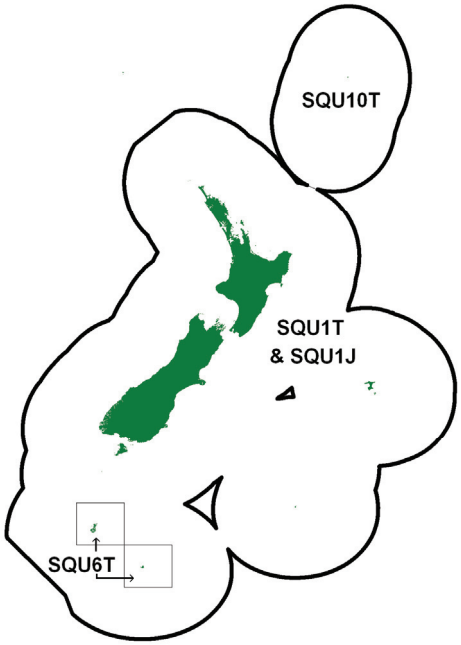
ARROW SQUID (SQU)

(*Nototodarus gouldi*, *N. sloanii*)
Wheketere



1. FISHERY SUMMARY

1.1 Commercial fisheries

The New Zealand arrow squid fishery is based on two related species. *Nototodarus gouldi* is found around mainland New Zealand north of the Subtropical Convergence, whereas *N. sloanii* is found in and to the south of the convergence zone.

Except for the Southern Islands fishery, for which a separate TACC is set, the two species are managed as a single fishery within an overall TACC. The Southern Islands fishery (SQU 6T) is almost entirely a trawl fishery. Although the species (*N. sloanii*) is the same as that found around the south of the South Island, there is evidence to suggest that the Auckland Island shelf stock is different from the mainland stocks. Because the Auckland Island shelf squid are readily accessible to trawlers, and because they can be caught with little finfish bycatch and are therefore an attractive resource for trawlers, a quota has been set separately for the Southern Islands. Total reported landings and TACCs for each stock are shown in Table 1, while historical landings and TACC are depicted in Figure 1.

The New Zealand squid fishery began in the late 1970s and reached a peak in the early 1980s when over 200 squid jigging vessels came to fish in the New Zealand EEZ. The discovery and exploitation of the large squid stocks in the southwest Atlantic substantially increased the supply of squid to the Asian markets causing the price to fall. In the early 1980s, Japanese squid jiggers would fish in New Zealand for a short time before continuing on to the southwest Atlantic. In the late 1980s, the jiggers stopped transit fishing in New Zealand and the number of jiggers fishing declined from over 200 in 1983 to around 15 in 1994. The jig catch in SQU 1J declined from 53,872 t in 1988–89 to 4865 t in 1992–93 but increased significantly to over 30,000 t in 1994–95, before declining to just over 9000 t in 1997–98. The jig catch declined to low levels for the next 4 years but then increased back up to almost 9000 t in 2004–05, before declining again to 1032 t in 2008–09.

From 1986 to 1998 the trawl catch fluctuated between about 30,000–60,000 t, but in the last few years in SQU 6T the impact of management measures to protect the Hooker's sea lion *(Phocarctos hookeri*) restricted the total catch to much lower levels.

Catch and effort data from the SQU 1T fishery show that the catch occurs between December and May, with peak harvest from January to April. The catch has been taken from the Snares shelf on the

south coast of the South Island right through to the Mernoo Bank (east cost), but statistical area 28 (Snares shelf and Snares Island region) has accounted for over 77% of the total in recent years. Based on observer data, squid accounts for 67% of the total catch in the target trawl fishery, with bycatch principally of barracouta, jack mackerel, silver warehou and spiny dogfish.

For 2005–06 a 10% in-season increase to the SQU 1T TACC was approved by the Minister of Fisheries. The catch for December - March was 40% higher than the average over the previous eight years and catch rates were double the average, indicating an increased abundance of squid. Previously, in 2003–04, a 30% in-season increase to the TACC was agreed, but catches did not reach the higher limit. Note that the TACC automatically reverts to the original value at the end of the fishing year.

Table 1: Reported catches (t) and TACCs (t) of arrow squid from 1986–87 to 2008–09. Source – QMS.

Fishstock	SQU1J*		SQU1T*		SQU6T†		SQU10T‡		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1986–87	32 394	57 705	25 621	30 962	16 025	32 333	0	10	74 040	121 010
1987–88	40 312	57 705	21 983	30 962	7 021	32 333	0	10	69 316	121 010
1988–89	53 872	62 996	26 825	36 081	33 462	35 933	0	10	114 160	135 080
1989–90	13 895	76 136	13 161	47 986	19 859	42 118	0	10	46 915	166 250
1990–91	11 562	46 087	18 680	42 284	10 658	30 190	0	10	40 900	118 571
1991–92	12 985	45 766	36 653	42 284	10 861	30 190	0	10	60 509	118 571
1992–93	4 865	49 891	30 862	42 615	1 551	30 369	0	10	37 278	122 875
1993–94	6 524	49 891	33 434	42 615	34 534	30 369	0	10	74 492	122 875
1994–95	33 615	49 891	35 017	42 741	30 683	30 369	0	10	99 315	123 011
1995–96	30 805	49 891	17 823	42 741	14 041	30 369	0	10	62 668	123 011
1996–97	20 792	50 212	24 769	42 741	19 843	30 369	0	10	65 403	123 332
1997–98	9 329	50 212	28 687	44 741	7 344	32 369	0	10	45 362	127 332
1998–99	3 240	50 212	23 362	44 741	950	32 369	0	10	27 553	127 332
1999–00	1457	50 212	13 049	44 741	6 241	32 369	0	10	20 747	127 332
2000–01	521	50 212	31 297	44 741	3 254	32 369	<1	10	35 071	127 332
2001–02	799	50 212	35 872	44 741	11 502	32 369	0	10	48 173	127 332
2002–03	2 896	50 212	33 936	44 741	6 887	32 369	0	10	43 720	127 332
2003–04	2 267	50 212	48 060	58 163#	34 635	32 369	0	10	84 962	127 332
2004–05	8 981	50 212	49 780	44 741	27 314	32 369	0	10	86 075	127 332
2005–06	5 844	50 212	49 149	49 215#	17 425	32 369	0	10	72 418	127 332
2006–07	2 278	50 212	49 495	44 741	18 479	32 369	0	10	70 253	127 332
2007–08	1 371	50 212	36 171	44 741	18 493	32 369	0	10	56 035	127 332
2008–09	1 032	50 212	16 407	44 741	28 872	32 369	0	10	46 311	127 332

* All areas except Southern Islands and Kermadec.
† Southern Islands.
‡ Kermadec.
# In season increase of 30% for 2003-04 and 10% for 2005-06

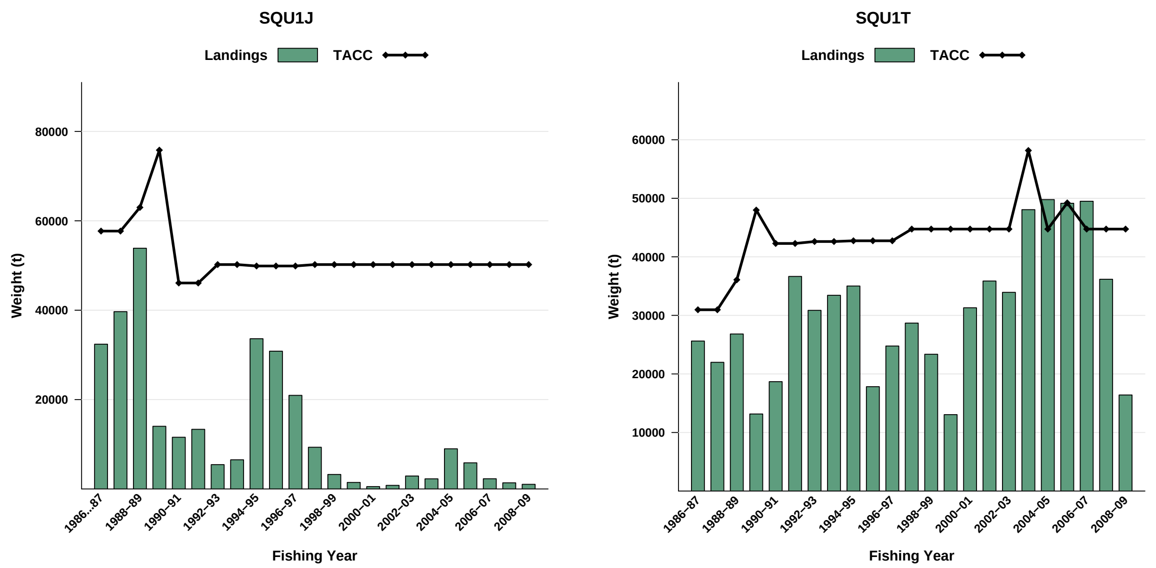


Figure 1: Historical landings and TACC for the three main SQU stocks. Left to right: SQU1J (All Waters Except 10T and 6T, Jigging) and SQU1T (All Waters Except 10T and 6T, All Other Methods). [Continued on next page]...

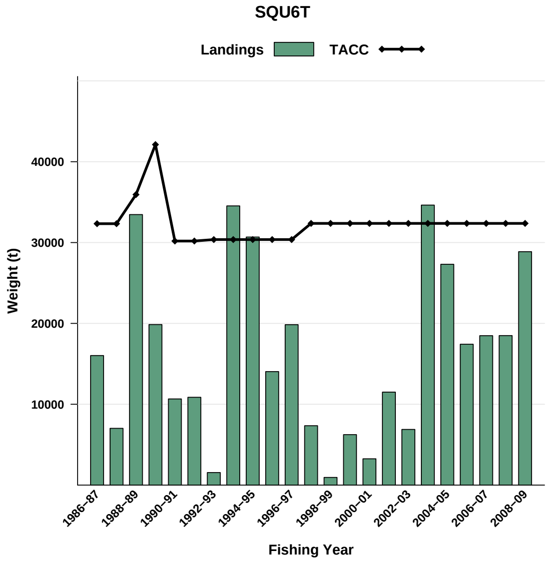


Figure 1 [Continued]: Historical landings and TACC for the three main SQU stocks. SQU6T (Southern Islands, All Methods). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries
The amount of arrow squid caught by recreational fishers is not known.

1.3 Customary non-commercial fisheries
No quantitative information is available on the current level of customary non-commercial take.

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

1.5 Other sources of mortality
No information is available on other sources of mortality.

2. BIOLOGY

Two species of arrow squid are caught in the New Zealand fishery. Both species are found over the continental shelf in water up to 500 m depth, though they are most prevalent in water less than 300 m depth. Both species are sexually dimorphic, though similar in biology and appearance. Individuals can be identified to species level based on sucker counts on Arm I and differences in the hectocotylized arm of males.

Recent work on the banding of statoliths from *N. sloanii* suggests that the animals live for around 1 year. Growth is rapid. Modal analysis of research data has shown increases of 3.0–4.5 cm per month for Gould's arrow squid measuring between 10 and 34 cm Dorsal Mantle Length (DML).

Estimated ages suggest that *N. sloanii* hatches in July and August, with spawning occurring in June and July. It also appears that *N. gouldi* may spawn one to two months before *N. sloanii*, although there are some indications that *N. sloanii* spawns at other times of the year. All squid taken by the fishery do not appear to have spawned.

Tagging experiments indicate that arrow squid can travel on average about 1.1 km per day with a range of 0.14–5.6 km per day.

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

Table 4: Estimates of biological parameters.

Fishstock	Estimate			Source
1. Weight = a (length)b (Weight in g, length in cm dorsal length)				
		a	b	
N. gouldi	≤ 12 cm DML	0.0738	2.63	Mattlin *et al*. (1985)
N. sloanii	≥ 12 cm DML	0.029	3	
2. von Bertalanffy growth parameters				
	K	t0	L	
N. gouldi	2.1–3.6	0	35	Gibson & Jones (1993)
N. sloanii	2.0–2.8	0	35	

3. STOCKS AND AREAS

There are no new data which would alter the stock boundaries given in previous assessment documents. It is assumed that the stock of *N. gouldi* (the northern species) is a single stock, and that *N. sloanii* around the mainland comprises a unit stock for management purposes, though the detailed structure of these stocks is not fully understood. The distribution of the two species is largely geographically separate but those occurring around the mainland are combined for management purposes. The Auckland Islands Shelf stock of *N. sloanii* appears to be different from the mainland stock and is managed separately.

4. ENVIRONMENTAL EFFECTS OF FISHING

This section was updated for the May 2010 Plenary and has been considered by the Aquatic Environment Working Group (AEWG). It includes a summary of the incidental bycatch of marine mammals and seabirds in this fishery as well as a summary of some other potential environmental effects. A more detailed assessment of environmental effects across all fisheries will be available in the Ministry's Aquatic Environment Plenary that is under development.

4.1 Role in the ecosystem

Not discussed by the AEWG.

4.2 Incidental catch (fish and invertebrates)

Ballara & Anderson (2008) described the bycatch of squid trawlers but a summary has not been discussed by the AEWG.

4.3 Incidental catch (seabirds and mammals)

4.3.1 Sea lion interactions – SQU6T

4.3.1.1 Introduction and management approach

New Zealand (or Hooker's) sea lions, *Phocarctos hookeri*, are caught by vessels trawling for arrow squid, most frequently around the Auckland Islands. Since 1992, the Minister of Fisheries has set an annual limit on the number of sea lions that can be killed in the SQU6T fishery before it is closed. Until 2003-04, this Fishing-Related Mortality Limit (FRML, Table 5) was set based on estimates of potential biological removals (PBR). Since then, the FRML has been set using the results of simulation models that explore the effects of different bycatch control rules on the Auckland Islands sea lion population.

Sea lion exclusion devices (SLEDs) are designed to allow sea lions to exit a trawl net if they get caught, and were introduced into the fishery from 2000–01. The average survival rate of sea lions that pass through trawls is uncertain, so total fishing-related mortality cannot be assessed directly. Since the widespread adoption of SLEDs, therefore, performance against the FRML in a year is estimated using an assumed "strike rate" of sea lions and an assumed survival rate of those that pass through a SLED.

4.3.1.2 Evaluation of management rules

Population modelling has been used to evaluate the population consequences of alternative bycatch control rules for the SQU 6T fishery (Breen et al. 2010). Models are fitted to data from population studies, mortality estimates (those assumed are shown in Table 6) and fishing effort which is driven by annual fluctuations in squid abundance. The joint posterior distribution of estimated parameters formed the basis of an operating model used to evaluate bycatch control rules by simulation. Several alternative operating models were developed to explore the effects of decisions made in the base case model (regarding density dependence and maximum rate of population increase). Operating models were used to evaluate candidate bycatch control rules against management objectives, using four different assumptions about the survival of sea lions that encounter nets with sea lion exclusion devices. The results of these evaluations form part of the advice to the Minister each year for use in their decision on the FRML.

4.1.3.3 Estimated interactions and captures

Model-based estimates have been generated for the total interactions, total captures and strike rate of sea lions in the SQU6T fishery for fishing years 1995-96 to 2007-08. Captures relate to those sea lions that are retained in the trawl net at the haul. The number of interactions with a trawl can be interpreted as the number of sea lions that would have been caught if a SLED had not been used (Thompson et al. 2009).

Estimated captures have decreased throughout this period; however, interactions are predicted to have fluctuated with high points in 1995-96 to 1996-97 and 2003-04 to 2005-06. The strike rate is estimated to have been low in 1995-96 and at its highest in 2000-01. In recent years the estimated strike rate has been between 5.2 and 5.9% with high variance (Table 7).

Table 5: Squid 6T fishery – sea lion FRML and closure dates from 1991–92 to 2008–09.

	SQU6T Landings (t)	Sea lion FRML	Fishery closure date
1991–92	10 861	32	
1992–93	1551	63	
1993–94	34 534	63	
1994–95	30 683	69	
1995–96	14 041	73	4-May
1996–97	19 843	79	28-May
1997–98	7344	63	27-Mar
1998–99	950	64	
1999–00	6241	65	8-Mar
2000–01	3254	75	a
2001–02	11 502	79	13-Apr
2002–03	6887	70	b
2003–04	34 635	62	c
2004–05	27 314	115	20 Apr[d]
2005–06	17 425	97/150	e
2006–07	17 479	93	
2007–08	18 493	81	
2008–09	28 872	113//95	f

a The fishery was not officially closed in 2000/01. Industry voluntarily withdrew most vessels on 7 March 2001.

b Under the Operational Plan the SQU 6T fishery was closed on 29 March 2003 when the FRML count reached 79 sea lions. A High Court ruling in April 2003 allowed for continued fishing in SQU 6T and established a separate procedure for estimating sea lion mortalities resulting in the 39 mortalities indicated. Fishers had voluntarily withdrawn from SQU 6T as at the end of June.

c Under the Operational Plan closure of the SQU 6T fishery was proposed on 22 March 2004 when the FRML count reached 62 sea lions. A Court of Appeal ruling in April 2004 set aside the 2003-04 Operational Plan and allowed for continued fishing in SQU 6T providing incidental NZSL captures did not exceed 124. Industry withdrew from the SQU 6T fishery before this limit was reached, as estimated using the procedures set out in the 2003-04 Operational Plan.

d Fishers voluntarily withdrew from the SQU 6T fishery upon reaching the 115 animal FRML on 17 April 2005.

e In 2005–06 the FRML was initially set at 97 animals, and the Minister chose to increase this mid-season to 150, on the basis of there being a squid utilisation opportunity. Fishing had practically ceased by early May 2006.

f In 2008-09 the FRML was set at 113, but was voluntarily reduced to the equivalent of 95 in response to unexpectedly low pup numbers,

4.3.1 Sea lion interactions – SQU1T

Sea lions have been observed caught in fisheries operating on the Stewart-Snares shelf including trawl fisheries targeting hoki and squid (SQU1T). The number of captures observed and capture rate is relatively low (Table 8) (Abraham & Thompson 2009, Abraham et al. 2010). The SQU1T fishery accounts for only a relatively small proportion of the currently estimated total captures of sea lions from New Zealand fisheries.

Table 6: SQU 6T bycatch vectors used by Breen et al (2010) to derive model inputs (mean, rounded to the nearest sea lion). The Breen-Kim-Starr (BKS) estimates use the Breen et al. (2005) method with data up to 2008. The final column shows the BKS strike rate estimates.

Year	IPP 2006	Smith & Baird 2005	Smith & Baird 2007	Abraham 2008	Breen-Kim-Starr	Default & discount	Mean	BKS strike rate
1997-88	33	–	–	–	–	–	33	–
1988-89	141	–	–	–	–	–	141	–
1989-90	117	–	–	–	–	–	117	–
1990-91	21	–	–	–	–	–	21	–
1991-92	82	79	–	–	–	–	81	–
1992-93	17	18	–	–	–	–	18	–
1993-94	32	43	–	–	–	–	38	–
1994-95	109	112	–	–	–	–	111	–
1995-96	101	104	–	–	–	–	103	–
1996-97	123	147	–	–	–	–	135	–
1997-98	62	65	–	–	–	–	64	–
1998-99	14	13	–	–	–	–	14	–
1990-00	71	69	–	53	–	–	64	–
2000-01	67	34	–	51	–	–	51	–
2001-02	84	76	–	56	63	79	72	0.043
2002-03	39	–	–	36	45	62	45	0.038
2003-04	118	–	147	223	153	107	149	0.076
2004-05	115	–	101	109	110	113	109	0.052
2005-06	110	–	–	110	166	104	122	0.085
2006-07	–	–	–	56	63	56	58	0.072
2007-08	–	–	–	–	45	57	51	0.045
2008-09	–	–	–	–	–	83	83	

Table 7: Annual trawl effort, observer coverage, observed numbers of sea lions captured, observed capture rate (sea lions per 100 trawls), estimated sea lion captures, interactions, and the estimated strike rate (with 95% confidence intervals), in the Auckland Islands squid fishery (SQU6T) (from Thompson et al. 2009).

	Observed				Estimated captures		Estimated interactions		Estimated strike rate (%)	
	Effort	% obs.	Captures	Rate	Mean	(95% c.i.)	Mean	(95% c.i.)	Mean	(95% c.i.)
1995–96	4 460	12	13	2.4	143	(73 - 249)	143	(73 - 245)	3.2	(1.7 - 5.4)
1996–97	3 733	20	28	3.8	141	(91 - 210)	141	(88 - 212)	3.8	(2.5 - 5.5)
1997–98	1 470	23	14	4.1	62	(35 - 101)	62	(34 - 104)	4.2	(2.6 - 6.7)
1998–99	402	38	5	3.3	15	(7 - 28)	15	(5 - 29)	3.8	(2.3 - 6.2)
1999–00	1 208	36	25	5.7	65	(42 - 101)	65	(39 - 102)	5.4	(3.8 - 8.00
2000–01	583	99	39	6.7	39	(39 - 40)	57	(37 - 81)	9.8	(8.3 - 12.0)
2001–02	1 648	34	21	3.7	45	(30 - 66)	73	(43 - 116)	4.4	(3.0 - 6.6)
2002–03	1 470	29	11	2.6	21	(13 - 32)	48	(24 - 82)	3.3	(2.0 - 5.2)
2003–04	2 594	30	16	2	43	(27 - 66)	169	(88 - 301)	6.5	(3.5 - 11.5)
2004–05	2 706	30	9	1.1	35	(19 - 59)	144	(69 - 269)	5.3	(2.6 - 9.8)
2005–06	2 462	22	9	1.6	34	(20 55)	146	(70 - 267)	5.9	(3.0 - 10.7)
2006–07	1 320	41	7	1.3	17	(10 - 28)	76	(33 - 140)	5.7	(2.7 - 10.2)
2007–08	1 265	46	5	0.9	14	(7 - 25)	65	(26 - 124)	5.2	(2.2 - 9.7)

Table 8: Summary of sea lion captures in the SQU1T trawl fishery, for the 2006-07 and 2007-08 fishing years, with the number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate (from Thompson et al. 2010c).

	Observed					Ratio estimated		
	Tows	No. obs	% obs	Captures	Rate	Captures	(95% c.i.)	% effort in estimate
2006–07	2 926	705	24.1	1	0.14	3	(2 - 5)	100.0
2007–08	2 413	864	35.8	0	0	1	(1 -2)	100.0

4.3.2 Interactions with seabirds and fur seals

This section provides an overview of the incidental captures of seabirds and fur seals in squid fisheries. Capture estimates include only those animals landed (alive, injured or dead) on fishing vessels but may not include all sources of cryptic mortality e.g. seabirds struck by the warp but not landed onboard the vessel. Various projects have estimated the total incidental captures in this fishery. This section refers to ratio estimates of incidental captures for all years and model based estimates where available (for methods see Abraham et al. 2010, Abraham & Thompson in press, Baird and Smith 2007, 2008, MacKenzie and Fletcher 2006, Smith & Baird 2009, Thompson et al. in press a).

Annual observed seabird capture rates ranged from 5.78 to 18.13 per hundred tows in squid fisheries during the period from 1998-99 to 2007-08. Estimated means of total annual captures ranged from 242 to 1 393 seabirds (ratio estimated) and 378 to 1 246 (model estimated) (Table 9). Capture rate and estimated totals fluctuated along with some fluctuation in level of effort. It is likely that decreases in catch rate since 2005-06 are related to trawl warp mitigation device regulations and voluntary improvements in offal and discard management.

Seabird species that were observed caught in the squid fishery from 1998-99 to 2007-08 are (with total numbers of each species observed caught during this period); white-capped albatross (910), sooty shearwater (609), white-chinned petrel (281), Buller's albatross (38), albatrosses (unidentified) (25), petrel (unidentified) (24), Salvin's albatross (19), seabird – small (19), seabird – large (15), shy albatross (14), southern royal albatross (7), Antarctic prion (6), black-browed albatross (unidentified) (5), common diving petrel (3), storm petrels (3), seabird (unspecified) (3), southern black-browed albatross (2), giant petrels (unidentified) (2), prions (unidentified) (2), cape petrels (1), and other species (10) (Abraham et al. 2010). Note that identification to species or group level is done by observers onboard and some birds are not readily identifiable.

Annual observed fur seals capture rates ranged from 0.41 to 3.62 per hundred tows in squid fisheries during the period from 1998-99 to 2007-08. Estimated means of total annual captures ranged from 30 to 290 fur seals (ratio estimated) and 31 to 266 (model estimated) (Table 10). The estimated total of fur seals captures has reduced markedly over this period.

4.4 Benthic interactions

Squid is taken using trawls or jigs. Since 1998 the fishery has predominantly used bottom and midwater trawls (Hurst et al. 2009 submitted) on or near the seabed but a summary has not been discussed by the AEWG.

5.5 Other considerations

Not discussed by the AEWG.

Table 9: Summary of all bird captures in the squid trawl fishery, for 10 fishing years, with the number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate (from Abraham et al. 2010) and model based estimates of capture with 95% confidence intervals or coefficient of variation (from MacKenzie & Fletcher 2006, vessels over 28 m only, Baird & Smith 2007, 2008 and Abraham & Thompson in press).

	Observed					Ratio estimated			Model based estimates of captures (95% c.i. or c.v.)					
	Tows	No. obs	% obs	Captures	Rate	Captures (95% c.i.)		% effort in estimate	MacKenzie & Fletcher		Baird & Smith	Abraham & Thompson	
1998–99	8 012	995	12.4	104	10.45	656	(474 - 867)	99.0	669	(541 - 821)			
1999–00	5 651	917	16.2	53	5.78	242	(171 - 332)	93.8	378	(303 - 471)			
2000–01	8 075	3 001	37.2	376	12.53	607	(550 - 677)	92.8	1 003	(878 - 1144)			
2001–02	7 475	1 455	19.5	225	15.46	830	(701 - 977)	95.5	889	(770 - 1024)			
2002–03	8 410	1 308	15.6	160	12.23	862	(701 - 1 044)	94.5	1 007	(859 - 1174)		1 058	(778 – 1665)
2003–04	8 336	1 769	21.2	204	11.53	821	(725 - 926)	95.7	1 246	(1073 -1444)	846 (c.v. = 12%)	905	(693 – 1195)
2004–05	10 490	2 511	23.9	382	15.21	1 393	(1 252 - 1 536)	98.8			1 324 (c.v. = 9%)	1 604	(1316 – 1961)
2005–06	8 582	1 103	12.9	200	18.13	1 307	(1 000 - 1 686)	99.3			1 458 (c.v. = 15%)	1 093	(830 – 1472)
2006–07	5 910	1 289	21.8	127	9.85	470	(400 - 549)	97.5				660	(468 - 1 021)
2007–08	4 237	1 456	34.4	167	11.47	440	(379 - 511)	99.9					

Table 10: Summary of New Zealand fur seal captures in the squid trawl fishery, for 10 fishing years, with the number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, percentage of tows included in the estimate (from Abraham et al. 2010) and model based estimates of captures with 95% confidence intervals (from Smith & Baird 2009 and Thompson et al. in press a). Note that Smith & Baird (2009) estimated captures by area, therefore confidence intervals are not readily available when aggregated at this level.

	Observed					Ratio estimated			Model based estimates of captures (95% c.i.)			
	Tows	No. obs	% obs	Captures	Rate	Captures (95% c.i.)		% effort in estimate	Smith & Baird	Thompson et al.		
1998–99	8 012	995	12.4	36	3.62	290	(211 - 380)	99.0	266			
1999–00	5 651	917	16.2	12	1.31	97	(60 - 140)	93.8	68			
2000–01	8 075	3 001	37.2	31	1.03	106	(64 - 158)	92.8	83			
2001–02	7 475	1 455	19.5	23	1.58	134	(95 - 176)	95.5	163			
2002–03	8 410	1 308	15.6	8	0.61	90	(54 - 132)	94.5	78	70	(34 - 128)	
2003–04	8 336	1 769	21.2	17	0.96	84	(58 - 112)	95.7	131	104	(57 - 181)	
2004–05	10 490	2 511	23.9	16	0.64	70	(46 - 99)	98.8	97	178	(95 - 319)	
2005–06	8 582	1 103	12.9	4	0.36	54	(26 - 87)	99.3	116	114	(56 - 215)	
2006–07	5 910	1 289	21.8	8	0.62	55	(31 - 83)	97.5		44	(23 - 78)	
2007–08	4 237	1 456	34.4	6	0.41	30	(18 - 44)	99.9		31	(16 - 55)	

5. STOCK ASSESSMENT

Arrow squid live for one year, spawn once then die. Every squid fishing season is therefore based on what amounts to a new stock. It is not possible to calculate reliable yield estimates from historical catch and effort data for a resource which has not yet hatched, even when including data which are just one year old. Furthermore, because of the short life span and rapid growth of arrow squid, it is not possible to estimate the biomass prior to the fishing season. Moreover, the biomass increases rapidly during the season and then decreases to low levels as the animals spawn and die.

5.1 Estimates of fishery parameters and abundance

No estimates are available.

5.2 Biomass estimates

Biomass estimates are not available for squid.

5.3 Estimation of Maximum Constant Yield (MCY)

It is not possible to estimate MCY.

5.4 Estimation of Current Annual Yield (CAY)

It is not possible to estimate CAY.

5.5 Other yield estimates and stock assessment results

There are no other yield estimates of stock assessment results available for arrow squid.

5.6 Other factors

N. gouldi spawns one to two months before *N. sloanii*. This means that at any given time *N. gouldi* is older and larger than *N. sloanii*. The annual squid jigging fishery begins on *N. gouldii* and at some time during the season the biomass of *N. sloanii* will exceed that of *N. gouldi* and the fleet will move south. If *N. sloanii* are abundant the fleet will remain in the south fishing for *N. sloanii*. If *N. sloanii* are less abundant the fleet will return north and resume fishing *N. gouldi*.

6. STATUS OF THE STOCKS

No estimates of current and reference biomass are available. There is also no proven method at this time to estimate yields from the squid fishery before a fishing season begins based on biomass estimates or CPUE data.

Because squid live for about one year, spawn and then die, and because the fishery is so variable, it is not practical to predict future stock size in advance of the fishing season. As a consequence, it is not possible to estimate a long-term sustainable yield for squid, nor determine if recent catch levels or the current TACC will allow the stock to move towards a size that will support the MSY. There will be some years in which economic or other factors will prevent the TACC from being fully taken, while in other years the TACC may be lower than the potential yield. It is not known whether New Zealand squid stocks have ever been stressed through fishing mortality.

There is continuing concern about the bycatch of sea lions in the Southern Islands trawl squid fishery (SQU 6T) that has been addressed by a management plan restricting the total number of kills per season.

TACCs and reported landings for the 2008–09 fishing year are summarised in Table 11.

Table 11: Summary of TACCs (t) and reported landings (t) of arrow squid for the most recent fishing year.

Fishstock	2008–09 Actual TACC	2008–09 Reported landings
SQU 1J	50 212	1 032
SQU 1T	44 741	16 407
SQU 6T	32 369	28 872
SQU 10T	10	0
Total	127 332	46 311

7. FOR FURTHER INFORMATION

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