Proposed Operational Plan To Manage The Incidental Capture Of New Zealand Sea Lions In The Squid (SQU) 6T Trawl Fishery For The 2005-06 Fishing Year

Initial Position Paper

Consultation Document
1 August 2005

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EXECUTIVE SUMMARY

1 This paper is the Ministry of Fisheries' (MFish) initial position on a proposed management regime to manage the interactions between the New Zealand (or Hooker's) sea lion and the southern squid trawl fishery (SQU 6T) during the 2005-06 fishing year. This regime will be implemented under a 2005-06 Operational Plan approved by the Minister of Fisheries.

2 The proposed regime will focus, as it has in past years, primarily on the use of a 'fishing-related mortality limit' (FRML) to constrain the New Zealand sea lion mortalities caused by SQU 6T trawl fishing to an acceptable biological level. The 2005-06 Operational Plan will continue to adopt an interim management objective to ensure fishing-related mortality does not prevent sea lions from increasing to near carrying capacity if they are depleted.

3 The 2004-05 Auckland Islands total pup production estimate is 2 148 animals (based on the Gales & Fletcher model), and represents about a 15% decrease on the previous two years[1]. A species estimate of New Zealand sea lions is 11 995 animals (10 391-13 791; 95% confidence limits) and includes the 2003 pup production estimate of 385 animals from Campbell Island. The 2005 species estimate represents the second estimate below 12 000 animals in the last four years and the second lowest estimate in the last ten years. The mean estimate of sea lions on the Auckland Islands is 10 165 animals (8 783-11 746; 95% confidence limits).

4 The Breen and Kim model has been run using the most recent (2004-05) Auckland Islands pup production estimate to provide a range of alternative FRMLs under six different harvest control rules (Rules 1, 305, 310, 320, 4, and the Cusp Rule). Five of these rules satisfy the interim management objective to provide a continuum of possible FRMLs the Minister of Fisheries could apply for the 2005-06 SQU 6T fishery. The choice of a FRML for the 2005-06 fishery needs to meet the dual requirements of the Fisheries Act 1996 to balance sustainability of the sea lion population with utilisation of the SQU 6T resource, while acknowledging information uncertainty. The FRMLs calculated by the Breen and Kim model range between 30 to 555 sea lions. Rule 4 generates a FRML with variable response to the sea lion production estimate.

5 MFish proposes the 2005-06 Operational Plan includes the following main components:

a) A FRML of 96 sea lions based on Rule 4 as calculated by the Breen and Kim model;

b) A predetermined strike rate of 5.3% (with the application of a 20% discount factor to any qualifying vessel) to estimate and monitor total sea lion mortalities against the FRML;

c) Monitoring and reporting requirements to support the FRML; and

d) Closure procedures in the event the FRML is reached.

6 Fishing under the proposed Operational Plan is projected to enable the SQU 6T fleet to catch between 40% and 70% of the SQU 6T TACC, depending upon squid availability and catch rates in the 2005-06 season. Other the past 17 seasons, reported landings in the SQU 6T fishery have varied significantly. On average, fishers have caught about 42% of the TACC.

[1] Memorandum. New Zealand Sea Lion Auckland Islands Pup Production 2004 / 2005. Louise Chilvers, Department of Conservation. 26 April 2005.

INTRODUCTION

7 In accordance with s 12(1) of the Fisheries Act 1996 (the Act), the purpose of this Initial Position Paper (IPP) is to commence consultation on a proposed management regime to manage the interactions between the New Zealand (or Hooker's) sea lion and the southern squid trawl fishery (SQU 6T) during the 2005-06 fishing year. This regime will be implemented under a 2005-06 Operational Plan approved by the Minister of Fisheries.

8 In this document, the term 'fishing-related mortality limit' or FRML describes the limit on fishing-related mortality applied under s 15(5)(b) of the Act[2].

9 MFish invites you to provide comments on the proposed Operational Plan for the 2005-06 SQU 6T fishery. All comments are to be received by **Friday, 19 August 2005** and should be sent to Paul Creswell, Senior Fisheries Analyst, Ministry of Fisheries, Private Bag 14, Nelson, or faxed to (03) 545 7799, or emailed to creswelp@fish.govt.nz.

10 If you have any questions about this IPP, please contact Paul Creswell or Jim Cornelius, Senior Fisheries Management Advisor (deepwater), at the Ministry's Nelson office on (03) 548 1069, or e-mail cornelij@fish.govt.nz.

BACKGROUND INFORMATION

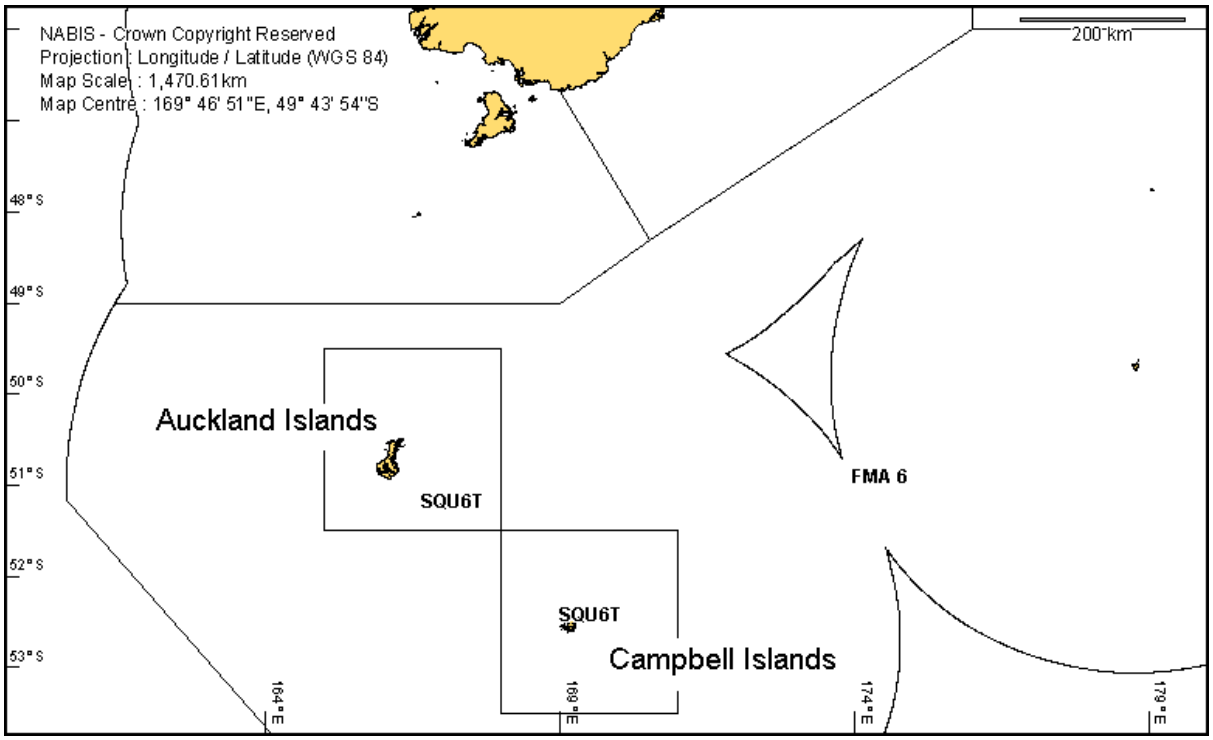
New Zealand sea lion

11 The New Zealand sea lion is New Zealand's only endemic pinniped (seals and sea lions) and one of the rarest sea lions in the world. This species primarily occurs in New Zealand's Sub-Antarctic zone, with small numbers present along the southern parts of the South Island. Remains of sea lions found in the North, South and Chatham Islands suggest this species may once have been more widespread than today. The geographic distribution of the New Zealand sea lion is limited and localised in comparison to other pinnipeds, increasing the vulnerability of the species.

12 Over 95% of the breeding population of this species occurs on two small breeding sites (rookeries) at Dundas and Enderby Islands in the Auckland Islands (Figure 1). A small breeding population also exists on Campbell Island. No established rookeries are found on the New Zealand mainland.

[2] Before the 2004-05 Operational Plan, previous plans used the term "Maximum Allowable Level of Fishing Related Mortality (MALFiRM)" to describe the limit on fishing related mortality the Minister of Fisheries enforces under s 15(5)(b) of the Act. This created confusion because a MALFiRM proper is an output of a Population Management Plan the Minister must enforce under s 15(5)(a) of the Act. In this document, MALFiRM refers to those considerations under s 15(5)(a) of the Act, and FRML refers to those considerations under s 15(5)(b) of the Act.

Figure 1 Map showing the location of the Auckland Islands and Campbell Islands



13 Breeding generally commences in late November when adult males establish territories. Males leave the rookery in February, but females stay on to suckle their pups. Female sea lions alternate periods ashore nursing their pups with periods at sea foraging. At any one time during the breeding season, approximately 50% of the females are foraging at sea.

14 The foraging range of New Zealand sea lions that inhabit the Auckland Islands can extend over 100 km. This foraging range overlaps the fishing grounds of the SQU 6T fishery and leads to the incidental captures of sea lions by trawl vessels that are targeting arrow squid.

15 To mitigate the risk these fishing interactions posed to the New Zealand sea lion population, Government imposed a 12 nautical mile exclusion zone[3] around the Auckland Islands in 1986 to prohibit fishing close to the major breeding areas of the sea lion. In 1994, the Auckland Islands Marine Mammal Sanctuary was established within this same area and with the same controls on fishing. This area became part of the Auckland Islands - Motu Maha Marine Reserve in January 2004, continuing the existing prohibition on all fishing activities within the 12 nautical mile exclusion zone. Outside the 12 nautical mile exclusion zone, there are many active commercial fisheries for various species, including arrow squid.

16 The New Zealand sea lion is classified under s 2(3) of the Marine Mammals Protection Act 1978 as a "*threatened species*". Under this classification, this species is considered not immediately threatened with extinction, but is potentially vulnerable to population decline.

[3] Regulation 15 of the Fisheries (Southland and Sub-Antarctic Commercial Fishing) Regulations 1986

Operational plans

17 In the past decade, the capture of sea lions within the SQU 6T fishery has lead to the implementation of annual operational plans to mitigate the effects of fishing on the New Zealand sea lion population.

18 These plans have focused primarily on the use of a FRML to constrain the total number of sea lion captures within a particular fishing year to a biologically acceptable level. The basic objective of the plans is to allow the SQU 6T fishery to continue to operate until the FRML is reached. At this point, the SQU 6T fishery is closed even if the Total Allowable Commercial Catch (TACC) is not fully taken.

19 An overview of the 2004-05 Operational Plan and season is provided in Annex One.

SQU 6T fishery

20 Squid is one of New Zealand's top 20 seafood exports by volume and by value. Export values vary significantly ranging from $69 million in 2003 to $171 million (FOB) in 2004, reflecting abundance and catch of squid. In 2005, export values are expected to exceed $100 million. The major product states are frozen whole, followed by frozen, headed and gutted. Major markets for frozen whole squid are the Peoples Republic of China, Greece, Korea, the U.S.A, and Taiwan. For frozen headed and gutted, the major markets are Spain, Italy and the Peoples Republic of China.

21 The difference in export figures reflects variable catch levels – the fishery is seasonal and catch fluctuates between years (Table 1). Squid live for about one year, spawn once, and then die, so every squid season is based on what amounts to a new stock[4]. Because of the short life span and rapid growth of arrow squid, it is not possible to estimate the biomass prior to the start of any fishing season. Moreover, the biomass increases rapidly during the season and then decreases to low levels as the animals spawn and die.

22 The SQU 6T fishery is almost entirely a target trawl fishery with over 99% of the annual catch in recent years taken by trawlers targeting arrow squid around the Auckland Islands[5]. The SQU 6T TAC equates to about 25% of the entire squid TACs (trawl and jig combined) throughout New Zealand.

23 Landings in SQU 6T have been irregular over time. The variable nature of catches reflect both unpredictable squid availability and season closures because of sea lion interactions. Table 1 compares annual reported landings, TACCs, FRMLs, estimated sea lion mortalities, and fishery closure dates (if triggered by the FRML) since 1987-88. Estimated mortalities have exceeded the FRML in some fishing years because of the unpredictability of sea lion bycatch, and the time needed to receive ongoing vessel operations data required to extrapolate FRML estimates.

[4] Sullivan.K.J., Mace.P.M., Smith.N.W.McL., Griffiths.M.H., Todd.P.R., Livingston.M.E., Harley.S.J., Key.J.M., & Connell.A.M. (2005). Report from the Fishery Assessment Plenary, May 2005: stock assessments and yield estimates; Ministry of Fisheries.

[5] Langley A (2001). New Zealand Fisheries Assessment Report 2001/51, Ministry of Fisheries.

Table 1 Squid 6T fishery – sea lion interaction statistics

fishing year	SQU6T TACC (t)	SQU6T catch (t)	sea lion FRML	estimated mortalities	closure date
1987-88	32 333	7 021	--	33	--
1988-89	35 933	33 462	--	141	--
1989-90	42 118	19 859	--	117	--
1990-91	30 190	10 658	--	21	--
1991-92	30 190	10 861	32	82	--
1992-93	30 369	1 551	63	17	--
1993-94	30 369	34 534	63	32	--
1994-95	30 369	30 683	69	109	--
1995-96	30 369	14 041	73	101	4 May
1996-97	30 369	19 843	79	123	28 Mar
1997-98	32 369	7 344	63	62	27-Mar
1998-99	32 369	950	64	14	--
1999-00	32 369	6 241	65	71	8-Mar
2000-01	32 369	3 254	75	67	-- [a]
2001-02	32 369	11 502	79	84	13-Apr
2002-03	32 369	6 887	70	39	-- [b]
2003-04	32 369	34 634	62	118	-- [c]
2004-05	32 369	26 437 (as at July 2005)	115	115	20-Apr[d]

[a] The fishery was not officially closed in 2000/01. Industry voluntarily withdrew most vessels on 7 March 2001. Some observed vessels with closed cover nets remained in SQU6T for a short period in an effort to obtain Sea Lion Exclusion Device (SLED) performance data[6].

[b] Under the Operational Plan the SQU6T 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 SQU6T and established a separate procedure for estimating sea lion mortalities resulting in the 39 mortalities indicated. This estimate (39) is derived from a different procedure from that set out in the 2002-03 Operational Plan. Fishers had voluntarily withdrawn from SQU6T as at the end of June.

[c] Under the Operational Plan the SQU6T fishery was closed 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 SQU6T providing incidental New Zealand sea lion captures did not exceed 124. Industry withdrew from the SQU6T fishery before they reached the Court established mortality limit 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.

Legal framework

24 The purpose statement of the Fisheries Act 1996 describes its overriding objective of providing for the utilisation of fisheries resources while ensuring sustainability. The 1996 Act defines "*ensuring sustainability*" as to "*maintain the potential of fisheries resources to meet the reasonably foreseeable needs of future generations*; and "*avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment*". "*Utilisation*" of fisheries resources is defined as "*conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural wellbeing*".

25 Within the parameters of sustainability, there is an obligation to provide for the use of fisheries resources. In the context of a harvestable species, this requires utilisation to occur at a level that enables most fishstocks to be managed at, or towards, a level that will produce the maximum sustainable yield (MSY). However, it is inappropriate to consider the incidental capture

[6] A sea lion exclusion device or SLED consists of a metal grid inside the trawl net that allows squid to pass through into the net cod-end while directing a sea lion and other large bycatch species (such as sharks, rays, etc) out through an escape hatch at the top of the net.

of a threatened or protected species in the same way that one considers harvesting a fishstock (*Squid Fishery Management Company Ltd v Minister of Fisheries*[7]). The Act sets no quantifiable criteria for considering sustainability as it relates to a threatened or protected species. As such, there is no requirement for the Minister to provide for the utilisation of a fishstock to the extent that the long-term viability of an associated protected species is compromised.

26 Consistent with the purpose and principles of the 1996 Act, s 15 of the Act provides the specific facility for the Minister of Fisheries to fulfill his obligations with respect to managing the effect of fishing-related mortality on marine mammals or other wildlife. Section 15 is driven first by an interaction with the Wildlife Act 1953 or Marine Mammals Protection Act 1978, but otherwise provides scope to meet the sustainability obligation of the Act, while providing for the utilisation of associated fishstocks.

27 Section 15 of the Act sets out the Minister of Fisheries' role in managing the effects of fishing on marine mammals or other wildlife depending on whether a *Population Management Plan* (PMP) exists. A PMP is developed under the Marine Mammals Protection Act 1978, and approved by the Minister of Conservation (after concurrence from the Minister of Fisheries). Under a PMP, the Minister of Fisheries shall take all reasonable steps to ensure the maximum allowable fishing-related mortality level (MALFIRM) set by the PMP is not exceeded, and may take such other measures as are considered necessary to further avoid, remedy, or mitigate any adverse effects of fishing on the relevant protected species (s 15(1) of the Act).

28 Without a PMP, the Fisheries Act provides alternative mechanisms to manage the effects of fishing-related mortality on the New Zealand sea lion. In particular, s 15(2) states that in the absence of a PMP, the Minister of Fisheries, after consultation with the Minister of Conservation, may take such measures as are considered necessary to avoid, remedy or mitigate the effect of fishing-related mortality on any protected species and this may include setting a limit on fishing related mortality. To give effect to any established limit on fishing-related mortality (ie, FRML), s 15(5) allows the Minister, by notice in the *Gazette*, to prohibit all or any fishing, or fishing methods in an area to ensure the limit is not exceeded.

29 There is no PMP for the New Zealand sea lion at present. The Department of Conservation is currently developing a draft PMP that is expected to be released for consultation sometime over the next twelve months.

30 Because of the absence of a PMP, MFish has in the past developed options for the Minister of Fisheries to implement a FRML-based approach to manage the effects of the SQU 6T fishery on the New Zealand sea lion population under s 15(2) of the Act. MFish proposes to adopt this approach again for the 2005-06 fishing year.

Interim management objective for the New Zealand sea lion population

31 When setting a FRML under s 15(2) of the Act, it is appropriate for the Minister of Fisheries to consider the broader legislative provisions dealing with fishing-related mortality of protected species. This includes the criterion for establishing a MALFiRM under a PMP pursuant to the Marine Mammals Protection Act 1978. In determining a MALFiRM for a species that is gazetted as "threatened" under a PMP (such as the New Zealand sea lion), the following criterion is prescribed in the Marine Mammals Protection Act 1978:

[7] Squid Fishery Management Company Ltd. v Minister of Fisheries; Court of Appeal 2004 (CA39/04).

> *"In the case of any threatened species, the level of fishing-related mortality should allow the species to achieve non-threatened status as soon as reasonably practicable, and in any event within a period not exceeding 20 years."*

32 The Minister of Fisheries is not specifically required to meet this criterion when operating under the Fisheries Act compared to that which is required when a PMP is in place. However, this criterion does provide a guide for a reasonable target rebuild period under any FRML that may be established under s 15(2)(b).

33 The management objective adopted in previous operational plans for the SQU 6T fishery focused on constraining fishing-related sea lion mortalities to a level that retained the existing number of breeding locations, and allowed population size to increase with the aim of moving the species towards a 'non-threatened' status within a 20 year time-frame by increasing the number of breeding sites to five. In practice, MFish has no direct ability to bring about an increase in the number of sea lion breeding locations through management of the SQU 6T fishery. As such, MFish sought more explicit objectives in 2003 for managing SQU 6T sea lion interactions in the 2003-04 Operational Plan.

34 A Technical Working Group (TWG) comprised of MFish, Department of Conservation, squid industry representatives, and environmental groups was established in early 2003 within MFish's Aquatic Environment Working Group to examine research findings and scientific matters relating to bycatch of the New Zealand sea lion.

35 In 2003, the TWG adopted the following interim management objective for the New Zealand sea lion to examine statistical models to assess the efficacy of several alternative management strategies:

> *To ensure the sea lion population remained above 90% of its carrying capacity, K, or else remained above 90% of the level it would obtain in the absence of fishery bycatch, 90% of the time in 20- and 100-year runs.*

36 This objective is intended to ensure that fishing-related mortality does not prevent sea lions from increasing to near carrying capacity if they are depleted.

37 The objective provides a criterion for evaluating alternative management strategies affecting sea lions, including setting of FRMLs at varying levels. In the development of the 2003-04 and 2004-05 Operational Plans, a number of strategies were examined with respect to this interim management objective (discussed below).

2005-06 SQUID (SQU 6T) SEA LION OPERATIONAL PLAN PROPOSAL

Brief summary of proposal

38 MFish proposes to implement a new Operational Plan for the 2005-06 SQU 6T fishery to constrain the total number of sea lion mortalities against a predetermined FRML. This Plan will effectively adopt the same approach used for the 2004-05 season, and is based on the following four main components:

a) A FRML of 96 sea lions based on Rule 4 as calculated by the Breen and Kim model;

b) A predetermined strike rate of 5.3% (with the application of a 20% discount factor for qualifying vessels) to estimate and monitor the total number of sea lions against the FRML;

c) Monitoring and reporting requirements to support the FRML; and

d) Closure procedures in the event the FRML is reached.

39 The proposed Plan includes several modifications to the reporting and monitoring arrangements to improve MFish's ability to monitor the incidental capture of sea lions within the SQU 6T fishery against the FRML.

40 Specific details and supporting rationale of the proposed 2005-06 Operational Plan are provided below.

2005 estimates of New Zealand sea lion pup production and total population size

41 The Department of Conservation estimates pup production at the Auckland Island rookeries each summer. Pup production is defined as all births of pups recorded at colonies on specified days falling within approximately one month of typical pupping dates and includes all known live pups, calculated through mark-recapture estimates, and all known dead pups to that date. This information is used to estimate total population size of the New Zealand sea lion. Estimates of pup production and total population size since 1994-95 are shown in Table 2.

Table 2 **Pup production and the estimation of population size (using data provided by Department of Conservation[8])**

Season	Total estimated pup production (std. error)[a]	Per annum increase in pup numbers	Population size estimates using 1996 Gales & Fletcher model including Campbell Island estimates		
			mean	95% CI	20th percentile
94/95	2 640 (20.8)		12 797	10 883 – 14 339	11 730
95/96	2 807 (22.3)	6.3%	13 606	11 564 – 15 239	12 472
96/97	3 097 (25.5)	10.3%	14 661	12 732 – 16 826	13 742
97/98	3 143 (93.8)	1.5%	14 868	12 812 – 17 175	13 884
98/99	2 989 (32.5)	-4.9%	14 163	12 337 – 16 262	13 272
99/00	2 978 (42.6)	-0.3%	14 104	12 272 – 16 230	13 199
00/01	2 980 (24.3)	0.1%	14 108	12 305 – 16 163	13 222
01/02	2 404 (33.7)	-20.2%	11 376	9 896 – 13 058	10 653
02/03	2 902 (70.0)[b]	20.7%	13 719	11 849 – 15 854	12 821
03/04	2 899 (40.0)[b]	-0.07%	13 716	11 891 – 15 698	12 838
04/05	2 533 (44.5)[b]	-12.7%	11 995	10 391 – 13 791	11 236

[a] Total pup production estimate is for Auckland Islands and Campbell Island combined. The Campbell Island estimate increased from 122 to 358 animals in the 2002-03 season.

[b] Incorporates an estimate of pup production at Campbell Island (385±28), which is approximately three times the estimate previously used.

42 The 2004-05 total pup production estimate is 2 533 animals (and includes an estimate of 385 pups from the Campbell Islands).

43 The 2004-05 Auckland Islands total pup production estimate is 2 148 animals. This estimate represents a 15% decrease in the Auckland Islands area on the previous two years and is the lowest estimate recorded since systematic estimates began (Table 3).

Table 3 **Total pup production from the Auckland Islands 1992–2005 (using Department of Conservation data[8]. These estimates do not include an estimate of pup production from Campbell Island)**

Season	Annual pup production			% Annual change in no. pups born	% Mortality rate up to peak of pupping
	total	alive	Dead		
92/93	2 389	2 304	85		
94/95	2 518	2 206	312	5.4%	12.4%
95/96	2 685	2 389	296	6.6%	11.0%
96/97	2 975	2 729	246	10.8%	8.3%
97/98	3 021	2 350	671	1.5%	22.2%
98/99	2 867	2 572	295	-5.1%	10.3%
99/00	2 856	2 689	167	-0.4%	5.8%
00/01	2 859	2 468	391	0.1%	13.7%
01/02	2 282	1 826	456	-20.2%	20.0%
02/03	2 518	2 078	438	10.3%	17.4%
03/04	2 515	2 347	168	-0.001%	6.6%
04/05	2 148	2 032	114	- 14.6%	5.3%

[8] Memorandum. New Zealand Sea Lion Auckland Islands Pup Production 2004 / 2005. Louise Chilvers, Department of Conservation. 26 April 2005.

44 The Department of Conservation considers the recent decrease in pup production at the Auckland Islands is linked with a corresponding low count of females present in the breeding areas[8]. This suggests a drop in breeding age females within the population and, therefore, an overall decreasing population. The number of females recorded this year is significantly lower than has been recorded in the last eight years.

45 The mean species estimate (total population size) in 2004-05 is estimated to be 11 955 animals (10 391-13 791; 95% confidence limits)[8]. This estimate includes the 2003 pup production estimate of 385 animals from Campbell Island.

46 The 2004-05 mean species estimate represents the second mean estimate below 12 000 animals in the last four years (Table 2) and the second lowest estimate in the last ten years. From this season's female counts, fecundity data and knowledge of population trends and mortality events, the Department of Conservation predicts the mean estimate will not increase and is likely to continue to fall in the next 5-10 years[8].

47 MFish notes the population estimates shown in Table 2 are based on the 1996 Gales and Fletcher model, not the Breen and Kim model used to evaluate alternative management strategies for the purposes of the Operational Plan. MFish also notes the pup production estimate driving the Breen and Kim model exercise excludes the Campbell Island pups. The extent and quality of information about the Campbell Island population was too limited for use in the Breen and Kim model. In addition, there is little evidence as to the extent to which sea lions from Campbell Island are killed in the SQU 6T fishery.

Calculation of a fishing-related mortality limit (FRML) for 2005-06

48 Prior to the 2003-04 SQU 6T fishing season, FRMLs were calculated using a formula developed by Wade (1998)[9] (see Annex Two).

49 Subsequent FRMLs for the 2003-04 and 2004-05 seasons were derived using variants of the Wade formula and an "adaptive" rule modelled by Breen and Kim (2004)[10]. MFish proposes to adopt this approach for the 2005-06 SQU 6T fishery and is discussed below.

Breen and Kim model and harvest control rules

50 Breen and Kim developed a model in 2003 to assess the New Zealand sea lion population using a fully-age-structured Bayesian approach. The model takes into account the full range of biological and fisheries data available to date, including observed maturity schedules, variable pupping rates, vulnerability at age information from by-caught animals, survival rates, and late-season pup mortality data. The model uses pup production estimates as an index of population size, as direct estimation of numbers of adult sea lions is hampered by their periodic foraging trips at sea.

51 The Breen and Kim model is used to generate a range of alternative FRMLs under six different management strategies (harvest control rules).

[9] Wade, P. (1998). Calculating limits to the allowable human caused mortality of cetaceans and pinnipeds. *Marine Mammal Science 14*: 1-37.

[10] Breen, P.A., Kim, S.W. (2004) Exploring alternative management procedures for controlling bycatch of New Zealand or Hooker's sea lions in the SQU 6T arrow or Wellington flying squid fishery. Final Research Report to the New Zealand Ministry of Fisheries.

52 The Breen and Kim model was evaluated in 2003 to compare the six different harvest control rules against how well they met the interim management objective (using several predetermined criteria). The harvest control rules evaluated were:

a) Rule 0 – 'no fishing';

b) Rule 1 – 'unconstrained fishing' at current levels of effort (13 weeks of fishing with 2 871 tows, calculated from mean fishing effort in 1998-2003);

c) Rule 3 variants - three variants of the 2002-03 FRML were tested:

   i) 310, approximating limitation on the level of sea lion captures at the rate of the 2002-03 FRML;

   ii) 305, being half the rate of 310; and

   iii) 320, being twice the rate of 310;

d) Rule 4. This is an adaptive rule in the sense that the permitted maximum exploitation rate, embodied in the bycatch limit, increases as the pup production increases and decreases as pup production decreases; whereas in the Wade family of rules the permitted maximum exploitation rate is constant.

53 In addition to the above harvest control rules, MFish contracted NIWA to calculate the FRML corresponding to a further harvest control rule that would just meet the formal assessment criteria associated with the interim management objective (as requested by the Squid Fishery Management Company in early 2003). Colloquially known as the 'Cusp Rule', this rule was essentially a variant of the Rule 3 family. NIWA determined the Cusp Rule by experimenting with larger multiples of Rule 310, running a complete set of simulations for each one until finding the rule that was very close to failing one of the three assessment criteria discussed below.

54 The Cusp Rule provided for over nine times the sea lion bycatch permitted by Rule 310, and its alternative name would be Rule 392. Determining the FRML associated with this variant was necessary to show the extent of management interventions the Minister could use under s 15(2) of the Fisheries Act to the point the sustainability objective for the sea lion/SQU 6T interaction is threatened.

Criteria used

55 The Aquatic Environment Working Group developed a series of criteria to assess whether or not the various harvest control rules satisfied the intent of the interim management objective (ie, "*to ensure the sea lion population remained above 90% of its carrying capacity, K, or else remained above 90% of the level it would obtain in the absence of fishery bycatch, 90% of the time in 20- and 100-year runs"*).

56 The probabilities of different outcomes against this objective were determined for several criteria. Specific criteria were chosen to ensure a successful management strategy:

a) Provide for an increase in the sea lion population to more than 90% of carrying capacity (*K*), or to within 10% of the proportion of *K* that would have been attained in the absence of fishing;

b) Attain the levels in (a), with 90% certainty, over 20-year and 100-year projection periods (*crit20* and *crit100*, respectively);

c) Attain a mean number of mature animals that exceeded 90%*K* (*crit Nmat/K*)%, in the second 50 years of 100-year projection runs (to allow for build-up of numbers in depleted, hypothetical populations over time).

57 Aside from these three primary criteria, evaluation of the harvest control rules was made using a larger suite of performance indicators. Also elaborated here are: mean annual and maximum bycatch during 100 year projection runs, population level at the end of 100 year runs as a proportion of *K* (*N100/K*), and the percentage of fishing seasons closed as an index of cost to the fishery. The lowest number of animals as a proportion of *K* (*nadir/K*), attained during the projection runs was examined, but showed very little difference between harvest control rules (79-83%), hence is not discussed further.

Results

58 All harvest control rules tested passed the *crit20* and *Nmat/K* criteria, while only rule 1 (unconstrained fishing) marginally failed the *crit100* criteria. Table 4 shows the evaluations of rules 305, 310, 320, the Cusp rule, and Rule 4, along with rules 0 and 1 as controls, for each of seven key performance indicators (including the three formal assessment criteria). *Crit20* and *crit100* show the sum of years in projection runs when the criterion was met. *Nmat/K* is presented here as the mean of the distribution for the parameter. *Lost fishing effort* is an indicator of lost fishing effort; not lost revenue. The other indicators are the median of the distribution for each index.

Table 4 **Rule performance against key indicators, from the base case projections from Breen and Kim, 2003.**

Performance Indices	**Harvest control rules**						
	0	1	305	310	320	4	Cusp
Crit20 [a]	N/a	97,781	100,000	100,000	99,989	99,997	98,115
Crit100 [b]	N/a	447,570	500,000	499,052	487,109	489,846	450,003
Nmat/K [c]	98.20%	91.70%	96.40%	95%	93.40%	93.50%	91.8%
Lost fishing effort [d]	100%	0%	56.20%	31.50%	11.40%	12.20%	0%
Seasons closed	100%	0%	77%	52%	23%	24%	0.4%
Maximum bycatch (100 yr runs)	0	545	39	77	151	169	542
Mean annual bycatch	0	99	31	53	76	75	98

[a] pass level for this index is 90,000 out of 100,000 projection-run years
[b] pass level for this index is 450,000 out of 500,000 projection-run years
[c] pass level for this index is 90% of *K*
[d] based on average annual fishing effort (2,871 tows) conducted during the years 1988-2003

59 **Rule 0** - (no fishing) results in a population at 98% of *K* on average, but with maximum lost fishing effort (100%) and no sea lion bycatch, by definition.

60 **Rule 1** – (unconstrained fishing). This rule failed the *Crit100* index by 0.54%, but successfully passed the other two criteria. Mean and maximum bycatch exceeded those for other rules considerably (excluding the Cusp Rule). Despite this higher bycatch, the population under this rule attains >91%*K* on average during 100 year projection runs. This rule showed the lowest level of lost fishing (0% closure and seasons closed, by definition).

61 **Rule 305** – (approximating half the exploitation rate of the 2002-03 FRML). This rule passed all the criteria for an acceptable management strategy. The proportion of *K* attained was 96.4%. Although mean annual and maximum bycatch was relatively low, the restrictions on fishing effort were high, at 77% of seasons closed and 56% lost fishing effort.

62 **Rule 310** – (approximating the exploitation rate of the 2002-03 FRML). This rule passed all the criteria for an acceptable management strategy. The proportion of *K* attained was 95% but lost fishing effort was still relatively high at 52% of seasons closed and 32% lost fishing effort.

63 **Rule 320** – (approximating twice the exploitation rate of the 2002-03 FRML). This rule passed the three acceptance criteria. A maximum and mean annual bycatch of 151 and 76 animals, respectively, allows the population to attain 93% *K* on average. Lost effort is less than half that of rule 310 with 11.4% foregone tows and 23% of seasons closed.

64 **Rule 4** – (adaptive rule). This rule passed the three acceptance criteria. A maximum and mean annual bycatch of 169 and 75 animals, respectively, allows the population to attain 93.5% *K* on average. Lost effort was 12% of tows and 24% of seasons closed. Rule 4 is based on a changing rate of sensitivity to annual pup count numbers. It does not assume a constant exploitation rate, but is responsive to population status (as determined by pup production), increasing as pup production increases (around mean pup production during 1999 to 2003), and decreases as pup production decreases.

65 **Cusp Rule**. By definition, the Cusp Rule maximises sea lion bycatch to the extent the formal assessment criteria associated with the interim management objective is almost violated, therefore this rule passed the evaluation. A mean maximum and mean annual bycatch of 542 and 98 animals respectively allows the population to attain 91.8% *K* on average. Lost fishing effort is slight as only 0.4% of seasons are closed. Only the *Crit100* criteria is close to being violated.

66 In general, these results indicated that a FRML corresponding to six of the seven harvest control rules examined satisfied the interim management objective; only Rule 1 (unconstrained fishing) failed to satisfy the specified criteria. The modeling exercise essentially showed a continuum of possible harvest control rules the Minister could apply in the Operational Plan that need to be considered in light of the Cusp Rule, the sustainability objective, squid utilisation opportunities, and information uncertainty. This is elaborated on in the following sections.

Breen and Kim model status

67 The Aquatic Environment Working Group accepted the Breen and Kim model in June 2003 as presenting a realistic model of the New Zealand sea lion population, and providing a sufficient scientific basis for decision making in managing sea lion interactions in the SQU 6T fishery. The model, discussed in Annex Two, was reviewed and approved with certain caveats by Dan Goodman, an independent population biologist and modeler, in 2003[11]. The reviewer's comments did not suggest serious errors in the Breen and Kim approach, but indicated grounds for caution when adopting the new model.

68 The Aquatic Environment Working Group accepted the findings of an updated iteration of the Breen and Kim model and associated harvest rules in August 2004. However, some working group members had concerns about some model parameters including the estimate used for the intrinsic rate of population increase (*Lambda*), and also whether the New Zealand sea lion species

[11] Copies of the Goodman review are available on request from the Ministry of Fisheries.

as a whole is actually near *K*. Some members also indicated that a more comprehensive assessment of the Goodman review was necessary before full support could be applied to the Breen and Kim model. However, MFish remained of the view there were no major considerations coming out of the Goodman review in terms of changes to the model structure or interpretations other than recommending to exercise caution when interpreting results. Further, there were no technical considerations that could be taken into account in revising the Breen and Kim work arising from the Goodman review, as suggestions for change referred to improvement of the datasets through time, or choice of alternative assessment criteria.

69 MFish contends the Breen and Kim model remains as the best available information to guide decision making in managing sea lion interactions in the SQU 6T fishery, in conjunction with ongoing observations about the status of the sea lion population. MFish advises that relevant concerns raised in the Goodman review, and by members of the Aquatic Environment Working Group, can be managed by taking into account the "information principles" in s 10 of the Fisheries Act. These principles require decision makers to consider any uncertainty in the available information, and to be cautious when information is uncertain, unreliable or inadequate.

70 Until a PMP is in place, MFish intends to build on the assessment exercise undertaken in 2003 and 2004, and again recommends a FRML based on the Breen and Kim model to manage the sea lion interactions in the 2005-06 SQU 6T fishery. Central to this process is the trade-off in terms of sustainability and utilisation offered by the harvest control rules and associated FRMLs, and consideration of the quality of information used when considering this trade-off.

Breen and Kim model results for 2005-06

71 The Breen and Kim model has been run to estimate a range of possible FRMLs for the 2005-06 SQU 6T fishery under the various harvest rules that satisfy the interim management objective (as shown in Table 5). The latest model run includes the most recent (2004-05) pup production estimate from the Auckland Islands (as shown in Table 3) to inform the decision rules that are applied to the model to assist with the establishment of the FRMLs. The model itself has not been updated with the last three years of data for the parameters in the model (ie, female fecundity, female survival, pup production or early mortality).

Table 5 **Calculation of estimated FRMLs under five harvest rules using the Breen and Kim model (using latest pup production estimates)**

Rule	Estimated FRML (number rounded up)
Rule 305	30 sea lions
Rule 310	60 sea lions
Rule 320	120 sea lions
Rule 4	96 sea lions
Cusp Rule	555 sea lions

Scope of management interventions for the 2005-06 season

72 Theoretically, to meet the interim management objective for the 2005-06 fishing season, up to 555 sea lions could be taken in SQU 6T based on the Cusp Rule. This approach would permit the most fishing while meeting the sustainability criteria. However, permitting utilisation of the squid fishery without threatening sustainability of the sea lion population does not mean the Minister is required to adopt a Cusp Rule approach. The Court of Appeal in the Squid Fisheries case[12] has noted that a sustainable harvest approach is not an acceptable way to manage a threatened species, and that:

> *"Given the underlying uncertainties involved in exercises of this sort, any MALFiRM* [FRML] *chosen is likely to carry some degree of risk (perhaps negligible) to the population in question. Optimum usage does not equate to maximum usage. We are not aware of a simple method by which risk on the one hand can be balanced against utilisation advantages on the other. A precautionary approach to the required balancing exercise is open to the Minister".*

73 The Cusp Rule represents the upper limit of the continuum the Minister of Fisheries could consider. As noted above, decision makers are required to take into account the "information principles" in s 10 of the Fisheries Act. In the context of the current situation, there is a degree of uncertainty over whether the sea lion population is at, or near, *K*; the accuracy of the estimate of incidental sea lion captures; the efficacy of Sea Lion Exclusion Devices ('SLEDs'); the extent, if any, of likely long term impacts associated with fishing activities; as well as the exact impact that fishing related mortality has on the population where other variables such as environmental stochasticity may not be modelled accurately. In addition, estimated pup production and overall population size has declined in the last twelve months. Therefore, MFish considers these uncertainties continue to highlight grounds for caution in determining the FRML for 2005-06 and, accordingly, does not recommend a FRML based on the Cusp Rule.

74 MFish recommends the Minister of Fisheries also consider evidence that indicates small numbers of sea lions are captured in other fisheries operating around the Auckland Islands. MFish considers this is additional grounds for caution in determining a FRML, since the FRML will only be measured against the SQU 6T fishery. Bycatch reports from MFish observers show sea lions also are caught incidentally to other fisheries operating in this area, including scampi, southern blue whiting, hoki, mackerel, and orange roughy. MFish observer reports reveal that an annual average (to September 2004) of 1.58 sea lions has been taken as bycatch within the SQU 6T QMA from these non-squid fisheries each year since the 1991–92 season. However, this is an absolute minimum in view of likely bycatch from unobserved vessels operating in these same fisheries.

Proposed harvest control rule for the 2005-06 season

75 Rules 0 and 1 are considered primarily as references for relative performance. Although rule 0 (no fishing) meets the sea lion population management objectives, MFish considers this option is needlessly restrictive in meeting squid fishery utilisation objectives, and the rule is not recommended as an option. By similar rationale, rule 305 is not recommended on the basis that the associated FRML unnecessarily reduces utilisation objectives for the SQU 6T fishery.

[12] Paragraph 77, CA39/04.

76 Rule 1 (unconstrained fishing) does not meet the sea lion management objectives (although only marginally), and is not recommended. MFish considers that unconstrained sea lion bycatch, and any harvest control rule that fails the assessment criteria associated with the interim management objective, is inconsistent with the intent of s15(2) of the Act, whereby the Minister is required to avoid, remedy, or mitigate the effects of fishing related mortality on any protected species.

77 Rules in the Rule 3 family represent a simple linear exploitation rate relative to the pup production index of population size, and provide a range of FRMLs. Rule 305 provides the lowest sea lion bycatch and projects highest lost fishing effort. Rules 310 and 320 provide a higher bycatch level than that offered by Rule 305 and provide for higher levels of squid utilisation. Rule 320 doubles the allowable sea lion bycatch relative to Rule 310 and substantially reduces projected lost fishing effort.

78 In contrast, Rule 4 is derived with fluctuating proportion of the population taken as bycatch relative to pup production estimates. Rule 4 is more responsive to the 'risk' posed to the sea lion population when pup production is at low levels, compared to the linear exploitation rates offered in the Rule 3 family. Likewise, Rule 4 is more responsive (ie, adaptive) to fishing opportunities when pup production is at high levels. Given this rationale, Rule 4 was used to set a FRML for the 2004-05 SQU 6T season.

79 MFish remains of the view the adaptive approach of Rule 4 continues to be the strategy best suited to optimise utilisation of the squid fishery, recognising information uncertainty and the sustainability objective of the sea lion population. This is particularly important given the recent decline in total pup production and Rule 4's responsiveness to a population decline in comparison with the other harvest control rules.

80 MFish continues to be satisfied the responsiveness offered by Rule 4 to changing circumstances in the Auckland Island sea lion population is the best available mechanism to guide decisions that will meet the dual requirements of the Fisheries Act to balance sustainability of the sea lion population with utilisation of the SQU 6T resource. Again, MFish notes that Rule 4 is one of a range of rules that could offer the same responsive approach. Other rules would provide a different balance between utilisation of the squid resource and the effects of fishing on the New Zealand sea lion population.

81 Last year's IPP recommended the adoption of Rule 4 to set a FRML for the 2004-05 SQU 6T season to provide the best balance between sustainability and utilisation. The IPP explicitly noted that the Minister of Fisheries should continue to adopt this rule in coming years subject to review only where assumption of the modeling work underpinning the management strategy evaluation framework are violated, or the model itself is found to be in error. MFish notes that stated grounds to review this approach have not been forthcoming for the 2005-06 season.

82 For the 2005-06 fishing season, MFish proposes to adopt Rule 4 as the basis for determining a FRML. This rule generates a FRML limit of 96 sea lions.

Impact of a FRML on the fishing industry

83 Although catches and market returns vary from year to year, the New Zealand squid fishery is generally one of New Zealand's top 20 seafood exports by volume and value.

84 Annual SQU 6T landings (Table 1) have averaged approximately 15 542 tonnes (48% of the TACC) over the past 18 years, reaching the TACC in just three seasons (1993-94, 1994-95 and, 2003-04). Estimated sea lion mortalities in those three years were 32, 109, and 118 respectively, indicating uncertain correlation between attaining the TACC and the associated level of sea lion bycatch.

85 The predicted closure of fishing seasons under the range of harvest control rules developed by the Breen and Kim model (as shown in Table 5) result in lost fishing effort. This should not be interpreted as an indicator of lost revenue, because squid abundance and condition can mean that squid fishing ceases before the TACC and/or FRML is reached.

86 Other than the 2003-04 season, the SQU 6T TACC has been under caught each year since the 1995-96 season. However, the portion of this foregone catch attributable to the FRML limit is uncertain. Depending on the availability of squid in SQU 6T and sea lion bycatch, the adverse economic impact of FRML limits may range from nil (based on those years when the FRML was not reached), to potentially as high as $26 million (assuming the entire TACC could have been caught in the absence of a closure)[13].

87 The majority of boats operating in the SQU 6T fishery have been foreign charter trawl vessels, although a higher proportion of New Zealand flagged vessels has participated in the fishery recently (approximately 25% of the SQU 6T fleet in the 2004-05 season). Squid trawl vessels rely upon the SQU 6T fishery as one of several fisheries available during the year. Combined, this portfolio of fishing opportunities allows New Zealand fishing companies to efficiently augment harvest capacity with charter vessels where it may not be economically practical for New Zealand companies to invest in additional vessels. The predictability of fishing opportunities given FRML constraints in the SQU 6T fishery thus becomes an important consideration in a more complex array of charter vessel arrangements in other fisheries over the course of a year.

88 Catches made in SQU 6T form a significant portion of the national squid catch. MFish acknowledges the significance of the squid fisheries to the fishing economy and the potential impacts on the industry if the SQU 6T fishery is closed. However, these impacts must be balanced against the legislative requirements in the Fisheries Act.

Proposed arrangements to monitor sea lion mortalities against the FRML

Predetermined strike rate

89 A separate decision is required on the method used to estimate sea lion mortalities within the SQU 6T fishery for comparison purposes against the FRML. MFish proposes to continue to estimate sea lion mortalities using a predetermined strike rate.

90 The 2004-05 Operational Plan required industry to operate under a predetermined strike rate of 5.3% (or 5.3 mortalities per 100 tows) to estimate the number of sea lion mortalities caused by the SQU 6T fishery. The predetermined strike rate was based on a simple average of the actual strike rate estimated during the seven fishing seasons 1996-97 to 2002-03, and for which a minimum 20% annual observer coverage was achieved (see Table 6). This option was considered the best method to estimate sea lion mortalities within the fishery as there was insufficient verified

[13] In the 1999-00 season, early closure of the SQU 6T season due to sea lion bycatch limited squid catch to 6 241 tonnes, about 26,000 tonnes below the TACC. Potential gross economic impacts are based on an assumed average port price over time of $1/kg.

(observer-observed) empirical information from which to monitor sea lion deaths against the FRML.

Table 6 **Reported strike rate of New Zealand sea lions (mortalities per 100 tows) by MFish scientific observers in the SQU 6T fishery.**

Fishing year	Actual strike rate[a] (%)	Observer Coverage[b] (%)
1987-88	1.8	24
1988-89	3.7	19
1989-90	2.2	12
1990-91	0.6	10
1991-92	3.8	10
1992-93	2.6	32
1993-94	0.7	10
1994-95	3.0	8
1995-96	2.3	13
1996-97	3.5	20
1997-98	4.4	23
1998-99	3.6	37
1999-00	6.0	35
2000-01	11.8	100
2001-02	5.1	46
2002-03	2.8	23
2003-04	[c]	31[d]
2004-05	[c]	29[d]

[a] Source: 2002-03 Operational Plan and Doonan (NIWA)
[b] Source: Doonan (NIWA), Paul Starr (SeaFIC), and Baird (NIWA)
[c] An actual strike rate cannot be calculated for 2003-04 because observed vessels variably used SLEDs to the effect not all mortally wounded sea lions were retained in the trawl.
[d] Based on vessel coverage data supplied by the MFish Observer programme

91 For the purposes of determining the predetermined strike rate for the 2003-04 fishing season, the Aquatic Environment Working Group examined alternative time series procedures using actual strike rate data before agreeing on a simple seven-year average. Although potential bias in the strike rate had been noted by the Aquatic Environment Working Group, MFish considers there is no new relevant information that supports a change in this approach.

92 Accordingly, MFish proposes to continue to estimate the total number of sea lion mortalities within the SQU 6T fleet using a predetermined strike rate of 5.3% (or 5.3 mortalities per 100 tows). MFish does not intend to develop a facility for in-season strike rate estimation for 2005-06.

93 The predetermined strike rate will apply to the total number of tows reported in the SQU 6T fishery by all vessels during the relevant reporting period[14] as follows:

predetermined strike rate x total number of tows in SQU 6T by all vessels

94 Ongoing estimated mortalities by the fleet will be applied cumulatively to the sea lion FRML in SQU 6T.

95 The proposed strike rate of 5.3% and a FRML of 96 sea lions will enable vessels to conduct about 1 811 tows before the FRML is reached. The application of a discount factor will increase both total tow number and total squid catch (discussed later).

96 Uncertainties surrounding the predetermined strike rate estimation process need to be taken into account when considering the most appropriate predetermined strike rate. The observed strike rate has varied considerably over time (ie, ranged between about 2% in 1995-96 to about 12% in 2000-01) when greater than 20% observer coverage was obtained. In addition, MFish notes that a number of variables have been found to influence strike rate[15], and MFish considers higher observer coverage is likely to reduce the bias that these factors may have on the observed strike rate.

97 While MFish is proposing a predetermined strike rate of 5.3% for the 2005-06 season, it is important to note there is a range of alternative strike rates that could be applied. In adopting a strike rate for the upcoming SQU 6T season, the s 10 information principles should be taken into account regarding uncertainty of information.

New strike rate information

98 The Squid Fishery Management Company has recently submitted a report estimating sea lion bycatch in the SQU 6T (and SQU 1T) fishery. This report has been prepared by the National Institute of Water and Atmospheric Research Limited (NIWA) and provides a simple model to estimate strike rate, SLED ejection rate, and the rate of reporting bycatch from non-observed tows. This model, based on industry data from the 2002-05 seasons, seeks to provide more robust strike rate estimates (with confidence limits) that could be applied to the SQU 6T fishery. The report suggests that estimated strike rates have median values less than 5.3% (ie, the proposed strike rate for the 2005-06 Operational Plan) in three of the past four years.

99 The report will need to be assessed by both the Aquatic Environment Working Group and Squid Fishery Management Company SLED working group before it can be considered for the 2005-06 season. Depending on the timing of this assessment and its outcome, any additional information from the report may be incorporated in the Final Advice Paper for the 2005-06 Operational Plan.

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[14] Up to the point where 70% of the FRML is reached, the reporting period used to measure observer coverage is to be the seven day calendar week commencing at 0001 hours Monday and ending at 2400 hours the following Sunday. At the point when 70% of the FRML is reached the reporting period will switch to a daily basis. MFish anticipates that fishers will begin fishing in SQU6T on 1 February 2006. For purposes of the applicable reporting period, the week covering the opening of the SQU6T fishery on 1 February will be shortened to the five-day period commencing 1 February 2006 at 0001 hours and ending at 2400 hours on 6 February 2006.

[15] Smith.M.H., Baird.S.J. (2004). Factors that may influence the level of incidental mortality of Hooker's sea lions (*Phocarctos hookeri*) in the squid (*Nototodarus* spp.) trawl fishery in SQU6T. Draft working group report prepared for the Ministry of Fisheries. ENV2002/02, Objective 1).

Sea lion exclusion devices and the discount factor

Sea lion exclusion devices

100 In recent years, the SQU 6T industry has experimented with SLEDs installed inside trawl nets. The purpose of a SLED is to reduce sea lion mortalities by ejecting live animals out of the trawl net (usually through a hole in the top of the net). Two factors influence how effective SLEDs are at reducing sea lion mortalities: (i) ejection rate and (ii) survival rate of animals.

101 For the 2004-05 season, MFish understands all SLED-equipped vessels deployed one standard design of SLED ('Mark 3/13' design) when fishing in the SQU 6T fishery. During this season, observers reported nine sea lion mortalities in SQU 6T, of which:

a) One animal was caught on a vessel not using a SLED at the time of capture;

b) Eight animals were caught on vessels using SLEDs at the time of capture. Five of the reported eight captures involved animals found in the cod-end of the trawl net meaning they had gone through the SLED and into the cod-end. It is not known whether the remaining three animals passed through the bars of the SLED or not.

102 Therefore, a minimum of 5/8 (63%) of the animals caught on vessels using SLEDs were a) not ejected from the SLED, and b) somehow passed through the SLED and into the cod-end.

103 The position of the five reported captures within the cod-end indicates the SLED devices failed completely to eject sea lions during the tows where these captures took place. Possible reasons for sea lions going through SLEDs and into the cod-end include:

a) SLED and net equipment not attached or deployed correctly;

b) Equipment broken and not fixed appropriately, or equipment broken during use;

c) Equipment inappropriately designed to eject sea lions successfully (including insufficient bar spacing on SLEDs); and

d) Deformed or unusually small animals.

104 Fisheries observers present during the tows where sea lions were caught by vessels using SLEDs did not provide any explanation for possible SLED failure.

105 The possible malfunction of SLEDs provides uncertainty as to the efficacy of SLEDs at ejecting sea lions. This malfunction could be due to SLED deployment failure and/or insufficient bar spacing to eject all captured animals (spacing between bars of Mark 3/13 SLEDs is about 28 cm). The failure of SLEDs to eject sea lions from the net is of concern as the tows concerned were given a 20% discount factor of the predetermined strike rate. This issue will be considered at the next meeting of the Squid Fishery Management Company SLED working group and will include discussions on reducing bar spacing to improve SLED efficacy.

106 In addition, the Squid Fishery Management Company is continuing to develop an industry protocol to require all SQU 6T vessels when fishing in the 2005-06 season to deploy a SLED that conforms to the 'Mark 3/13' design. The SLED design is likely to include a number of modifications including the inclusion of smaller bar spacing to prevent animals from passing through the SLED device. This protocol will be considered at the next meeting of the Squid

Fishery Management Company SLED working group, and if accepted, the 2005-06 Operational Plan will require all SQU 6T vessels using SLEDs to deploy the modified 'Mark 3/13' design.

Discount factor

107 The potential to increase utilisation of the SQU 6T fishstock through SLED use lead to the application of a 20% discount factor in the 2004-05 season and applied to the strike rate of vessels employing SLEDs. The discount factor effectively gave a lower strike rate of 4.24% to those qualifying tows.

108 In addition to the ejection rate, the application of a discount factor principally relies on an accurate estimation of the sea lion survival from SLED-equipped trawl nets. However, this estimation cannot be made at this time with any reliable degree of certainty owing to considerable uncertainty on actual strike rate, and survivability of ejected sea lions.

109 The decision to grant a discount factor to the predetermined strike rate for the 2005-06 season requires balancing the uncertainty on whether SLEDs improve the long-term survivability of captured sea lions against the need to provide a genuine incentive for vessels to deploy SLEDs. Therefore, while acknowledging the apparent SLED design problems observed in the 2004-05 season and the process to address these problems (ie, development and implementation of an industry protocol, modified 'Mark 3/13' SLED design), MFish considers it is appropriate at this time to continue to adopt a 20% discount factor for the 2005-06 season. The application of a discount factor will only apply to vessels using SLEDs in accordance with the MFish approved industry protocol on SLED design and use, and thereby encourage all vessels to deploy these SLEDs when fishing in SQU 6T.

110 The use of a discount factor allows enable the SQU 6T fleet to conduct a greater number of tows before the FRML is reached. As noted earlier, the application of the 5.3% strike rate will enable vessels to theoretically conduct about 1 811 tows before the FRML is reached. The application of a 20% discount factor (based on 90% deployment of SLEDs by SQU 6T vessels as observed in the 2004-05 season) generates an additional 408 tows (ie, total tow number is 2 219) before the FRML is reached. The overall catch given the estimate of possible tows will depend on squid abundance and catch rates. Catch per tow varied from about 4.7 tonnes/tow to over 12.7 tonnes/tow in recent years. Thus, the proportion of the TACC likely to be taken with a FRML of 96 sea lions is uncertain ranging from about 40% with average catch rates, to as much as 70% at catch rates comparable to the 2003-04 season.

Requirements to qualify for the discount factor for 2005-06

111 MFish contends the application of a discount factor should only apply to those vessels meeting the following conditions:

a) Vessels must comply with an MFish approved industry protocol on the design and deployment of SLEDs when targeting squid within the SQU 6T fishery;

b) The SLED specifications have been provided by the Squid Fishery Management Company to MFish for any vessel seeking the discount factor prior to the departure of that vessel to the SQU 6T fishery (regardless of whether an observer is to be placed on that vessel or not); and

c) Vessels operating within the SQU 6T fishery must use a SLED, and the escape hatch on the SLED must remain open at all times during fishing operations.

112 MFish seeks the cooperation of the Squid Fishery Management Company to provide estimates and advanced notice of the likely number of SLED-equipped vessels that intend to operate in SQU 6T in order for appropriate observer coverage to be arranged. This will include notification to the MFish Observer Programme with a list of all likely SQU 6T vessels by 1 December 2005.

113 In addition, MFish will require vessel operators to notify the MFish Observer Programme at least 72 hours prior to departure (not including Saturdays, Sundays and holidays) of their intentions to obtain the SLED discount factor. This will include the following information:

a) declare their intended SLED use;

b) declare the SLED device to be used will comply with the agreed SLED design protocol and that it can be verified by MFish against the approved SLED design (vessels using SLEDs that do not satisfy the approved design will not be eligible for the 20% discount factor); and

c) provide dates of expected voyage date and place of departure.

114 MFish notes that supporting the eligibility of vessels to apply for a 20% discount factor will require a high level of observer coverage for the SQU 6T fishery. As in previous years, MFish will seek to achieve a 30% observer coverage of all tows undertaken in the SQU 6T fishery. However, the observer coverage level may be affected by the requirement to deploy observers in other fisheries where seabird bycatch is problematic

115 MFish cannot guarantee that all requested observer coverage for SLED vessels can be satisfied given the expected level of demand for the discount factor. In which case, MFish will explore alternative audit mechanisms including remote electronic monitoring and random vessel checks.

Reporting requirements

116 MFish proposes to adopt the same reporting requirements as used in past operational plans. These requirements include the following:

a) Masters of all vessels are to submit a report on any encounter with a marine mammal that resulted in death or injury, at the end of the voyage (as required under the Marine Mammals Protection Act 1978);

b) MFish observers will inform (by telex, e-mail, or fax) the Fisheries Communication Centre immediately following any observed New Zealand sea lion capture on their vessel;

c) The Squid Fishery Management Company, through the New Zealand Seafood Industry Council, will co-ordinate a daily vessel reporting regime. This information will generate in-season estimates of New Zealand sea lion catches against the FRML based on the predetermined strike rate of 5.3%;

d) Given the proposed arrangements, all observed and unobserved vessels will be required to report the following information to the Squid Fishery Management Company:

i) each tow undertaken;
ii) whether the tow was observed by a MFish observer;
iii) whether a qualifying SLED was used on the tow;
iv) whether the escape hatch on the SLED was open or closed; and
v) whether a sea lion was caught during a tow.

117 MFish notes that past audited comparisons between MFish tow-by-tow data and industry 'real time' tow-by-tow data undertaken by the National Institute of Water and Atmospheric Research Limited have demonstrated no significant discrepancies. MFish believes the use of industry tow data continues to remain appropriate at this time.

Pound grids

118 In past seasons, some vessels have voluntarily placed grids over the entrance of the pounds on deck to prevent any captured sea lion (alive or dead) from entering the pounds. The use of these grids serves two purposes. Firstly, it improves the ability for fisheries observers to observe and record any captured animal when brought on board, particular if there is only one observer present (ie, the observer only needs to watch the emptying of the net and not wait for the pound to be emptied). Secondly, the use of a pound grid prevents the problem of removing a live, likely agitated animal from the pound by vessel crew.

119 The use of pound grids on all SQU 6T vessels in the 2005-06 season was discussed at a recent meeting of the Squid Fishery Management Company SLED working group (21 June 2005). This working group recommended that further consideration be given to the use of pound grids at the next meeting. While this meeting has yet to occur, MFish considers there is considerable merit to require all SQU 6T vessels to use pound grids for the upcoming season. In particular, the ability of pound grids to improve the effectiveness of observers to monitor sea lion bycatch will be important next season given the likely need to deploy observers in other fisheries where seabird bycatch is problematic. As such, MFish invites comments from industry on this matter. If pound grids are to be used, this requirement will be included in the 2005-06 Operational Plan.

Fishery closure process

120 Under the sea lion mortality estimation proposal, monitoring effort will focus on fishing effort as conveyed in total vessel tows. Projections using weekly tows will be used to estimate total sea lion bycatch in the SQU 6T fishery. Once 70% of the FRML has been reached, projections will be undertaken on a daily basis.

121 If information indicates the point estimate for the total catch of sea lions by the entire fleet is about to reach the FRML, MFish will advise the Minister of Fisheries to immediately close the SQU 6T fishery under s 15(5) of the Fisheries Act 1996.

122 Given timing constraints in which to effectively monitor estimated total sea lion catch against the FRML, and the requirement to immediately close the fishery, no consultation will be undertaken with stakeholders during the closure procedures. Nevertheless, MFish will closely co-ordinate the fishery closure process with the Squid Fishery Management Company to ensure that vessel operators are kept informed as to the status of the fishery in respect to the FRML.

NGAI TAHU CLAIMS SETTLEMENT ACT 1998

123 Section 288 of the Ngai Tahu Claims Settlement Act 1998 requires the Crown to acknowledge the cultural, spiritual, historic, and traditional association of Ngai Tahu with their taonga species. Section 287 prescribes the New Zealand sea lion (or Rapoka/Whakahao) as a taonga species under this Act. MFish acknowledges the associations between Ngai Tahu and the New Zealand sea lion and notes that s 293 of the Settlement Act requires the Minister of Conservation on behalf of the Crown to undertake advisory steps with Ngai Tahu in regards to the management of taonga species.

PRELIMINARY RECOMMENDATIONS

124 MFish proposes the following management measures to manage the interactions between the New Zealand sea lion and the southern squid trawl fishery (SQU 6T) for the 2005-06 fishing year:

a) Implement an Operational Plan for the 2005-06 SQU 6T fishery;

b) Apply an interim management objective to ensure the sea lion population remains above 90% of its carrying capacity, *K*, or else remains above 90% of the level it would obtain in the absence of fishery bycatch, 90% of the time in 20- and 100-year runs;

c) Set a FRML of 96 sea lions based on Rule 4 as calculated by the Breen and Kim model;

d) Use of a predetermined strike rate of 5.3% to estimate the total number of sea lion mortalities against the FRML;

e) Use of a 20% discount factor (to provide a strike rate of 4.24% for all qualifying tows) for vessels deploying an MFish approved SLED design; and

f) Close the SQU 6T fishery under s 15(5) of the Fisheries Act 1996 in the event the FRML is reached.

ANNEX ONE

The 2004-05 SQU 6T Sea Lion Operational Plan

125 Incidental catch of sea lions in the 2004-05 SQU 6T season was managed under an Operational Plan approved by the Minister of Fisheries (after consultation with the Minister of Conservation) on 29 October 2004. Officials of MFish and the Department of Conservation developed this plan, after consultation with industry, non-government organisations, Te Runanga o Ngai Tahu, and other relevant groups.

Fishing-related mortality limit (FRML)

126 The 2004-05 plan implemented a FRML of 115 New Zealand sea lions. The plan required the fishery to be closed if the estimated total number of sea lions reached the FRML during the season.

127 The FRML was based on 'Rule 4', which was one of several alternative harvest control rules developed for the 2004-05 SQU 6T sea lion. These rules were derived from a sea lion population model process developed by Breen and Kim (2004), and used 2004 pup production data provided by the Department of Conservation as the proxy for population size.

128 The use of Rule 4 to set a FRML acknowledged the range in mortality limits satisfying the interim management objectives, but also recognised information uncertainty and the Court of Appeal determination that sea lions cannot be managed like a harvestable stock that can be exploited at MSY. This rule provided an adaptive approach to balance in meeting the dual obligations in the Act.

Monitoring procedures

129 The 2004-05 Operational Plan estimated the total sea lion captures by the SQU 6T fleet by applying a predetermined strike rate of 5.3% to all tows undertaken in SQU 6T. The application of this strike rate provided an estimate of 5.3 sea lion mortalities for every 100 tows undertaken in the SQU 6T fishery. The cumulative total estimated mortalities using this method were counted against the FRML.

130 The 5.3% strike rate was based on a simple average of actual strike rate achieved during years where a minimum 20% annual observer coverage of tows was achieved (based on the period 1996-97 to 2002-03). This approach was earlier adopted by the Operational Plan for the 2003-04 SQU 6T fishery as a result of discussions by Aquatic Environment Working Group in 2003.

131 The Operational Plan allowed for the application of a discount factor of 20% to the predetermined strike rate of SLED-equipped vessels to acknowledge possible survival of sea lions ejected by these vessels operating without cover nets over the SLED escape hatch. This had the effect of reducing the strike rate from qualifying vessels to 4.24%. The Operational Plan provided for MFish Observers to be placed on-board SLED equipped vessels to document SLED use. However, MFish could not meet the subsequent demand for observer coverage and developed alternative procedures to document SLED use on non-observed vessels including random port checks of trawl nets.

The 2004-05 season

132 Fishing commenced in the first week of February 2004.

133 The Minister of Fisheries closed the SQU 6T fishery effective from 20 April 2005 on the basis that estimated sea lion mortality would reach 115 animals (the FRML for the 2004-05 SQU 6T fishing year) by the closure date.

134 A total of 26 437 tonnes of squid was reported caught in the 2004-05 SQU6T fishing year (as at July 2005), amounting to about 82% of the TACC.

Estimated number of New Zealand sea lion captures

135 A total of 2 645 tows were conducted in the 2004-05 SQU6T season. Using the monitoring and estimation procedures in the Operational Plan, a total of 115 sea lions were estimated killed in the SQU 6T fishery in 2004-05. About 91% of tows qualified for the discount factor (effectively a strike rate of 4.24) because vessels used approved SLEDs with open cover nets. The full 5.3% predetermined strike rate was applied to the remaining 9% of tows.

136 An actual sea lion strike rate for the 2004-05 season could not be estimated because observed and unobserved vessels variably used SLEDs with no cover nets to retain captured sea lions. This prevented the actual number of mortally wounded sea lions passing through the escape hatch of a SLED from being determined.

137 A total of 727 tows were observed by MFish observers in the 2004-05 SQU 6T season (representing about 29% of all tows). Nine sea lion mortalities were recorded in SQU 6T by observers during the season. Eight animals were caught on vessels using SLEDs at the time of capture. Five of the reported eight captures involved animals found in the cod-end of the trawl net (ie, behind the position of the SLED).

ANNEX TWO

The Wade rule

138 Until the 2003-2004 fishing season, the FRML for the New Zealand sea lion was calculated from a formula developed by Wade (1998) that estimated the potential biological removals ("PBR") that could safely occur.

139 The FRML and was calculated each year as:

Equation 1 $$C_y^{FRML} = 0.5\left(\frac{N_{y-1}^{vuln} + N_{y-2}^{vuln}}{2}\right) l\, F_r$$

where N_y^{vuln} is a conservative estimate of vulnerable sea lion numbers in year y, l (called $R_{\max}$ in Wade 1998) is the maximum rate of population increase and F_r is a "recovery factor". The central term is the average, over two years, of conservative estimates of vulnerable numbers.

N_y^{vuln} was taken as the lower 20th percentile of the population estimate obtained from the Gales and Fletcher (1996) model, as calculated each year by DoC. The inputs were estimated pup births in year y from Campbell Island and the Auckland Islands combined, and a set of assumed distributions of population parameters. There was a one-year lag because of the need to consult on bycatch management: for instance, the 2001 pup counts were first used in the calculations for the alternative FRML limits for the 2002 fishing season. Wade (1998) suggested that l = 0.12 would be a suitable default value for pinnipeds, but l = 0.08 was adopted in New Zealand. F_r was set at 0.15.

The Breen and Kim approach

140 The modeling work of Breen & Kim explored two simple variants of the Wade rule used in New Zealand. In this work, the Wade rule was simplified so that it could be evaluated within the Breen and Kim model without reference to the Gales and Fletcher model. In the simplified version, the empirical relation between estimated pup productivity and vulnerable numbers was simplified, along with the l and F_r constants, into a single constant:

Equation 2 $$C_y^{FRML[310]} = 0.02577\left(\frac{N_{0,y-1} + N_{0,y-2}}{2}\right)$$

where $N_{0,y}$ is the estimated number of pup births, at the Auckland Islands rookeries only, in year y.

141 In the modeling work, this rule was named Rule 310, where "3" denoted the Wade rule family and "10" denoted 1.0 times the Wade rule. Other variants (multiples) of the Rule 3 family were also explored. These are members of a family of rules described by the equation below. In Rule 305, n = 0.5; in Rule 310, n =1; in Rule 320, n = 2.

Equation 3 $$C_y^{FRML[3n]} = n\left[0.02577\left(\frac{N_{0,y-1}+N_{0,y-2}}{2}\right)\right]$$

Adaptive Rule 4

142 Rule 4 is adaptive in the sense that the permitted maximum exploitation rate, embodied in the bycatch limit, increases as the pup production increases and decreases as the pup production decreases, whereas in the Rule 3 family the permitted maximum exploitation rate is constant.

143 There is an infinite number of possible rules with this property. Breen & Kim's (2004) Rule 4 evolved from the adaptive rule of Breen *et al*. (2003), which was a three-step function involving two thresholds. In that rule the fishery was closed when pup production was low, unconstrained when high pup production was high, and governed by Rule 310 at intermediate values. Rule 4 of Breen & Kim (2004), agreed to by the Aquatic Environment Working Group, is a smooth function - it has no thresholds - and is described by:

Equation 4 $$C_y^{FRML[4]} = 102\left(\frac{N_{0,y-1}+N_{0,y-2}}{2\bar{N}}\right)^2 + 32\left(\frac{N_{0,y-1}+N_{0,y-2}}{2\bar{N}}\right)^4$$

144 where $\bar{N}$ is the mean number of pup births observed from 1999 through 2003.

The Cusp Rule

145 The Squid Management Company requested this rule in early 2003. It was to be the member of the Rule 3 family that just met the formal assessment criteria discussed in body of the consultation document. To find this rule, the value of n in equation (3) was varied, and at each value a complete set of simulations was made. This was repeated, changing n with a simple homing algorithm, until the rule was very close to failing one of the three tests described above.

146 The cusp rule was obtained with $n = 9.23$, that is:

Equation 5 $$C_y^{FRML[cusp]} = 9.23\left[0.02577\left(\frac{N_{0,y-1}+N_{0,y-2}}{2}\right)\right]$$

147 The alternative name for this rule would thus be Rule 392.

148 The model does not in itself specify a singular or optimal level of sea lion bycatch, but rather offers a range of allowable mortalities that meet the interim management objective (from nil to 598). This approach illustrates that many alternative rules can be used to generate a FRML. The rules put forth have been reviewed by the Aquatic Environment Working Group, but there has not been consensus agreement by the working group specifically, or stakeholders in general, for a preferred harvest control rule. Rather, rules were evaluated against a set of performance criteria, determined by the Aquatic Environment Working Group before the modeling work was carried out, to enable an objective assessment of rule performance relative to management objectives. An acceptable management regime was determined to be among those rules that passed all performance criteria.