



Population Management Plan
for New Zealand Sea Lion
Phocarctos hookeri

DRAFT

AUGUST 2007



Department of Conservation
Te Papa Atawhai

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Draft Document for Public Consultation

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Executive Summary

The major conclusions of the draft New Zealand sea lion Population Management Plan (PMP) are:

Classification Issues

The IUCN classification of New Zealand sea lions as “vulnerable” (D2), and the New Zealand Threat Classification System listing of this species as “range restricted”, highlight that it is the limited number of breeding locations that lead to this species being classified as threatened.

The Department has adopted 5 locations as a threshold with reference to the IUCN classification for the New Zealand sea lion.

Fisheries and Fisheries Management Areas of Principal Interest

The majority of fishing-related New Zealand sea lion mortalities occur from interactions with the squid trawl fishery in the SQU6T management area (waters around Auckland and Campbell Islands). If an area-specific MALFiRM is developed, the area to consider will be SQU6T.

Management Objective

The following objective will be used when developing a New Zealand sea lion MALFiRM for all New Zealand fisheries waters:

The New Zealand sea lion population increases at a rate** that is not reduced by more than 10% compared to the increase that would have been achieved with zero fishing-related mortality.*

** Taking into account natural variation*

***Refers to sea lion population growth over time*

In the event that the New Zealand sea lion population has stabilised despite the impacts of fishing, maintenance of that stable population size will be required. If, however, the population is exhibiting an increasing trend, that rate shall not be compromised by more than 10% of that which would occur in the absence of fishing-related mortality. This concept can be applied equally to a naturally declining population.

Use of Breen and Kim Model

Using the above objective, the Breen and Kim model used for the Auckland Islands subpopulation, and providing separately for the Campbell Island and Otago Peninsula populations using the Potential Biological Removal (PBR) approach is the most robust options to derive MALFiRMs for New Zealand fisheries waters.

Range of Mortalities in New Zealand Fishing Waters

There is a very board range of New Zealand sea lion deaths that appear to meet the management objective from 31 to 552.

The Department recommendation on the rule and subsequent MALFiRM for New Zealand fishing waters is:

- Series “300” **Rule 315** is used;
- and an allowance of -1 animal is made for non-fishing, human-induced mortality,
- thus the MALFiRM is **89**.

Area-Specific MALFiRM

The Department proposes to utilise the Breen and Kim model to assist in establishing an area-based MALFiRM for SQU6T.

Inclusion of the Campbell Island Subpopulation

Under the present distribution of fishing effort, when establishing an area-specific MALFiRM for SQU6T vessels, the Campbell Island subpopulation of sea lion will not be included in the MALFiRM calculations.

The Department recommendation on the rule and subsequent MALFiRM for SQU6T is:

- the most suitable rule is **Rule 314**, thus
- the specific-area MALFiRM should be **76**.

1. Introduction

Purpose of introduction

1. The *Marine Mammals Protection Act 1978* (the Act), Section 3E(1), stipulates matters that may be included in a Population Management Plan (PMP). It does not provide for the incorporation of a formal introduction as part of a PMP.
2. Due to the complexity of the issues associated with management of interactions between fisheries and New Zealand sea lions, the Department of Conservation (the Department) believes that the following information be made available, in addition to the draft PMP, for stakeholders' reference. This introduction does not form part of the PMP itself and is provided to give some context that stakeholders may wish to think about when considering the draft PMP.

Background to management of this issue

3. To date, management of fisheries impacts on New Zealand sea lions has been limited to the squid fishery in quota management area 6T (SQU6T) (Figure 1). Annually, in accordance with Section 15(2) of the *Fisheries Act 1996* (the Fisheries Act), the Minister of Fisheries has approved and implemented an Operational Plan that contains a fisheries-related mortality limit (FRML) for the SQU6T fishery. The Operational Plan also includes provisions to monitor the fishery and ensure the FRML is not exceeded. These include details on:
 - a) the levels of observer coverage for the SQU6T fishery;
 - b) a predetermined strike rate to be applied in the event that an approved sea lion exclusion device (SLED) with an open cover net is used by SQU6T vessels;
 - c) a discount factor that vessels using an approved SLED may receive off the predetermined strike rate to account for sea lions that are presumed to have escaped in a survivable state from the SLED;
 - d) how monitoring of the FRML will be undertaken; and
 - e) how the SQU6T fishery will be closed in the event that the limit is reached.

What a PMP could do

4. If a PMP is approved by the Minister of Conservation (with concurrence from the Minister of Fisheries), the extent of incidental mortalities of New Zealand sea lions from fishing will be managed through establishing a maximum allowable level of fishing-related mortality (MALFiRM) for all New Zealand fisheries waters (out to 200 nautical miles offshore). In contrast to the Operational Plan approach, it is important to note that the PMP MALFiRM for New Zealand fisheries waters will apply to all fisheries, though there is a focus on the trawl fisheries, especially to the squid fishery in SQU6T.
5. A MALFiRM for a specific area, such as SQU6T, may also be established through a PMP, once a New Zealand fisheries waters MALFiRM has been established. There are a number of conditions specified by the Act (Section 3G(1) & (2)).

6. Except for the recommendation to establish one or more MALFiRMs, this draft PMP contains no other enforceable provisions, meaning that an Operational Plan, established in accordance with the Fisheries Act containing monitoring and enforcement provisions such as described in (a)-(e) above, will still be required. This will allow the Minister of Fisheries to undertake implementation responsibilities in accordance with Section 15(1) of the Fisheries Act.

Comparing the two approaches

7. The following table shows how the Operational Plan has, to date, managed limits on the fishing-related mortality for New Zealand sea lions, compared to how it could be done using a PMP (Table 1).

Table 1: Difference between the Operational Plan and the Population Management Plan

Aspect	Operational Plan	Population Management Plan
Legislation	<i>Fisheries Act 1996</i>	<i>Marine Mammals Protection Act 1978</i>
Management objectives	Refer to Part 2 of the Fisheries Act: purpose and principles. Utilisation of fisheries resources while ensuring sustainability.	For MALFiRMs covering all of New Zealand fisheries waters: Allow species to achieve non threatened status as soon as reasonably practicable, and in any event within 20 years. For area(s)-specific MALFiRMs: Neither cause a net reduction in size of the population nor seriously threaten the reproductive capacity of that population.
Threats addressed	Fishing in SQU6T	All fishing in New Zealand fisheries waters (includes vessels targeting all species (including squid) and using all fishing methods) and could include provisions for specific areas, such as SQU6T, via an area-specific MALFiRM.
Management details	Fisheries-Related Mortality Limit (FRML) Management provisions including: <ul style="list-style-type: none"> • Levels of observer coverage; • Pre determined strike rate; • Management of sea lion exclusion devices (SLEDs) including any discount factor; and • Procedures to close the fishery. 	Maximum allowable level of fishing-related mortality (MALFiRM) for New Zealand fisheries waters. A MALFiRM for specific areas (e.g. SQU6T) may also be established. Recommendations to the Minister of Fisheries on the standard of information to be collected and measures to mitigate the fishing-related mortality of the species.
Term	Annual	5 years, proposed in this draft PMP, although the actual MALFiRM figures could be set each year.
Agency responsible for plan development	Ministry of Fisheries	Department of Conservation
Approval responsibilities	Minister of Fisheries in <i>consultation</i> with Minister of Conservation	Minister of Conservation with <i>concurrence</i> from Minister of Fisheries
Implementation responsibilities	Minister of Fisheries	Minister of Fisheries

The contents of the draft PMP

8. The matters that may be included in a PMP are specified by Section 3E(1)(a)-(i) of the Act. While the Act provides for the inclusion of up to 9 specific provisions, it is not mandatory that a PMP include all of them.
9. The PMP has a specific scope and the only enforceable provisions it may contain are a MALFiRM for New Zealand fisheries waters, and any MALFiRMs developed for specific areas. The PMP is focused on controlling the effects of fishing on a protected species and does not provide for the management of other threats that may impact that species, such as other human (non-fishing-related) impacts or natural events.
10. Assessment of biology and status of the species is considered to be an important part of a PMP as it outlines what is known about the biology of the protected species and the nature of its threatened status.
11. With respect to the threatened status of a species, there are two aspects to be understood:
 - (1) the threat classification afforded the species by established systems such as the IUCN Red List and the New Zealand Threat Classification System; and
 - (2) whether the species has been declared to be threatened for the purposes of the Act.
12. The New Zealand sea lion has been declared as threatened for the purpose of the Act, therefore the management objective to be attained when setting a MALFiRM for New Zealand fisheries waters requires the recovery of the species to non-threatened status as soon as reasonably practical, and in any event within 20 years.
13. An evaluation of the nature of the New Zealand sea lion's threatened status has been undertaken as this determines the management objective that is subsequently modelled to assist in the determination of the New Zealand fisheries waters MALFiRM.
14. Assessment of known fisheries interaction with New Zealand sea lion has been undertaken to identify the quota management areas in which a specified area MALFiRM might be established (such as SQU6T), and the issues that can be brought to the Minister of Fisheries' attention through the PMP via recommendations on measures to mitigate the fishing-related mortality of the species, and the standards of information to be collected.

Assessment of the degree of risk caused by fishing-related mortality and other human-induced sources of mortality

15. The Act provides the opportunity for the inclusion of a risk assessment in a PMP, though this provision is not mandatory. A risk assessment could help to determine the location for which an area-based MALFiRM could be used to control fishing-related mortality. A risk assessment will not be used in setting a MALFiRM.
16. The detailed information necessary to quantify the probabilities and impacts of the full range of fisheries and other human-induced sources of mortality on New Zealand sea lions is currently not available. Quantifying the effects of natural phenomena on this species is similarly complex and detailed information is not available. A comprehensive robust quantitative risk assessment can not, therefore,

be undertaken. Also, given that a risk assessment does not contribute directly to a MALFiRM, a comprehensive risk assessment has not been included in the draft PMP.

Establishing MALFiRMs

17. The Act provides for a progressive, stepwise approach to the determination of MALFiRMs for:

- (a) New Zealand fisheries waters, and,
- (b) specified areas within New Zealand fisheries waters, for species declared as threatened and subject to certain conditions.

This approach is reflected in the draft PMP.

18. Starting with an estimate of the range of human-induced mortality for the species that would allow management criteria to be met (Section 3E(1)(d)), the Act then provides for the PMP to include an estimate of the range of fishing-related mortality for the species that would allow management criteria to be met (Section 3E(1)(e)). From within this range, a New Zealand fisheries waters MALFiRM may be established (Section 3E(1)(f)). Following the setting of a New Zealand fisheries waters MALFiRM, and subject to conditions (Section 3G), an area-based MALFiRM may also be established (Section 3E(1)(g)).

Recommendations to the Minister of Fisheries

19. Apart from establishing MALFiRM(s), the PMP is unable to direct the management actions of the Minister of Fisheries. There is, however, an opportunity to make recommendations to the Minister of Fisheries on measures to mitigate the fishing-related mortality of the species, and the standard of information to be collected. These recommendations have been included in the draft PMP.

Review

20. The Act outlines the procedures for amending the PMP in Section 3H(3). Procedures for the review are outlined in Section 3H(1)(a)-(p) and (2)(a)-(c). For clarity, the draft PMP includes a section identifying the circumstances whereby amendment and/or review of a PMP may be undertaken.

Species Management Plan

21. The Department of Conservation has also prepared a draft Species Management Plan for New Zealand sea lions to replace the current Recovery Plan. This draft Species Management Plan is a non-statutory document and will undergo a period of public consultation prior to any decision to finalise, or not, of the Species Management Plan.

22. The draft Species Management Plan is to guide the Department with respect to community relations, management and research actions to address the wider range of threats, and to support species recovery. As a non-statutory document, the Species Management Plan is unable to direct any other agency or party.

References

23. A number of reports were commissioned by the Department of Conservation in the process of developing the draft PMP and these reports contain much of the analysis which forms the basis of the draft PMP. The draft PMP summarises key conclusions and findings of these reports only and references relevant reports where appropriate. Stakeholders are encouraged to refer to these reports where further detail is required.
24. The key reports for which the above comment is particularly relevant are:
 - Breen, P.A, 2006; Advice on the Sea lion PMP; NIWA consultancy report April 2006.
 - Breen, P.A and S.W Kim, 2005b; Modelling the effects of bycatch on the New Zealand sea lion (*Phocarcos bookeri*) population. NIWA consultancy report September 2005
 - Fletcher, D, 2004; Review of Modelling Approaches for the New Zealand Sea lion PMP, Proteus Wildlife Research Consultants report November 2004.
 - Kim, S.W, D.J Gilbert, and P.A Breen, 2004; Exploring management procedures for controlling bycatch of Hooker's sea lions in the SQU6T fishery, NIWA consultancy report December 2004.
25. Copies of these reports are available at the CSP Publications website (<http://www.doc.govt.nz/templates/summary.aspx?id=33988>) or by contacting Doug Nicol, Marine Conservation Unit, DOC, (04) 471 3121 or by email (dnicol@doc.govt.nz).

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2. An Assessment of the Biology and Status of the Species

26. An assessment of the biology of the New Zealand sea lion may be included in the population management plan (PMP) but is not mandatory. This information is available in the Draft New Zealand sea lion Species Management Plan.
27. In contrast, an assessment of the status of the species is pivotal in determining the management objectives to be used in establishing a **maximum allowable level of fishing-related mortality (MALFiRM)** for New Zealand fisheries waters and determining whether an area-based MALFiRM is able to be established. On this basis, an assessment of the status of the species is considered an important inclusion in the draft PMP and the following two related aspects of species status will be explored:
 - i. The “threat status” for the purpose of the Act; and
 - ii. The threat classification status of the species determined by relevant classification systems (International Union for the Conservation of Nature (IUCN) (<http://www.iucnredlist.org/>) and New Zealand Threat Classification System(<http://www.doc.govt.nz/templates/MultiPageDocumentTOC.aspx?id=42704>) (Hitchmough *et al.* 2007).

Threatened species declaration

28. The New Zealand sea lion was classified as a threatened species under Section 2 (3) of the Act on 31 July 1997 for the purpose of the Act. The declaration was made having regard to relevant international standards (e.g. IUCN) and the Department’s system in place at the time (Molloy and Davis 1992).
29. Declaring the New Zealand sea lion as a threatened species has determined what management objective is relevant for establishing a MALFiRM; that is “... *determine a level of fishing-related mortality which 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.*” (Section 3(F)(a)). Declaring the New Zealand sea lion as threatened also means that an area-specific MALFiRM may be established.
30. For the purposes of this draft PMP, when interpreting threat status of the New Zealand sea lion, the IUCN classification has been used as the principle guide. The classification system presented by Molloy and Davis (1992) has been replaced by the New Zealand Threat Classification System (Molloy *et al.* 2002). As the New Zealand Threat Classification System was not established at the time the New Zealand sea lion was declared as threatened, it will not be retrospectively imposed to establish management objectives (i.e. by setting a medium-term objective of 10 locations).

31. The IUCN classification of New Zealand sea lions as “vulnerable” (D2), and the New Zealand Threat Classification System classification of this species (Hitchmough 2002)) as ‘range restricted’, are consistent in highlighting that it is the limitation of the number of breeding locations of sea lions that makes this species threatened, not its absolute numbers (c. 12 000). It is worth noting that the new Threatened Species List (Hitchmough *et al.* 2007) has removed the qualifier of stable from the New Zealand sea lion classification.
32. In accordance with the *Interpretation Act 1999*, a species may be removed as a threatened species for the purposes of the Act in a manner consistent with the process with which it was originally declared. For New Zealand sea lions to be no longer declared as threatened, the Minister would need to have regard to any relevant international standards (IUCN) and any relevant standards within New Zealand (New Zealand Threat Classification System).
33. Where a species is not declared as a threatened species for the purposes of the Act, a PMP may still be developed and contain a MALFIRM for New Zealand fisheries waters.

International Union for the Conservation of Nature (IUCN)¹

34. The New Zealand sea lion was classified in 1996 in the IUCN Red List of Threatened Species as vulnerable (VUD2) on the basis that the:

“Population is characterised by an acute restriction in its area of occupancy (typically less than 100 km²) or in the number of locations (typically less than five). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.”

This species classification was assessed by the IUCN/SSC Seal Specialist Group (<http://www.iucnredlist.org/search/details.php/17026/summ>).
35. Using the IUCN definition of ‘area of occupancy’ criteria, the New Zealand sea lion is limited in the number of locations at which it is present.
36. There is some debate amongst stakeholders as to whether this species has been appropriately classified. It is worth noting that “A Global Mammal Assessment”² and “Global Marine Species Assessment”³ have been initiated by the IUCN. In the interim, the Department will continue to use the IUCN classification for the New Zealand sea lion and the Act provisions will be interpreted in accordance with this classification.

Interpretation of IUCN threat classification criteria

37. The IUCN has issued guidelines to assist in interpreting, and using the IUCN Red List Categories and Criteria. These *Guidelines for Using the IUCN Red List Categories and Criteria* (April 2005)⁴ (the Guidelines) are relevant to New Zealand sea lions.

¹ http://www.redlist.org/search/search.php?freetext=Phocarcos&modifier=phrase&criteria=wholedb&taxa_species=1&redlistCategory%5B%5D=all&country%5B%5D=all&aquatic%5B%5D=all®ions%5B%5D=all&habitats%5B%5D=all&threats%5B%5D=all

² <http://www.iucn.org/themes/ssc/programs/gma/index.htm>

³ http://www.iucn.org/themes/ssc/biodiversity_assessments/indexgmsa.htm

⁴ <http://app.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf>

38. The New Zealand sea lion has been classified in the IUCN Red List of Threatened Species as vulnerable (VUD2) on the basis that the *“Population is characterised by an acute restriction... in the number of locations (typically less than five).”*
39. IUCN categories and criteria version 2.3 define location as follows:
“Location defines a geographically or ecologically distinct area in which a single event (e.g. pollution) will soon affect all individuals of the taxon present. A location usually, but not always, contains all or part of a subpopulation of the taxon, and is typically a small proportion of the taxon's total distribution.”
40. The Guidelines stipulate that justification for the number of locations should include reference to the most serious plausible threat(s), and also elaborate that the scope of location may vary with the threat with respect to the number of sub-populations that may be included within a single location.

Most serious plausible threat

41. In 1996 the IUCN listed threats to New Zealand sea lions as including invasive alien species (directly affecting the species): Predators (ongoing), harvesting (hunting/gathering) (ongoing); and accidental mortality (ongoing). The IUCN listed threats include those that had been historically recognised as impacts on the species, or that were identified as ongoing threats in 1996. This is useful in defining the status of the species, rather than guiding management initiatives. Since then, research has identified natural epizootic disease events as a threat that was not recorded when assessment was undertaken in 1996.
42. For the purpose of determining what will be considered as locations under the IUCN criteria, the Department believes that the most serious plausible threat that may occur, as a stochastic event, are natural epizootic disease events. The impacts of natural disease events on the already depleted and restricted population may be further increased by ongoing human impacts such as the fishing-related mortalities. It is unclear if, or how, such threats impact the New Zealand sea lion's ability to establish breeding colonies at new locations. Note that incidental mortality due to fishing is not considered to be a stochastic event. The New Zealand sea lion population has been reduced both in absolute numbers and range as a result of historic harvesting activities.
43. Other plausible serious threats include stochastic human related events such as oil spills, non-natural disease events, and natural events such as earthquakes and tsunamis.

Scope of location

44. As explained above, the scope of location will be defined with respect to disease. While fishing impacts are also considered to be a threat, these are a known actual occurrence which is to be managed through provisions in the PMP and the operational plans under the Fisheries Act.
45. Disease is transferred between individuals through contact with any body fluids. For example, faecal-oral contact, would allow transfer to occur. Some epizootic strains may also persist in the environment. Aggregations of animals (such as during the breeding season) enhance incidence of transfer and impact on the aggregated individuals. For this reason the boundaries of locations will be defined with respect to the scope of the threat of natural epizootic events, i.e. breeding subpopulations of New Zealand sea lions.

46. The IUCN has defined subpopulations as follows
- “Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little exchange (typically one successful migrant individual or gamete per year or less).”*
47. During the breeding season (early December – mid February), females exhibit strong philopatry to the breeding site and their ability to range is limited particularly when suckling a pup. Conversely, male New Zealand sea lions have been recorded as travelling extensively outside the breeding season, and between aggregations of females during the breeding season (e.g. between Sandy Bay and South East point on Enderby Island, and Dundas Island) although they are not known to travel between subpopulations (Northern Auckland Islands, Figure of Eight Island, and Campbell Island) during this period. In determining the scope of locations, isolation of subpopulations of breeding and non-breeding females and attendant males, from other subpopulations of New Zealand sea lions during the period of the breeding season, is therefore required.
48. Accordingly, the Department considers (consistent with interpretation of IUCN categories and criteria) that subpopulations of New Zealand sea lions occur at three locations:
- the northern Auckland Islands (comprising one aggregation at Dundas Island and the two aggregations on Enderby Island—Sandy Bay and South East Point);
 - Figure of Eight Island (southern Auckland Island); and
 - Campbell Island.
49. New Zealand sea lions are breeding on the Otago coastline but in low numbers (less than 5 pups per year (McConnell 2001)).
50. The establishment of additional subpopulations of New Zealand sea lions at distinct locations is required to reduce the risk that any one threat or impact may compromise the entire species. As most of the New Zealand sea lion population is located within the Auckland Islands during the breeding season, other subpopulations must be sufficiently viable to sustain the species should a catastrophe occur at the species stronghold.
51. For clarification, a subpopulation will be considered to be formed when a distinct group of New Zealand sea lions is established with the following characteristics:
- *has a number of mature female sea lions exhibiting breeding philopatry⁵ equal to or greater than 35 individuals⁶; and*
 - *maintains a population age structure conducive to ongoing recruitment.*

⁵ Breeding philopatry occurs when female returns to the proximity of a site in which she has bred at least once (successfully or unsuccessfully). This may not necessarily be the site at which she was born (natal philopatry).

⁶ The minimum number of breeding females has been arbitrarily selected by calculating 0.5% of the total number of mature individuals of the entire species of New Zealand as at 2004 (approximately 7000 individuals)

52. This definition has been developed by the Department as a guide to when a new subpopulation that has established in a distinct location will be considered viable in the event that other locations are impacted by human activities or stochastic events. It will also be used for determining when an existing subpopulation has decreased to a size below which the group is considered not to substantially contribute towards recovery of the species with respect to threat status. This definition has been developed because, while the IUCN defines "subpopulation", they do not define the size of the group.

Clarification of number of locations

53. As noted above, the IUCN criteria notes that a species is considered threatened when present in typically less than 5 locations. The Guidelines note that "The numerical thresholds are given more by way of example and are not intended to be interpreted as strict thresholds." In the categories and criteria in Section 4 'Derivation of quantitative criteria' it is noted that:

"The quantitative values presented in the various criteria associated with threatened categories were developed through wide consultation and they are set at what are generally judged to be appropriate levels, even if no formal justification for these values exists. The levels for different criteria within categories were set independently but against a common standard."

54. Accordingly, the Department has adopted 5 locations as a threshold with reference to the IUCN Red list Threat Classification for the New Zealand sea lion. Disease events have been proven to result in substantial increases in pup mortality. The establishment of two new subpopulations at distinct locations would assist in reducing the risk to the New Zealand sea lion population as a whole from disease and other impacts. The additional locations would provide a proportion of the population that is less likely to be simultaneously affected by such impacts. This position is consistent with the guidance of the IUCN criteria themselves. In addition, it would be inconsistent to adopt a lesser number of locations (below 5 referred to by the IUCN) as a threshold when the New Zealand Threat Classification System developed by the Department states 10 subpopulations of a species are required before range restricted threat classification no longer applies.

3. Assessment of Known Fisheries Interaction with New Zealand sea lion

55. Section 3E(1)(b) of the Act provides for an assessment of known fisheries interaction with New Zealand sea lions to be made. Guidance on the nature of such an assessment is not given and may be interpreted as a qualitative or quantitative assessment that may assist the setting of a MALFiRM for New Zealand sea lions either within New Zealand fisheries waters or for a specified area. The purpose of this section is to confirm the fisheries, methods and locations in which New Zealand sea lion interactions, particularly mortalities, are occurring.
56. For the purpose of this exercise it will be assumed that no New Zealand sea lions are interacting with fishing vessels beyond the 200 nautical mile zone. This assumption is supported by there being no recorded New Zealand sea lion bycatch events from the Australian EEZ around Macquarie Island (Bruce Wallner AFFM).
57. New Zealand sea lion mortalities occur as a result of interactions with trawl fisheries only. Currently, interactions are known to occur in the following trawl fisheries: squid (SQU6T and 1T), scampi (SCI6A), orange roughy (ORH3B), jack mackerel (JMA3), hoki (HOK1), and southern blue whiting (SBW6A).
58. In order to assess known fisheries interactions with New Zealand sea lions the following data were obtained from the Ministry of Fisheries:
- (a) Effort (number of tows) by fishing year and target species from all catch effort records on commercial Trawl Catch Effort and Processing Forms (TCEPR) provided for vessels over 28 m in length, which met the following criteria:
 - i. 1 October 1997 – 30 September 2004;
 - ii. South of 46°S; and
 - iii. Target species include scampi (SCI), orange roughy (ORH), hoki (HOK), jack mackerel (JMA), southern blue whiting (SBW) and squid (SQU).

46°S was selected as the northern boundary for data collection as this latitude corresponds with the approximate northernmost recorded breeding location for New Zealand sea lions.

Only vessels over 28 metres in length are required to complete TCEPR forms, therefore this summary excludes data from catch effort and landing returns that are provided by smaller trawlers. Since less than one percent of smaller vessels reported trawling south of 46°S this data would not have a significant effect on the results.
 - (b) Observer coverage has been derived by assessing the number of tows recorded in Ministry observer log books that meet the criteria (a) i-iii above.

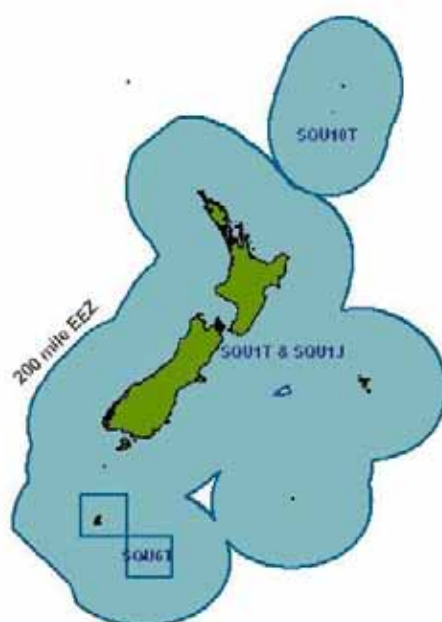
(c) Recorded bycatch of New Zealand sea lion in absolute numbers as recorded in non-fish bycatch forms completed by Ministry of Fisheries observers that meet the criteria (a) i – iii above.

59. In Table 2, the estimate of the percentage observer coverage is calculated by **Number of tow observed (a) / total number of tows (b)**

60. Results were rounded to the nearest whole digit. Note that for observer coverage in SQU, the table refers to combined effort deployed in SQU6T and SQU1T fishery south of 46°S (Figure 1). Because SQU6T is a more intensively managed fishery and estimated bycatch for this quota management area are available, these were included in the table also.

Table 2: Summary of recorded trawl fisheries interactions south of 46° (1997/98 – 2003/04).

Fishing Year	SCI Recorded by catch (fishery observer coverage %)	ORH Recorded bycatch (fishery observer coverage %)	JMA Recorded bycatch (fishery observer coverage %)	HOK Recorded bycatch (fishery observer coverage %)	SBW Recorded bycatch (fishery observer coverage %)	SQU Recorded bycatch (fishery observer coverage %)	SQU6T Estimated bycatch ⁷
1997/98	0 (4)	1 (22)	0 (15)	0 (3)	0 (10)	15 (2)	62
1998/99	0 (2)	1 (14)	0 (9)	0 (7)	0 (7)	5 (3)	14
1999/00	0 (4)	0 (19)	2 (17)	1 (4)	0 (9)	25 (5)	71
2000/01	4 (4)	0 (1)	0 (45)	0 (2)	0 (18)	42 (6)	67
2001/02	0 (4)	0 (10)	0 (18)	0 (3)	1 (10)	23 (3)	84
2002/03	1 (9)	0 (13)	0 (18)	1 (3)	0 (15)	11 (2)	39
2003/04	3 (9)	0 (25)	0 (8)	0 (5)	1 (10)	17 (2)	118



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Figure 1 Squid Management areas in New Zealand fishing waters.

⁷ Taken from the Ministry of Fisheries Initial Position Paper, Operational Plan to Manage the Incidental Capture of New Zealand sea lions in the squid (SQU) 6T Trawl Fishery for the 2005/06 Fishing Year. Refer to this document for details of how estimated bycatch were derived.

Discussion

61. The six fisheries identified above have been subject to varying levels of observer coverage, which will influence the probability of bycatch incidents being recorded. While figures for “SQU6T estimated bycatch” and the actual recorded bycatch in other observed fisheries are presented above, direct comparisons between these two sets of figures cannot be made. The squid fishery in SQU6T has typically had high levels of observer coverage (between 20–30%) as required by the management regime in place⁸. Scampi and hoki fisheries have received lower levels of observer coverage, relative to coverage achieved in orange roughy, jack mackerel and southern blue whiting fisheries in waters south of 46°S. SQU1 have lower levels of observer coverage than SQU6T.
62. Despite the variance in observer coverage between fisheries, it is evident that the majority of fishing-related New Zealand sea lion mortalities occur from interactions with the squid trawl fishery. On the basis of observer records to date, the Ministry of Fisheries has managed interactions in the SQU6T area through annual operational plans developed in accordance with Section 15(2) of the Fisheries Act⁹.
63. A very small number of seal lion interactions are recorded for other trawl fisheries.
 - The scampi trawl fishery has operated on the Auckland Islands shelf since 1990 where the first captures of New Zealand sea lions were recorded as early as the 1992/93 fishing season (3), with 3 other bycatch incidents recorded in the 1995/96 fishing year, and a further capture reported in 1996/97.
 - An early account of sea lion interactions with southern blue whiting fisheries commenced in 1995. However, despite observer coverage, low levels of interaction with New Zealand sea lions in this fishery have been recorded.
 - Only very limited intermittent interactions between orange roughy, jack mackerel and hoki fisheries and New Zealand sea lions have been recorded.
64. In the event that an area-specific MALFiRM is developed in accordance with Section 3E (1) (g) of the Act, SQU6T would be the most appropriate fishery management area within which to establish an area-based MALFiRM. The number of New Zealand sea lions that are recorded as bycaught in other trawl fisheries in spite of low levels of observer coverage by tow, in particular Scampi, highlight that increased attention will be required in these fisheries in future years (see Section 9 for recommendations in relation to this matter).

⁸ Operational Plan to Manage the Incidental Capture of New Zealand sea lions in the squid (SQU) 6T Trawl Fishery

⁹ *ibid*

4. Degree of Risk Caused by Fisheries-Related Mortality and Other Human-induced Sources of Mortality

65. Section 3E(1)(c) of the Act provides for "*an assessment of the degree of risk caused by fishing-related mortality and other human-induced sources of mortality to the species, whether within New Zealand fisheries waters or elsewhere within the range of the species.*" Undertaking such an assessment may assist (though not determine) decision making around the use of one or more MALFiRMs to control fishing-related mortality. The inclusion of a risk assessment in any population management plan is, however, not mandatory. In addition, a risk assessment will not be used in setting a New Zealand fisheries waters or area-specific MALFiRM. The Act does not stipulate that there is any relationship between the risk assessment and establishment of MALFiRMs, so none is drawn here.
66. Given that a risk assessment does not contribute directly to the development of MALFiRMs for New Zealand fisheries waters or a specific area, and is itself not mandatory for inclusion in the PMP, a formal risk assessment will not be undertaken.
67. The information necessary to quantify the probabilities, and impacts, of the full range of fisheries and other human-induced sources of mortality on New Zealand sea lions is currently not available. Quantifying the effects of natural phenomena on this species is similarly complex and not available; therefore, a comprehensive robust quantitative risk assessment can not be undertaken. Also, given that a risk assessment does not contribute directly to a MALFiRM, no risk assessment has been included in the draft PMP.

5. Development of Maximum Allowable Level of Fishing-related Mortality

5.1 INTRODUCTION

68. The Act provides for the inclusion of two types of MALFiRMs for a species declared as threatened under the Act:

- New Zealand fisheries waters MALFiRM;
- Area-specific MALFiRM.

69. The conditions under which each of these MALFiRMs may be developed, and the statutory objectives that are required to be met if these MALFiRMs are established, are summarised in Table 3.

Table 3: Summary of statutory objectives and MALFiRMs

Status of species	MALFiRM for all NZ Fisheries waters	MALFiRM for specified areas
Declared as threatened in accordance with Section 2(3) of the Act	<p>May be established under Section 3(E)(1)(f) which would allow the criteria specified in Section 3(F)(a) to be met:</p> <p><i>“...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.”</i></p>	<p>Area-based MALFiRMs may be developed for threatened species:</p> <ul style="list-style-type: none"> • if a MALFiRM under Section 3(E)(1)(f) has been set; and • populations are geographically or genetically discrete <p>for fisheries management areas or quota management areas.</p> <p>The criteria to be met when producing an area based MALFiRM are:</p> <p><i>“...should neither cause a net reduction in the size of the population nor seriously threaten the reproductive capacity of that population.”</i></p>
Other marine mammals	<p>May be established under Section 3(E)(1)(f) which would allow the criteria specified in Section 3(F)(b) to be met:</p> <p><i>...should neither cause a net reduction in the size of the population nor seriously threaten the reproductive capacity of the species.</i></p>	<p>Not possible to develop MALFiRMs for specified areas for other marine mammals as Section 3(G)(1)(a) stipulates that provisions are for populations of threatened species.</p> <p>Section 2 provides that <i>threatened species means any marine mammal that is for the time being declared by notice under Subsection (3) of this section to be a threatened species.</i></p>

70. There are a number of modelling approaches that may be used to assist in the determination of New Zealand fisheries waters and area-specific MALFiRMs for New Zealand sea lions. The four main approaches evaluated for use in the draft PMP context (Fletcher 2004) were:
- Potential Biological Removal, as proposed by Wade (1998);
 - Modelling Approach used by Maunder *et al.* (2000);
 - Modelling Approach used by Breen and Kim (2005b); and
 - Population Viability Analysis (Fletcher 2004).
71. Of the four approaches considered, Maunder *et al.* (2000) and Population Viability Analysis were not considered to be as robust or useful as other available methods in the context of assisting in the establishment of MALFiRMs for the PMP (Fletcher 2004). Accordingly, the draft PMP focuses on the modelling approach used by Breen and Kim (2005b) and the Potential Biological Removal approach proposed by Wade (1998).
72. The modelling approach of Breen and Kim (2005b) will be used when addressing the Auckland Island subpopulation of New Zealand sea lions in any MALFiRM calculations, and the approach developed by Wade (1998) will be used for the subpopulation of sea lions at Campbell Island, and for the small group at Otago. A detailed discussion of how these approaches were applied follows.

5.2 NEW ZEALAND FISHERIES WATERS MALFiRM

73. The Act requires that when developing a MALFiRM for any marine mammal species (declared as threatened or otherwise) that a MALFiRM is initially developed on a New Zealand fisheries waters scale.

5.2.1 Management objective

74. Development of interim management objectives for a New Zealand fisheries waters MALFiRM for New Zealand sea lions is complicated by uncertainty regarding the factors that may influence the establishment of sea lion populations at new locations. While the legislation implicitly focuses on the population numbers of threatened species (through establishing limits on the numbers of animals killed in the course of fishing), the New Zealand sea lion was classified as threatened on the basis of limited geographic distribution, not because of any limitation on the absolute numbers of individuals in the population as a whole.
75. Interim management objectives for the establishment of fishing-related mortality limits in accordance with Section 15(2) of the Fisheries Act have focused on enabling the populations to increase to a level of the carrying capacity at the Auckland Islands, based on the assumption that this will facilitate new New Zealand sea lion populations being established in new locations¹⁰.
76. This approach to objective setting was possible for the Auckland Island population as substantially more information is known about this subpopulation. This allowed attempts to model and approximate carrying capacity (K) for the SQU6T area in a manner that is not possible for an area as extensive as New Zealand fisheries waters.

¹⁰ A population density (i.e. population size when space is finite) increase leading to establishment of new colonies is a robust assumption and is supported by specific references; Gaggiotti, *et al.* (2002), Hofmeyr *et al.* (1997), Bradshaw, *et al.* (2000), Roux (1987) and McConkey *et al.* (2002). The classic ecology reference Begon, *et al.* (1996) also supports this assumption.

77. While the historic distribution of New Zealand sea lion throughout New Zealand is recorded in the literature, abundance was less well documented, precluding accurate estimation of carrying capacity.
78. In developing the New Zealand fisheries waters MALFiRM objective, consistent with Section 17N *Conservation Act 1987*, consideration has also been given to relevant general policy, conservation management strategies or conservation management policy. The Department of Conservation General Policy - Conservation Act and Related Legislation provides a policy statement (4.4(f)) *Protected marine species should be managed for their long-term viability and recovery throughout their natural range.*
79. There are four Conservation Management Strategies (CMS) that are relevant for consideration: Otago (1998 - 2008), Stewart Island - Rakiura (1997 - 2007), Subantarctic Islands (1998 - 2008) and Mainland Southland/West Coast (1998 - 2008).
80. The Otago CMS (6.5) contains the general objective for marine mammals: *To minimise disruption to marine mammals and advocate that Otago coastal waters and shorelines be a safe and healthy environment for their continued presence and survival.*
81. Stewart Island - Rakiura CMS ((2.3.3.2), Subantarctic Islands CMS (2.5.2) and Mainland Southland/West Coast CMS (2.3.3.2) contain the same objective: *To protect and conserve marine mammals.* Each CMS also contains a similar objective: *To increase the Department's and the public's understanding of marine mammal behaviour, ecology and the effects of human activities on them* (Mainland Southland/West Coast and Stewart Island - Rakiura); with the comparable Subantarctic Islands objective: *To increase understanding of marine mammal behaviour, ecology and the effects on them of human activities.*
82. The following interim objective for the draft PMP has been developed to assist in the management of fishing-related mortality through the derivation of a MALFiRM for New Zealand fisheries waters. This objective has been developed to take into account the level of information currently available, and reflects previous assumptions that enhancing absolute numbers of New Zealand sea lions will support the establishment of populations at new locations.
83. This objective will be used when developing a New Zealand sea lion MALFiRM for all New Zealand fisheries waters:
- The New Zealand sea lion population* increases at a rate** that is not reduced by more than 10% compared to the increase that would have been achieved with zero fishing-related mortality.*
- * *Taking into account natural variation*
- ** *Refers to sea lion population growth over time*
84. In the event that the New Zealand sea lion population has stabilised despite the impacts of fishing, maintenance of that stable population size will be required. If, however, the population is exhibiting an increasing trend, that rate shall not be compromised by more than 10% of that which would occur in the absence of fishing-related mortality. This assumes that the New Zealand sea lion population is either stable or increasing; however the concept can be applied equally to a naturally declining population.¹¹

¹¹ *Where the sea lion population may be in decline, the modelling approach is to compare sea lion population behaviour of each run with the behaviour under no fishing-related mortality" (page 6 Breen and Kim (2005b)).*

85. A delay factor of 10% has been selected to take into account the ability to robustly detect population changes, as well as to allow for some natural variation. The delay criteria selected is consistent with percentages selected for recovery rate goal in Wade (1998), has been identified as a maximum acceptable delay for recovery of endangered species in Barlow *et al.* (1995), and has also been used in criteria in Breen and Kim (2005b).
86. Interpretation of this objective when establishing a MALFiRM is provided in subsequent sections of the PMP which contain provisions developed to be consistent with Sections 3E (1) (d), (e) and (f) of the Act.

5.2.2 An Estimate of the range of human-induced mortality that would allow the criteria in Section 3F of the Act to be met.

87. This component of the PMP contextualises and informs the establishment of a MALFiRM for New Zealand fisheries waters (Section 3E (1)(f)) by providing an estimate of the overall range of mortality that the population may withstand while still achieving non-threatened status.
88. For clarification the terms 'estimate', 'range' and 'human-induced mortality' will be elaborated upon. Discussion of the approaches used to establish this estimate (and the provisions of Section 3E (1)(e) and (f)) will follow.

- (i) Estimate

This provision of the PMP is not enforceable; therefore, an estimate is sufficient.

- (ii) Range

The range of human-induced mortalities is the focus of Section 3E (1)(d). This shall be interpreted to mean that a spectrum of mortality limits be determined which achieves the criteria in Section 3F with some degree of confidence by identifying upper and lower MALFiRM figures. Note that this will be estimated for all New Zealand fisheries waters and the entire New Zealand sea lion population.

- (iii) Human-induced mortality

Human-induced mortality is defined in the Act as "*the death of any marine mammal that can be attributed directly or indirectly to any human activity*" (Section 2). Human-induced mortality is defined very broadly to capture the range of possible human impacts that may result in the death of New Zealand sea lions. It is worth noting that, though broadly defined, this estimate does not consider 'non-death' impacts on the population such as lowered fecundity rates. Human-induced mortality may include, for example, the following human interactions:

- a) Mortalities from commercial fishing includes New Zealand sea lions killed during fishing, the indirect deaths of a pup following the death of lactating female sea lion, and sea lions unable to survive interaction with fishing equipment (e.g. sea lions ejected through SLEDs alive but mortally injured);
- b) Indirect effects of human activities (including, for example, commercial fishing for food and pollution) that result in the death of sea lions;
- c) Harassment of sea lions by members of the public which directly or indirectly result in death, including disturbances associated with dogs, use of vehicles, and shootings;

d) Mortality as a result of disease events, where disease has been demonstrated to have been sourced to human population.

89. For clarification, deaths of New Zealand sea lion have been recorded to have resulted from bycatch in commercial fishing and harassment. Ideally, New Zealand sea lion deaths not related to fishing would have been included in modelling exercises investigating all human-induced mortality, however, non-fishing mortality has not specifically been included (Breen 2006). New Zealand sea lion deaths from epizootic disease events have not been proven to be linked to human disease sources.
90. Quantifying the indirect impact of human interactions on the sea lion population is complex, and figures qualifying mortality arising from indirect human impacts are not available.
91. For a full account of the evaluation of how the Breen and Kim model may be used in development of a New Zealand fisheries waters MALFiRM for the PMP refer to Breen and Kim (2005b).
92. In summary, four options were explored as to how the Breen and Kim model could be used to estimate a range of human and fishing-related mortality, and subsequently derive MALFiRMs for New Zealand fisheries waters. Options included:
1. Using the objectives and results of Breen and Kim (2005a) to extrapolate the MALFiRM from the Auckland Islands to New Zealand fisheries waters;
 2. Using objectives in Breen and Kim (2005a) or the objectives outlined in this draft PMP and incorporating Campbell Island, Stewart Island and Otago Peninsula populations into the Breen and Kim model;
 3. Using the objectives outlined in this draft PMP in the Breen and Kim model (Breen and Kim 2005a) and providing separately for the Campbell Island and Otago Peninsula populations using the Potential Biological Removal (PBR) approach of Wade (1998); or
 4. Using the objectives and results of Breen and Kim (2005a) and providing separately for the Campbell Island and Otago Peninsula populations using the PBR approach of Wade (1998).
93. Of the above options, option 3 was determined to be the more robust based on an assessment of how to deal with the New Zealand sea lion populations outside the Auckland Islands rookeries, and how the draft PMP modelling objectives may be best framed (Breen 2006). On this basis work was progressed on option 3.
94. In order to rerun the current Breen and Kim model using objectives consistent with the Act, the management objective for New Zealand fisheries waters MALFiRM was translated into an objective and, subsequently, a formula able to be used for modelling.
95. The following formula describes the management objective that there is at least a 90% probability that the sea lion population in any year is at or above 90% of where it would have been in the absence of fishing,
- $$P(N_1^{Rule n} \geq 0.9N_1^{Rule 0}) > 0.90$$
- where $N_1^{Rule n}$ is the mature population in year t under Rule n and $N_1^{Rule 0}$ is the mature population in year t under no fishing (Breen and Kim 2005b).

96. Using this approach the following results (Table 4) are calculated for the Auckland Islands subpopulations using the Series “300” rules (refer to Table 4 from Breen (2006)):

Table 4: MALFiRMs for various members of the Series “300” rules based on the 2005 and 2006 pup birth estimates from the Auckland Islands.

Rule	AKL
305	27
310	55
315	82
320	109
325	136
330	164
335	191
340	218
345	246
350	273
355	300
360	328
365	355
370	382
375	409
380	437
385	464
390	491
Cusp	504

97. MALFiRMs from the PBR approach using various combinations of R_{max} (the maximum rate of population increase) and F_r (a recovery factor) are shown in Table 5 (below), using the following equation:

$$MALFiRM_y = F_r 0.5 R_{max} N_{min}$$

where $MALFiRM_y$ is the resulting bycatch limit for year y , N_{min} is the ‘minimum population estimate’ of the population (Breen 2006).

98. For Campbell Island they range from 4 to 48, depending on the values chosen for λ (the mathematical symbol used for the population’s maximum annual rate of increase (Breen and Kim 2005b)) and, F_r and for Otago they are all less than 1.

Table 5: MALFiRMs from the PBR approach using the estimated 20th percentile of vulnerable numbers (Table 3 Breen (2006)) and the PBR procedure described in the text (refer to Table 5 from Breen (2006)).

	λ	F_r		
Campbell Is.	0.15	0.35	0.50	
	0.03	4	8	12
	0.08	10	22	32
	0.12	14	33	48
Otago				
	0.03	0.0	0.1	0.1
	0.08	0.1	0.2	0.3
	0.12	0.1	0.3	0.5

99. The sums of the estimates in Table 5 in combination with Series “300” rules (in Table 4) are shown in Table 6.

Table 6: New Zealand fisheries waters MALFiRMs for the 2006-07 fishing year; based on the estimates shown for individual areas in Table 4 and 5 (above). Addition has been done on exact values (before rounding), then rounded to the nearest sea lion (refer to Table 6 Breen (2006)).

R_{max}	PBR inputs								
	0.03	0.03	0.03	0.08	0.08	0.08	0.12	0.12	0.12
Recovery factor	0.15	0.35	0.50	0.15	0.35	0.50	0.15	0.35	0.50
Series “300” rule									
305	31	36	39	37	50	59	42	61	76
310	58	63	67	64	77	87	69	88	103
315	86	90	94	92	104	114	96	116	130
320	113	118	121	119	132	141	124	143	157
325	140	145	149	146	159	169	151	170	185
330	167	172	176	173	186	196	178	198	212
335	195	200	203	201	214	223	206	225	239
340	222	227	230	228	241	251	233	252	267
345	249	254	258	255	268	278	260	279	294
350	277	281	285	283	295	305	287	307	321
355	304	309	312	310	323	332	315	334	349
360	331	336	340	337	350	360	342	361	376
365	358	363	367	365	377	387	369	389	403
370	386	391	394	392	405	414	397	416	430
375	413	418	422	419	432	442	424	443	458
380	440	445	449	446	459	469	451	471	485
385	468	472	476	474	487	496	479	498	512
390	495	500	503	501	514	524	506	525	540
Cusp	508	512	516	514	526	536	518	538	552

100. Breen and Kim (2005b) provides a summary for each rule and confirms that each rule satisfies the management objective established for New Zealand fisheries waters.

Discussion of results

101. Prior to making any decisions regarding what values are most appropriate for the PBR inputs of R_{\max} and F_r , the table above reveals that there is a very broad range from which the MALFiRM for New Zealand fisheries waters may be selected. The range extends from a bycatch limit of 31 under Rule 305, $R_{\max} = 0.03$ and $F_r = 0.15$, to 552 under the cusp rule, $R_{\max} = 0.12$ and $F_r = 0.50$.

5.2.3 Estimate of the range of fishing-related mortality that would allow the criteria in Section 3F of the Act to be met.

102. This component of the draft PMP recognises that when establishing fishing-related mortality limits, the effects of other human-induced sources of mortality must be considered. Estimates of a range of fishing-related mortalities for the species that would allow the criteria in Section 3F to be met must have regard to the broad range of human-induced mortality previously identified. The selection of a MALFiRM for New Zealand fisheries waters will subsequently be determined from within the range of fishing-related mortality.
103. The terms ‘estimate’, ‘range’ and ‘human-induced mortality’ have been clarified in previous sections of the draft PMP based on interpretation of the Act and will similarly apply to this section.
104. Fishing-related mortality is defined by Section 2 of the Act as the accidental death or incidental death of any marine mammal in the course of fishing.
105. As this definition uses the phrase “...**death of any marine mammal in the course of fishing**” (emphasis added), indirect fishing-related impacts such as food competition or habitat alteration will not be considered as part of fishing-related mortality. In addition, fishing-related mortality will not include the death of pups after a lactating female sea lion is killed, and will not include lower fecundity as a result of reduced food availability and increased pup mortality.
106. The range of fishing-related mortality was calculated by removing non-fishing-related mortality (direct and indirect) and fishing-related mortality (indirect or non contemporaneous) statistics from estimate of range of (total) human-induced sources of mortality. This is undertaken as follows:

Estimate of range of fishing-related mortality (direct effects) =
Estimate of range of human-induced mortality - [Estimate of range of non-fishing-related mortality (direct effects) + Estimate of range of non-fishing-related mortality (indirect effects) + Estimate of range of fishing-related mortality (indirect effects)]

107. As previously described, the estimate of the range of human-induced mortality for New Zealand sea lions that would allow the criteria specified in Section 3F of the Act to be met is 31 - 552 New Zealand sea lions (Table 6).

108. The Department has records of New Zealand sea lion deaths (suspected or actual) from 1992 that are related to mortality associated with human interaction (not related to fishing). Records of these deaths are made opportunistically and a comprehensive monitoring programme of human-induced sea lion mortality on the mainland has not been undertaken. As a result, the figures in Table 7 below are conservative though they do provide a guide to estimates for non-fishing-related mortality. As previously stated, the disease events documented in the New Zealand sea lion population are not currently considered to be human-induced mortality. Should new information emerge confirming that disease events are human induced, a revision of these mortality figures will be required in accordance with Section 6 of the draft PMP.

Table 7: Department of Conservation recorded (confirmed or suspected) non-fishing-related deaths of New Zealand sea lions.

Fishing year	Calendar year in which mortalities occur¹²	Recorded non-fishing-related mortalities¹³
1991-92	1992	2 ¹⁴
1992-93	1993	2
1993-94	1994	2
1994-95	1995	1
1995-96	1996	0
1996-97	1997	0
1997-98	1998	0
1998-99	1999	0
1999-00	2000	1
2000-01	2001	1
2001-02	2002	1
2002-03	2003	2
2003-04	2004	3
2004-05	2005	0
AVERAGE¹⁵	-	1.07

¹² For the purpose of comparing fishing-related mortality with other human-induced mortality, the year in which fishing-related mortalities occurred is taken to be the second half of the fishing season, as typically the squid season does not commence until 1 February each year.

¹³ Department of Conservation information of death of New Zealand sea lion confirmed or suspected as a result of harassment on the South Island and Stewart Island. For the purposes of risk assessment, all suspected deaths (5/15) will be assumed to have occurred.

¹⁴ 1992 - 1994 figures based on average/yr of 6 animals confirmed or suspected killed over a 3-year period.

¹⁵ Average of records for each column, noting that more data is available for some sources of mortality than others.

109. For the purpose of this process, non-fishing-related mortality due to direct effects is considered to range between 0 – 3 sea lions per annum, with an average of 1 New Zealand sea lion documented as killed per year due to non-fishing-related human interactions.
110. Quantifying the mortality of New Zealand sea lions as an indirect result of fishing and other human activities is problematic. Unless severe, the impact of indirect effects on New Zealand sea lions is considered likely to manifest itself in parts or all the population in the form of lowered health status (body weight, immune response) and lowered fecundity rates than mortality itself.
111. There is currently insufficient information to quantify or estimate this parameter.
112. For the purpose of this draft PMP, the estimate of the range of non-fishing mortality due to indirect effects (pollution etc) is considered to be zero.
113. For consistency, the estimate of the range of fishing mortality due to indirect effects is also considered to be zero. There is currently insufficient information to estimate or quantify fishing-related mortalities as a result of indirect effects of fishing. While it may be possible to derive estimates of the numbers of pups dying as a result of their mothers being killed in the SQU6T trawl fishery for example, this is a complex exercise which would be reliant on a number of assumptions regarding sex ratio of adults killed and female fecundity.

Results

114. While recognising that the approach is not ideal, the Department has estimated the range of fishing-related mortality that will allow the criteria to be met. This is achieved by subtracting figures in Table 7 from the values in Table 6. The resulting estimate of the range of fishing-related mortality that will allow the criteria in Section 3F to be met are presented in Table 8.

Table 8: Estimates of the range of fishing-related mortality

Rule	305	Cusp
Human-induced mortality range from Table 6	31	552
Upper bound (-0)	31	552
Lower bound (-3)	28	549

5.2.4 MALFiRMs that would allow the criteria in Section 3F of the Act to be met.

115. Establishing a MALFiRM for New Zealand fisheries waters rests principally on the analysis and calculations undertaken in accordance with Section 3E (1) (d) and (e). Section 3E (2) provides guidance on how the MALFiRM may be set for species that range beyond the outer boundary of New Zealand's exclusive economic zone (EEZ). New Zealand sea lions are considered to be endemic to New Zealand; however, individual vagrant male New Zealand sea lions have occasionally hauled up on Macquarie Island. No New Zealand sea lion bycatch beyond the New Zealand EEZ has been reported. For the purpose of establishing a MALFiRM under Sections 3E (f) and (g), fishing-related mortality beyond 200 nautical miles will be considered to be zero.

116. Previous sections of the draft PMP have identified estimates of the range of human-induced and fishing-related mortality for sea lions that allow the criteria in Section 3F to be met. Two modelling approaches (Breen and Kim and Wade) were utilised for this purpose. This section of the draft PMP outlines options for the approach that may be taken for determination of MALFiRMs on an annual basis. The approach developed offers a broad range from which a specific MALFiRM must be selected. The draft PMP proposes that the determination of New Zealand fisheries waters MALFiRM and area-specific MALFiRM should be made on an annual basis to allow updated sea lion population and fisheries information to be taken into account (refer Section 7 of this draft PMP). The annually adjusted MALFiRM will be notified by a notice in the Government Gazette following PMP amendment procedures outlined in Section 3E(3) of the Act.
117. The New Zealand fisheries waters MALFiRM will be established on an annual basis through the use of the Breen and Kim model. Determining a specific rule combination as a means of establishing a MALFiRM for New Zealand fisheries waters involves two key considerations:
- a) What parameters for PBR should be used to account for Campbell Island and Otago groups of sea lions?
 - b) Which of the Series “300” rules (from 305 - 392) will be used to select the final MALFiRM for New Zealand fisheries waters for the 2006/07 fishing year and in subsequent years?¹⁶

5.2.4.1 Selection of parameters for PBR component of the New Zealand fisheries waters MALFiRM

118. Breen (2006) provides discussion and advice on how values for N_{\min} , R_{\max} and recovery factors could be selected.
119. Values for N_{\min} have been determined through use of the Breen and Kim model and empirical constants relating to pup birth estimates to vulnerable New Zealand sea lions yielding the following values:
- | | |
|-----------------------------------|------|
| Auckland Island (20th percentile) | 8768 |
| Campbell Island (20th percentile) | 1593 |
| Otago (20th percentile) | 29 |
120. Breen (2006) does not recommend specific values for R_{\max} but states that 0.03 and 0.12 represent the range of values for R_{\max} . The PBR approach is to be used to account for Campbell Island and Otago subpopulations of New Zealand sea lions, in conjunction with Breen and Kim approach for the Auckland Island subpopulations to assist in determining a New Zealand fisheries waters MALFiRM. It is consistent to utilise the values generated by the Breen and Kim model (0.03). Consequently, $R_{\max} = 0.03$ will be used.

¹⁶ The adaptive rule is not considered an appropriate rule to manage sea lion bycatch issues on the basis that the points at which the management regime changes from half to single to double MALFiRM figures are not biologically relevant

121. With respect to recovery factor, Wade's recovery rate goal (which proposes a recovery factor of 0.15) appears analogous to the draft PMP management objective for New Zealand fisheries waters. Breen (2006) notes that while these goals are not "exactly congruent", he considers that the draft PMP management objective for New Zealand fisheries waters is "similar to, but not quite the same as Wade's recovery rate goal" and concludes that the range for this value should lie between 0.15 - 0.50. A F_r of 0.35 was used in PBR calculations for New Zealand fisheries waters, for the Campbell Island and Otago groups of sea lions.
122. This leads to the narrowing of the range of MALFiRM options for New Zealand fisheries waters, as in Table 9 (below) based on the estimates shown for individual areas in Tables 4 and 5 (above) using addition based on exact values (before rounding), then rounded to the nearest sea lion.

Table 9: Narrowed range of New Zealand fisheries waters MALFiRMs for the 2006-07 fishing year through defining PBR values.

R_{max}	0.03
Recovery factor	0.35
Series "300" rule	
305	36
310	63
315	90
320	118
325	145
330	172
335	200
340	227
345	254
350	281
355	309
360	336
365	363
370	391
375	418
380	445
385	472
390	500
Cusp	512

123. While the table above suggests that a MALFiRM may be determined with respect to any of the rules that satisfy criteria established (up to and including the cusp rule) there are numerous reasons why such an approach is not prudent. In interpreting the outputs of the Breen and Kim model and applying these outputs to management, caution is advised for reasons including, but not limited to, the following:
- a) some datasets used in the model are relatively small (and so may not be representative of the full range of states found in nature);
 - b) standard diagnostics suggest that the model outputs may be limited by the data;
 - c) issues with parameterisation e.g. unknown effects of decoupling survival and maturity;
 - d) low stochastic process error in projections;
 - e) implementation errors¹⁷ of the bycatch control rule; and
 - f) potential for changes in the operating environment, which can affect interactions between the fishery and sea lions (e.g. changing fishing effort).

See Fletcher (2004) and Breen (2006) for further information.

124. Breen (2006) suggests that it is appropriate to manage somewhat below the cusp. The inappropriateness of managing at the extreme end of the range, e.g. the cusp rule, has also been commented on during an Appeal Court decision (Squid Fishery Management Company verses Minister of Fisheries 7 April 2004, NZ Court of Appeal CA39/04). Further, it is not appropriate to use the results of modelling conducted by Breen and Kim (2005b) and Kim et al. (2004) to date, if fishing effort changes.
125. Given the need for caution when using the Breen and Kim model to assist in establishing a MALFiRM for New Zealand fisheries waters, selection from amongst the “eligible” rules will be taken from the lower end of the Series “300” rules. In an Aquatic Environment Working Group meeting (1 Sept 2006) Breen advised that the range within which the Breen and Kim model could currently be used with confidence was 310-320, further reinforcing advice previously reflected in written reports (Minutes of the AEWG Meeting 1 Sept 2006).
126. The Department recognises that Rule 310 is at the conservative end of the recommended range for rules that may be used to determine a New Zealand fishing waters MALFiRM. Given the number of fishing practise changes that are evident in the SQU6T fishery (longer tows, within season increased in bycatch limit in the 2005/06 season that has an unknown impact on model outputs) and continued declines in the New Zealand sea lion pup production (Chilvers *et al.* in press.) not anticipated by the model, a degree of conservatism is required. Accordingly, rule 320 is not preferred and therefore rule **315** is selected as the means by which the New Zealand fishing waters MALFiRM should be determined. Using the PBR approach to account for sea lions in the Campbell Island and Otago peninsula areas, results in a New Zealand fisheries waters MALFiRM for 2006/07 of **90** sea lions (refer Table 9).

¹⁷ Implementation errors is a modelling term that “...relates to “the extent to which management policies will be successfully implemented” (Butterworth and Punt 1999).

127. The Wade PBR approach is very different in how it determines limits on bycatch and is not comparable to Breen and Kim. It is a conservative approach useful for determining bycatch limits for New Zealand sea lion subpopulations or aggregations for which comprehensive population data is not currently available (such as Campbell Island and Otago peninsula based sea lions). For reference only, calculations of New Zealand fisheries waters MALFiRM using PBR approach for Auckland Island, Campbell Island and Otago Peninsular sea lions ($N_{\min} = 10390$, $R_{\max} = 0.03$ and $F_r = 0.35$) results in a bycatch limit of 54.
128. Note that while consistency may be achieved with respect to which rule is applied to determine the New Zealand fisheries waters MALFiRM from year to year, the absolute number of the MALFiRM will almost certainly alter in response to new data on New Zealand sea lion population dynamics.

Providing for other human-induced sources of mortality

129. Following the selection of a specific rule (and therefore a resultant MALFiRM), allowance is required to be made for other human-induced sources of mortality before the final New Zealand fisheries waters MALFiRM is arrived at.
130. Three alternative approaches to accounting for other human-induced sources of mortality may be utilised:
- assuming this to be zero;
 - subtracting an average of other human-induced sources of mortality (1 animals – refer Table 7); or
 - subtracting the maximum values of other human-induced sources of mortality recorded (3 animals – refer Table 9).
131. Due to the sporadic nature of these impacts and the very small numbers involved, it is recommended that the average (1 animal) be used when accounting for other human-induced sources of mortality.
132. It is **recommended** that a reduction of **1** animal for other human-induced (non-fishing) mortality of New Zealand sea lions (e.g. shootings, etc.) be subtracted from the MALFiRM determined in relation to the options above.

5.2.5 Overall Recommendation for a New Zealand fishing waters MALFiRM

133. The Department recommends that the Series “300” rule **315** is used and an allowance of **-1** animal is made for non-fishing, human-induced mortality, thus the MALFiRM is **89** (see Table 9).

5.3 MALFiRM FOR A SPECIFIED AREA

134. The circumstances in which an area-based MALFiRM may be established for species declared as threatened are constrained and are subject to certain conditions:
- (i) a New Zealand fisheries waters MALFiRM has been previously set;
 - (ii) the population of threatened species is geographically or genetically discrete; and
 - (iii) the MALFiRM is being established in an area corresponding to areas having effect under the Fisheries Act as fisheries management areas or quota management areas.
135. Provision of the establishment of a New Zealand fisheries waters MALFiRM have been described in Section 5.2.
136. There is no evidence that populations of New Zealand sea lions are genetically discrete, however, although males are capable of travelling large distances outside of the breeding season (Robertson *et al.* 2005), they are not known to travel between the three subpopulations at established locations¹⁸ during the breeding season.¹⁹
137. In addition, during the breeding season, adult females are geographically isolated from females in other breeding locations, although at sea, interactions may occur. On this basis, New Zealand sea lion are considered to form geographically discrete subpopulations during the breeding season.
138. Assessment of fishing-related mortality in accordance with Section 3E (1) (b) has identified that SQU6T (Figure 1) is the area in which the majority of recorded fishing-related mortality events occur. This area is a logical focus for establishment of an area-based MALFiRM.

5.3.1 Management objective

139. Consistent with Section 3G(2) of the Act, the interim objective for an area specific MALFiRM is:

“Fishing-related mortality should neither cause a net reduction in the size of the population nor seriously threaten the reproductive capacity of that population.”

5.3.2 Specified area MALFiRM for SQU6T

140. The following major references are the basis for this section: Kim *et al.* (2004) has more details on how the Breen and Kim model may be used to assist in establishing an area-specific MALFiRM for SQU6T; and Breen (2006) for discussion of MALFiRM for SQU6T determination.

¹⁸ The Department of Conservation believes that (consistent with interpretation of IUCN categories and criteria), at present existing breeding aggregations are formed within three locations:

- the northern Auckland Islands (comprising one aggregation at Dundas Island and the two aggregations on Enderby Island – Sandy Bay and South East Point),
- Figure of Eight Island and
- Campbell Island.

¹⁹ Breeding season for New Zealand sea lions is typically between early December and mid January.

141. The Department proposes to utilise the Breen and Kim model to assist in establishing an area-based MALFiRM for SQU6T. Consideration of alternative modelling approaches concluded that the Breen and Kim model is the most robust and integrated approach to be used in establishment of an area-based MALFiRM (Fletcher 2004). This model has been used to establish a fisheries-related mortality limit (FRML) for SQU6T under the Fisheries Act using a mathematical derivation of a previously determined carrying capacity objective (Breen and Kim 2005a)²⁰.
142. The model needed to be rerun using the objective consistent with the Act (as stated above) before it was used to assist in developing an area-based MALFiRM for SQU6T for the draft PMP.
143. To ensure consistency with the Act, the following terms have been interpreted for modelling purposes as follows:
- 'the population' refers to the population that is discrete and occurring within the boundaries of the fisheries management or quota management area during the breeding season (December - February) for which an area-based MALFiRM is to be established, i.e. the Auckland Islands population;
 - 'size of the population' refers to the number of sexually mature individuals in 2004, estimated in this study by the posterior distribution;
 - the period over which modelling would assess 'net reduction' is determined to be 20 years, and the study would be based on a comparison of numbers in 2024 with 2004. The 20 year timeframe was selected in absence of any specific statutory guidance on this issue, and is consistent with the timeframe stated in Section 3F(a) which is used to assist in derivation of a MALFiRM for threatened species for New Zealand fisheries waters;
 - 'reproductive capacity of that population' will be interpreted as being represented by the number of sexually mature females of the population assuming a 50:50 sex ratio. Female sea lions have been selected as a measure of reproductive capacity as male sea lions are capable of holding harems with multiple females. Thus reproductive capacity of the population is less constrained by the number of male sea lions, than the number of sexually mature females in the population.
 - Both criteria 'no net reduction in the size of the population' and 'not seriously threatened the reproductive capacity of that population' are referring to the same population of New Zealand sea lions. In addition, both criteria are measured using sexually mature individuals (using total numbers and females respectively). On this basis the 'no net reduction' criterion is considered to be a stricter test in this situation than the 'seriously threaten the reproductive capacity' criterion, therefore the latter would be satisfied only if the former was tested. On this basis a single 'no net reduction' criterion was modelled.

²⁰ 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-year and 100-year runs.

144. Two alternative criteria were assessed.

(i) Simple criterion

The first criterion considered was:

$$p^X = \frac{\text{count} [N_{20,i}^X < N_{0,i}]}{5000}$$

where p^X is the probability obtained by counting the runs that satisfy the inequality, under bycatch control rule X, that the population will decrease in the i th run, $N_{20,i}^X$ is the mature population size in the i th run after 20 years (in 2024) and $N_{0,i}$ is the mature population size in the i th run initially (in 2004). An interpretation of the ‘no net decrease’ criterion was that this would be achieved when Rule X produced $p^X = 0.50$. That is, if the chance of increase and decrease are equal, when integrated over the estimation and process uncertainty, the median expectation for the population is ‘no net decrease’.

(ii) Complex criterion

An alternative more complex criterion was also evaluated as the criterion above does not examine the scale of fluctuation caused by stochastic changes in population processes. A second criterion was considered that did so:

$$p^X = \frac{\text{count} [N_{20,i}^X < \gamma \times \frac{1}{5000} \sum_{i=1}^{5000} N_{0,i}]}{5000}$$

The parameter γ is related to the scale of variation in N_{20}^X , and is

$$\gamma = \frac{p^{10}(N_{20}^X)}{\frac{1}{5000} \sum_{i=1}^{5000} N_{20,i}^X}$$

where $p^{10}(N_{20}^X)$ denotes the 10th percentile of the distribution of numbers after 20 years. Simple simulations suggested that, in the absence of any change in mean or median population size, the value of p^X is 0.10 if the 10th percentile is used to calculate γ , 0.05 if the 5th percentile is used and so on. In simple simulations, $p^X = 0.50$ and $p^X = 0.10$ when distributions were compared that had no mean change.

145. Thus both criteria could be used to assess ‘no net reduction’ in the sets of model runs. Both criteria appeared to be robust to skewing of their distributions in the absence of any real change in mean or median population size. The precision of the complex criterion was slightly higher, but precision of the simple criterion could be increased by making more model runs, with different random numbers, from the same bycatch control rule. On this basis the simple criterion was used with 25 0000 projections to increase precision (Kim *et al.* 2004).

5.3.3 Results for SQU6T with current fishing effort

146. The fishing-related mortality limits approved by the Minister of Fisheries (implemented through the Ministry of Fisheries' Operational Plan) have not included the Campbell Island subpopulation. This has been due to the discrete nature of the two subpopulations of New Zealand sea lions on the Auckland Islands, and the focusing of squid trawl fishing activity around the Auckland Islands.
147. Under the present distribution of fishing effort, a similar approach is proposed by the Department through this draft PMP, which means that when establishing an area-specific MALFiRM for SQU6T vessels (which does not include vessels targeting non-squid species while operating within SQU6T boundaries) Campbell Island subpopulation of sea lion will not be included in the MALFiRM calculations.
148. Accordingly, there is a range of MALFiRM values for SQU6T using the revised management objective consistent with the Act, Table 10 (derived from Breen (2006), refer to table 7).

Table 10: SQU6T MALFiRMs for 2006/07 fishing season, based on Auckland Island New Zealand sea lion population data (no inclusion for Campbell Island) (refer to Table 7 Breen (2006)).

Series "300" rule

305	27
310	54
311	60
312	65
313	71
314	76
315	81
316	87
317	92
318	98
319	103
320	109
325	136
330	163
335	191
340	218
345	245
350	273
355	300
360	327
365	354
370	382
375	404
380	436
385	464
390	491
Cusp	503

Discussion of results and selection of area-specific MALFiRM

149. According to analysis undertaken in Kim *et al.* (2004) the rule that comes closest to $p^X = 0.50$ is Rule 314. Kim *et al.* (2004) recognised that the differences between Rules 312 and 316 were small, and surmised that small changes in modelling choices would affect the specific rule that most closely met the criterion. While recognising the sensitivity around identifying the Series “300” rule that would be closest to meeting the criterion established of ‘no net reduction’, Kim *et al.* (2004) also recommended that if this approach is used as a sea lion bycatch management tool then the rule should be used consistently for a specified period (tentatively proposing a 5-year term) before further review is undertaken. This means that selection of Rule 314 as a means of determining the SQU6T MALFiRM may be undertaken but it is seen as an aggressive approach. It is proposed that this be reconsidered when the PMP is reviewed in 5 years time.

5.3.4 Results for SQU6T with Expanded Distribution of Fishing Effort

150. If the distribution of fishing effort of the squid fishery in SQU6T changes to include the waters around Campbell Island a new MALFiRM for the entire SQU6T quota management area will need to be developed to take into account the subpopulation of New Zealand sea lions on Campbell Island. The PBR approach is used to account for the Campbell Island subpopulation. Using this approach, the results are as follows:

“In the event that squid fishing effort within SQU6T changes and extends around Campbell Island then a PBR approach will be employed to account for the subpopulation of animals at Campbell Island. [Table 11] provides for the use of the PBR approach to account for Campbell Island subpopulation of sea lions when determining a MALFiRM for the entire SQU6T quota management area. If the Campbell Island subpopulation is to be included in the calculation of a MALFiRM for SQU6T, PBR values for R_{max} , and Recovery Factor would also need to be determined. For consistency it is appropriate to use R_{max} of 0.03, with a Fr of 0.5 recognising the difference in management objectives for New Zealand fisheries waters.” Breen (2006).

5.3.5 Recommendations for specified-area MALFiRM for SQU6T

151. For the current distribution of fishing effort (i.e. around the Auckland Islands part of SQU6T) the MALFiRM should be determined using **Rule 314** in Table 10, i.e. a **MALFiRM is 76**.
152. If the distribution of fishing effort expands (i.e. includes the waters around Campbell Island part of SQU6T) then the MALFiRM should use **Rule 314** from Table 11 with **R_{max} of 0.03** and **Fr of 0.5**, i.e. a **MALFiRM of 88**.

Table 11: SQU 6T MALFiRMs for the 2006-07 fishing year; based on the estimates shown for individual areas in Table 4 and 5 above. Addition has been done on exact values (before rounding), then rounded to the nearest sea lion (refer to Table 7 Breen (2006)).

PBR inputs										
R _{max}	0.03	0.08	0.12							
Recovery factor	0.15	0.35	0.50	0.15	0.35	0.50	0.15	0.35	0.50	
Series "300" rule										
305	31	36	39	37	50	59	42	61	75	
310	58	63	67	64	77	86	69	88	102	
311	64	68	72	70	82	92	74	94	108	
312	69	74	77	75	88	97	80	99	113	
313	75	79	83	81	93	103	85	104	119	
314	80	85	88	86	99	108	91	110	124	
315	85	90	94	91	104	114	96	115	130	
316	91	96	99	97	110	119	102	121	135	
317	96	101	105	102	115	125	107	126	141	
318	102	107	110	108	121	130	113	132	146	
319	107	112	116	113	126	136	118	137	152	
320	113	118	121	119	131	141	124	143	157	
325	140	145	148	146	159	168	151	170	184	
330	167	172	176	173	186	196	178	197	212	
335	195	199	203	201	213	223	205	225	239	
340	222	227	230	228	241	250	233	252	266	
345	249	254	258	255	268	278	260	279	293	
350	277	281	285	283	295	305	287	306	321	
355	304	309	312	310	323	332	315	334	348	
360	331	336	340	337	350	359	342	361	375	
365	358	363	367	364	377	387	369	388	403	
370	386	391	394	392	404	414	396	416	430	
375	413	418	421	419	432	441	424	443	457	
380	440	445	449	446	459	469	451	470	485	
385	468	472	476	474	486	496	478	498	512	
390	495	500	503	501	514	523	506	525	539	
Cusp	507	512	516	513	526	536	518	537	552	

6. Recommendations to the Minister of Fisheries on Mitigation and the Standard of Information to be Collected on Fishing-Related Mortality.

153. A PMP may include recommendations to the Minister of Fisheries on measures to mitigate the fishing-related mortality of the species (Section 3E (1) (h) the Act) and the standard of information to be collected on fishing-related mortality (Section 3E (1) (i) of the Act).
154. Consideration of these recommendations by the Minister of Fisheries will likely be had during the development and approval of an Operational Plan used to guide the implementation of the PMP.

6.1 RECOMMENDATIONS TO THE MINISTER OF FISHERIES ON MITIGATION

155. The fishing-related mortality impacts on sea lions are influenced by the location in which fishing occurs, and the manner in which trawling activities are undertaken. In identifying measures to mitigate fishing-related mortality, consideration may be given to either of these two aspects of fishing in the SQU6T area (being the fishery in which the majority of fishing-related mortality occurs) and throughout New Zealand fisheries waters where trawling activity causes interactions with New Zealand sea lions.

(a) Location of fishing

Distance to colony has been shown to be very important in accounting for variance in captures to date (Smith and Baird 2004). Currently fishing is only permitted to occur beyond 12 nautical miles (nm) from the Auckland Islands to give effect to the existing Auckland Island Marine Reserve and Mammal Sanctuary.

It is **recommended** that the Minister of Fisheries considers extending the area around the Auckland Islands within which commercial trawling fishing activities are constrained to avoid, remedy, or mitigate any adverse effects of fishing on New Zealand sea lions, in accordance with Section 15 (1) (b) of the Fisheries Act,

(b) Characteristics of fishing: mitigation practises

Investigating the timing of fishing activity in terms of both time during the fishing season and time during the day in which fishing is conducted may bring to light methods for reducing the number of New Zealand sea lion captures occurring. The magnitude of these effects, however, may be sex-specific (Smith and Baird 2004). For example, analysis of observer records reveals:

- i. that tows conducted entirely at night have lower capture rates than at other times, although time-of-day effects are stronger on male captures than female captures;

- ii. there is a recorded drop in male captures when males leave the fishing area (mid-February until some return at the end of March), but no corresponding drop in female captures at this time. Longer tows capture more female sea lions than shorter tows (although no effect is recorded for male captures); and
- iii. tows that deviate from a straight line capture more females than straight tows, with no detected effect on male captures.

Clearly therefore, recommending modifications to fishing operations with the goal of decreasing New Zealand sea lion captures must be approached cautiously. Based on existing data, fishing at night, after males have left SQU6T fishing areas, and using shorter tows conducted over straight line paths could reduce captures. Monitoring any recommended operational practices would be essential to confirm their efficacy.

Utilising the opportunities to gather data on fishing characteristics as a part of ongoing observer coverage and monitoring of the fisheries activities, and impacts, should continue in the event that a significant trend or characteristic of fishing more conducive to testing may be identified.

(c) Characteristics of fishing: SLEDs

It is noted, however, that observer coverage will only effectively assist in gaining great understanding of effects of fishing characteristics if either SLEDs are removed from all, or a proportion, of trawl vessels, or if a reliable method of quantifying accurately the numbers of sea lions passing through the SLED (strike rate) is developed, and the rate of survival of sea lions passing through SLEDs is more accurately quantified. Currently, the means of determining the characteristics (such as gender) of sea lions ejected through SLEDs remains elusive.

Since the 1990s, work has been conducted on devices aiming to reduce the number of sea lions incidentally killed in the course of squid trawl fishing (Gibson and Isakssen 1998). Sea Lion Exclusion Devices (SLEDs) provide an opportunity for sea lions entering trawl nets to escape through a hole in the net, with minimal loss to target squid (Cawthorn pers. comm.). Exclusion devices have been reported to eject sea lions effectively (Hilborn and Starr 2000), however captures of animals that passed through SLEDs into the codend of trawl nets in the 2003/04, 2004/05 and 2005/06 fishing year suggest that continued high rates of escape can not be assumed. Modification to SLED specifications with respect to the bar width of the grill has been undertaken to address this latter issue in the 2005/06 season. And finally, sea lion viability after exclusion is yet to be demonstrated, and has been the subject of much controversy.

Although SLEDs provide some encouraging possibilities for reducing sea lion mortalities in fisheries interactions, confirming that SLEDs of standardised design are being deployed, that sea lions are escaping from SLEDs, and that escaped sea lions are in a viable condition after exiting SLEDs and the associated cover nets are all critical before SLEDs can be considered to be completely effective in reducing mortality of sea lions entering trawl nets. Information quantifying the extent to which SLEDs may reduce sea lion mortality remains an important research focus.

It is **recommended** that *should SLEDs continue to be used in trawl fisheries as a means of mitigation to sea lion mortality, that greater understanding of SLED efficacy be quantified.*

(d) Approach to monitoring for mitigation of fishing-related mortality

Although the relationship between the number of tows conducted in SQU6T and the number of sea lions captured differs between years (e.g. Wilkinson *et al.* 2003), there is clearly a relationship between fishing effort and sea lion mortalities. A reduction in fishing effort, therefore would lead to a reduction in sea lion mortalities. The rate and volume of capture of the target species of squid is also highly variable between years, therefore, effort reduced is expected to coincide with a decrease in the amount of product landed.

The variable relationship between the landed catch and fishing effort means that monitoring or regulating on the basis of sea lion deaths is expected to address the New Zealand sea lion mortality issue more directly than working with changes to fishing effort or amount of squid caught each season.

It is recognised that currently, with the use of SLEDs in the SQU6T fishery, the fishery is managed via a constraint on effort (as a calculation of annually determined New Zealand sea lion fishery-related mortality limit and predetermined strike rate), in the absence of a known strike rate. It is **recommended** that *the fisheries continue to be managed on the basis of a sea lion mortality limit.* It is acknowledged that this may need to be implemented through a constraint on effort until the need for the use of a predetermined strike rate is overcome.

6.2 RECOMMENDATIONS ON THE STANDARD OF INFORMATION

(a) Information for MALFiRM

Captures of New Zealand sea lions in the SQU6T fishery have been recorded since 1978, and these have been monitored by government observers since 1988 (Wilkinson *et al.* 2003). Levels of coverage have varied between years, and although New Zealand sea lions are captured in fisheries outside SQU6T, by far the majority of captures occur in this area. At a minimum, it is **recommended** that, where possible, i.e. for fisheries not using SLEDs, observers collect information on the number of New Zealand sea lions captured on vessels per tow. This is particularly important for southern trawl fisheries targeting Scampi, Jack Mackerel, Hoki, Orange Roughy and Southern Blue Whiting. These fisheries, to date, have received lower levels of observer coverage than the SQU6T fishery, and do not have a record of New Zealand sea lion bycatch. Securing increased levels of observer coverage is seen as a priority for these fisheries.

To ensure verification of the assumption upon which the MALFiRM is established that 50:50 male:female bycatch continues, an assessment of sex will also be necessary, although this will, again, only be possible in fisheries not employing the use of SLEDs. If modelling to assess fisheries' effects on the New Zealand sea lion population is to be conducted in the future, additional information (e.g. age and reproductive status) is necessary, and this would require continuing

the necropsies of dead animals that are currently conducted by the Ministry of Fisheries.

(b) Strike rate

The number of 'fisheries-related sea lion mortalities' in SQU6T are currently estimated in-season using an assessment of strike rate (i.e. number of sea lions captured per 100 tows), which is multiplied by the number of tows conducted. The so-called 'predetermined strike rate' is an average of the actual strike rates from the seven years prior to 2002/03 where observer coverage exceeded 20% of tows undertaken in the SQU6T fishery. Actual strike rates vary substantially between years however, and the predetermined strike rate may not be a realistic reflection of actual strike rate in any one fishing year. From a conservation perspective, applying an underestimate of strike rate is risky, as it would lead to an underestimate of the number of sea lion mortalities.

The deployment of open net SLEDs in the SQU6T fishery since 2003/04 has prevented an assessment of actual strike rates for subsequent seasons being obtained. The predetermined strike rate has therefore been unable to be updated since 2002/03. Unless the predetermined strike rate remains current, it is **recommended** that *this estimate is treated with increasing caution for monitoring purposes*.

In the 2003/04, 2004/05 and 2005/06 fishing years, fishing vessels using SLEDs that were specified as the standard design identified by the Ministry of Fisheries were able to receive a 20% discount on strike rate. This reduced the predetermined strike rate of 5.3% to an effective strike rate of 4.24% for qualifying vessels. There are several risks in applying this discount rate. As yet, a robust quantification of New Zealand sea lion survival from SLED-equipped trawl nets has not been achieved, therefore, appropriate empirical evidence supporting the 20% discount rate is lacking. Before a discount rate could be confidently applied, it would be necessary to robustly quantify the escape and survival statistics for New Zealand sea lions entering trawl nets (see previous section). Also, ensuring that SLEDs of the standard required are used on all tows on trawlers seeking any discount rate is necessary. This could be achieved with observers.

As observers are unable to monitor sea lions escaping through the open cover nets of SLEDs, it is **recommended** that *a method to monitor the number of animals passing through the hatch (whether or not in a viable state) be developed*. In the meantime, the 20% discount is acknowledged as an estimate only, as decided by the Minister of Fisheries. This discount factor could be revisited once likelihoods of escape from SLEDs and the survival of New Zealand sea lions that have escaped are robustly quantified.

7. Review of the Population Management Plan

156. The term of the PMP for New Zealand Sea lions will be for a maximum of 5 years from the time the PMP is first approved. During that time, amendment or review of the PMP may be undertaken in the following circumstances:

7.1 AMENDMENT TO THE POPULATION MANAGEMENT PLAN

157. An amendment to the PMP may be undertaken following the consultation process outlined in Section 3H(3) of the Act:
- a) on an annual basis to allow for inclusion of up-to-date data and recalculation of MALFiRMs using the approach consistent with the approved PMP where the approach to calculation of the MALFiRM does not change to a significant degree; and
 - b) periodically to allow for incorporation of new information as necessary that does not change the calculation of the MALFiRM to a significant degree.

7.2 REVIEW OF THE POPULATION MANAGEMENT PLAN

158. A review of the PMP following the full consultation process outlined in Sections 3H(1)(a)-(p) and 3H(2)(a)-(c) the Act will be undertaken in any of the following circumstances where:
- a) the PMP has been in place for 5 years without review; and/or
 - b) the New Zealand Threat Classification System or the International Union for the Conservation of Nature Red List of Threatened Species reclassifies the New Zealand sea lion from current threat status (At Risk (range restricted; qualifiers: conservation dependent; human induced) or Vulnerable D2 respectively) to a more or less severe threat status; and/or
 - c) the approach to selection of a MALFiRM for New Zealand fisheries waters or for a specific area (SQU6T) changes to a significant degree including as a result of availability of new information.

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9. Glossary

Cusp rule “This rule... is the rule that just meets the criteria agreed by the MFish-convened Aquatic Environment Working Group in 2003.” (Breen 2006).

Breeding philopatry occurs when a female returns to the proximity of a site in which she has bred at least once (successfully or unsuccessfully). This may not necessarily be the site at which she was born (natal philopatry).

Exclusive economic zone of New Zealand ... as defined by Section 9 of the *Territorial Sea and Exclusive Economic Zone Act 1977*;

9 (1) The exclusive economic zone of New Zealand comprises those areas of the sea, seabed, and subsoil that are beyond and adjacent to the territorial sea of New Zealand, having as their outer limits a line measured seaward from the baseline described in Sections 5 and 6 [and 6A] of this Act, every point of which line is distant 200 nautical miles from the nearest point of the baseline.

F_r is a recovery factor that “*allocates the annual population increase between the fishery... and the recovering population...*” (Breen and Kim 2005b). “Wade suggested that F_r can be seen as both an additional factor to account for additional uncertainties other than the precisions of the abundance estimate and that it could be used to address potential biases caused by our ignorance of some important factors, such as stock boundaries.” (Breen 2006).

New Zealand fishing waters has the same meaning as in Section 2(1) of the *Fisberies Act 1996*, which is

New Zealand fisheries waters means—

- (a) *All waters in the exclusive economic zone of New Zealand;*
- (b) *All waters of the territorial sea of New Zealand;*
- (c) *All internal waters of New Zealand; and*
- (d) *All other fresh or estuarine waters within New Zealand where fish, aquatic life, or seaweed that are indigenous to or acclimatised in New Zealand are found.*

New Zealand sea lions are *Phocarctos bookeri* formerly called Hookers sea lions.

Potential Biological Removal (PBR) “(20) *The term ‘potential biological removal level’ means the maximum number of animals, not including natural mortality, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The potential biological removal level is the product of the following factors:*

- (A) *The minimum population estimate of the stock.*
- (B) *One-half of the maximum theoretical or estimated net productivity rate of the stock at a small population size.*
- (C) *A recovery factor of between 0.1 and 1.0.”* quoted from the *US Marine Mammal Protection Act* in (Wade 1998).

R_{\max} is the maximum net rate of population increase at small population sizes (Wade 1998).

The Series “300” rules are: “...Rule 310, where “3” denoted the Wade rule family and “10” denoted a rule giving 1.0 times the bycatch from the New Zealand Wade rule. Variants are generated by changing n. When n is 0.5, this rule gives half the bycatch limit of rule 310 for any input, and is named Rule 305. When n is 2, the rule gives by catch limits twice as great as Rule 310; it is named Rule 320, and so on.” (Breen 2006)

SQU6T is the Squid fishery in quota management area 6T (see Figure 1).

λ is the mathematical symbol used for the population’s maximum annual rate of increase (Breen and Kim 2005b).

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