 340 |
| SCI 4A | 126 | 0 | 0 | 6 | 120 |
| SCI 5 | 42 | 0 | 0 | 2 | 40 |
| SCI 6A | 321 | 0 | 0 | 15 | 306 |
| SCI 6B | 53 | 0 | 0 | 3 | 50 |
| SCI 7 | 79 | 0 | 0 | 4 | 75 |
| SCI 8 | 5 | 0 | 0 | 0 | 5 |
| SCI 9 | 37 | 0 | 0 | 2 | 35 |
| SCI 10 | 0 | 0 | 0 | 0 | 0 |

### 1.1 Commercial fisheries

Target trawl fisheries for scampi developed first in the late 1980's. Access was restricted and, until the 1999–00 fishing year, there were restrictions on the vessels that could be used in each stock. Between October 1991 and September 2002, catches were restrained using a mixture of competitive and individually allocated catch limits but between October 2001 and September 2004, all scampi fisheries were managed using competitive catch limits (Table 2).

The fishery is conducted mainly by 20–40 m vessels using light bottom trawl gear. All vessels use multiple rigs of two or three nets of very low headline height. The main fisheries are in waters 300–500 m deep in SCI 1 (Bay of Plenty), SCI 2 (Hawke Bay, Wairarapa Coast), SCI 3 (Mernoo Bank) SCI 4A (western Chatham Rise and Chatham Islands) and SCI 6 (Sub-Antarctic). Some fishing has been reported on the Challenger Plateau outside the EEZ.

**Table 2. Estimated commercial landings (t) from the 1986–87 to 2010-11 fishing years (based on management areas in force since introduction to the QMS in October 2004) and catch limits (t) by Fishstock (from CLR and TCEPR, MFish landings and catch effort databases, early years may be incomplete). No limits before 1991–92 fishing year, (†) catch limits allocated individually until the end of 2000–01. *Note that management areas SCI 3, 4A, 6A and 6B changed in October 2004, and the catch limits applied to the old areas are not relevant to the landings, which have been reallocated to the revised areas on a pro-rata basis in relation to the TECPR data, which has previously been found to match landings well.**

| | SCI 1 | | SCI 2 | | SCI 3 | | SCI 4A | | SCI 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | Limit (†) / TACC | Landings | Limit (†) / TACC | Landings | Limit / TACC | Landings | Limit (†) / TACC | Landings | Limit / TACC |
| 1986–87 | 5 | – | 0 | – | 0 | – | 0 | – | – | – |
| 1987–88 | 15 | – | 5 | – | 0 | – | 0 | – | 0 | – |
| 1988–89 | 60 | – | 17 | – | 0 | – | 0 | – | 0 | – |
| 1989–90 | 104 | – | 138 | – | 0 | – | 0 | – | 0 | – |
| 1990–91 | 179 | – | 295 | – | 0 | – | 32 | – | 0 | – |
| 1991–92 | 132 | 120 | 221 | 246 | 153 | – | 78 | – | 0 | 60 |
| 1992–93 | 114 | 120 | 210 | 246 | 296 | – | 11 | – | 2 | 60 |
| 1993–94 | 115 | 120 | 244 | 246 | 324 | – | 0 | – | 1 | 60 |
| 1994–95 | 114 | 120 | 226 | 246 | 292 | – | 0 | – | 0 | 60 |
| 1995–96 | 117 | 120 | 230 | 246 | 306 | – | 0 | – | 0 | 60 |
| 1996–97 | 117 | 120 | 213 | 246 | 304 | – | 0 | – | 2 | 60 |
| 1997–98 | 107 | 120 | 224 | 246 | 296 | – | 0 | – | 0 | 60 |
| 1998–99 | 110 | 120 | 233 | 246 | 292 | – | 28 | – | 30 | 60 |
| 1999–00 | 124 | 120 | 193 | 246 | 322 | – | 23 | – | 9 | 40 |
| 2000–01 | 120 | 120 | 146 | 246 | 333 | – | 0 | – | 7 | 40 |
| 2001–02 | 124 | 120 | 247 | 246 | 304 | – | 30 | – | < 1 | 40 |
| 2002–03 | 121 | 120 | 134 | 246 | 264 | – | 79 | – | 7 | 40 |
| 2003–04 | 120 | 120 | 64 | 246 | 277 | – | 41 | – | 5 | 40 |
| 2004–05 | 114 | 120 | 71 | 200 | 335 | 340 | 101 | 120 | 1 | 40 |
| 2005–06 | 109 | 120 | 77 | 200 | 319 | 340 | 79 | 120 | < 1 | 40 |
| 2006–07 | 110 | 120 | 80 | 200 | 307 | 340 | 39 | 120 | < 1 | 40 |
| 2007–08 | 102 | 120 | 61 | 200 | 209 | 340 | 8 | 120 | < 1 | 40 |
| 2008–09 | 86 | 120 | 52 | 200 | 190 | 340 | 1 | 120 | < 1 | 40 |
| 2009–10 | 111 | 120 | 125 | 200 | 302 | 340 | < 1 | 120 | < 1 | 40 |
| 2010-11 | 114 | 120 | 128 | 100 | 256 | 340 | 43 | 120 | < 1 | 40 |

| | SCI 6A | | SCI 6B | | SCI 7 | | SCI 8 | | SCI 9 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | Limit (†) / TACC | Landings | Limit / TACC | Landings | Limit / TACC | Landings | Limit / TACC | Landings | Limit / TACC |
| 1986–87 | 0 | – | 0 | – | 0 | – | 0 | – | 0 | – |
| 1987–88 | 0 | – | 0 | – | 0 | – | 0 | – | 0 | – |
| 1988–89 | 0 | – | 0 | – | 0 | – | 0 | – | 0 | – |
| 1989–90 | 0 | – | 0 | – | 0 | – | 0 | – | 0 | – |
| 1990–91 | 2 | – | 0 | – | 0 | – | 0 | – | 0 | – |
| 1991–92 | 325 | – | 0 | – | 0 | 75 | 0 | 60 | 0 | 60 |
| 1992–93 | 279 | – | 0 | – | 2 | 75 | 0 | 60 | 2 | 60 |
| 1993–94 | 303 | – | 0 | – | 0 | 75 | 0 | 60 | 1 | 60 |
| 1994–95 | 239 | – | 0 | – | 2 | 75 | 0 | 60 | 0 | 60 |
| 1995–96 | 270 | – | 0 | – | 1 | 75 | 0 | 60 | 0 | 60 |
| 1996–97 | 275 | – | 0 | – | 0 | 75 | 0 | 60 | 0 | 60 |
| 1997–98 | 279 | – | 0 | – | 0 | 75 | 0 | 60 | 0 | 60 |
| 1998–99 | 325 | – | < 1 | – | 1 | 75 | 0 | 60 | < 1 | 60 |
| 1999–00 | 328 | – | 0 | – | 1 | 75 | 0 | 5 | 0 | 35 |
| 2000–01 | 264 | – | 0 | – | < 1 | 75 | 0 | 5 | 0 | 35 |
| 2001–02 | 272 | – | 0 | – | < 1 | 75 | 0 | 5 | 0 | 35 |
| 2002–03 | 255 | – | 0 | – | < 1 | 75 | 0 | 5 | 0 | 35 |
| 2003–04 | 311 | – | 0 | – | 1 | 75 | 0 | 5 | 0 | 35 |
| 2004–05 | 295 | 306 | 0 | 50 | 1 | 75 | 0 | 5 | 0 | 35 |
| 2005–06 | 286 | 306 | 0 | 50 | 1 | 75 | 0 | 5 | 0 | 35 |
| 2006–07 | 302 | 306 | 0 | 50 | < 1 | 75 | 0 | 5 | 0 | 35 |
| 2007–08 | 287 | 306 | 0 | 50 | 1 | 75 | 0 | 5 | 0 | 35 |
| 2008–09 | 264 | 306 | < 1 | 50 | 1 | 75 | 0 | 5 | 0 | 35 |
| 2009–10 | 144 | 306 | 0 | 50 | 2 | 75 | 0 | 5 | 0 | 35 |
| 2010–11 | 198 | 306 | < 1 | 50 | 4 | 75 | 0 | 5 | 0 | 35 |

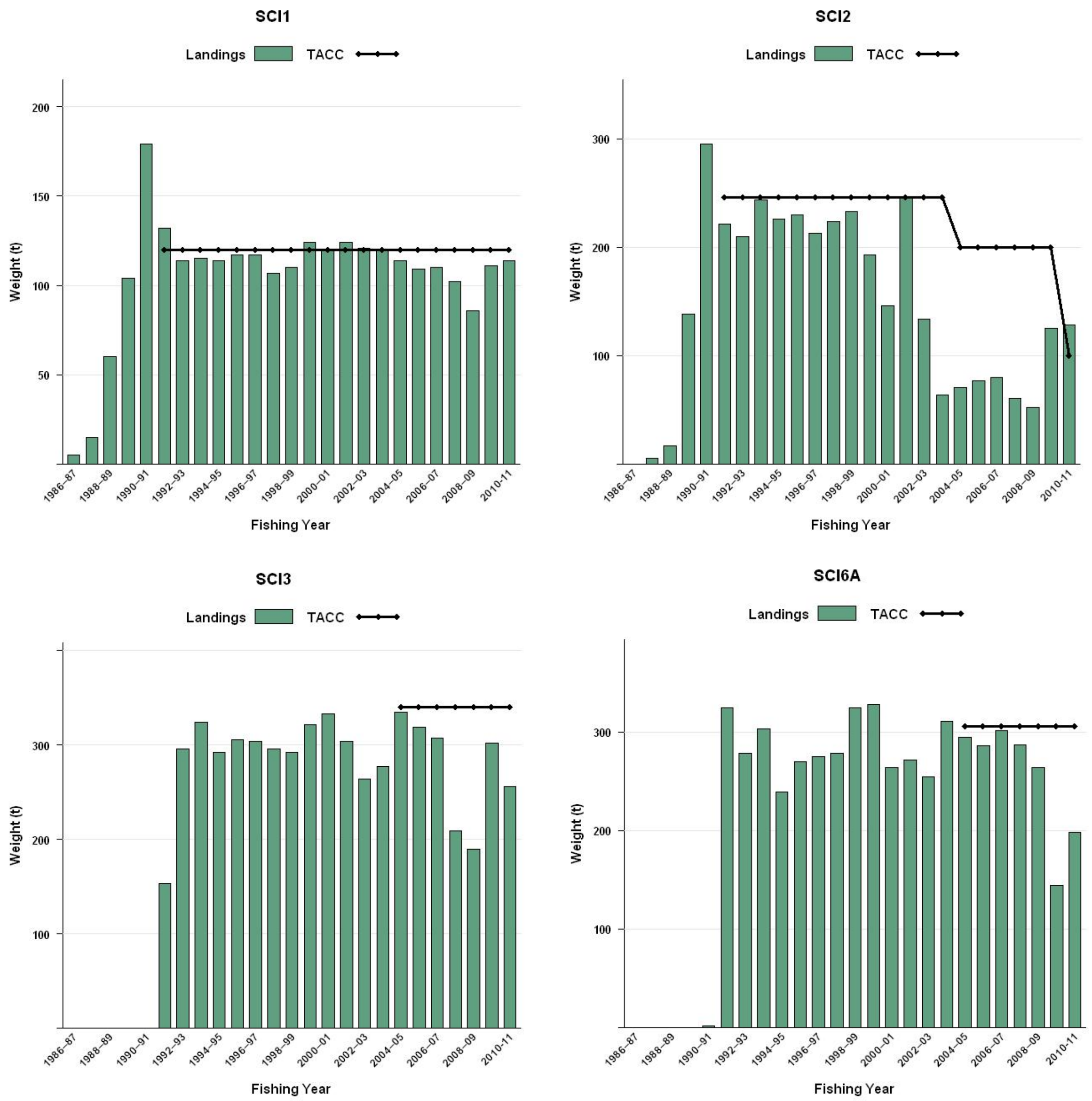



**Figure 1: Historical landings and TACC for the four main SCI stocks from fishing years 1986-97 to present. Left to right: SCI 1, SCI 2, SCI 3 and SCI6A. QMS data from 1991-92 to present for SCI 1 and SCI 2 stocks, and 2004-05 to present for SCI 3 and SCI 6A stocks.**

In all Fishstocks, but especially in SCI 2, landings are below the TACC. This may be related to fleet economics to some extent. Minimal fishing for scampi has taken place in SCI 5, 6B, 7, 8 and 9.

## 1.2 Recreational fisheries

There is no recreational fishery for scampi.

## 1.3 Maori customary fisheries

There is no customary fishery for scampi.

## 1.4 Illegal catch

There is no quantitative information on the level of illegal catch.

### 1.5 Other sources of mortality

Unaccounted sources of mortality in scampi could include incidental effects of trawl gear on the animals and their habitat.

## 2. BIOLOGY

Scampi are widely distributed around the New Zealand coast, principally in depths between 200 and 500 m on the continental slope. Like other species of *Metanephrops* and *Nephrops*, *M. challengeri* builds a burrow in the sediment and may spend a considerable proportion of time within this burrow. From trawl catch rates, it appears that there are daily and seasonal cycles of emergence from burrows onto the sediment surface.

Scampi moult several times per year in early life and probably about once a year after sexual maturity (at least in females). Early work suggested that female *M. challengeri* achieve sexual maturity at about 40 mm orbital carapace length (OCL) in the Bay of Plenty and on the Chatham Rise, about 36 mm OCL off the Wairarapa coast, and about 56 mm OCL around the Auckland Islands. Examination of ovary maturity on more recent trawl surveys suggest that 50% of females were mature at 30 mm OCL in SCI 1 and 2, and at about 38 mm in SCI 6A. The peak of moulting and spawning activity seems to occur in spring or early summer. Larval development of *M. challengeri* is probably very short, and may be less than 3 days in the wild. The abbreviated larval phase may, in part, explain the low fecundity of *M. challengeri* compared with *N. norvegicus* (that of the former being about 10–20% that of the latter).

Relatively little is known of the growth rate of any of the *Metanephrops* species in the wild. Tagging of *M. challengeri* to determine growth rates was undertaken in the Bay of Plenty in 1995, and the bulk of recaptures were made late in 1996. About 1% of tagged animals were recaptured, similar to the average return rate of similar tagging studies for scampi and prawns overseas. Many more females than males were recaptured, and small males were almost entirely absent from the recapture sample. Scampi captured and tagged at night were much more likely to be recaptured than those exposed to sunlight. Estimates from this work of growth rate and mortality for females are given in Table 3. The data for males were insufficient for analysis, although the average annual increment with size appeared to be greater than in females.

**Table 3: Estimates of biological parameters.**

| **Population** | **Estimate** | | **Source** |
|---|---|---|---|
| **1. Weight = a(orbital carapace length)$^b$ (weight in g, OCL in mm)** | | | |
| All males: SCI 1 | a = 0.000373 | b = 3.145 | Cryer & Stotter (1997) |
| Ovigerous females: SCI 1 | a = 0.003821 | b = 2.533 | Cryer & Stotter (1997) |
| Other females: SCI 1 | a = 0.000443 | b = 3.092 | Cryer & Stotter (1997) |
| All females: SCI 1 | a = 0.000461 | b = 3.083 | Cryer & Stotter (1997) |
| **2. von Bertalanffy growth parameters** | | | |
| | ***K* (yr$^{-1}$)** | **$L_\infty$ (OCL, mm)** | |
| Females: SCI 1 (tag) | 0.11–0.14 | 48.0–49.0 | Cryer & Stotter (1999) |
| Females: SCI 2 (aquarium) | 0.31 | 48.8 | Cryer & Oliver (2001) |
| Males: SCI 2 (aquarium) | 0.32 | 51.2 | Cryer & Oliver (2001) |
| **3. Natural mortality (*M*)** | | | |
| Females: SCI 1 | *M* = 0.20–0.25 | | Cryer & Stotter (1999) |

Scampi from SCI 2 were successfully reared in aquariums for over 12 months in 1999–2000. Results from these growth trials suggested a von Bertalanffy K of about 0.3 for both sexes, compared with < 0.15 for the tagging trial. Extrapolating the length-based results to age-based curves suggests that scampi are about 3–4 years old at 30 mm carapace length and may live for 15 years. There are many uncertainties with captive reared animals, however, and these estimates should not be regarded as

definitive. In particular, the rearing temperature was 12º C compared with about 10º C in the wild (in SCI 1 and 2), and the effects of captivity are largely unknown.
The maximum age of New Zealand scampi is not known, although analysis of tag return data and aquarium trials suggest that this species may be quite long lived. *Metanephrops* spp in Australian waters may grow rather slowly and take up to 6 years to recruit to the commercial fishery (Rainer 1992), consistent with estimates of growth in *M. challengeri* (Table **3**). *N. norvegicus* populations in some northern European populations achieve a maximum age of 15–20 years (Bell *et al*. 2006), consistent with the estimates of natural mortality, *M*, for *M. challengeri*.

A tagging project has been conducted in SCI 6A, with three release events (March 2007, 2008 and 2009). By August 2010, 6.3% of the 2007 releases had been recaptured, 3.5% of the 2008 releases and 4% of the 2009 releases. Most recaptures occur within a year of release. Tagging work has also more recently been conducted in SCI 1, 2 and 3. These data will be fitted within assessment models to estimate growth.

## 3. STOCKS AND AREAS

Stock structure of scampi in New Zealand waters is not well known. Preliminary electrophoretic analyses suggest that scampi in SCI 6A are genetically distinct from those in other areas, and there is substantial heterogeneity in samples from SCIs 1, 2, and 4A. The abbreviated larval phase of this species may lead to low rates of gene mixing. Differences among some scampi populations in average size, size at maturity, the timing of diel and seasonal cycles of catchability, catch to bycatch ratios and CPUE trends also suggest that treatment as separate management units is appropriate.

A review of stock boundaries between SCI 3 and SCI 4A and between SCI 6A and SCI 6B was conducted in 2000, prior to introduction of scampi into the Quota Management System. Following the recommendation of this review, the boundaries were changed on 1 October 2004, to reflect the distribution of scampi stocks and fisheries more appropriately.

## 4. STOCK ASSESSMENT

Attempts have been made to index scampi abundance using CPUE and trawl survey indices and, more recently, photographic surveys of scampi burrows. There is some level of agreement between the relative trends shown, at least for SCI 1 (Figure 2), and all three indices are included in the length based assessment model.

Standardised CPUE indices were first calculated for SCI 1 and used as abundance indices for the assessments in 1992, 1993 and 1995. Similar standardised indices for SCIs 2, 3, 4 and 6A were estimated in 1997, 1998 and 1999. These indices for all areas were highly correlated with the unstandardised index (total catch divided by total effort). In 1998 the Shellfish Fishery Assessment Working Group concluded that the standardised CPUE analyses may not be providing reliable indices of abundance for scampi.

### 4.1 Estimates of fishery parameters and abundance

Annual unstandardised CPUE indices (total catch divided by total effort in hours of trawling) have been calculated for each area using the data from all vessels that fished (Figure 2). The Shellfish Fishery Assessment Working Group has raised concerns in the past that potential variability in catchability between years mean that CPUE may not provide a reliable index of abundance. The indices for areas SCI 3, 4A 6A and 6B have been recalculated over the time series in light of the alterations of some stock boundaries, following the review described above. In SCI 1, CPUE increased in the early 1990s, and then declined between 1995–96 and 2001–02, increased to 2002-03, but has decreased to the 2001-02 level in the most recent years. In SCI 2, CPUE declined steadily between 1994–95 and 2001–02 and has increased slowly since then. In SCI 3, CPUE rose steadily through the early 1990s, fluctuated around a slowly declining trend in the late 1990s and early 2000s, showed a steeper decline to 2007-08, but has increased in recent years. In SCI 4A, CPUE observations were intermittent between 1991–92 and 2002-03, showing a dramatic increase over this period. Since 2002-03 CPUE has been far lower, but 2010-11 data show an increase on the more recent years. In SCI 6A, after an initial decline in the early 1990s, CPUE has been relatively stable, although CPUE in the most recent years appears to be slightly lower than the longer term average. With the revision of the stock boundaries, data are only available for one year for SCI 6B, and are therefore not presented. For both SCI 5 and SCI 7, observations have been intermittent, and consistently low.

A time series of trawl surveys designed to measure relative biomass of scampi in SCIs 1 and 2 ran between January 1993 and January 1995 (Table 4). Research trawling for other purposes has been conducted in both SCI 1 and SCI 2 in several other years, and catch rates from appropriate hauls within these studies have been plotted alongside the dedicated trawl survey data in Figure 3 and Figure 4. In SCI 1 the additional trawling was conducted in support of a tagging programme (1995 & 1996), which was conducted by a commercial vessel in the peak area of the fishery, while work to assess trawl selectivity (1996) and in support of photographic surveys (since 1998) may have been more representative of the overall area. In SCI 2 the additional trawling was conducted in support of a growth investigation through length frequency data (1999 & 2000) and in support of photographic surveys (since 2003). All the work was carried out by the same research vessel, but while the work in support of photographic surveys was carried out over the whole area, the work related to the growth investigation was concentrated in a small area at the south of the SCI 2 area. Only the additional trawl survey work in support of photographic surveys has been included in Table 4, since the other studies did not have comparable spatial coverage. The trends observed are similar to the trends in commercial CPUE (Figure 2).

Surveys have been conducted in SCI 3 in 2001 (two surveys, pre and post fishery), 2009 and 2010. The trawl component of the surveys did not suggest any difference between the pre and post fishery periods in 2001, but the photographic survey observed more scampi burrows after the fishery. Trawl, photographic and CPUE data indicate a significant decline in scampi abundance between 2001 and 2009, but an increase in the most recent year (Figure 5).

**Table 4: Trawl survey indices of biomass (t) for scampi in survey strata within SCIs 1, 2, 3 and 6A. CVs of estimates in parenthesis.**

| | SCI 1 | SCI 2 | SCI 3 | SCI 6A | Comments |
|---|---|---|---|---|---|
| 1993 | 175.8 (0.12) | 174.6 (0.12) | | | Dedicated trawl survey |
| 1994 | 192.1 (0.17) | 141.7 (0.14) | | | Dedicated trawl survey |
| 1995 | 243.3 (0.17) | 154.4 (0.17) | | | Dedicated trawl survey |
| 1996 | | | | | |
| 1997 | | | | | |
| 1998 | 123.3 (0.21) | | | | Trawling in support of photo survey |
| 1999 | | | | | |
| 2000 | 129.9 (*) | | | | Trawling in support of photo survey |
| 2001 | 115 (0.27) | | 311.7 (0.26) (strata 902–3) | | Trawling in support of photo survey<br>SCI 3 pre season survey |
| 2002 | 75.7 (0.22) | | | | Trawling in support of photo survey |
| 2003 | | 17.8 (*) | | | Trawling in support of photo survey |
| 2004 | | 29.7 (0.21) | | | Trawling in support of photo survey |
| 2005 | | 33.1 (0.34) | | | Trawling in support of photo survey |
| 2006 | | 26.8 (0.26) | | | Trawling in support of photo survey |
| 2007 | | | | 780.6 (0.18) | Trawling in support of photo survey |
| 2008 | 132.4 (*) | | | 952.1 (0.15) | Trawling in support of photo survey |
| 2009 | | | 63.2 (0.39) (strata 902–3)<br>377.9 (0.29) | 697.3 (0.09) | Trawling in support of photo survey |
| 2010 | | | 64.6 (0.12) (strata 902–3)<br>611.7 (0.04) | | Trawling in support of photo survey |
| 2011 | | | | | |
| 2012 | 90.0 (0.25) | 102.7 (0.33) | | | Trawling in support of photo survey |

* - where no cv is provided, one stratum had only one valid station. Strata included: SCI 1 – 302,303, 402, 403; SCI 2 – 701, 702, 703, 801, 802, 803; SCI 3 – 902, 903, 904; SCI 6A (main area) – 350m, 400m, 450m, 500m. SCI 3 survey in 2009 of split into area surveyed in 2001, and new area (strata 902A–C & 903A)

## SCAMPI (SCI)

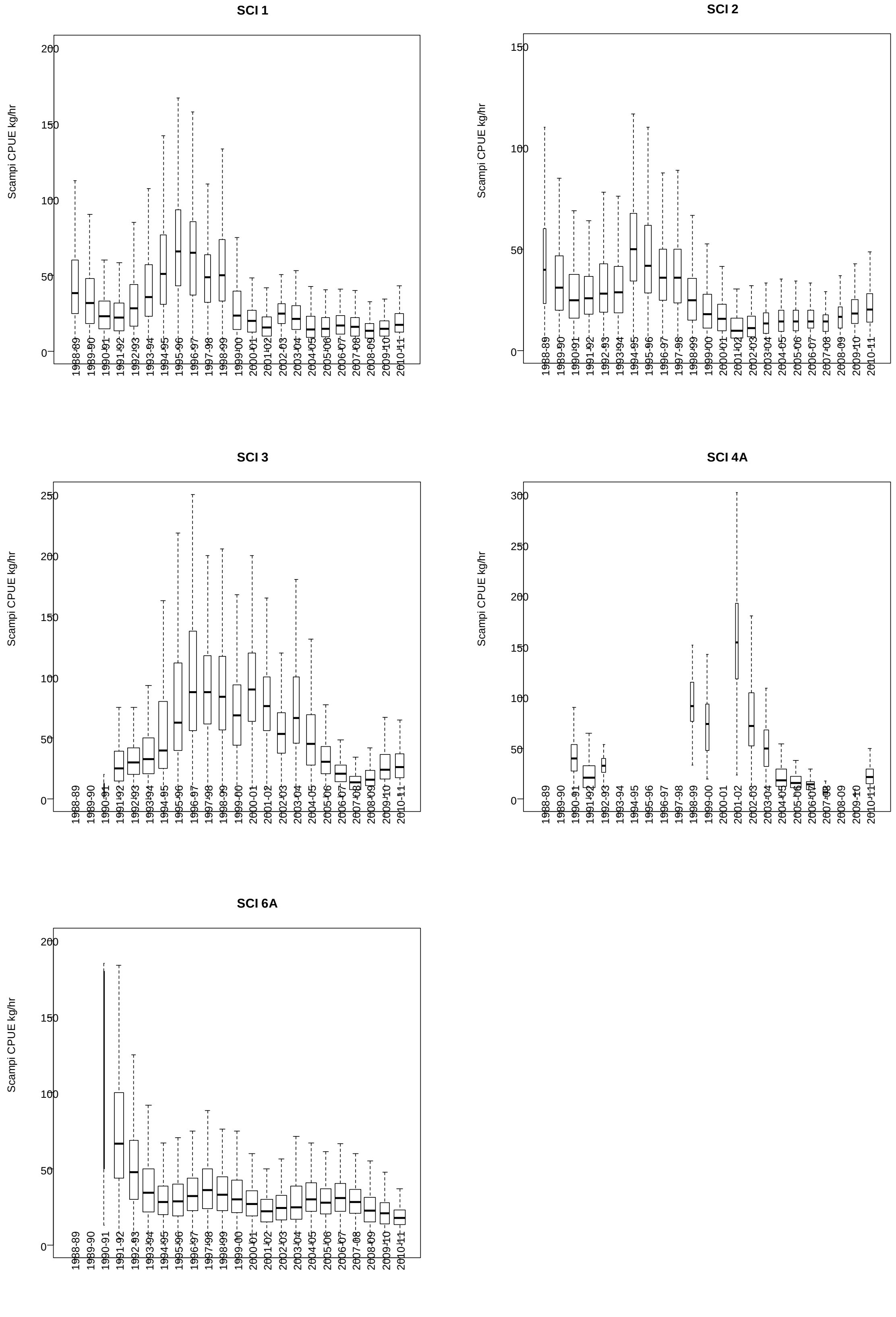



**Figure 2: Box plots (with outliers removed) of individual observations of unstandardised catch rate for scampi (tow catch (kg) divided by tow effort (hours)) with tows of zero scampi catch excluded, by fishing year for main stocks. Note different scales between plots. Horizontal bars within boxes represent distribution median. Upper and lower limits of boxes represent upper and lower quartiles. Whisker extends to largest (or smallest) observation which is less than or equal (greater than or equal) to the upper quartile plus 1.5 times the interquartile range (lower quartile less 1.5 times the interquartile range). Outliers (removed from this plot) are values outside the whiskers. Box width proportional to square root of number of observations.**

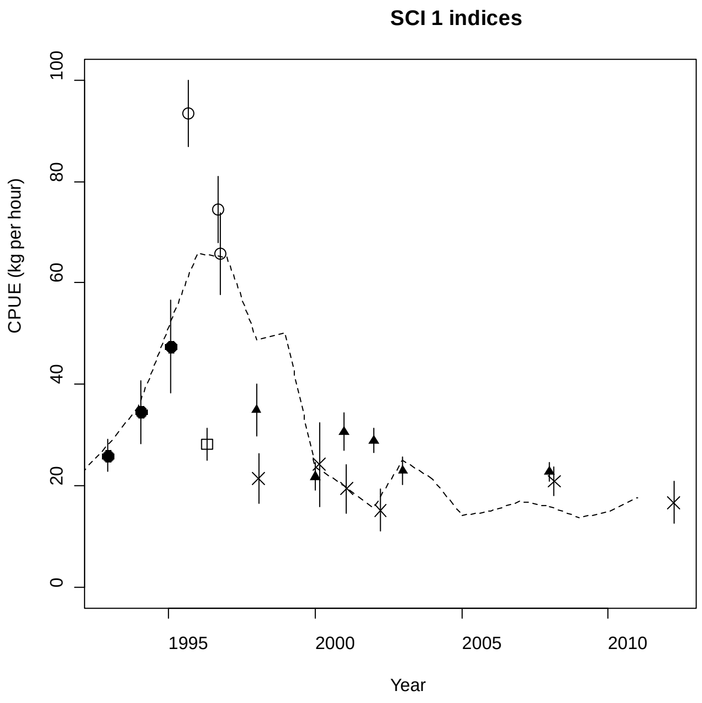



**Figure 3: Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 1. Symbols represent different aims of survey work (● – trawl survey, ○ – tagging work, □ – trawl selectivity, ×- trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 1 from Figure.**

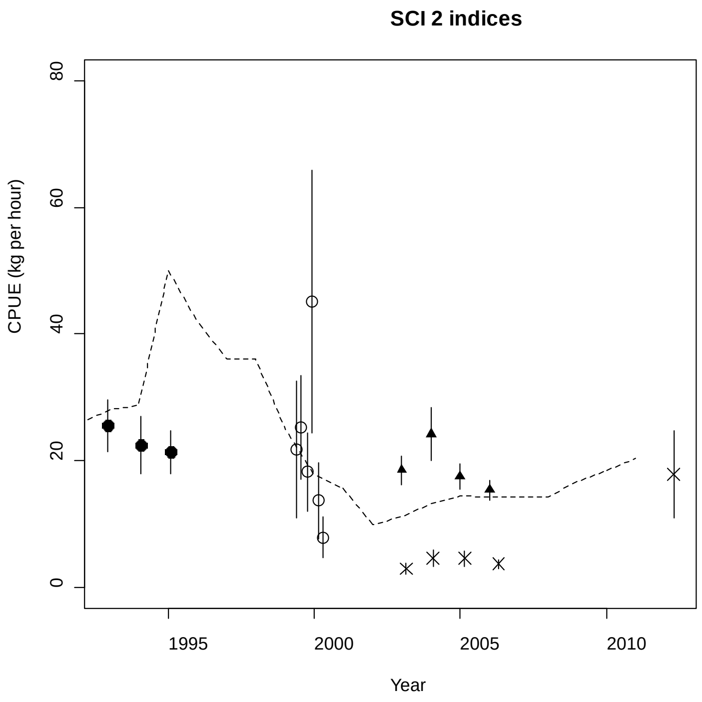



**Figure 4: Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 2. Symbols represent different aims of survey work (● – trawl survey, ○ – tagging work, , ×- trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 2 from Figure.**

**Table 5: Photographic survey estimates of abundance (millions) based on major openings and visible scampi in survey strata within SCIs 1, 2, 3 and 6A. CVs of estimates in parenthesis.**

| | SCI 1 | | SCI 2 | | SCI 3 | | SCI 6A | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | Major openings | Visible scampi | Major openings | Visible scampi | Major openings | Visible scampi | Major openings | Visible scampi | |
| 1998 | 155.1 (0.15) | 27.9 (0.22) | | | | | | | |
| 1999 | | | | | | | | | |
| 2000 | 96.7 (0.13) | 18.2 (0.18) | | | | | | | |
| 2001 | 135.9 (0.12) | 12.3 (0.26) | | | 267.3 (0.09) (strata 902–3)<br>443.8 (0.17) (strata 902–3) | 72.9 (0.16) (strata 902–3)<br>77.5 (0.14) (strata 902–3) | | | SCI 3, two surveys in 2001, Aug/Sept and Oct |
| 2002 | 128.2 (0.08) | 16.7 (0.21) | | | | | | | |
| 2003 | 101.9 (0.12) | 14.4 (0.21) | 161.6 (0.12) | 10.0 (0.39) | | | | | |
| 2004 | | | 210.8 (0.17) | 20.6 (0.28) | | | | | |
| 2005 | | | 152.5 (0.11) | 14.6 (0.20) | | | | | |
| 2006 | | | 134.2 (0.10) | 13.3 (0.23) | | | | | |
| 2007 | | | | | | | 153.7 (0.08) | 44.5 (0.10) | SCI 6A estimate for main area* |
| 2008 | 100.8 (0.08) | 12.5 (0.13) | | | | | 57.3 (0.07) | 24.9 (0.10) | |
| 2009 | | | | | 61.1 (0.20) (strata 902–3)<br>260.6 (0.08) (larger survey) | 23.6 (0.17) (strata 902–3)<br>124.8 (0.10) (larger survey) | 120.4 (0.08) | 24.2 (0.11) | SCI 3, estimates provided for 2001 survey coverage (strata 902–3) and new larger survey |
| 2010 | | | | | 74.6 (0.11) (strata 902–3)<br>348.0 (0.05) (larger survey) | 10.9 (0.23) (strata 902–3)<br>91.4 (0.10) (larger survey) | | | SCI 3, estimates provided for 2001 survey coverage (strata 902–3) and new larger survey |

* - SCI 6A estimate provided for main area as future surveys may not survey secondary area

**Table 6: Photographic survey estimates of biomass (t) based on major openings and visible scampi in survey strata within SCIs 1, 2, 3 and 6A. CVs of estimates in parenthesis.**

| | SCI 1 | | SCI 2 | | SCI 3 | | SCI 6A | | Mean weight* |
|---|---|---|---|---|---|---|---|---|---|
| | Major openings | Visible scampi | Major openings | Visible scampi | Major openings | Visible scampi | Major openings | Visible scampi | |
| 1998 | 3996 (0.15) | 719 (0.22) | | | | | | | SCI 1 – 25.76g |
| 1999 | | | | | | | | | |
| 2000 | 2373 (0.13) | 447 (0.18) | | | | | | | SCI 1 – 24.54g |
| 2001 | 3451 (0.12) | 312 (0.26) | | | 9490 (0.09)<br>15756 (0.17) | 2588 (0.16)<br>2752 (0.14) | | | SCI 1 – 25.40g<br>SCI 3 – 35.5g |
| 2002 | 3366 (0.08) | 438 (0.21) | | | | | | | SCI 1 – 26.26g |
| 2003 | 3364 (0.12) | 475 (0.21) | 4572 (0.12) | 283 (0.39) | | | | | SCI 1 – 33.01g<br>SCI 2 – 28.29g |
| 2004 | | | 4298 (0.17) | 420 (0.28) | | | | | SCI 2 – 20.28g |
| 2005 | | | 4701 (0.11) | 450 (0.20) | | | | | SCI 2 – 30.83g |
| 2006 | | | 3727 (0.10) | 369 (0.23) | | | | | SCI 2 – 27.77g |
| 2007 | | | | | | | 4775 (0.08) | 1382 (0.09) | SCI 6A – 31.70g |
| 2008 | 2723 (0.08) | 338 (0.13) | | | | | 1816 (0.07) | 789 (0.10) | SCI 1 – 27.0g<br>SCI 6A – 31.70g |
| 2009 | | | | | 2169 (0.20) (strata 902–3)<br>9251 (0.08) (larger survey) | 838 (0.17) (strata 902–3)<br>4430 (0.10) (larger survey) | 3817 (0.08) | 767 (0.11) | SCI 6A – 31.70g<br>SCI 3 – 35.5g |
| 2010 | | | | | 2648 (0.11) (strata 902–3)<br>12354 (0.05) (larger survey) | 387 (0.23) (strata 902–3)<br>3245 (0.10) (larger survey) | | | SCI 3 – 35.5g |

* - Mean weight for SCI 1 and SCI 2 for each survey to 2006 estimated from size distribution of burrows, and relationship between burrow and scampi size. Mean weight for SCI 1 in 2008 taken as average of previous SCI 1 surveys. Mean weight for SCI 3 assumed. Mean weight for SCI 6A estimated from length cohort analysis of removals to estimate population size >20 mm CL. The same mean weight has been applied to both the major openings and visible scampi within each survey/year combination.

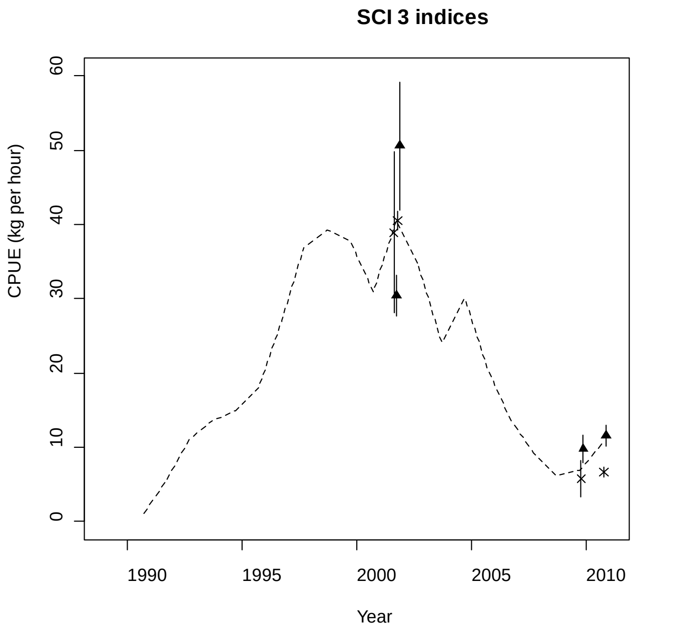



**Figure 5: Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 3. Symbols represent different aims of survey work (×- trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 3 from Figure .**

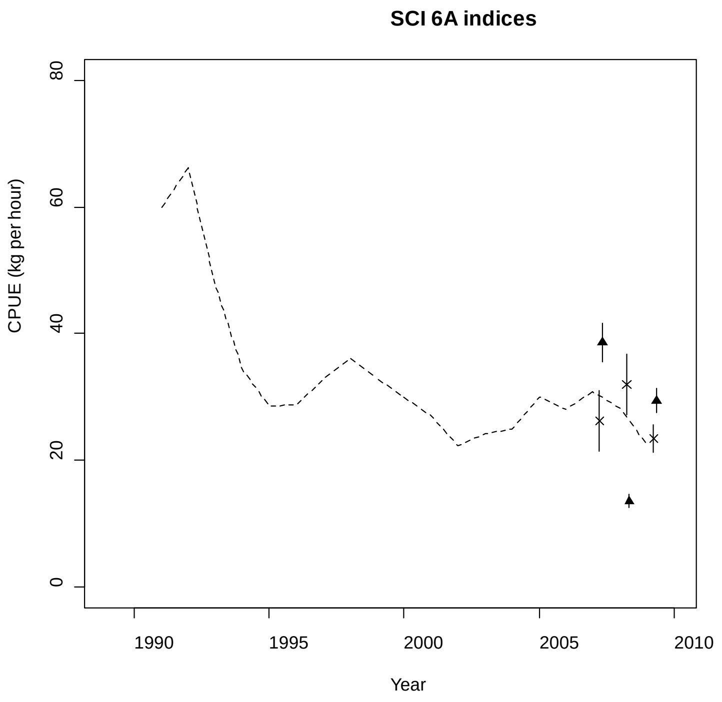



**Figure 6: Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 6A. Symbols represent different aims of survey work (×- trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 6A from Figure .**

Surveys have only been conducted in SCI 6A in 2007–2009. The trawl component of the surveys suggests that biomass has remained relatively stable in recent years. The photographic survey suggested a considerable decline in abundance between 2007 and 2008, but an increase towards the 2007 level in 2009. Over the longer term, the CPUE data indicate that following a rapid decline in the early 1990s, abundance may have declined slightly since 1995 (Figure 6).

Photographic surveying (usually by video) has been used extensively to estimate the abundance of the European scampi *Nephrops norvegicus*. In New Zealand, development of photographic techniques, including surveys, has been underway since 1998. To-date, six surveys have been undertaken in SCI 1 (between Cuvier Island and White Island at a depth of 300 to 500 m), four surveys have been undertaken in SCI 3 (northeastern Mernoo Bank only, 200 to 600 m depth), four surveys have been undertaken in SCI 2 (Mahia Peninsula to Castle Point 200 to 500 m depth), and three surveys in SCI 6A (to the east of the Auckland Islands, 350–550 m depth). The association between scampi and burrows in SCI 6A appears to be different to other areas examined, and it is uncertain whether the relationship between scampi and burrow abundance is constant between areas, or whether the marked decline in burrow abundance observed between 2007 and 2009 in SCI 6A (Table 5 and Table 6) reflects scampi abundance (particularly when trawl survey catch rates increased (Table 4).

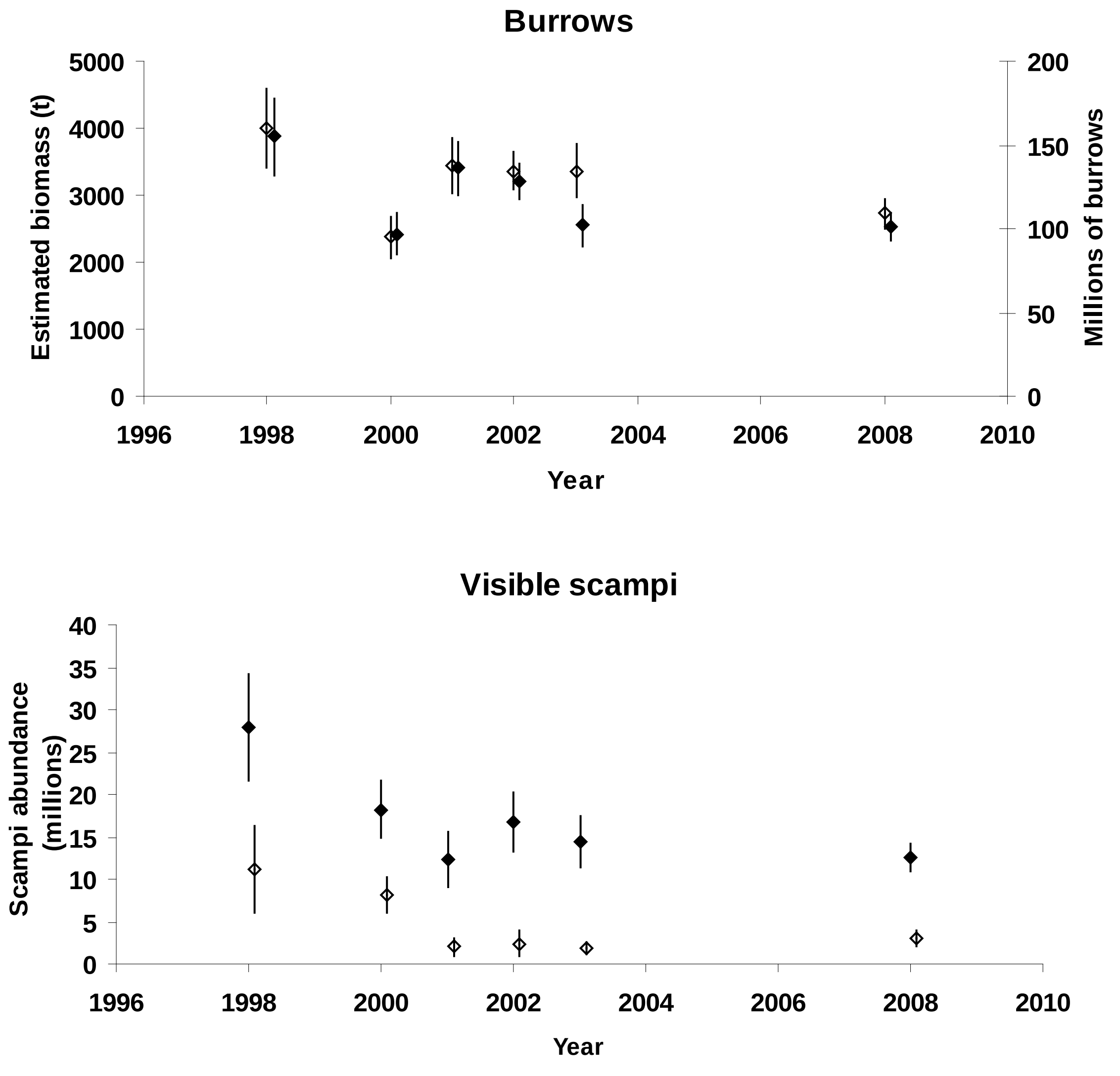



**Figure 7: Estimated abundance (± c.v.s) of major burrow openings (upper plot, solid symbols), biomass (upper plot, open symbols, assuming 100% occupancy and a relationship between burrow and occupant size), all visible scampi (lower plot, solid symbols), and scampi entirely free of burrows (lower plot, open symbols) in the core area of the SCI 1 fishery, 1998 to 2008.**

At this stage in the development of photographic survey techniques, two indices are showing promise: the density of visible scampi and the density of major burrow openings (counts of which are now consistent among experienced readers, and repeatable, following development of a between reader standardisation process). Both of these can be used to estimate indices of biomass, using estimates of mean individual weight or the size distribution of animals in the surveyed population. The Bayesian length based model currently under development for scampi uses the estimated abundance of major burrow openings as an abundance index, and future development plans include using the estimated abundance of visible scampi.

Estimates of major burrow opening and visible scampi abundance are provided in Table 5. The two indices estimated from the core areas of SCI 1 and SCI 2 are shown in Figure 7 and Figure 8.

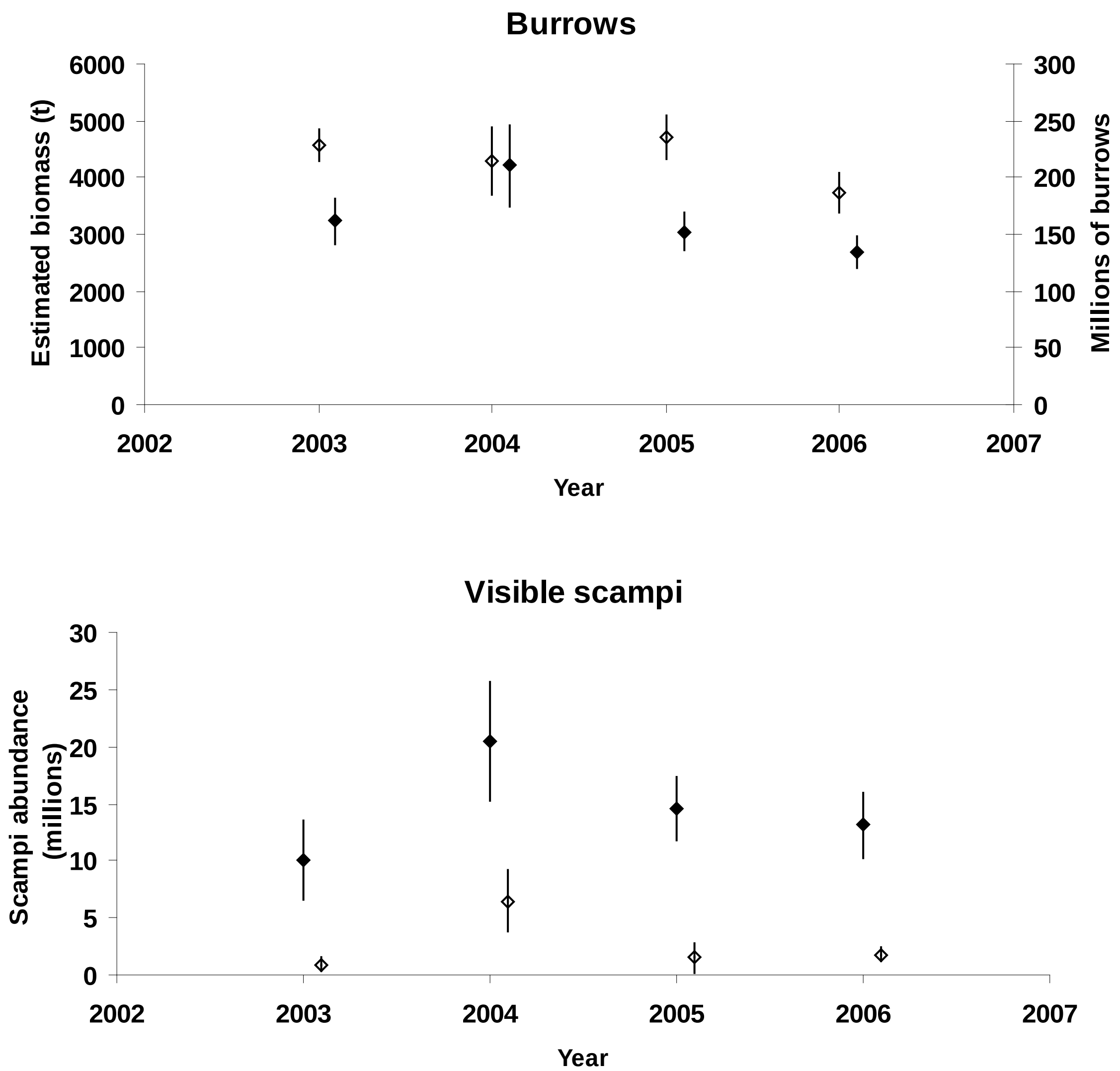



**Figure 8: Estimated abundance (± c.v.s) of major burrow openings (upper plot, solid symbols), biomass (upper plot, open symbols, assuming 100% occupancy and a relationship between burrow and occupant size), all visible scampi (lower plot, solid symbols), and scampi entirely free of burrows (lower plot, open symbols) in the core area of the SCI 2 fishery, 2003 to 2006.**

Length frequency distributions from trawl surveys and from scientific observers do not show a consistent increase in the proportion of small individuals in any SCI stock following the development of significant fisheries for scampi. Analyses of information from trawl survey and scientific observers in SCI 1 and 6A up to about 1996 suggested that the proportion of small animals in the catch declined markedly in both areas, despite the fact that CPUE declined markedly in SCI 6A and increased markedly in SCI 1. Where large differences in the length frequency distribution of scampi measured by observers have been detected (as in SCIs 1 and 6A), detailed analysis has shown that the spatial coverage of observer samples has varied with time, and this may have influenced the nature of the length frequency samples. Observer sampling practices may have also introduced bias or increased uncertainty. The length composition of scampi is known to vary with depth and geographical location, and fishers may deliberately target certain size categories.

Some commercial fishers reported that they experienced historically low catch rates in SCI 1 and 2 between 2001 and 2004. They further suggest that this reflects a decrease in abundance of scampi in these areas. Other fishers consider that catch rates do not necessarily reflect changes in abundance because they are influenced by management and fishing practices.

## 4.2 Biomass estimates

In 2010 the SFWG accepted the stock assessments for SCI 1 and SCI 2, undertaken using the length-based population model that has been under development for several years (Tuck and Dunn 2012). A number of model runs were examined over a range of combinations of structural complexities (spatial and depth structure) and sets of included data (CPUE, trawl surveys, length distributions). For SCI 1, model runs 1C (stratification on basis of time step) and 2C (stratification on basis of time step and depth) could not be decided between by the SFWG so both were accepted. For SCI 2, model run 4C (stratification on basis of time step) was accepted.

The model's annual cycle is based on the fishing year and is divided into three time-steps (Table 7). The choice of three time steps was based on current understanding of scampi biology and sex ratio in catches. Note that model references to "year" within this report refer to the modelled or fishing year, and are labelled as the most recent calendar year, i.e., the fishing year 1998–99 is referred to as "1999" throughout.

**Table 7: Annual cycle of the population model for SCI 1, showing the processes taking place at each time step, their sequence within each time step, and the available observations. Fishing and natural mortality that occur together within a time step occur after all other processes, with 50% of the natural mortality for that time step occurring before and 50% after the fishing mortality.**

| Step | Period | Process | Proportion in time step |
|---|---|---|---|
| 1 | Oct–Jan | Growth (both sexes) | |
| | | Natural mortality | 0.33 |
| | | Fishing mortality | From TCEPR |
| 2 | Feb–April | Recruitment | 1.0 |
| | | Maturation | 1.0 |
| | | *Growth (males)** | |
| | | Natural mortality | 0.25 |
| | | Fishing mortality | From TCEPR |
| 3 | May–Sept | Natural mortality | 0.42 |
| | | Fishing mortality | From TCEPR |

* - the main period of male moulting appears to be from February to April. In the model both sexes are assumed to grow at the start of step 1, and this male growth period (February to April) is ignored. Sensitivities to an additional growth for males at this time are explored.

Investigations into factors affecting scampi catch rates and size distributions (Cryer & Hartill 2000, Tuck 2009) have identified significant depth and spatial effects and therefore spatial and depth stratification was also considered for the model. Catches generally occur throughout the year, and were divided among the time-steps according to the proportion of estimated catches recorded on Trawl Catch, Effort, and Processing Returns (TCEPR). Recreational catch, customary catch, and illegal catch are ignored. The maximum exploitation rate (i.e., the ratio of the maximum catch to biomass in any year) is not known, but was constrained to no more than 0.9 in a time-step. Individuals are assumed to recruit to the model at age 1, with the mean expectation of recruitment success predicted by a Beverton & Holt stock-recruitment relationship. Length at recruitment is defined by a normal distribution with mean of 10 mm OCL with a c.v. of 0.4. Relative year class strengths are encouraged to average 1.0. Natural mortality is assumed known at 0.2 (Cryer & Stotter 1999). Growth is estimated in the model, fitting to the tag (Cryer & Stotter 1997, Cryer & Stotter 1999) and aquarium data (Cryer & Oliver 2001) from SCI 1 and SCI 2.

The model uses logistic length based selectivity curves for commercial fishing, research trawl surveys, and photographic surveys, assumed constant over years, but allowed to vary with sex, time step and spatial strata (where included). While the sex ratio data suggest that the relative catchability of the sexes vary through the year (hence the model time structure adopted), there is no reason to suggest that assuming equal availability, selectivity at size would be different between the sexes. Therefore a new selectivity implementation was developed within CASAL, which allowed the $L_{50}$ and $a_{95}$ selectivity parameters to be estimated as single values shared by both sexes in a particular time step and spatial strata, but allowed for different availability between the sexes through estimation of different $a_{max}$ values for each sex. In SCI 1 and SCI 2 selectivity is assumed to be the same in time steps 1 and 3, owing to the relative similarity in sex ratio.

Data inputs included CPUE, trawl and photographic survey indices, and associated length frequency distributions. The stocks were considered over a single area, and also stratified on the basis of depth and latitude.

The assessment reported $B_0$, and $B_{current}$ and used the ratio of current and projected spawning stock biomass ($B_{current}$ and $B_{2015}$) to $B_0$ as preferred indicators. Projections were conducted up to 2015 on the basis of a range of catch scenarios (slightly above and below catch in most recent year or recent average catch, and also TACC if this differs from the previous catch levels). Recent recruitment is estimated to have been lower than the long term average, and projections have been conducted on the basis of both long term and recent (last decade) recruitment scenarios. The probability of exceeding the default Harvest Strategy Standard target and limit reference points are reported.

For SCI 1, model outputs suggest that spawning stock biomass (SSB) decreased until the early 1990s, increased to a peak in about 1995, declined to the early 2000s, and has remained relatively stable since this time. The SSB in SCI 1 in 2010 is estimated to be 40%–60% of $B_0$ (Figure 9 & Figure 10, Table 8). For SCI 2, model outputs suggest that spawning stock biomass (SSB) in SCI 2 decreased until 1990, increased to a peak in about 1994, declined to the early 2000s, increased slightly until about 2005, and has remained relatively stable since this time. The SSB in SCI 2 in 2010 is estimated to be 38%–50% of $B_0$ (Figure 11, Table 10).

The default management target for scampi of 40% $B_0$ is within the range of % $B_0$ estimated for both stocks. On the basis of the outputs from model 1C, and annual catches at the TACC (120 tonnes), the probability of SSB in SCI 1 being below either of the limits by 2015 is very low (Table 9), irrespective of the recruitment scenario applied. Model 2C suggests the probability of SSB in SCI 1 being below the limits is greater, particularly for the recent recruitment scenario. For SCI 2, on the basis of outputs from model 4C, and annual catches at the TACC (200 tonnes), the probability of SSB being below the 20% $B_0$ limit is 63% and 29% for the recent and long term recruitment scenarios, respectively. For annual catches at the level of 2009-10 (125 tonnes), the probability of SSB being below the 20% $B_0$ limit is 15% and 5% for the recent and long term recruitment scenarios, respectively, while for catches at the level of the average of the last 5 years (75 tonnes), the probability of being below either limit is very low, irrespective of the recruitment scenario applied (Table 11).

Length based assessments are also under development for SCI 3 and SCI 6A, but are yet to be accepted by the SFWG.

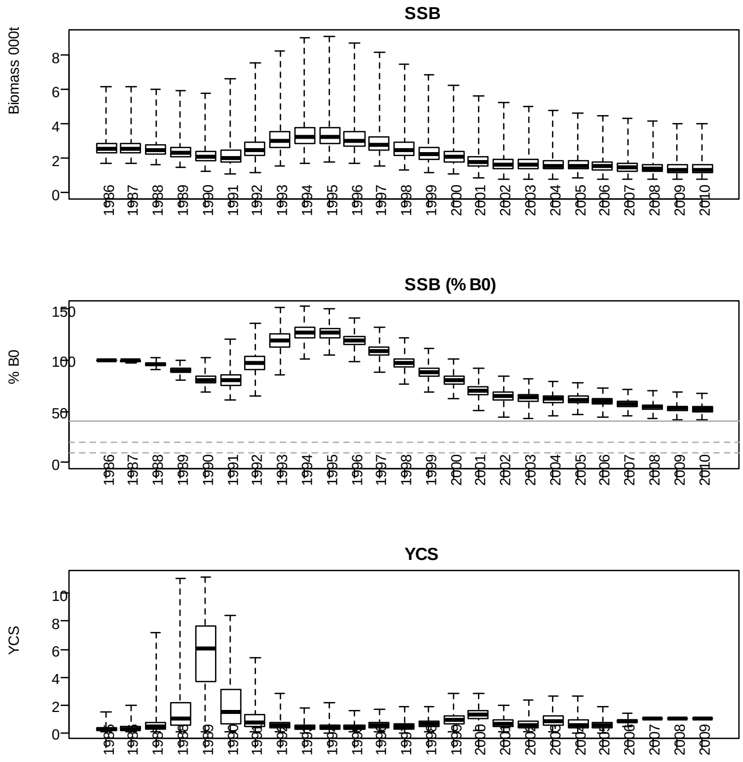



**Figure 9: Posterior trajectory from model 1C of spawning stock biomass and YCS. Upper plot shows boxplots of SSB, while middle plot shows SSB as a percentage of $B_0$. On middle plot, target and limit reference points shown in grey solid and dashed lines. Box shows the median of the posterior distribution (horizontal bar), the 25th and 75th percentiles (box), with the whiskers representing the full range of the distribution.**

**Table 8: Results from MCMC runs showing $B_0$, $B_{curr}$ and $B_{2015}$ estimates at varying catch levels for both models for SCI 1 for recent (R) and long term (L) recruitment scenarios.**

| | | | | 100 tonnes | | 110 tonnes (2009-10 catch) | | 120 tonnes (TACC) | | 130 tonnes | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | $B_0$ | $B_{curr}$ | $B_{curr}/B_0$ | $B_{2015}/B_0$ | $B_{2015}/B_{curr}$ | $B_{2015}/B_0$ | $B_{2015}/B_{curr}$ | $B_{2015}/B_0$ | $B_{2015}/B_{curr}$ | $B_{2015}/B_0$ | $B_{2015}/B_{curr}$ |
| **1C (R)** | 2521 | 1267 | 0.50 | 0.44 | 0.87 | 0.42 | 0.84 | 0.41 | 0.81 | 0.39 | 0.78 |
| **2C (R)** | 1883 | 772 | 0.41 | 0.32 | 0.77 | 0.30 | 0.72 | 0.28 | 0.67 | 0.26 | 0.63 |
| | | | | | | | | | | | |
| **1C (L)** | 2521 | 1297 | 0.50 | 0.50 | 0.94 | 0.48 | 0.92 | 0.47 | 0.88 | 0.45 | 0.86 |
| **2C (L)** | 1883 | 834 | 0.43 | 0.47 | 1.00 | 0.45 | 0.95 | 0.43 | 0.90 | 0.41 | 0.86 |

**Table 9: Results from MCMC runs for SCI 1, showing probabilities of projected spawning stock biomass exceeding the default Harvest Strategy Standard target and limit reference points.**

| | | | 100 tonnes | | 110 tonnes (2009-10 catch) | | 120 tonnes (TACC) | | 130 tonnes | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | | 2015 | | 2015 | | 2015 | | 2015 | |
| **Recent recruitment** | **1C** | **2C** | **1C** | **2C** | **1C** | **2C** | **1C** | **2C** | **1C** | **2C** |
| **P(SSB<10% $B_0$)** | 0 | 0 | 0 | 0.016 | 0 | 0.028 | 0.001 | 0.047 | 0.001 | 0.064 |
| **P(SSB<20% $B_0$)** | 0 | 0 | 0.005 | 0.134 | 0.007 | 0.183 | 0.013 | 0.235 | 0.020 | 0.297 |
| **P(SSB<40% $B_0$)** | 0.035 | 0.473 | 0.341 | 0.757 | 0.405 | 0.797 | 0.467 | 0.832 | 0.530 | 0.860 |
| **P($B_{2015}$<$B_{2010}$)** | | | 0.800 | 0.839 | 0.851 | 0.868 | 0.879 | 0.902 | 0.908 | 0.929 |
| | | | | | | | | | | |
| **Long term recruitment** | | | | | | | | | | |
| **P(SSB<10% $B_0$)** | 0 | 0 | 0 | 0.014 | 0 | 0.027 | 0 | 0.041 | 0 | 0.059 |
| **P(SSB<20% $B_0$)** | 0 | 0 | 0.008 | 0.097 | 0.011 | 0.127 | 0.020 | 0.151 | 0.028 | 0.185 |
| **P(SSB<40% $B_0$)** | 0.041 | 0.377 | 0.300 | 0.402 | 0.335 | 0.432 | 0.373 | 0.463 | 0.401 | 0.493 |
| **P($B_{2015}$<$B_{2010}$)** | | | 0.570 | 0.506 | 0.605 | 0.540 | 0.621 | 0.575 | 0.638 | 0.611 |

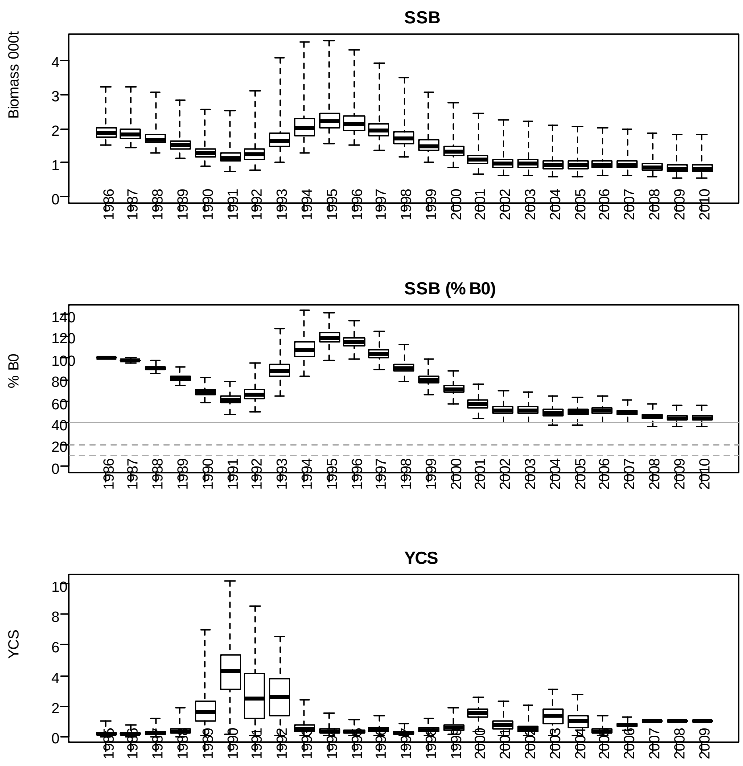



**Figure 10: Posterior trajectory from model 2C of spawning stock biomass and YCS. Upper plot shows boxplots of SSB, while middle plot shows SSB as a percentage of $B_0$. On middle plot, target and limit reference points shown in grey solid and dashed lines. Box shows the median of the posterior distribution (horizontal bar), the 25th and 75th percentiles (box), with the whiskers representing the full range of the distribution.**

**Table 10: Results from MCMC runs showing $B_0$, $B_{curr}$ and $B_{2015}$ estimates at varying catch levels for SCI 2 for recent (R) and long term (L) recruitment scenarios.**

| | | | | 75 tonnes (average last 5 years) | | 100 tonnes | | 125 tonnes (2009-10 catch) | | 200 tonnes (TACC) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | **$B_0$** | **$B_{curr}$** | **$B_{curr}/B_0$** | **$B_{2015}/B_0$** | **$B_{2015}/B_{curr}$** | **$B_{2015}/B_0$** | **$B_{2015}/B_{curr}$** | **$B_{2015}/B_0$** | **$B_{2015}/B_{curr}$** | **$B_{2015}/B_0$** | **$B_{2015}/B_{curr}$** |
| **4C (R)** | 2248 | 881 | 0.39 | 0.38 | 0.95 | 0.34 | 0.84 | 0.30 | 0.74 | 0.17 | 0.43 |
| **4C (L)** | 2248 | 938 | 0.41 | 0.50 | 1.15 | 0.46 | 1.06 | 0.41 | 0.96 | 0.29 | 0.67 |

**Table 11: Results from MCMC runs for SCI 2, showing probabilities of projected spawning stock biomass exceeding the default Harvest Strategy Standard target and limit reference points.**

| | | 75 tonnes (average last 5 years) | 100 tonnes | 125 tonnes (2009-10 catch) | 200 tonnes (TACC) |
|---|---|---|---|---|---|
| | **2010** | **2015** | **2015** | **2015** | **2015** |
| **Recent recruitment** | **4C** | **4C** | **4C** | **4C** | **4C** |
| **P(SSB<10% $B_0$)** | 0 | 0 | 0.002 | 0.015 | 0.243 |
| **P(SSB<20% $B_0$)** | 0 | 0.021 | 0.071 | 0.146 | 0.635 |
| **P(SSB<40% $B_0$)** | 0.572 | 0.609 | 0.768 | 0.863 | 0.986 |
| **P($B_{2015}$<$B_{2010}$)** | | 0.614 | 0.799 | 0.919 | 0.999 |
| **Long term recruitment** | | | | | |
| **P(SSB<10% $B_0$)** | 0 | 0 | 0.001 | 0.002 | 0.091 |
| **P(SSB<20% $B_0$)** | 0 | 0.003 | 0.019 | 0.051 | 0.291 |
| **P(SSB<40% $B_0$)** | 0.443 | 0.256 | 0.373 | 0.467 | 0.678 |
| **P($B_{2015}$<$B_{2010}$)** | | 0.303 | 0.433 | 0.551 | 0.771 |

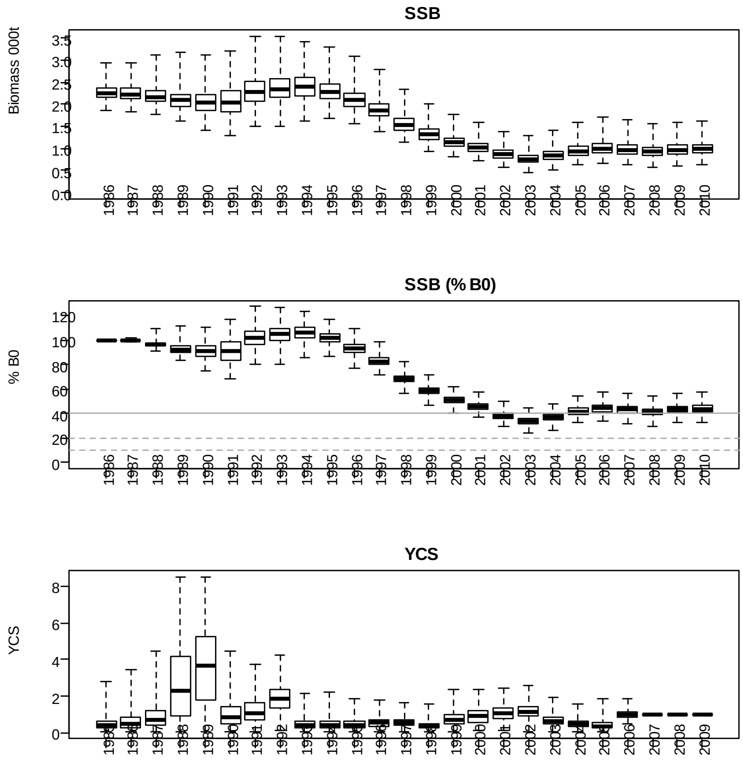



**Figure 11: Posterior trajectory from model 4C of spawning stock biomass and YCS. Upper plot shows boxplots of SSB, while middle plot shows SSB as a percentage of $B_0$. On middle plot, target and limit reference points shown in grey solid and dashed lines. Box shows the median of the posterior distribution (horizontal bar), the 25th and 75th percentiles (box), with the whiskers representing the full range of the distribution.**

Biomass estimates for SCI also include estimates made using the area swept method from trawl surveys (Table 4) and using photography in parts of SCI 1, 2, 3 and 6A (Table 6). Trawl survey estimates can be considered to be minimum estimates of biomass as it is unlikely that there will be any herding effect of sweeps and bridles. Vertical availability to trawls can be expected to be <1 as many scampi will be found in burrows during the day. A preliminary estimate of scampi abundance for an area off the Auckland Islands has been generated from tag return data, although it should be noted that this programme was not designed to estimate biomass and violates many of the assumptions of the Petersen method. The estimated density of scampi for the Petersen method was similar to that estimated for visible scampi over the whole survey area from the photographic survey, although no account was taken of mortality or tag loss.

Burrow counts from photographic surveys are intended as an index of abundance, as an input into an assessment model. Estimates of biomass on the basis of abundance estimates of major openings and visible scampi are provided in Table 6. These estimates are calculated from estimates of abundance and an annually calculated mean weight (estimated from burrow size distributions and a relationship between burrow and scampi size, where possible). There is some uncertainty over the most appropriate mean weight to apply to the abundance estimates.

### 4.3 Estimation of Maximum Constant Yield (*MCY*)

*MCY* was not determined.

### 4.4 Estimation of Current Annual Yield (*CAY*)

*CAY* was not determined.

### 4.6 Other yield estimates and stock assessment results

There are no other yield estimates.

## 5. ENVIRONMENTAL & ECOSYSTEM CONSIDERATIONS

This section was updated for the May 2012 Fishery Assessment Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of the scampi fishery; a more detailed summary from an issue-by issue perspective is, or will shortly be, available in the Aquatic Environment & Biodiversity Annual Review (http://fs.fish.govt.nz/Page.aspx?pk=113&dk=22982).

### 5.1 Role in the ecosystem

Scampi are predators which are thought to prey mainly on invertebrates (Meynier *et al*. 2008) or carrion. A 3-year diet study on the Chatham Rise showed scampi was the first, third and fourth most important item (by IRI, Index of Relative Importance) in the diet of smooth skate, ling and sea perch, respectively (Dunn *et al*. 2009). Scampi build and maintain burrows in the sediment and this bioturbation is thought to influence oxygen and nutrient fluxes across the sediment-water boundary, especially when scampi density is high (e.g., Hughes and Atkinson 1997, who studied *Nephrops norvegicus* at densities of 1–3 $m^{-2}$). Observed densities from photographic surveys in New Zealand have been 0.02–0.1 $m^{-2}$ (Tuck 2009), similar to densities of *N. norvegicus* in comparable depths.

### 5.2 Incidental catch (fish and invertebrates)

In the 1999–00 to 2005–06 fishing years, total annual bycatch was estimated to range from 2 910 to 8 070 t compared with total landed scampi catches of 791–1 045 t and scampi typically represents less than 20% of the catch by weight (Ballara and Anderson 2009). The main QMS bycatch species (>2% of the total catch) were sea perch, ling, hoki, red cod, silver warehou, and giant stargazer. The amount and composition of bycatch varies both within and between QMAs (see also Cryer 2000), being lowest in SCI 1 and SCI 6A (0.5 and 0.6 t per tow, respectively) and higher in SCI 3 and SCI 4A (1.0 and 1.1 t per tow) with SCI 2 intermediate. The most bycatch per tow is taken in SCI 5 (2.7 t per tow) but this is a very small fishery.

The non-QMS incidental catch ranges from a similar weight to the QMS bycatch (SCI 2 and 3) to about double the QMS bycatch (SCI 3 and 6A). Most of this non-QMS incidental catch is discarded on the grounds (Ballara and Anderson record 485 species as discarded). Total annual discard estimates from 1999–00 to 2005–06 ranged from 1 540 to 5 140 t and were dominated by sea perch (especially SCI 2 and 3) javelinfish and other rattails (all areas), spiny dogfish (all areas), skates (SCI 1 and 2), crabs (SCI 6A), toadfish (SCI 3 and 6A), and flatheads (SCI 1–3) (Ballara and Anderson 2009). Discards averaged 2.5 kg per kilogram of scampi caught, typical of crustacean trawl fisheries internationally (Kelleher 2005). Bycatch and discards may have reduced since about 2005 because of modifications to the gear (Tuck 2012 in press, also evident in the most recent year analysed by Ballara and Anderson 2009).

The finer mesh used by scampi trawlers has the potential to catch more juvenile fish than standard finfish trawls and Cryer *et al*. (1999) showed raw length frequency distributions for major QMS bycatch species up to 1996–97. Small proportions of small gemfish (20–40 cm) and small hoki (30–50 cm) were recorded in SCI 1–4 in a few years, but juveniles made up a major proportion of the catch only for ling in SCI 6A where more than half of ling measured were 30–70 cm long in 4 of the 6 years studied (1990 to 1996-97).

### 5.3 Incidental Catch (seabirds, mammals, and protected fish)

For protected species, capture estimates presented here include all animals recovered to the deck (alive, injured or dead) of fishing vessels but do not include any cryptic mortality (e.g., seabirds struck by a warp or caught on a hook but not brought onboard the vessel, Middleton and Abraham 2007, Brothers *et al*. 2010).

## Marine mammal interactions

Scampi trawlers occasionally catch marine mammals, including NZ sea lions and NZ fur seals (which were classified as "Nationally Critical" and "Not Threatened", respectively, under the NZ Threat Classification System in 2010, Baker *et al*. 2010).

In the 2009/10 fishing year there were no observed captures of NZ sea lion in scampi trawl fisheries (Table 12) and no estimates of total sea lion captures were made. Sea lions captured in previous years were all taken close to the Auckland Islands in SCI 6A (Thompson and Abraham 2012). In the 2009/10 fishing year there was one observed capture of a NZ fur seal in scampi trawl fisheries. There were 6 (95% c.i.: 1 - 15) estimated captures, with the estimates made using a statistical model (Table 13). Since 2002–03, only about 1% of the estimated total captures of NZ fur seals have been taken in scampi fisheries; these have been on the western Chatham Rise, on the Stewart-Snares shelf, and close to the Auckland Islands. Rates of capture for both species were low and have fluctuated without obvious trend.

**Table 12: Number of tows by fishing year and observed NZ sea lion captures in scampi trawl fisheries, 2002–03 to 2009–10. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows. Data from Thompson and Abraham (2012), retrieved from http://bycatch.dragonfly.co.nz/v20120315/**

| | Tows | No. obs | % obs | Captures | Rate |
|---|---|---|---|---|---|
| 2002–03 | 5130 | 512 | 10.0 | 0 | 0.00 |
| 2003–04 | 3753 | 412 | 11.0 | 3 | 0.73 |
| 2004–05 | 4652 | 143 | 3.1 | 0 | 0.00 |
| 2005–06 | 4867 | 331 | 6.8 | 1 | 0.30 |
| 2006–07 | 5135 | 389 | 7.6 | 1 | 0.26 |
| 2007–08 | 4804 | 524 | 10.9 | 0 | 0.00 |
| 2008–09 | 3975 | 396 | 10.0 | 1 | 0.25 |
| 2009–10 | 4251 | 348 | 8.2 | 0 | 0.00 |

**Table 13: Number of tows by fishing year and observed and model-estimated total NZ fur seal captures in scampi trawl fisheries, 2002–03 to 2009–10. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows, % inc, percentage of total effort included in the statistical model. Data from Thompson and Abraham (2012), retrieved from http://bycatch.dragonfly.co.nz/v20120315/**

| | | Observed | | | | Estimated | | |
|---|---|---|---|---|---|---|---|---|
| | Tows | No. obs | % obs | Captures | Rate | Captures | 95% c.i. | % inc. |
| 2002–03 | 5 130 | 512 | 10.0 | 2 | 0.39 | 7 | 2 - 16 | 99.8 |
| 2003–04 | 3 753 | 412 | 11.0 | 1 | 0.24 | 5 | 1 - 13 | 99.4 |
| 2004–05 | 4 652 | 143 | 3.1 | 0 | 0.00 | 18 | 3 - 48 | 99.8 |
| 2005–06 | 4 867 | 331 | 6.8 | 0 | 0.00 | 8 | 1 - 22 | 100.0 |
| 2006–07 | 5 135 | 389 | 7.6 | 0 | 0.00 | 6 | 0 - 18 | 100.0 |
| 2007–08 | 4 804 | 524 | 10.9 | 1 | 0.19 | 10 | 2 - 26 | 100.0 |
| 2008–09 | 3 975 | 396 | 10.0 | 1 | 0.25 | 6 | 1 - 16 | 99.9 |
| 2009–10 | 4 251 | 348 | 8.2 | 1 | 0.29 | 6 | 1 - 15 | 100.0 |

## Seabird interactions

Observed seabird capture rates in scampi fisheries ranged from about 1 to 6 per 100 tows between 1998-99 and 2008-09 (Baird 2001, 2004 a,b,c, 2005a, Abraham & Thompson 2009, Abraham *et al*. 2009, Abraham & Thompson 2011) and have fluctuated without obvious trend. In the 2009/2010 fishing year there were five observed captures of birds in scampi trawl fisheries. There were 162 (95% c.i.: 101 - 245) estimated captures, with the estimates made using a statistical model (Thompson and Abraham 2012). These estimates are based on relatively low observer coverage and include all bird species and should, therefore, be interpreted with caution. The average capture rate in scampi trawl fisheries over the last eight years (all areas combined) is about 3.53 birds per 100 tows, a moderate

rate relative to trawl fisheries for squid (13.3 birds per 100 tows) and hoki (2.2 birds per 100 tows) over the same years. The scampi fishery accounted for about 5% of seabird captures in the trawl fisheries modelled by Thompson & Abraham (2012).

Observed seabird captures since 2002–03 have been dominated by four species: Salvin's and white-capped albatrosses make up 51% and 27% of the albatrosses captured, respectively; and flesh-footed and sooty shearwaters make up 42% and 38% of other birds, respectively (Table 15). Most of the captures occur on the Chatham Rise (36%), close to the Auckland Islands (30%), or in the Bay of Plenty (29%). These numbers should be regarded as only a general guide on the distribution of captures because observer coverage is not uniform across areas and may not be representative.

**Table 14: Number of tows by fishing year and observed and model-estimated total NZ seabirds captures in scampi trawl fisheries, 2002–03 to 2009–10. No. obs, number of observed tows; % obs, percentage of tows observed; Rate, number of captures per 100 observed tows, % inc, percentage of total effort included in the statistical model. Data from Thompson and Abraham (2012), retrieved from http://bycatch.dragonfly.co.nz/v20120315/**

| | | Observed | | | | Estimated | | |
|---|---|---|---|---|---|---|---|---|
| | Tows | No. obs | % obs | Captures | Rate | Captures | 95% c.i. | % inc. |
| 2002–03 | 5 130 | 512 | 10.0 | 8 | 1.56 | 161 | 104 - 240 | 100.0 |
| 2003–04 | 3 753 | 412 | 11.0 | 8 | 1.94 | 106 | 67 - 155 | 100.0 |
| 2004–05 | 4 652 | 143 | 3.1 | 9 | 6.29 | 240 | 156 - 360 | 100.0 |
| 2005–06 | 4 867 | 331 | 6.8 | 13 | 3.93 | 219 | 140 - 332 | 100.0 |
| 2006–07 | 5 135 | 389 | 7.6 | 24 | 6.17 | 172 | 117 - 246 | 100.0 |
| 2007–08 | 4 804 | 524 | 10.9 | 11 | 2.10 | 155 | 101 - 232 | 100.0 |
| 2008–09 | 3 975 | 396 | 10.0 | 19 | 4.80 | 187 | 126 - 271 | 100.0 |
| 2009–10 | 4 251 | 348 | 8.2 | 5 | 1.44 | 162 | 101 - 245 | 100.0 |

**Table 15: Number of observed seabird captures in scampi trawl fisheries, 2002–03 to 2009–10, by species and area. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Potential Biological Removals, PBR (from Richard *et al.* 2011 where full details of the risk assessment approach can be found). It is not an estimate of the risk posed by fishing for scampi. Other data from Thompson and Abraham (2012), retrieved from http://bycatch.dragonfly.co.nz/v20120315/**

| Species | Risk ratio | Auckland Islands | Bay of Plenty | Chatham Rise | ECNI | ECSI | Total |
|---|---|---|---|---|---|---|---|
| Salvin's albatross | 2.49 | 0 | 0 | 21 | 1 | 3 | 25 |
| White capped albatross | 0.83 | 11 | 1 | 1 | 0 | 0 | 13 |
| Unidentified albatross | – | 0 | 2 | 2 | 0 | 1 | 5 |
| Southern Buller's albatross | 1.28 | 0 | 0 | 4 | 0 | 0 | 4 |
| Campbell albatross | 1.84 | 0 | 1 | 0 | 0 | 0 | 1 |
| Chatham Island albatross | 2.71 | 0 | 0 | 1 | 0 | 0 | 1 |
| **Total albatrosses** | | **11** | **4** | **29** | **1** | **4** | **49** |
| | | | | | | | |
| Flesh footed shearwater | 2.51 | 0 | 20 | 0 | 0 | 0 | 20 |
| Sooty shearwater | 0.02 | 14 | 1 | 3 | 0 | 0 | 18 |
| Cape petrel | 0.76 | 1 | 0 | 2 | 0 | 0 | 3 |
| Unidentified petrel | – | 0 | 2 | 0 | 0 | 0 | 2 |
| White chinned petrel | 0.79 | 1 | 0 | 1 | 0 | 0 | 2 |
| Black petrel | 11.15 | 0 | 1 | 0 | 0 | 0 | 1 |
| Common diving petrel | 0.00 | 1 | 0 | 0 | 0 | 0 | 1 |
| Northern giant petrel | 3.00 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Total other birds** | | **18** | **24** | **6** | **0** | **0** | **48** |

## 5.4 Benthic interactions

Bottom trawl effort for scampi peaked in 2001–02 at over 6 500 tows (roughly 10% of all TCEPR bottom trawls in that year) but has typically been 3 500 to 5 200 tows per year since 1989–90. About

98% has been reported on TCEPR forms (Baird *et al*. 2011) with most of the 1 477 reports on CELR forms being between 1998–99 and 2002–03. Tows were located in Benthic Optimised Marine Environment Classification (BOMEC, Leathwick *et al* 2009) classes F, G (upper slope), H, J, and L (mid-slope) (Baird and Wood 2012), and 95% were between 300 and 500 m depth (Baird *et al*. 2011).

Bottom trawling for scampi, like trawling for other species, is likely to have effects on benthic community structure and function (e.g., Cryer *et al*. 2002 for a specific analysis and Rice 2006 for an international review) and there may be consequences for benthic productivity (e.g., Jennings 2001, Hermsen *et al*. 2003, Hiddink *et al*. 2006, Reiss *et al*.2009). These consequences are not considered in detail here but are discussed in the Aquatic Environment and Biodiversity Annual Review (2012).

### 5.5 Other considerations

None

## 6. STATUS OF THE STOCKS

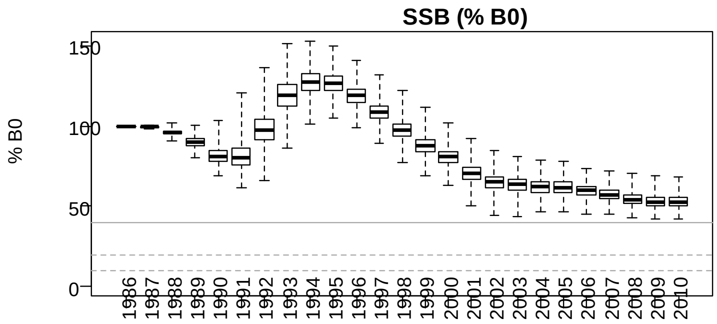
### Stock Structure Assumptions

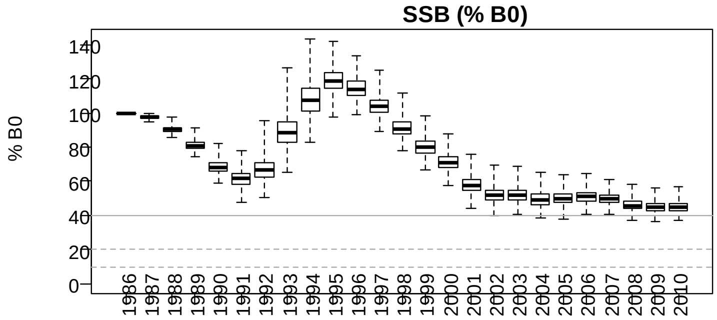
Stock structure of scampi in New Zealand waters is not well known. Preliminary electrophoretic analyses suggest that scampi in SCI 6A are genetically distinct from those in other areas, and there is substantial heterogeneity in samples from SCIs 1, 2, and 4A. The abbreviated larval phase of this species may lead to low rates of gene mixing. Differences among some scampi populations in average size, size at maturity, the timing of diel and seasonal cycles of catchability, catch to bycatch ratios and CPUE trends also suggest that treatment as separate management units is appropriate.

- **SCI 1**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Assessment Runs Presented | Bayesian length based models with (model 2C) and without (model 1C) spatial structure |
| Reference Points | Target: 40% $B_0$<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Likely (> 60%) to be at or above target |
| Status in relation to Limits | Very Unlikely (< 10%) to be below the soft or hard limits |

## Historical Stock Status Trajectory and Current Status




**Posterior trajectory spawning stock biomass (SSB) as a percentage of $B_0$ for SCI 1, from model 1C (upper plot) and model 2C (lower plot). Target and limit reference points shown in grey solid and dashed lines. Box shows the median of the posterior distribution (horizontal bar), the 25th and 75th percentiles (box), with the whiskers representing the full range of the distribution.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | Spawning stock biomass decreased up to the early 1990s, increased to a peak in about 1995, declined to the early 2000s, and has remained relatively stable since this time. |
| Recent Trend in Fishing Mortality or Proxy | Catches and stock abundance appear to have remained relatively stable in recent years, suggesting exploitation rates have been relatively stable. |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Under the recent recruitment scenario, the stock is predicted to remain at or above 40% $B_0$ up to 2015 under current catches and TACC for model 1C, while the stock is projected to decline to 30% $B_0$ by 2015 for model 2C. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Very Unlikely (< 10%) for model 1C, Unlikely (< 40%) for model 2C<br>Hard Limit: Very Unlikely (< 10%) |

| **Assessment Methodology and Evaluation** | | |
|---|---|---|
| Assessment Type | Level 1. Full Quantitative stock assessment | |
| Assessment Method | Length-based Bayesian Model | |
| Assessment Dates | Latest assessment: 2011 | Next assessment: 2013 |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs (rank) | - Standardised catch and effort data (TCEPR) from MPI | 1 – High Quality |

| | | |
|---|---|---|
| | - Length frequency data from MPI observer sampling<br>- Photographic survey abundance index<br>- Trawl survey abundance index<br>- Length frequency data from research sampling<br>- Length frequency predicted from burrow sizes | 1 – High Quality<br><br>1 – High Quality<br>1 – High Quality<br><br>1 – High Quality<br><br>1 – High Quality |
| Data not used (rank) | N/A | |
| Changes to Model Structure and Assumptions | | |
| Major Sources of Uncertainty | Relationship between CPUE and abundance, growth, burrow occupancy, emergence and catchability | |

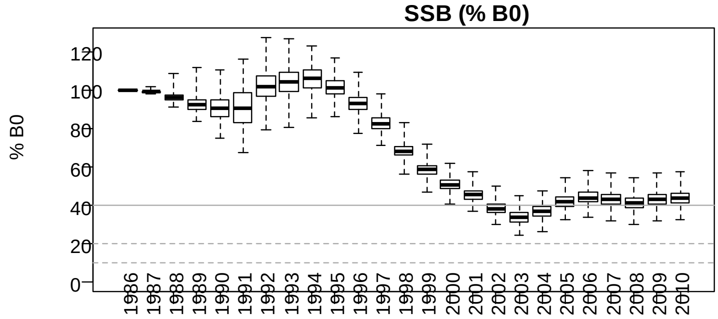
| **Qualifying Comments** |
|---|
| Projections are sensitive to recruitment scenarios applied. CPUE index previously considered to be potentially strongly influenced by changes in catchability, and therefore not reliable as an index of abundance. Re-examination of the data, consistency between indices and also with similar species has addressed some of the concerns. The Plenary has accepted the recommendations of the WG that CPUE is an acceptable index of abundance. |

| **Fishery Interactions** |
|---|
| Main QMS bycatch species include ling, hoki, sea perch, red cod, silver warehou and giant stargazer. Discards dominated by rattails, javelinfish, skates and crabs, ling, red cod, hoki, spiny dogfish and sea perch. There have been interactions with seabirds recorded. A wide range of benthic invertebrate species are taken as bycatch. |

- **SCI 2**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Assessment Runs Presented | Bayesian length based model without (model 4C) spatial structure |
| Reference Points | Target: 40% $B_0$<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Likely (> 60%) to be at or above target |
| Status in relation to Limits | Very Unlikely (< 10%) to be below the soft or hard limits |

**Historical Stock Status Trajectory and Current Status**




**Posterior trajectory spawning stock biomass (SSB) as a percentage of $B_0$ for SCI 2, from model 4C. Target and limit reference points shown in grey solid and dashed lines. Box shows the median of the posterior distribution (horizontal bar), the 25th and 75th percentiles (box), with the whiskers representing the full range of the distribution.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | CPUE, trawl survey and photo survey data suggest the stock has remained at a relatively stable level since early 2000s. CPUE data suggest abundance may have increased (from levels higher to those currently observed) quite rapidly through the early 1990s, peaked about 1995, and then declined to current levels by the early 2000s. |
| Recent Trend in Fishing Mortality or Proxy | Catches and stock abundance appear to have remained relatively stable in recent years, suggesting that exploitation rates have been relatively stable. |
| Other Abundance Indices | |
| Trends in Other Relevant Indicators or Variables | |

| **Projections and Prognosis** | | |
|---|---|---|
| Stock Projections or Prognosis | Under the recent recruitment scenario the stock is predicted to decline slightly to 38% $B_0$ under recent average catch of 75 tonnes by 2015, and to 30% under 2009-10 catch (125 tonnes) and to 17% $B_0$ under the current TACC of 200 tonnes. | |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unlikely (< 40%) for 2009-10 catch, Likely (> 60%) for 2009-10 TACC, both assuming recent recruitment<br>Hard Limit: Unlikely (< 40%) | |
| **Assessment Methodology and Evaluation** | | |
| Assessment Type | Level 1. Full Quantitative stock assessment | |
| Assessment Method | Length-based Bayesian Model | |
| Assessment Dates | Latest assessment: 2011 | Next assessment: 2013 |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs (rank) | - Standardised catch and effort data (TCEPR) from MPI | 1 – High Quality |
| | - Length frequency data from MPI observer sampling | 1 – High Quality |
| | - Photographic survey abundance index | 1 – High Quality |
| | - Trawl survey abundance index | 1 – High Quality |
| | - Length frequency data from research sampling | 1 – High Quality |
| | - Length frequency predicted from burrow sizes | 1 – High Quality |
| Data not used (rank) | N/A | |
| Changes to Model Structure and Assumptions | | |
| Major Sources of Uncertainty | Relationship between CPUE and abundance, growth, burrow occupancy, emergence and catchability | |

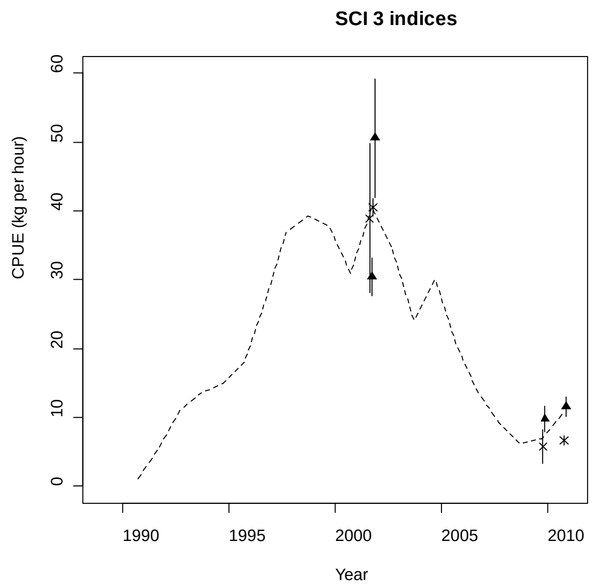
| **Qualifying Comments** |
|---|
| Projections are sensitive to recruitment scenarios applied. CPUE index previously considered to be potentially strongly influenced by changes in catchability, and therefore not reliable as an index of abundance. Re-examination of the data, consistency between indices and also with similar species has addressed some of the concerns. The Plenary has accepted the recommendations of the WG that CPUE is an acceptable index of abundance. |

| **Fishery Interactions** |
|---|
| Main QMS bycatch species include ling, hoki, sea perch, red cod, silver warehou and giant stargazer. Discards dominated by rattails, javelinfish, skates and crabs, ling, red cod, hoki, spiny dogfish and sea |

| |
|---|
| perch. There have been interactions with seabirds recorded. A wide range of benthic invertebrate species are taken as bycatch. |

- **SCI 3**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | No accepted assessments. |
| Assessment Runs Presented | |
| Reference Points | Target: 40% $B_0$<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Unknown |
| **Historical Stock Status Trajectory and Current Status** | |




**Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 3. Symbols represent different aims of survey work (×- trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 3.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | CPUE, trawl survey and photo survey data suggest the stock declined between 2001 and 2009, but increased in 2010. CPUE data suggest abundance may have increased through the early 1990s, peaked from mid 1990s to early 2000s, and then declined 2007, and then increased in recent years. |
| Recent Trend in Fishing Mortality or Proxy | Unknown |
| Other Abundance Indices | - |
| Trends in Other Relevant Indicators or Variables | - |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Quantitative stock projections are unavailable. |
| Probability of Current Catch or TACC causing decline below | Soft Limit: Unknown<br>Hard Limit: Unknown |

| | | |
|---|---|---|
| Limits | | |
| **Assessment Methodology and Evaluation** | | |
| Assessment Type | Level 2. Abundance indices from CPUE, trawl and photo surveys | |
| Assessment Method | | |
| Assessment Dates | 2012 | Next assessment: 2015 |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs (rank) | - Standardised catch and effort data (TCEPR) from MPI<br>- Length frequency data from MPI observer sampling<br>- Photographic survey abundance index<br>- Trawl survey abundance index<br>- Length frequency data from research sampling | 1 – High Quality<br>1 – High Quality<br>1 – High Quality<br>1 – High Quality<br>1 – High Quality |
| Data not used (rank) | N/A | |
| Changes to Model Structure and Assumptions | | |
| Major Sources of Uncertainty | Relationship between CPUE and abundance, growth, burrow occupancy, emergence and catchability | |

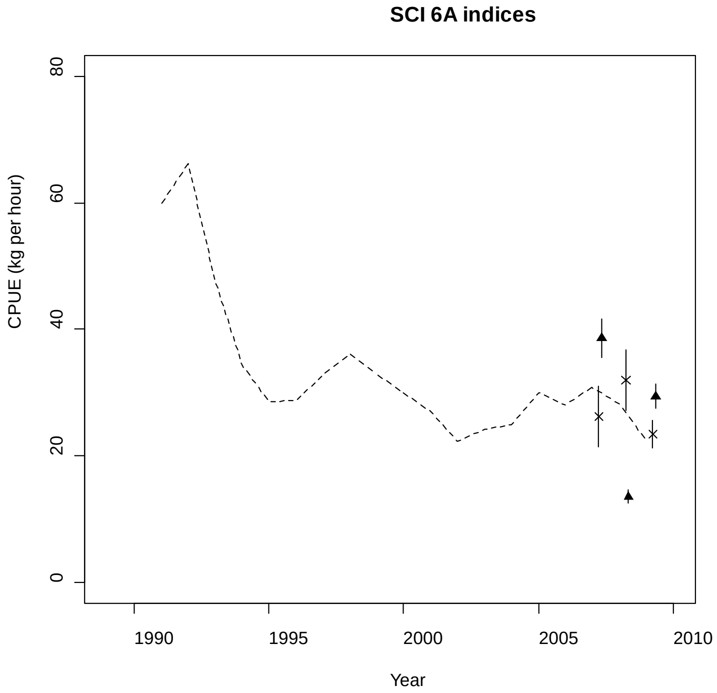
| **Qualifying Comments** |
|---|
| Scampi catches from SCI 3 are taken from three relatively distinct areas near the Mernoo Bank on the Chatham Rise. Trends in CPUE from these areas both increase and then decrease, but peaked in different years (1997 & 2001). Where available, the CPUE for the most recent years suggests an increase. The extended period of higher CPUE shown from this area may be an artefact of the fishing activity moving location.<br>CPUE index previously considered to be potentially strongly influenced by changes in catchability, and therefore not reliable as an index of abundance. Re-examination of the data has addressed some of the concerns, and the consistency between indices and also with similar species, may indicate the index is not as implausible as first considered. |

| **Fishery Interactions** |
|---|
| Main QMS bycatch species include ling, hoki, sea perch, red cod, silver warehou and giant stargazer. Discards dominated by rattails, javelinfish, skates and crabs, ling, red cod, hoki, spiny dogfish and sea perch. There have been interactions with seabirds recorded. A wide range of benthic invertebrate species are taken as bycatch. |

- **SCI 6A**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | No accepted assessments |
| Assessment Runs Presented | |
| Reference Points | Target(s): 40% $B_0$<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Unknown |

| Historical Stock Status Trajectory and Current Status |
|---|




Mean catch rates and relative abundance (± one standard error) of research trawling and photo survey counts in the core area of SCI 6A. Symbols represent different aims of survey work (×-trawling within photo survey, ▲-scaled photo survey abundance). Dotted line represents median of annual unstandardised CPUE for SCI 6A.

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | CPUE data suggest the stock may have declined in the early years of the fishery, but has remained at a relatively stable level since the mid 1990s. Photo and trawl survey data (2007 - 2009) suggest the stock has remained relatively stable in recent years |
| Recent Trend in Fishing Mortality or Proxy | Catches and stock abundance appear to have remained relatively stable in recent years, suggesting exploitation rates have been relatively stable |
| Other Abundance Indices | |
| Trends in Other Relevant Indicators or Variables | |

| **Projections and Prognosis** | | |
|---|---|---|
| Stock Projections or Prognosis | Quantitative stock projections are unavailable. | |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown | |
| **Assessment Methodology and Evaluation** | | |
| Assessment Type | Level 2. Abundance indices from CPUE, trawl and photo surveys | |
| Assessment Method | | |
| Assessment Dates | Latest assessment: 2011 (CPUE analysis), 2009 (photo survey) | Next assessment: 2014 (CPUE & assessment model), 2013 (photo survey) |
| Overall assessment quality rank | 1 – High Quality | |
| Main data inputs | - Standardised catch and effort | 1 – High Quality |

| | | |
|---|---|---|
| | data (TCEPR) from MPI<br>- Length frequency data from MPI observer sampling<br>- Photographic survey abundance index<br>- Trawl survey abundance index<br>- Length frequency data from research sampling | <br>1 – High Quality<br><br><br>1 – High Quality<br>1 – High Quality<br><br>1 – High Quality |
| Data not used (rank) | N/A | |
| Changes to Model Structure and Assumptions | Length based model currently under development | |
| Major Sources of Uncertainty | Relationship between CPUE and abundance, growth, burrow occupancy, emergence and catchability | |

| **Qualifying Comments** |
|---|
| Photo surveys in SCI 6A observer a high number of scampi out of burrows, relative to burrows counted, than has been observed in other areas. This may be related to animal size or sediment characteristics. If emergence is greater, this may imply scampi in SCI 6A are more vulnerable to trawling than other areas.<br>CPUE index previously considered to be potentially strongly influenced by changes in catchability, and therefore not reliable as an index of abundance. Re-examination of the data has addressed some of the concerns, and the consistency between indices and also with similar species, may indicate the index is not as implausible as first considered. |

| **Fishery Interactions** |
|---|
| Main QMS bycatch species include ling, hoki, sea perch, red cod, silver warehou and giant stargazer. Discards dominated by rattails, javelinfish, skates and crabs, ling, red cod, hoki, spiny dogfish and sea perch. There have been interactions with seabirds and mammals (fur seals and sealions) recorded. A wide range of benthic invertebrate species are taken as bycatch. |

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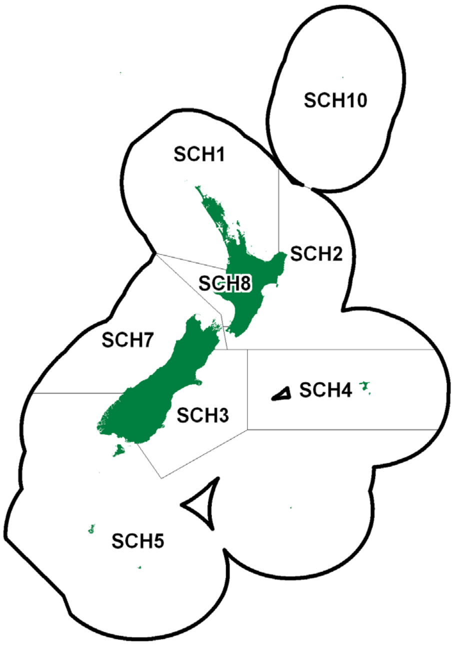
# SCHOOL SHARK (SCH)

(*Galeorhinus galeus*)
Tupere, Tope, Makohuarau




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

This moderate-sized shark has supported a variety of fisheries around New Zealand from the early 1940s onwards. Landings rose steeply from the late 1970s until 1983 (Table 1), with the intensification of setnetting targeting this and other species, and a general decline in availability of other, previously more desirable, coastal species. However, because of the earlier discarding and under-reporting, this recorded rise in landings does not reflect an equal rise in catches. After a small decline in 1984-85, catches decreased by about 50% from 1986 onwards because of reduced quotas within the QMS (Table 2). From 1987-88 to 1991-92 total reported landings were around 2200-2500 t. In 1995-96 total landings increased markedly to 3387 t and the total TACC (3107 t) was exceeded for the first time. Landings have remained around the TACC level since 1995-96. TACCs for SCH 3, 5, 7 & 8 were increased by between 5% (SCH 5) and 20% (the remainder) under AMP management in October 2004. From the 1 October 2007 the TACC for SCH 1 was increased to 689 t, at that time a TAC was set for the first time at 893 t with 102 t, 68 t and 34 t being allocated to customary, recreational and other sources of motility respectively. In 2004 SCH 3, 5, 7 & 8 were allocated an equal recreational and customary non-commercial catch of 48 t, 7 t, 58 t, and 21 t respectively and other sources of mortality were allocated 19 t, 37 t, 32 t, and 26 t respectively. All AMP programmes ended on 30$^{th}$ September 2009. Table 1 shows the historical landings and TACC values for the main SCH stocks.

**Table 1: Reported domestic landings (t) of school shark from 1948 to 1983.**

| Year | Landings | Year | Landings | Year | Landings | Year | Landings |
|---|---|---|---|---|---|---|---|
| 1948 | 75 | 1957 | 301 | 1966 | 316 | 1975 | 518 |
| 1949 | 124 | 1958 | 323 | 1967 | 376 | 1976 | 914 |
| 1950 | 147 | 1959 | 304 | 1968 | 360 | 1977 | 1 231 |
| 1951 | 157 | 1960 | 308 | 1969 | 390 | 1978 | 161 |
| 1952 | 179 | 1961 | 362 | 1970 | 450 | 1979 | 481 |
| 1953 | 142 | 1962 | 354 | 1971 | 597 | 1980 | 1 788 |
| 1954 | 185 | 1963 | 380 | 1972 | 335 | 1981 | 2 716 |
| 1955 | 180 | 1964 | 342 | 1973 | 400 | 1982 | 2 965 |
| 1956 | 164 | 1965 | 359 | 1974 | 459 | 1983 | 3 918 |

Source: MAF data.

During the period of high landings in the mid 1980s setnetting was the main fishing method, providing about half the total catch, with lining accounting for one-third of the catch, and trawling the remainder. There were large regional variations.
Small amounts of school shark are also caught by the foreign charter tuna longliners fishing offshore in the EEZ to well beyond the shelf edge.

The Banks Peninsula Marine Mammal Sanctuary was established in 1988 by the Department of Conservation under the Marine Mammal Protection Act 1978, for the purpose of protecting Hector's dolphins. The sanctuary extends 4 nautical miles from the coast from Sumner Head in the north to the Rakaia River mouth in the south. Prior to 1 October 2008, no setnets were allowed within the sanctuary between 1 November to the end of February. For the remainder of the year, setnets were allowed; but could only be set from an hour after sunrise to an hour before sunset, be no more than 30 metres long, with only one net per boat which was required to remain tied to the net while it was set.

Voluntary setnet closures were implemented by the SEFMC from 1 October 2000 to protect nursery grounds for rig and elephantfish and to reduce interactions between commercial setnets and Hector's dolphins in shallow waters. The closed area extended from the southernmost end of the Banks Peninsula Marine Mammal Sanctuary to the northern bank of the mouth of the Waitaki River. This area was closed permanently for a distance of 1 nautical mile offshore and for 4 nautical miles offshore for the period 1 October to 31 January.

From 1 October 2008, a suite of regulations intended to protect Maui's and Hector's dolphins was implemented for all of New Zealand by the Minister of Fisheries.

For SCH 1, there have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island. The first was a closure to setnet fishing from Maunganui Bluff to Pariokariwa Point for a distance of 4 nautical miles on 1 October 2003. This closure was extended by the Minister to 7 nautical miles on 1 October 2008. An appeal was made by affected fishers who were granted interim relief by the High Court, allowing setnet fishing beyond 4 nautical miles during daylight hours between 1 October to 24 December.

For SCH 3, commercial and recreational set netting was banned in most areas to 4 nautical miles offshore of the east coast of the South Island, extending from Cape Jackson in the Marlborough Sounds to Slope Point in the Catlins. Some exceptions were allowed, including an exemption for commercial and recreational set netting to only one nautical mile offshore around the Kaikoura Canyon, and permitting setnetting in most harbours, estuaries, river mouths, lagoons and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour and Timaru Harbour. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SCH 5, commercial and recreational setnetting was banned in most areas to 4 nautical miles offshore, extending from Slope Point in the Catlins to Sandhill Point east of Fiordland and in all of Te Waewae Bay. An exemption which permitted setnetting in harbours, estuaries and inlets was allowed. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SCH 7, both commercial and recreational setnetting were banned to 2 nautical miles offshore, with the recreational closure effective for the entire year and the commercial closure restricted to the period 1 December to the end of February. The closed area extends from Awarua Point north of Fiordland to the tip of Cape Farewell at the top of the South Island. There is no equivalent closure in SCH 8, with the southern limit of the Maui's dolphin closure beginning north of New Plymouth at Pariokariwa Point. There have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island.

## 1.2 Recreational fisheries

Although school shark is a listed gamefish and is regularly caught by recreational fishers, it is not considered to be a particularly desirable target species at the present time. Recreational catch records have been obtained from diary surveys undertaken in 1991-94, 1996 and 1999-00 (Tables 3 and 4).

**Table 2: Reported landings (t) of school shark by Fishstock from 1983-84 to 2010-11 and actual TACCs (t) from 1986-87 to 2010-11. QMS data from 1986-present.**

| Fishstock | SCH 1 | | SCH 2 | | SCH 3 | | SCH 4 | | SCH 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA (s) | 1 & 9 | | 2 | | 3 | | 4 | | 5 & 6 | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84* | 1 087 | - | 298 | - | 630 | - | 8 | - | 792 | - |
| 1984-85* | 861 | - | 237 | - | 505 | - | 12 | - | 995 | - |
| 1985-86* | 787 | - | 214 | - | 370 | - | 23 | - | 647 | - |
| 1986-87 | 418 | 560 | 137 | 160 | 283 | 270 | 19 | 200 | 382 | 610 |
| 1987-88 | 530 | 604 | 123 | 168 | 320 | 289 | 22 | 200 | 529 | 613 |
| 1988-89 | 483 | 624 | 134 | 188 | 222 | 294 | 25 | 200 | 494 | 615 |
| 1989-90 | 585 | 652 | 154 | 197 | 272 | 305 | 27 | 235 | 450 | 635 |
| 1990-91 | 559 | 664 | 139 | 198 | 227 | 318 | 21 | 239 | 480 | 649 |
| 1991-92 | 596 | 664 | 161 | 198 | 264 | 318 | 34 | 239 | 612 | 686 |
| 1992-93 | 820 | 664 | 202 | 199 | 220 | 320 | 38 | 239 | 593 | 686 |
| 1993-94 | 658 | 667 | 156 | 199 | 202 | 322 | 41 | 239 | 624 | 686 |
| 1994-95 | 658 | 668 | 159 | 199 | 237 | 322 | 86 | 239 | 656 | 694 |
| 1995-96 | 804 | 668 | 212 | 199 | 296 | 322 | 229 | 239 | 690 | 694 |
| 1996-97 | 793 | 668 | 228 | 199 | 290 | 322 | 179 | 239 | 662 | 694 |
| 1997-98 | 764 | 668 | 214 | 199 | 270 | 322 | 127 | 239 | 623 | 694 |
| 1998-99 | 783 | 668 | 275 | 199 | 331 | 322 | 100 | 239 | 714 | 694 |
| 1999-00 | 820 | 668 | 250 | 199 | 341 | 322 | 97 | 239 | 706 | 694 |
| 2000-01 | 799 | 668 | 178 | 199 | 364 | 322 | 100 | 239 | 724 | 694 |
| 2001-02 | 691 | 668 | 208 | 199 | 324 | 322 | 93 | 239 | 673 | 708 |
| 2002-03 | 689 | 668 | 225 | 199 | 410 | 322 | 130 | 239 | 746 | 708 |
| 2003-04 | 758 | 668 | 187 | 199 | 323 | 322 | 149 | 239 | 727 | 708 |
| 2004-05 | 694 | 668 | 201 | 199 | 424 | 387 | 206 | 239 | 743 | 743 |
| 2005-06 | 634 | 668 | 177 | 199 | 325 | 387 | 183 | 239 | 712 | 743 |
| 2006-07 | 661 | 668 | 200 | 199 | 376 | 387 | 88 | 239 | 738 | 743 |
| 2007-08 | 708 | 689 | 227 | 199 | 345 | 387 | 133 | 239 | 781 | 743 |
| 2008-09 | 713 | 689 | 232 | 199 | 364 | 387 | 145 | 239 | 741 | 743 |
| 2009-10 | 589 | 689 | 213 | 199 | 426 | 387 | 191 | 239 | 784 | 743 |
| 2010-11 | 777 | 689 | 187 | 199 | 366 | 387 | 174 | 239 | 701 | 743 |

| Fishstock | SCH 7 | | SCH 8 | | SCH 10 | | | |
|---|---|---|---|---|---|---|---|---|
| FMA (s) | 7 | | 8 | | 10 | | Total | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings§ | TACC |
| 1983-84* | 1 039 | - | 694 | - | 0 | - | 4 776 | - |
| 1984-85* | 1 030 | - | 698 | - | 0 | - | 4 501 | - |
| 1985-86* | 851 | - | 652 | - | 0 | - | 3 717 | - |
| 1986-87 | 454 | 470 | 229 | 310 | 0 | 10 | 1 946 | 2 590 |
| 1987-88 | 515 | 500 | 374 | 345 | 0 | 10 | 2 367 | 2 729 |
| 1988-89 | 532 | 522 | 419 | 433 | 0 | 10 | 2 309 | 2 886 |
| 1989-90 | 516 | 524 | 371 | 438 | 0 | 10 | 2 377 | 2 996 |
| 1990-91 | 420 | 531 | 369 | 441 | 0 | 10 | 2 215 | 3 050 |
| 1991-92 | 431 | 531 | 409 | 441 | 0 | 10 | 2 508 | 3 086 |
| 1992-93 | 482 | 531 | 484 | 441 | 0 | 10 | 2 839 | 3 089 |
| 1993-94 | 473 | 531 | 448 | 441 | 0 | 10 | 2 603 | 3 093 |
| 1994-95 | 370 | 534 | 417 | 441 | 0 | 10 | 2 583 | 3 105 |
| 1995-96 | 635 | 534 | 521 | 441 | 0 | 10 | 3 387 | 3 107 |
| 1995-96 | 542 | 534 | 459 | 441 | 0 | 10 | 3 153 | 3 107 |
| 1997-98 | 471 | 534 | 447 | 441 | 0 | 10 | 2 917 | 3 107 |
| 1998-99 | 681 | 534 | 533 | 441 | 0 | 10 | 3 421 | 3 107 |
| 1999-00 | 639 | 534 | 469 | 441 | 0 | 10 | 3 324 | 3 107 |
| 2000-01 | 576 | 534 | 453 | 441 | 0 | 10 | 3 193 | 3 107 |
| 2001-02 | 501 | 534 | 449 | 441 | 0 | 10 | 2 913 | 3 121 |
| 2002-03 | 512 | 534 | 448 | 441 | 0 | 10 | 3 161 | 3 121 |
| 2003-04 | 574 | 534 | 405 | 441 | 0 | 10 | 3 124 | 3 121 |
| 2004-05 | 546 | 641 | 554 | 529 | 0 | 10 | 3 368 | 3 416 |
| 2005-06 | 568 | 641 | 503 | 529 | 0 | 10 | 3 102 | 3 416 |
| 2006-07 | 583 | 641 | 534 | 529 | 0 | 10 | 3 180 | 3 416 |
| 2007-08 | 606 | 641 | 497 | 529 | 0 | 10 | 3 299 | 3 437 |
| 2008-09 | 694 | 641 | 588 | 529 | 0 | 10 | 3 477 | 3 437 |
| 2009-10 | 605 | 641 | 460 | 529 | 0 | 10 | 3 268 | 3 436 |
| 2010-11 | 677 | 641 | 587 | 529 | 0 | 10 | 3 469 | 3 436 |

* FSU data. § Includes landings from unknown areas before 1986-87.

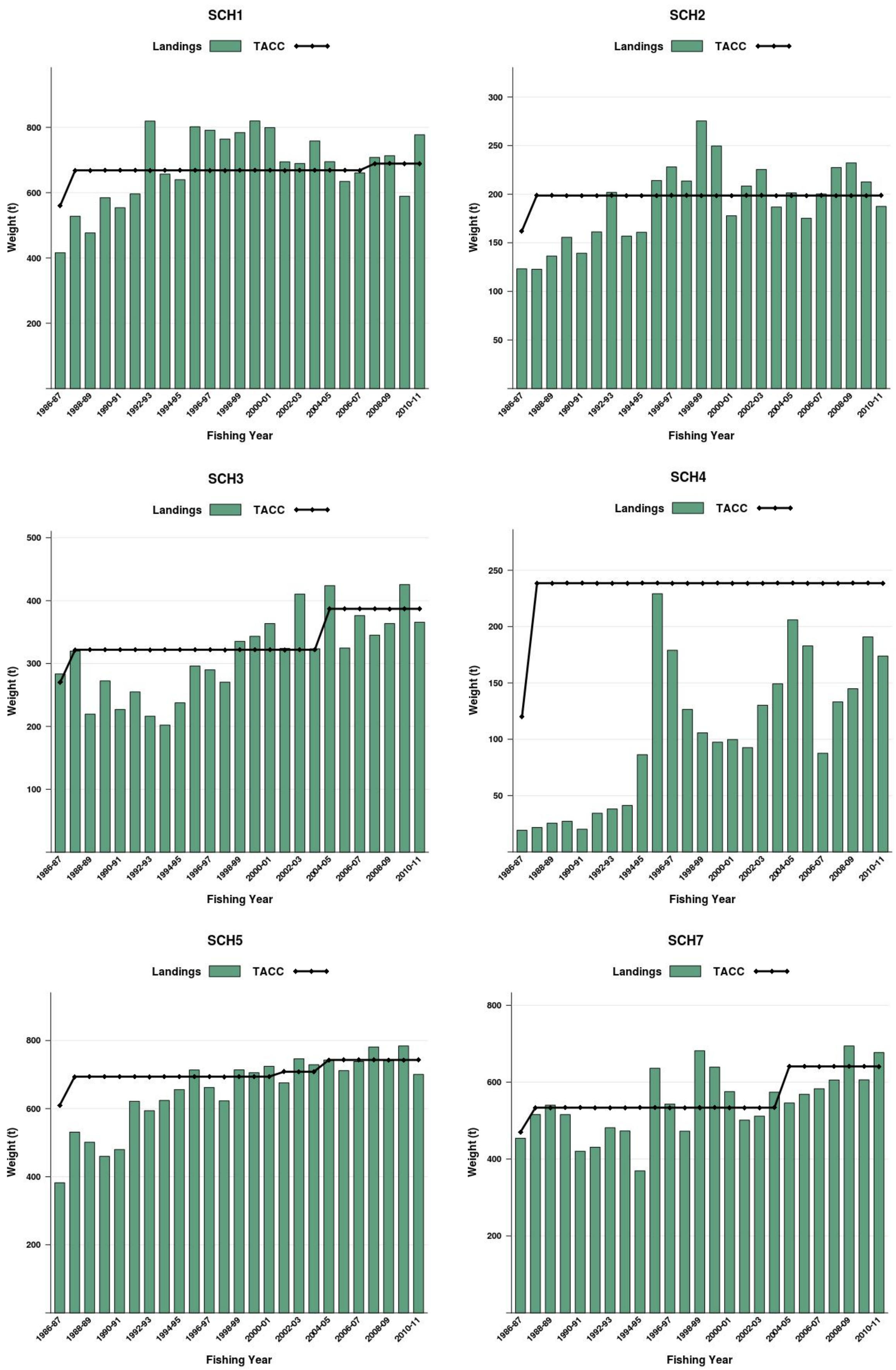



**Figure 1: Historical landings and TACC for the seven main SCH stocks. From top left: SCH1 (Auckland East), SCH2 (Central East), SCH3 (South East coast), SCH4 (South East Chatham Rise), SCH5 (Southland), SCH7 (Challenger). [Continued on next page].**

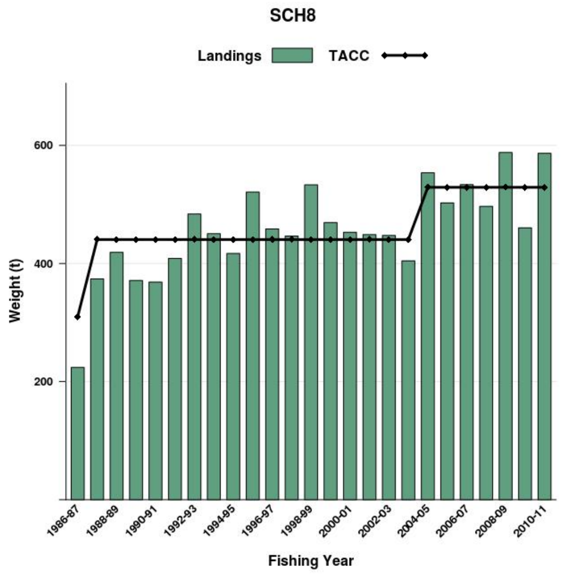



**Figure 1 [Continued]: Historical landings and TACC for the seven main SCH stocks. SCH8 (Central Egmont). Note that these figures do not show data prior to entry into the QMS.**

The Recreational Technical Working Group recommends that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries. Relative comparisons may be possible between stocks within these surveys.

**Table 3: Estimated number and weight of school sharks harvested by recreational fishers relative to Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991-92, Central in 1992-93 and North in 1993-94 (Teirney *et al.* 1997).**

| | | Total | | |
|---|---|---|---|---|
| Fishstock | Survey | Number | CV (%) | Survey harvest (t) |
| SCH 1 | North | 17 000 | 24 | 10-170 |
| SCH 1 | Central | 1 000 | - | 0-10 |
| SCH 2 | Central | 13 000 | 27 | 25-45 |
| SCH 3 | South | 6 000 | 33 | 15-35 |
| SCH 5 | South | 1 000 | - | 0-10 |
| SCH 7 | Central | 9 000 | 84 | 10-35 |
| SCH 7 | South | 3 000 | - | 5-15 |
| SCH 8 | Central | 7 000 | 45 | 10-30 |

**Table 4: Estimates of annual number and weight of school shark harvested by recreational fishers from national diary surveys in 1996 (Bradford 1998) and Dec1999-Nov 2000 (Boyd & Reilly 2005). The mean weights used to convert numbers to catch weight are considered the best available estimates. Estimated harvest is also presented as a range to reflect the uncertainty in the point estimates.**

| Fishstock | Number caught | CV (%) | Estimated harvest range (t) | Point estimate (t) |
|---|---|---|---|---|
| 1996 | | | | |
| SCH 1 | 23 000 | 17 | 35-55 | 46 |
| SCH 2 | 5 000 | - | - | - |
| SCH 3 | 3 000 | - | - | - |
| SCH 5 | 1 000 | - | - | - |
| SCH 7 | 8 000 | 24 | 5-25 | 16 |
| SCH 8 | 11 000 | 22 | 15-25 | 21 |
| 1999-00 | | | | |
| SCH 1 | 27 000 | 42 | 38-93 | 66 |
| SCH 2 | 7 000 | 30 | 13-24 | 18 |
| SCH 3 | 19 000 | 46 | 26-70 | 48 |
| SCH 5 | 3 000 | 66 | 2-11 | 7 |
| SCH 7 | 23 000 | 56 | 26-91 | 58 |
| SCH 8 | 3 000 | 55 | 4-13 | 8 |

### 1.3 Customary non-commercial fisheries

Maori fishers made extensive use of school shark in pre-European times for food, oil, and skin. There is no quantitative information on the current level of customary non-commercial take.

### 1.4 Illegal catch

There is no quantifiable information on the level of illegal catch. There is an unknown amount of unreported offshore trawl and pelagic longline catch of school shark, either landed (under another name, or in "mixed") or discarded.

### 1.5 Other sources of mortality

There is an unknown discarded bycatch of juvenile, mainly first-year, school shark taken in harbour and bay setnets. Quantitative information is not available on the level of other sources of mortality.

## 2. BIOLOGY

School sharks are distributed across the shelf, generally being inshore in summer and offshore in winter. They extend in smaller numbers near the seafloor down the upper continental slope, to at least 600 m. The capture of school sharks by tuna longliners shows that their distribution extends well offshore, up to 180 nm off the South Island, and 400 nm off northern New Zealand towards the Kermadec Islands. They feed predominantly on small fish and cephalopods (octopus and squid).

Growth rates have not been estimated for New Zealand fish, but in Australia and South America school sharks are slow growing and long-lived (Grant *et al.* 1979, Olsen 1984, Peres & Vooren 1991). They are difficult to age by conventional methods, but up to 45 vertebral rings can be counted. Growth is fastest for the first few years, slows appreciably between 5 and 15 years, and is negligible at older ages, particularly after 20. Results from an Australian long-term tag recovery suggest a maximum age of at least 50 years. Age-at-maturity has been estimated at 12-17 years for males and 13 to 15 years for females (Francis & Mulligan 1998). The size range of commercially caught maturing and adult school shark is 90-170 cm total length (TL), with a broad mode at 110-130 cm TL, which varies with area, season and depth.

Breeding is not annual; it has generally been assumed to be biennial, but recent work on a Brazilian stock suggests that females have a 3-year cycle (Peres & Vooren 1991). Fecundity (pup number) increases from 5-10 in small females to over 40 in the largest. Mating is believed to occur in deep water, probably in winter. Release of pups occurs during spring and early summer (November-January), apparently earlier in the north of the country than in the south. Nursery grounds include harbours, shallow bays and sheltered coasts. The pups remain in the shallow nursery grounds during their first one or two years and subsequently disperse across the shelf. The geographic location of the most important pupping and nursery grounds in New Zealand is not known.

**Table 5: Estimates of biological parameters for school shark.**

| Fishstock | Estimate | | Source |
|---|---|---|---|
| 1. Weight = a (length)$^b$ (Weight in g, length in cm fork length) | | | |
| | Both sexes combined | | |
| | a | b | |
| SCH 1 | 0.0003 | 3.58 | McGregor (unpub.) |
| SCH 3 | 0.0035 | 3.08 | McGregor (unpub.) |
| SCH 5 | 0.0181 | 2.72 | McGregor (unpub.) |
| SCH 5 | 0.0068 | 2.94 | Hurst *et al.* (1990) |
| SCH 7 | 0.0061 | 2.94 | Blackwell (unpub.) |
| SCH 8 | 0.0104 | 2.84 | Blackwell (unpub.) |
| 2. Estimate of *M* for Australia | | | |
| | 0.1 | | Grant *et al.* (1979), Olsen (1984) |

The combination of late maturity, slow growth, and low fecundity gives a low overall productivity. In Australia, *M* has been estimated as 0.1.

New Zealand tagging studies have shown that school shark may move considerable distances, including trans-Tasman migrations (for details see the 1995 Plenary Report).

Biological parameters relevant to stock assessment are shown in Table 5.

## 3. STOCKS AND AREAS

Information relevant to determining school shark stock structure in New Zealand was reviewed in 2009 (Smith 2009, Blackwell & Francis 2010, Francis 2010). Primarily based on the tagging evidence, there is probably a single biological stock in the New Zealand EEZ. Genetic, biological, fishery and tagging data were all considered, but the evidence for the existence of distinct biological stocks is poor. Some differences were found in CPUE trends between OMAs, but stock separation at the QMA level seems unlikely, and the CPUE differences may have resulted from processes acting below the stock level, such as localised exploitation of different sexes or different size classes of sharks. An apparent lack of juvenile school shark nursery areas in SCH 4 and SCH 5 suggests that these Fishstocks are not distinct, but are instead maintained by recruitment from other QMAs.

The most useful source of information was an opportunistic tagging programme undertaken mainly on research trawlers since 1985 (Hurst *et al*. 1999). However most tag releases were made around the South Island so little information is provided for North Island school shark. Female school shark were slightly more mobile than males, with higher proportions of the former moving to non-adjacent QMAs and to Australia. About 30% of school shark recaptures were reported from outside the release QMA within a year of release, and this was maintained in the second year after release. After 2-5 years at liberty about 60% of recaptured school sharks (both sexes) were reported from outside the release QMA. After more than 5 years at liberty, 8% of males and 19% of females were recaptured from Australia. A large proportion of tagged school sharks moved outside the QMA of release within 5 years, and a significant proportion eventually moved to Australia. These trends in apparent movement are consistent across two decades of tagging. The relative importance of various breeding grounds around New Zealand (e.g., aggregations of breeding females in Kaipara Harbour) and whether females return to the area in which they were born are unknown.

The current stock management units are a precautionary measure to spread fishing effort; amalgamation of all QMAs into one QMA for the whole EEZ could create unacceptable risks to stock sustainability.

## 4. STOCK ASSESSMENT

### 4.1 Estimates of fishery parameters and abundance

Fishery characterisations and CPUE analyses for SCH 1, SCH2, SCH3, SCH 5, SCH 7 and SCH 8 were undertaken in 2010 as part of the review of AMP stocks. Although SCH 1 and SCH 2 are not AMP stocks they were included by Industry to obtain a better understanding of the status of New Zealand school shark.

**SCH 1**

SCH 1 are primarily taken by bottom trawl while targeting tarakihi and snapper, with smaller catches when targeting trevally and red gurnard. The bottom longline SCH 1 fishery is primarily directed at school shark, with hapuku and snapper being other important targets. The setnet fishery is also primarily targeted at school shark, with some targeting of rig, trevally, gurnard and snapper.

The previously accepted indices for SCH 1 were based on bottom longline snapper (1E) and a bottom trawl mixed (1W) catches. The 2010 assessment explored a wide range of alternative fishery definitions and the AMP FAWG accepted indices based on SN and BLL catches on both the east and west coasts. These indices were based on Generalized Linear Models of positive catches with log normal error distribution. Models of bottom trawl catch were not explored.

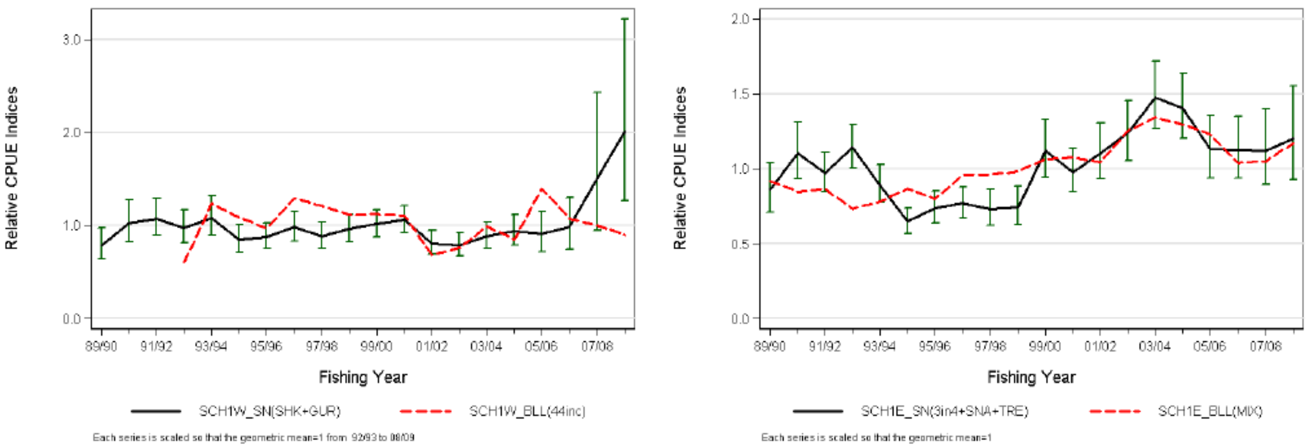
Standardised CPUE abundance indices for SCH 1 show different trends west and east of North Cape (Fig. 2).

**SCH 1 W**

Discounting the last two years of the analysis (2007/08 and 2008/09) for setnet (which are poorly estimated), the SN and BLL indices for SCH 1W are flat, indicating no change in abundance over the past 20 years (Fig. 2). Analysis of the spatial distribution of catches revealed that the BLL catches were concentrated around North Cape and the SN catches were mostly made in the North Taranaki Bight; near the SCH 8 boundary line. The SN index shows very high uncertainty over the last two years of the analysis (2007/08 and 2008/09), potentially being affected by recent setnet closures on the west coast. There are now only two vessels in this west coast SN fishery and the index may become unreliable in future.

**SCH 1E**

Since 1998-99 the SCH 1E index shows an increasing trend to above the long-term average, peaking in 2003-04, and then dropping to just above the average by 2005-06 and remained at about that level to 2008/09(Fig. 2).




**1W_BLL(44inc); [right panel] comparison of the two SCH 1E standardised series: SCH 1E_SN(3in4+SNA+TRE) and SCH 1W_BLL(MIX). (Each series is scaled so that the geometric mean = 1) Starr & Kendrick (2010a).**

**SCH 2**

SCH 2 are caught primarily in the bottom trawl fishery (46%) targeting tarakihi, hoki, gemfish and gurnard; and the bottom longline fishery (30%) targeting school shark, ling, hapuku/bass and bluenose. Sixteen per cent of the catch is taken in setnet targeting school shark, blue warehou and blue moki.

The 2010 analyses used setnet and bottom longline (no bottom trawl index was attempted), based on a broader range of target fisheries than previously. The previous assessment used tarakihi bottom trawl index.

Two indices were considered for SCH 2 in 2010: one based on setnet catches with a range of target (SN[MIX]) and the other based on bottom longline catches, also with a range of targets. These two indices present conflicting trends, the setnet index generally increasing over the series and the bottom longline index decreasing steadily (Fig. 3). The AMP FAWG noted particular concerns with the bluenose targeted bottom longline index, related to suggestions of a steady shift towards mid-water targeting of bluenose. There is a substantial correspondence between the standardised setnet index for SCH 2 with setnet and bottom longline indices for SCH 1E, which together indicate a slow but steady increase in CPUE to 2005-06, levelling off since then.

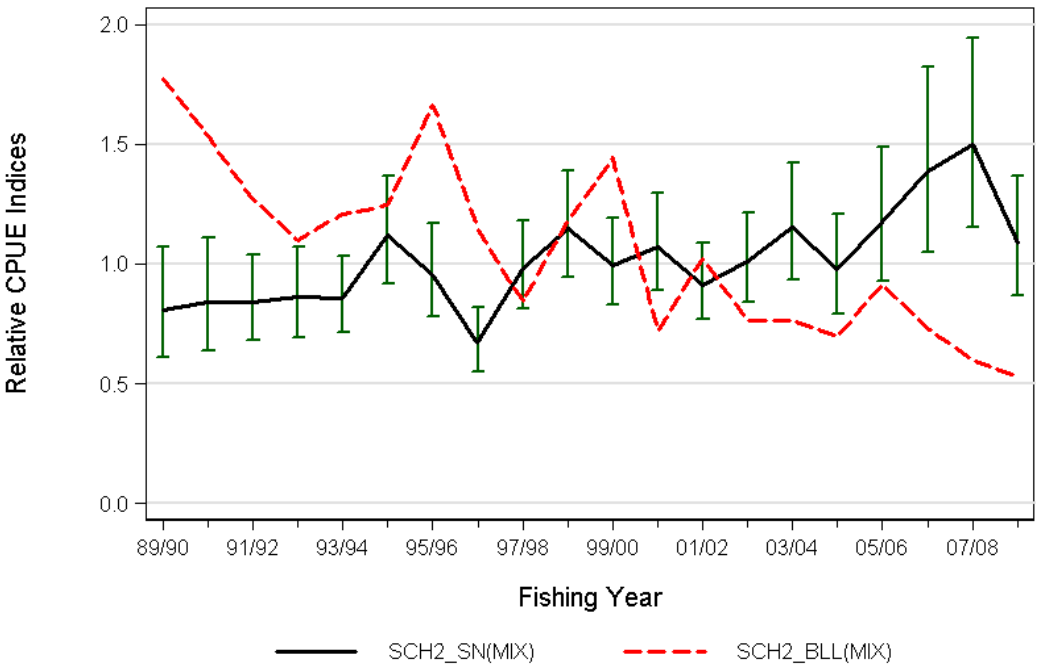



**Figure 3: Comparison of the lognormal indices from the two fisheries operating in SCH 2: a) SN[MIX]: mixed target species; b) BLL[MIX]: mixed target species Starr & Kendrick (2010b).**

**SCH 3**

SCH 3 is predominantly caught in the setnet fishery (56%) targeting school shark and rig, with some targeting of spiny dogfish and tarakihi; and in the bottom trawl fishery (36%) targeting red cod, with some targeting of flatfish, barracouta and tarakihi. Mixed targeted bottom longline takes 7% of the catch.

The mixed shark target SN(SHK) standardised CPUE is the accepted index of abundance for SCH 3. The 2010 CPUE analysis is an update of the shark-targeted setnet CPUE analysis conducted in 2003 and 2007, with no extension to other target species or other model changes. This index shows a sharp decline of almost 60% from a peak in 1989-90 to its lowest point over the 20 year series in 1992-93 (Fig. 4). Thereafter the index shows a steady and continual increase through to 2003-04 / 2004-05 to a level about 10% above the long-term average and about 40% above the lowest level, fluctuating around this level thereafter.

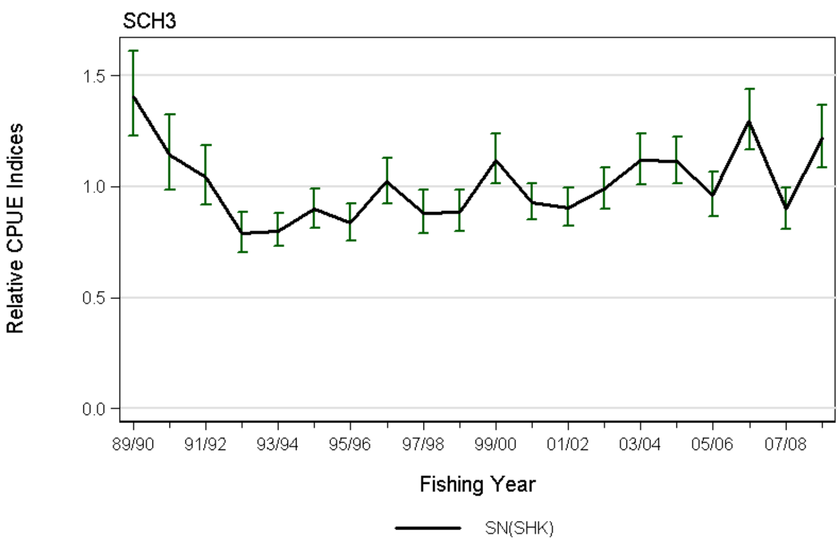



**Figure 4: Lognormal SCH 3_SN(SHK) standardised indices with core vessel criteria of at least 10 trips in a minimum of 6 years) (series is scaled so that the geometric mean = 1). From Starr *et al*. (2010a).**

**SCH 5**

SCH 5 is almost entirely caught in the school shark targeted setnet fishery (83%), with some minor targeting of rig. Seven percent is taken by bottom trawl primarily targeting stargazer and squid, and 5% by bottom longline primarily targeting hapuku/bass and ling.

The targeted SN(SCH) standardised CPUE index is the accepted indicator of SCH 5 abundance. The 2011 CPUE analysis is an update of previous analyses conducted in 2003, 2007 and 2010, with no substantial changes to the fishery definitions or standardisation models. The index fluctuated around long-term average levels through to 2005-06 (Fig. 5). Thereafter the index declines to slightly below average levels over 2006-07/2007-08, and then steeply to about half average levels in 2008-09. The index is considered to be less reliably estimated in the final year, due to changes in fleet size and structure.

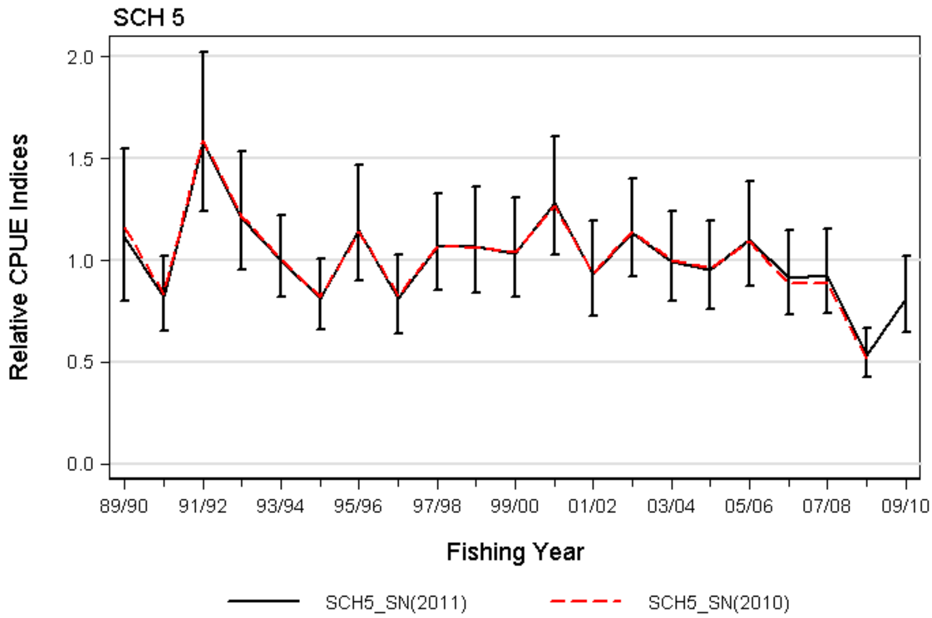



**Figure 5: Lognormal SCH 5_SN(2011) standardised index and the index from the 2010 assessment SCH5_SN(2010). From Starr and Kendrick (2011).**

There is close correspondence in the declining indices for SCH 5 and SCH 7, except in the final year. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern about the declines in both these areas.

**SCH 7**

SCH 7 are caught about one-third each by setnet targeting school shark, rig and spiny dogfish; bottom longline targeting school shark, hapuku/bass and ling; and bottom trawl targeting barracouta, tarakihi, flatfish, hoki, red cod and others.

The mixed shark target SHK7_SN(2011) standardised CPUE index is the accepted indicator of SCH 7 abundance. The 2011 CPUE analysis updates previous analyses conducted in 2003, 2007 and 2010, with no substantial changes to the fishery definitions or standardisation models. The index remained stable around long-term average levels over 1989-90 to 1995-96 and then increased to a peak about 50% above average levels in 1999-00, then declined steadily to its lowest value over the 20 year period by 2007-08 (Figure 6). The index increased in 2008-09 and then decreased in the final year to below the long-term mean.

There is close correspondence in the declining indices for SCH 5 and SCH 7, except in the final two years where SCH 5 and SCH 7 vary inversely. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern about the declines in both these areas.

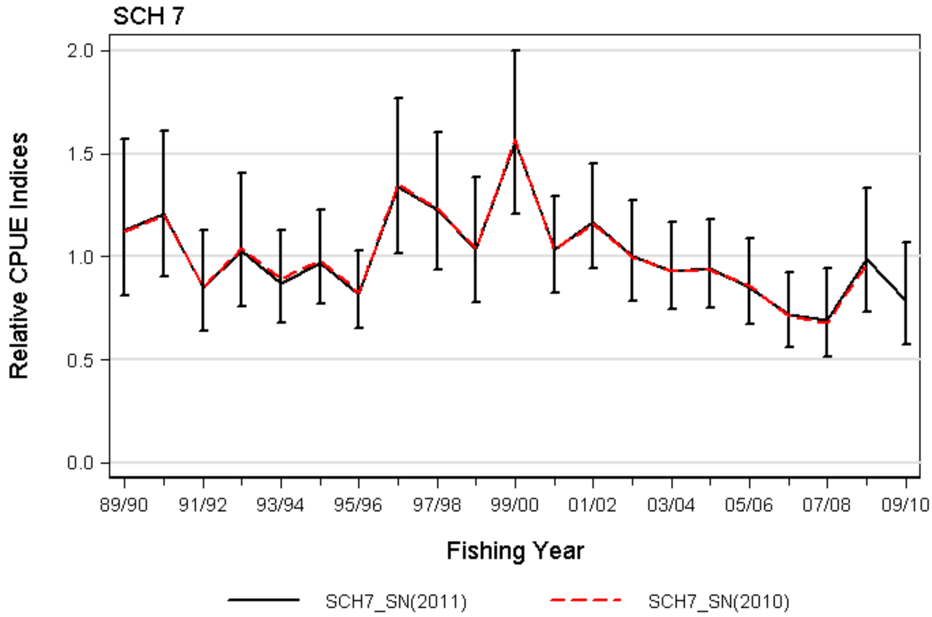



**Figure 6: Lognormal indices from the setnet target shark CPUE series for SCH 7 SCH7_SN(2011) and the index from the 2010 assessment SCH7_SN(2010). From Starr & Kendrick (2011).**

## SCH 8

SCH 8 are caught mainly (66%) by setnet targeting school shark and rig; and by bottom longline (22%) targeting school shark and hapuku/bass. Ten percent is caught by bottom trawl targeting gurnard, tarakihi and trevally.

The mixed shark target SCH8_SN(2011) standardised CPUE index is the accepted indicator of SCH 8 abundance. The 2011 CPUE analysis is an update of previous analyses conducted in 2003, 2007 and 2010, with no substantial changes to the fishery definitions or standardisation models. The index remains flat at the long-term average, apart from a drop to lower levels over 1997-98 to 2000-01 (Figure 7). The Working Group concluded that the SCH 8 index showed no change in abundance over the series. There was an inverse relationship between the SCH 7 and SCH 8 indices over this period, suggesting a possible shift in stock distribution between these areas.

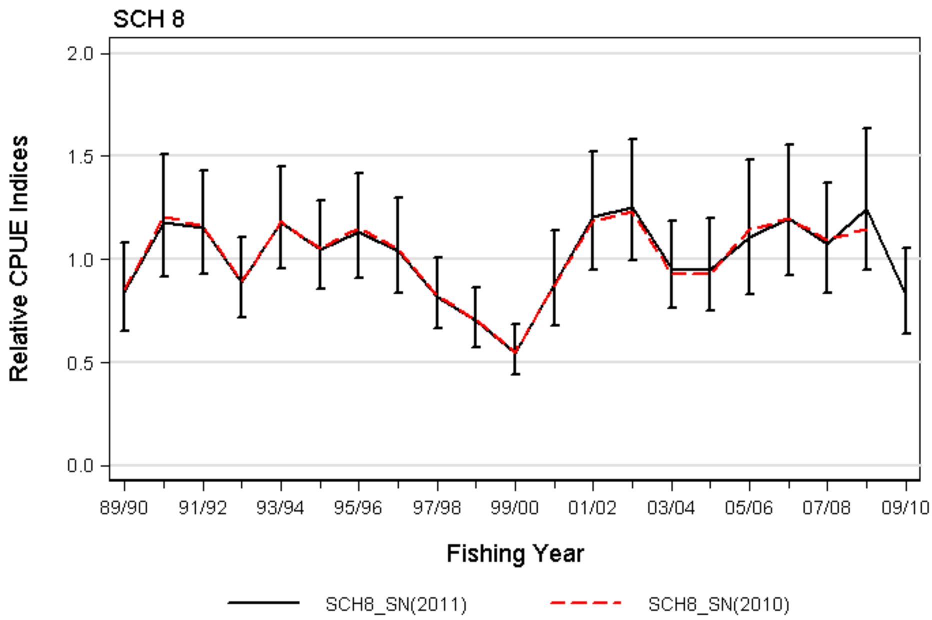



**Figure 7: Lognormal indices from the setnet target shark CPUE series for SCH 8 SCH8_SN(2011) and the index from the 2010 assessment SCH8_SN(2010). From Starr and Kendrick (2011).**

**SCH overview**
SCH are mainly caught in setnet fisheries targeting sharks (school shark, rig, elephantfish and spiny dogfish); in bottom trawl fisheries targeting red cod, tarakihi, gurnard and snapper and others; and in bottom longline fisheries targeting school shark, hapuku/bass and ling.

In SCH 3, 5, 7 and 8, CPUE indices have been conducted using the same, or similar, models since entry into AMPs. In some areas, additional target species have been added to fishery definitions, particularly for bottom longline indices. New analyses were developed for SCH 1 and 2. Bottom trawl indices previously produced for SCH 1 and 2 were not updated in 2010.

There is a close similarity in trends in the indices for 1E, 2 and 3; SCH 5 and SCH 7; and SCH 8 and 1W. The indices show higher recent CPUE for SCH 1E, 2 and 3; stable CPUE for SCH 1W and 8; and declining CPUE for SCH 5 and 7. The Working Group noted that SCH 5 and 7 have accounted for 41% of the SCH catch over the past 20 years, and are the areas in which the highest proportion of mature fish are caught. SCH 1E, 2 and 3, have accounted for 26% of the SCH catch over the past 20 years. Areas 1W and 8 have accounted for 30% of the catch.

Recent setnet closures have potentially compromised the continuity of setnet indices for SCH 1W, 3, 5 and 7.

### 4.2 Biomass estimates
Estimates of current and reference biomass are not available.

### 4.3 Estimation of Maximum Constant Yield (*MCY*)
The estimates of *MCY* are no longer considered valid.

### 4.4 Estimation of Current Annual Yield (*CAY*)
Current biomass cannot be estimated, so *CAY* cannot be determined.

### 4.5 Other yield estimates and stock assessment results
No information is available.

### 4.6 Other factors
In Australia, recruitment overfishing has occurred to such an extent that the stock is considered seriously threatened and a series of conservative management measures (TAC reductions) have been progressively imposed between 1996 and 2007 (Wilson *et al*. 2008). The Australian modelling work indicates that the stock is overfished. Wilson *et al*. (2008) note that the stock has been in an overfished state and overfishing was occurring from 1992 to 2004. While the stock was still listed as overfished since then, they are uncertain as to whether overfishing is still occurring.

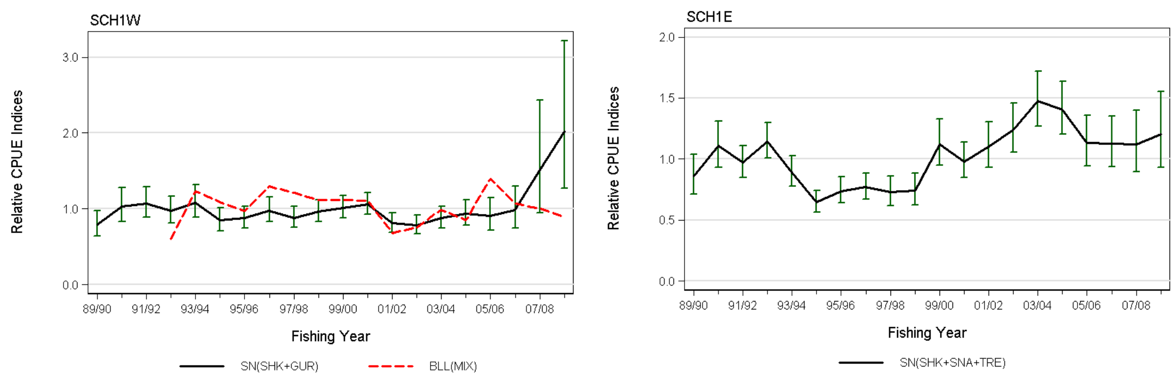
The most important conclusion from this for New Zealand is that fishing pressure on large mature females should be minimised to maintain the productivity of this species.

## 5. STATUS OF THE STOCKS

**Stock Structure Assumptions**
SCH are known from tagging studies to be highly mobile, moving between the North and South Islands, and as far as Australia. From the tagging evidence, there is probably a single biological SCH stock in the New Zealand EEZ. However, differences in average modal length and CPUE trends between FMAs indicate that movement between areas may be viscous, and that components of the stock may aggregate in different areas. Larger females predominate in catches around Southland and west coast of the South Island. Therefore, the current stock management units are a precautionary measure to spread fishing effort and mortality across components of the stock.

## SCH 1

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 (Fishery characterisation and CPUE standardisation) |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |
| Historical Stock Status Trajectory and Current Status | |




**Left: Comparison of the two SCH 1W standardised series: SCH 1W_SN(SHK+GUR) and SCH 1W_BLL(44inc); Right: The SN (SHK+SNA+TRE) index for SCH 1E.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | Standardised CPUE abundance indices for SCH 1 show different trends west and east of North Cape. Discounting the last two years for setnet (which are poorly estimated), the SN and BLL indices for SCH 1W are flat, indicating no change in abundance over the past 20 years.<br>The index for SCH 1E shows higher than long-term average abundance since 1999-00. From 1999-00 the SCH 1E index shows an increasing trend to above the long-term average, peaking in 2003-04, and then dropping to just above the average by 2006-07. |

| | |
|---|---|
| Recent Trend in Fishing Mortality or Proxy | Overfishing is Unlikely (< 40%) to be occurring. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | SCH 1E: Stock size is Likely (> 60%) to remain near current levels or increase under current catches and TACCs<br>SCH 1W: Stock size is Likely (> 60%) to remain near current levels under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 1 abundance. | |
| Main data inputs | Catch and effort data derived from the Ministry of Fisheries catch returns | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2013 |

| | |
|---|---|
| Changes to Model Structure and Assumptions | The previously accepted indices were based on bottom longline snapper (1E) and a bottom trawl mixed (1W). This assessment explored a wide range of alternative fishery definitions. Four credible indices were selected: setnet (SN) and bottom longline (BLL) on both the east and west coasts. |
| Major Sources of Uncertainty | Setnet closures have jeopardised the continuity of the west coast setnet index in recent years. The BLL(W) index is considered to index the top of the North Island and lacks data. |

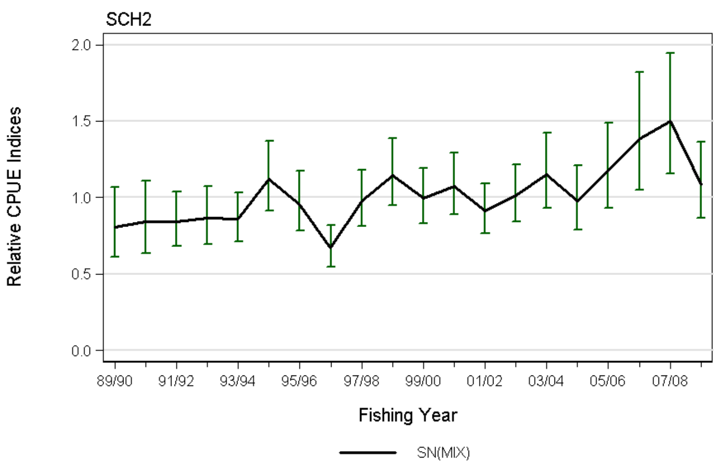
| **Qualifying Comments** |
|---|
| Recent setnet closures designed to protect Maui's dolphin have affected setnet fisheries which take school shark off the west coast of the North Island. These closures have resulted in changes in fleet deployment and jeopardised the setnet indices. |

| **Fishery Interactions** |
|---|
| SCH 1 are primarily taken by bottom trawl while targeting tarakihi and snapper, with smaller catches when targeting trevally and red gurnard. The bottom longline SCH 1 fishery is primarily directed at school shark, with hapuku and snapper being other important targets. The setnet fishery is also primarily targeted at school shark, with some targeting of rig, trevally, gurnard and snapper. The bottom pair trawl fishery is almost entirely directed at snapper and trevally, with tarakihi becoming more important in recent years. |

## SCH 2

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 (Fishery characterisation and CPUE standardisation) |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

**Historical Stock Status Trajectory and Current Status**




**The lognormal index for SCH 2: SN[MIX]: mixed target species (scaled so that the geometric mean = 1).**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The CPUE index generally increases over the series. There is a substantial correspondence between the standardised SN index for SCH 2 with SN and BLL indices for SCH 1E, which together |

| | |
|---|---|
| | indicate a slow but steady increase in CPUE to 2005-06, levelling off since then. |
| Recent Trend in Fishing Mortality or Proxy | Overfishing is Unlikely (< 40%) to be occurring. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | Correspondence between SN indices for SCH 1E, SCH 2 and SCH 3 indicates that. SCH 2 stock size is Likely to remain near current levels or increase under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 2 abundance. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries compulsory catch reporting. | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | The previous assessment used tarakihi bottom trawl index. The 2010 analyses used setnet and bottom longline (no bottom trawl index was attempted), based on a broader range of target fisheries than previously. | |
| Major Sources of Uncertainty | | |

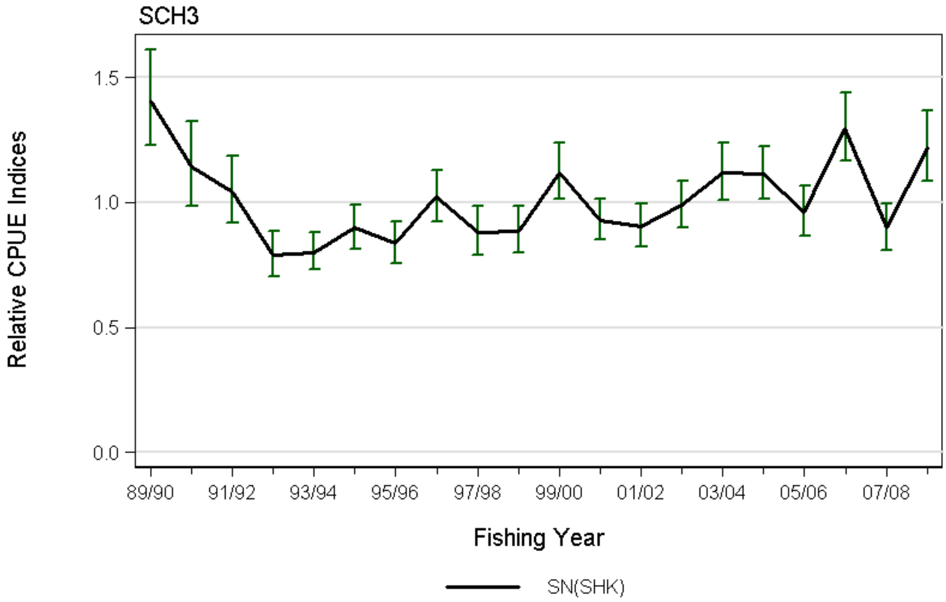
| **Qualifying Comments** |
|---|
| There have been no regulation changes affecting SCH 2 in recent years. |

| **Fishery Interactions** |
|---|
| SCH 2 are caught primarily in the bottom trawl fishery (46%) targeting tarakihi, hoki, gemfish and gurnard; and the bottom longline fishery (30%) targeting school shark, ling, hapuku/bass and bluenose. 16% of the catch is taken in setnet targeting school shark, blue warehou and blue moki. |

**SCH 3**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010 (Fishery characterisation and CPUE standardisation) |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

**Historical Stock Status Trajectory and Current Status**




**Lognormal SCH 3_SN(SHK) standardised indices with core vessel criteria of at least 10 trips in a minimum of 6 years) (series is scaled so that the geometric mean = 1).**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The mixed shark target SN(SHK) standardised CPUE is the accepted index of abundance. This index shows a sharp decline of almost 60% from a peak in 1989-90 to its lowest point over the 20 year series in 1992-93. Thereafter the index shows a steady and continual increase through to 2003-04 to 2004-05 to a level about 10% above the long-term average and about 40% above the lowest level, fluctuating around this level thereafter. |
| Recent Trend in Fishing Mortality or Proxy | Overfishing is Unlikely (< 40%) to be occurring. |

| **Projections and Prognosis** | | |
|---|---|---|
| Stock Projections or Prognosis | Quantitative stock projections are unavailable. The long period of increase in the SN(SHK) index for SCH 3 since 1992-93, over a period when catches have increased steadily from about 200t to an average of 366t over the recent five years, indicates that stock size is Likely to remain near current levels or increase under current catches. | |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) | |
| **Assessment Methodology** | | |
| Assessment Type | Level 2: Standardised CPUE abundance index, and a review of length data. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 3 abundance. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries reporting requirements.<br>- Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme. | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | The 2010 CPUE analysis is an update of the shark-targeted setnet CPUE analysis conducted in 2003 and 2007, with no extension to | |

| | |
|---|---|
| | other target species or other model changes. |
| Major Sources of Uncertainty | Recent setnet closures have affected fleet distribution patterns, potentially jeopardising setnet indices in this area. These changes may have contributed to the strong fluctuations in the SCH 3 SN indices in recent years. |

| **Qualifying Comments** |
|---|
| Like other setnet abundance indices, the SCH 3 setnet indices have been affected, and possibly compromised, by setnet closures. |

| **Fishery Interactions** |
|---|
| SCH 3 is predominantly caught in the setnet fishery (56%) targeting school shark and rig, with some targeting of spiny dogfish and tarakihi; and in the bottom trawl fishery (36%) targeting red cod, with some targeting of flatfish, barracouta and tarakihi. Mixed targeted bottom longline takes 7% of the catch. |

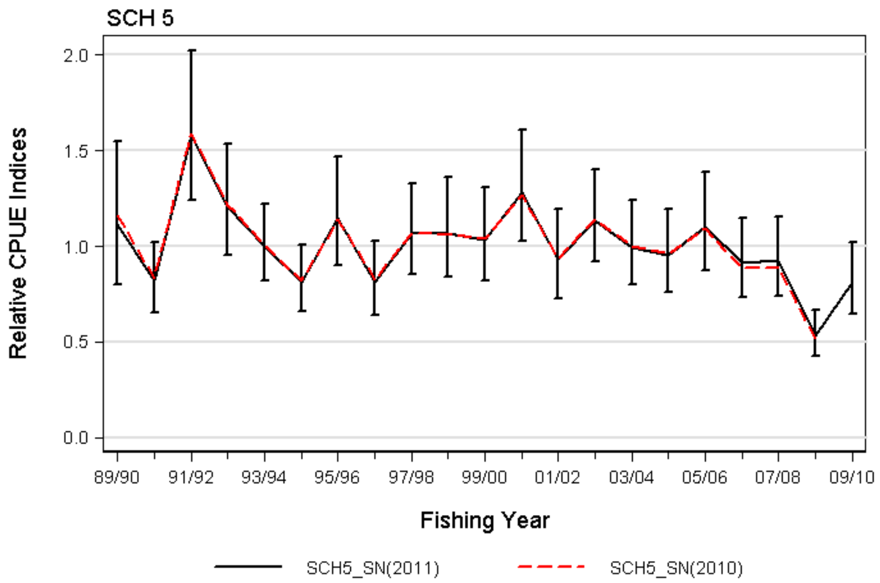
**SCH 4**

The status of SCH 4 relative to $B_{MSY}$ is unknown.

**SCH 5**

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 (Fishery characterisation and CPUE standardisation) |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below |

**Historical Stock Status Trajectory and Current Status**




**Lognormal SCH 5_SCH5_SN(2011) standardised index.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The targeted **SCH5_SN(2011)** CPUE index fluctuated around long-term average levels through to 2005-06. Thereafter the index declines to slightly below average levels over 2006-07 / 2007-08, |

| | |
|---|---|
| | and then steeply to about half average levels in 2008-09. The value of the index in the most recent year has increased but is still below the long-term mean. |
| Recent Trend in Fishing Mortality or Proxy | Overfishing is About as Likely as Not (40-60%) to be occurring. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | The **SCH5_SN(2011)** abundance index has declined steadily since 2005-06, reaching the lowest level over the 20 year period of the index in 2008-09, at about half of long-term average levels.<br><br>This gives rise to concern that current catches, and the current TACC, may not be sustainable. While the most recent data point is above that of 2010, it is still below the long-term mean. The working group therefore concluded that the SCH 5 stock is Likely to decline under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index, and a review of length data. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 5 abundance. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries catch reporting.<br>- Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | The 2011 CPUE analysis is an update of previous analyses conducted in 2003, 2007 and 2010, with no substantial changes to the fishery definitions or standardisation models. | |
| Major Sources of Uncertainty | Recent setnet closures have affected fleet distribution patterns, potentially jeopardising setnet indices in this area. | |

| **Qualifying Comments** |
|---|
| Concerns regarding the status of this stock are prompted by the decline in CPUE from the early 2000s. There is close correspondence in the indices for SCH 5 and SCH 7. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern for both these areas. |

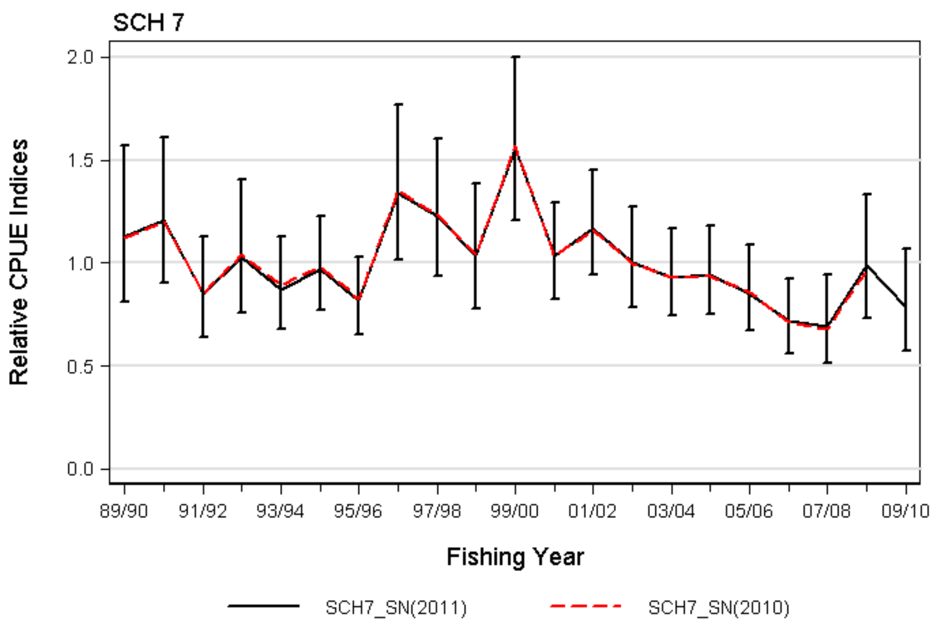
| **Fishery Interactions** |
|---|
| SCH 5 is almost entirely caught in the school shark targeted setnet fishery (83%), with some minor targeting of rig. Seven percent is taken by bottom trawl primarily targeting stargazer and squid, and 5% by bottom longline primarily targeting hapuku/bass and ling. |

## SCH 7

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |

| | |
|---|---|
| Status in relation to Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below |

**Historical Stock Status Trajectory and Current Status**




**Lognormal indices from the setnet target shark CPUE series for SCH 7.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The mixed shark target SHK7_SN(2011) standardised CPUE index remained stable around long-term average levels over 1989-90 to 1995-96 and then increased to a peak about 50% above average levels in 1999-00, then declined steadily to its lowest value over the 20 year period by 2007-08. There was a sharp increase in the final year; however, the working group considered the last data point to be less reliably estimated. |
| Recent Trend in Fishing Mortality or Proxy | Overfishing is About as Likely as Not (40-60%) to be occurring. |
| **Projections and Prognosis** | |
| Stock Projections or Prognosis | The SHK7_SN(2011) abundance index declined steadily from 1999-00 to its lowest level over the 20 year period of the index in 2007-08. The Working Group concluded that the SCH 7 Fishstock stock size is Likely to decline under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unknown |

| **Assessment Methodology** | | |
|---|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index, and review of length frequency data. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 7 abundance. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries catch reporting.<br>- Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | The 2011 CPUE analysis is an update of previous analyses conducted in 2003, 2007 and 2010, with no substantial changes to the fishery definitions or standardisation models. | |

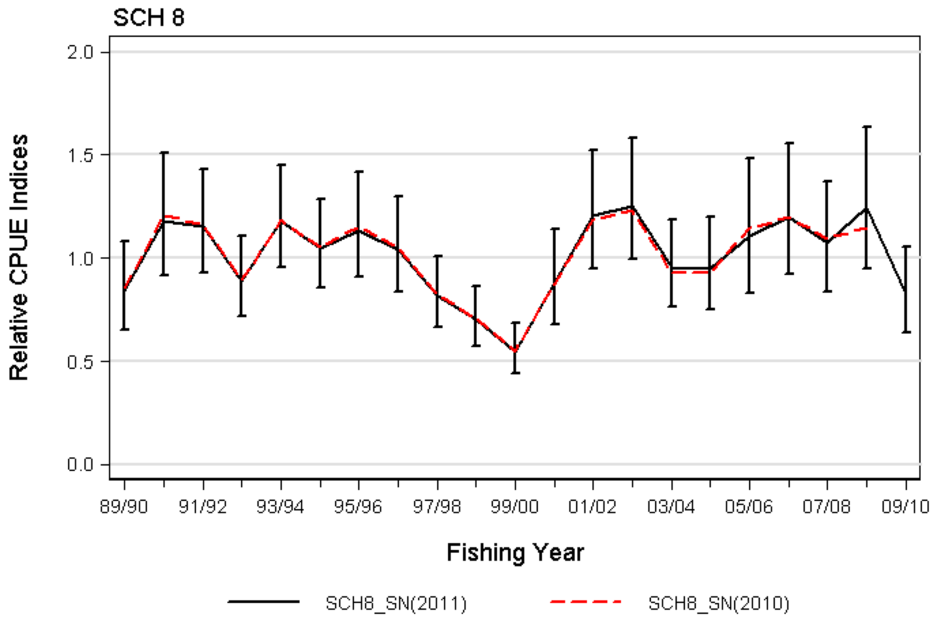
| | |
|---|---|
| Major Sources of Uncertainty | SCH 7: The fleet distribution has changed in the last 2-3 years. Furthermore, setnet closures have potentially compromised the setnet indices in the last two years. |
| **Qualifying Comments** | |
| Concerns regarding the status of this stock are prompted by the decline in CPUE from the early 2000s. There is close correspondence in the indices for SCH 5 and SCH 7. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern for both these areas. | |

| **Fishery Interactions** |
|---|
| SCH 7 are caught about one-third each by setnet targeting school shark, rig and spiny dogfish; bottom longline targeting school shark, hapuku/bass and ling; and bottom trawl targeting barracuda, tarakihi, flatfish, hoki, red cod and others. |

## SCH 8

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2011 |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft limit: Unknown<br>Hard Limit: Unlikely (< 40%) to be below. |

**Historical Stock Status Trajectory and Current Status**




**Lognormal indices from the setnet target shark CPUE series for SCH 8**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | The SCH8SN(2011) index remains flat at the long-term average, apart from a drop to lower levels over 1997-98 to 2000-01. The Working Group concluded that the SCH 8 index showed no change in abundance over the series. There is an inverse relationship between the SCH 7 and SCH 8 indices over this period, suggesting a possible shift in stock distribution between these areas. |
| Recent Trend in Fishing Mortality or Proxy | Overfishing is Unlikely (< 40%) to be occurring. |

| **Projections and Prognosis** | | |
|---|---|---|
| Stock Projections or Prognosis | The lack of any trend in the SCH 8 CPUE index indicates the stock size is Likely to remain near current levels under current catches and TACCs. | |
| Probability of Current Catch or TACC causing decline below Limits | Soft Limit: Unknown<br>Hard Limit: Unlikely (< 40%) | |
| **Assessment Methodology** | | |
| Assessment Type | Level 2: Standardised CPUE abundance index, and review of length frequency data. | |
| Assessment Method | Evaluation of agreed standardised CPUE indices thought to index SCH 8 abundance. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries catch reporting.<br>- Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme. | |
| Period of Assessment | Latest assessment: 2011 | Next assessment: 2013 |
| Changes to Model Structure and Assumptions | The 2010 CPUE analysis are updates of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models. | |
| Major Sources of Uncertainty | | |

| **Qualifying Comments** |
|---|
| - |

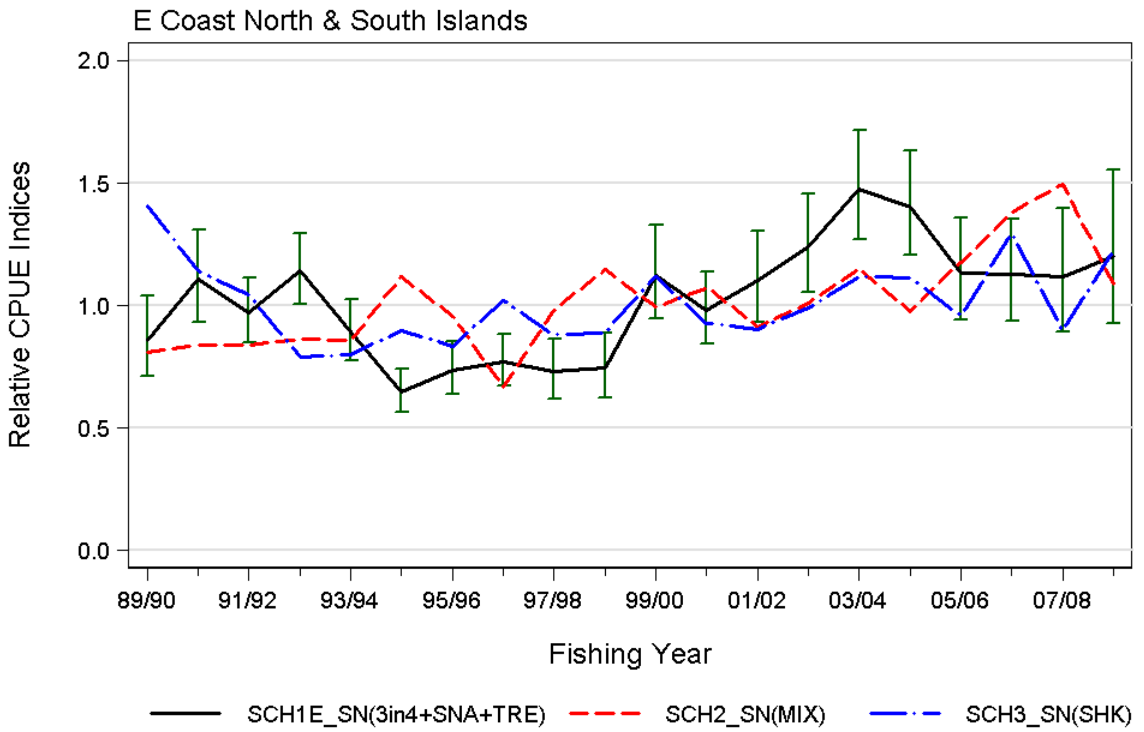
| **Fishery Interactions** |
|---|
| SCH 8 are caught mainly (66%) by setnet targeting school shark and rig; and by bottom longline (22%) targeting school shark and hapuku/bass. Ten percent is caught by bottom trawl targeting gurnard, tarakihi and trevally. |

**Combined SCH Stocks**

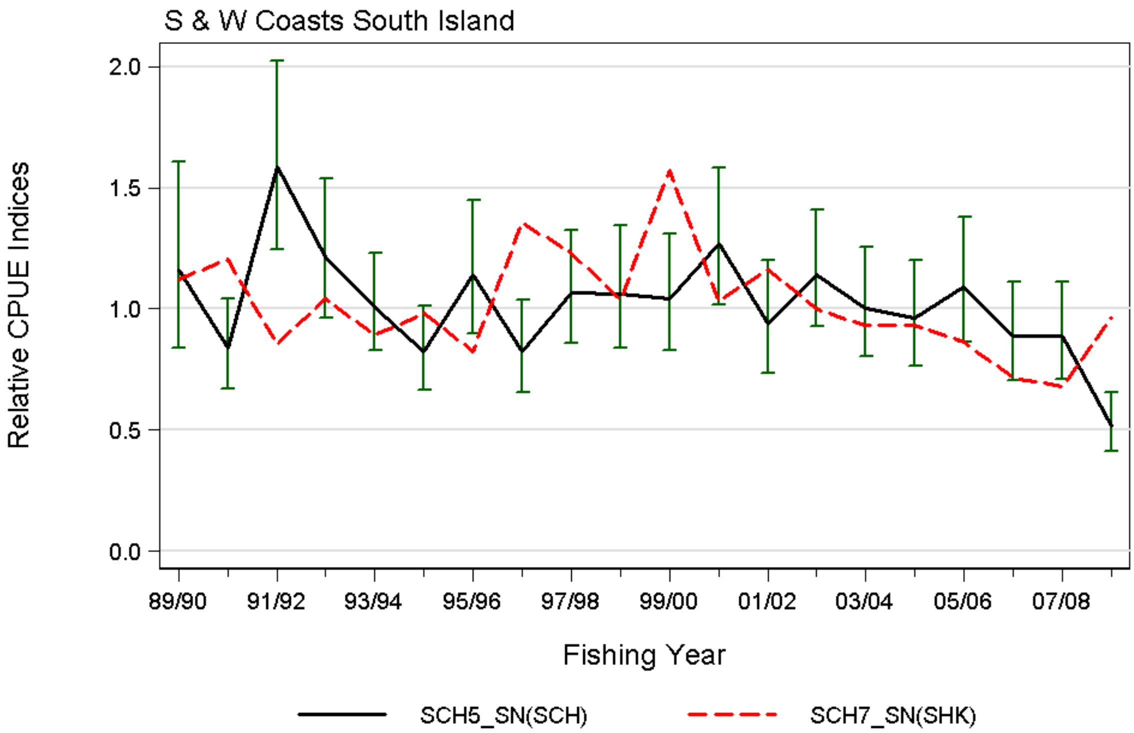
School shark are believed to be a single biological stock around the North and South Islands. It may therefore be appropriate for management responses to be consistent across areas broader than single QMAs.

| **Stock Status** | |
|---|---|
| Year of Most Recent Assessment | 2010; 2011 for SCH 5, 7 and 8 |
| Reference Points | Target: Not established but $B_{MSY}$ assumed<br>Soft Limit: 20% $B_0$<br>Hard Limit: 10% $B_0$ |
| Status in relation to Target | Unknown |
| Status in relation to Limits | Soft limit: Unknown<br>Hard Limit: Unlikely (< 40%) |

**Historical Stock Status Trajectory and Current Status**
SCH 1E, 2 and 3

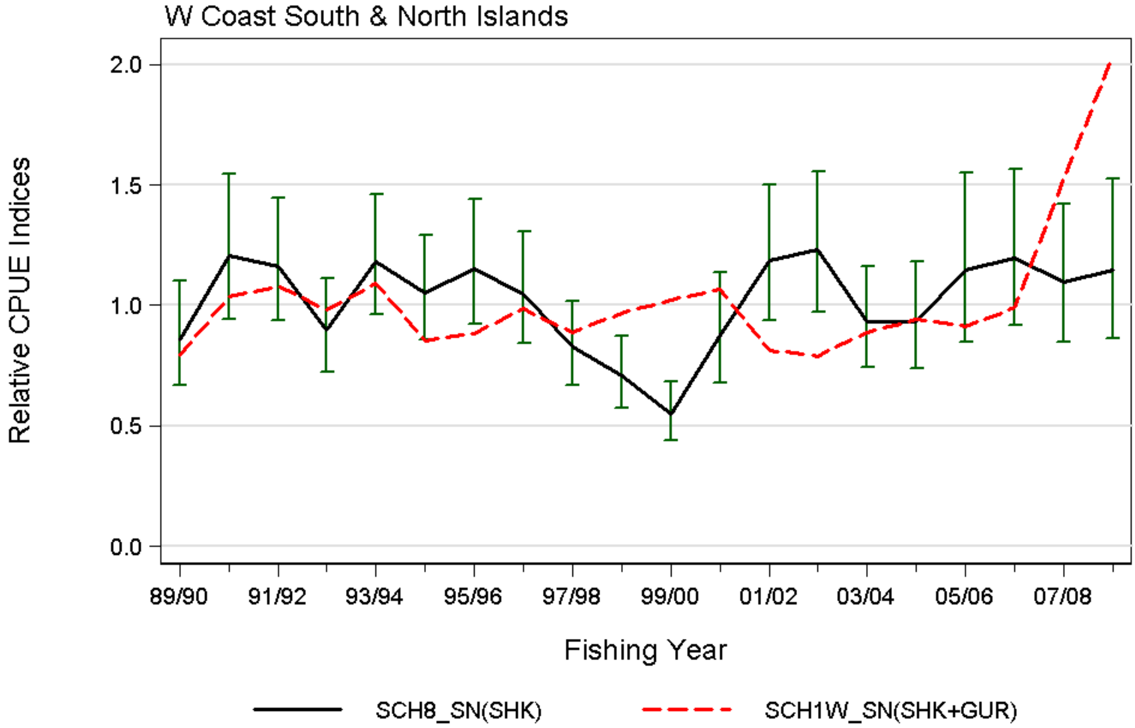



**Comparison of three lognormal indices from a) the SCH 1E setnet series: [SCH 1E_SN(3in4+SNA=TRE)]; b) a setnet series from SCH 2: [SCH2_SN(MIX)]; c) a setnet series from SCH 3: [SCH3_SN(SHK)]**




**Comparison of the selected SCH 5 [SCH5_SN(SCH)] series with the equivalent series selected for the SCH 7 [SCH7_SN(SHK)] CPUE evaluation. Confidence intervals only shown for one series.**

SCH 8 and 1W




**Comparison of the selected SCH 8 [SCH8_SN(SHK)] series with the equivalent series selected for the SCH1W [SCH1W_SN(SHK+GUR)] CPUE evaluation.**

| **Fishery and Stock Trends** | |
|---|---|
| Recent Trend in Biomass or Proxy | There is a close similarity in trends in the indices for 1E, 2 and 3; SCH 5 and SCH 7; and SCH 8 and 1W. The indices show an increase or higher recent CPUE for SCH 1E, 2 and 3; and stable CPUE for SCH 1W and 8; SCH 5 and 7 show CPUE declining. The Working Group noted that SCH 5 and 7 have accounted for 41% of the SCH catch over the past 20 years, and are the areas in which the largest females are caught. SCH 1E, 2 and 3, have accounted for 26% of the SCH catch over the past 20 years. Areas 1W and 8 have accounted for 30% of the catch. |
| Recent Trend in Fishing Mortality or Proxy | Varies among FMAs. |

| **Projections and Prognosis** | |
|---|---|
| Stock Projections or Prognosis | • SCH 1E, 2, 3: Stock size is Likely to remain near current levels or increase under current catches and TACCs.<br>• SCH 1W, 8: Stock size is Likely to remain near current levels under current catches and TACCs.<br>• SCH 5&7: Stock size is Likely to decline under current catches and TACCs. |
| Probability of Current Catch or TACC causing decline below Limits | Combined stocks:<br>Soft Limit: Unknown<br>Hard Limit: Varies among FMAs |

| **Assessment Methodology** | |
|---|---|
| Assessment Type | Level 2: Standardised CPUE abundance index, and length frequency analysis. |
| Assessment Method | Evaluation of a range of agreed standardised CPUE indices |

| | | |
|---|---|---|
| | thought to index abundance of the SCH fishstocks in each FMA. Comparison of length frequencies from SCH 3, 5, 7 and 8. | |
| Main data inputs | - Catch and effort data derived from the Ministry of Fisheries catch reporting.<br>- Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme. | |
| Period of Assessment | Latest assessment: 2010 | Next assessment: 2011 (SCH 5 and 7) and 2013 (SCH 1 , 2, 3 and 8) |
| Changes to Model Structure and Assumptions | In SCH 3, 5, 7 and 8, CPUE indices have been conducted using the same, or similar, models since entry into AMPs. In some areas, additional target species have been added to fishery definitions, particularly for bottom longline indices. New analyses were developed for SCH 1 and 2. Bottom trawl indices previously produced for SCH 1 and 2 were not updated in 2010. | |
| Major Sources of Uncertainty | Recent setnet closures have potentially compromised the continuity of setnet indices for SCH 1W, 3, 5 and 7. | |

| **Qualifying Comments** |
|---|
| See individual Fishstock Status of Stocks summaries. |

| **Fishery Interactions** |
|---|
| SCH are predominantly caught in setnet fisheries targeting sharks (school shark, rig, elephantfish and spiny dogfish); in bottom trwl fisheries targeting red cod, tarakihi, gurnard and snapper and others; and in bottom longline fisheries targeting school shark, hapuku/bass and ling. |

Yield estimates, reported landings and TACCs for the 2010-11 fishing year are summarised in Table 6.

**Table 6: Summary of yield estimates (t), TACCs (t) and reported landings (t) of school shark for the most recent fishing year.**

| Fishstock | | QMA | *MCY* Estimates | 2010-11 Actual TACC | 2010-11 Reported Landings |
|---|---|---|---|---|---|
| SCH 1 | Auckland (East) (West) | 1 & 9 | | 689 | 777 |
| SCH 2 | Central (East) | 2 | | 199 | 187 |
| SCH 3 | South-east (Coast) | 3 | | 387 | 366 |
| SCH 4 | South-east (Chatham) | 4 | | 239 | 174 |
| SCH 5 | Southland and Sub-Antarctic | 5 & 6 | | 743 | 701 |
| SCH 7 | Challenger | 7 | | 641 | 677 |
| SCH 8 | Central (West) | 8 | | 529 | 587 |
| SCH 10 | Kermadec | 10 | | 10 | 0 |
| Total | | | | 3 436 | 3 469 |

## 6. FOR FURTHER INFORMATION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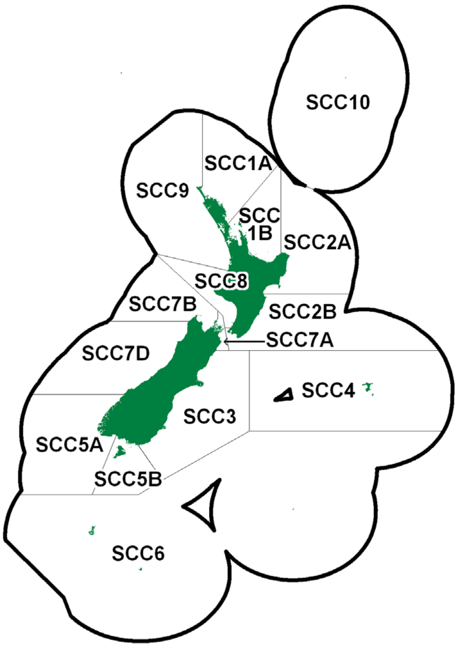
# SEA CUCUMBER (SCC)

(*Stichopus mollis*)




## 1. FISHERY SUMMARY

Sea cucumbers were introduced into Quota Management System on 1 April 2004. The fishing year is from 1 April to 31 March. A breakdown of each QMAs Total Allowable Catch (TAC) is listed in Table 1. Each TAC is made up of a total allowed commercial catch (TACC), customary, and recreational allocation and has remained unchanged since entering the QMS.

### 1.1 Commercial fisheries

More than 100 species of sea cucumber are found in New Zealand waters, but *Stichopus mollis* is the only species of commercial value, and the only species for which exploratory commercial fishing has taken place. Sea cucumbers are currently targeted only by diving but they are also a common bycatch of bottom trawl and scallop dredge fisheries. Sea cucumber landings of all species are reported as a single code (SCC), although most reported landings are probably *S. mollis,* as other species have no commercial value.

**Table 1: Recreational and customary non-commercial allowances (t), Total Allowable Commercial Catches (TACC, t) and Total Allowable Catch (TAC, t) as declared for SCC on introduction into the QMS in October 2004.**

| Fishstock | Recreational Allowance | Customary non-commercial Allowance | TACC | TAC |
|---|---|---|---|---|
| SCC 1A | 3 | 2 | 2 | 7 |
| SCC 1B | 4 | 2 | 2 | 8 |
| SCC 2A | 1 | 1 | 2 | 4 |
| SCC 2B | 4 | 2 | 5 | 11 |
| SCC 3 | 2 | 1 | 2 | 5 |
| SCC 4 | 1 | 1 | 2 | 4 |
| SCC 5A | 1 | 1 | 2 | 4 |
| SCC 5B | 1 | 1 | 2 | 4 |
| SCC 6 | 0 | 0 | 0 | 0 |
| SCC7A | 2 | 1 | 5 | 8 |
| SCC 7B | 2 | 1 | 5 | 8 |
| SCC 7D | 1 | 1 | 2 | 4 |
| SCC 8 | 1 | 1 | 2 | 4 |
| SCC 9 | 1 | 1 | 2 | 4 |
| SCC 10 | 0 | 0 | 0 | 0 |
| TOTAL | 24 | 16 | 35 | 75 |

**Table 2: TACCs and reported landings (t) of Sea cucumber by Fishstock from 1990-91 to 2011-12 from CELR and TCEPR data. Until 2003-04 QMAs are the same as FMAs, since when FMAs 1, 2, 5, and 7 were subdivided. These landings are reported in the 2nd and 3rd parts of this table.**

| | SCC 1 | | SCC 2 | | SCC 3 | | SCC 4 | |
|---|---|---|---|---|---|---|---|---|
| Fishstock | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1998-99 | 0 | - | 0 | - | 0.032 | - | 0 | - |
| 1999-00 | 0 | - | 0 | - | 0.04 | - | 0.01 | - |
| 2000-01 | 0.037 | - | 0 | - | 0.652 | - | 0.001 | - |
| 2001-02 | 0.16 | - | 0.012 | - | 1.005 | - | 1.683 | - |
| 2002-03 | 0.39 | - | 0.365 | - | 4.616 | - | 0.92 | - |
| 2003-04 | 0.07 | N/A | N/A | N/A | 3.785 | 2 | 0.115 | 2 |
| 2004-05 | N/A | N/A | N/A | N/A | 1.136 | 2 | 0.4 | 2 |
| 2005-06 | N/A | N/A | N/A | N/A | 2.853 | 2 | 0 | 2 |
| 2006-07 | N/A | N/A | N/A | N/A | 2.699 | 2 | 0.004 | 2 |
| 2007-08 | N/A | N/A | N/A | N/A | 3.673 | 2 | 0 | 2 |
| 2008-09 | N/A | N/A | N/A | N/A | 3.795 | 2 | 0 | 2 |
| 2009-10 | N/A | N/A | N/A | N/A | 0.366 | 2 | 0.009 | 2 |
| 2010-11 | N/A | N/A | N/A | N/A | 0.780 | 2 | 0.009 | 2 |
| 2011-12 | N/A | N/A | N/A | N/A | 3.397 | 2 | 0.004 | 2 |

| | SCC 1A | | SCC 1B | | SCC 2A | | SCC 2B | | SCC 5A | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fishstock | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 2003-04 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 2 |
| 2004-05 | 0 | 2 | 1.503 | 2 | 0 | 2 | 0 | 5 | 0.005 | 2 |
| 2005-06 | 0 | 2 | 1.429 | 2 | 0 | 2 | 0 | 5 | 0 | 2 |
| 2006-07 | 0 | 2 | 2.089 | 2 | 0 | 2 | 0 | 5 | 0 | 2 |
| 2007-08 | 0.120 | 2 | 2.176 | 2 | 0 | 2 | 0 | 5 | 0 | 2 |
| 2008-09 | 0.122 | 2 | 0.531 | 2 | 0 | 2 | 0 | 5 | 0.001 | 2 |
| 2009-10 | 0.176 | 2 | 1.780 | 2 | 0 | 2 | 0.190 | 5 | 0 | 2 |
| 2010-11 | 0.012 | 2 | 1.403 | 2 | 0 | 2 | 0.047 | 5 | 0 | 2 |
| 2011-12 | 1.468 | 2 | 2.013 | 2 | 0 | 2 | 0.666 | 5 | 0.307 | 2 |

| | SCC 5B | | SCC 7A | | SCC 7B | | SCC7D | | SCC6 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fishstock | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 2003-04 | 0.005 | 2 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 0 |
| 2004-05 | 0.102 | 2 | 3.194 | 5 | 1.076 | 5 | 0 | 2 | 5 | 0 |
| 2005-06 | 0.002 | 2 | 5.467 | 5 | 0.122 | 5 | 0 | 2 | 0.310 | 0 |
| 2006-07 | 0 | 2 | 0.17 | 5 | 0.04 | 5 | 0 | 2 | 0 | 0 |
| 2007-08 | 0.004 | 2 | 8.341 | 5 | 0 | 5 | 0.023 | 2 | 0 | 0 |
| 2008-09 | 0.018 | 2 | 4.190 | 5 | 0 | 5 | 0 | 2 | 0.011 | 0 |
| 2009-10 | 0 | 2 | 4.314 | 5 | 1.357 | 5 | 0 | 2 | 0 | 0 |
| 2010-11 | 0.014 | 2 | 5.086 | 5 | 5.458 | 5 | 0 | 2 | 0 | 0 |
| 2011-12 | 0.366 | 2 | 4.768 | 5 | 4.700 | 5 | 2.146 | 2 | 0.042 | 0 |

**Table 2 Continued :**

| | SCC 9 | | SCC 10 | | Total | |
|---|---|---|---|---|---|---|
| Fishstock | Landings | TACC | Landings | TACC | Landings | TACC |
| 1990-91 | 0 | - | 0 | - | 4.653+ | - |
| 1991-92 | 0 | - | 0 | - | 3.843+ | - |
| 1992-93 | 0 | - | 0 | - | 0.682+ | - |
| 1993-94 | 0 | - | 0 | - | 2.5+ | - |
| 1994-95 | 0 | - | 0 | - | 2.41+ | - |
| 1995-96 | 0 | - | 0 | - | 2.679+ | - |
| 1996-97 | 0 | - | 0 | - | 1.415+ | - |
| 1997-98 | 0.05 | - | 0 | - | 0.148 | - |
| 1998-99 | 0 | - | 0 | - | 0.032 | - |
| 1999-00 | 0 | - | 0 | - | 0.052 | - |
| 2000-01 | 0 | - | 0 | - | 1.659 | - |
| 2001-02 | 0 | - | 0 | - | 8.954 | - |
| 2002-03 | 0 | - | 0 | - | 16.847* | - |
| 2003-04 | 0 | 2 | 0 | 0 | 21.861 | 35 |
| 2004-05 | 0.016 | 2 | 0 | 0 | 12.213 | 35 |
| 2005-06 | 0 | 2 | 0 | 0 | 10.183 | 35 |
| 2006-07 | 0.01 | 2 | 0 | 0 | 5.012 | 35 |
| 2007-08 | 0.001 | 2 | 0 | 0 | 14.315 | 35 |
| 2008-09 | 0.074 | 2 | 0 | 0 | 8.731 | 35 |
| 2009-10 | 0.029 | 2 | 0 | 0 | 8.221 | 35 |
| 2010-11 | 0.137 | 2 | 0 | 0 | 12.946 | 35 |
| 2011-12 | 0.141 | 2 | 0 | 0 | 20.249 | 35 |

*In 2002-03 50 kg were reportedly landed, but the QMA is not recorded. This amount is included in the total landings for that year.

+In 1990-1997, catch was reported, but no QMA was, therefore only the total is shown.

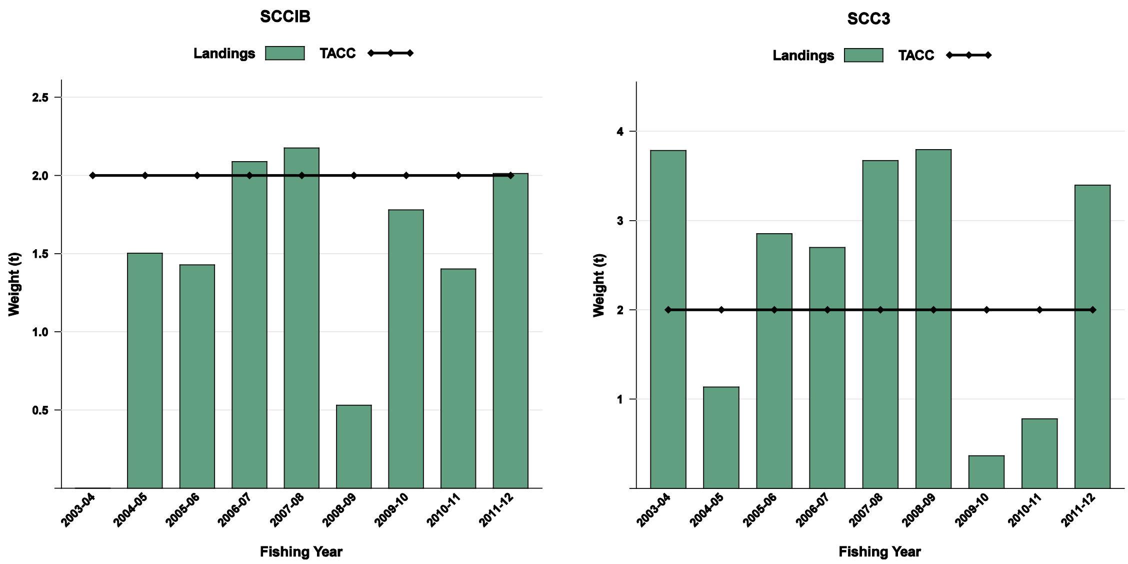



**Figure 1: From Top Left: Historical landings and TACC for SCC1B (Hauraki Gulf, Bay of Plenty) and SCC3 (South East Coast). Note that these figures do not show data prior to entry into the QMS.**

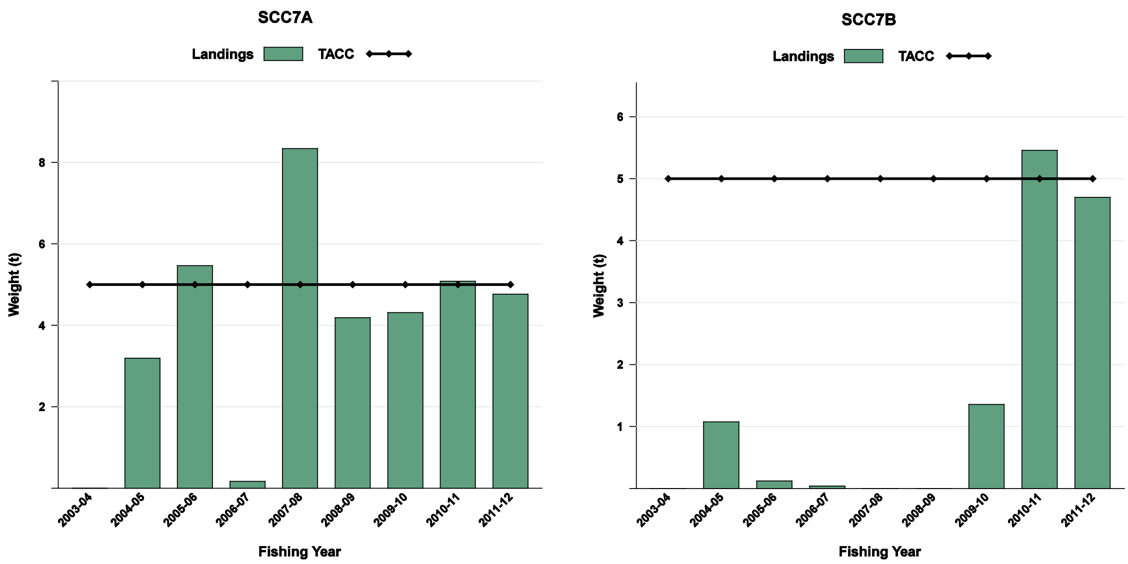



**Figure 1 [Continued]: From Top Left: Historical landings and TACC for SCC7A (Challenger Marlborough Sounds) and SCC7B (Challenger Nelson). Note that these figures do not show data prior to entry into the QMS.**

Between 1990 and 2001 about 45% of the catch was taken as bycatch in scallop dredging in Tasman and Golden Bays. About 13% was taken as bycatch in bottom trawling around the Auckland Islands, and about 38% was taken by diving. The remainder of the bycatch has been reported from mid-water trawls, rock lobster pots and bottom longlining.

Reported landings have generally been small except for the period between 2001-2002 and 2005-2006, when they ranged between about 9 and 22 t (Table 2). Most of this catch was bycatch from bottom trawling in SSC 6. The catches taken by diving were from Fisheries Statistical Area 31 (Fiordland) in 1990-91 (when a special permit was being operated) and 1995-96. The historical landings and TACC for the main SCC stocks are depicted in Figure 1.

## 1.2 Recreational fisheries

Recreational fishing surveys indicate that sea cucumbers are not caught by recreational fishers. It is likely that members of the Asian community harvest sea cucumber, but their fishing activity is poorly represented in the recreational surveys.

### 1.3 Customary non-commercial fisheries
There is no documented customary non-commercial use of sea cucumbers.

### 1.4 Illegal catch
There is no known illegal catch of sea cucumbers.

### 1.5 Other sources of mortality
There is no quantitative information on other sources of mortality, although sea cucumbers are often taken as a bycatch in bottom trawl and dredge fisheries.

## 2. BIOLOGY

*Stichopus mollis* is distributed throughout New Zealand, and as far south as the Snares Islands. It also occurs off west and south Australia. It is found in shallow water between 5 and 40 m in a wide range of habitats from rocky shores to sandy bottoms. It is common in north-east New Zealand, Fiordland, the Marlborough Sounds, and Stewart Island, and displays a preference for sheltered coastline with complex and diverse habitats. *S. mollis* is less common on exposed coasts, but if present, tends to be in deeper water.

Sea cucumbers are mobile and form part of the benthic epifaunal community where they are detritus feeders. If disturbed, they can eviscerate their entire gut which can then be regenerated. They tend to be sedentary in suitable habitat, but are able to move away relatively quickly if stressed.

Little is known about the biology of *S. mollis.* They have an annual reproductive cycle, spawning between November and February. The sexes are separate and develop synchronously. They are broadcast spawners, eggs and sperm are released into the water column, and following fertilization, they undergo a 3 to 4 week larval phase before settlement. Populations from sheltered areas such as fiords and sheltered bays may be largely ‘self seeding’, while larvae released on open coasts may disperse more widely.

There is some evidence that recruitment and growth are both patchy and variable. Recruited fish appear in the adult population at about 10–12 cm (40–60 g) and adults grow to about 18–20 cm (180 g). During an exploratory fishing survey in Fiordland (SCC5A) in 1989, divers observed small *S. mollis* under rubble, suggesting that pre-recruit sea cucumbers may have different habitat preferences to adults. By contrast, comprehensive surveying in the Mahurangi harbour (SCC1B) showed the substratum at sites with high densities of juveniles to be dominated by silt and mud with large shell fragments (>10 cm) of the horse mussel *Atrina zelandica* (Morrison 2000). The restricted distribution of juveniles at this locality was shown to be unrelated to sediment type, and theorized to be a consequence of localised effects such as predation or larval settlement (Slater & Jeffs 2010). Caging studies comparing growth at different densities underneath and away from a Coromandel mussel farm (SCC1B) showed growth ranged from a 15.4% increase in weight over 6 months, at a density of 2.5 per $m^2$ under a mussel farm, to a 13.9% decrease in weight over 2 months, at a density of 15 per $m^2$ away from the mussel farm (Slater & Carton 2007). Age at maturity is thought to be about 2 years, and the life span of *S. mollis* is thought to be between 5 and 15 years.

## 3. STOCKS AND AREAS

The management of sea cucumbers is based on 15 QMAs, which are a combination of existing and sub-divided FMAs. Although there is currently little biological or fishery information which could be used to identify stock boundaries, the QMAs recognise that sea cucumbers are a sedentary shallow water species, and that many sheltered populations may be isolated and vulnerable to localised depletion. Finer scale QMAs therefore provide a mechanism whereby stocks can be managed more appropriately. Also, because it is likely that the same group of commercial fishers will be targeting kina and sea cucumbers, and because there are some similarities in their respective habitats, the QMAs for sea cucumber are the same as those for kina.

# 4. STOCK ASSESSMENT

## 4.1 Estimates of fishery parameters and abundance

There are no estimates of fishery parameters or abundance for any sea cucumber fishstock.

## 4.2 Biomass estimates

There are no biomass estimates for any sea cucumber fishstock, although estimates exist for some discrete areas. For Fiordland, crude biomass estimates of 59, 89, 97 and 134 t for Thompson, Bradshaw, Charles and Doubtful Sounds respectively are reported by Mladenov & Gerring (1991), and Mladenov & Campbell (1998). Their survey did not include the outer coastline, but extrapolating to all fiords between Puysegur Point and Cascade Point, they estimate a total biomass of 1937 t in the 0 to 20 m depth range.

## 4.3 Estimation of Maximum Constant Yield (*MCY*)

There are no estimates of *MCY* for any sea cucumber fishstock.

## 4.4 Estimation of Current Annual Yield (*CAY*)

There are no estimates of *CAY* for any sea cucumber fishstock.

# 5. STATUS OF THE STOCKS

There are no estimates of reference or current biomass for any sea cucumber fishstock.

# 6. FOR FURTHER INFORMATION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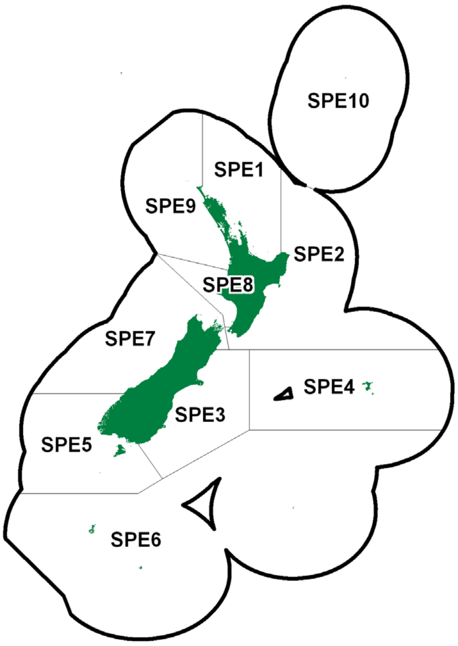
# SEA PERCH (SPE)

(*Helicolenus percoides*)
Pohuiakaroa




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

Sea perch was introduced into the QMS from 1 October 1998. From 1 October 2000 the TACC for SPE 3 was increased to 1000 t under the Adaptive Management Programme (AMP). The TACC for SPE 4 was increased from 533 t to 910 t from 1 October 2004 under the low knowledge bycatch framework, and from 1 October 2006 the TACC for SPE 1 was increased from 18 to 33 t. In SPE 1 landings were above the TACC for a number of years and the TACC has been increased to the average of the previous 7 years plus an additional 10%. Current TACCs and allowances for non-commercial fishers are displayed in Table 1, while the historical landings and TACC values for the four major SPE stocks are depicted in Figure 1.

Very small quantities of sea perch have been landed for local sale for many years, but are largely unreported. Catches have been made by foreign vessels since the 1960s, but were also not recorded (they were most probably included within a “mixed” or “other finfish” category), and most were probably discarded. Despite poor reporting rates, estimated landings are thought to have increased from 400 t in the early 1980s to approximately 2000 t in recent years; an unknown quantity has been discarded over this period.

**Table 1: Recreational and customary non-commercial allowances and Current TACCs, by Fishstock, for sea perch.**

| | Recreational | Customary non-commercial | Other sources | TACC | TAC |
|---|---|---|---|---|---|
| SPE 1 | 1 | 1 | 0 | 33 | 35 |
| SPE 2 | 9 | 5 | 0 | 79 | 93 |
| SPE 3 | 11 | 11 | 0 | 1 000 | 1 022 |
| SPE 4 | 0 | 0 | 46 | 910 | 956 |
| SPE 5 | 1 | 1 | 0 | 36 | 38 |
| SPE 6 | 0 | 0 | 0 | 9 | 9 |
| SPE 7 | 8 | 8 | 0 | 82 | 98 |
| SPE 8 | 4 | 2 | 0 | 15 | 21 |
| SPE 9 | 1 | 1 | 0 | 6 | 8 |
| SPE 10 | 0 | 0 | 0 | 0 | 0 |
| Total | 34 | 21 | 46 | 2 155 | 2280 |

About 75% of New Zealand's landed sea perch is taken as a bycatch in trawl fisheries off the east coast of the South Island, including the Chatham Rise. A small catch is made in some central and southern line fisheries, e.g., for groper.

Recent reported landings of sea perch by QMAs are shown in Table 2. The most important QMAs in most years are QMA 3 (east coast South Island) and QMA 4 (Chatham Rise).

The catch from SPE 3 is spread throughout the fishing year. There is a variable seasonal distribution between years. A higher proportion of the catch is taken during April, May and September and catches are lower from December to February, and in July. Most of the SPE 3 catch is taken as a bycatch from the red cod (~30 %) and hoki fisheries (15%) and from the sea perch target fishery (21%). The remainder is taken as a bycatch from the target barracouta, flatfish, ling, squid and tarakihi fisheries. Virtually all the SPE 3 catch is taken by bottom trawling, with a small proportion taken by bottom longline. SPE 3 catch rates are highest between 150-400 m depth.

The trawl fisheries operating in SPE 4 catch sea perch along the northern and southern edge of the Chatham Rise between 200 and 700 m depth. The majority of the SPE 4 catch is taken as a bycatch of the hoki target fishery (~ 59%), with the ling and hake fisheries accounting for around 25% and 10% of the total SPE 4 catch, respectively.

**Table 2: Reported landings (t) of sea perch by fishstock and fishing year, 1983-84 to 2010-11. The data in this table have been updated from that published in previous Plenary Reports by using the data through 1996-97 in table 38 on p. 278 of the "Review of Sustainability Measures and Other Management Controls for the 1998-99 fishing year - Final Advice Paper" dated 6 August 1998.**

| Fishstock | SPE 1 | | SPE 2 | | SPE 3 | | SPE 4 | | SPE 5 & 6 | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA | 1 | | 2 | | 3 | | 4 | | 5 &6 | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84 | 14 | - | 2 | - | 150 | - | 58 | - | 36 | - |
| 1984-85 | 10 | - | 2 | - | 290 | - | 70 | - | 26 | - |
| 1985-86 | 14 | - | 2 | - | 213 | - | 218 | - | 28 | - |
| 1986-87 | 19 | - | 2 | - | 507 | - | 71 | - | 19 | - |
| 1987-88 | 20 | - | 1 | - | 544 | - | 63 | - | 18 | - |
| 1988-89 | 14 | - | 1 | - | 262* | - | 36 | - | 18 | - |
| 1989-90 | 2 | - | 6 | - | 287* | - | 177 | - | 9 | - |
| 1990-91 | 5 | - | 9 | - | 559* | - | 68 | - | 33 | - |
| 1991-92 | 12 | - | 8 | - | 791* | - | 222 | - | 36 | - |
| 1992-93 | 15 | - | 15 | - | 783* | - | 317 | - | 55 | - |
| 1993-94 | 16 | - | 26 | - | 690* | - | 223 | - | 28 | - |
| 1994-95 | 25 | - | 66 | - | 626* | - | 415 | - | 18 | - |
| 1995-96 | 23 | - | 50 | - | 1 047* | - | 404 | - | 62 | - |
| 1996-97 | 19 | - | 77 | - | 655* | - | 435 | - | 45 | - |
| 1997-98 | 24 | - | 54 | - | 913 | - | 656 | - | 29 | - |
| 1998-99 | 21 | 18 | 79 | 79 | 903 | 738 | 872 | 533 | 27 | 45 |
| 1999-00 | 27 | 18 | 82 | 79 | 862 | 738 | 821 | 533 | 28 | 45 |
| 2000-01 | 25 | 18 | 81 | 79 | 798 | 738 | 840 | 533 | 19 | 45 |
| 2001-02 | 41 | 18 | 89 | 79 | 720 | 1 000 | 910 | 533 | 22 | 45 |
| 2002-03 | 19 | 18 | 78 | 79 | 696 | 1 000 | 1 685 | 533 | 25 | 45 |
| 2003-04 | 30 | 18 | 80 | 79 | 440 | 1 000 | 1 287 | 533 | 28 | 45 |
| 2004-05 | 27 | 18 | 104 | 79 | 372 | 1 000 | 894 | 910 | 24 | 45 |
| 2005-06 | 40 | 18 | 73 | 79 | 436 | 1 000 | 502 | 910 | 24 | 45 |
| 2006-07 | 30 | 33 | 98 | 79 | 519 | 1 000 | 591 | 910 | 31 | 45 |
| 2007-08 | 38 | 33 | 91 | 79 | 422 | 1 000 | 568 | 910 | 20 | 45 |
| 2008-09 | 27 | 33 | 46 | 79 | 328 | 1 000 | 338 | 910 | 13 | 45 |
| 2009-10 | 47 | 33 | 53 | 79 | 428 | 1 000 | 345 | 910 | 21 | 45 |
| 2010-11 | 53 | 33 | 83 | 79 | 644 | 1 000 | 572 | 910 | 24 | 45 |

## 1.2 Recreational fisheries

Sea perch are seldom targeted by recreational fishers, but are caught in large numbers. Some are used for bait, but most are probably discarded.

Three recreational fishing surveys were carried out by the Ministry of Fisheries in the 1990s (Table 3). However, because of identification problems and incomplete records, recreational fishing surveys probably do not provide good estimates of the recreational sea perch catch. The highest reported recreational catch of sea perch during these surveys was from QMAs 2, 3 and 7.

**Table 2 [Continued].**

| Fishstock | SPE 7 | | SPE 8 | | SPE 9 | | SPE 10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA | 7 | | 8 | | 9 | | 10 | | Total | |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84 | 16 | - | 2 | - | 55 | - | 0 | - | 0 | - |
| 1984-85 | 14 | - | 1 | - | 2 | - | 0 | - | 0 | - |
| 1985-86 | 12 | - | 2 | - | 4 | - | 0 | - | 0 | - |
| 1986-87 | 11 | - | 3 | - | 1 | - | 0 | - | 0 | - |
| 1987-88 | 8 | - | 6 | - | 0 | - | 0 | - | 0 | - |
| 1988-89 | 5 | - | 2 | - | 1 | - | 0 | - | 0 | - |
| 1989-90 | 14 | - | 1 | - | 0 | - | 0 | - | 0 | - |
| 1990-91 | 28 | - | 1 | - | 0 | - | 0 | - | 0 | - |
| 1991-92 | 20 | - | 2 | - | 0 | - | 0 | - | 0 | - |
| 1992-93 | 71 | - | 18 | - | 0 | - | 2 | - | 2 | - |
| 1993-94 | 52 | - | 10 | - | 0 | - | 0 | - | 0 | - |
| 1994-95 | 67 | - | 7 | - | 0 | - | 0 | - | 0 | - |
| 1995-96 | 78 | - | 7 | - | 1 | - | 0 | - | 0 | - |
| 1996-97 | 64 | - | 7 | - | 1 | - | < 1 | - | 1 310 | - |
| 1997-98 | 118 | - | 5 | - | 7 | - | < 1 | - | 1 808 | - |
| 1998-99 | 109 | 82 | < 1 | 15 | 2 | 6 | 0 | 0 | 2 014 | 1 516 |
| 1999-00 | 80 | 82 | 2 | 15 | 5 | 6 | 0 | 0 | 1 907 | 1 516 |
| 2000-01 | 80 | 82 | 4 | 15 | 3 | 6 | 0 | 0 | 1 853 | 1 778 |
| 2001-02 | 95 | 82 | 6 | 15 | 3 | 6 | 0 | 0 | 1 888 | 1 778 |
| 2002-03 | 103 | 82 | 4 | 15 | 4 | 6 | 0 | 0 | 2 619 | 1 778 |
| 2003-04 | 95 | 82 | 6 | 15 | 3 | 6 | 0 | 0 | 1 972 | 1 778 |
| 2004-05 | 47 | 82 | 5 | 15 | 2 | 6 | 0 | 0 | 1 475 | 2 155 |
| 2005-06 | 75 | 82 | 5 | 15 | 2 | 6 | 0 | 0 | 1 157 | 2 155 |
| 2006-07 | 67 | 82 | 2 | 15 | 2 | 6 | 0 | 0 | 1 338 | 2 170 |
| 2007-08 | 103 | 82 | 2 | 15 | 2 | 6 | 0 | 0 | 1 247 | 2 170 |
| 2008-09 | 96 | 82 | 2 | 15 | 4 | 6 | 0 | 0 | 854 | 2 170 |
| 2009-10 | 117 | 82 | 4 | 15 | 3 | 6 | 0 | 0 | 1 016 | 2 170 |
| 2010-11 | 124 | 82 | 3 | 15 | 2 | 6 | 0 | 0 | 1 506 | 2 170 |

*These numbers may contain erroneous landings data, the situation is currently under investigation and the data will be amended if an error is identified during the course of that investigation.

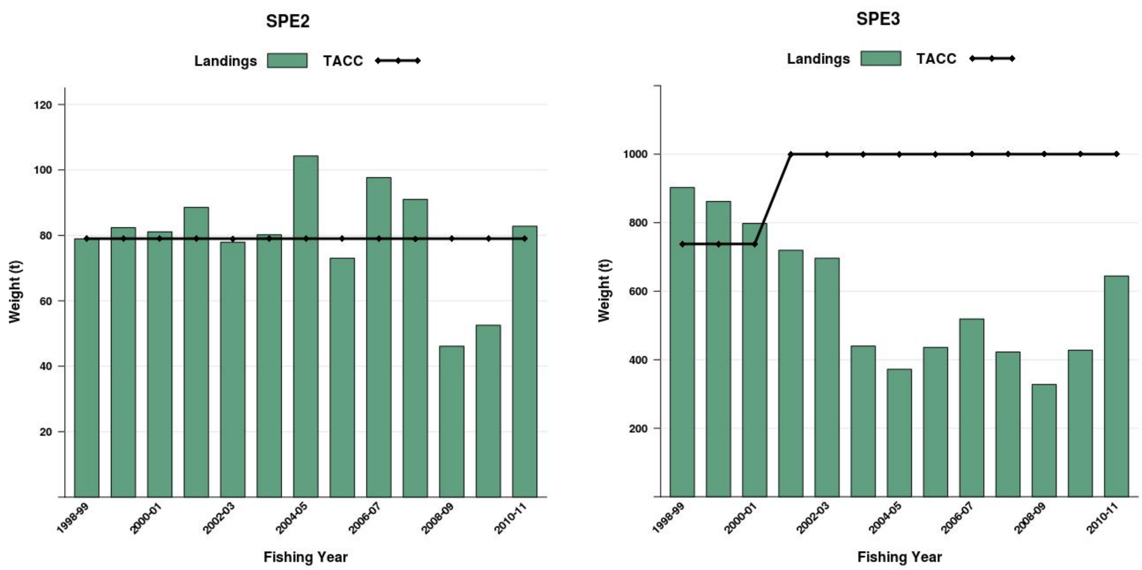



**Figure 1: Historical landings and TACC for the four main SPE stocks. From left to right: SPE2 (Central East) and SPE3 (South East Coast). Note that these figures do not show data prior to entry into the QMS.**

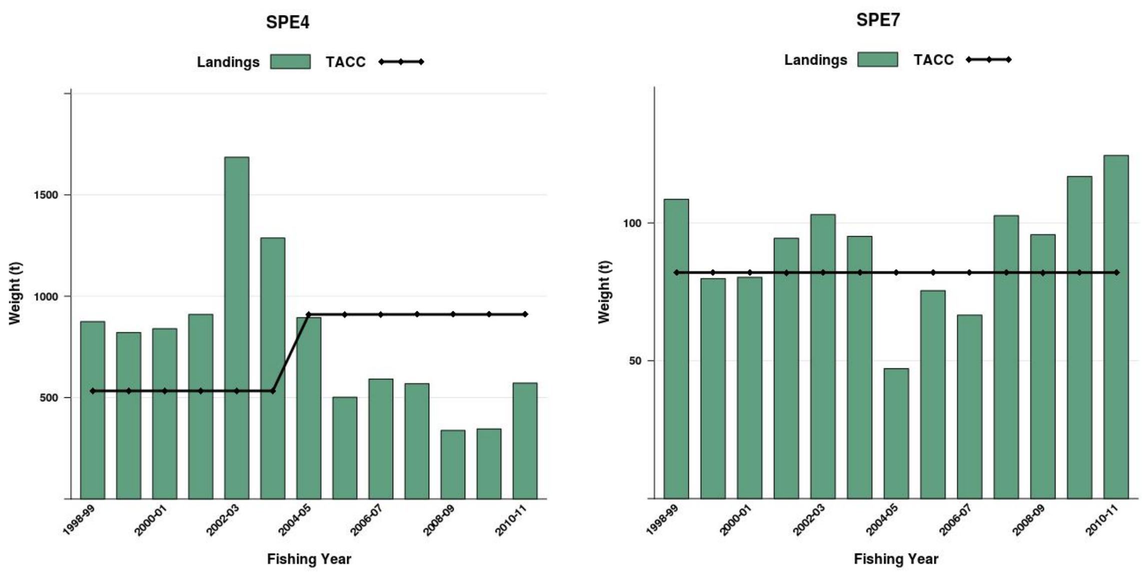



**Figure 1 [Continued]: Historical landings and TACC for the four main SPE stocks. From left to right: SPE4 (South East Chatham Rise) and SPE7 (Challenger). Note that these figures do not show data prior to entry into the QMS.**

**Table 3: Estimated number and weight of sea perch harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991-92, Central in 1992-93, North in 1993-94 (Teirney *et al.* 1997) and nationally in 1996 (Bradford, 1998) and 1999-00 (Boyd & Reilly 2005).**

| Fishstock | Survey | Number | CV% |
|---|---|---|---|
| 1991-92 | | | |
| SPE 3 | South | 110 000 | 25 |
| SPE 5 | South | 18 000 | 35 |
| SPE 7 | South | 16 000 | - |
| 1992-93 | | | |
| SPE 2 | Central | 27 000 | - |
| SPE 3 | Central | < 500 | - |
| SPE 5 | Central | < 500 | - |
| SPE 7 | Central | 65 000 | 40 |
| SPE 8 | Central | 11 000 | - |
| 1993-94 | | | |
| SPE 1 + 9 | North | < 500 | - |
| SPE 2 | North | < 500 | - |
| SPE 8 | North | < 500 | - |
| 1996 | | | |
| SPE 1 + 9 | National | 2000 | 37 |
| SPE 2 | National | 23 000 | - |
| SPE 3 | National | 28 000 | 17 |
| SPE 5 | National | 3000 | - |
| SPE 7 | National | 20 000 | 17 |
| SPE 8 | National | 11 000 | - |
| 1999-00 | | | |
| SPE 2 | National | 10 000 | 94 |
| SPE 2 | National | 16 000 | 64 |
| SPE 3 | National | 154 000 | 38 |
| SPE 5 | National | 10 000 | 58 |
| SPE 7 | National | 63 000 | 46 |
| SPE 8 | National | < 500 | 101 |

A key component of estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Technical Working Group concluded that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and, c) the 2000 and 2001 estimates are implausibly high for many important fisheries. The 1999-2000 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

### 1.3 Customary non-commercial fisheries
The customary non-commercial take has not been quantified.

### 1.4 Illegal catch
There is no quantitative information on illegal fishing activity or catch, and given the low commercial value of sea perch, such activity is unlikely.

### 1.5 Other sources of mortality
No quantitative estimates are available about the impact of other sources of mortality on sea perch stocks. However, they are commonly caught as bycatch and a moderate quantity, particularly of small fish, is undoubtedly discarded.

## 2. BIOLOGY

Sea perch are widely distributed around most of New Zealand, but are rare on the Campbell Plateau. They inhabit waters ranging from the shoreline to 1200 m and are most common between 150 and 500 m. Previously it was believed that there were two species of sea perch, *H. percoides* and *H. barathri* in New Zealand waters. However, genetics research determined that there is probably only one species of sea perch in New Zealand waters, *H. percoides* (Smith 1998). Because of confusion between *H. percoides* and *H. barathri* until recent years, there is limited information on sea perch biology. Trawl surveys from about 1990 show sea perch size to vary with depth and locality without an obvious pattern, possibly representing population differences as well as life history characteristics.

Sea perch are viviparous, extruding small larvae in floating jelly-masses during an extended spawning season. Sex ratios observed in trawl survey samples show more males, generally in the ratio 1:0.7 to 1:0.8. Sea perch are opportunistic feeders and prey on a variety of animals on or close to the seafloor.

**Table 4: Estimates of biological parameters for sea perch.**

| Fishstock | | | | | | Estimate | Source |
|---|---|---|---|---|---|---|---|
| 1. Natural mortality (*M*) | | | | | | | |
| SPE 3 | | | | | | 0.10-0.13 (Hoenig method) | Paul & Francis (2002) |
| SPE 3 | | | | | | 0.07-0.09 (Chapman Robson estimator) | Paul & Francis (2002) |
| 2. Weight = a (length)$^b$ (Weight in g, length in cm fork length) | | | | | | | |
| | | | | | | Both sexes | |
| | | | a | | | b | |
| SPE 3 | | | 0.007767 | | | 3.219132 | Schofield & Livingston (1996) |
| 3. von Bertalanffy growth parameters | | | | | | | |
| | | | Females | | | Males | |
| | $K$ | $t_0$ | $L_\infty$ | $K$ | $t_0$ | $L_\infty$ | |
| ECSI 1996 | 0.128 | -0.725 | 40.7 | 0.117 | -0.64 | 43.6 | Paul & Francis (2002) |
| ECSI 2000 | 0.13 | -0.895 | 37.9 | 0.116 | -0.956 | 42.4 | Paul & Francis (2002) |

Growth is relatively slow throughout life. After about age 5 years, males appear to grow faster than females (there is some uncertainty due to small sample sizes). Males mature at 19-25 cm, about 5–7 years, whereas females mature at between 15 and 20 cm, around 5 years (Paul & Francis 2002). Maximum observed ages estimated for sea perch from the east coast South Island and Chatham Rise were 32 and 43 years. The natural mortality estimates derived from these are 0.13 and 0.10 (using the Hoenig method) and 0.07–0.09 (using the Chapman-Robson estimator) (Paul & Francis 2002). Ageing studies have not identified the species involved, but the maximum age of Australian fish listed as

*H. percoides* by Withell & Wankowski (1988), is about 40 years. The maximum size for sea perch is about 56 cm.

Biological parameters relevant to stock assessment are shown in Table 4.

# 3. STOCKS AND AREAS

There are no data relevant to stock boundaries. However, regional variation in colouration suggests that separate populations could exist.

# 4. STOCK ASSESSMENT

## 4.1 Estimates of fishery parameters and abundance

Estimates of relative abundance from trawl surveys are presented in Table 5. Annual biomass estimates from the winter and summer east coast South Island and Southland surveys have been variable between years, and were determined with only moderate precision (generally CVs around 30%).

The time series of biomass estimates from the West Coast South Island surveys increased between 1992 and 1995 and declined substantially from 667 t in the subsequent surveys. The 2005 estimate of relative biomass was 150 t. Annual trawl survey biomass estimates from the Chatham Rise have a low associated coefficient of variation (8-15%). The time series of indices is relatively constant between 1992 and 1994, drops significantly in 1995, and recovers in 1996. Biomass estimates increased dramatically from 2713 t in 1997 to 8417 t in 2002, but then declined until 2008. (Figure 2). The 2010 estimate was 5594 t (Table 5).

## 4.2 Biomass estimates

Estimates of current and reference absolute biomass are not available.

## 4.3 Estimation of Maximum Constant Yield (*MCY*)

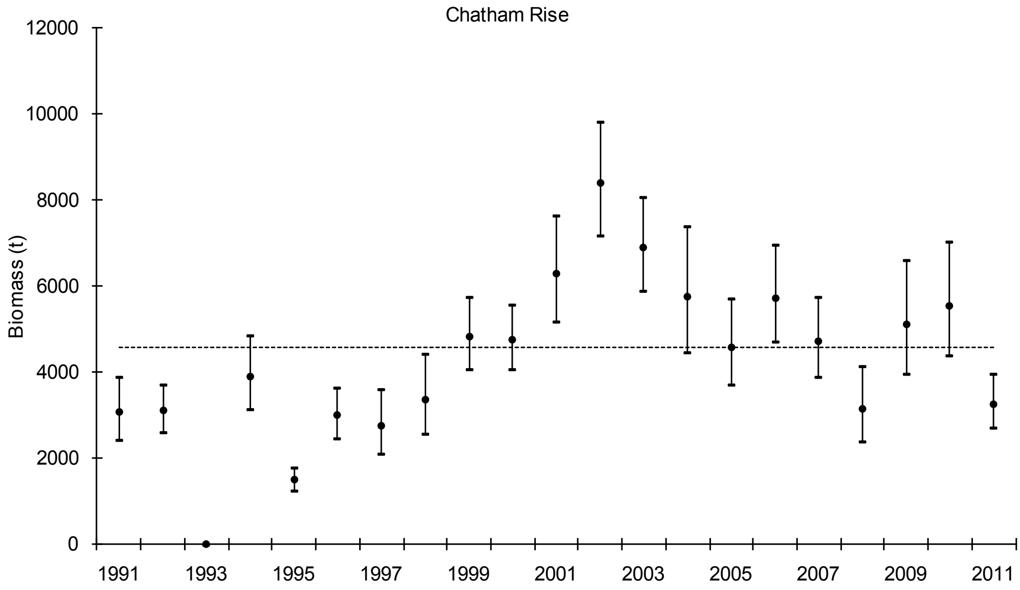
No estimate of *MCY* can be made. The method $MCY = cY_{AV}$ (Method 4) requires a longer period of relatively stable, or at least known, catches (in view of a potential longevity of 40 years) than is available.

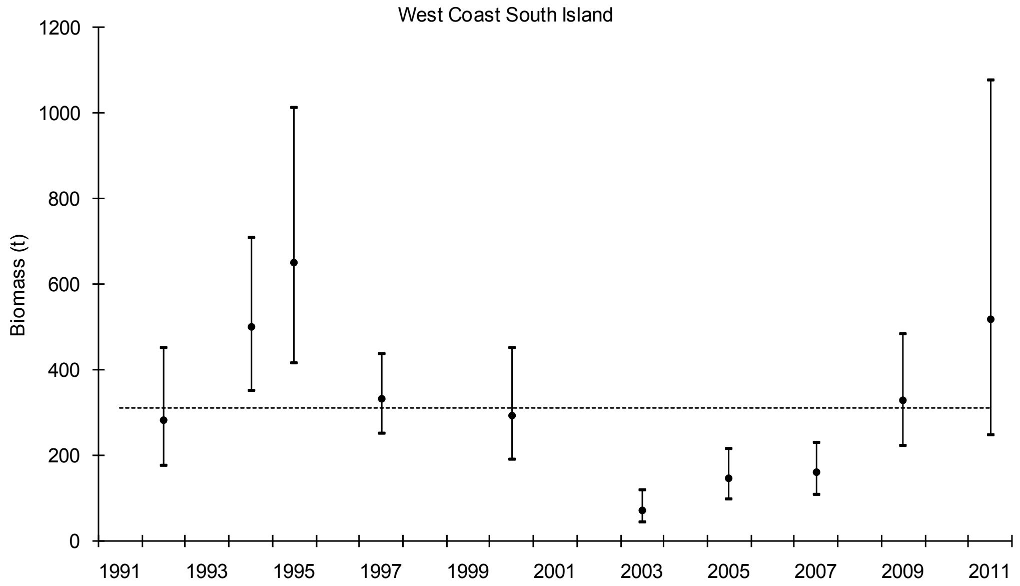
## 4.4 Estimation of Current Annual Yield (*CAY*)

No estimates of current biomass, fishing mortality, or other information are available which would permit the estimation of *CAY*.

## 4.5 Other factors

Factors influencing yield estimates (species identification, catch history, biomass estimates, longevity/mortality, and natural fluctuations in population size) are poorly known for sea perch and preclude any reliable yield estimates at present.



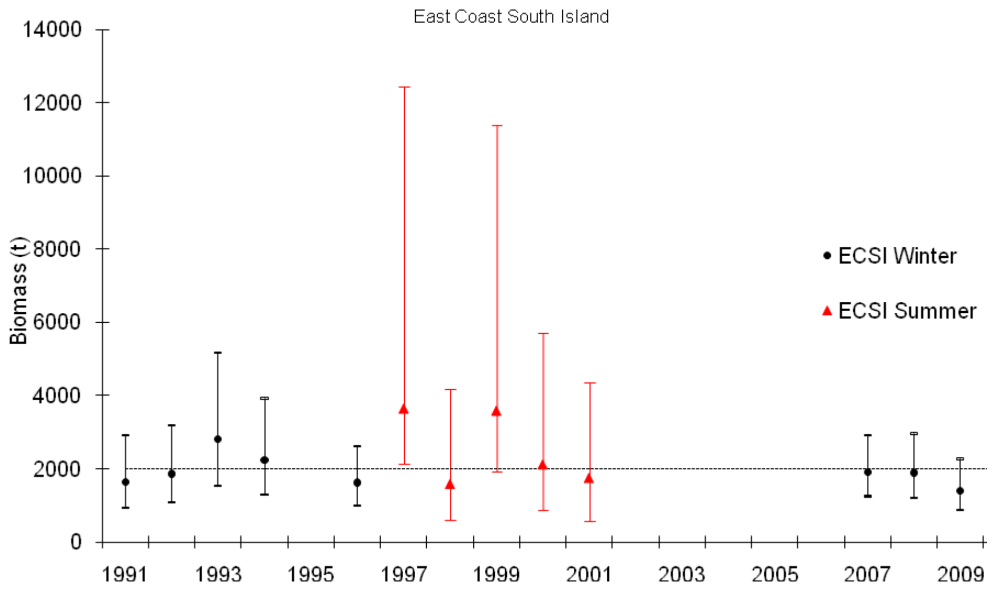




**Figure 2: Biomass estimates ±95% CI from the Chatham Rise (top), West (middle), and East (bottom) Coast South Island trawl surveys.**

**Table 5: Relative biomass indices (t) and coefficients of variation (CV) for west coast South Island, Stewart-Snares Island, east coast South Island (ECSI) - summer and winter, and Chatham Rise trawl surveys. Note, because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid.**

| Region | Survey | Date | Biomass (t) | CV% |
|---|---|---|---|---|
| West coast, | KAH9204 | Mar-Apr 1992 | 293 | 24 |
| South Island | KAH9404 | Mar-Apr 1994 | 510 | 18 |
| | KAH9504 | Mar-Apr 1995 | 667 | 23 |
| | KAH9701 | Mar-Apr 1997 | 338 | 14 |
| | KAH0004 | Mar-Apr 2000 | 302 | 22 |
| | KAH0304 | Mar-Apr 2003 | 76 | 25 |
| | KAH0503 | Mar-Apr 2005 | 150 | 20 |
| | KAH0704 | Mar-Apr 2007 | 163 | 19 |
| | KAH0904 | Mar-Apr 2009 | 336 | 20 |
| | KAH1004 | Mar-Apr 2010 | 558 | 39 |
| Southland | TAN9301 | Feb-Mar 1993 | 469 | 33 |
| (Stewart-Snares | TAN9402 | Feb-Mar 1994 | 443 | 26 |
| shelf) | TAN9502 | Feb-Mar 1995 | 450 | 27 |
| | TAN9604 | Feb-Mar 1996 | 480 | 29 |
| East coast. | KAH9105 | May-Jun 1991 | 1 802 | 30 |
| South Island | KAH9205 | May-Jun 1992 | 2 288 | 27 |
| (Winter) | KAH9306 | May-Jun 1993 | 3 348 | 30 |
| | KAH9406 | May-Jun 1994 | 2 327 | 29 |
| | KAH9606 | May-Jun 1996 | 1 671 | 26 |
| | KAH0705 | May-Jun 2007 | 1 954 | 22 |
| | KAH0806 | May-Jun 2008 | 1 944 | 23 |
| | KAH0905 | May-Jun 2009 | 1 444 | 25 |
| East coast. | KAH9618 | Dec-Jan 1996-97 | 4 041 | 47 |
| South Island | KAH9704 | Dec-Jan 1997-98 | 1 638 | 25 |
| (Summer) | KAH9809 | Dec-Jan 1998-99 | 3 889 | 41 |
| | KAH9917 | Dec-Jan 1999-00 | 2 203 | 27 |
| | KAH0014 | Dec-Jan 2000-01 | 1 792 | 20 |
| Chatham Rise | TAN9106 | Dec-Jan 1991-92 | 3 050 | 12 |
| | TAN9212 | Dec-Jan 1992-93 | 3 110 | 9 |
| | TAN9401 | Jan 1994 | 3 914 | 11 |
| | TAN9501 | Jan 1995 | 1 490 | 9 |
| | TAN9601 | Jan 1996 | 3 006 | 10 |
| | TAN9701 | Jan 1997 | 2 713 | 14 |
| | TAN9801 | Jan 1998 | 3 448 | 14 |
| | TAN9901 | Jan 1999 | 4 842 | 9 |
| | TAN0001 | Jan 2000 | 4 776 | 8 |
| | TAN0101 | Jan 2001 | 6 310 | 10 |
| | TAN0201 | Jan 2002 | 8 417 | 8 |
| | TAN0301 | Jan 2003 | 6 904 | 8 |
| | TAN0401 | Jan 2004 | 5 786 | 13 |
| | TAN0501 | Jan 2005 | 4 615 | 11 |
| | TAN0601 | Jan 2006 | 5 752 | 10 |
| | TAN0701 | Jan 2007 | 4 737 | 10 |
| | TAN0801 | Jan 2008 | 3 081 | 14 |
| | TAN0901 | Jan 2009 | 5 149 | 13 |
| | TAN1001 | Jan 2010 | 5 594 | 12 |
| | TAN1101 | Jan 2011 | 3 278 | 10 |
| | TAN1201 | Jan 2012 | 4 827 | 10 |

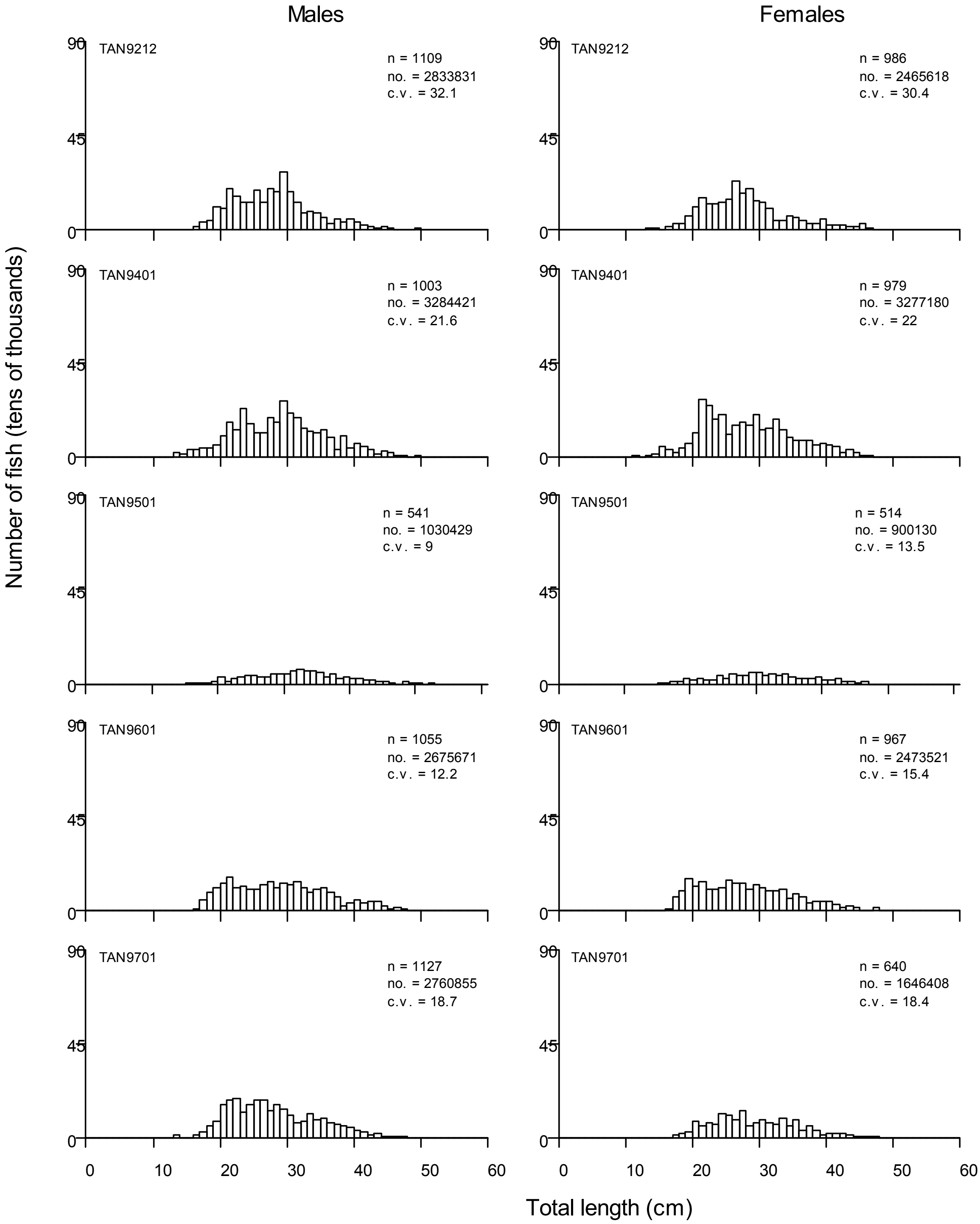



**Figure 3: Scaled length frequency distributions for sea perch, for Chatham Rise surveys. M, males and F, females, (CV) (Stevens *et al.* 2011).**

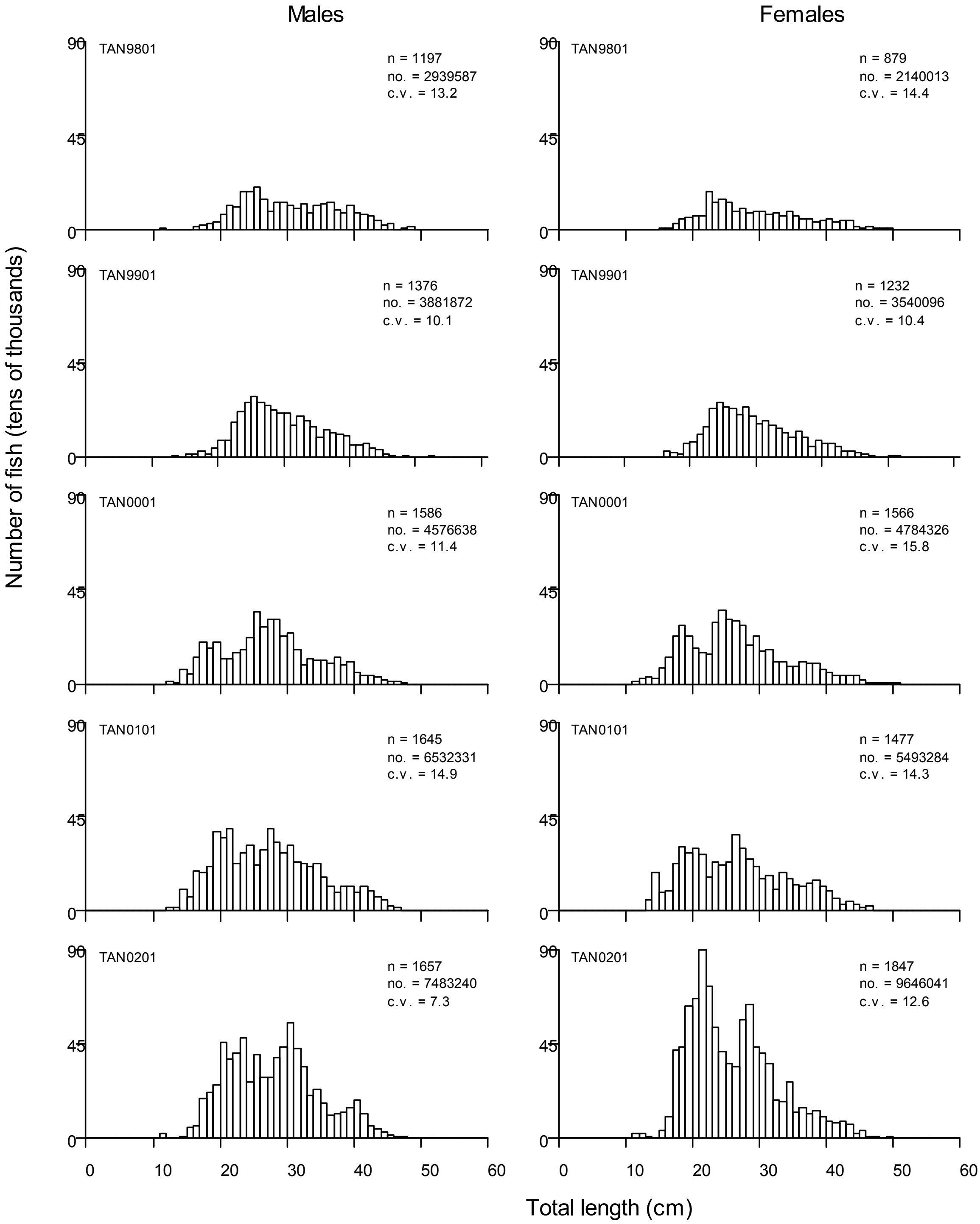
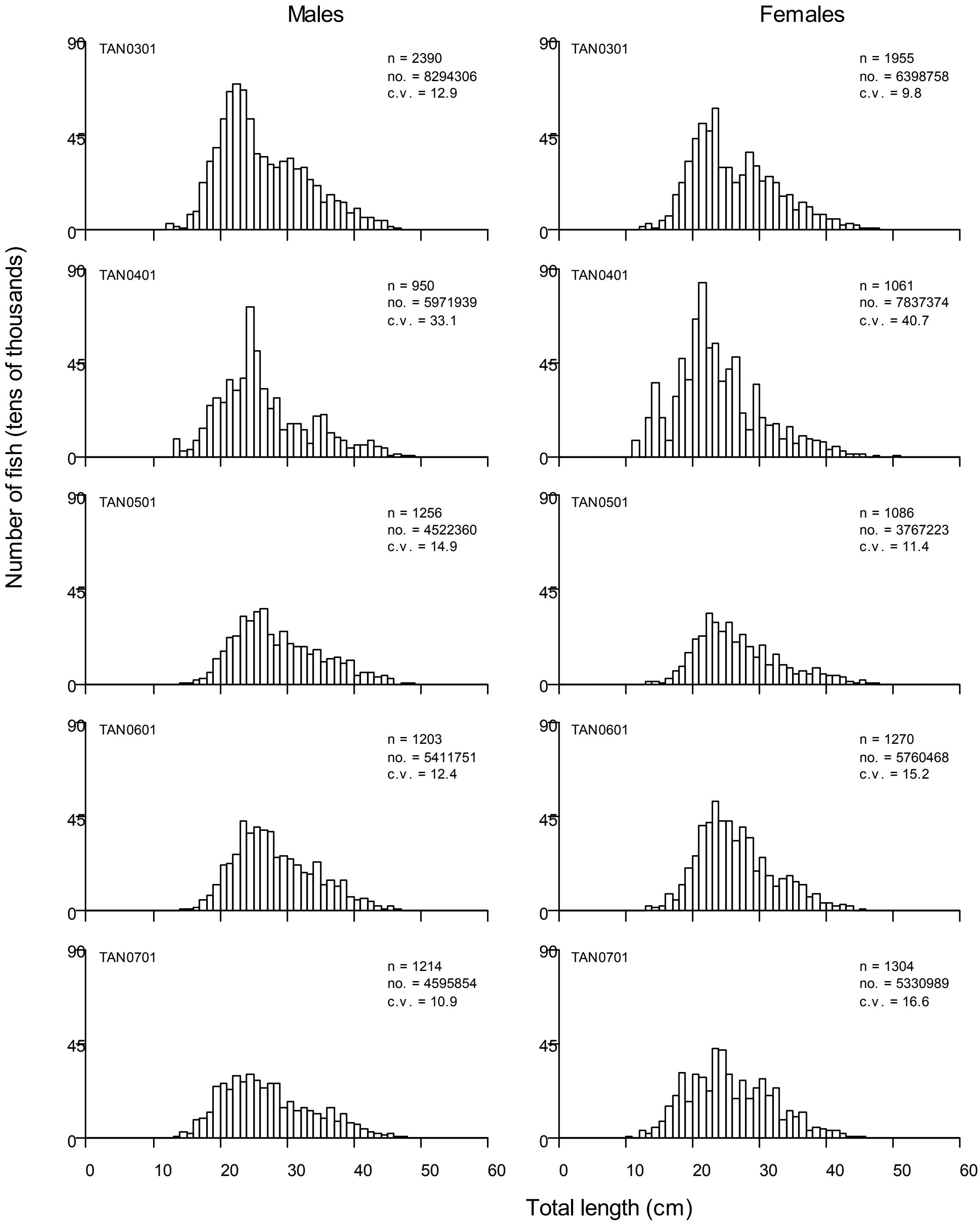



**Figure 3 [Continued].**

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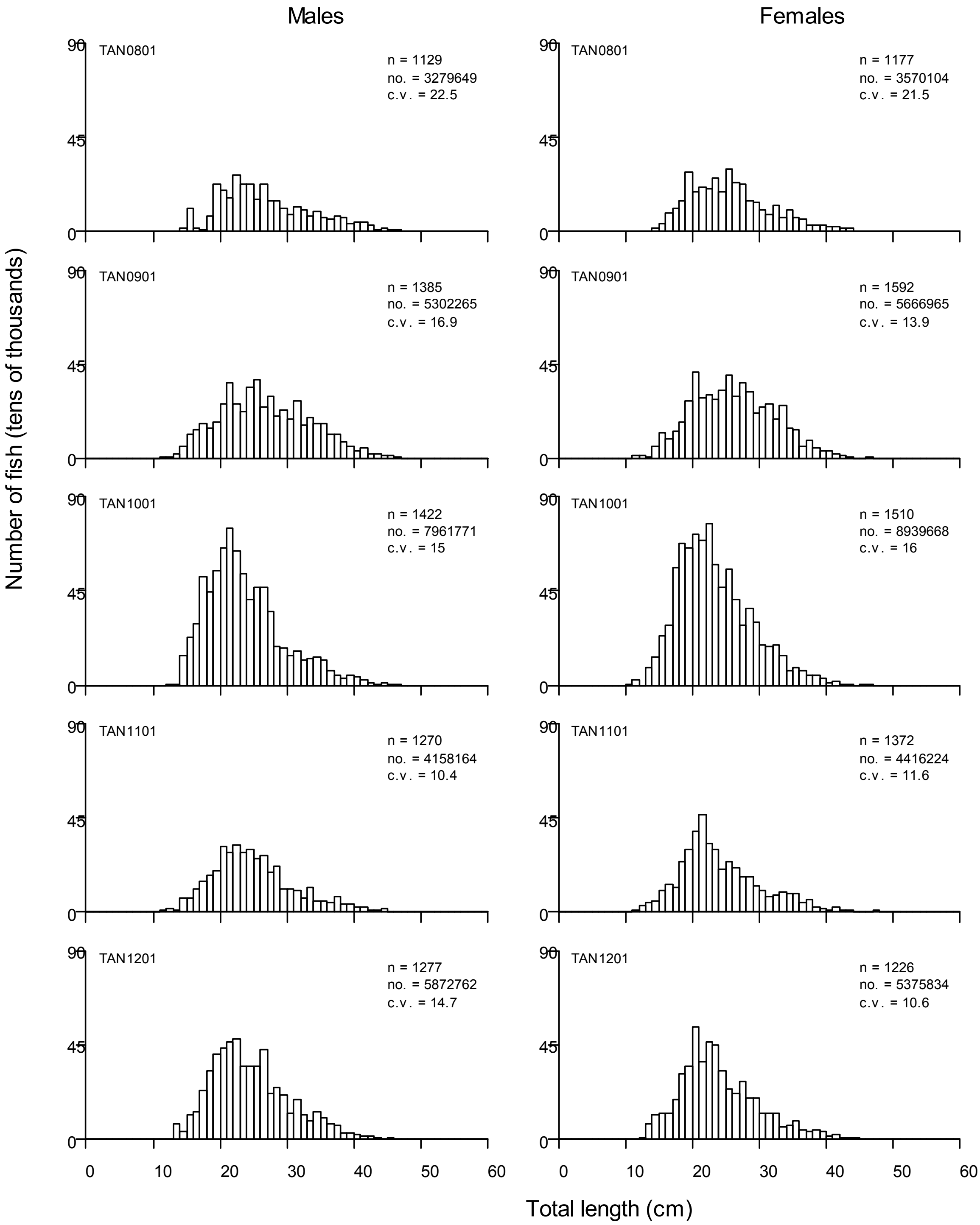


**Figure 3 [Continued].**

## 5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new AMP Working Group was held.

Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal,
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

**2008 AMP review of SPE 3**

SPE 3 entered the QMS in 1998-99, and subsequently was put in the AMP in October 2001 with a TACC increase from 738 t to 1000 t. The TACC has since remained at that level with a 11 t customary and recreational catch, raising the TAC to 1022 t. Prior to entry into the QMS, catches of SPE 3 increased steadily from approximately 100 t/year in 1982-83 to a peak of 903 t in 1998-99. After the TACC increase to 1000 t, catches declined to 372 t by 2004-05, then increased to 519 t in 2006-07, around the level of catch in the mid-1990s. Since entry into the AMP, SPE 3 annual catches have averaged about half of the TACC.

In 2008 the AMP FAWG reviewed the performance of the AMP (Starr *et al*. 2008). The Working Group noted:

**Fishery characterization**

- Most (94%) SPE 3 have been caught by bottom trawl (BT) since 1998-99, with the remaining 6% divided between bottom longline, mid-water trawl, setnet and Dahn line fisheries. 48 t of SPE is reported as being caught in cod and rock lobster pots, but this may the result of misreporting species such as Mäori chief and Jock Stewart.
- Most bottom trawl effort landing SPE occurs in Area 020: Pegasus Bay and Area 022: Canterbury Bight. Significant SPE-directed effort also occurred in Area 018: Kaikoura, although this fishery almost ceased since 2001-02. Bottom longline (BLL) SPE 3 effort occurs mainly off Pegasus Bay, with some effort in Areas 018 022.
- BT and BLL SPE 3 landings occur throughout the year, with somewhat higher BT catches in late autumn or early winter in some years. Setnet landings mainly occur from December to May, and have also been diminishing in recent years. A Dahn line fishery for sea perch has developed since 2004-05, primarily from October to February.
- Landings of SPE 3 by statistical area show changes over time. Most notable is the disappearance of the Area 018 target SPE fishery after 2001-02. Area 022 has higher landings in many years from February to May, coinciding with the peak of the red cod fishery. Area 020 tends to have higher landings in October and September, whereas Areas 020 or 022 show no strong seasonal patterns.
- SPE is caught by BT targeting barracouta, tarakihi and flounder. BLL effort catching sea perch mainly target ling, with some targeting of bluenose and hapuku/bass. Setnet SPE 3 catches are taken by fisheries targeting tarakihi, ling, spiny dogfish, bluenose and rig. The recently developed Dahn line fishery is almost entirely targeted at sea perch.
- Depth information on TCEPR forms show that sea perch are mainly taken between 90 m and 580 m of depth (median 323 m, mean 369 m), depending on target species, shallower for red cod and barracouta targeting, and deeper for hoki, scampi or hake tows.

**CPUE analysis**

- Two CPUE analyses were performed on the SPE 3 catch and effort for sea perch catches in a range of east coast South Island bottom trawl fisheries, updating similar analyses presented to the AMP FAWG in 2006:
    - BT(MIX): a mixed target trawl fishery targeting red cod, barracouta, tarakihi and sea perch in statistical areas valid for SPE 3.
    - BT(HOK): a target hoki trawl fishery operating at the deeper end of the sea perch depth distribution fishing in statistical areas valid for SPE 3.
- The target SPE 3 bottom trawl fishery, under which the original SPE 3 AMP was granted, largely ceased when the main participant withdrew from the fishery in 2002-03. The total

number of target SPE tows has since declined and it appears that new participants are fishing in different areas from the previous fishery that was centred around Kaikoura. The SPE-targeted BT CPUE series presented in 2004 is therefore no longer considered to be representative of SPE abundance, and has not been updated.

- Unstandardised CPUE indices for the BT(HOK) analysis show high variability and no clear trends. Sea perch are not well reported from this fishery, resulting in an unreliable index, and the Working Group also did not accept the BT(HOK) analysis.
- The preferred lognormal BT(MIX) model shows a gradual declining trend since the start of the series in 1998/99, with some suggestion that the decline may have levelled off since 2005-06 (Figure 3). Unstandardised series are similar to the standardised series, although with a somewhat steeper decline to a slightly lower level in recent years.
- The decline in the BT(MIX) series occurred over a period when catches were decreasing, partially as a result of departure of the main participant in this fishery. Changes in participation and spatial fishing patterns are probably contributing both to the observed CPUE decline as well as possible changes in abundance.

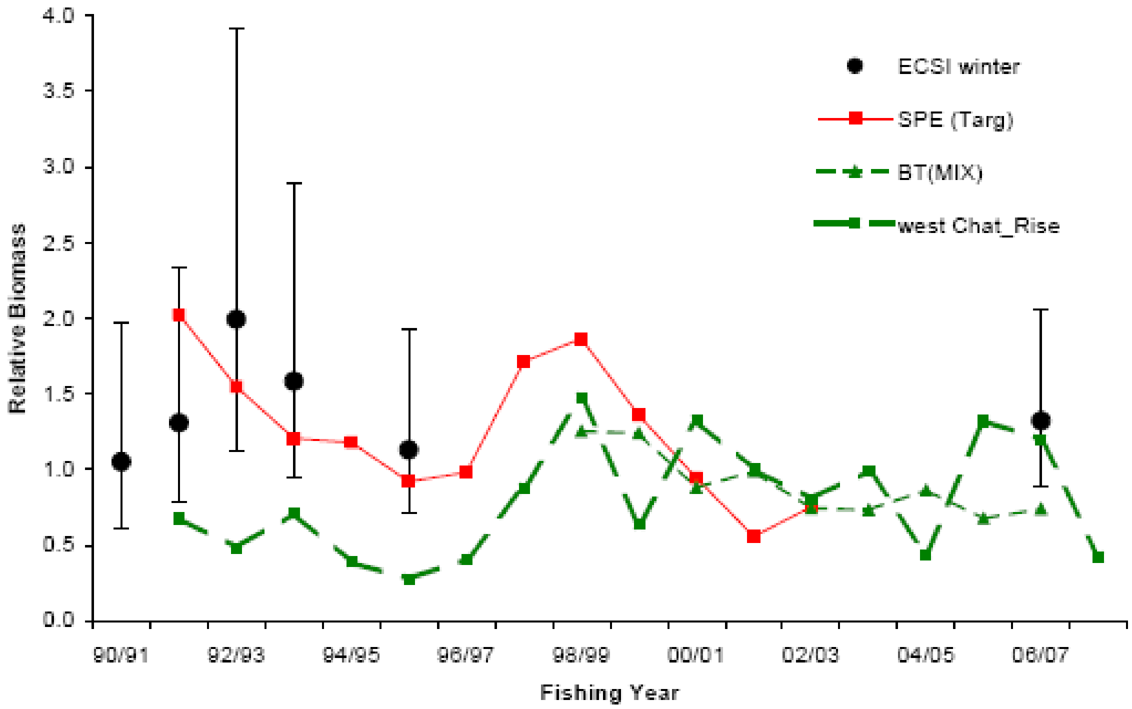


**Figure 4: Comparison plot of the winter ECSI and western Chatham Rise SPE survey biomass indices with the SPE(Targ) CPUE series and the BT(MIX) CPUE series. The survey series were assumed to relate to the final year of the fishing year pair. The two CPUE series and the western Chatham Rise series have been standardised to a common geometric mean from 1998- 99 to 2002-03 and the ECSI series has been standardised to the common geometric mean with the SPE(Targ) series from 1991-92 to 1993-94 and 1995-96.**

## Trawl survey abundance indices

- Data from three trawl surveys in SPE 3 and 4 have been summarised to examine trends in SPE relative abundance and length composition: east coast South Island (ECSI) winter surveys from 1991-1996 (5 surveys) and 2007 (1 survey); ECSI summer surveys from 1997-2001 (5 surveys) and Chatham Rise summer surveys (restricted to the strata west of 176°E) from 1992-2008 (17 surveys).
- Catches of sea perch from the ECSI trawl surveys were low in depths < 80 m in the Canterbury Bight and Pegasus Bay. Highest catch rates were achieved in the 100 m to 180 m depth along the edge of the continental shelf, and catches were low in depths exceeding 200m. SPE were only caught in small quantities in the Chatham Rise survey, with highest catches in the shallower areas of the northern central Chatham Rise.

- Biomass estimates from the ECSI winter survey show no trend among the first five survey indices, increasing between 1991 and 1993 and then declining in 1994 and 1996 (Figure 2 and 3). The ECSI winter series was reinstated in 2007, with a biomass estimate near the median of the earlier five surveys and likely indicative of no overall trend in the 11 year gap between survey periods. ECSI summer survey results are not considered to be reliable indices of SPE abundance.
- Biomass estimates from the western Chatham Rise show no overall trend, with a steady increase from the lowest estimate in 1995 to a peak in 2002, followed by a decline at a similar rate to a level in 2008 similar to the 1996-1998 levels (Figure 3). It is not known how the sea perch population on the Chatham Rise relates to the population being fished in SPE 3.
- Length compositions from the winter ECSI surveys were dominated by a strong 20-25 cm length mode. There was no significant difference in the length composition for male and female fish and no indication of substantial changes in the length composition over the study period.
- Length compositions from the Chatham Rise surveys were slightly larger, mostly 20 cm - 30 cm and attaining 50 cm, but with high variability between surveys. Strong modal peaks are evident, with some suggestion from modal progression that these may represent year classes. It may be feasible to assess recruitment variation from these data once information on SPE age and growth is available. However, most of this survey falls into SPE 4.

**Logbook programme**

- A bottom trawl logbook programme which only sampled the target SPE 3 fishery was introduced in 2001-02. This programme collected data for about one year before the primary participant left the fishery, after which the programme was discontinued. A general programme to sample the east coast South Island trawl fishery started in 2003-04, initially to sample elephantfish, but was gradually extended to sample other AMP species, including sea perch.
- The SPE 3 bottom trawl logbook programme obtained possibly adequate coverage of the SPE 3 target bottom trawl fishery for sea perch in 2001-02 and 2004-05. The coverage of the by-catch of sea perch was poor in all years due to the diversity of the mixed BT fishery and the scarcity of SPE in individual tows. The number of reported tows in the programme has ranged from 144 to 905 per year, over all sampled tows. However, the amount of sea perch catch sampled was only 200 kg to 11 t of estimated catch. Coverage levels of SPE by catch weight have ranged from 0 to 2.5% and only 153 tows, out of the total of 2 526 reported tows, recorded sampled SPE catch.
- Coverage of the target sea perch fishery was over 10% in 2001-02 when the principal operator was participating, and coverage of the smaller target SPE fishery in 2004-05 was about 16%. Coverage of the bycatch fishery was 0.3% in 2006-07.
- There are indications in length-frequency data from logbooks of a decrease in the proportion of large (> 35 cm) fish from catches between 2001-02 and 2006-07, and a resultant decrease in modal size from around 32 cm in 2001-02 to 25 cm in 2006-07. However, these conclusions need to be considered against the general lack of representative and consistent sampling from this programme.

**Effects of fishing**

- Incidental mortality of Hectors dolphin from trawling appears to be rare. One capture of a Hectors dolphin was observed in the red cod trawl fishery in QMA 3 in 1997 -1998 (Starr & Langley 2000). In particular, the majority of trawls which catch SPE 3 occur between 90 m and 600 m (median 330 m), outside the known distribution of Hectors dolphin, which is within 4 nautical miles of the coast, particularly in the summer months.
- Low observer coverage and lack of fine scale catch reporting has made it difficult to objectively evaluate the environmental effects of fishing under the STA 3 AMP. The rates of non-fish bycatch are unknown, monitoring is not adequate. Since the last review of STA 3 in 2006:

- The Non-fish/Protected Species Catch Return to be implemented from 1 October 2008 should provide information on the level of non-fish/protected species bycatch for the next review of STA 3. However, adequate observer coverage will still be required to validate reporting rates.
- The draft Hector's and Maui's Dolphin Threat Management Plan (TMP) released for consultation (MFish and DOC 2007) proposes an extension to the existing Banks Peninsula marine mammal sanctuary.
- Under the seabird sustainability measures that begin on 1 June 2008, trawlers cannot discharge offal or fish on more than one occasion per tow or during shooting or hauling or within 20 minutes before shooting.

**Conclusions**

- A direct comparison of the indices considered most reliable for SPE 3 (the historic SPE(Targ) CPUE, the BT(MIX) CPUE and the ECSI and West Chatham Rise surveys) indicates that the indices from the ECSI survey agree reasonably well with the historic SPE(Targ) CPUE series but lie above the two current CPUE series. The two survey series (western Chatham Rise and ECSI) show similar trends (Figure 2). The western Chatham Rise survey series lies below the ECSI series and the SPE(Targ) series in the early 1990s, but agrees reasonably well with the two CPUE series in the early to mid-2000s.
- Interpretation of these results depends on the relative weight given to the various indices. The ECSI survey series, and particularly the 2007 survey estimate, suggests stable catch rates with no trend across the series. However, the SPE(Targ) index, the BT(MIX) index and the western Chatham Rise survey index from 1999-2005 all indicate a decline in abundance since 1998-99, perhaps levelling off in the last two years. The 2007 ECSI survey estimate requires confirmation from repeat surveys in 2008 and 2009.

**AMP review checklist**

1. The East Coast South Island winter trawl survey is likely to be the best index of abundance for the SPE 3 stock, although there are concerns that this may not be indexing the full population (SPE occur deeper than the survey), and that SPE 3 may be linked to the Chatham Rise SPE population. Of the CPUE indices, the BT(MIX) index may be providing a reasonable index of the currently fished component of SPE 3.
2. With the drop in interest in the targeted SPE bottom trawl fishery and the departure of the main, logbook coverage of remaining SPE 3 bycatch fishery has been negligible.
3. Additional analyses recommended by the Working Group included:
    - For the next review, CPUE standardisation should be conducted for the full time series in the BT(MIX) SPE bycatch fishery, and not just from 1998-99 onwards, to evaluate the degree of correspondence with the historic SPE(Targ) index. In extending this analysis back in time, target should be used as a categorical explanatory variable to evaluate the possible effect of change in reporting practices before and after entry of SPE 3 into the QMS in 1998-99.
4. The combination of optimistic recent trawl surveys estimates and levelling off in the BT(MIX) CPUE index indicate that current harvest levels should be sustainable. However, most indices indicate a decline over the period of the targeted SPE 3 fishery from 1998-99 to 2002-03, when catches were about double current levels. There are therefore indications that the current TACC may not be sustainable.
5. The status of the SPE 3 stock in relation to $B_{MSY}$ has not been estimated. Further ECSI winter trawl survey results may further inform this view over the next two years.
6. Observer coverage levels of the inshore trawl fisheries are low, and the effects of fishing are not currently adequately monitored. Introduction of the '*Non-fish/Protected Species Catch Return*' into the suite of regulated MFish forms from 1st October 2008 may provide a credible source of information on the level of protected species bycatch. However, observer coverage will still be required to validate fisher reporting rates.
7. Given the low observer coverage in this fishery, rates of non-fish bycatch are not known with any confidence, and it is not known whether rates of bycatch are acceptable.

8. The Working Group concluded that this stock does not need to be referred to the Plenary for review. However, catches should be monitored and consideration given to bringing forward the next SPE 3 review if catches increase substantially.

## 6. STATUS OF THE STOCKS

No estimates of current and reference biomass are available.

For all SPE Fishstocks it is not known if recent catch levels are sustainable.

TACCs and reported landings of sea perch in the 2010-11 fishing year are summarised in Table 6.

**Table 6: Summary of TACCs (t), and reported landings (t) of sea perch for the most recent fishing year.**

| Fishstock | | QMA | 2010-11 Actual TACC | 2010-11 Reported landings |
|---|---|---|---|---|
| SPE 1 | Auckland (East) | 1 | 33 | 53 |
| SPE 2 | Central (East) | 2 | 79 | 83 |
| SPE 3 | South-east (coast) | 3 | 1 000 | 644 |
| SPE 4 | South-east (Chatham) | 4 | 910 | 572 |
| SPE 5 | Southland | 5 | 36 | 22 |
| SPE 6 | Sub-Antarctic | 6 | 9 | 2 |
| SPE 7 | Challenger | 7 | 82 | 124 |
| SPE 8 | Central (West) | 8 | 15 | 3 |
| SPE 9 | Auckland (West) | 9 | 6 | 2 |
| SPE 10 | Kermadec | 10 | 0 | 0 |
| Total | | | 2 170 | 1 506 |

## 7. FOR FURTHER INFORMATION


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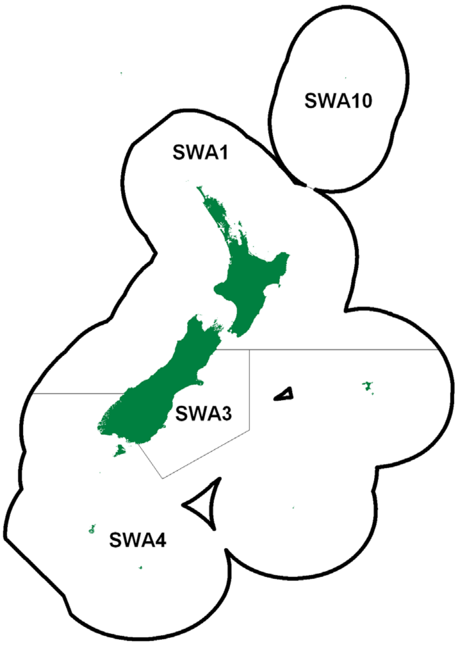
# SILVER WAREHOU (SWA)

(*Seriolella punctata*)
Warehou




## 1. FISHERY SUMMARY

### 1.1 Commercial fisheries

Silver warehou entered the Quota Management System (QMS) on 1 October 1986. Silver warehou are common around the South Island and on the Chatham Rise in depths of 200-800 m. The majority of the commercial catch is taken from the Chatham Rise, Canterbury Bight, southeast of Stewart Island and the west coast of the South Island. Reported landings by nation from 1974 to 1987-88 are shown in Table 1.

**Table 1: Reported landings (t) by nation from 1974 to 1987-88. Source: 1974-1978 (Paul 1980); 1978 to 1987-88 (FSU).**

| Fishing Year | New Zealand | | | Foreign Licensed | | | | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Domestic | Chartered | Total | Japan | Korea | USSR | Total | |
| 1974* | | | | | | | | 7 412 |
| 1975* | | | | | | | | 6 869 |
| 1976* | | estimated as 70% of total warehou landings | | | | | | 13 142 |
| 1977* | | | | | | | | 12 966 |
| 1978* | | | | | | | | 12 581 |
| 1978-79** | ? | 629 | 629 | 3 868 | 122 | 212 | 4 203 | 4 832 |
| 1979-80** | ? | 3 466 | 3 466 | 4 431 | 217 | 196 | 4 843 | 8 309 |
| 1980-81** | ? | 2 397 | 2 397 | 1 246 | - | 13 | 1 259 | 3 656 |
| 1981-81** | ? | 2 184 | 2 184 | 1 174 | 186 | 3 | 1 363 | 3 547 |
| 1982-83** | ? | 3 363 | 3 363 | 1 162 | 265 | 189 | 1 616 | 4 979 |
| 1983† | ? | 1 556 | 1 556 | 510 | 98 | 3 | 611 | 2 167 |
| 1983-84§ | 303 | 3 249 | 3 552 | 418 | 194 | 3 | 615 | 4 167 |
| 1984-85§ | 203 | 4 754 | 4 957 | 1 348 | 387 | 15 | 1 749 | 6 706 |
| 1985-86§ | 276 | 5 132 | 5 408 | 1 424 | 217 | 5 | 1 646 | 7 054 |
| 1986-87§ | 261 | 4 565 | 4 826 | 1 169 | 29 | 100 | 1 299 | 6 125 |
| 1987-88§ | 499 | 7 008 | 7 507 | 431 | 111 | 39 | 581 | 8 088 |

* Calendar year.
**1 April to 31 March.
†1 April to 30 September.
§1 October to 30 September.

Before the establishment of the EEZ, silver warehou landings were lumped with white and blue warehou landings under the title "warehous". Between 1974 and 1977, 70% of the "warehou" landings are estimated to have been silver warehou because of the areas fished. The depth distributions of silver warehou and blue warehou are reasonably distinct, and white warehou form a very small proportion of more recent warehou catches and biomass estimates from trawl surveys.

The estimated catches of silver warehou before the declaration of the EEZ were particularly high in 1976, 1977 and 1978 (Table 1). Concern about overfishing on the eastern Stewart-Snares shelf led to closure of this area to trawlers between October 1977 and January 1978. The high catch in 1978 represents a shift in effort, particularly by Japan, to the Chatham Rise, presumably because of the restriction on the Stewart-Snares shelf. Total reported catches since 1978-79 have been generally lower than estimated landings before 1978.

In recent years, most of the silver warehou catch has been taken as a bycatch of the hoki, squid, barracouta and jack mackerel trawl fisheries. Catches from SWA 1 increased substantially after 1985-86 following the development of the west coast South Island hoki fishery. Overruns of the TAC probably partly reflected the hoki fleet fishing in relatively shallow water (northern grounds) in the later part of the season, but could also have reflected changes in abundance. Some target fishing for silver warehou does still occur, predominantly on the Mernoo Bank and along the Stewart-Snares shelf. Recent reported landings are shown in Table 2, while Figure 1 shows the historical landings and TACC values for the main SWA stocks.

The TACC in SWA 1 was increased in 1991-92 under the "adaptive management" programme (AMP). A review of this fishstock at the completion of 5 years in the AMP concluded that it was not known if the current TACC would be sustainable and an appropriate monitoring programme was not in place. Under the criteria developed for the AMP the Minister therefore removed this fishstock from the AMP in October 1997 and set the TACC at 2132 t. A new AMP proposal in 2002 resulted in the TACC being increased to 3000 t from 1 October 2002, with 1 t customary and 2 t recreational allowances within a TAC of 3003 t. Catches have not approached the new TACC level in recent years as reductions in the hoki quota have resulted in much less effort on the WCSI in winter.

In most years from 2000-01 to 2006-07 catches in SWA 3 and SWA 4 were well above the TACCs as fishers landed catches well in excess of ACE holdings and paid deemed values for the overcatch. From 1 October 2007 the deemed values were increased to $1.22 per kg for all SWA stocks and two differential rates were also introduced. The second differential rate applies to all catch over 130% of ACE holding at which point the deemed value rate increased to $3 per kg. The effect of these measures was seen immediately in 2007-08 as fishing without ACE was reduced and catch fell well below the TACCs in both SWA 3 and SWA 4.

**Table 2: Reported landings (t) of silver warehou by Fishstock from 1983-84 to 2010-11 and TACCs (t) from 1986-87 to 2010-11. QMS data from 1986-present.**

| Fishstock | SWA 1 | | SWA 3 | | SWA 4 | | SWA 10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FMA (s) | 1, 2, 7, 8 & 9 | | 3 | | 4, 5 & 6 | | 10 | | | Total |
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1983-84* | 541 | - | 725 | - | 1 829 | - | 0 | - | 3 095 | - |
| 1984-85* | 587 | - | 1 557 | - | 4 563 | - | 0 | - | 6 707 | - |
| 1985-86* | 806 | - | 2 284 | - | 3 966 | - | 0 | - | 7 056 | - |
| 1986-87 | 1 337 | 1 800 | 1 931 | 2 600 | 2 779 | 3 600 | 0 | 10 | 6 047 | §8 010 |
| 1987-88 | 2 947 | 1 815 | 3 810 | 2 601 | 2 600 | 3 600 | 0 | 10 | 9 357 | §8 026 |
| 1988-89 | 1 605 | 1 821 | 1 476 | 2 640 | 2 789 | 3 745 | 0 | 10 | 5 870 | 8 216 |
| 1989-90 | 2 316 | 2 128 | 2 713 | 3 140 | 3 596 | 3 855 | 0 | 10 | 8 625 | 9 133 |
| 1990-91 | 2 121 | 2 128 | 1 889 | 3 144 | 3 176 | 3 855 | 0 | 10 | 7 186 | 9 137 |
| 1991-92 | 1 388 | 2 500 | 2 661 | 3 144 | 3 018 | 3 855 | 0 | 10 | 7 066 | 9 509 |
| 1992-93 | 1 231 | 2 504 | 2 432 | 3 145 | 3 137 | 3 855 | 0 | 10 | 6 800 | 9 514 |
| 1993-94 | 2 960 | 2 504 | 2 724 | 3 145 | 2 993 | 3 855 | 0 | 10 | 8 677 | 9 514 |
| 1994-95 | 2 281 | 2 504 | 2 336 | 3 280 | 2 638 | 4 090 | 0 | 10 | 7 255 | 9 884 |
| 1995-96 | 2 884 | 2 504 | 2 939 | 3 280 | 3 581 | 4 090 | 0 | 10 | 9 404 | 9 884 |
| 1996-97 | 3 636 | 2 504 | 4 063 | 3 280 | 5 336 | 4 090 | 0 | 10 | 13 035 | 9 884 |
| 1997-98 | 3 380 | 2 132 | 3 721 | 3 280 | 3 944 | 4 090 | 0 | 10 | 11 045 | 9 512 |
| 1998-99 | 1 980 | 2 132 | 2 796 | 3 280 | 4 021 | 4 090 | 0 | 10 | 8 797 | 9 512 |

**Table 2 Continued:**

| | SWA 1 | | SWA 3 | | SWA 4 | | SWA 10 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC | Landings | TACC |
| 1999-00 | 2 525 | 2 132 | 4 129 | 3 280 | 4 606 | 4 090 | 0 | 10 | 11 260 | 9 512 |
| 2000-01 | 3 025 | 2 132 | 3 664 | 3 280 | 4 650 | 4 090 | 0 | 10 | 11 339 | 9 512 |
| 2001-02 | 1 004 | 2 132 | 2 899 | 3 280 | 4 648 | 4 090 | 0 | 10 | 8 551 | 9 512 |
| 2002-03 | 1 029 | 3 000 | 3 772 | 3 280 | 4 746 | 4 090 | 0 | 10 | 9 547 | 10 380 |
| 2003-04 | 1 595 | 3 000 | 3 606 | 3 280 | 5 529 | 4 090 | 0 | 10 | 10 730 | 10 380 |
| 2004-05 | 1 467 | 3 000 | 3 797 | 3 280 | 4 279 | 4 090 | 0 | 10 | 9 543 | 10 380 |
| 2005-06 | 1 023 | 3 000 | 4 524 | 3 280 | 5 591 | 4 090 | 0 | 10 | 11 138 | 10 380 |
| 2006-07 | 2 093 | 3 000 | 6 059 | 3 280 | 6 022 | 4 090 | 0 | 10 | 14 174 | 10 380 |
| 2007-08 | 1 679 | 3 000 | 2 918 | 3 280 | 3 510 | 4 090 | 0 | 10 | 8 107 | 10 380 |
| 2008-09 | 1 366 | 3 000 | 3 264 | 3 280 | 4 213 | 4 090 | 0 | 10 | 8 843 | 10 380 |
| 2009-10 | 712 | 3 000 | 2 937 | 3 280 | 3 429 | 4 090 | 0 | 10 | 7 078 | 10 380 |
| 2010-11 | 938 | 3 000 | 3 559 | 3 280 | 3 507 | 4 090 | 0 | 10 | 8 004 | 10 380 |

*FSU data.

§Totals do not match those in Table 1 as the data were collected independently and there was under-reporting to the FSU in 1987-88.

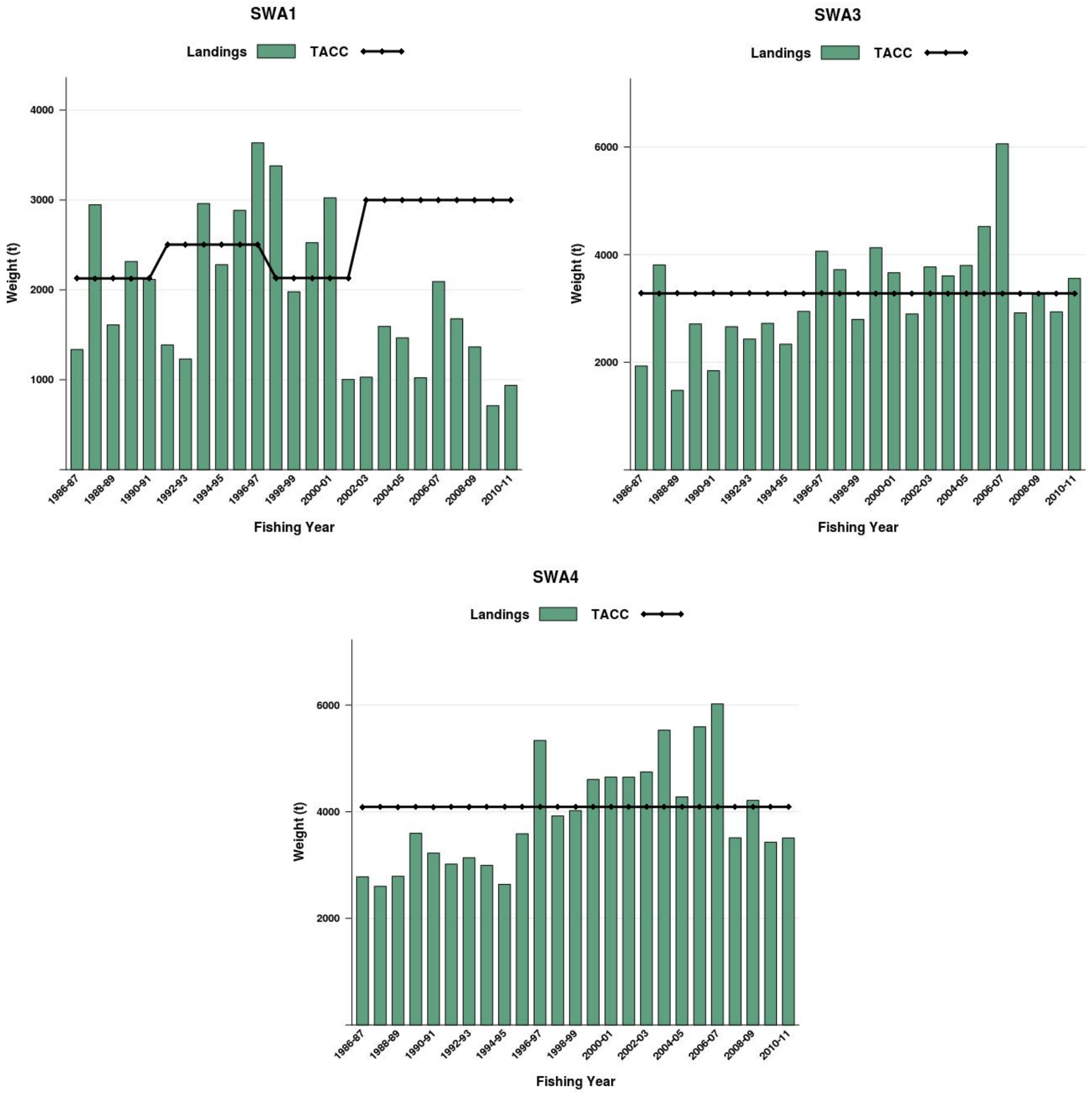



**Figure 1: Historical landings and TACC for the three main SWA stocks. From top left: SWA1 (Auckland East), SWA3 (South East Coast), and SWA4 (South East Chatham Rise). Note that these figures do not show data prior to entry into the QMS.**

## 1.2 Recreational fisheries

There are no current recreational fisheries for silver warehou.

### 1.3 Customary non-commercial fisheries
Quantitative information on the current level of customary non-commercial take is not available.

### 1.4 Illegal catch
Silver warehou have been misreported as white and blue warehou in the past. The extent of this practice is unknown and could lead to under-reporting of silver warehou catches.

### 1.5 Other sources of mortality
Other sources of mortality are unknown.

## 2. BIOLOGY

Initial growth is rapid and fish reach sexual maturity at around 45 cm fork length in 4 years. Based on a study of ageing methodology and growth parameters (Horn & Sutton 1995), maximum age is considered to be 23 years for females and 19 years for females. An estimate of instantaneous natural mortality ($M$) was derived by using the equation $M = \log_e 100/A_{MAX}$, where $A_{MAX}$ is the age reached by 1% of the virgin population. From their study, $A_{MAX}$ of 19 years for female silver warehou and 17 years for males produced estimates of $M$ of 0.24 and 0.27 respectively. Horn & Sutton (1995) qualified this result as the samples used in their study were not from virgin populations and the sampling method did not comprehensively sample the whole population. Based on these results $M$ is likely to fall within the range 0.2-0.3.

Horn & Sutton also calculated von Bertalanffy growth curve parameters from their sample of fish from off the south and southeast coasts of the South Island (Table 3). Other biological parameters relevant to the stock assessment are shown in Table 3. Length weight regressions were calculated from two series of random trawl surveys using *Tangaroa*. One series was conducted on the Chatham Rise in January, 1992-97 and the other in Southland during February-March, 1993-96.

Silver warehou is a schooling species, aggregating to both feed and spawn. During spring-summer, both adult and juvenile silver warehou migrate to feed along the continental slope off the east and southeast coast of the South Island. Late-stage silver warehou eggs and larvae have been identified in plankton samples, and the early life history of silver warehou appears typical of many teleosts. Juvenile silver warehou inhabit shallow water at depths of 150-200 m and remain apart from sexually mature fish. Few immature fish are consequently taken by trawlers targeting silver warehou. Juveniles have been caught in Tasman Bay, on the east coast of the South Island and around the Chatham Islands. Once sexually mature, fish move out to deeper water along the shelf edge.

**Table 3: Estimates of biological parameters of silver warehou.**

| Fishstock | | Estimate | Source |
|---|---|---|---|
| 1. Weight = a(length)$^b$ (Weight in g, length in cm, total length). | | | |
| | | Both sexes | |
| | a | b | Tangaroa Survey: |
| Chatham Rise | 0.00848 | 3.214 | January 1992-97 |
| Southland | 0.00473 | 3.380 | February - March 1993-96 |

| 2. von Bertalanffy growth parameters | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Female | | | Males | | |
| | $L_\infty$ | $k$ | $t_0$ | $L_\infty$ | $k$ | $t_0$ | |
| | 54.5 | 0.33 | -1.04 | 51.8 | 0.41 | -0.71 | Horn & Sutton (1995) |

## 3. STOCKS AND AREAS

The stock structure is unknown. However, there is no new data which would alter the stock boundaries given in previous assessment documents. Horn *et al*. (2001) found no differences in growth rates of silver warehou from the Southern Plateau, Chatham Rise and WCSI, and reached the same conclusions as Livingston (1988) based on an analysis of gonad stages (ripe female samples) and juvenile distribution.

Livingston (1988) found that spawning occurs on the Chatham Rise (Mernoo), east coast North Island and west coast South Island in late winter and at the Chatham Islands in late spring-early summer. There is some evidence for another spawning ground on the Stewart-Snares shelf, also in late winter. It is uncertain whether the same stock migrates from one area to another, spawning whenever conditions are appropriate, or if there are several separate stocks. The current boundaries bear little relation to known spawning areas and silver warehou distribution.

## 4. STOCK ASSESSMENT

The assessment of silver warehou stocks was not updated in 2009 but a mid-term review was carried out for the SWA 1 AMP. There are no new data that would alter the yield estimates given in the 1997 Plenary Report. Yield estimates are based on commercial landings only.

### 4.1 Estimates of fishery parameters and abundance

CPUE data of silver warehou from the west coast South Island hoki fishery were analysed as a possible means of monitoring abundance in this part of SWA 1. However, the Middle Depths FAWG did not accept that the CPUE from the WCSI fishery were an index of abundance.

Age frequency distributions from otoliths collected by the Scientific Observer Programme from the west coast south island hoki fishery indicate that a wide range of year classes were present in the catch for all seasons 1992-96. Catch curve analysis based on the age structure of annual catches made from 1992-05 suggested that fishing mortality is lower than natural mortality (SeaFIC 2007).

### 4.2 Biomass estimates

Estimates of reference and current biomass are not available for any Fishstock.

Biomass indices from *Tangaroa* trawl surveys in QMAs 3 (part), 4 and 5 since 1991 are variable between years and have high CVs, and are therefore unsuitable for stock assessment.

### 4.3 Estimation of Maximum Constant Yield (*MCY*)

*MCY* cannot be determined. Problems with mis-reporting of warehou catches and the lack of consistent catch histories make *MCY* estimates based on catch data alone unreliable.

### 4.4 Estimation of Current Annual Yield (*CAY*)

An estimate of current biomass is not available, and *CAY* cannot be estimated.

### 4.5 Other factors

The degree of interdependence between Fishstocks is unknown. The 1996-97 landings were the highest on record but catches have decreased in both 1997-98 and 1998-99.

## 5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new Adaptive Management Programme Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

## SWA 1

The SWA 1 TACC was increased from 2132 to 3000 t in October 2002 under the Adaptive Management Programme (AMP). A full-term review of the LIN 1 AMP was carried out in 2007.

**Mid-term review 2009** (AMP WG/09/10, 11)

### Characterisation

- Silver warehou were introduced into the QMS from 1 Oct 1986 as four fishstocks, the SWA 1 fishstock including the waters around the North Island and the west coast of the South Island (FMAs 1, 2, 7, 8 and 9). The SWA 1 TACC rose from 1800 t in 1986-97 to 2128 t in 1989-90 as a result of quota appeals and was increased to 2500 t in 1991-92 upon entry into an AMP. A further 4 t increase in 1992-93 resulted from a quota appeal. The TACC was reduced to 2132 t for 1997-98 and increased to 3000 t (within a TAC of 3003 t) from 2002-03 onwards under a second AMP.
- The early catch history for SWA 1 has been reconstructed from historical data collected by the Fisheries Statistical Unit (FSU) data from January 1979 onwards. While total New Zealand SWA catches are reported in these data to be highest in the 1970s, most of this catch is thought to have been made on the Chatham-Rise and Stewart-Snares Shelf by Japanese vessels, with only a small proportion made in SWA 1. Estimated annual SWA 1 catches averaged about 260 t per year over the period 1979 - 1982.
- Subsequent catches increased from around 500 t – 1000 t in 1983-84 to 2948 t in 1987-88, declined to 1 231 t in 1992-93 and then increased to a historic peak of 3636 t in 1996-87. Catches remained at high levels through to 2000-01, exceeding the TACC in all but two years from 1993-94 to 2000-01. Catches then dropped sharply to only 1004 t in 2001-02 due to reduction in the hoki TACC, of which SWA is primarily a by-catch, and have continued to fluctuate below the TACC, between 1023 t and 2093 t up to 2007-08. Increased catches over 2006-07 to 2007-08 have resulted from increased active targeting of SWA
- From 1989-90 to 2000-01 82% of the SWA 1 catch was taken by midwater trawl off the west coast of the South Island. However, 87% of the catch since 2001-02 in the WCSI fishery is now taken by bottom trawl. In other regions, bottom trawl catches have dominated throughout the entire period 1989-90 to 2007-08. The proportion of catch taken by midwater trawl has not decreased to the same extent as the WCSI fishery. Catches by bottom longline and other methods have been sporadic.
- SWA 1 has primarily been a bycatch of trawls targeting hoki. As catches of hoki have declined since 2000-01, the proportion of SWA target trawls has increased. Since 2006-07 target SWA catches have dominated, with bycatch in barracouta and hake target trawls also increasing in importance.
- Peak catches in the WCSI fishery are taken in July to September. In other parts of the SWA 1 fishery, the seasonal pattern has shown more variation.

### Length-frequency & catch at age

- SWA have been biologically sampled by Ministry of Fisheries observers from 1989-90 to 2007-08. Sampling has generally been representative of areas where SWA are caught, but length-frequency samples have varied in the extent to which they represented catches from which they came, with the majority of samples prior to 2006-07 comprising < 10 fish. Catch-weighted length-frequency distributions were calculated from these samples.
- There is little variation in the mean length of SWA in the WCSI fishery. Smaller fish tend to occur in the north of the area, and in shallower depths, with larger fish in deeper areas to the west and south.
- Length distributions show dominance of fish 45 cm – 55 cm in catches, but with evidence of strong year classes (modes of smaller fish 40 cm – 45 cm) in 1993-94, 1997 and 2002 - 2005.
- Observers also collect otoliths from measured fish. Of the otoliths collected, 2240 from 1991-92 to 1995-96 and 4350 from 1995-96 to 2004-05 have been aged by NIWA and the Central Ageing Facility, Victoria, Australia (CAF) respectively. There is generally good agreement between age

readings by these two facilities. Age frequency distributions were then estimated for the WCSI fishery from weighted length frequency distributions and applying an annual age-length key.

**Catch curve estimation of total mortality**

- Resulting annual age-frequency distributions by sex were used to generate annual total mortality ($Z$) estimates from 1992 to 2005 using catch curves and either regression-based or Chapman-Robson estimators. These estimates of Z are unchanged from the previous report on SWA 1 made to the AMP WG in 2007 (Middleton *et al*. 2007).
- The 224 mortality estimates calculated using the Chapman Robson estimator span a range from 0.22 to 0.63. Eleven are less than 0.25, the current estimate of natural mortality for silver warehou (Horn & Sutton 1996, Ministry of Fisheries 2006) and 172 (77%) are less than 0.4. Strong year classes entering the fishery appear to produce a temporary upward shift in the estimated total mortality, especially for younger assumed ages at full recruitment, but otherwise no particular trends in the estimates are apparent.

**CPUE analysis**

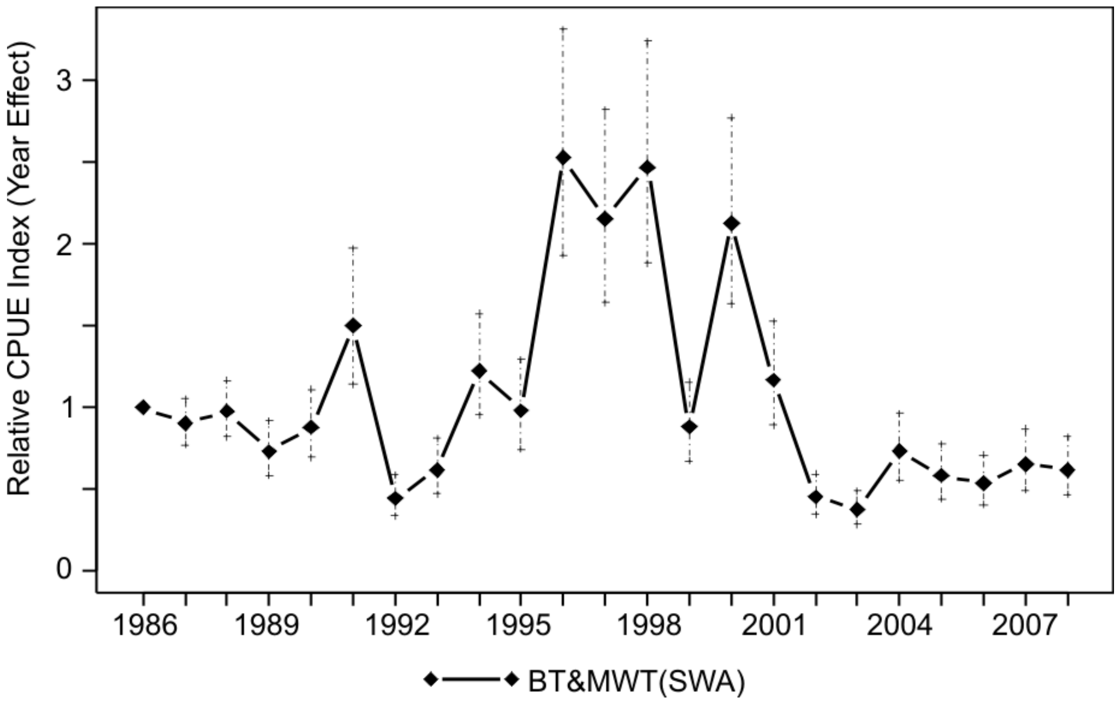



**Figure 2: Standardised CPUE index (year effects) for SWA 1 from an analysis of Scientific Observer Programme trawl records (Cordue 2009).**

- Previous SWA 1 CPUE analyses based on the MFish catch/effort returns were rejected as being unreliable as indices of SWA 1 abundance.
- A CPUE analysis for this stock was conducted in 2009 using selected observer catch and effort data for positive bottom and midwater trawl SWA catches in area FMA 7 for winter fishing within a WCSI box (40.2°S - 43.3°S).
- The data were groomed and records were selected for a core fleet (vessels which fished in at least 2 years with at least 20 tows in each year). The core fleet records were checked to ensure there was adequate linkage of vessels across years. The final data selection included 74 vessels that fished at some time over the period 1986 to 2008.
- CPUE for this data selection was standardised using a variety of lognormal models, including an all categorical variables model, a partly continuous (depth and tow duration) model, and complex models with interactions and year * latitude interactions. An adequate fit was obtained with a model that includes year, duration, month, latitude and vessel; specifying continuous variables

and complex interactions offered little improvement over the all categorical model. Strongest effects on the standardisation were by target, vessel, month and tow duration.
- The resulting index (Figure 2) is noisy but shows a general trend of slow CPUE decline from 1986 to 1992, a steep increase from 1992 to 1996 and high levels through to 2000, followed by a steep decline back to low levels by 2002 and a stable trend at slightly above historically lowest levels since then.
- The WG considered that this CPUE index was possibly consistent with strong year classes in 1993-94 and in 1997 (evident in the length frequency data), and resulting increased abundance over the ensuing few years.
- The WG considered that this CPUE standardisation might be indexing SWA 1 abundance and, given the substantial amount of catch-at-age data for this stock, recommended that a stock assessment should now be conducted to investigate the coherence between catch-at-age data and this abundance index.

**Status of the stock**

Analysis recommendations

The following analyses were recommended following the 2009 review:
- Given the amount of length-frequency and catch-at-age data, and the availability of a potential CPUE abundance index for SWA 1, the WG suggested that a stock assessment now be conducted for this stock. The WG noted that a stock assessment would require updating the age frequencies since 2005.

Abundance indices

CPUE indices have previously been considered to be unreliable for SWA 1. However, the WG considered that the BT&MWT(SWA) index prepared in 2009 using observer data seems to be consistent with observed good recruitment in 1993-94 and in 1997, with ensuing strong year classes contributing to increased catch rates over the ensuing few years. The WG concluded that this CPUE index was potentially indexing SWA 1 abundance.

This index shows a period of slowly declining CPUE from 1986 - 1992, followed by a rapid increase in CPUE to levels twice the long-term average by 1996. High catch rates continued to 1998, dipped in 1999 and rose to high levels again in 2000. Thereafter CPUE declined back to about half historic average levels, and appears to have remained stable at that level since 2004.

Sustainability of current catches

Catch curve analyses indicate that the average exploitation rate on silver warehou in the WCSI hoki fishery is probably less than the natural mortality rate, indicating that the stock was not being overfished.

Annual catches have averaged 1 480 t since the increase in TACC to 3000 t in 2002-03 and catches at this level are likely sustainable in the short to medium term. However, the TACC is double the current catch and it is not known whether catches at the level of the TACC are sustainable.

The WG noted that this Fishstock sustained catches which averaged 2800 t/year from 1993-94 to 2000-01 without resulting in high $Z$ estimates, but that this occurred over a period where CPUE indices indicate abundance of more than double current levels. A stock assessment is considered to be a more appropriate methodology to assess this Fishstock than relying on analyses of catch curves.

Stock status

This stock is most likely above $B_{MSY}$ as the average $F$ over the last 10 years has been below $M$. Estimates of $B/B_{MSY}$ should be provided by the recommended stock assessment.

## 6. STATUS OF THE STOCKS

Since the 2008 Plenary report was published, no new stock assessments have been completed for SWA stocks but a mid-term review has been completed for the SWA 1 AMP.

**SWA 1**

SWA 1 has been managed with a TACC of 3000 t since October 2002 under the AMP. CPUE indices have previously been considered to be unreliable for SWA 1. However, the SWA bottom and midwater trawl index prepared in 2009 seems to be consistent with indications of good recruitment in 1993, 1994 and 1997, with strong year classes contributing to increased catch rates over the ensuing few years. The WG concluded that this CPUE index may be indexing SWA 1 abundance.

This index shows a period of stable or slowly declining CPUE from 1986 - 1992, followed by a rapid increase in CPUE to levels twice the long-term average by 1996. High catch rates continued to 1998, dipped in 1999, and rose to high levels again in 2000. Thereafter CPUE declined back to about half historic average levels, and appears to have remained stable at that level since 2004.

Catch curve analyses indicate that the average exploitation rate on silver warehou in the WCSI hoki fishery is probably less than the natural mortality rate, indicating that overfishing is not occurring.

Annual catches have averaged 1480 t since the increase in TACC to 3000 t in 2002-03 and catches at this level are likely sustainable in the short to medium term. However, it is not known whether catches at the level of the TACC are sustainable.

**Other stocks**

No estimates of biomass are available.

In most years from 2000-01 to 2008-09 catches in SWA 3 and SWA 4 were well above the TACCs as fishers landed catches well in excess of ACE holdings. The sustainability of current TACCs and recent catch levels for these Fishstocks is not known, and it is not known if they will allow the stocks to move towards a size that will support the maximum sustainable yield.

Yield estimates, TACCs and reported landings for the 2010-11 fishing year are summarised in Table 4.

**Table 4: Summary of yields (t), TACCs (t), and reported landings (t) of silver warehou for the most recent fishing year.**

| Fishstock | | FMA | *MCY* | 2010-11 Actual TACC | 2010-11 Reported landings |
|---|---|---|---|---|---|
| SWA 1 | Auckland (East) (West), Central (East) (West), & Challenger | 1, 2, 7, 8, & 9 | 650-1400 | 3 000 | 938 |
| SWA 3 | South-East (Coast) | 3 | - | 3 280 | 3 559 |
| SWA 4 | South-East (Chatham), Southland, and Sub-Antarctic | 4, 5 & 6 | - | 4 090 | 3 507 |
| SWA 10 | Kermadec | 10 | - | 10 | 0 |
| Total | | | - | 10 380 | 8 004 |

## 7. FOR FURTHER INFORMATION

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