Proposed Operational Plan To Manage The Incidental Capture Of New Zealand Sea Lions In The Squid (SQU) 6T Trawl Fishery For The 2004-05 Fishing Year

Initial Position Paper

Consultation Document
3 September 2004

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INTRODUCTION

1 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 process to manage the interactions between the New Zealand (or Hooker's) sea lion and the southern squid trawl fishery (SQU6T) during the 2004-05 fishing year. This management process will focus, as it has in past years, on the use of a 'fishing-related mortality limit' ("FRML") to constrain New Zealand sea lion mortalities caused by SQU6T trawling to an acceptable biological level. Previous Operational Plans use 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 has 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 the latter and FRML to the former.

2 This paper is the Ministry of Fisheries' initial position on the proposed management process it will implement under an Operational Plan approved by the Minister of Fisheries. The Operational Plan will include three components:

- The FRML for the 2004-05 SQU6T season;
- Operational procedures to estimate and monitor the total number of sea lions caught by the fleet against the FRML;
- Closure procedures by the Minister of Fisheries if the FRML is reached.

3 MFish requests that you provide comments on the proposed FRML for the 2004-05 SQU6T fishery and the options proposed to estimate and monitor the total number of sea lion mortalities against this FRML. In September 2004, MFish will prepare a final advice paper and an Operational Plan for the Minister of Fisheries to establish the operational procedures that will apply to the 2004-05 SQU6T fishery.

4 MFish requests that all comments in response to this IPP are received by **Friday 17 September 2004**. These comments should be sent to Nathan Glassey, Fisheries Analyst, Ministry of Fisheries, Private Bag 14, Nelson, or faxed to (03) 546 9327, or emailed to glasseyn@fish.govt.nz.

5 If you have any questions about this document, please contact Nathan Glassey or Jim Cornelius at the Ministry's Nelson office on (03) 548 1069, or e-mail glasseyn@fish.govt.nz.

BACKGROUND INFORMATION

New Zealand sea lion

6 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[1]. 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 that this species may

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

have once 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.

7 Breeding behaviour concentrates the adult New Zealand sea lion population at two breeding sites (rookeries). Over 95% of the breeding population of this species occurs on two small rookeries on Dundas and Enderby Islands in the Auckland Islands. A small breeding population also exists on Campbell Island. No established rookeries are found on the New Zealand mainland. 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. The foraging range of New Zealand sea lions that inhabit the Auckland Islands overlaps the fishing grounds of the SQU6T fishery. This overlap leads to the incidental captures of sea lions by trawl vessels that are targeting squid.

8 To mitigate the risk these captures posed to the population, Government imposed a 12 nautical mile exclusion zone[2] around the Auckland Islands in 1986 to prohibit fishing close to the major breeding areas of the New Zealand 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-mile exclusion zone. Outside the 12-mile exclusion zone, there are active commercial fisheries for various species, including arrow squid (*Nototodarus sloanii)* in quota management area SQU6T.

9 In the past decade, the capture of sea lions within the SQU6T fishery has lead to the development and implementation of operational plans to mitigate the effects of fishing on the New Zealand sea lion population. These plans have focused primarily on the use of a "Fishing Related Mortality Limit (FRML)" to constrain the total number of captures of sea lions to a biologically acceptable level within a particular fishing year. The basic objective of these plans is to allow the SQU6T fishery to continue to operate until the FRML is reached. At this point, the SQU6T fishery is closed even if the Total Allowable Commercial Catch (TACC) is not fully taken.

Squid (SQU) 6T fishery

10 Squid is one of New Zealand's top 20 seafood exports earning $86 million in exports in 2002 and $61 million in exports in 2003. Export values are expected to exceed $150 million in 2004 in view of the significant increase in squid catch this past season. The difference in export figures reflect variable catch levels – the fishery is seasonal and catch fluctuates between years (refer to 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. 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[3].

11 The Southern Islands fishery (SQU6T) is almost entirely a target trawl fishery with over 99% of the annual catch taken by trawlers targeting arrow squid around the Auckland Islands[4]. The

[2] Regulation 15 of the Fisheries (Southland and Sub-Antarctic Commercial Fishing) Regulations 1986
[3] Annala.J.H., Sullivan.K.J., Smith.N.W.M., Griffiths.M.H., Todd.P.R., Mace.P.M., Connell.A.M. (2004). Report from the Fishery Assessment Plenary, May 2004: stock assessments and yield estimates; Ministry of Fisheries.
[4] Langley A (2001). New Zealand Fisheries Assessment Report 2001/51, Ministry of Fisheries.

SQU6T TACC equates to 25.42% of the entire squid TACC. Catch from SQU6T has accounted for 25.5% of the entire squid catch over the last ten year period[5].

12 Landings in SQU6T have been irregular over time. The variable nature of catches reflects both unpredictable squid availability and season closures because of sea lion mortalities. Table 1 compares reported landings, the TACC, FRML, estimated sea lion mortalities, and closure date if triggered by the FRML. Estimated mortalities have exceeded the FRML in some fishing years because of the unpredictability of sea lion bycatch, and the time needed to communicate ongoing vessel operations data required to extrapolate FRML estimates.

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	6,847	70	39	-- [b]
2003-04	32,369	34,634 (as of August 2004)	62	118	-- [c]

[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. An Appeal Court 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.

[5] The 2003-04 fishing year is not complete, reported catches of August 2004 has been used.

[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. The history of SLEDs in the SQU6T fishery is discussed in detail later in this consultation document.

Legal framework

13 The purpose statement of the 1996 Act 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*".

14 Within the parameters of sustainability, there is a positive obligation to provide for the use of fisheries resources. In the context of a harvestable species, this requires utilisation to the extent that is sustainable. However, it is inappropriate to consider the incidental capture of a protected species in the same way that one considers harvesting a fish stock (Squid Fishery Management Company Ltd v Minister of Fisheries[7]).

15 Complicating this balancing exercise is the difference in the operational sustainability standard for fisheries resources and for other aquatic life, and in particular, protected species. Most fish stocks are managed towards a level that will produce the maximum sustainable yield, but the Act sets no quantifiable criteria for considering sustainability as it relates to threatened species. Suffice to note that there is no requirement the Minister provide for the utilisation of a fish stock to the extent that the viability of associated protected species is threatened.

16 Consistent with the purpose and principles of the Fisheries Act 1996, 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 another statute (discussed below) but otherwise provides scope to meet the sustainability obligation of the Fisheries Act 1996 while providing for the utilisation of associated fish stocks.

17 A *Population Management Plan* (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 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 Fisheries Act 1996).

18 Without a PMP, the Fisheries Act 1996 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 (MALFiRM or 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.

19 There is no PMP for the New Zealand sea lion, however, the Department of Conservation is developing one. Because a PMP is not available, MFish has, in the past, developed options for the Minister of Fisheries to implement a FRML-based approach to manage the effects of the SQU6T

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

fishery on the New Zealand sea lion population under s 15(2) of the Fisheries Act 1996. MFish proposes to adopt this approach again for the 2004-05 fishing year.

Interim Management Objective

20 When setting a FRML under s 15(2) of the Act, it is appropriate for Ministers to consider the specific legislative provisions dealing with the establishment of maximum allowable mortality limits on 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:

> *"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."*

21 The Minister is not specifically required to meet this criterion, as is required when a PMP is in place, but this criterion does provide a possible guide for a reasonable target rebuild period under any FRML that may be established under s 15(2).

22 The MFish management consideration in previous Operational Plans for New Zealand sea lions included consideration to retain existing breeding locations, and allow population size to increase with the aim of moving this species towards a 'non-threatened' status within a 20-year time-frame by increasing the number of breeding sites to five. For example, sea lion Operational Plans from 2000-01 and 2001-02 incorporate this terminology. In practice, MFish has little direct ability to bring about an increase in the number of sea lion breeding locations through management of the SQU6T fishery, and in 2003 sought more explicit objectives for managing SQU6T sea lion interactions in the Operational Plan.

23 A group comprised of industry, environmental groups, Department of Conservation, and MFish was established in early 2003 within the Ministry of Fisheries Aquatic Environment Working Group (AEWG) to examine research findings and scientific matters relating to bycatch of the New Zealand sea lion. For purposes of examining statistical models to assess the efficacy of several alternative management strategies, this working group adopted the following interim management objective:

> *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.*

24 The intent of the interim management objective is to provide a criterion for evaluating alternative management strategies affecting sea lions, including setting of FRMLs at varying levels. In the development of the 2003-04 SQU6T sea lion Operational Plan, a number of strategies were examined with respect to this objective. The outputs of that exercise (discussed below) formed the basis for consultation on the 2003-04 Operational Plan.

THE 2003-04 SQU6T SEA LION OPERATIONAL PLAN

25 Incidental catch of sea lions in the 2003-04 SQU6T season was managed under an Operational Plan approved by the Minister of Fisheries (after consultation with the Minister of Conservation) on 16 September 2003. Officials of MFish and the Department of Conservation

developed this plan, after consultation with industry, non-government organisations, Ngai Tahu, and other relevant groups. The 2003-04 plan was based on a FRML of 62 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.

26 The Operational Plan offered two monitoring procedures to estimate total sea lion captures by the SQU6T fleet. The first was based on using designated 'FRML' vessels to get an actual in-season strike rate (expressed as the number of sea lion captures per 100 tows). FRML vessels were required to carry observers and to fish in a way that retained all sea lions that entered the trawl nets. The capture rate of sea lions on those vessels would be extrapolated to the entire fleet, provided those vessels performed at least 20% of tows in SQU6T; if they did not, then a second monitoring option based on a default strike rate of 5.3% would apply. The Operational Plan required MFish observers to be placed on all FRML vessels when fishing in the SQU6T fishery to count all sea lions caught by these vessels.

27 Industry opted for the second monitoring procedure where the predetermined strike rate (5.3%) was applied to all tows undertaken in SQU6T, and estimated mortalities were counted against the FRML.

28 The 2003-04 Operational Plan allowed a discount factor of 20% to be applied to the predetermined strike rate of sea lion exclusion device (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 2003-04 season

29 Fishing commenced in the first week of February 2004. On 19 March 2004, acting on what he believed to be the best available information, the Minister of Fisheries closed the SQU6T fishery effective from 22 March 2004. He did so on the basis that estimated sea lion mortality would soon reach 62 animals – the FRML approved by his predecessor. However, the Court of Appeal gave orders on 22 March 2004 that the Minister could not close the fishery pending a substantive review of his predecessor's decision to set the FRML at 62 sea lions. The substantive review was undertaken in the Court of Appeal on 5 April 2004, and on 6 April 2004 the Court set aside the Operational Plan, and allowed fishing to continue, providing sea lion mortalities did not exceed 124.

30 A total of 34,634 tonnes of squid was reported caught in the 2003-04 SQU6T fishing year as at mid-August, amounting to 107% of the TACC[8]. Although one and a half months remain in the current season, it appears that the fleet withdrew from the fishery at the end of June because of low squid catches.

[8] The 7% overrun is accounted for by "allocation of additional annual catch entitlement in case of underfishing" under s 67A 2(b) of the Act.

Estimated number of New Zealand sea lion captures

31 In the absence of guidance from the Court on procedures to estimate mortalities (the Court set aside the entire plan, not just the FRML), MFish and industry agreed to continue using the monitoring and estimation procedures of the Operational Plan.

32 A total of 2,555 tows had been conducted in the 2003-04 SQU6T season as at the cessation of periodic vessel reporting in the week ending 7 July 2004. Using the monitoring and estimation procedures in the Operational Plan, a total of 118 sea lions were estimated killed in the SQU6T fishery in 2003-04. Sixty nine percent of tows qualified for the strike rate discount factor (effectively a strike rate of 4.24) because vessels used SLEDs with open cover nets. The full 5.3% pre-determined strike rate was applied to the remaining 31% of tows. An actual sea lion strike rate for the 2003-04 season cannot be estimated because observed and unobserved vessels variably used SLEDs, so that mortally wounded sea lions passing through the escape hatch of a SLED would be incorrectly excluded from the estimation procedure.

33 A total of 788 tows were observed by MFish observers in the 2003-04 season. This represents 30.8% of tows conducted as at the cessation of periodic vessel reporting. Sixteen sea lion mortalities were recorded in SQU6T by MFish observers during this period. Two additional sea lion mortalities were reported by industry employed observers. Six additional animals returned for autopsy are thought to have been captured in SQU6T, but have not yet been accounted for by fishery from available records. Fourteen of the 16 sea lion mortalities observed by MFish observers were from vessels that used SLEDs during the tows that captured the sea lions.

2004-05 SQU6T SEA LION OPERATIONAL PLAN PROPOSAL

Breen-Kim model and harvest control rules

34 Until the 2003-04 fishing season, the FRML was calculated from a formula developed by Wade (1998)[9] (see Annex 1). For the 2003-04 season however, variants of the Wade formula were explored in a modelling study by Breen & Kim (2004)[10] and were used to establish alternative management strategies that could be evaluated against the interim management objective.

35 In the Breen & Kim research, the sea lion population is modeled using a fully-age-structured Bayesian approach. It differs from the previous work of Breen and others by taking 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.

36 All of the management strategies evaluated using the model use pup production as an index of population size, because direct estimation of numbers of adult sea lions is hampered by their

[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.

periodic foraging trips at sea. The Department of Conservation estimates pup production[11] at the Auckland Island rookeries each summer.

37 Inputs to the evaluation exercise consisted of six different management strategies (harvest control rules). The rules were compared with respect to how well they met the interim management objective using several predetermined criteria (discussed below). The rules were:

a) Rule 0 - no fishing;

b) Rule 1 - unconstrained fishing at current levels of effort (13 weeks of fishing with 2871 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 - the adaptive rule. Rule 4 is an adaptive rule in which the permitted exploitation rate increases with increasing pup productivity. It was set at an arbitrary level by the AEWG, using a polynomial function that fitted a line equating to ½ the 2002-03 FRML at less than 50% of mean pup production from 1999-2003, and twice the 2002-03 FRML level when pup production is over 80% of mean pup production from 1999-2003.

38 Several other potential management strategies were considered by the AEWG for evaluation, including fishing exclusion zones, but these were not advanced pending further analysis.

39 In addition to the harvest control rules evaluated in 2003, MFish recently contracted NIWA to calculate the FRML corresponding to a harvest control rule that would just meet the formal assessment criteria associated with the interim management objective. The Squid Fishery Management Company Limited first requested this rule from NIWA in early 2003. Colloquially known as the 'Cusp Rule', this rule is 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.

40 The Cusp Rule provides 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 is necessary to show the extent of management interventions the Minister could theoretically use under section 15(2) of the Fisheries Act to the point the sustainability objective for the sea lion/SQU6T interaction is threatened.

[11] Pup production is all births of pups recorded at colonies on specified days falling within approximately 1 month of typical pupping dates and includes all known live pups, calculated through mark-recapture estimates, and all known dead pups to that date.

Evaluation criteria

41 Criteria for acceptance of management strategies were developed by the AEWG to ensure a strategy satisfied the intent of the interim management objective. The probabilities of different outcomes 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).

42 Aside from these three primary criteria, evaluation of the management strategies 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 strategies (79 – 83%), hence is not discussed further.

Evaluation Results

43 All harvest control rules tested passed the *crit20* and *Nmat/K* criteria, while only rule 1 (unconstrained fishing) marginally failed the *crit100* criteria. Table 2 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 revenue loss to the fishery in terms of reduced fishing opportunity due to closure. The other indicators are the median of the distribution for each index.

Table 2 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

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

45 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).

46 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.

47 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.

48 Rule 320 – (approximating two times 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.

49 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 vice versa.

50 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.

51 In general, these results indicate a FRML corresponding to six of the seven strategies MFish examined (Table 2) would theoretically satisfy the interim management objective. The modeling exercise essentially shows a continuum of possible harvest control rules that 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-Kim model status

52 The AEWG accepted the model on 11 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 SQU6T fishery. The model, discussed in Annex 1, was

reviewed and approved with certain caveats by Dan Goodman, an independent population biologist and modeler, in 2003[12]. The reviewer comments did not suggest serious errors in the Breen-Kim approach, but indicated grounds for caution when adopting the new model.

53 The most recent AEWG (30 August 2004) accepted the findings of the latest iteration of the Breen-Kim model and associated harvest rules. Some members of the AEWG specified a number of 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 as a whole is actually near *K*. Some members also indicated that a more comprehensive assessment of the Goodman review is necessary before full support could be applied to Breen-Kim model. However, MFish advises there are no major considerations coming out of the Goodman review in terms of changes to the model structure or interpretations. There were no technical considerations that could be taken into account in revising the Breen-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.

54 MFish acknowledges existing concerns, but advises that the Breen-Kim modeling process remains as the best available information to consider for decision making in managing sea lion interactions in the SQU6T fishery. MFish advises that relevant concerns raised in the Goodman review, and by members of the AEWG, can be managed taking into account the "information principles" in section 10 of the Fisheries Act, which requires decision makers to consider any uncertainty in the available information, and should be cautious when information is uncertain, unreliable or inadequate.

55 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 interim management objective developed by the Aquatic Environment Working Group. Central to this process is the trade-off in terms of sustainability and utilisation offered by the harvest control rules and associated FRMLs.

Scope of management interventions for the 2004-05 season

56 Theoretically, to meet the interim management objective for the 2004-05 fishing season, up to 598 sea lions could be taken in SQU6T based on the Cusp Rule (incorporating the 2004 pup production data into the Breen-Kim modeling). 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[13] 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".*

57 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

[12] Copies of the Goodman review are available on request from the Ministry of Fisheries.
[13] Paragraph 77, CA39/04.

uncertainty over whether the sea lion population is at or near *K*; the accuracy of the estimate of incidental sea lion captures; 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. MFish considers these uncertainties highlight grounds for caution in determining the FRML for 2004-05, and accordingly MFish does not recommend a FRML approaching 598 sea lions.

58 In line with the Court of Appeal determination, MFish intends to advise the Minister that the sea lion/SQU6T interaction cannot be managed by considering sea lions a harvestable stock that can be exploited to a point just below the level that populations are no longer sustainable. There is still a positive obligation to provide for utilisation of the associated squid resource, albeit under the limitations explicit in the degrees of uncertainty and the status of the New Zealand sea lion as a threatened species, encompassed in the interim management objective. The Court of Appeal has put it this way:

> "*Recognising as we do, that a value judgment was in the end called for and that a precautionary approach was available to the Minister, we are satisfied that the legislative framework required the Minister to form a view as to the extent to which (or the point at which) utilisation of the squid resource threatened the sustainability of the sea lion population. We see this as implicit in the way in which s15(2) is expressed; the Minister may only take such measures which he or she "considers necessary' in terms of avoiding, remedying or mitigating … effects of fishing on a protected species*."

59 In addition, the Court noted that in this exercise, the information principles provided for in section 10 of the Act were applicable:

> "*So the Minister was required to take into account the principle that decisions "should be based on the best available information" but with the appropriate allowances for uncertainty and caution where information is uncertain, unreliable or inadequate.*"

60 MFish recommends the Minister also consider evidence that indicates 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 SQU6T fishery. Bycatch reports from MFish observers show sea lions are also 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 August 2003) of 1.75 sea lions have been taken as bycatch 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.

MFish proposed harvest control rule

61 MFish has evaluated several options that could be used to determine the FRML target in light of the objectives established for managing the sea lion/SQU6T interaction. Of these, the Cusp Rule represents the theoretical limit of the continuum the Minister could consider. For reasons outlined above, MFish does not recommend the Minister entertain the Cusp Rule. 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 SQU6T fishery.

62 Rule 1 (unconstrained fishing) does not meet the sea lion management objectives (although only marginally), and is not recommended by MFish. 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.

63 Given the available information on the status of the sea lion population, MFish considers that Rule 310 unnecessarily restricts squid fishing opportunities and does not recommend this option. MFish also acknowledges that the exploitation rate of Rule 310 was set at a level equivalent to the 2002-03 FRML exploitation rate. This is relevant because the 2002-03 FRML was fashioned on an earlier modeling exercise that is no longer considered the best available information. The new Breen-Kim approach indicates that bycatch higher than that offered by Rule 310 meets the sustainability objective for the sea lion/SQU6T interaction, potentially providing 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. The 2004 Court of Appeal ruling accepted the mortality limit set out from Rule 320 as a basis for managing sea lion interactions in the 2003-04 SQU6T season.

64 Rules in the Rule 3 family represent a simple linear exploitation rate relative to the pup production index of population size. In contrast, Rule 4 is derived with an increasing proportion of the population exploitable 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 to fishing opportunities when pup production is at high levels. MFish considers the adaptive approach of Rule 4 is the strategy best suited to optimise utilisation of the squid fishery, recognising information uncertainty and the sustainability objective of the sea lion population. Unlike the Rule 3 variants, Rule 4 is not fashioned on modeling exercises preceding the Breen-Kim approach described above.

65 Rule 4 satisfies all three criteria for management of the sea lion/SQU6T interaction. Under Rule 4, the SQU6T fishery is closed in fewer than 25% of the modelled seasons and represents a 12% decline in the 1988-2003 mean fishing effort in the SQU6T fishery.

66 Rule 4 results in proportionately smaller FRMLs when pup counts are low, and relatively larger FRMLs as the pup count increases. Compared with the Rule 3 variants considered, Rule 4 generates the greatest maximum FRML at high pup production and offers better squid utilisation opportunities when pup production is strong.

67 The variable responsiveness in the FRML to pup counts offered by Rule 4 represents a precautionary approach in setting bycatch limits at low pup counts. However, the progressive increases in sea lion bycatch allowed under Rule 4 at higher pup counts raises concerns relative to s 15(2) in the Fisheries Act. A modification of Rule 4 to cap bycatch at some upper limit might address these concerns, but this modification has not been evaluated in terms of the impact on performance criteria. Rule 4 is also consistent with a balanced approach in that it recognises the inherent uncertainty in the data available to the Ministry.

68 MFish is satisfied the responsiveness offered by Rule 4 to changing circumstances in the Auckland Island sea lion population is a mechanism suited to meet the dual requirements of the Fisheries Act 1996 to balance sustainability of the sea lion population with utilisation of the SQU6T resource. Rule 4 is consistent with s15(2) in that it is consistent with the Minister taking

only such measures as he "considers necessary" to avoid, remedy, or mitigate effects of fishing for squid on the sea lion population, and it also offers a considered balance between sea lion management objectives and SQU6T fish stock utilisation opportunities for fishers.

69 MFish notes the Department of Conservation is developing a PMP. However, in its absence, MFish also recommends that should the Minister of Fisheries agree that Rule 4 is a considered balance between sustainability and utilisation, he continue to adopt Rule 4 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.

2004 estimates of New Zealand sea lion pup production and total population size

70 Department of Conservation estimates of New Zealand sea lion pup production and total population size since 1994-95 are shown in Table 3. The Department's estimate of the mean New Zealand sea lion population in 2003-04 is 13,596 animals (11,783 – 15,643; 95% confidence limits).

71 Estimates of pup production at the Auckland Islands made in January 2004 are similar to those made in 2003. The estimates are approximately 10% higher than in 2002, but around 12% lower than those seen in the 1999, 2000 and 2001 seasons. Pup mortality was not significantly high at 6.6%, relative to the last two seasons which showed mortality levels of over 30% and 20% (at the Sandy Bay sea lion population), respectively. No adult females were seen to be affected during these mortality events and it is unclear if similar levels of mortality occurred at Dundas Island.

72 Pup production at Campbell Island was estimated during the 2002-03 breeding season. 136 dead pups were found during the survey at Davis Point and 2 elsewhere. A further 161 live pups were tagged during the summer. The total estimated pup production for Campbell Island in 2002-03 was 358 animals (95% CI 330 – 440). This estimate is about three times the previous estimate of 122 animals obtained in 1991-92. However, due to differences in the methodology between counts, the two estimates of pup production cannot be said to differ.

Table 3 Pup production and the estimation of population size

Season	Total estimated pup production (std. error)[a]	Per annum increase in pup numbers	Population size estimates using 1996 Gales & Fletcher model		
			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	2,875 (70.0)[b]	19.6%	13,608	11,812 – 15,663	12,737
03/04	2,873 (49.3)[b]	-0.07%	13,596	11,783 – 15,643	12,705
03/04[c]	2,515 (44.0)	N/A	11,914	10,311 – 13,669	11,166

[a] Total pup production estimate is for Auckland Islands and Campbell Island combined. Figure for Campbell Island between 1994-95 and 2001-02 is 122 (based on estimate in 1991-92).

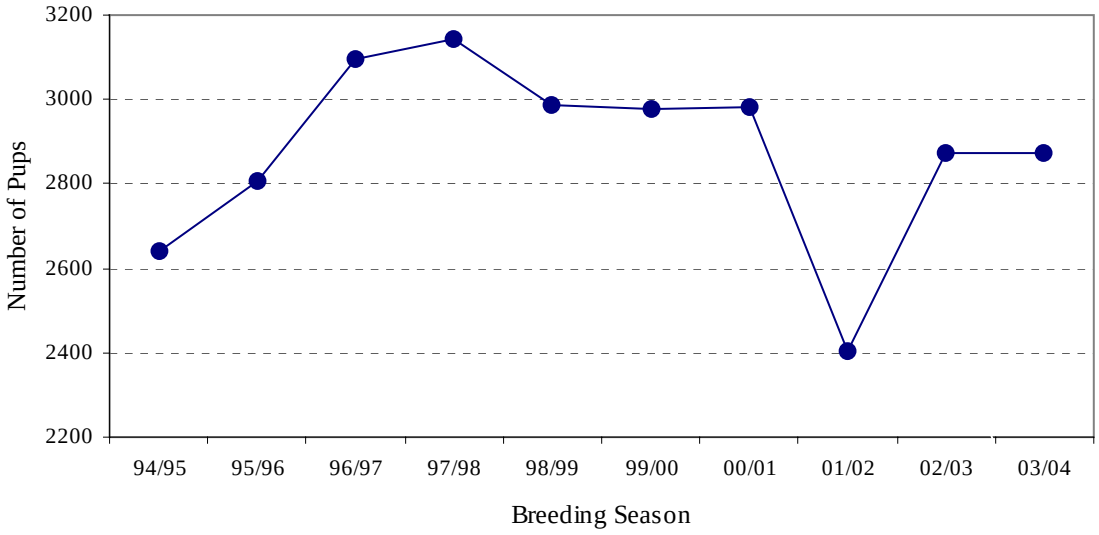
[b] Incorporates the latest estimate of pup production at Campbell Island (358±28), which is approximately three times the estimate previously used.

[c] Estimates calculated using only the Auckland Islands pup production value.

73 The Department of Conservation estimates the total pup population (Auckland Islands and Campbell Island combined) in 2003-04 is 2,873 animals. This estimate indicates that total sea lion pup production in 2003-04 is similar to 2002-03 and about 20% higher compared with the 2001-02 estimate. Although the latest estimates are about equal to the average of the previous eight years (2,880 pups), comparisons are influenced by the significant three-fold increase in the Campbell Island pup count estimate. The combined Auckland and Campbell Island pup production estimates since 1994/95 are illustrated in Figure 1.

74 MFish notes the population estimates shown in Table 3 are based on the 1996 Gales and Fletcher model, not the Breen-Kim modeling used to evaluate alternative management strategies for the purposes of the Operational Plan. MFish also notes that the pup production estimate driving the Breen-Kim modeling 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-Kim model. In addition, there is little evidence as to the extent to which sea lions from Campbell Island are killed in the SQU6T fishery.

Figure 1 New Zealand sea lion pup production estimates since 1994/95



MFish proposed FRML for the 2004-05 fishing year

75 Incorporating the 2004 pup production estimates from the Auckland Islands into the Breen-Kim model, NIWA has calculated the FRML corresponding to Rule 4, and also to Rules 310, 320 and the Cusp Rule for reference. The modeling work calculates the following FRMLs:

- Rule 310: 65 sea lions
- Rule 320: 130 sea lions
- **Rule 4: 115 sea lions** (MFish preferred option)

- Cusp Rule: 598 sea lions

76 The modeling work uses exact numbers, whereas rounding to integers is required for actual FRMLs. Conventional rounding is used here. For the 2004-05 fishing season, MFish proposes adoption of Rule 4, which generates a FRML limit of 115 sea lions.

Impact of a FRML on the Fishing Industry

77 Although catches and market returns vary from year to year, the New Zealand squid fishery is considered to be one of New Zealand's top 20 seafood exports. Annual SQU6T landings have averaged approximately 14,885 tonnes (46% of the TACC) over the past 17 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 little correlation between squid catch and sea lion bycatch.

78 Prior to the 2003-04 season, the SQU6T TACC has been under caught each year since the 1995-96 season, averaging 27% of the TACC. However, the portion of this foregone catch attributable to the FRML limit is uncertain. Depending on the availability of squid in SQU6T 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 as high as $26 million (if early closure lead to significant foregone catch.)[14].

79 The majority of boats operating in the SQU6T fishery have been foreign charter vessels, many of which rely upon squid 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 SQU6T fishery thus become an important consideration in a more complex array of charter vessel arrangements in other fisheries over the course of a year.

80 Catches made in SQU6T form a significant portion of the overall squid catch (SQU6T TACC comprises 25% of total SQU TACC). MFish acknowledges the significance of the squid fisheries to the fishing economy and the potential impacts on the industry if the SQU6T fishery is closed. However, these impacts must be balanced against the legislative requirements in both the Fisheries Act 1996 and the Marine Mammals Protection Act 1978.

PROPOSED ARRANGEMENTS TO MONITOR THE FRML

81 Estimation of the FRML as described above is the measure of allowable sea lion mortalities attributed to unintentional bycatch in associated fisheries in the SQU6T fishery. A separate decision is necessary concerning how sea lion mortalities should be counted against the FRML. Monitoring the FRML involves counting sea lion deaths that accrue as a result of fishing.

82 In the past, MFish considered several options to monitor and estimate the total number of sea lion captures in the SQU6T fleet. These ranged from closely monitored plans with empirical verification of sea lion deaths, to less structured plans based on expected or simulated outcomes. Both approaches have been employed in previous seasons.

[14] In the 1999-00 season, early closure of the SQU6T season due to sea lion bycatch limited squid catch to 6,247 tonnes, about 26,000 tonnes below the TACC. Gross economic impacts are based on an assumed average port price over time of $1/kg.

83 In the event an observer oversaw each and every tow undertaken, and all dead and mortally wounded sea lions were retained in the trawl net, the SQU6T fishery could be monitored based on an empirical count of actual bycatch. As this has not been possible in recent years, observer coverage has been less than 100%[15], such that the FRML has been monitored based on an estimate of total sea lion bycatch. To estimate total mortalities, a strike rate is multiplied by the number of trawls conducted in order to project total sea lion bycatch. The strike rate is a measure of the number of sea lions captured per 100 tows. This is conveyed as a percentage; if 5 sea lions are captured in 100 tows, the strike rate is 5%. Use of a strike rate for monitoring the FRML is founded in the concept that sea lion interactions with squid trawl nets in this fishery occur with some level of predictability, and that this predictability can be used to estimate the number of mortalities associated with unobserved vessels. However, there is uncertainty associated with this assumption (discussed below) that introduces potential bias in the estimation of sea lion mortalities against the FRML using a strike rate.

84 In the 2003-04 Operational Plan there were two strike rate options. The first was the use of an in-season strike rate. Under this option, observed sea lion mortalities on designated 'FRML vessels' in a given reporting period were divided by the number of tows performed by those vessels in the same period. The product of this calculation was a real time strike rate that could be extrapolated to tows by all vessels in that reporting period. MFish required between 20% and 30% 'FRML vessel' coverage in a reporting period for this option to operate. FRML vessels were required to operate without SLEDs (or with the cover nets tied down) and to fish in a manner representative of the SQU6T fleet. All FRML vessels required MFish observers.

85 In 2003-04 industry elected to operate with the second strike rate option, a 'predetermined strike rate'. For the purposes of determining the predetermined strike rate for the 2003-04 Operational Plan, representatives from MFish, the Department of Conservation, Squid Fishery Management Company, SeaFIC, the World Wildlife Fund-New Zealand, NIWA, and Te Ohu Kai Moana agreed that the use of a simple average of the actual strike rate achieved during recent years, and for which a minimum 20% annual observer coverage was achieved was the most appropriate method for setting a default strike rate (see Table 4). This agreement[16] resulted in a default strike rate of 5.3% (or 5.3 mortalities per 100 tows) that was applied across tows in SQU6T in 2003-04 in order to estimate sea lion mortalities.

Table 4 Reported strike rate of New Zealand sea lions (mortalities per 100 tows) by MFish scientific observers in the SQU6T 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

[15] Nearly 100% observer coverage of SQU6T vessels was obtained during the 2000-01 season under the sea lion Operational Plan in effect at that time. Observer coverage has averaged less than 50% in all other seasons since 1987-88.

[16] Achieved at the 10 July 2003 sea lion Operational Plan meeting.

Fishing year	Actual strike rate[a] (%)	Observer Coverage[b] (%)
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]

[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

Predetermined strike rate for 2004-05

86 For 2004-05, empirical verification of actual sea lion deaths is not an option because MFish is unable to provide 100% observer coverage for the SQU6T fleet, and industry are likely to use SLEDs to the effect some mortally wounded sea lions will not be retained. Instead, MFish proposes to monitor and estimate the total number of sea lion mortalities within the SQU6T fleet using a predetermined strike rate. MFish does not intend to develop a facility for in-season strike rate estimation for 2004-05.

87 Available information indicates there is a range of predetermined strike rates that could be used to estimate sea lion mortalities for the purpose of the Operational Plan. Table 4 shows the reported strike rate of sea lions from MFish observers in SQU6T at a range of different observer coverage levels since 1987-88. These strike rates range from 0.6 to 11.8 sea lions per 100 tows, the latter being the case when observer vessel coverage nearly reached 100% in 2000-01.

88 For the purposes of determining the predetermined strike rate that was used to estimate sea lion mortalities for the 2003-04 fishing season, the AEWG examined alternative time series procedures using actual strike rate data before agreeing on a simple seven-year average (described above). Although potential bias in the strike rate has been noted in the AEWG, MFish considers there is no new relevant information that supports a change in this approach.

89 Uncertainties surrounding the predetermined strike rate estimation process need to be taken into account when considering the most appropriate predetermined strike rate. For example, MFish notes that the highest reported strike rate was achieved when almost all tows were observed in 2000-01 (Table 4). This is more than double the reported strike rate from other years when observer coverage has been less than 50%. This relationship could be indicative of biases in the estimation of sea lion captures when they are measured empirically. The mechanism and magnitude of these biases is unknown, and data of this nature does allow causal relationships to be established. However, it introduces grounds for caution (in setting the predetermined strike rate) because MFish will not have the capacity to observe all SQU6T tows in 2004-05. In addition,

MFish notes that a number of variables have been found to influence strike rate[17], and MFish considers higher observer coverage is likely to reduce the bias that these factors may have on the observed strike rate.

90 MFish does not propose to update the seven-year average predetermined strike rate with the actual strike rate from the most recently completed fishing year (2003-04), despite observer coverage being greater than 20%. The use of sea lion exclusion devices (discussed below) in observed tows means it is likely an unknown number of mortally wounded sea lions were not recovered. Any estimate of a real-time strike rate using actual captures from the 2003-04 season would incorrectly exclude these animals.

91 MFish acknowledges that selection of the predetermined strike rate bears directly on the number of tows allowed for any given FRML, and that a higher predetermined strike rate may limit squid utilisation opportunities. However, MFish contends that, given uncertainties in the strike rate estimation process, a predetermined strike rate lower than 5.3 would undermine the integrity of the FRML that MFish proposes.

92 The predetermined strike rate will apply to the *total* number of tows reported by all vessels (that are not using an approved SLED design – see next section) in SQU6T during the relevant reporting period[18] as follows:

(predetermined strike rate) x (total number of tows in SQU6T by all vessels)

93 Reporting arrangements necessary to calculate sea lion mortalities will be the responsibility of industry with MFish oversight, and are discussed later in this consultation document. Ongoing estimated mortalities by the fleet will be applied cumulatively to the sea lion FRML in SQU6T. The SQU6T fishery will be closed when the Minister determines the FRML is about to be, or has been, reached.

SEA LION EXCLUSION DEVICES AND THE DISCOUNT STRIKE RATE

Recent history

94 In recent years, the squid fishing industry has experimented with sea lion exclusion devices ('SLEDs') installed inside trawl nets. SLEDs are intended to reduce sea lion mortalities by directing live animals out of the trawl net. The potential to increase utilisation of the SQU6T fish stock through SLED use has inspired consideration of a "discount" factor applied to the strike rate of vessels employing this technology. If SLEDs were known to reduce sea lion mortalities by a given level, the strike rate applied to vessels employing a SLED might be reduced by that appropriate level in compiling the FRML count.

[17] 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).

[18] 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 2005. For purposes of the applicable reporting period, the week covering the opening of the SQU6T fishery on 1 February will be shortened to the six-day period commencing 1 February 2005 at 0001 hours and ending at 2400 hours on 6 February 2005.

95 Key to this logic, however, is accurate estimation of the sea lion survival from SLED-equipped trawl nets. MFish has established a set of criteria dating back to amendments in the 1999-2000 SQU6T Operational Plan that set out the basis for measuring sea lion survivability, and how this information would be applied in consideration of a discount factor to the strike rate. The criteria established at that time, and renewed under recommendation from the 16 June 2003 AEWG technical working group meeting on SLEDs, are that an animal must be noted to have been successfully ejected using video monitoring and also exhibit necropsy pathologies that do not compromise its long-term survival[19].

96 Over time, the survival criteria have been reassessed periodically as researchers have obtained more information concerning the efficacy of SLEDs through filmed observation of sea lions encountering SLEDs, as well as necropsy reports from sea lions retrieved from both SLED and non-SLED squid trawl nets operating in SQU6T. However, as at August 2004, the scientific criteria described above to establish SLED survivability have not been satisfied, such that statistically reliable conclusions on SLED efficacy cannot be made.

97 MFish acknowledges that in the absence of a sound scientific basis to determine the survival rate of sea lions ejected by SLEDs, the Minister is still required by s 10 of the Act to take into account the principle that his decisions on management actions should be based on the best available information. Such information may be drawn from injury diagnosis provided in the sea lion necropsy reports, conditioned with factors thought to further influence survival beyond the condition of the sea lion at the time drowning occurred, such as the consciousness of the animal on release from the trawl net.

98 For the 2003-04 Operational Plan, MFish considered the available information on injury diagnosis provided in sea lion necropsy reports, recognising this evidence suggests not all sea lions exiting trawl nets via SLEDs are mortally wounded. The extent to which the necropsy reports support survival prognoses or otherwise are subject of considerable debate, although an independent review by a panel of experts from the United States in late 2003 generally confirmed the sea lion survival prognoses made by Massey University veterinary pathologist Dr Padrig Duignan.

99 The AEWG technical working group considered this review and concluded that for purposes of determining the efficacy of SLEDs at ejecting sea lions in viable condition, there was some certainty that a proportion (2/7) had a high likelihood of survival. The technical working group did not agree, however, that this information constituted sufficient certainty that a proportion of sea lions were exiting from SLEDs in viable condition to enable a discount for SLED use to be recommended, for reasons relating to sample size and deficiencies in the sampling regime.

100 In the absence of sufficient SLED evidence to draw conclusions under the preferred criteria, MFish recommended that a discount factor of 20% be applied to the actual or predetermined strike rate used to monitor the FRML based on the limited evidence considered above. This recommendation acknowledged the likelihood of modest survival, but MFish withheld any scientific endorsement of SLED efficacy pending better information. MFish further acknowledged that the survival criteria established in the amendment to the Operational Plan in 1999-2000 remains as the preferred protocol for estimating both sea lion survival and the consideration of an appropriate discount factor. The technical working group meeting of the Aquatic Environment Working Group confirmed this on 16 June 2003.

[19] See paragraphs 58-61 of the 2001-02 SQU6T sea lion Operational Plan, available on request from MFish.

Strike rate discount factor for 2004-05

101 The preferred criteria for estimating sea lion survival and the consideration of an appropriate discount factor (as confirmation of SLED efficacy) has not yet been satisfied. Nevertheless, MFish is obliged to use the best available information in formulating management advice, and the best available information indicates not all sea lions ejected by SLEDs are mortally wounded. However, interpretation of the sea lion necropsies indicate the Minister could choose from a range of discount factors to apply to the strike rate of SLED equipped vessels for the 2004-05 SQU6T fishing season.

102 MFish acknowledges that industry has obtained professional assessments from independent pathologists suggesting that; Dr. Duignan's survival judgments are conservative, sea lions are known to be hardy animals, the injuries sustained may arise from struggling within the cover net, and that survival rates are likely higher than those estimated[20]. These judgments also raised questions concerning the extent, timing, and protocol of the autopsies conducted in terms of their ability to consistently assess likelihood of survival.

103 Alternatively, former Department of Conservation marine mammal specialist Dr. Ian Wilkinson has noted that judgments on survival based solely on autopsy information overlook critical variables such as the consciousness of the animal at the time of capture in the cover net, the animal's vulnerability after escaping the net, and undetected injury that may threaten long term survivability. MFish also notes that 14 of the 16 observed sea lion mortalities in 2003-04 came from vessels using SLEDs. MFish advises that this introduces further uncertainty over the efficacy of the devices in terms of successfully reducing sea lion mortalities in SQU6T.

104 Considering this, MFish is satisfied the necropsy reports and survival prognoses prepared by Dr Duignan are the best available information upon which to consider a strike rate discount factor. As noted above, the interpretation by a technical working group of an independent review of Dr Duignans work concluded that for purposes of determining the efficacy of SLEDs at ejecting sea lions in viable condition, there was some certainty that a proportion (2/7), had a high likelihood of survival. In the absence of any new comparable information[21], MFish proposes to carry forward the strike rate discount factor that applied in 2003-04 but cautions that there is significant uncertainty in extrapolating this survival prognosis from the necropsy results to SLED efficacy conclusions that underlie justification of a discount factor. MFish notes the small sample of sea lions necropsied is not sufficient to establish reliable conclusions on SLED efficacy.

105 Considering this uncertainty, MFish recommends the Minister take the same approach adopted in 2003-04 (pursuant to s 10 of the Act) in setting the strike rate discount factor at 20%. MFish contends that resolving current disagreements over SLED efficacy and the justification for a discount factor will require additional scientific information on SLED performance. MFish supports ongoing work in the area of sea lion bycatch mitigation, and encourages efforts by stakeholders to work cooperatively in advancing the understanding of SLED efficacy. MFish continues to urge the Squid Fishery Management Company (SFMC) to provide a research plan for SLED testing that details statistical design of the sampling regime, addresses heterogeneity issues with the data, and provides specifications of the SLEDs to be tested. MFish officials have on

[20] Reports prepared by KJ Thomson, TD Koelmeyer and TR Spraker on behalf of the Squid Fishery Management Company. Copies available from the Ministry of Fisheries.

[21] Necropsies were performed on sea lions captured in SQU6T for the 2003-04 fishing season, however, the final results have not yet been released, and may not be comparable with previous necropsies used to determine survivability of ejected animals. Industry elected to leave SLED escape hatches open in 2003-04 to the effect that MFish is unable to determine the survival prognosis of those animals ejected from the device.

several occasions since January 2003 urged the SFMC to submit their research plan for review by the Aquatic Environment Working Group. MFish understands that the SFMC has recently agreed to establish an independently chaired working group to examine issues related to SLED efficacy. MFish supports this initiative as a potential input into the formal AEWG process.

Requirements to qualify for the strike rate discount factor for 2004-05

106 MFish recommends the Minister allow a discount factor apply to those vessels meeting the following conditions:

a) That vessel used a SLED device approved by the Squid Fishery Management Company and the Ministry of Fisheries, and that the escape hatch on the SLED remained open during fishing operations.

b) The SLED specifications have been provided by the Squid Fishery Management Company to the Ministry of Fisheries for use in observer briefings.

c) A Ministry of Fisheries observer may be placed on that vessel to document net deployment and report on sea lion interactions associated with fishing activity.

107 MFish notes that ensuring observer coverage of all SLED vessels seeking the 20% discount factor is likely to require a significant increase in observers available for the SQU6T fishery. In the 2003-04 season, approximately 31% of SQU6T tows had observer coverage. MFish seeks the early cooperation of the SFMC in providing estimates and advanced notice of the likely number of SLED vessels operating in SQU6T in order that appropriate observer coverage can be arranged.

108 In order to coordinate availability and placement of MFish observers on SQU6T vessels requesting the 20% SLED discount factor, vessel operators are required to notify the MFish Observer programme at least 72 hours prior to departure. MFish also asks that the SFMC provide the MFish Observer programme with a list of all likely SQU6T vessels by 1 December 2004.

109 MFish cannot guarantee that all requested observer coverage for SLED vessels could be satisfied in the event there is an unanticipated increase in demand for this service. In which case, MFish will explore alternative audit mechanisms including remore electronic monitoring and random vessel checks.

REPORTING REQUIREMENTS

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

a) Masters of all vessels would 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 Mammal Protection Act 1978)

b) MFish observers would immediately inform (by telex or fax) the Fisheries Communication Centre immediately following any observed New Zealand sea lion capture on their vessel.

c) The Squid Fishery Management Company Limited, through the New Zealand Seafood Industry Council, would co-ordinate a vessel daily voluntary reporting

regime. This information is required to generate in-season extrapolations of New Zealand sea lion catches against the FRML based on the predetermined strike rate.

d) Given the proposed arrangements, all observed vessels would be required to report the following information:

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.

111 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 remains appropriate at this time.

POSSIBLE CLOSURE PROCESS

112 Under the mortality estimation proposal, monitoring effort will focus on fishery effort as conveyed in total vessel tows. Extrapolations using weekly tows would be used to estimate total sea lion bycatch in the fishery. Once 70% of the FRML has been reached, extrapolations would also be undertaken on a daily basis.

113 Once information indicates that the point estimate for the total catch of sea lions by the entire fleet is about to reach the FRML, the Minister of Fisheries would be advised to immediately close the SQU6T fishery under s 15(5) of the Fisheries Act 1996. 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 Limited to ensure that vessel operators are kept informed as to the status of the fishery in respect to the FRML. Stakeholders will also be regularly informed by email on the estimated number of sea lions caught by the fleet.

NGAI TAHU CLAIMS SETTLEMENT ACT 1998

114 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 section 293 of the Settlement Act requires the Minister of Conservation to undertake advisory and consultative steps with Ngai Tahu in regards to the management of toanga species.

PRELIMINARY RECOMMENDATIONS

115 MFish proposes that the Minister of Fisheries:

a) **Note** that management interventions for sea lion interactions in SQU6T fishery have been designed to ensure that 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;

b) Taking into account the balance between sustainability and utilisation offered by different approaches, **consider** the range:

   i) of harvest control rules concerning the Fishing Related Mortality Limit (FRML);

   ii) of actual FRMLs covered by the harvest control rules;

   iii) of possible pre-determined strike rates;

   iv) of possible strike rate discount factors;

c) **Agree**, under s 15(2) of the Fisheries Act 1996, to establish a management intervention prescribing a FRML of **115,** based on harvest control rule 4, New Zealand sea lions for the 2004-05 fishing year;

d) **Agree** to implement a monitoring and reporting regime to estimate the total number of New Zealand sea lion catches against the FRML using a predetermined strike rate of **5.3%**;

e) **Note** that continued research is necessary to establish the efficacy of SLEDs as they effect sea lion survival;

f) **Agree** that a **20%** discount be applied to vessels employing a SLED design approved by the Squid Fishery Management Company and MFish, and carrying an observer to document net configuration and use.

g) **Agree** to close the fishery under s 15(5) of the Fisheries Act 1996 in the event that the FRML is reached.

ANNEX 1

The Wade rule

116 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.

117 The FRML and was calculated each year as:

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

where N_y^{vuln} is a conservative estimate of vulnerable numbers in year *y*, λ (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 λ = 0.12 would be a suitable default value for pinnipeds, but λ = 0.08 was adopted in New Zealand. F_r was set at 0.15.

The Breen-Kim approach

118 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-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 λ and F_r constants, into a single constant:

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

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

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

Adaptive Rule 4

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

121 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 AEWG, is a smooth function - it has no thresholds - and is described by:

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

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

The Cusp Rule

123 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.

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

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

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