S7686

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Minister of Fisheries

2006-07 SQU6T SEA LION OPERATIONAL PLAN: FINAL ADVICE PAPER

Purpose

1 This paper provides you with the Ministry of Fisheries (MFish) recommendations for the management of the interactions between the squid (SQU6T) fishery and New Zealand sea lions during the 2006-07 fishing year. Management of these interactions will be implemented through an Operational Plan under s 15 (2) of the Fisheries Act 1996 (the Act).

Executive summary

2 Under s 15 (2) of the Act you may take such measures as you consider are necessary to avoid, remedy, or mitigate the effect of fishing-related mortality on any protected species, and such measures may include setting a limit on fishing-related mortality (FRML). The proposed management regime is similar to that used in previous years and focuses on the use of a FRML to constrain sea lion mortalities to a sustainable level.

3 A range of FRMLs is available to you based on the harvest control rules, assessed with the Breen-Kim model, which met the management criteria. Given the uncertainty associated with the Breen-Kim model and the continued decline in sea lion pup estimates, MFish recommends that you set the FRML based on one of four harvest control rules: Rule 4, 320, 330 or 340. This recommended set of rules results in a FRML that is higher than that submitted by environmental groups, and lower than that submitted by industry. However, you may choose any FRML you consider appropriate.

4 Proposed procedures to monitor sea lion bycatch against the FRML include the use of a pre-determined strike rate of 5.3% and an associated 20% discount factor when SLEDs are deployed.

5 MFish is working closely with the DWG to ensure the appropriate monitoring and reporting requirements are achieved during the 2006-07 fishing season.

Summary of options

6 MFish recommends you consider the following measures to manage the interactions between the SQU6T fishery and sea lions for the 2006-07 fishing year:

a) Implement an Operational Plan for the 2006-07 SQU6T fishery

b) Choose one of the following harvest control rules to set the fishing-related mortality limited (FRML) for the season:

   i) Rule 4: FRML of 77 sea lions

   ii) Rule 320: FRML of 109 sea lions

   iii) Rule 330: FRML of 164 sea lions

   iv) Rule 340: FRML of 218 sea lions

   v) Or any other FRML you consider appropriate.

c) Use a predetermined strike rate of 5.3% to estimate the total number of sea lion mortalities against the FRML; or such other strike rate that you consider necessary in the circumstances.

d) Use a 20% discount factor (to provide a strike rate of 4.24% for all qualifying tows) for vessels deploying an approved sea lion exclusion device (SLED); or such other discount factor that you consider necessary in the circumstances.

e) Close the SQU6T fishery under s 15 (5) of the Fisheries Act 1996 in the event the FRML is reached.

Submissions received

7 The following submissions were received:

a) Deepwater Group Limited **(DWG)**

b) Audrey Eagle, Macandrew Bay, Dunedin **(Audrey Eagle)**

c) Environment and Conservation Organisations of NZ Inc. **(ECO)**

d) Royal New Zealand Forest & Bird Protection Society **(Forest & Bird)**

e) New Zealand Seafood Industry Council Ltd (Technical submission provided in association with DWG by the SeaFIC science group) **(SeaFIC)**

f) Associate Professor Liz Slooten, Department of Zoology, University of Otago **(Liz Slooten)**

8 A summary of submissions is available in Part 2 of this paper and copies of the full submissions are provided in Part 3.

Background information

9 The foraging range of New Zealand sea lions that inhabit the Auckland Islands overlaps the fishing grounds of the SQU6T fishery and leads to the incidental capture of sea lions by trawl vessels.

10 Section 15 of the Act sets out your responsibilities for managing the fishing-related mortality of marine mammals. In the absence of a Population Management Plan[1] which is the case for sea lions, you are required to consult with the Minister of Conservation to take such measures as you consider necessary to avoid, remedy, or mitigate the effect of fishing related mortality on sea lions. These measures include setting a limit on permitted sea lion mortality so as to ensure the sea lion population is not threatened by fishing activity.

11 In making your decision you are required to balance utilisation opportunities and the sustainability risk to the sea lion population. In particular you should consider:

a) The purpose of the Act and the need to provide for utilisation while ensuring sustainability.

b) That your decision should be based on best available information recognising that not all the information available to you will be of the same standard.

c) That some of the best available information is uncertain. When dealing with uncertain information you are required to adopt a cautious approach that is appropriate to the circumstances. You should adopt a cautious approach in relation to ensuring both the sustainability and utilisation requirements of the Act are met. You should consider the nature of the uncertainty of this information and decide upon the appropriate weighting. Furthermore, the absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure necessary to avoid, remedy or mitigate the effect of fishing-related mortality on sea lions.

d) That in making your decision you should take into account the environmental principles set out in section 9 of the Act 1996.

e) Section 15 (2) requires you to take the measures you consider **are necessary** to avoid, remedy or mitigate the adverse effects of fishing-related mortality on any protected species. That includes the point at which utilisation of the SQU6T squid resource threatens the sustainability of the sea lion population.

f) The sea lion population around the Auckland Islands is a protected species under the Marine Mammals Protection Act 1978.

g) Your selection of the FRML, the predetermined strike rate and the SLED discount factor are separate management decisions.

12 You must also be mindful of:

a) The uncertainties associated with the Breen-Kim model

[1] The Minister of Conservation has powers under the Marine Mammal Protection Act 1978 to approve a Population Management Plan (PMP), including the setting of a Maximum Allowable Limit on Fishing Related Mortality (MALFiRM), for the New Zealand sea lion. PMPs provide for the management of fishing related mortality of threatened and other protected species. The Department of Conservation are currently in the process of developing a PMP for sea lions.

b) The recent decline in the sea lion pup count around the Auckland Islands

c) The impact the abundance of squid in any particular fishing season has on the likelihood of the FRML being reached

d) The uncertainties that surround setting the predetermined strike rate

e) The uncertainties that surround the levels of sea lion survival after they come into contact with a SLED.

Rationale for management options

Fishing Related Mortality Limited (FRML)

13 Under s 15 (2) of the Act you may set a limit on fishing related mortality to protect marine mammals. The FRML sets a limit on the maximum number of sea lions that can be caught as bycatch in the SQU6T fishery.

14 Since the 2003-04 fishing season the Breen-Kim model has been used to determine an appropriate FRML. The Breen-Kim model allows the impact of different levels of sea lion mortality, or 'harvest control rules', to be examined, both in terms of their biological effects on the sea lion population and the potential fishing opportunities foregone as a result of constraining fishers from catching the squid Total Allowable Commercial Catch (TACC).

15 Each harvest control rule is assessed against the following three management criteria:

a) Provide for an increase in the sea lion population to more than 90% of carrying capacity[2], or to within 10% of the proportion of carrying capacity 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 projections.

c) Attain a mean number of mature mammals that exceeded 90% of carrying capacity in the second 50 years of 100-year projection runs (to allow for build up of numbers in hypothetical depleted populations over time).

16 Table 1 below details the performance of twelve harvest control rules against the management criteria (performance of rules 360 and 370 do not appear explicitly in the 2003 Breen and Kim results). The model also details the impact of each rule against levels of sea lion bycatch and potentially lost utilisation.

17 To help interpret Table 1 the following provides an explanation for the numbers relating to Rule 320:

a) The chances that the population will be at a level greater than 90% of carrying capacity or within 10% of the proportion of carrying capacity that would have been attained over a 20 year period is likely 99,989 times out of 100,000 (99.98% of cases).

b) The chances that the population will be at a level greater than 90% of carrying capacity or within 10% of the proportion of carrying capacity that would have

[2] Carrying capacity of an ecosystem is the maximum size of a group (population, subpopulation, stock, whatever) that can be supported by the ecosystem in which it lives.

been attained over a 100 year period is likely in 487,109 times out of 500,000 (97.42% of cases).

c) The requirement that the population will exceed the 90% carrying capacity criteria in the second 50 years of a 100-year projection run is likely in 93.4% of cases.

d) On average (based on 5,000 model runs) if the FRML is set using Rule 320 the fishery will forego 328 tows. (see paragraph 35)

e) On average (based on 5,000 model runs) if the FRML is set using Rule 320 the fishery could potentially close early in 23% of seasons.

f) The maximum sea lion bycatch in one year in 100 years is expected to 151 sea lions.

g) The average annual bycatch over the same 100 year period will be 76 sea lions.

Table 1: Harvest Control rule performance against key indicators from the base case projections from Breen and Kim 2003

Harvest control rule	Crit20 [a]	Crit100 [b]	Nmat/K [c]	Lost fishing effort [d] (tows)	Seasons closed [e]	Max bycatch [f] (100yr runs)	Mean annual [g] bycatch
0	na	na	98.2%	2 910	100%	0	0
305	100 000	500 000	96.4%	1 614	77%	39	31
310 (Wade)	100 000	499 052	95.0%	904	52%	77	53
Rule 4	99 997	489 846	93.5%	350	24%	169	75
320	99 989	487 109	93.4%	328	23%	151	76
330	99 810	473 902	92.6%	138	11.1%	222	87
340	99 409	464 642	92.2%	64	5.7%	290	92
350	99 006	458 702	92.0%	31	3.2%	355	95
380	98 264	451 181	91.8%	0	0.7%	516	98
390	98 131	450 181	91.8%	0	0.5%	540	98
Cusp (392)	98 115	450 003	91.8%	0	0.4%	542	98
1	97 781	447 570	91.7%	0	0.0%	545	99

[a] **Crit20**: Whether the number of mature animals in the population in a specific year are **either** above 90% of *K* **or** above 90% of the numbers that would have occurred with no fishing, evaluated over the first 20 years of each run only with a pass level for this index of 90 000 out of 100 000 projection-run years.

[b] **Crit100**: Whether the number of mature animals in the population in a specific year are **either** above 90% of *K* **or** above 90% of the numbers that would have occurred with no fishing, evaluated for each of the half million years in a set of runs, and that it should be true for least 90% of years, ie 450 000 out of 500 000 projection-run years.

[c] ***Nmat*/*K***: the median of the numbers in the final year of each run expressed as a percentage of *K* - pass level for this index is 90% of *K*.

[d] **Lost fishing effort**: the median (of the 5 000 runs) of the mean tows lost through the operation of the harvest control rule during the run (as a measure of cost to the fishing industry), this is based on average annual fishing effort (2 871 tows) conducted during the years 1988-2003. It is not possible to determine percentage of tows lost at this stage, unless the model is run again with further indicators included.

[e] **Seasons closed**: the median % of seasons closed early through the operation of the harvest control rule during the run.

[f] **Max bycatch (100 yr runs)**: the median of maximum annual bycatch in each run.

[g] **Mean annual bycatch**: the median of mean annual bycatch in each run.

18 With the exception of Rule 1 (which models unconstrained fishing activity) **all** harvest control rules meet the three management criteria detailed in paragraph 15. These harvest control rules remain unchanged from season to season; each rule is used to calculate a

possible FRML each season. Consequently the FRML does change from season to season to reflect changes in the key input data. For the 2006-07 fishing season the rules use the average of the 2004-05 and 2005-06 pup production estimates from the Auckland Islands. Since the pup count declined in these years, the FRML based on each rule is lower than it was last year.

19 The Act allows you to set a maximum allowable sea lion mortality limit that could be caused by fishing activity when choosing an FRML. As a result considerable attention is given to the fishing-related mortality limit associated with each rule. However, in many years the FRML will not be reached because low levels of squid abundance will mean the vessels will leave the fishery earlier in the season. To illustrate this point, the mean annual expected bycatch details the annual sea lion mortalities likely to arise under any particular rule.

20 Fourteen harvest control rules, assessed with the Breen-Kim model were considered for the 2006–07 season and FRMLs were produced for each of these rules (See Table 2 below). This range of harvest control rules, therefore, represents a theoretical minimum and maximum level of fishing-related mortality that were, in 2003, considered sustainable over time.

Table 2: Estimate FRMLs for the 2006-07 SQU6T fishing season for each of the 14 harvest control rules using latest pup production estimates.

Rule	Estimated FRML (numbers rounded)
Rule 0	no fishing (0 sea lions)
Rule 305	27 sea lions
Rule 310	55 sea lions
Rule 4	77 sea lions
Rule 320	109 sea lions
Rule 330	164 sea lions
Rule 340	218 sea lions
Rule 350	273 sea lions
Rule 360	328 sea lions
Rule 370	382 sea lions
Rule 380	437 sea lions
Rule 390	491 sea lions
Cusp Rule	504 sea lions
Rule 1	none

21 Rules at the lower end of the spectrum provide for less utilisation, whilst rules at the higher end of the spectrum provide for greater levels of utilisation. Conversely, rules at the higher end of the spectrum represent a greater risk to the sustainability of the sea lion population, whereas rules at the lower end of the spectrum represent little or no risk. When selecting an appropriate rule you are required to balance the extent of an increase or decrease in potential utilisation in the SQU6T fishery against the extent of an increase or decrease in possible sea lion mortalities and the impact this may have on sea lion sustainability.

22 The Aquatic Environment Working Group (AEWG) has accepted the Breen-Kim model as the best available method to provide options on setting the FRML. However, information suggests a degree of uncertainty surrounds the results produced by this model. This information is discussed in more detail in a later section.

Strike rate

23 Once the FRML has been determined, fishing activity is then monitored against this limit. However, the actual number of sea lions that are incidentally caught in squid fishing gear cannot be directly recorded.

24 Therefore a proxy for mortal interaction between squid vessels and sea lions is used. This is known as the predetermined strike rate (strike rate) and in recent seasons it has been set at 5.3%. Applying this strike rate means that for every 100 tows undertaken in the squid fishery 5.3 sea lions are presumed killed and counted against the FRML.

25 The 5.3% rate is based on a simple average of the actual strike rate amongst vessels operating in the SQU6T fishery during seven fishing seasons from 1996-97 to 2002-03. This average is based on observed seasonal strike rates which over this period ranged from 2.8% to 11.8%.

Sea lion exclusion devices (SLEDs)

26 SLEDs are installed inside trawl nets to reduce sea lion mortality levels by allowing live animals to escape from the net. Two factors influence how effective SLEDs are at reducing sea lion mortalities:

a) The escapement rate of individuals from the net through the SLED

b) The survival rate of animals that do escape.

27 Industry considers the deployment of SLEDs on SQU6T vessels results in far fewer sea lion mortalities. Industry considers the strike rate is reduced when SLEDs are deployed, meaning vessels deploying SLEDs should be able to undertake more tows before reaching the FRML.

28 However, while industry is keen to refine and use SLEDs, available information on their efficacy is incomplete and uncertain. The most reliable study, using limited data, suggests that the use of SLEDs would have permitted approximately 20% of autopsied sea lions to have escaped from the net and survived.[3] This information has been used to provide a discount of 20% on the strike rate for those vessels deploying an approved SLED. The discount reduces the strike rate from 5.3% to 4.24%, meaning that for every 100 tows from a vessel deploying a SLED, 4.24 sea lions are counted against the FRML.

29 In order for vessels to secure this discount, industry must fulfil monitoring and reporting obligations. These obligations are discussed in more detail in the later section on monitoring.

Assessment of management options

FRML

30 In total, 14 harvest control rules, assessed with the Breen-Kim model were considered for the 2006-07 fishing season. Thirteen of these rules met the management criteria described

[3] The results of this study are contained as an addendum to the 2003-04 SQU6T Operational Plan IPP. Copies are available from the Ministry on request.

above and therefore could be used to set the FRML. However, you also need to consider that there is some degree of uncertainty surrounding the outputs from the Breen-Kim model given:

a) The continued decline in pup count numbers in recent years

b) Possible limitations with the actual model.

Fluctuations in sea lion population

31 Since 1998 the estimates of the Auckland Island pup production have declined by 30% which suggests that the Auckland Island sea lion population has also declined. Whether this decline is simply the expected natural fluctuations of a population near carrying capacity, or if it is an indicator of something more serious is uncertain. There is information to suggest this decline is due to two recent bacterial infections which resulted in many pups and adults dying. However, there are concerns that this alone does not entirely explain the decline in pup count numbers.[4]

32 There is no evidence to suggest this decline in population is the direct result of fishing activity but it is unclear how the decline may impact on outputs from the Breen-Kim model. One interpretation from the Breen-Kim model is that the population is at carrying capacity. A certain level of variability in pup production numbers was built into the model but the current level is outside this range. MFish considers this information to be relevant but does not consider it is sufficient justification to disregard the model. Instead it could mean that the upper range rules are insufficiently cautious and are less likely to meet the sustainability criteria.

33 FRMLs calculated for the 2006-07 season, based on the various harvest control rules assessed with the Breen-Kim model, take into account the decline in pup production over the most recent two years. Therefore the FRMLs calculated for each of the harvest control rules will be lower than those same harvest control rules in the 2005-06 season. Therefore, some of this decline is included in the model outputs and the resulting FRML.

34 The uncertainty around whether the population is actually at carrying capacity means some stakeholder groups believe you should select a lower FRML.

Limitations with model

35 There are a number of acknowledged limitations with the Breen-Kim model:

a) The model is a representation of the actual squid fishery and sea lion population interaction. What is sustainable in theory may in reality be unsustainable if the model is not an accurate representation of real life. This means there is an inherent level of uncertainty associated with using this, or indeed any model.

[4] Three unusual mortality events occurred in the Auckland Islands between 1992-93 and 2004-05, whereby higher than usual numbers of adults, and in particular pups, died as a result of disease outbreaks. In February 1998 a significant mass mortality event occurred whereby 74 adults and >50% of the 1997-98 season's pups died during a mass mortality event. The females of this cohort were therefore under-represented in the breeding female population in 2003-04 and 2004-05 as they reached reproductive age. High pup mortality rates also occurred in 2001-02 and 2002-03.

b) The model has not been used in the way it was originally intended. It has been used to provide options for setting the FRML on an annual basis irrespective of the harvest control rule associated with this FRML. The assessment of the ability of control rules to meet the sustainability criteria was based on an application of a particular rule for 100 years. The model's original purpose was to select a harvest control rule and to apply the FRML based on that rule for at least a five year period.[5] The expectation is that a rule is selected and the annual FRML is set using this rule. The AEWG has not assessed how using the model in this way, changing the rules from year to year, will affect the model outputs.

   MFish considers the model outputs, and the subsequent management measures selected, would benefit from consistency of rule application. This is a view shared by SeaFIC in their submission on the IPP.

c) Paul Breen, co-developer of the model, raised a number of possible issues at the aquatic environment working group (AEWG) meeting on 1 September 2006. He asserts that when these issues are tested they are likely to indicate that the existing model may have been optimistic in some areas but pessimistic in others. These issues are discussed in more detail in Appendix 1.

36 In addition, some submissions from environmental stakeholders discussed the review of the Breen-Kim model undertaken by Daniel Goodman in 2003.[6] This review concluded that while the model displayed state of the art modelling, some further testing may be necessary to give the model, and the approach used, greater certainty in specific areas. This uncertainty related to the newness of the techniques being used and the fact that the approach has had a narrow application. ECO in particular has raised concerns that this further testing has not occurred. MFish does not consider this to be a valid reason to disregard the Breen-Kim model.

37 The limitations with the model, detailed above, have been acknowledged by both stakeholders and the AEWG. MFish expects that the model will be updated in the coming year.

38 To date, the Breen-Kim model is accepted by the Ministry and the AEWG to be the best available information.

Utilisation

39 It is difficult to accurately assess the potential lost utilisation likely to arise from setting the FRML based on any rule other than Rule 0. This is largely because:

a) The availability of squid varies from fishing season to fishing season, which influences the amount of squid caught per tow. Typically greater quantities are caught per tow in seasons of abundance.

b) Market price is influenced by the size and quality of squid, and the global availability and demand for squid.

[5] Rule 4 was selected in the 2004-05 fishing season and again in the 2005-06 season prior to the in-season adjustment made to the FRML. In the first year of the Breen-Kim model Rule 310 was chosen but following a ruling by the Court of Appeal, the FRML was set using Rule 320.

[6] 'Review of Breen & Kim model for Auckland Islands Hooker Sea lion population interaction with squid trawl fishery', Daniel Goodman, Director of the Environmental Statistics Group, Montana State University.

c) The information available to MFish on the value of squid is limited to either port price or export price. Export data do not provide a price specifically for squid caught in 6T.

40 Therefore MFish has estimated potential lost utilisation opportunities in terms of tows forgone and landed value of squid using the 2006-07 port price of $790 per tonne. See Table 3 below.

41 Calculating an estimate of tows forgone uses the historical mean annual tows from 1998 – 2003 as a base (2871 tows). This is then compared with the number of tows permitted for each of the harvest control rules, with and without the SLED discount rate, before the FRML is reached and the fishery is closed.

42 The estimation of the impact of a particular FRML on landed value is based on an average catch rate of 6 tonnes per tow. Catch levels have been higher when the squid is more abundant and fewer tows are required. The port price of $790/tonnes for SQU6T is used to calculate the lost value associated with each FRML. Industry did note in their submission on the IPP that using this port price underestimates squid earnings in the order of 200-300%. MFish does acknowledge that port price may provide a low estimate of value but considers this is the best available information. Therefore, MFish considers these estimates of potential lost value may be conservative.[7]

Table 3: Estimates of potential loss to value associated with each of the FRMLs when compared to the mean historical annual tows 1998-2003

Rule	FRML	Max tows	Lost effort: tows*	Lost effort: value ($M)*[x]	Max tows with 20% discount	Lost effort: tows**	Lost effort: value ($M)**[x]
Rule 0	0	0	2871	13.6	0	2871	13.6
Rule 305	27	509	2362	11.9	637	2234	10.6
Rule 310	55	1038	1833	8.7	1297	1574	7.4
Rule 4	77	1453	1418	6.7	1816	1055	5
Rule 320	109	2057	814	3.8	2571	300	1.4
Rule 330	164	3094	0	0	3868	0	0
Rule 340	218	4113	0	0	5142	0	0
Rule 350	273	5151	0	0	6439	0	0
Rule 360	328	6189	0	0	7736	0	0
Rule 370	382	7208	0	0	9009	0	0
Rule 380	437	8245	0	0	10307	0	0
Rule 390	491	9264	0	0	11580	0	0
Cusp Rule	504	9509	0	0	11887	0	0
Rule 1	**Unconstrained fishing**						

*Based on a strike rate of 5.3% and a historical mean annual tow of 2871

**Based on a strike rate of 5.3% but with the 20% SLED discount and a historical mean annual tow of 2871

[x] Estimated value is based on 6 tonnes per tow and a port price of $790 per tonne

43 MFish does not consider it useful to compare the potential lost utilisation opportunities associated with each FRML in terms of percentage of the TACC forgone. Fluctuations in squid abundance mean that in many years it would not have been possible to catch the full TACC, even without the constraints of a sea lion fishing related mortality limit.

[7] Estimates of potential earnings do not take into account the fixed and variable costs associated with fishing activity.

44 You should also note that if the 2006-07 SQU6T season is poor the FRML is likely to be reached with relatively little squid having been caught. In effect this will mean there will be a high ratio of sea lion mortalities to squid. It could also mean that the squid vessels will abandon the fishery before the FRML is reached.

Analysis of harvest control rules

45 The three management criteria outlined in paragraph 15 set the threshold beyond which management intervention could be considered to be necessary. Even if the management criteria have been met, you are still permitted to adopt a cautious approach, given the uncertainties associated with the Breen-Kim model and the decline in the Auckland Islands sea lion population. However, in choosing a cautious approach the appropriate degree of caution is that which is necessary in the circumstances.

46 The FRML should be set at a level where you think an increase in utilisation of the squid resource poses an unacceptable risk to the sea lion population. You are not required to set the FRML at a level beyond what is necessary.

47 The views expressed in the submissions regarding where the FRML should be set for the 2006-07 fishing season were conflicting. Environmental stakeholders (ECO, Forest & Bird, Liz Slooten) favour setting the FRML using a potential biological removal (PBR) approach or at the very least using harvest control Rule 310. Using this rule, the FRML would be set at 55 sea lions for the coming fishing season.

48 In comparison industry (DWG and SeaFIC) consider the FRML should be set at 250 which equates to half of the Cusp Rule. Industry does not believe that the uncertainty associated with the Breen-Kim model requires the FRML to be set at a level lower than 250. They conclude that in setting the FRML at 250 sea lions you would be still be exercising sufficient caution.

49 As noted, Rule 1 does not meet the three management criteria and therefore is not included for further consideration. The remaining rules do meet the management criteria. This means the Cusp Rule is the starting point for assessing which is the most appropriate rule to select. The further away from the Cusp Rule, the greater the likelihood that any uncertainties associated with using the model will be mitigated.

50 MFish does not recommend you select the lower rules (Rule 0, Rule 305, Rule 310). FRMLs set lower than Rule 4 provide for low levels of sea lion bycatch but could potentially impact considerably on fishing effort and therefore potential utilisation opportunities. MFish does not consider the risk to the sea lion population warrants such a measure.

51 Rule 310 was included in the possible acceptable range of harvest control rules consulted on in the IPP. MFish now believes it will produce a FRML that is more restrictive than is necessary. Section 10 (c) of the Act requires you to adopt a cautious approach when the information available to you is uncertain. However, MFish considers that setting the FRML based on Rule 310 would likely over estimate the risk that utilisation in the squid fishery has on the sustainability of the sea lion population.

52 Given the decline in pup count numbers and the uncertainties associated with the model, MFish does not recommend you select the higher rules (Rule 350, Rule 360, Rule 370, Rule 380, Rule 390, Cusp Rule). Rules greater than 340 result in relatively small

increases in utilisation opportunities but allow for greater levels of sea lion mortality as expressed in the higher FRMLs produced from these rules. Although these rules meet the management criteria, if you set the FRML based on these rules, the assumption is that the declining pup numbers and model uncertainties are insignificant or of marginal effect. MFish does not believe this to be the case.

53 Therefore MFish recommends that you set the FRML for the 2006 – 07 fishing season based on one of four harvest control rules. This recommendation does not mean that you are unable to set the FRML using any of the other rules that meet the management criteria. The four recommended harvest control rules are:

a) Rule 4: FRML of 77 sea lions

b) Rule 320: FRML of 109 sea lions

c) Rule 330: FRML of 164 sea lions

d) Rule 340: FRML of 218 sea lions.

54 The uncertainties with the Breen-Kim model have been discussed above. MFish considers these uncertainties have been sufficiently mitigated by choosing to dismiss the higher and lower rules, as discussed above. Table 4 below summarises the key information relevant to each of these four rules.

Table 4: Summary of key information relevant for recommended harvest control rule 4 to 340.

Rule	FRML	Max. bycatch	Mean annual bycatch	Tows forgone: Strike rate of 5.3%	Tows forgone: Strike rate of 4.24%
4	77	169	75	1418	1055
320	109	151	76	814	300
330	164	222	87	n/a	n/a
340	218	290	92	n/a	n/a

If the FRML is set using either Rule 330 or 320 the FRML is unlikely to limit the number of tows vessels can take when compared to the historical mean annual tows of 2,871

55 Rule 4 is an adaptive rule and is based on sea lion 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 but it also provides for more fishing opportunities when pup production is at higher levels. If you choose Rule 4 you are placing greater emphasis on the sustainability risk associated with fishing activity and the societal benefits associated with maintaining and protecting the sea lion population.

56 If you choose Rule 320 you would continue to place greater emphasis on sustainability at some risk to utilisation opportunities.

57 If you choose Rule 330 to set an FRML of 164 sea lions you are unlikely to constrain the number of tows fishers can make since the number of tows permitted under this FRML is well in excess of the historical mean annual tows of 2,871.

58 If you choose Rule 340 you are placing a greater emphasis on utilisation and will provide for greater levels of fishing effort. This rule will not provide for much additional utilisation opportunity beyond that provided for by Rule 330, but it will give industry greater headroom to fish to the limit of the TACC should there be a high level of squid abundance in

the 2006-07 season. Of the four recommended harvest rules, this option does pose a greater risk to sea lion sustainability because the maximum mortality limit will be set at 218.

Potential Biological Removal (PBR) approach

59 Submissions from environmental stakeholders were unanimously in favour of rejecting the outputs from the Breen-Kim model as the best available information and instead determining the FRML for the 2006-07 fishing season using a PBR approach. However, MFish does not consider it appropriate to set the FRML using this approach for the following reasons:

a) The PBR approach is a recognised robust approach when there is a clear understanding of goals but minimal information is available. However, for the Auckland Islands sea lion population there are considerable data that can be used and the Breen-Kim model was developed specifically to incorporate all of this data.

b) There is also considerable uncertainty and misunderstanding in how the PBR approach should be applied. The PBR approach can provide management advice across three possible goals and the choice of goals will influence inputs into the PBR equation. Before the PBR approach could be used effectively there needs to be consensus on the appropriate goal.

60 MFish acknowledges the uncertainty with the Breen-Kim model but considers this uncertainty is not sufficient to preclude using it to assess possible harvest control rules in favour of the PBR approach.

Predetermined strike rate

61 MFish proposes to continue to estimate sea lion mortalities using a predetermined strike rate. The IPP presented two options for an appropriate strike rate for the 2006-07 fishing season, 5.3% and 5.8%.

62 5.3% has been used as the strike rate since the 2003-04 fishing season. This strike rate is based on the average actual strike rate from 1997-2003 amongst vessels operating in the SQU6T fishery when more than 20% of all tows were observed. There is some uncertainty around the appropriateness of using this as a strike rate in the current season because:

a) It is based on outdated information. Since 2003 the actual strike rate has not been accurately monitored because the use of SLEDs means it is difficult to assess the actual squid trawl gear and sea lion interaction.

b) There is considerable variability in strike rate from year to year. For the seven years from which the average strike rate of 5.3% is calculated, annual strike rates varied from 2.8% to 11.8%.

c) Fishing practices appear to have changed in recent years including an increase in the observed tow length. The average tow length observed in 2005-06 was 6.3 hours compared to the average tow length of 4.1 hours in the 2002-03 fishing season. If there is a positive relationship between tow length and strike rate, this means the current strike rate of 5.3% could underestimate the extent

of the interactions between squid fishing vessels and sea lions. However, this relationship is uncertain.

63 A second option of 5.8% was provided in the IPP. This rate is based on an estimated average strike rate during fishing seasons from 2000-2004 reported (but not recommended) in a study by NIWA scientists M. Smith and S. Baird.[8] During the AEWG meeting on 1 September 2006 the two possible strike rate options were discussed. The members of the group failed to reach consensus with some participants favouring the existing strike rate and others favouring an increase based on the results of the NIWA study because they believed it would mitigate any risks likely to arise from the increase in tow length.

64 While there have been observed increases in the length of tow time in recent years there has been insufficient research to investigate the actual effects of tow time on sea lion interactions and hence sea lion mortalities. MFish considers such research is necessary and believes the research should also focus on why the tow length has increased - is it a response to the management regime limiting the number of tows or is it a result of a change in fleet dynamics?

65 In the absence of any better information which could be used to set the strike rate at a higher or lower level, MFish recommends the strike rate for the 2006-07 fishing season remains at 5.3%. However, there are uncertainties surrounding this rate and a higher strike rate is available to you, should you consider that a more cautious approach is merited based on the information set out above.

66 MFish acknowledges that the approach used to set the strike rate requires updating.

SLED discount factor

67 In previous seasons vessels deploying an approved SLED have received a 20% discount on the strike rate. This means that instead of deducting 5.3 sea lions from the FRML for every 100 tows, 4.24 sea lions are deducted, enabling vessels to undertake a greater number of tows before the FRML is reached.

68 Limited information is available to evaluate the appropriate discount rate and the current rate of 20% is in part based on a single study. This study is based on expert evaluations of dead sea lions recovered from SLED trials where the vessels tied down their cover nets. The use of tied down cover nets meant that none of the sea lions that interacted with these nets were able to escape. In total seven sea lions were captured and autopsies were undertaken. The study showed that two of the seven sea lions would have had a high likelihood of surviving their interaction with the SLED. Despite the small sample size, this study has been used to apply the current discount rate of 20%.

69 Industry consider that a discount rate of 20% is too conservative and believes that MFish should present you with a range of discount options and allow you to choose the one you consider is the most appropriate. Submissions from environmental groups on the IPP universally rejected the use of a discount factor given the small sample size used in the study discussed above and the fact there is limited information to show that there are benefits from using a SLED.

[8] ENV2004-02. Estimation of New Zealand sea lion incidental captures in New Zealand Fisheries. M. Smith & S. Baird (NIWA)

70 MFish accepts that providing you with a range of options is preferable. However, there has been no other comparable study of the impact of SLEDs on sea lion interactions and mortality levels, other than the one described above. This means MFish is recommending an appropriate SLED discount rate with limited information. The lack of research means there is insufficient information to present you with a range of discount options. MFish considers setting a discount rate of 20% is the only feasible option available to you at this time. MFish also notes that ongoing research and development, through the SLED working group may provide better information upon which to base a discount in the future.

71 A key difficulty in setting a discount rate is assessing the number of sea lion interactions that take place when a SLED is deployed. During the 2005-06 fishing season there were 16 actual sea lion mortalities captured and reported amongst vessels, all of which were using SLEDs – although some of these vessels were not using the approved type of SLED nor were all SLEDs in optimal working condition. These mortalities are evidence that the SLEDs failed in some way because these sea lions were not able to escape. What is not possible to assess is the proportion of total sea lion interactions these dead sea lions represent.

72 It is also difficult to assess the rates of survival for sea lions that do interact with the squid gear but manage to escape from the net through the SLED. The SLED working group recommend that sea lion survival should only be considered if the sea lion lives for five days following an encounter with a SLED.

73 As part of their submission, the DWG also provided a DVD showing footage of seals and sea lions interacting with SLEDs in New Zealand and in Australia. Industry considers this footage lends support to the view that SLEDs in SQU6T are more effective than the 20% discount rate recommended by MFish.

74 MFish considers this video footage provides potentially useful information regarding pinniped behaviour around trawl nets with SLEDs. However, MFish does not consider that the information is sufficiently relevant to squid/sea lion interactions in the SQU6T fishery as to outweigh the scientific information relating to SLED efficacy gleaned from actual captures of New Zealand Sea Lions in the SQU6T fishery itself. Further, no information is provided on how the footage was selected from what was presumably a much larger pool. This may not be a representative sample of the interactions observed and the sampling methods, protocols, and inferences also do not appear to have been the subject of peer review. Last, the extent of post-interaction survivability is not easily evaluated from the footage.

75 MFish does note that trials are planned for the current season that will allow similar footage to be taken in SQU6T with New Zealand sea lions that may provide more relevant contextual information to your decision on SLED efficacy in the future.

76 MFish acknowledges the considerable work undertaken by industry, in particular the DWG, in developing and promoting the effective use of SLEDs. However, MFish considers the limited information available and the misuse of SLEDs in the 2005-06 fishing season means that it is not appropriate to amend the discount rate at this time. MFish recommends a discount rate of 20% be applied for the 2006-07 season.

Monitoring and reporting requirements

77 Before a vessel can receive the recommended SLED discount rate certain conditions must be met.

a) Vessels must deploy a SLED that meets the approved design specification (Mark 3/13 design).

b) The SLED must be deployed with the escape hatch open at all times during fishing operations.

c) Each SLED must be stamped with a unique number and photographed before the start of the fishing season by the DWG.

78 MFish is working closely with the DWG to ensure these conditions are met and that there will be accurate monitoring against the FRML throughout the squid fishing season. MFish is confident that many of the problems experienced last year will be resolved.

79 Once MFish receives information on the vessels deploying a SLED this will be made available to the MFish Observer Programme to enable observers to undertake spot checks to ensure:

a) The vessel is still carrying the SLED for which it was given approval and,

b) The SLED has not been adjusted or modified and is in working order.

80 MFish proposes that the reporting requirements in place in previous fishing seasons continue throughout the 2006-07 fishing season. This requires:

a) The fishing vessel operator to notify the MFish Observer Programme at least 72 hours before leaving port to ensure there is sufficient time to place an observer on board the vessel before it sails. This notification may also be used as an opportunity for either fishery officers or observers to undertake a port inspection of the SLED.

b) The Master of the fishing vessel is required to report to MFish, at the end of the fishing trip, any encounter with a marine mammal that resulted in death or injury.

c) MFish observers will notify the Observer Programme immediately following the capture of sea lions.

d) All vessels in the SQU6T fishery will participate in a weekly reporting regime managed by the DWG. When 70% of the FRML is reached, reporting will be daily. The information reported will include:

   i) Each tow undertaken in the SQU6T fishery

   ii) Whether the tow was observed by a MFish Observer

   iii) If an approved SLED was deployed during the tow

   iv) If any sea lions were caught during the tow and whether they were released dead or alive.

81 MFish intends to retrospectively remove the discount rate accreditation for all tows where a non-approved SLED was deployed or where the reporting requirements have not been met.

Observer coverage

82 As in previous fishing years MFish aims to achieve 30% observer coverage for all tows in the SQU6T fishery. Some of the IPP submissions received by MFish recommend the observer coverage should be increased to 100%. The purpose of this increased coverage would be to monitor the actual rate of interaction between squid fishing vessels and sea lions and to ensure vessels are correctly deploying their SLEDs.

83 MFish does not consider that the cost associated with this additional observer coverage would deliver the benefits submitters consider are important. It will be extremely difficult for observers to accurately monitor the actual strike rate given the difficulties in observing actual levels of sea lion interaction. Further, the processes MFish has in place to monitor SLED deployment - using the DWG to audit SLEDs at the start of the season and using observers and fishery officers to undertake in season inspections will mitigate the risks of vessels incorrectly deploying SLEDs or deploying SLEDs that do not meet the design standard.

84 There is limited observer coverage available to monitor all of New Zealand's fisheries and any increase in the level of coverage in one fishery would come at a cost to another. MFish considers the current level of coverage is adequate.

85 MFish intends to continue with 30% observer coverage across the SQU6T fishery during the 2006-07 fishing season.

Closure procedures

86 Under s 15 (5) of the Act you may close the SQU6T fishery when the FRML is reached.

87 MFish will work with the DWG to monitor performance against the FRML. Once the FRML is about to be reached MFish will advise you of this fact so that you may close the SQU6T fishery by gazette notice.

88 This closure will be undertaken without consultation but MFish will ensure all participants in the fishery are kept updated on levels of fishing activity against the FRML throughout the fishing season.

Other management issues

89 A number of other issues were raised during the IPP consultation process. These issues were:

a) Levels of sea lion interaction with fishing vessels in other fisheries

b) Use of jigging as the preferred harvest method for squid

c) Review of the Breen-Kim model.

Sea lion and fishing vessel interaction across other fisheries

90 Environmental submissions raised concerns over the fact that the FRML only applies in the SQU6T fishery. They consider an FRML should be applied across all vessels in

fisheries where there have been recorded incidences of fishing-related sea lion mortality during the past five years.

91 MFish acknowledges these concerns but the extent of sea lion mortalities caused by other fisheries is not well established. In comparison to all fisheries, SQU6T takes the vast majority of sea lions. No FRML is set for sea lion mortality in other fisheries primarily for pragmatic reasons. Estimating the appropriate annual 'non-SQU6T' FRML would be difficult to establish due to the limited information available, compounded by lower levels of observer coverage and issues surrounding reporting.

92 The assumption that there are no significant sea lion mortalities in other fisheries is offset by the assumption that sea lions are only found on the Auckland Islands (when in fact there are sea lions on Campbell Island and the Otago coast). However, MFish does acknowledge that this may be a reason to set the SQU6T FRML more cautiously.

Squid jigging versus Squid trawling

93 Environmental stakeholders maintain that imposing a trawling method restriction in SQU6T and, instead, require jigging-only in the fishery would mitigate sea lion fishing-related mortalities. They consider squid jigging presents a simple, cheap means of reducing sea lion bycatch.

94 MFish acknowledge that the method of jigging is likely to pose a significantly smaller risk of catching individual sea lions than trawling. However, MFish consider that requiring fishers to use jigging would likely impart additional costs and/or lost utilisation opportunities associated with the efficacy and practicality of jigging in the southern ocean and the nature of the year round fishing plans of the current trawl fleet.

95 There is strong evidence (satellite altimetry data and commercial vessel weather logbook records[9, 10]) regarding the difficult sea and wind conditions around the Auckland Islands which is also likely to impact on the feasibility of squid jigging in this area. The frequent high seas and strong winds in SQU6T create potentially hazardous working conditions for squid jig vessels of the size that successfully operate elsewhere in New Zealand.

96 MFish considers that imparting such additional costs on the industry does not meet the Minister's obligations to provide for utilisation given that the use of a FRML already meets the Minister's obligation to take such steps that he considers necessary to avoid, remedy or mitigate the effects of fishing on a protected species.

97 MFish welcomes any industry initiative to investigate jig feasibility in reducing or eliminating sea lion interactions in the SQU6T fishery. Therefore, before recommending that the Minister impose a restriction on trawling for squid and require jigging, MFish would require greater certainty that:

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[9] Laing, A. (2000) New Zealand Wave Climate from Satellite Observations. New Zealand Journal of Marine & Freshwater Research 34 727-744 online: http://www.rsnz.org/puplish/nzjmfr/2000/62.php

[10] Reid, S; & Collen, B. (1983) Analyses of wave and wind reports from ships in the Tasman Sea and New Zealand areas. New Zealand Meteorological Society, 74 pages plus microfiche.

i) Jigging was a feasible, practical and safe method of fishing in the southern ocean; and

ii) Jigging was economically viable given the current composition and operation of the New Zealand fishing fleet.

Review of the Breen-Kim model

98 The uncertainties with the Breen-Kim model discussed above also featured heavily in the submissions received on the IPP. In addition the AEWG has also acknowledged that a review of the model would be appropriate. MFish agrees with these views and is currently considering an update of the Breen-Kim model. The results of such an update may be available in time for the 2007-08 fishing seasons but the priority is to ensure the work is completed properly.

Future Management

99 The Fisheries Act allows you to take such measures that you consider are necessary to avoid, remedy, or mitigate the effect of fishing-related mortality on sea lions. This has included the setting of a FRML for many years, a decision that relies on information subject to considerable uncertainty. MFish considers that the future management should ideally focus on limiting the interaction of sea lions with the squid fishery, or limiting the effects of that interaction, rather than focusing on setting a FRML. This could include the use of a SLED (or other device) that is proven effective, and/or minimising or eliminating the contact between sea lions and trawl gear.

100 If achieved, your obligations under the Act may be met without the time consuming and contentious debate over the FRML.

101 Research is needed to better understand when and with what frequency sea lions come into contact with squid trawls (to inform the strike rate), and the effectiveness of SLEDs on increasing the survival rate of sea lions that do interact with the trawl (to inform the discount rate). Effort in the past has focused on underwater cameras to film sea lions at the trawl. However, this is technically difficult, will be expensive, and there is no off-the-shelf system that can be used.

102 If the cameras are successful, and the footage can be successfully analysed, the results will not prove survivability, but will inform our understanding of the behaviour and interaction of sea lions with SLEDs. This will only give an indication of SLED efficacy, and suggest what additional work might be required to prove survivability.

103 The Ministry has also begun work on a deepwater fisheries plan, which will include a section (or perhaps a separate plan) on the squid trawl fishery. As with all plans, this will be done collaboratively with stakeholders. With respect to sea lion interaction, the Ministry will continue to work closely with Industry to improve SLED design, ensure proper deployment, monitor use, and research their interaction and efficacy. As noted above, the Breen-Kim model will also be updated, to inform future decisions on FRMLs.

Statutory considerations

104 The following statutory considerations have been taken into account in providing the final advice on the interactions between the SQU6T fishery and sea lions.

105 **Section 8:** MFish considers the management options presented in this paper seek to achieve the purpose of the Act.

106 **Section 9 (a):** Management proposals have been recommended to the Minister so as to ensure the sea lion population around the Auckland Islands will be maintained above a level that ensures their long term viability.

107 **Section 9 (b) and (c):** The specific impact on squid trawling in the SQU6T fishery on biological diversity and habitats of particular significance is not known. Squid vessels engage in mid water trawling so they are unlikely to impact on benthic habitats.

108 **Section 10:** MFish considers the information used to support the proposals set out in this paper is the best available information. Given the uncertainties associated with some aspects of this information the management options proposed balance the risks to both potential utilisation and the sustainability of the sea lion population.

109 **Section 14:** The squid TAC is set under section 14 because the inter-annual variability associated with squid means there is insufficient information from which to determine a maximum sustainable yield. The management issues detailed in this paper do not impact on the management of the squid resource under s. 14.

110 **Section 15 (2):** MFish considers that providing recommendations on a FRML satisfies the option for the Minister to take such measures as he considers necessary to avoid, remedy or mitigate the effect of fishing-related mortality.

111 **Section 15 (5):** This section provides the Minister with the discretionary power to prohibit all or any fishing if the fishing-related mortality limit has been met. This has been addressed in this final advice paper.

Recommendations

112 MFish recommends you consider the following management measures to manage the interactions between the SQU6T fishery and sea lions for the 2006-07 fishing year:

a) **Agree** to implement an Operational Plan for the 2006-07 SQU6T fishery to ensure the management objectives for the sea lion population is met;

b) **Agree** to choose one of the following harvest control rules to set the FRML for the season:

   i) Rule 4: FRML of 77 sea lions

   ii) Rule 320: FRML of 109 sea lions

   iii) Rule 330: FRML of 164 sea lions

   iv) Rule 340: FRML of 218 sea lions

   v) Or any other FRML you consider appropriate.

c) **Agree** to use a predetermined strike rate of 5.3% to estimate the total number of sea lion mortalities against the FRML; or such other strike rate as you consider necessary in the circumstances;

d) **Agree** to apply a 20% discount factor (to provide a strike rate of 4.24% for all qualifying tows) to those vessels deploying an approved SLED and where the prescribed reporting procedures have been met; or such other discount factor as you consider necessary in the circumstances;

e) **Note** that you may close the SQU6T fishery under s 15 (5) of the Fisheries Act 1996 in the event the FRML is reached;

f) **Note** that Ministry officials are available to brief you on this issue at your convenience;

g) **Note** you are required to consult with the Minister of Conservation. An additional copy of this Final Advice Paper and a letter to the Minister of Conservation are provided.

Stefan Leslie
Manager, Deepwater Fisheries

APPROVED / NOT APPROVED / APPROVED AS AMENDED

Hon Jim Anderton
Minister of Fisheries

/ 11 / 2006

Appendix 1: Current issues with the Breen-Kim model, raised by Paul Breen at the AEWG meeting held 1 September 2006.

1. Recent pup counts were lower than the minimum estimates generated by the model, suggesting that insufficient process error was allowed in the model. The model cannot reproduce the declines seen recently, and survival rate or pupping rate may have changed. The effect of introducing more variability would be that high-numbered harvest control rules would no longer meet the 90:90:90 sustainability criterion, and the cusp rule would be some lower-numbered rule than 392. Lower pup counts would also cause uncertainty in the minimisation of the model because it assumes observation error and no process error.

2. Late-season pup mortality estimates were not included in the original model. Late season mortality appears to be more variable than early season mortality. This suggests that the model should include process error on pup mortality.

3. Some other data sets not available in 2003 have since become available.

4. The 2003 model had no implementation error, even though actual mortality of sea lions is poorly known.

5. The 2003 model was restricted to SQU6T even though some sea lions are caught elsewhere and some other fisheries have sea lion interactions in the SQU6T box.

6. It was acknowledged that, in hindsight, different parameterisations of survival might have been better to avoid parameter correlations.

7. The model assumed homogeneous dynamics in the four rookeries and this may not be realistic.

8. The "strike rate" may have a time trend but this was not modelled in the 2003 projections.

9. The very low growth rate favoured by the model is thought to be unrealistic and suggests problems in the specification of density dependence. It is possible that there is density dependence in survival as well as, or instead of, in pupping rate.

10. Catch and effort data are assumed known.