Ministry for Primary Industries
Manatū Ahu Matua

Squid 6T Operational Plan

Decision Document

December 2017

ISSN: 978-1-77665-751-3 (online)

New Zealand Government

Growing and Protecting New Zealand

Contents

Executive Summary

1. The New Zealand sea lion is one of the rarest sea lions in the world with a current estimated population of around 11,800 individuals. The commercial southern squid trawl fishery (SQU6T) overlaps with the foraging range of sea lions that breed at the Auckland Islands. This can lead to the incidental capture of sea lions in fishing gear.

2. A combination of regulatory and non-regulatory measures have been employed to manage interactions between the SQU6T fishery and sea lions since 1991. In recent years these have been set out in an 'Operational Plan to Manage the Incidental Capture of New Zealand sea lions in the Southern Squid Trawl Fishery (SQU6T)'. The 2016/17 Operational Plan expired on 30 September 2017.

3. The main regulated measure in the Operational Plan was a Fishing-Related Mortality Limit (FRML), set by the Minister of Fisheries, after consultation with the Minister of Conservation, under section 15 of the Fisheries Act 1996. The FRML defined the maximum number of sea lion mortalities that could occur in the fishery before it was closed.

4. Sea Lion Exclusion Devices (SLED) have been deployed by all vessels in the fishery to allow sea lions to escape from trawl gear. It is therefore not possible to directly count mortalities that occur in the fishery. To monitor the number of mortalities against the FRML, mortalities are assumed based on two parameters:

    - The 'Strike Rate', which approximates the assumed rate of sea lion 'interactions' that would be fatal in the absence of SLEDs; and

    - The 'Discount Rate', a management setting intended to reflect the probability that, in an interaction with fishing gear equipped with an approved SLED, a sea lion will escape from the net via the SLED and subsequently survive.

5. Simply put, with full deployment of SLEDs, the estimated mortality with respect to the FRML is a function of the number of tows in the fishery. Past Operational Plans have also included a range of non-regulated notification and reporting requirements that enabled MPI to monitor progress against the FRML. Other components have included a trigger for early review of the Operational Plan, a commitment to a minimum level of MPI Observer coverage in the fishery, and the process to close the fishery should the FRML be reached.

6. A review and update of management settings in the Operational Plan is included as an action in the 'New Zealand sea lion/rāpoka Threat Management Plan' (TMP). The TMP provides a framework for sea lion research and management of threats to sea lions. Initial discussions on Operational Plan management settings and content was undertaken by the inaugural meeting of the multi-stakeholder Squid 6T Operational Plan Technical Advisory Group (TAG) in June 2017.

7. MPI subsequently consulted publically on proposed options for management settings in a new Operational Plan in August 2017. The proposed Operational Plan would follow the same structure and content of previous Operational Plans. A total of 1,569 submissions were received, 1,553 of which were generated from an online submission set up by World Wildlife Fund New Zealand. Key issues covered by submitters included the uncertainties

associated with the data and models informing management settings and the resulting level of precaution considered appropriate.

8. MPI notes that you have broad discretion in exercising your powers of decision-making, and may make your own independent assessment of the information presented when making your decision. You are not bound to choose the option recommended to you, but you will need to take into account your statutory obligations when making any decision.

Purpose

9. This document provides you with MPI's final advice on measures to manage incidental captures of New Zealand sea lions in the SQU6T fishery.

10. Your decisions will apply for the SQU6T fishery from January 2018.

11. MPI has consulted on your behalf on the key management setting options in Table 1.

Table 1: Key management setting options consulted on

Fishing-related mortality limit	
Option	Proposed setting
1 – Status Quo	68
2	38

Strike Rate (per 100 tows)	
Option	Proposed setting
1 – Status Quo	5.89
2	4.78
3	6.34
4	5.89*
5	7.58

Discount Rate	
Option	Proposed setting
1 – Status Quo	82%
2	75%
3	50%

* Option 4 for Strike Rate would result in the same Strike Rate as the status quo, however it is based on a distinct rationale and is therefore proposed as a separate option.

12. MPI also consulted on additional components which may be included as part of the Operational Plan as in previous years. Detail on these can be found in the Public Consultation section of this document.

13. The Department of Conservation was provided with a draft of this advice paper and its comments have been incorporated.

14. A summary of key issues raised by submitters is provided below and the full submissions are included as Appendix 1.

Background

NEW ZEALAND SEA LION

15. The New Zealand sea lion (rāpoka) is an endemic, protected species that is a taonga for tangata whenua. New Zealand sea lions have been protected since 1894 when hunting of sea lions was prohibited. As a result of hunting prior to 1894, the breeding distribution is now concentrated in the subantarctic islands with around 98% of annual pup production coming from Auckland and Campbell Islands. The New Zealand sea lion is currently categorised as a threatened species under section 2(3) of the Marine Mammals Act 1978.

16. New Zealand sea lions were classified by the Department of Conservation (DOC) in 2010 as 'Nationally Critical' under the New Zealand Threat Classification System. This was based on their population size, the observed decline in pup production at the main breeding sites on the Auckland Islands and the limited number of breeding sites.

17. The New Zealand sea lion population is monitored using pup counts to estimate pup production, which in turn then provides an index of total population size. A total species population estimate of 11,800 New Zealand sea lions (including pups) was generated in 2014/15.[1]

18. Pup counts at the Auckland Islands have been completed annually for over 20 years. Pup production declined by 50% between 1998 and 2009 but appears to have stabilised over the last eight years (Figure 1). Pup numbers appear to be increasing at the three other main breeding sites.

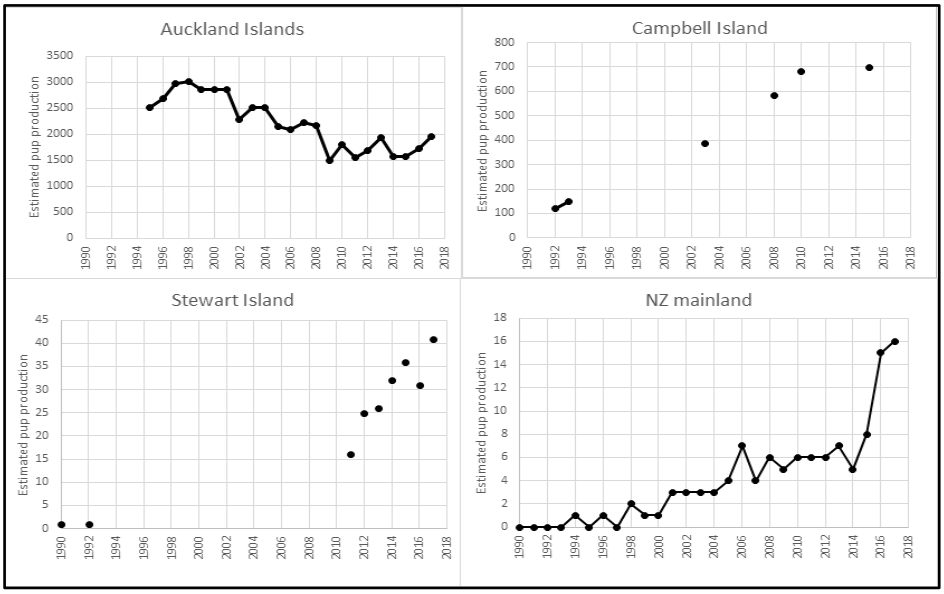

Figure 1: Sea lion pup count estimates from each breeding site. Note that the scale for each figure is different. Trendlines are not included for Campbell and Stewart islands as count methodology has changed and counts are not necessarily comparable. (Adapted from Roberts and Doonan, 2016, and updated with the most recent pup counts from 2016 and 2017).

COMMERCIAL FISHERIES

19. The Minister of Fisheries excluded all commercial fishing activity from the Territorial sea at the Auckland Islands (out to a distance of 12 nautical miles) in 1982. The exclusion zone was replaced by a Marine Mammal Sanctuary in 1995 and designated as a Marine Reserve in 2003.

20. Sea lions forage beyond 12 nautical miles from shore, meaning there is an overlap between foraging adult sea lions and commercial fisheries.

21. The two main deepwater commercial fisheries that occur in this area target squid (SQU6T) and scampi (SCI6A). The decisions in this paper relate to management measures for the SQU6T fishery.

Squid (SQU6T)

22. The southern squid trawl fishery (SQU6T) targets arrow squid around the Auckland Islands from January to June each year (Figure 2). Arrow squid are short lived and their

[1] Roberts, J.; Doonan, I. (2016). Quantitative Risk Assessment of Threats to New Zealand Sea Lions. *New Zealand Aquatic Environment and Biodiversity Report No. 166*. 111 p

biomass is highly variable between years, which drives variation in the level of fishing effort each year.

23. The total allowable commercial catch for SQU6T since 1992/93 is 32,369 tonnes, although landings have not reached this level since 2004. In the last 10 years to 2015/16, the average annual catch has been 16,464 tonnes, ranging from 6,127 to 28,872 tonnes. The estimated export value of SQU6T in the 2016 calendar year was $68 million.

24. The number of vessels participating in the SQU6T fishery has declined over time, from 63 vessels in 1990 to 20 in 2017. In 2016/17, 1,294 trawl tows targeted squid in the SQU6T fishery.

25. In the last five years up to 2016/17, there have been nine observed sea lion captures in SQU6T. When the management settings (Strike Rate of 5.89 and Discount Rate of 82%) from the previous Operational Plan are applied, the total captures over the five year period are assumed to be 54 sea lions. Over the same period, an average of 84% of tows were observed annually by MPI Observers.

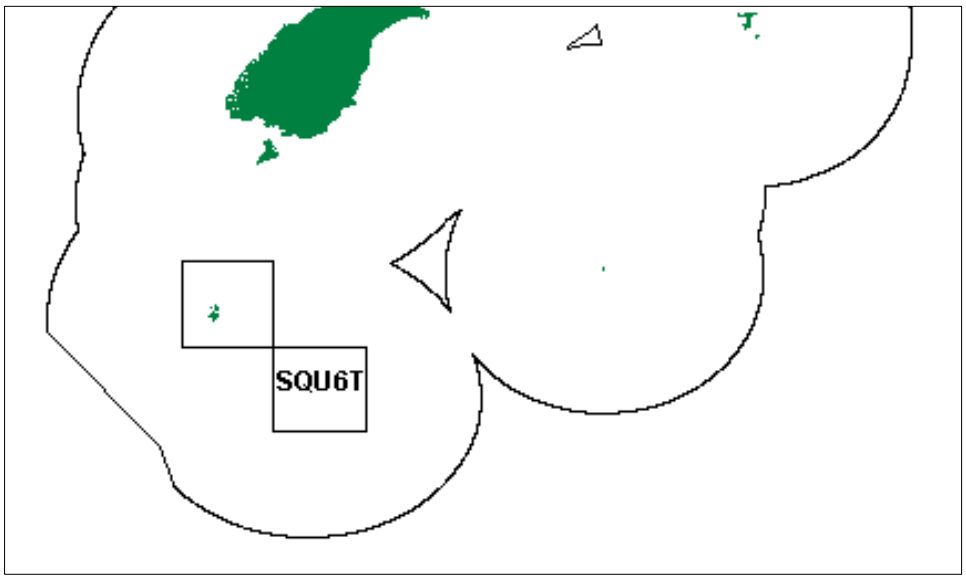

Figure 2: Quota Management Area SQU6T

Scampi (SCI6A) and other fisheries

26. The trawl fishery for scampi around the Auckland Islands (SCI6A) operates nearly year-round, however the most effort is generally in November and April-June. Interactions with sea lions have previously been reported (2 observed captures since 2006/07). While no captures have been observed in over five years, observer coverage in the scampi fishery is generally low. Exports from SCI6A were estimated to be worth $7.7 million in the 2016 calendar year.[2]

27. In the 10-year period to 2014/15, three sea lion captures were observed in scampi and other commercial trawl fisheries around the Auckland Islands (excluding SQU6T). An average of 10.9% of tows were observed annually over this period and modelling estimates that seven sea lions are killed annually in scampi and other trawl fisheries, excluding squid, around the Auckland Islands (Abraham and Berkenbusch, in prep.).[3]

[2] Based on export figures for 2016 calendar year of $29.25/kg. Precise revenue is difficult to estimate and will be influenced by factors such as commodity prices, exchange rate, catching costs and export state.
[3] Abraham, E.R. and Berkenbusch, K. in prep. Estimated captures of New Zealand fur seal, New Zealand sea lion, common dolphin, and turtles in New Zealand trawl and longline fisheries, 1995-96 to 2014-15

MPI is planning to develop a fishery-specific approach to understanding and management of sea lion interactions with the SCI6A fishery in 2018/19.

Statutory Considerations

MARINE MAMMALS PROTECTION ACT 1978

28. The New Zealand sea lion is categorised as a threatened species under section 2(3) of the Marine Mammals Protection Act 1978.

29. Section 3E provides the opportunity for the Minister of Conservation to approve a population management plan (PMP) for New Zealand sea lions. A PMP may contain an assessment of known fisheries interactions with sea lions, an assessment of the risk caused by fishing-related mortality and can also be used to set a maximum allowable level of fishing-related mortality.

30. There is no PMP currently in place for New Zealand sea lions, so interactions between sea lions and the SQU6T fishery are managed under the protected species provisions of the Fisheries Act 1996.

FISHERIES ACT 1996

31. Statutory considerations relevant to your decision are detailed below.

Section 5(a) – International Obligations

32. Section 5(a) says the Act is to be interpreted, and all persons exercising or performing functions, duties, or powers under it are required to act, in a manner consistent with New Zealand's international obligations relating to fishing. As a general principle, where there is a choice in the interpretation of the Act or the exercise of discretion, the decision maker must choose the option that is consistent with New Zealand's international obligations relating to fishing.

33. International obligations relevant to the management of sea lion interactions derive from New Zealand being a signatory to a number of international agreements and commitments, including: the United Nations Convention on Biological Diversity 1992; the United Nations Food and Agriculture Organisation Code of Conduct on Responsible Fisheries 1995; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the Convention on Migratory Species; and the Convention on the Conservation of Antarctic Marine Living Resources.

Section 5(b) – Treaty of Waitangi (Fisheries Claims) Settlement Act 1992

34. Section 5(b) says the Act is to be interpreted, and all persons exercising or performing functions, duties, or powers under it are required to act, in a manner consistent with the provisions of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 (the Settlement Act).

Section 8 – Purpose

35. The purpose of the Fisheries Act 1996 (the Act) is to provide for the utilisation of fisheries resources while ensuring sustainability. For the purpose of the Act:

    - Ensuring sustainability means:

i. Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and

ii. Avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment

- Utilisation means conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural well-being.

Section 9 – Environmental Principles

36. Section 9 of the Fisheries Act 1996 sets out environmental principles which any person exercising or performing functions, duties, or powers under the Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account. The principles are:

a) associated or dependent species should be maintained above a level that ensures their long-term viability:

b) biological diversity of the aquatic environment should be maintained:

c) habitats of particular significance for fisheries management should be protected.

Section 10 – Information Principles

37. Section 10 of the Act sets out information principles which any person exercising or performing functions, duties, or powers under the Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account. The principles are:

a) decisions should be based on the best available information:

b) decision makers should consider any uncertainty in the information available in any case:

c) decision makers should be cautious when information is uncertain, unreliable, or inadequate:

d) the absence of, or any uncertainty in, any information should not be used as a reason for postponing or failing to take any measure to achieve the purpose of this Act.

38. Specifically, you should be mindful of the best available information and associated uncertainties that surround the information that supports key management settings, including the fishing-related mortality limit, the Strike Rate, and the Discount Rate.

Section 11 and 11A – Sustainability measures and Fisheries Plans

39. Section 11 of the Act stipulates a number of matters you must take into account when making decisions on sustainability measures (including decisions under section 15 of the Act). These include taking into account any relevant fisheries plan approved under section 11A.

40. A *National Fisheries Plan for Deepwater and Middle-depth Fisheries* was approved by the Minister of Fisheries in 2010. However, this plan has reached the end of its five-year timeframe, and a revised plan is being finalised but has not yet been approved under section 11A.

Section 15 – Fishing related mortality of marine mammals or other wildlife

41. Your responsibilities for managing the fishing-related mortality of marine mammals or other wildlife are set out in Section 15 of the Act. Section 15(2) states that, in the absence of a PMP, you may, after consultation with the Minister of Conservation, take such measures as you consider are necessary to avoid, remedy or mitigate the effect of fishing-related mortality on any protected species, and such measures may include setting a 'Fishing Related Mortality Limit' (FRML).

42. If the FRML is reached, the fishery may be closed via Gazette notice in accordance with section 15(5) of the Act.

CASE LAW

43. In 2004 the fishing industry sought judicial review of the Minister's decision to set a FRML of 62 sea lions (including a strike rate of 5.3 and a SLED discount rate of 20%).[4] The Court Of Appeal set-aside the 2003-2004 Operational Plan and the FRML was increased to 124 for that season. In doing so, the Court emphasised that section 15(2) of the Act only authorises measures that are "necessary" to avoid, remedy or mitigate the effect of fishing-related mortality on the sea lion population and stated:

> [7] "Fishing related mortality" refers only to the death of sea lions in the course of fishing activity. It does not extend to impacts on the sea lion population associated with, for instance, competition for squid. Further, what is important is the impact of fishing on the sea lion population as a whole and the section does not provide for measures aimed simply at eliminating or reducing individual deaths."

44. Further, this assessment should be guided by the purpose and principles of the Fisheries Act and the Court commented that the Minister was required to balance utilisation objectives and conservation values, and in the context of a harvestable species. This requires utilisation to the extent that it is sustainable.[5]

45. In recognising this the court stated:

> [77]"The point of the exercise is not to arrive at a number of sea lions which can be harvested sustainably, and thinking associated with sustainability of a harvestable species is not appropriate."

46. Given the underlying uncertainties involved, the Court noted that any FRML chosen is likely to carry some degree of risk to sea lions and that optimum usage does not equate to maximum usage. There is no simple method by which risk can be balanced against utilisation advantages and that a precautionary approach to the required balancing exercise is open to the Minister. The Court also commented that a value judgement was called for and the Court was satisfied that the legislative framework required the Minister to form a view as to the extent to which (or perhaps the point at which) utilisation of the squid SQU6T resource threatened the sustainability of the sea lion population and the Minister may only take measures which he considers necessary in terms of avoiding, remedying or mitigating adverse effects of fishing on a protected species.

[4] Squid Fishery Management Company Limited v Minister Of Fisheries and Chief Executive of Ministry Of Fisheries, CA 39/04
[5] Ibid

Management Context

NEW ZEALAND SEA LION POPULATION MODEL AND RISK ASSESSMENT

47. Your decisions on management measures for the SQU6T fishery are informed by updated population modelling information that has been developed in support or the Threat Management Plan (TMP) for New Zealand sea lions. The new information includes a new demographic population model, and a quantitative multi-threat risk assessment of both fishery and non-fishery threats.

48. Both the demographic population model and quantitative multi-threat risk assessment have been peer-reviewed by the DOC Conservation Services Programme Technical Working Group, the MPI Aquatic Environment Working Group, and by an independent panel of international marine mammal experts at two expert workshops held during the development of the TMP, all of whom endorsed the model and risk assessment methods and outputs.

Demographic Population Model

49. The new integrated Bayesian demographic population model for sea lions at the Auckland Islands incorporates all data collected from the Auckland Islands sea lion population between 1991 and 2015. The available data, including pup count data, age distribution data from lactating females, and tag-resight/recapture data, informs estimates of critical demographic rates of the population (including estimates of survival for different ages and probability of pupping).

50. The model structure allows the underlying demographic rates responsible for the observed population decline to be identified. The results indicate that the observed population decline since 2000 is a consequence of both low pup survival and low adult survival. Low pup survival has also been confirmed by direct observations of the population. Field teams completing the annual pup count record pup mortalities observed, and have noted years with high pup mortality, considered to be the result of the disease *Klebsiella pneumoniae*.

51. Low pup survival is important in that the apparent levels of pup mortality are far higher than could be explained as a consequence of impacts on lactating mothers that may interact with or be captured in the SQU6T fishery.

52. The demographic model was updated in June 2017 to include the two most recent years of pup count data (January 2016 and 2017 counts). Pup production has increased slightly in recent years, and outputs of the updated model suggest that the population may be stabilising. Greater certainty regarding the population trend will be achieved via inclusion of two additional years of tag resight/recapture data; this work is planned to be completed in mid-late 2018.

Alternative population model

53. The TMP expert workshops also considered an alternative population model for the Auckland Islands sea lion population developed by researchers at the University of Otago.

54. Experts considered this model provided largely similar outputs to the NIWA-developed model, but was too simple to accurately reflect the complexities of the Auckland Island sea lion population dynamics. They therefore agreed that the NIWA-developed model should continue to be used as a tool for developing management options.

Risk Assessment

55. A key piece of work that underpins conservation of New Zealand sea lions is the quantitative risk assessment of threats to New Zealand sea lions. The demographic population model was used to inform a multi-threat risk assessment which evaluated the likely impacts of eliminating the effects of each identified threat on the affected population.

56. To assess the impact that each threat has on the sea lion population, the marine mammal experts at the TMP workshops identified all threats that are known to impact each breeding colony. This included both fishing and non-fishing related threats. The independent expert panel quantified the level of sea lion mortality caused by each threat at each colony, using the data available.

57. The upper bounds of the mortality estimates were used to screen out threats that had little effect on projected population growth rate. The impacts of the remaining threats were evaluated in more detail using 'best-estimates' as agreed by the first TMP expert workshop.

58. For the Auckland Islands population, detailed threat evaluations were completed for:

- *Klebsiella pneumoniae*-related mortality of pups (disease);
- trophic effects (food or nutritional limitation);
- direct fishing-related mortality;
- pups drowning in holes;
- male aggression; and
- hookworm mortality.

59. When mortality from each threat was individually removed and the resulting population trajectory was compared with baseline projections with all threats included, only three threats were estimated to change the expected population growth rate by more than 1 % in 20 years' time. Of those three, there was only one threat, *Klebsiella pneumoniae*, for which elimination of the threat in isolation was likely to result in a positive population growth rate.

60. Direct fishing-related mortality was estimated to have changed the population growth rate by more than 1% only when modelled using implausibly pessimistic estimates of cryptic mortality (e.g. assuming every interaction results in mortality even when the sea lion successfully exits the net). Removing fishing-related mortality at this level did not result in an increasing population trend. Projections using a more realistic estimate of cryptic mortality indicate that eliminating direct fisheries mortality would result in less than half of one percentage improvement in the population growth rate.

Population Sustainability Threshold

61. New Zealand is implementing a risk-based framework for managing impacts of fisheries on the aquatic environment. This framework includes calculating a 'population sustainability threshold' (PST) to identify where fishing may be having an adverse impact on a non-target population. The PST is an estimate of the maximum number of annual human-induced mortalities that can occur while still allowing the population to achieve a defined population outcome.

62. Generally a PST is defined with reference to a defined population recovery or stabilisation outcome, with a specified level of certainty (e.g. 'the population will recover to or stabilise at an equilibrium level no more than X% lower than would occur in the absence of human caused mortality, with Y% certainty'). Where the population is projected to decline due to natural demographic rates even in the absence of fisheries mortality (as is the case for sea lions), the reference population outcome is defined as a percent change in population status relative to that which would occur in the absence of human-caused mortality.

63. The demographic model for New Zealand sea lions at the Auckland Islands was used to generate PST estimates corresponding to a range of population outcomes based on recommendations of the Squid 6T Operational Plan Technical Advisory Group. In every instance, the PST reflects a population outcome at a defined proportion of what the population would otherwise be (in the absence of human-caused mortality), with 90% certainty, within a defined timeframe.

64. The concept of the Population Sustainability Threshold was reviewed by an independent expert panel in early 2017 as part of the review of the Spatially Explicit Fisheries Risk Assessment approach and was considered appropriate for use in informing management.[6]

NEW ZEALAND SEA LION/RAPOKA THREAT MANAGEMENT PLAN

65. The New Zealand sea lion/rāpoka Threat Management Plan (TMP) provides the over-arching framework for sea lion threat management and research over the next five years. The TMP was published by the Department of Conservation and Ministry for Primary Industries in 2017 following a collaborative process that included engagement across all key stakeholders[7] on the vision, objectives and management priorities. The vision of the TMP is to:

> *'promote the recovery and ensure the long-term viability of New Zealand sea lions, with the ultimate goal of achieving 'Not Threatened' status.'*[8]

66. The objectives of the TMP are to:

    1. Halt the decline of the New Zealand sea lion population within five years; and
    2. Ensure the New Zealand sea lion population is stable or increasing within 20 years, with the ultimate goal of achieving 'Not Threatened' status.

67. To achieve this, a five-year strategic programme of work is set out, consisting of four work streams: Engagement; Direct Mitigation; Targeted Research; Evaluation. The actions include population level initiatives and site-specific actions for mitigating all main threats at the four breeding sites.

68. The population modelling and risk assessment that supported the development of the TMP (detailed above) shows that the direct impacts of fishing alone are not the major cause of the observed population change at the Auckland Islands. It was considered a requirement that the TMP take a holistic approach to management, and addresses a number of key threats to the population.

[6] Lonergan, M.E., Phillips, R.A., Thomson, R.B., Zhou, S. 2017. Independent review of New Zealand's Spatially Explicit Fisheries Risk Assessment approach – 2017. New Zealand Fisheries Science Review 2017/2.
[7] Stakeholder engagement on the development of the TMP included representatives of iwi, environmental groups, the fishing industry, local councils, and sea lion interest groups.
[8] To achieve 'Not Threatened' status, the overall population trend needs to stabilise, the number of mature individuals be over 20,000, and more than the two current populations/breeding colonies (Auckland Islands and Campbell Island)

69. In relation to managing interactions with commercial fishing, for the Auckland Islands in particular, the TMP included a specific action for the establishment of a Squid 6T Operational Plan Technical Advisory Group (see paragraphs 99-105) to contribute to the review and development of the January 2018 Operational Plan.

70. In addition, the TMP includes focal areas for Targeted Research, which include research to better understand sea lion interactions with fishing effort, and examination of SLED efficacy to better inform estimates of cryptic mortality in fisheries that deploy SLEDs. MPI is progressing some of this work in 2017/18 and some in 2018/19, engaging with the Technical Advisory Group throughout the planning and prioritisation processes.

SQU6T OPERATIONAL PLAN

71. The past management approach for interactions of sea lions with the SQU6T fishery has been to set a fishing-related mortality limit (FRML) for New Zealand sea lions taken in the SQU6T fishery which, if reached, would result in the closure of the fishery.

72. SLEDs are deployed in the fishery to allow sea lions to escape from trawl gear during tows. It is therefore not possible to directly count sea lion interactions with fishing gear. Monitoring the number of sea lion mortalities against the FRML has therefore been based on an approximation of fatal interactions between squid fishing effort and sea lions, estimated on a per tow basis, without reference to the actual number of observed captures. Actual observed or reported sea lion captures are not relevant to this management approach.

73. Performance against the FRML each year has been determined by accompanying management settings (Strike Rate and Discount Rate) which, in combination, assume a number of sea lion mortalities per tow in the SQU6T fishery, resulting in a limit on effort in the fishery.

74. The conservation benefits obtained from applying these parameters need to be balanced against the utilisation objectives for the fishery, in line with the purpose of the Fisheries Act 1996 which is to provide for utilisation while ensuring sustainability.

75. It is proposed that the new Operational Plan maintain the structure and content of previous Operational Plans. As a result, the recommended Operational Plan would set the FRML, Strike Rate, Discount Rate, and other measures to manage interactions with New Zealand sea lions and the SQU6T fishery, detailing:

- Notification requirements;
- Reporting requirements;
- A trigger point;
- Observer coverage; and
- A fishery closure process.

Fishing Related Mortality Limit (FRML) and Management Criteria

76. The FRML defines the maximum number of sea lion mortalities that may occur in the fishery before it is closed.

77. The FRML is intended to ensure that fishing does not have an adverse impact on the Auckland Islands sea lion population. From 2003 to 2016, an adverse impact, for the

purposes of setting the FRML, was defined as the level of fishing related mortality that would allow the population to meet agreed management criteria. The management criteria was that direct mortality from the squid trawl fishery would not have more than a 10% impact on the Auckland Islands sea lion population. Specifically, fishing mortality could not cause the population to be less than 90% of carrying capacity, or more than 10% lower than the population size that would have been attained in the absence of fishing, with 90% certainty over 20 years.

78. The new demographic population model does not estimate or apply a carrying capacity. In addition, in recognition of environmental factors that can affect sea lion populations on a decadal scale, it is no longer considered appropriate to use projections beyond a 5-year time horizon to inform management. For these reasons, MPI discussions with the Squid 6T Technical Advisory Group and consultation on options for the FRML were based on revised management criteria for what could be considered an 'adverse effect' on the sea lion population.

79. These criteria, the 'allowable' impact of the fishery on the sea lion population, represent a value judgement of what impact is considered to be acceptable, taking into consideration the status of the population, the views of stakeholders, and the impact on utilisation of the fishery.

Sea Lion Exclusion Devices (SLEDs)

80. Sea Lion Exclusion Devices (SLEDs) are designed to guide actively swimming sea lions to an escape hole to exit the trawl net. SLEDs were adopted by the SQU6T fleet gradually between 2000 and 2007. Over this time, the design of SLEDs was regularly adjusted to improve performance but has been standardised since 2007 when the 'Mark 3/13' design was agreed on and since been used (Appendix 2).

81. The use of SLEDs is not regulated; however, under the Operational Plan, all vessel operators that intend to fish for squid in SQU6T have agreed to deploy SLEDs on all tows. Tows without a SLED are not subject to the Discount Rate i.e. it is assumed that all sea lions captured in the net will die. Vessels have carried at least two SLEDs on every trip to SQU6T, which are inspected at the start of every season by a registered net manufacturer to ensure they meet the specifications. MPI Observers on vessels in the SQU6T fishery have also audited SLED specifications, confirmed that SLEDs are in good working order and were being deployed in the correct manner (average of 84% observer coverage).

82. In the last five years, every vessel fishing in SQU6T has complied with the Operational Plan and deployed a SLED on every tow.

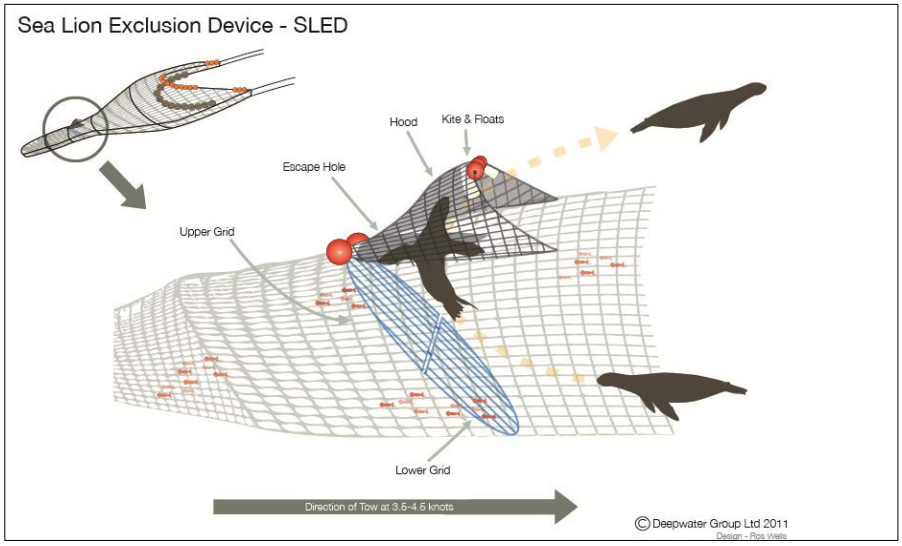

Figure 3: Diagram of a SLED (Source: Deepwater Group Ltd)

83. MPI notes that after the public consultation period, a paper was published in the Proceedings of the National Academy of Sciences Journal (US-based)[9] which concluded that the use of exclusion devices in SQU6T obscures rather than alleviates fishery impacts on New Zealand sea lions. This article has been reviewed against the Research and Science Information Standard for New Zealand Fisheries and graded as a 3, meaning it should not be used to inform management advice (Appendix 3).

Strike Rate

84. 'Strike Rate' is a management setting used to approximate the assumed rate of sea lion 'interactions' (interaction rate) with fishing gear that would be fatal in the absence of SLEDs. The Strike Rate represents the number of sea lion mortalities that would occur per 100 tows if no SLEDs were deployed.

85. Before the introduction of SLEDs all 'interactions' resulted in a sea lion capture, which could be counted by an independent observer if they were on board. Observed capture data from the early years of the fishery is therefore very important in the estimation of the interaction rate.

86. Since the introduction of SLEDs, there is no empirical data to inform estimates of interaction rate because sea lions entering the net and successfully exiting via the SLED cannot currently be observed. As a result, estimates of interaction rate have become less precise and less stable over time due to an increasing proportion of the data coming from years in which all vessels are utilising SLEDs.

Discount Rate

87. The 'Discount Rate' is a management setting intended to reflect the probability that, in an interaction with fishing gear equipped with a SLED, a sea lion will escape from the net via the SLED and will subsequently survive. The Discount Rate is applied as a proportional reduction in Strike Rate for tows where a SLED has been deployed and

[9] Meyer et al. (2017). Marine mammal population decline linked to obscured by-catch. PNAS 114(44)11781-11786

vessel operators have complied with the notification and reporting requirements set out in the Operational Plan.

88. To understand uncertainty in factors affecting the Discount Rate, it is useful to distinguish between the possible fates of animals interacting with a trawl net (with SLED). The sea lion may:

    a) successfully escape the net via the SLED, and survive (survivor);

    b) drown in the net despite the presence of a SLED, and be retained in the trawl gear (observable capture); or

    c) exit the net via the SLED but nonetheless die as a consequence of the interaction (cryptic mortality).

89. Possible causes of cryptic mortality include:

    i. the sea lion suffers 'mild traumatic brain injury'(MTBI) due to interaction with the SLED, and either drowns before reaching the surface or otherwise dies of its injuries after exiting via the SLED;

    ii. the sea lion dies in the net but the body is subsequently lost via the SLED prior to retrieval (body non-retention); and

    iii. the sea lion escapes via the SLED but drowns before reaching the surface (post-escape drowning).

90. Cryptic mortality is, by definition, difficult to quantify as it occurs out of sight during fishing activity, or, in the case of post-escape drowning, after the fishing activity is complete.

91. MPI has invested considerable resources to estimate the likelihood of mild traumatic brain injury. Extensive 'crash-test dummy' modelling suggests that mortality from mild traumatic brain injury will be very low (around 3% of interactions, range 1%-8%).

92. The other two causes of cryptic mortality are currently less well understood.

93. MPI considers that while there is limited empirical evidence to quantify body non-retention, it is considered likely to be relatively low based on several factors including:

    - Dead sea lions are considered to be negatively buoyant, meaning they are unlikely to float upwards and out of a SLED;

    - Preliminary information from a study currently underway in Australia, where video footage from Australian fur seal interactions with their hoki fishery that deploys identical bycatch mitigation devices is currently being analysed. The preliminary indications are that marine mammal non-retention is very low, if not negligible.

94. The Discount Rate is currently calculated based on the estimated exit probability (the inverse of the estimated retention rate) adjusted for an estimate of cryptic mortality.

95. MPI is not aware of any current methodology available to quantify post-escape drowning, but it is judged unlikely to be significant based on camera observations of sea lion behaviour in SLEDs, and known sea lion physiological characteristics including breath holding capacity and swimming speed (to return to the surface).

96. MPI has committed to working with the Squid 6T Operational Plan Technical Advisory Group to progress research to reduce uncertainty in the information used to estimate cryptic mortality.

Interaction of Strike Rate and Discount Rate

97. Estimates of the interaction rate and resulting captures have been updated annually by MPI using a Bayesian model, as a function of multiple variables (e.g. distance from sea lion colony and tow duration). In the model, interaction rate is estimated by assuming that the actual observed captures (those brought up on deck) are the result of the number of interactions (interaction rate) multiplied by the probability that an interaction results in an observable capture (SLED retention rate, which is a component of the Discount Rate).

98. This means that the estimation of the interaction rate and the SLED retention rate are interdependent and the model cannot distinguish between a situation with a high interaction rate and low retention rate and one with a low interaction rate and high retention rate. Because of the statistical uncertainty around the estimates of interaction rate and retention rate, the model can estimate interaction rates that are implausible if combined with some values of retention rate (i.e. some combinations result in mortality estimates that are impossible given the known population trajectory of Auckland Island sea lions).

99. For this reason, management settings for Strike Rate and Discount Rate should be considered together, as some combinations of these management settings are implausible.

SQUID 6T OPERATIONAL PLAN TECHNICAL ADVISORY GROUP

100. The purpose of the Technical Advisory Group is to provide advice and recommendations to MPI on:

- Management settings and content of the current Operational Plan (2016/17) in preparation for the 2017/18 Operational Plan
- Updated 'population objective' (management) criteria for future Operational Plans
- If Strike Rate and Discount Rate remain key components of future Operational Plans:
  - Information gaps/research needs to better inform setting of Strike Rate; and
  - Information gaps/research needs to better inform setting of the Discount Rate (focused on understanding SLED non-retention)

101. MPI established the Squid 6T Operational Plan Technical Advisory Group (TAG) and held the first meeting on 14 and 15 June 2017. The TAG was attended by:

- MPI and DOC
- Iwi - Due to availability issues, iwi were represented at the first meeting of the TAG by Te Ohu Kaimoana. Wider representation is expected for future meetings
- Environmental group representatives – World Wildlife Fund, Forest & Bird, and ECO
- Fishing industry representatives – Deepwater Group Ltd, Seafood NZ
- Four independent experts/advisers invited by MPI based on recommendations from stakeholders and internal knowledge.

102. The TAG was chaired by Dr Neil Gilbert from Constantia Consulting Ltd, who also chaired the New Zealand Sea Lion Forum and Advisory Groups set up under the TMP.

103. The TAG discussed the key management settings of the Operational Plan and relevant research, both projects underway and potential future work. The TAG also made a number of general recommendations and short/long term recommendations on the management settings.

104. Specifically, the TAG recommended that options for the FRML be provided to reflect updated management criteria of fishing being allowed to have no more than a 10%, 5%, and 2% impact on the Auckland Islands sea lion population.

105. MPI proposed options for the FRML for the status quo and for a 5% impact on the population. This was presented as the midpoint of the defined population outcomes suggested by the TAG, and stakeholder views were requested as to how 'adverse effects' should be defined with regards to providing for the utilisation of fisheries resources while ensuring sustainability.

106. The recommendations of the Group are attached (Appendix 4), and are reflected in the following sections that describe the options proposed in the public consultation process.

Public Consultation

107. Consultation on options for management settings for the Squid 6T Operational Plan took place between 8 August 2017 and 7 September 2017. A consultation document setting out MPI's initial position on management measures was posted on the MPI website. In addition, a press release about the consultation was made, and MPI directly contacted members of the TAG including Ngai Tahu, all SQU6T quota owners, commercial iwi interests and environmental groups to notify them of the consultation.

108. The proposed options for three key management settings; the FRML, the Strike Rate and the Discount Rate are summarised in Table 2.

Table 2: Proposed options for key management settings as consulted on

Fishing-related mortality limit	
Option	Proposed setting
1 – Status Quo	68
2	38

Strike Rate (per 100 tows)	
Option	Proposed setting
1 – Status Quo	5.89
2	4.78
3	6.34
4	5.89*
5	7.58

Discount Rate	
Option	Proposed setting
1 – Status Quo	82%
2	75%
3	50%

* Option 4 for Strike Rate would result in the same Strike Rate as the status quo, however it is based on a distinct rationale and is therefore proposed as a separate option.

109. Other aspects of the plan consulted on included:

- A proposed 2-year duration for the Operational Plan – the Operational Plan would apply for the 2017/18 and 2018/19 fishing years and be reviewed in 2019.

- Notification requirements – 72 hours' notice prior to entering SQU6T required to allow for placement of an MPI Observer as required and to facilitate monitoring of vessel activity and tows in the fishery. Tows completed by any vessel that does not give notice are not eligible for the Discount Rate.

- Reporting requirements – vessel operators report weekly to MPI to allow for tracking of assumed mortalities against the FRML. If 80% of the FRML is reached, reporting must be completed daily. Tows which are not reported per the reporting requirements are not eligible for the Discount Rate.
- A trigger point for a review of the Operational Plan in advance of 2019, if significant new information becomes available (e.g., significantly low pup count in January 2018, or major changes in fishing operations or level of effort).
- Observer coverage – MPI commits to a minimum observer coverage of 50% of tows observed. MPI Observers audit SLED measurements and observe all hauls while they are on board vessels fishing in SQU6T.
- Fishery closure process – If the FRML is reached, the SQU6T fishery will be closed without consultation via gazette notice. MPI will continue to provide weekly updates to interested stakeholders providing information on fishing effort, observer coverage, and notification of any sea lion captures.

SUBMISSIONS RECEIVED

110. 1,569 submissions were received, of which 1,553 were generated from an online form provided by WWF New Zealand to allow members of the public to more conveniently make submissions. Seventy three of these submissions included personalised messages supporting the content of the template submission, although the technical content of the submission remained the same.

111. In addition, 16 individual submissions were received from the following individuals or organisations:

Associate Professor Bruce C. Robertson, University of Otago (Dr Bruce Robertson)	Royal New Zealand Society for the Prevention of Cruelty to Animals Inc. (RNZSPCA)
Deepwater Group Ltd (DWG)	The Royal Forest and Bird Protection Society of New Zealand Inc. (Forest & Bird)
Environment and Conservation Organisations of NZ (ECO)	Shaun McConkey, Science Advisor to NZ Sea Lion Trust (Shaun McConkey)
Gail Powell	Dr Stefan Meyer
New Zealand Sea Lion Trust (NZSLT)	Southland Conservation Board (SCB)
Otago Conservation Board (OCB)	Te Ohu Kaimoana (TOKM)
Paige H	Te Rūnanga o Ngāi Tahu (Ngāi Tahu)
Project Jonah New Zealand Inc (Project Jonah)	WWF NZ (WWF)

112. Full copies of submissions are attached (Appendix 1).

GENERAL THEMES

113. The key points raised in the majority of submissions included uncertainty in the underlying data and models and the subsequent level of precaution in the management settings that is considered appropriate, and more technical questions or concerns on the demographic population model and the PST approach.

114. A number of stakeholders commented on the need for precaution, given uncertainties in the information supporting the development of options for key management settings in the Operational Plan. In a number of submissions it was considered that where there is uncertainty, the most precautionary option should be taken, irrespective of the information that does exist to support other options.

115. Submitters including WWF, Forest & Bird, RNZSPCA, Project Jonah, Ngāi Tahu, and ECO consider that a precautionary approach is essential until uncertainty, limitations, and issues with the science can be addressed.

116. Many stakeholder submissions seem to confuse statistical uncertainty in the estimation of individual model parameters with actual uncertainty regarding sea lion captures and deaths. MPI notes that actual uncertainty in the estimation of total fishery related captures and deaths arises only from the potential for cryptic mortality (paragraphs 86-91).

117. MPI notes there is remaining uncertainty with respect to the information underpinning management settings for the Operational Plan, especially with respect to some types of potential cryptic mortality. However, MPI considers that this level of uncertainty does not preclude the available information being considered the best available and sufficient to support the development of management options and advice.

118. Reference is also made by several submitters to Section 10 of the Act and the Information Principles therein, focusing on the principle that decision makers should consider any uncertainty in the information available in any case and that decision makers should be cautious when information is uncertain, unreliable, or inadequate.

119. MPI acknowledges the importance of the Information Principles of the Act, and has developed management options that are based on the best available information while acknowledging and taking into account relevant uncertainty.

General Issues

Input and participation in consultation with Maori

120. Under section 12 of the Fisheries Act, we provide for input and participation of tangata whenua and you must have particular regard to kaitiakitanga when making decisions.

Tangata Whenua

121. Ngāi Tahu note in their submission that management measures within SQU6T should be formed so that they recognise and provide for environmental and cultural values in the context of a true treaty partnership –

> *"Mō tātou, ā, mō kā uri, ā muri ake nei – for us and our children after us."*

122. Ngāi Tahu recommends that the final Operational Plan reflects the unique relationship Ngāi Tahu have to rāpoka, and the obligations the Crown has as Treaty Partners.

123. In exercising their rights as kaitiakitanga, Ngāi Tahu have submitted their support for management settings as laid out below. They supported Option 2 for the FRML, Option 5 for the Strike Rate and Option 3 for the Discount Rate. They indicated a preference for the most conservative options in all cases.

Consultation with Maori

124. Te Ohu Kaimoana submitted on behalf of a number of iwi, excluding Ngāi Tahu who submitted separately. TOKM's submission supported Deepwater Group Ltd's submission.

Research

125. A number of submitters noted the need for continued research, especially on the efficacy of SLEDs to inform options for the Discount Rate and better estimation of the interaction rate that informs options for Strike Rate.

126. Forest & Bird request that a commitment be made to research the indirect effects of fishing on sea lions, how changes in fishing practice affect interaction rate, estimates of spatial overlap of sea lions with fisheries, and into body retention in SLEDs. WWF provided a number of suggestions to address limitations and issues in a number of relevant areas.

127. There are some specific suggestions, including ECO recommending that "cameras should be used to estimate actual strike rate and level of sea lion survival in SLEDs", Shaun McConkey suggests using PIT (Passive Integrate Transponder) tags and sensors in the SLED to better estimate interaction rate and potentially body non-retention.

128. The TAG convened by MPI to discuss the Operational Plan discussed research needs to better inform management settings. A number of projects were discussed. MPI is progressing work to better understand the spatial overlap of fishing effort with sea lion foraging, and is planning an analysis to integrate all available information to estimate and understand cryptic mortality.

129. Also discussed at the TAG was the feasibility of deploying cameras or using tag technology to better estimate interaction rate or improve understanding of SLED efficacy. It was generally agreed that cameras are not feasible in the squid fishery because of significant visibility issues resulting from the depth the fishery operates, sediment stirred up by the trawl, and the ink released from the squid. MPI has explored, and will continue to monitor, available tagging technology, but notes that at this stage, there is no technology that has the range required at depth to operate as would be required. Furthermore because interaction rates are relatively low (only 1-2% of the Auckland Islands population may interact with fisheries in a given year), any research design requiring observation of capture events would take many years to achieve a statistically meaningful answer even with universal application across the fleet.

130. In addition, MPI is working with the Australian Fisheries Management Authority (AFMA) on a project to evaluate video footage to inform estimates of body non-retention. The same project may also provide insight to better understand the potential for post-escape drowning.

Economic analysis

131. A number of submitters, including NZSLT, ECO and Shaun McConkey noted the need to consider the wider value of sea lions, including revenue and jobs generated by wildlife tourism, when making decisions. They note that an economic value estimate is provided for the fishery, but no similar estimate was provided for sea lions. Submitters also commented on the intrinsic value of maintaining a healthy sea lion population and the potential risk to New Zealand's reputation of impacting the population.

132. NZSLT provided an estimate that wildlife tourism in Dunedin was worth $100 million dollars annually in 2008 and generated 800-1000 full time jobs (Tisdell 2008).

133. MPI notes that last summer season it was estimated that approximately 1,000 visitors were booked to go to the Auckland Islands or Campbell Island or both. The trips range in price from NZ$5,000-10,500USD per person, which equates to between NZ$7.8-16.2M.

This does not include indirect spending by these tourists, which results in economic boosts to the local communities where the trips may depart from or come into port in New Zealand.

Fishing Methods

134. Project Jonah, RNZSPCA, Forest & Bird and WWF New Zealand suggest that the SQU6T fishery should adopt alternative fishing methods, such as jigging, because it poses no risk to sea lions and can produce higher quality/value product and is utilised in similar marine environments internationally.

135. Jigging for squid requires relatively calm weather conditions in order to provide a stable platform from which the jiggers may operate. This means that jigging isn't feasible in rough seas, which are common conditions in the subantarctic around the Auckland Islands. While there may be some days that squid jig vessels could operate, the number of days per year with unfavourable weather conditions would likely severely limit the ability of the fishery to operate and be economically viable as a commercial fishery.

Analysis of Options

136. Options for the key management settings subject to consultation are set out in the table below.

Table 3: Proposed options for key management settings

Option	Proposed setting
Fishing-related mortality limit	
1 – Status Quo	68
2	38

Option	Proposed setting
Strike Rate	
1 – Status Quo	5.89
2	4.78
3	6.34
4	5.89*
5	7.58

Option	Proposed setting
Discount Rate	
1 – Status Quo	82%
2	75%
3	50%

* Option 4 for Strike Rate would result in the same Strike Rate as the status quo, however it is based on a distinct rationale and is therefore proposed as a separate option.

FISHING RELATED MORTALITY LIMIT

137. The integrated demographic population model for sea lions was used to calculate a Population Sustainability Threshold for the Auckland Islands sea lion population for the midpoint of the defined population outcomes suggested by the TAG. The PST was subsequently adjusted to account for sea lion mortalities in fisheries other than SQU6T.

138. Submitters were generally pleased with the inclusion of an option for the FRML lower than status quo and the acknowledgement within the proposed FRML of potential sea lion mortalities in fisheries other than SQU6T.[10]

Table 4: Proposed options for fishing-related mortality limit for SQU6T

	Proposed FRML	Defined population outcome used for PST calculation
Option 1 (status quo)	68	Based on outdate model criteria of no more than 10% difference in population
Option 2	38	PST estimated so population would be no more than 5% lower than it would be in the absence of human-caused mortality (with 90% confidence)

[10] Allowance of eight based on an estimated average of seven mortalities per year in scampi and an estimated one per year in other subantarctic trawl fisheries (e.g. hoki, hake, Stewart-Snares shelf squid)

Option 1 – Status Quo

Rationale

139. The FRML has been set at 68 sea lions per year since 1 October 2010. This FRML was based on a New Zealand sea lion-specific population model known as the Breen-Fu-Gilbert Model.[11] The Breen-Fu-Gilbert model was reviewed in 2013. The review concluded that the model was correctly implemented; however, some aspects of the model were unclear, and a recommendation was made to explore other modelling options, which led to the development of the demographic population model used to inform the other options.

Submissions

140. DWG and TOKM considered there to be no need for a FRML, considering that mitigation measures applied have reduced captures and the fishery is monitored sufficiently well to identify any change in the level of captures. In addition, DWG submits that pup counts have been stable over the most recent eight years, indicating that the current management and fishing related mortality in the SQU6T fishery is not significantly affecting the Auckland Islands sea lion population.

141. However, DWG and TOKM note that if it is decided that a FRML is required, they support Option 1, with a modification to allow for estimated sea lion mortalities in other fisheries. This would result in a FRML set at 60 sea lions per year.

142. DWG also view the proposal to change the defined population outcome to no more than a 5% impact (Option 2) as a unilateral change and considers that it cannot be accepted until all stakeholders are fully informed on the need for changes, on the impact of the change, and appropriately consulted on the new criteria.

143. No other submitters supported the status quo.

144. MPI notes that the management criteria change is necessary given the structure of the new demographic population model. MPI discussed this with the Squid 6T Technical Advisory Group, and subsequently consulted publically on revision of the management criteria.

145. MPI also notes that the Breen-Fu Gilbert model is no longer considered to be the best available information to support the setting of the FRML. Application of management criteria of no more than a 10% impact on the population would, based on the demographic population model, result in a higher FRML, which MPI does not consider to be appropriate at this time.

Option 2 (MPI Recommended)

Rationale

146. The PST that underpins Option 2 was modelled to meet a defined population objective of the Auckland Islands population being no more than 5% lower than it would be in the absence of human-caused mortality with 90% confidence, over five years, also incorporating uncertainty. This resulted in a PST of 46 sea lions.

[11] Breen, P.A.; Fu, D.; Gilbert, D.J. (2016). Sea lion population modelling and management procedure evaluations. *New Zealand Aquatic Environment and Biodiversity Report No. 175.* 89 p.

147. As recommended by the TAG, the PST was then adjusted to allow for sea lion mortalities in fisheries other than SQU6T that may impact on the Auckland Islands sea lion population. The allowance of eight is based on the five-year average annual estimated captures from scampi and other trawl fisheries around the Auckland Islands (7) plus one additional to allow for capture in the Stewart Snares shelf fishery area of one sea lion (1) originating from the Auckland Islands population. [12]

148. Following incorporation of the allowance for sea lion mortalities in other fisheries, a fishing-related mortality of 38 sea lions was proposed in consultation as the mid-point of the range of defined population objectives proposed by the TAG (the TAG suggested consideration of a range from 2% - 10% allowable impact on the sea lion population).

Submissions

149. In general, all submitters other than DWG and TOKM supported a FRML lower than the status quo. A number of submissions refer to reducing sea lion mortalities in the SQU6T fishery as far as possible without referencing a particular limit, however many of these submissions also highlight Option 2 as their preferred option.

150. A number of submitters including the WWF form submission, NZSL Trust, Project Jonah, Shaun McConkey, SCB, OCB, and RNZSPCA consider that the previous criteria of allowing fishing to have up to a 10% impact on the sea lion population to be too high. These submitters consider that allowing fishing to have any more than a 5% impact on the population would be unacceptable. ECO note that they consider a FRML of zero to be more appropriate for an endangered species like the sea lion.

151. WWF and Forest & Bird submit that the FRML should be set based on a PST estimated to meet a defined population outcome of the population being no more than 2% lower than it would be in the absence of human-induced mortality. They consider that this is more appropriate given the uncertainties and issues they see with the modelling and PST (see Uncertainties section).

152. NZSLT also submit that the FRML should take into account the gender of sea lions killed because of the impact on pups (and future pups) of the mortality of a female.

153. Dr Bruce Robertson submits in support of Option 2, noting that the BFG model (on which Option 1 is based) should not be used to inform management and should not be presented as an Option in this advice.

154. SCB and OCB submit that because of the uncertainty associated with SLEDs the FRML should be set as low as possible.

155. DWG considers that the latest modelling used to estimate the PST has not been provided to nor assessed by the Aquatic Environment Working Group or stakeholders and that it does not meet the Research and Science Information Standard for New Zealand Fisheries. DWG also submit that the calculation of the PST using the demographic population model that did not incorporate the two most recent years of mark-resight data results in an overly pessimistic PST estimate.

Analysis and Recommendation

156. After considering submissions, MPI recommends Option 2, considering it to represent the option most likely to support achievement of the objectives of the TMP while

[12] From https://psc.dragonfly.co.nz/2016v1/released/explore/ accessed 5 July 2017.

recognising the purpose of the Fisheries Act. MPI considers that the demographic population model and the use of that model to estimate a PST to be the best available information.

157. MPI acknowledges that the demographic population model was not fully updated when used to calculate the PST and therefore, the proposed FRML may be conservative. In relation to the point about recognising sex in the FRML, the demographic population model is based on females and accounts for flow on effects of female mortality using precautionary model assumptions regarding mortality of the pup on shore and future pup production.

158. MPI also recognises that as with any science, there remain uncertainties; however, MPI considers these are accounted for in the requirement for there to be 90% confidence that the impact on the population will be less than 5%. This requirement results in advice being provided based on the lower 90% confidence interval of the PST estimate, building a level of precaution into the proposed FRML.

159. In preparation for the next Operational Plan, MPI is planning to fully update the demographic population model and ensure a thorough review. MPI considers that the consultation completed for this Operational Plan constitutes consultation on the management criteria, but will continue to engage with stakeholders through the TAG on management approaches, criteria, modelling, and ongoing research in advance of the next Operational Plan.

STRIKE RATE

160. Estimates of interaction rate are modelled/estimated as part of MPI's annual protected species capture estimation project. The proposed options for Strike Rate are based on the average estimated interaction rate over three different time periods, including the period recommended by the TAG and an additional option using what MPI considers to be the most robust estimate but accounting for the associated uncertainties.

161. A number of submitters made general comments on the high levels of uncertainty associated with the data which inform the options for Strike Rate. These are addressed in in the Uncertainty section above (paragraphs 112-115). The estimates of interaction rate from years after the universal introduction of SLEDs are not based on any empirical data and are therefore very uncertain. This uncertainty reflects a limitation of the model, and does not imply uncertain capture rates.

162. Submitters also generally confuse interaction rate (a statistical estimate of the rate of sea lions interacting with fishing gear) with the Strike Rate (a management setting informed by, and meant to approximate, the interaction rate). The majority of references by stakeholders to refine or estimate 'strike rate' are actually in reference to the estimation of the interaction rate.

163. Dr Stefan Meyer submitted that the Strike Rate implies a constant impact of sea lions across years, but that the actual interaction rate has varied considerably since first estimates have been reported. He submits that this 'implies that the dynamics which determine the actual or realised rate of interactions in SQU6T are not well understood and thus assuming a constant strike rate prior to each fishing season can mislead SQU6T management re its impact on the NZSL population'. This conclusion is the same as in his published paper, which was reviewed against the Research and Science Information Standard for New Zealand Fisheries (see paragraph 82) and not considered suitable to inform management.

164. MPI note that, as in paragraph 58, management settings for Strike Rate and Discount Rate (below) should be considered together as some combinations of these management settings are implausible.

Table 5: Proposed options for Strike Rate

Option	Strike Rate	Reference period	95% Confidence Range
1 – (Status quo)	5.89	2000/01 – 2009/10 Mean	
2	4.78	1995/96 – 2004/05 Mean	3.64 - 6.34
3 (MPI Recommended)	6.34	1995/96 – 2004/05 Upper 95% Confidence Bound	
4	5.89*	1995/96 – 2014/15 Mean	3.43 – 14.7
5	7.58	2005/06 – 2014/15 Mean	2.14 – 29.6

* Option 4 for Strike Rate would result in the same Strike Rate as the status quo, however it is based on a distinct rationale and is therefore proposed as a separate option.

Option 1 – Status Quo

165. The current Strike Rate of 5.89 was set in 2012 based on the mean interaction rate over the ten year period from 2000/01 to 2009/10 as per Thompson et al.[13] which was reviewed and accepted by MPI's Aquatic Environment Working Group but never published as a final report.

166. There were no submissions in support of Option 1. DWG noted that it uses only a subset of the available information to inform the choice of Strike Rate and will be biased high given the lower sea lion population numbers that prevailed from 2008 to today. They consider this option also does not reflect any shifts in fishing practice since 2008.

167. MPI now considers Option 1 to be inappropriate, given that it is based on limited empirical data, and does not recommend this option.

Option 2

168. Option 2 proposes a Strike Rate of 4.78 sea lions per 100 tows. This is based on the 10 earliest years of available strike rate data, including all data from the period prior to the implementation of SLEDs. This option is informed by direct observations of sea lion captures in the SQU6T fishery.

169. While this is likely to be the best informed estimate of the interaction rate, there have been changes in sea lion abundance or behaviour (e.g. changes in diet or foraging patterns) and/or changes in fishing operations (changes in vessel numbers, tow duration) that may have impacted on interaction rate.

170. There were no submissions in support of Option 2. DWG noted that Option 2 uses only a subset of the available information, doesn't include data on any changes in fishing practice since 2005, and will result in an estimate that is biased high because of the lower sea lion population numbers from 2008 to present.

171. MPI considers Option 2 to be based on the longest time period of empirical data and therefore to represent the best available information on interaction rate. However, it does not incorporate any adjustment to allow for potential changes in interaction rate or fishing practices since 2005.

[13] Thompson. F.N. et al (unpublished). Marine mammal bycatch in New Zealand trawl fisheries, 1995–96 to 2009–10.

Option 3 (MPI Recommended)

172. Option 3 proposes to use the upper 95% confidence bound of the 1995/96 – 2004/05 time series. This option is similar to Option 2 but more explicitly recognises that there have been changes in factors that are likely to affect interaction rate, and therefore proposes a Strike Rate of 6.34 sea lions per 100 tows.

173. Project Jonah and RNZSPCA submitted that Option 3 would be preferable to all but Option 5, because it accounts for the changes that have taken place since data was collated.

174. DWG submits that Option 3 uses only a subset of the available information, doesn't include data on any changes in fishing practice since 2005, and will result in an estimate that is biased high because of the lower sea lion population numbers from 2008 to present. They also note that this option incorporates caution into the component estimate and DWG would prefer to see caution exercised at the aggregate level.

175. MPI considers Option 3 to be based on the upper 95% confidence bound of the longest time period of empirical data. Therefore, it represents the best available information on interaction rate but includes a level of precaution to allow for changes in interaction rate over time because of changes in fishing practices or behaviours.

Option 4

176. Option 4 proposes a Strike Rate of 5.89 sea lions per 100 tows, based on the average of the full 20 years of the fishery where estimates of interaction rate are available. Coincidentally, this rate is the same as the Status Quo.

177. A key uncertainty with this option is the lack of empirical data on sea lion interaction rate to underpin all estimates later than the early 2000s.

178. DWG, supported by TOKM, submitted their support for Option 4 if it is decided that a FRML is to be set. They consider it to be based on the most robust data set, both in terms of the time length of the series and the capacity of the rate to reflect changes in fishing practices and the sea lion population.

179. No other submitters explicitly commented on Option 4.

180. MPI considers this option to incorporate all empirical data, but the inclusion of the later data may bias the estimate of total interaction rate as estimates from years later than 2004-05 are based on no empirical data and may be misleading.

Option 5

181. Option 5 proposes a Strike Rate of 7.58 sea lions per 100 tows based on the average of the most recent 10 years where estimates of interaction rate are available.

182. All submissions other than DWG and TOKM supported Option 5, generally under the rationale that there is uncertainty in the estimation of interaction rate which results in a need for a precautionary approach.

183. DWG submits that Option 5 uses only estimated interactions and to that extent fails to use the full information available to inform the output.

184. ECO expressed concern that MPI has 'failed to refine the real strike rate', and noted that the year when there was 100% observer coverage the 'strike rate' was 9.8 sea lions per

100 tows. They consider that longer tows in the fishery has increased the risk of a sea lion being caught in each tow, assuming the risk of sea lion capture is a factor of the area swept by the trawl, and therefore 'any strike rate per tow is likely to under-estimate the number of sea lions caught'.

185. Project Jonah and the NZRSPCA supported Option 5 because they consider the statistics supporting the current Strike Rate to be outdated and not recognise changes in fishing practices. They also consider a precautionary approach must be taken because it is not possible to directly count sea lion mortalities in the fishery and statistics are based on an approximation. They also consider Option 5 to be based on the most recent 10 years of data and is therefore the most reliable.

186. Bruce Robertson supports Option 5 because 'MPI likes to use the most recent data available to them' and this option uses the last 10 years of data available. In addition, it is supported as a more precautionary estimate and considered 'more consistent with the observation that in the only year with 100% observer coverage the strike rate was over 10'.

187. WWF and Forest & Bird note the change in fishing practices and the need to understand the impact of that on the interaction rate. They submit that until more information is available on the effects of longer tows and more turns in the fishery the most precautionary option should be taken. Forest & Bird adds that they would prefer a Strike Rate of 10, but in the absence of that option support Option 5 as it is the most precautionary.

188. MPI considers that Option 5 is based solely on modelled estimates of interaction rates that are not based on empirical data. Two submitters made reference to the year (2001) where there was 100% observer coverage and a higher strike rate estimated. MPI notes that the interaction is known to be variable between years, and selecting a single year instead of using all available data is considered inappropriate and doesn't acknowledge the variability in the rate.

Analysis and Recommendation

189. MPI recommends Option 3, with the Strike Rate set at 6.34 sea lions per 100 tows. This option is based on the most empirical data, as it uses the data from before the implementation of SLEDs. By using the upper confidence bound of the estimate, this option reflects the structural uncertainty arising from potential changes that may have occurred since the data was collected and represents a conservative approach based on the best available information.

190. While Option 5 was supported by a range of submitters, MPI considers there is significant uncertainty associated with the estimates of interaction rate and the number of factors that may influence changes in the modelled interaction rate over time. For sea lions, the model estimates of interaction rates have become less precise and less stable over time due to an increasing proportion of the data coming from years in which all vessels are utilising SLEDs. Interaction rate estimates arising from models based only on recent data (in which all vessels use SLEDs) are not informed by meaningful capture data. Estimates of SLED retention rate and interaction rate are linked within the modelling, and have been found to be correlated such that the modelled interaction rates have become virtually meaningless in recent years, and may actually be misleading.

191. This continuing uncertainty in the estimation of interaction rate is one driver for MPI to continue working with the TAG to identify potential solutions, either through research or

through the development of an alternative management approach that does not require an estimate of interaction rate.

DISCOUNT RATE

192. Setting of the Discount Rate requires consideration of two key factors:

    1) Probability that the sea lion exits the net via the SLED (exit probability); and
    2) Probability that a sea lion that has exited the net survives the encounter (cryptic mortality), which includes MTBI, body non-retention, and post-escape drowning.

193. The TAG recommended that multiple options be provided, including clear consideration of the best available data and uncertainty with regards to cryptic mortality. A sub-set of TAG members also requested that a specific option be provided for consultation (Option 3).

194. Note that the Discount Rate is calculated based on the exit probability multiplied by the proportion of those that exit that don't survive (ie it is not additive).

195. As previously noted in paragraphs 96-98, management settings for Strike Rate and Discount Rate (below) should be considered together as some combinations of these management settings are mathematically implausible.

Table 5: Proposed options for Discount Rate

Option	Discount Rate	Considerations
1 – (Status quo)	82%	1) 85% exit probability 2) 3% allowance for MTBI
2 (MPI Recommended)	75%	1) 86% exit probability 2) 3% allowance for MTBI; 10% allowance for body non-retention and post-escape drowning
3	50%	Arbitrary – from Bradshaw et al 2013

Option 1 – Status Quo

196. The status quo is based on modelling of the change in observed captures in SQU6T pre and post-SLED deployment. This modelling, completed in 2011, estimated that 85% of sea lions that enter a trawl net can be expected to exit through a SLED when one is fitted.[14]

197. Additional work looking at potential injuries to sea lions encountering a SLED grid estimated that 3% of encounters with a grid could potentially prove fatal by causing a mild traumatic brain injury.[15]

198. DWG submitted in support of the discount rate being set at 82%. They submit it is supported by a wide range of empirical data and sciences processes, and note that other potential fishing mortality (i.e. cryptic mortality) is included in the FRML modelling (the demographic population model).

[14] Thompson, F.N.; Abraham, E.R. (2011). Estimation of the capture of New Zealand sea lions (Phocarctos hookeri) in trawl fisheries, from 1995–96 to 2008–09. New Zealand Aquatic Environment and Biodiversity Report No. 66. 25p.
[15] Abraham, E R (2011) Probability of Mild Traumatic Brain Injury for sea lions interacting with SLEDs. Final Research Report for Ministry of Fisheries project SRP2011-03 (Unpublished report held by the Ministry for Primary Industries, Wellington). 21 pages

Option 2 (MPI Recommended)

199. Option 2 is based on an updated exit probability using the same model and approach as previously, but incorporating an additional three years of data. This results in an estimated exit probability of 86%.[16]

200. Cryptic mortality is then accounted for in two ways: first by incorporating an assumption that 3% of those sea lions that escape will not survive as the result of MTBI from impact with the SLED and second by including a conservative and somewhat arbitrary assumption that an additional 10% of those that exit the SLED potentially drown before they can return to the surface (post-release drowning) or drown in the net and fall out of the SLED (body non-retention).

201. Applying this allowance for cryptic mortality to the updated exit probability leads to the following calculation of the Discount Rate of 75%:

0.86	x	(1-	(0.03	+	0.1))	=	0.748 (75%)
Exit probability (assumed survivor)		Convert cryptic mortality into a proportion that survive (to be comparable to exit probability)	Proportion that die from MTBI		Proportion body non-retention and/or drowning		Proposed Discount Rate
			Cryptic mortality				

Option 3

202. Option 3 was proposed by environmental stakeholders at the Technical Advisory Group. The Technical Advisory Group recognised that there are uncertainties associated with the calculation of Strike Rate and Discount Rate and it was therefore requested that a more precautionary option be provided to account for those uncertainties.

203. The 50% is based on the report of an independent review of models and data underpinning the management of fishing-related mortality of New Zealand sea lions in the SQU6T fishery. In the view of the authors, until real data to inform the setting of the Discount Rate becomes available, MPI's options are limited to, among others, 'setting a coin toss discount rate of 0.5 (which would be arbitrary)'(Bradshaw et al 2013).

Submissions

204. All submissions other than DWG and TOKM supported Option 3. In general, this option was supported as the most precautionary option, and many submitters highlighted uncertainties associated with the data and assumptions that inform the setting of the Discount Rate.

205. A number of submitters cited the report of the expert panel review of sea lion management, (Bradshaw et al 2013) from which the 50% was taken.

206. ECO noted that the options for Discount Rate are all based on assumptions of impact and that only one possible cause of cryptic mortality (brain injury) has been investigated in depth by MPI. ECO consider the consultation document to overstate the certainty of the information supporting the other options.

207. Stefan Meyer submits that it remains unknown as to whether or not sea lions are able to escape trawl nets and subsequently survive. He notes the lack of empirical data to estimate

[16] Abraham, E.R.; Berkenbusch, K. (in prep). Estimated captures of New Zealand fur seal, New Zealand sea lion, common dolphin, and turtles in New Zealand trawl and longline fisheries, 1995-96 to 2014-15.

post-SLED survival of sea lions, and considers that the degree of uncertainty accepted in regards to the Discount Rate is at odds with the general approach of assessing other threats to the sea lion population.

208. OCB and SCB submit on the uncertainties with survival of sea lions that interact with SLEDs, and advocate for a precautionary approach of using a Discount Rate of 50%.

Analysis and Recommendation

209. MPI recommends Option 2 – setting of a Discount Rate of 75%.

210. MPI recognises the continued uncertainty associated with the estimation of SLED efficacy, but like the estimate of Strike Rate, considers there to be available information to allow its estimation.

211. This information includes estimates of SLED retention from modelling reviewed through the Aquatic Environment Working Group, work MPI completed quantifying probability of Mild Traumatic Brain Injury resulting in sea lion deaths, and some anecdotal information based on personal communication with AFMA officials which suggests that body non-retention in SLEDs is likely to be negligible. This information supports a Discount Rate of 75%.

212. Setting the Discount Rate at 50%, as supported by a number of submitters would be arbitrary and suggest that there is no information to support a more informed estimate. In addition, the Bradshaw *et al* report from which the 50% was taken only suggests this as an option 'until real data become available'.

213. MPI also notes that other options suggested by the panel in the Bradshaw *et al* report include 'making a subjective choice as to the most 'plausible' value (but perhaps deliberately 'low' to provide a precautionary approach)'.

214. The Strike Rate and Discount Rate settings can also be used to calculate a corresponding implied estimate of cryptic mortalities per observed capture (i.e. how many sea lion deaths are occurring per observed sea lions capture). This can provide some idea of how 'realistic' particular combinations of settings may be. As an example, the table below provides an estimate of the number of assumed sea lion mortalities per observed capture based on fishery information for 2008 and the last 2 years and a range of Strike Rate/Discount Rate combinations.

Table 6: Implied cryptic mortalities per observed sea lion capture for 2008, 2016, and 2017 fisheries under a range of Strike Rate/Discount Rate combinations

Year	# tows	Observed captures	Strike Rate	Discount Rate	Interactions	MTBI mortality	Other cryptic mortalities	Implied cryptic mortalities/ observed capture
2017	1,294	3	5.89	82	76.2	1.9	11.8	4.6
	1,294	3	7.58	50	98.1	1.5	47.6	16.3
	1,294	3	6.34	75	82.0	1.8	18.7	6.8
2016	1,364	0	5.89	82	80.3	2.0	12.5	14.5
	1,364	0	7.58	50	103.4	1.6	50.1	51.7
	1,364	0	6.34	74	86.5	1.9	19.7	21.6
2008	1,257	5	5.89	82	74.0	1.8	11.5	2.7
	1,257	5	7.58	50	95.3	1.4	46.2	9.5
	1,257	5	6.34	74	79.7	1.2	38.7	8.0

215. These results indicate that for a Strike Rate of 7.58 and a Discount Rate of 50%, in 2016, 50 sea lions would have to fall out or exit the net and then die for each observed capture. Given the information available, including anecdotal reports that body non-retention is likely to be low if not negligible, even an estimate of 10 sea lions falling out per observed capture seems implausibly high (implied cryptic mortalities/observed capture column in Table 6).

OTHER MANAGEMENT SETTINGS

216. Other proposed Operational Plan settings on which MPI requested views include:

- Duration of the Operational Plan;
- Notification Requirements;
- Reporting Requirements;
- Trigger point for early review;
- MPI Observer coverage; and
- Fishery Closure Process.

Duration of Operational Plan

217. MPI is proposing that this Operational Plan apply to the 2017/18 and 2018/19 fishing years. The TAG recognised and supported the need for a multi-year plan but expressed some concern about maintaining the status quo for two years, as that could be viewed as delaying action. In addition, the TAG recommended that there be trigger points to allow for the Operational Plan to be reviewed if significant new information becomes available.

218. The majority of submitters expressed some level of comfort with a two-year duration of the Operational Plan, although there were a number that considered two years was an absolute maximum for how long the Operational Plan should last.

219. Forest & Bird support this Operational Plan being for a one year interim period, and request a commitment to SLED efficacy research be made. In addition, ECO consider the Operational Plan should only apply for one year as they consider there to be too much uncertainty in the results of modelling.

Notification requirements

220. Vessel operators to provide MPI's Observer Programme with 72 hours' notice prior to the vessel leaving port for each fishing trip where the vessel intends to operate in SQU6T. If a vessel is already out fishing, the operator must still provide 72 hours' notice prior to entering SQU6T and the vessel must be available to return to port to pick up an MPI Observer if required.

221. The notification provides the MPI Observer Programme time to organise and deploy observers as required. Tows undertaken in SQU6T by any vessel for which a full 72 hours' notice was not received are not eligible for the 'Discount Rate'.

222. All submitters supported the proposed notification requirements.

Reporting requirements

223. All vessel operators must report weekly to MPI, through Commercial Fisheries Services Ltd (FishServe), including the number of tows, whether a SLED was deployed, if each tow was observed, and if any sea lions were captured.

224. If 80% of the FRML is reached, the above information must be reported daily.

225. Tows which are not reported as per this requirement are not eligible for the 'Discount Rate'.

226. Submitters supported the reporting requirements as proposed.

Trigger point for early review

227. Trigger points set out conditions under which the Operational Plan will be reviewed in advance of the scheduled expiry of the Operational Plan.

228. It is proposed that for this plan, the only trigger point will be to review the Operational Plan if significant new information becomes available (e.g. significantly low pup count in January 2018, major changes in fishing operations or level of effort).

229. A number of submitters commented on the need for a trigger for early review of the Operational Plan.

230. RNZSPCA suggested amended text for the trigger point of 'if new research or information becomes available that indicates fisheries activities are having a greater impact on sea lion survival than previously thought, if there are changes in fishing operations or level of effort, or if there are concerns regarding sea lion populations'.

231. MPI has amended the trigger point in the proposed Operational Plan to match the suggested language from RNZSPCA.

Observer Coverage

232. MPI commits to a minimum observer coverage of 50% of tows observed in SQU6T. MPI Observers will continue to audit SLED measurements and ensure that they observe all hauls in SQU6T.

233. In recent years, this coverage target has been exceeded, with average observer coverage over the most recent five years of 84% of tows observed.

234. A number of submitters commented on the importance of observer coverage, both in the squid fishery and other fisheries that operate around the Auckland Islands and may interact with sea lions.

235. RNZSPCA and Project Jonah submitted that all vessels operating in SQU6T should carry an observer at all times instead of the current commitment made to have at least 50% of tows observed.

236. The observer coverage in the Auckland Islands scampi fishery was also highlighted because relatively low coverage in recent years makes estimates of sea lion captures more uncertain.

237. MPI considers that the current commitment for at least 50% observer coverage in the SQU6T fishery to be sufficient to provide for robust statistical estimation of total sea lion captures in the fishery and verification of SLED use and observed captures. For the scampi fishery, over the last two years, MPI has significantly increased the number of planned observer days for scampi fisheries and is planning to continue to increase the priority of coverage in this fishery.

238. In addition, ongoing work under the Integrated Electronic Monitoring and Reporting System (Digital Monitoring) programme, including the deployment of cameras on board vessels, may in future provide additional information on sea lion interactions in other

trawl fisheries including scampi, where total captures are estimated based on observed captures.

Fishery Closure Process

239. If the FRML is reached, the SQU6T fishery will be closed without consultation via gazette notice. MPI will work with DWG to ensure that all fishers are aware of levels of fishing activity against the FRML throughout the season and are informed in advance of any impending closure.

240. MPI will continue to provide a weekly update to interested stakeholders providing information on the number of vessels, tows, observer coverage, and notification of any sea lion captures.

Conclusion

241. MPI consulted on options for management settings in an Operational Plan to manage incidental interactions of sea lions in the SQU6T fishery. After consideration of the 1,569 submissions received, MPI recommends that you agree to a 2-year Operational Plan of the same structure and content as previous Operational Plans but with changes to key parameters to reflect new and updated information and uncertainty.

242. With regards to key management settings, MPI recommends that you set the annual Fishing-Related Mortality Limit for the SQU6T fishery at 38 sea lions, the Strike Rate at 6.34, and the Discount Rate at 75.

243. MPI notes that these options result in a more conservative approach than that taken in recent years, mainly due to a change in the management criteria used to define an ‘adverse impact’ on the sea lion population, acknowledgement of increased uncertainty regarding factors supporting estimation of the interaction rate, and a more cautious approach to allowing for cryptic mortality in the Discount Rate.

244. The management settings of the previously Operational Plan resulted in an effort limit of 6,414 tows provided that all tows deployed SLEDs and vessels complied with reporting and notification requirements. The recommended management settings for this Operational Plan would result in an effort limit of 2,397 tows. This level of tows was last exceeded in 2005/06, so while not expected to significantly constrain effort, it is possible for this to limit the fishery in some years.

245. MPI intends to move away from calculation of the interaction rates in future given the lack of empirical data to inform the estimation, and focus research on better understanding cryptic mortality associated with SLED use instead. This will allow for an amended management approach, which does not rely on estimations of interaction rate to ensure that fishing does not have an adverse impact on the New Zealand sea lion population.