Department of Conservation
Te Papa Atawhai

Ministry for Primary Industries
Manatū Ahu Matua

Development of the Threat Management Plan for New Zealand sea lions: Progress Report - NZSL Threat workshop 1

Purpose of Document:

This document provides a process summary on progress in developing a Threat Management Plan (TMP) for New Zealand sea lions (NZSL). It reports at a high-level on Workshop 1 and seeks to provide context around the threat characterisation spreadsheet and expert panel recommendations.

Background:

For further information on the process involved in the development of the New Zealand sea lion TMP, please see http://www.doc.govt.nz/nzsl-tmp.

Risk assessment forms a key work stream in the development of the New Zealand sea lion TMP. The first major milestone of the risk assessment process was a multi-stakeholder workshop held in Wellington between 28 April and 1 May 2015.

The purpose of the workshop was to identify and consistently characterise the threats to the New Zealand sea lion population, as well as review the demographic model's suitability to assess risk. For More detail on the purpose of the workshop see **Appendix 1**.

Invited subject matter experts were present in the capacity of "Advisors" to provide support to an Expert Panel on their particular topic of expertise and to provide feedback to inform the threat characterisation.

The Expert Panel was comprised of four invited national/international persons with expertise relevant to the assessment of risk to the sea lion, who were considered independent of current New Zealand sea lion research or management. A list of participants is included in **Appendix 2**.

The Expert Panel took part in the identification and characterisation of threats, and reviewed the sea lion demographic population model which will be used to assesses key threats and inform latter steps of the TMP process.

Workshop 1 Outputs:

The workshop provided two key outputs,

1. A list of prioritised recommendations from the Expert Panel on: the demographic model, monitoring and research, risk characterisation, mitigation, and the threat assessment modelling process (**Appendix 3**); and

2. A list of threats (**Appendix 5**) which have been characterised by Advisors and confirmed by the Expert Panel. This characterisation will be used to inform the risk assessment model. Where possible the characterisation was based on evidence and plausible estimates of impact were made, however for most threats only upper and lower bounds of the impact were estimated. Impacts of threats considered to be data rich were not characterised at the workshop as they will be more effectively assessed through a quantitative method.

An initial list of threats was populated which outlined all possible pathways through which a threat could impact the population.[1] While DOC and MPI acknowledge all of these potential threats, for many of them there is little to no information, nationally or internationally, on how they impact a pinniped population. It was therefore proposed by the TMP Project Team and agreed on by the Expert Panel that these threats were removed from the list for the time being so that the workshop would focus on threats which could plausibly be characterised within the TMP. Some threats were also aggregated to help improve the characterisation.

Even after refining the list of threats it was not possible to characterise all of the remaining threats within the workshop timeframe. To ensure all direct threats were characterised for the TMP, workshop attendees agreed to a process by which DOC and MPI would contact relevant Advisors after the workshop to help characterise any remaining threats that were not addressed at the workshop. All threat characterisations conducted after the workshop were circulated to all Advisors and Expert Panel members for review and feedback prior to the list of threats being finalised.

Next Steps:

- July/August 2015 – High and medium priority recommendations from the expert panel members that relate to the demographic model will be incorporated and presented at a DOC (CSP)/MPI (AEWG) technical working group to update stakeholders on the progress of the model development. The Panel's recommendations on monitoring and research, risk characterisation, and mitigation will be used to help develop management options for the TMP
- July/August 2015 – A stakeholder meeting will also be held to discuss the draft management objectives and targets for the three high-level goals of the TMP.
- September 2015 – The second TMP workshop will be held where the same Expert Panel will review the outputs of the risk assessment model.
- October/November 2015 – A progress report will be released to stakeholders to update them on the outputs of the second workshop.
- October/November 2015 – The outputs of the second workshop will be used to inform the development of management options that make up the TMP.
- January 2016 – Draft management options will undergo public consultation.
- April 2016 – Final advice presented to Ministers.

For updates on the process moving forward visit the Department of Conservation website: http://www.doc.govt.nz/nzsl-tmp.

[1] There were 137 threats initially listed

APPENDIX 1: Threat Management Plan Workshop Terms of Reference New Zealand sea lion Threat Workshop 1 – Development of the TMP

Introduction

There are concerns for the New Zealand sea lion (NZSL), primarily because pup production at the Auckland Island, the main breeding area, has been in a decline for over a decade. In 2014 the Minister of Conservation and Minister for Primary Industries instructed officials to begin work to develop a Threat Management Plan (TMP) as a means to further the recovery of the species throughout its range.

A number of potential factors are thought to be contributing to the sea lion decline. In developing the NZSL TMP it is envisaged that the Department of Conservation (DOC) and Ministry for Primary Industries (MPI), in consultation with iwi and stakeholders, will look at all potential threats to all breeding sites, and develop management options to minimise or mitigate key threats to the sea lions.

A plan and timeline for developing the NZSL TMP was agreed by Ministers in April 2014. An integral part of developing the NZSL TMP is conducting a comprehensive risk assessment for the whole sea lion population. As the amount of information on each possible threat to sea lions varies it has been decided that two workshops will be needed to inform the risk assessment. This April Workshop is the first of the two.

More details on the April workshop is provided below, but very broadly speaking the first workshop is focused on an initial review of the developing sea lion demographic model and to consistently characterise the threats to the NZ sea lion. The second workshop will be focused on reviewing the outcomes of the risk assessment.

The outputs of the risk assessment will be used to inform management options that might make up the NZSL TMP. Prior to the finalisation of the NZSL TMP and to aid decision-making, a public consultation over the draft NZ TMP will be undertaken. It is expected that Ministers will be presented with the options on the content of the NZSL TMP, as well as all submissions, in April 2016.

Purpose of April Workshop

The purpose of the April workshop is to bring together international and national experts to:

1. Review the New Zealand sea lion demographic model as a potential construct to underpin the risk assessment,
2. Characterise threats to sea lions across all breeding sites, and
3. Discuss the likelihood of certain population trends given different assumptions around carrying capacity and accumulative impacts.

Scope

This workshop will address three topics over four days:

1. A review of the demographic model framework (Day 1)
2. Threat characterisation, highlighting the breeding site and age each threat is likely to impact (Day 2-3)
3. Discussion on the implementation of modelling multiple threats on sea lion populations (Day 4)

The three topics are described in more detail within the Workshop Schedule and Methodologies below.

The focus of the workshop is risk assessment, not risk management. Discussion of alternative options for managing the identified risks will be out of scope for the workshop. Development and evaluation of threat management options will be addressed separately, following the conclusion of the risk assessment.

Conduct of the Workshop

The workshop will be conducted in a professional, collegial and scientifically objective manner. Members of the Advisory Group will have their own views and interpretations of available evidence and are expected to provide these views objectively, explaining how they consider them to be supported by the available evidence. A clear distinction will be made between evidence-based interpretation and personal opinion.

All members of the Scientific Panel will be accorded equal opportunity to express their views, and are required to respect the views of other participants, whether they share those views or not.

All workshop participants will commit to:

- facilitating an atmosphere of honesty, openness and trust;
- having respect for the role of the Chair; and
- listening to the views of others, and treating them with respect.

All Members of the Scientific Panel and Advisory Group will further commit to:

- participating in the discussion in an objective and unbiased manner;
- adopting a constructive approach;

Participants who do not adhere to the above protocols of participation may be excluded by the Chair from a particular part of the workshop or, in more serious instances, from the remainder of the workshop.

Participants

The workshop participants will include:

- An independent workshop Chair;
- A facilitation group of nominated DOC and MPI scientists that will assist the chair;
- A science panel comprising invited national and international experts to address each workshop topic;
- A group of advisors consisting of nominated national experts; and
- Observers.

The workshop is open for observers, however due to limited space being available at the workshop venue, space will be made available first and foremost for the expert panel and invited advisors. Expectations and responsibilities of participants are explained in more detail below.

Chairperson

The Chair of the workshop will be an independent scientist selected by MPI and DOC to be an objective, impartial and respected scientists in their field, able to Chair and actively participate in scientific debates on the research topics to be dealt with by the workshop. The Chair is primarily a facilitator, and is responsible for:

- Ensuring that all participants adhere to the workshop terms of reference and agenda, including adhering to allotted times specified in the agenda.
- implementing the rules of procedure consistent with the workshop's purpose and scope;
- promoting full participation and constructive discussion by all participants;

- working to achieve consensus from the Expert Panel where possible, based on available evidence. Where consensus cannot be reached, the Chair may refer to the facilitation group for support in identifying or clarifying and recording alternative views; and
- identifying and managing conflicts of interest.

Expert Panel

The expert panel will be comprised of invited national/international persons with expertise relevant to the assessment of risk to the sea lion, which are considered not to be directly involved with any NZSL research or management. The expert panel members will be responsible for:

- Familiarising themselves with the material circulated to them prior to the workshop
- Adhering to the workshop code of conduct
- Providing constructive review/input on the review of the demographic model
- Provide constructive review/input into the threat characterisations
- Provide constructive review/input into discussions on modelling population dynamics
- Drawing on the information and experience of the invited advisors

The panel is not required to produce any documents as a result of this workshop. However they are asked to review the workshop meeting notes to ensure their thoughts/ideas have been effectively and accurately communicated.

Advisors

Advisors are national experts that have been invited to attend the workshop by the TMP Project Team to advise the panel on their own specific topic of expertise, provide feedback to inform the threat classification, and to ensure transparency in the scientific process.

Advisors will be invited to attend the workshop on certain days. On those days they may be asked to give a presentation on a relevant topic. Advisors giving presentations will have 15 min to present and five minutes after the presentation to answer any questions from the Expert Panel or Advisors.

Advisors are responsible for:

- Adhering to the workshop code of conduct
- Providing information to the expert panel on the topic which they have been invited to communicate on

Advisors are welcome to attend the workshop on the days they have not specifically been invited to. However they will be attending as an observer and no longer as an advisor

Observers

Those participating as observers are only there to observe the proceedings, to facilitate transparency and understanding of the process. Observers will not be permitted to contribute to workshop discussion unless specifically asked to by the Chair.

Observers will include any persons who are interested in attending the workshop and are not participating as chosen advisors or expert panel members. Observers are responsible for adhering to the workshop terms of reference.

Conflicts of Interest

Participants will be asked to declare any interests that may give rise to actual, perceived or likely conflicts of interest before involvement in the workshop is approved. Expert panel members and advisors will be expected to declare any conflicts of interest that arise during the workshop. These will be clearly documented in the notes of the workshop. Observers will be expected to register on the sign in sheet the group or groups which they represent.

The Chair will be responsible for managing any conflicts of interest that arise during the workshop in consultation with the facilitation group, to ensure that conflicts of interest do not jeopardise the objectivity of the workshop outcomes.

Documents and record-keeping

The workshop will be run formally with an agenda and background documents circulated prior to the workshop and formal records kept of recommendations, conclusions and action items.

Other than publically available published reports, workshop working documents circulated to participants are done so in confidence. Participants may not distribute these to others without the prior agreement of DOC and MPI in writing. Participants who do not maintain the confidentiality of workshop papers will be excluded from the workshop.

Presentations (unless otherwise specified) should be 15 minutes. There will be 5 minutes after a presentation for questions.

The overall responsibility for record-keeping rests with nominated DOC and MPI staff, including:

- Recording the threat classification, including comments and spatial information (e.g. GIS files)
- Recording any recommendations, conclusions or follow-up actions; and
- In cases designated by the Chair or the facilitation group, recording the extent to which agreement or consensus was achieved, and recording any disagreement.

Material provided to the International experts will be circulated prior to the workshop so everyone is aware of the material. Information presented will have been reviewed by both the MPI Aquatic Environment Working Group and the DOC Conservation Services Programme Technical Working Group.

Material provided at the workshop will include:

- Workshop Schedule
- Draft New Zealand sea lion literature review
- Copy of all presentations
- Initial list of threats and draft characterisation
- Map of sea lion distribution and map of fishing effort

Schedule

Day 1: A review of the demographic model framework

- *Scope* - The first day of the workshop will be primarily focused on reviewing the demographic model's suitability as a framework for risk assessment. To facilitate this discussion, brief presentations on sea lion biology, genetics, demographic rates, and population structure will be given.
- *Aim* - The aim of this first day is to provide constructive feedback to NIWA on the models potential as a construct to underpin the risk assessment as well as recommendations on future work for model construction
- *Advisors* - Due to the technical topics being discussed, Advisors invited to participate on day one will have an understanding of population modelling and/or sea lion population demographics.

Day 2 – Day 3: Threat Characterisation

- *Scope* - The second and third day of the workshop will focus on characterising threats to the NZSL population initially identified by DOC and MPI, and subsequently on any new threats identified during the workshop.
- *Aim* - For each potential threat identified, the panel are tasked with:
  - identifying one or more population parameter through which each threat is most likely to impact on the population (e.g. adult survival, pup production).
  - Recommending plausible time bounds of the impact
  - Identifying the geographic range over which the threat is plausible.
- *Advisors* - People invited as Advisors over these two days are considered to have a considerable amount of knowledge about either the specific breeding locations (and possible threats found at these locations), direct impact of fishing, disease, climate change or diet. A series of presentations on both sea lion biology/ecology and known threats will be made to the panel.
- *Process* - At the start of Day 2 DOC and MPI will present the draft list of threats and threat characterisation. Other threats may be added to the list at this point. The rest of Day 2 will comprise a range of presentations from Advisors to provide context before characterising the threats. We will aim to go through one trial characterisation at the close of Day 2 and the bulk of the characterisations on Day 3.

Day 4: Discussion on the implementation of modelling multiple threats on sea lion populations

- *Scope* - Following the identification and characterisation of threats (Days 2 and 3), the final day of the workshop will focus on consideration of how cumulative threats may act on sea lion populations and associated issues with modelling this. The need for density-dependence, and its mechanism, in such modelling will form part of the considerations.
- *Aim* - To provide recommendations to the NIWA modelling team on the most appropriate mechanisms to model multiple threats on multiple population parameters. This will allow NIWA to develop a robust modelling framework for evaluating potential management strategies.
- *Advisors* - Due to the technical topics being discussed, Advisors invited to participate on day four will have an understanding of population modelling and/or sea lion population demographics.

APPENDIX 2: List of Attendees

Chair:
Andrew Penney

TMP Project Team Attendees:
Nathan Walker, Laura Boren, Michelle Beritzhoff-Law, Katie Clemens-Seely,

TMP Project Executive:
Vicky Reeve, Ian Angus

Independent Expert Panel:
- David Hayman
- Jason Baker
- Mark Hindell
- Mike Lonergan

Advisors: [2]

Day 1	Day 2 and Day 3	Day 4
• Ed Abraham • Darryl MacKenzie • Jim Roberts • Ian Doonan • Simon Childerhouse • Catherine Collins • Martin Cryer • Paul Breen	• Louise Chilvers • Brittany Graham • Chris Lalas • Wendi Roe • Ros Cole • Martin Cryer • Jim Fyfe • Shaun McConkey • Brent Beaven • Jim Roberts • Ian Doonan • Richard Wells • Simon Childerhouse • Richard O'Driscoll	• Ed Abraham • Jim Roberts • Ian Doonan • Simon Childerhouse • Martin Cryer

Observers:[1]
- Sarah Michael
- Mark Geytenbeek
- Kyle Morrison
- David Middleton
- Martin Cawthorn
- Annie Galland

[2] Many of the Advisors attended other days of the workshop as Observers, therefore the list of Observers are people that attended who are not already listed as an Advisor

APPENDIX 3: Final Recommendations from the Expert Panel

Expert panel priorities are indicated as **H**igh (important to the current TMP process, or for research in the near future), **M**edium (useful to the current TMP process, or important for medium term research) or **L**ow (potentially interesting for future research).

Demographic Model

- **H** - The workshop noted and supported the recommendations already made by the AEWG for model improvements, revisions and exploratory analyses.
- **H** - Model outputs, such as estimates of demographic parameters and trends should be presented with information on their precision (such as standard errors or confidence intervals) where possible. Use of MCMC for final analyses would allow credible intervals to be provided for all parameter estimates.
- **L** - Use of tag re-sighting data to estimate tag loss rates depends on knowledge about when each tag type (flipper tags, PIT tags or branding) was looked for. It is not clear that this information was recorded for all re-sightings. If a particular tag type was not looked for, then that record cannot be used in estimation of tag loss rates for that tag type. There seems to be a particular need to check this for the PIT tag re-sighting estimates.
- **L** - Questions were raised about the most appropriate way to deal with animals of unknown pupping status in the model. At present, decision rules are used to determine pupping status from observations (observed suckling, at least 3 sightings with a pup or 3 sightings without a pup) to determine pupping status, with the remaining animals classified as unknown and divided in the proportion of known pupping / non-pupping. Exclusion of animals of unknown status results in increased estimates of pupping rate. Alternative approaches should be considered and the sensitivity of pupping rate to relaxing the decision rules should be explored, such as relaxing the decision rules used to determine pupping status to 2 or 1 observations with or without a pup, or use of other information such as females calling to pups.
- **M** - Similar questions were raised about determining pupping status before an animal that has moved between colonies is used to estimate migration(translocation) rates. As an alternative, this requirements could be relaxed to include animals simply observed (but not confirmed to be pupping) at another colony to be included in migration rate estimation.
- **H** - Questions were raised about the fixing of pup survival rates for 1985 - 1989, 1994 - 1997 and 2008 at 0.5. Exploratory analyses presented at the workshop suggested that use of cohort strength from age structure data may provide estimates for the earlier years, but results in a very low survival estimate for 2008. The confounding effect of apparent poor tag retention in that year makes the veracity of this low estimate uncertain. Alternatives should be investigated other than fixing survival for these years at 0.5, including the use of age structure or, for 2008, using the average of previous and next years.
- **M** - The assumption of a CV of 0.06 for pup census indices, as the only way of specifying a relative weighting between census and tag-recapture data, was questioned. Alternative CVs and weighting approaches should be determined using something like standard deviations of Pearson residuals.
- **H** - The use of 0.95 as an upper bound for survival rate for all age classes was questioned. Higher survival rate upper bounds (1.00) are used for other pinnipeds. Some potential alternative explanations for the lower apparent survival after age 6 yr include: 1) adults experience higher tag loss rates but the model is fitting age-invariant tag loss, which would negatively bias adult survival estimates; 2) Low adult

survival for a few cohorts in the 2000s might have pulled down the average for all years - this could be investigated by examining lx curves for each cohort to determine whether the depression in adult survival relative to sub-adults is consistent among cohorts, and 3) the age 6+ group may be made up of quite different age structures over time, including senescent animals.

- **H** - Exploratory analyses presented at the workshop showed that a number of parameters vary by year and age. This was observed for tag loss estimates, at least partially related to different tagging approaches in different years. Using fixed estimates of tag loss contributes to under-estimation of tag loss and resulting effects on survival estimates for older age classes, particularly the 8+ group. This may be a combined effect of different tagging approaches and increasing tag loss rate for older animals. Options for modelling time-varying tag loss (by year and age) should be explored.
- **M** - Incorporation of time-varying re-sighting probability was noted to improve model fits, indicating that that re-sighting probabilities did vary over time. One could explore whether the number of days on which re-sightings were conducted each year are correlated with effort days, in which case effort days could be used to estimate re-sight probabilities for recent years that have not been back-corrected.
- **M** - It was recommended that the effect of incorporation of 'phantom tags' on parameters such as re-sighting probability should be explored. An alternative approach would be to simply multiply the survival rate from tagging to age 1 yr by the directly estimated proportion of pups that die prior to tagging. The latter is, after all, the basis for how many phantom tags are added.
- **H** - The decision to use an area-aggregated model for the Auckland Islands area was supported. However, this raised questions about which census data should be used. Noting that the key tag re-sighting index was for Sandy Bay, it was recommended that the base-case model use the tag re-sighting and census data for Sandy Bay only. A second analysis should use the incorporate the Sandy Bay and Southeast Point census data. A third analysis should use combined census data for the entire Auckland Islands area.
- **H** - Concerns were expressed at restricting analysis to an 8+ group, noting that full maturity is achieved at 6 or 7 years, that older animals show increasing reproductive senility and that much of the available age-composition data is for animals older than 8 years. It was recommended that an older plus group be considered, appropriate to data availability, possibly to 15+. Sensitivity of model estimates to the definition of the plus group, and to possible grouping of some ages below the plus group, should be explored.
- **H** - There were concerns at apparent instability and indications of correlation between some parameter estimates in initial MCMC analyses. These may be resolved by running longer MCMC chains, and there may be a need to investigate reasons for any remaining problems in MCMC chains. It should be attempted to achieve adequate effective sample sizes in these analyses.
- **H** - Questions were raised about the appropriateness of the Seabird demographic model for conducting projections under alternative risk-reduction strategies. The approach used in fisheries assessments would be to develop a base-case demographic model using the current model selection criteria (best AIC) and use this to develop best estimates of demographic rate parameters. A limited number of

alternative specifications of this model, exploring key unresolved uncertainties, should be specified and used as robustness trials to explore the effects of these uncertainties on projections and risk reduction strategy evaluations. An alternative approach could be to develop a simpler model for projections and planning conservation strategies. Implementation of conservation strategies should be followed by well-designed data collection to evaluate efficacy.

- H - Retrospective analyses could be used to evaluate and correct for the increase in historical pup survival rate estimates as the number of years of re-sighting increase for each estimate. This would be important for projections. However, this initial downward bias in survival estimates may result from fixing survival for ages 2 - 5. If so, then it would be preferred to estimate survival for each of these age classes separately or fit a trend in survival over these ages. This may not be that important for projections which could draw from a distribution of observed rates excluding recent years. Alternately, one could estimate recent rates by fixing re-sight probabilities based on an observed relationship between field effort and re-sight rates.
- H - Interpretation of the results of modelling and projections incorporating density dependent effects is problematic as results will primarily be driven by assumptions regarding the density-dependence relationships. Projections should focus on the short to medium-term (5 - 10 year) timeframe.
- L - Hierarchical modelling approaches should be considered for future (i.e. beyond the current TMP) demographic modelling work, to provide for the estimation and fixing of certain parameter estimates before moving on to estimation of further parameters.
- H - Subsets of data could be used to explore fitting to part of the data (training data set) and then determining how well the resulting parameter estimates predict the remaining data.

Monitoring& Research

Campbell Island

- H - There are currently irregular census data and limited re-sighting data available for the Campbell Island colony. This limits the capability to conduct demographic modelling of the population there. Efforts to understand the drivers behind population trends should be enhanced by comparing declining (Auckland) and growing (Campbell) sub-populations. The trends (population growth) and demographic rates (apparent high pup mortality) at Campbell Island differ from those at the Auckland Islands, and it would be useful to understand the reasons for these. Options for improving data collection at this site should be investigated.

Mark / Recapture Studies

- M - It is important for all re-sighting records to record which type of marking (flipper tag, PIT or brand) were actually looked for, in addition to recording which were seen / detected.

- **H** - Mark loss is a challenge for all long-term demographic studies based on tracking individuals. The fact that nearly all pups born at Sandy Bay have been tagged in the past 17 years, yet only some 20-40% of the population is currently marked, is a concern. The field program should investigate methods for maintaining ID's longer, either through active re-tagging of single tagged seals, re-tagging PIT tagged seals, photo ID or perhaps branding at some age prior to significant tag loss.

Dietary Analysis

- **M** - Stable isotope ratio analysis of historically collected sea lion whiskers should be used to further investigate diet composition and benthic / pelagic prey switching for the Auckland Islands sea lions.
- **M** - Stable isotope ratio dietary analysis of existing samples should be extended beyond the Auckland Islands to all other colonies. Results from whisker and tooth analyses from the same individuals should be compared to ascertain whether high isotope variability in tooth analyses is a methodological issue.
- **L** - Sea lion stable isotope ratio diet analyses should be compared with broader data sets and longer time series, including similar analyses for species such as fur seals, to try and detect consistent signals indicating environmentally driven changes in food web isotope ratios.
- **L** - Future field biological data collection should include collection of sea lion whiskers for use in further dietary studies using isotope ratios.
- **M** - Future dietary studies using scats or casts should attempt to determine whether such samples emanate from male or female sea lions, using genetic analysis of a portion of the sample.
- **H** - Existing information and results of past sea lion dietary studies should be summarised and collated into a single document. This review should evaluate the strengths and weaknesses of alternative approaches and methods used and identify relevant data sources.

Disease Analysis

- **H** - Time series of weekly pup mortalities at the Auckland Islands should be used to develop an epidemiological model to understand the course of annual disease outbreaks, estimate R_0 vales and estimate annual epidemic sizes.
- **H** - Molecular epidemiology (genetic) analyses should be conducted of *Klebsiella* outbreaks to evaluate whether these all emanate from a recent introduction and clonal expansion, or from a wider spread historical background of pathogens that recently started entering the population.
- **H** - There is a gap in information on disease processes at a time of high unobserved mortality in the period after females and pups disperse after the pupping season. Efforts should be made to collect information after the pupping season. This could be achieved by conducting winter surveys to the Auckland Islands.
- **M** - Efforts should be made to collect additional information on predisposing risk factors (such as immuno-competence) for bacterial infection in pups at various sites.
- **M** - A mainland disease surveillance program should be implemented to detect potential sea lion diseases and disease vectors, including fur seals and other potential pathogen reservoirs or vectors (domestic and feral animals, livestock, etc.) This information could be used to develop approaches to reduce disease transmission and facilitate successful mainland re-colonization by sea lions.

Risk Characterisation

- **H** - Initial model evaluations of threats should focus on using their upper bounds to evaluate whether significant effects are expected at this level. If not, then these insignificant threats can be excluded from further analyses. If yes, then further threat analysis should be based on an appropriate probability distribution of the significant threats between the proposed upper and lower bounds.
- **M** - Further correlation/regression analysis is needed to assess the relative effects of fishing and environmental effects on prey availability and nutritional stress, particularly in years of low pupping rate.
- **M** - A central database should be compiled to document all observed impacts (injuries, mortalities, disappearances, entanglements, etc) of sea lions.
- **H** - Efforts should be made to better quantify strike rates in trawl fisheries, such as by use of cameras to detect entry of sea lions into nets.
- **L** - Efforts should be made to model the effect of loss of a breeding site as a result of a catastrophic site-specific event. Consideration of meta-population hypotheses might be useful in this respect.

Mitigation

- **H** - Suitable education programs should be developed and implemented to inform the public regarding protection and conservation of mainland sea lions in the Stewart Island, Otago and Southland areas, to reduce human impacts in these areas.
- **H** - While the long term aim is for the population to exist in as natural a state as possible, with minimal human intervention, the potential for beneficial interventions to improve survival, reproductive success or distribution should be investigated.
- **H** - At sites where significant numbers of pups die due to entrapment or drowning in holes, proven methods (such as escape ramps for pups) or other promising tools should be tested and evaluated for their efficacy.
- **M** - The recent re-colonization by monk seals of the Main Hawaiian Islands (MHI) has become a central focus of the species' recovery. Several lines of evidence suggest that mainland NZ represents under-occupied habitat that may hold potential for population recovery of sea lions. As such, efforts to foster re-colonization of the mainland should be a focus conservation planning.

Threat Assessment Modelling Process

- Threat assessment modelling for the Auckland Islands and Otago area will primarily be conducted using the Seabird software.
- The integrated demographic model will be fitted to available historical since 1960, including tag-resight data, pup census data, age structure and available data on mortality resulting from known threats.
- Assessment for Campbell Island and Stewart Island will be conducted using simpler Lesley matrix approaches.
- Demographic assessments will use a starting year of 1960.
- Demographic models will extend to including a 15+ age class. Alternative groupings of younger age classes (such as the 2 - 5 years, prime breeding females) will be evaluated and selected.

- Projections will be run over 20 year periods, with indicators of status against appropriate reference levels at 5, 10 and 20 years.
- Appropriate metrics and reference levels will be chosen to measure projected status. These may include mature numbers, mature female numbers, pup numbers, population reproductive capacity, age structure or relevant demographic rates, as appropriate to the projection.
- All parameter estimates, and projections and measures against reference levels will be provided with credibility intervals.
- Results of demographic model fits to historical data will be evaluated to inform decisions on which years to use for determining demographic rate parameters to use in projections. Options include using averages over shorter or longer periods of recent years, sampling from a range of values over a selected period of years and excluding recent years of high uncertainty. The choice of approach will be discussed and finalised at an Aquatic Environment Working Group meeting at which initial exploratory modelling results are discussed.
- Threats for which data are available will be modelled in projections by providing the projection model with estimated future mortality vectors in the form of 'pseudo-fisheries, or by providing the model with values or distributions of changes in demographic rates resulting from those threats.
- Potential effects of other threats will be investigated by running projections varying key demographic rates, and then mapping results against threats that could have caused those changes in demographic rates.
- The effect of past mortality resulting from key threats for which data are available (such as disease and fishing mortality), or for which plausible estimates are available (such as cryptic mortality), will be explored by fitting the historical demographic model including data on mortality arising from known threats to estimate starting (1960) and current population structure. Threat-derived mortality will then be excluded from the model and re-run from the estimated starting population to predict population structure in the absence of such mortality.
- Identified episodic threats (such as periodic catastrophic disease outbreaks) identified in the threat characterisation process will be modelled as characterised. However, it is not expected that other unexpected periodic threats will be modelled.
- The potential impact of other unexpected periodic threats (such as oil spills) will be evaluated by modelling the impact of loss of 90% of the population at the Auckland Islands or Otago, using Otago (small population) demographic rates to project the Auckland Islands population after the population loss.

APPENDIX 4: Glossary for Threat Characterisation Spreadsheet

Population:

AI = Auckland Islands
ML = Mainland (Otago, Southland)
SI = Stewart Island
CI = Campbell Island

Justification/Confidence Score:

Confidence scores, given for each estimation of impact, were characterised using the rating system from Hobday 2007:

Confidence rating	Score	Rationale for confidence score
Low	1a	Data exists, but is considered poor or conflicting.
	1b	No data exists.
	1c	Agreement between experts, but with low confidence
	1d	Disagreement between experts
High	2a	Data exists and is considered sound.
	2b	Consensus between experts
	2c	High confidence exposure to impact cannot occur (e.g. no spatial overlap of fishing activity and at-sea seabird distribution)

Model or Not:

Rows shaded blue indicate the threats which will be carried forward into the first modelling phase. This distinction was often based on the amount and quality of information available on the threat.

APPENDIX 5: Threat Characterisation Spreadsheet

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	Threat	Description of threat	Population likely to affect	Units used	Estimated actual Impact	Shape of distribution	Lower bound of impact	Upper bound of impact	Justification / Confidence score around estimates	Periodicity of threat	Model or not?	Duration of impact if not annual
Coastal development	Noise	Injury/mortality, indirect effect on pup, & compromised health	ML, SI		0				1b		No	
Coastal development	Habitat alterations & related issues (ex: pollution)	Displacement & compromised health	ML, SI		0				1b		No	
Disease	Klebsiella	Pup mortality	AI, others?	Pup mortality rate			6%	Highest (from the model) mortality rate from all causes of death	2a	Annual	Yes	N/A
Disease	Klebsiella	Adult mortality	AI, ML, others?	# of adults	1 in 15 yrs (in Otago - ML), none anywhere else (that we know)		0	2 in 15 years (ML)	2b	Annual	Yes	N/A
Disease	Klebsiella	Indirect effect on pup	AI, ML, others?	# of pups			0	1 in 30 years	1c	Annual	Yes	N/A
Disease	Hookworm	Compromised health	AI, others?	Pup mortality rate			0	13% of pup mortality in the first year	2a	Annual	Yes	N/A
Disease	Hookworm	Pup mortality	AI, others?	# of pups			2 pups per year (Enderby)	10 pups per year (Enderby)	2b	Annual	Yes	N/A
Disease	Wildlife vectors	Adult & pup mortality, & compromised health	ML, SI		0				1b		No	
Disease	TB	Adult mortality	ALL	# of adults			3 for AI (0 for ML)	1% of the adult population	2c	Annual	Yes	N/A
Disease	Novel agent	Pup mortality	ALL	# of pups				90% of the pups born at the site in question	2a	Decadal	Yes - Sensitivity	
Disease	Novel agent	Adult mortality	ALL	# of adults				70% of the adults at the site in question	2a	Decadal	Yes - Sensitivity	

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	**Threat**	**Description of threat**	**Population likely to affect**	**Units used**	**Estimated actual Impact**	**Shape of distribution**	**Lower bound of impact**	**Upper bound of impact**	**Justification / Confidence score around estimates**	**Periodicity of threat**	**Model or not?**	**Duration of impact if not annual**
Environmental change	Coastal erosion/sand dune loss	Lack of suitable habitat & indirect effect on pup	All, mostly ML, SI		0				1b		No	
Environmental change	Pups drowning in holes	Pup mortality	AI	# of pups	2 a year*	Skewed towards lower bound	0	70 per year	2b	Fluctuates - AI	Yes	
Environmental change	Pups drowning in holes	Pup mortality	CI	# of pups	80 out of 600 pups		20	160 (out of 600)	2b	Annually - CI	Yes	
Environmental change	Storms	Direct effects	All						1b		No	
Trophic effects	Prey availability	Direct & indirect effects of nutritional stress, competition for prey, & changes in prey and predator abundance	All	Pup production rate & pup survival rate, pup survival in current yr, pupping rate in subsequent yr			Good years	Change in pupping rate b/w good yrs (03,04,08) and bad yrs (02,05,06,09) AND change in pup survival rate b/w good yrs (03,04,08) and bad yrs (02,05,06,09)	2a	4 in 15 yrs	Yes	1 yr
Finfish farming	Habitat modification	Displacement	ML, SI	# of adults	0		0	0	2c	Annual	No	-
Finfish farming	Pollution	Compromised health	ML, SI	# pups	0		0	0	1a	Annual	No	-
Finfish farming	Negative human interactions	Shooting/mortality	ML, SI	# of adults	0		0	-	1b		No	N/A
Finfish farming	Entanglement	Adult mortality	ML, SI	# of adults			0	2	2a	Annual	Yes	-
Shellfish farming	Habitat alterations, pollution, & negative human interactions	Displacement, compromised health, effect on food availability, harassment (fatal or not), & indirect impact on pup	ML, SI		0		0	0	2a		No	

*This is the estimated actual impact if the ‘plank for pups’ program continues, if it does not it will most likely be higher.

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	**Threat**	**Description of threat**	**Population likely to affect**	**Units used**	**Estimated actual Impact**	**Shape of distribution**	**Lower bound of impact**	**Upper bound of impact**	**Justification / Confidence score around estimates**	**Periodicity of threat**	**Model or not?**	**Duration of impact if not annual**
Fishing	SLEDs	Adult female mortality that is not retained (cryptic mortality)	AI, CI (AI-F, CI-M)	# of females	3% of interactions (including those retained)		0	(# of Female Interactions - # of retained dead females)* 10%	1c	Annual	Yes	N/A
Fishing	SLEDs	Indirect effect on pup from cryptic death (non-retained breeding female)	AI	# of pups			0	(# of Breeding females interactions - retained dead breeding females) * 10%	1c	Annual	Yes	N/A
Fishing	Commercial set net	Incidental capture	SI, ML	# of females			0	Theoretical upper bound from estimated observed captures of HSL in comparison to effort over the NZ range (OBS/fishing), and female population size	1a	Annual	Yes	N/A
Fishing	Commercial set net	Entanglement/injury	SI, ML	# of females			0	Theoretical upper bound from estimated observed captures of HSL in comparison to effort over the NZ range (OBS/fishing), and female population size	1a	Annual	Yes	N/A
Fishing	Commercial set net	Indirect effect on pup	SI, ML	# of pups			0	Theoretical upper bound from estimated observed captures of HSL in comparison to effort over the NZ range (OBS/fishing), and female population size	1a	Annual	Yes	N/A
Fishing	Recreational set net	**Incidental capture**	**ML, SI**				**0**	-	**1b**	**Annual**	**No**	**N/A**
Fishing	Recreational line	Entanglement/incidental capture/injury	SI, ML	# of adults				Based on recorded observations of entangled/hooked NZSLs	1a	Annual	Yes	N/A
Fishing	Recreational line	Indirect effect on pup	SI, ML	# pups				Based on female proportion of recorded observations of entangled/hooked NZSLs	1a	Annual	Yes	N/A
Fishing	Commercial potting	**Incidental capture**	**SI, ML**		**0**		**0**	-	**1a**	**Annual**	**No**	**N/A**
Fishing	Commercial potting	**Entanglement**	**SI, ML**		**0**		**0**	-	**1a**	**Annual**	**No**	**N/A**
Fishing	Commercial potting	**Indirect effect on pup**	**SI, ML**		**0**		**0**	-	**1a**	**Annual**	**No**	**N/A**
Fishing	Surface long line	**Entanglement/incidental capture/injury & indirect effect on pup**	**SI, ML**		**0**				**1a**		**No**	

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	**Threat**	**Description of threat**	**Population likely to affect**	**Units used**	**Estimated actual Impact**	**Shape of distribution**	**Lower bound of impact**	**Upper bound of impact**	**Justification / Confidence score around estimates**	**Periodicity of threat**	**Model or not?**	**Duration of impact if not annual**
Fishing	Commercial trawl*	Incidental capture	All? Or AI, CI	# of females					2a		Yes	
Fishing	Commercial trawl*	Indirect effect on pup	All? Or AI, CI	# of pups					2a		Yes	
Fishing	Vessel noise	Compromised health	All		0				1b		No	
Fishing	Habitat modification	Displacement	All		0				1b		No	
Mining and oil activities	Noise	Compromised health, injury/mortality, indirect effect on pup	ML		0		0	-	1b		No	
Mining and oil activities	Habitat alterations/degradation & related issues (ex: pollution)	Displacement & compromised health	ML		0				1b		No	
Natural behaviour	Male NZSL aggression	Female mortality	All, mostly ML, SI	# of females	Enderby - Avg 1 F/year relative to # of F on the beach, need to be scaled to other colonies; Otago - 3 F in 15 years)		0	11 F / year	2a	Annual	Yes	N/A
Natural behaviour	Male NZSL aggression	Pup mortality	All, mostly ML, SI	# of pups	Wendi to provide #s for Enderby, Otago - 2 in 15 years; scaled relative to the population present in each location		0	20% of pup mortality for that season	2a	Annual	Yes	N/A
Natural behaviour	Male NZSL aggression	Female injury	All, mostly ML, SI		84% of F (Enderby) have scars from males, but no information on how many of that have reproductive success impacted				1c		No	

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	**Threat**	**Description of threat**	**Population likely to affect**	**Units used**	**Estimated actual Impact**	**Shape of distribution**	**Lower bound of impact**	**Upper bound of impact**	**Justification / Confidence score around estimates**	**Periodicity of threat**	**Model or not?**	**Duration of impact if not annual**
Other humans	Dogs	Injury & compromised health	ML, SI		0				1b		No	
Other humans	Dogs	Adult mortality	ML, SI	# of adult females			0	0	2a	Annual	Yes	N/A
Other humans	Dogs	Pup mortality	ML, SI	# of pups	1 pup in 15 yrs		0	4 in 15 years	1c	Annual	Yes	N/A
Other humans	Deliberate harassment	Injury & compromised health	All, mostly ML, SI				0	-	1b		No	
Other humans	Deliberate mortality	Adult mortality	All, mostly ML, SI	# of adults	SI-8 (1 F) ; Sthland 5 (1 F), Otago - 4 (1 F), Blenheim - 1 (in 15 years)		18 in 15 years	3x lower bound	1c	annual	Yes	N/A
Other humans	Deliberate mortality	Pup mortality	All, mostly ML, SI	# of pups	0		0	9	1c	annual	Yes	N/A
Other humans	Deliberate mortality	Indirect effect on pup	All, mostly ML, SI				0	9	1c		No	
Other humans	Domestic animals as disease vectors	Compromised health	ML, SI		0				1b		No	
Other humans	Domestic animals as disease vectors	Adult mortality	ML, SI		0				1b		No	
Other humans	Domestic animals as disease vectors	Pup mortality	ML, SI		0				1b		No	
Other humans	Disease vectors	Compromised health, adult & pup mortality	All		0				1b		No	
Pollution	Plastics - entanglement	Adult mortality	All	# of adults	Enderby - 4 in 25 yrs (2 F (1 trawl net) & 2 M (other 3 longline)); 5 in 15 years - Otago (all M)		0	Enderby - 8 in 25 years; Otago - 10 in 15 years	2a		Yes	
Pollution	Plastics - entanglement	Juvenile mortality	All	# of juveniles	0		0	Enderby - 1 per year; Otago - 10 in 15 years	1c		Yes	
Pollution	Plastics - entanglement	Compromised health	All		0				1b		No	
Pollution	Agricultural & industrial run-off, & sewage related issues	Compromised health & displacement	ML, SI, All		0				1b		No	
Pollution	Plastics - ingestible	Adult & pup mortality, & compromised health	All		0				1b		No	
Pollution	Oil spills - ingestion & inhalation	Adult & pup mortality, & compromised health	All		0				1b		No	

Description of Potentially Threatening Activities				Scale of impact								
Threat Class	**Threat**	**Description of threat**	**Population likely to affect**	**Units used**	**Estimated actual Impact**	**Shape of distribution**	**Lower bound of impact**	**Upper bound of impact**	**Justification / Confidence score around estimates**	**Periodicity of threat**	**Model or not?**	**Duration of impact if not annual**
Predation	Orca	Injury, adult & pup mortality	ML, SI		0				1b		No	
Predation	Sharks	Injury	All	# of adults	AI 6 to 9 fresh shark bites in 2015; CI - less than 1% scarring rate	Enderby - trend is flat			1c		Yes	
Predation	Sharks	Adult mortality	All	# of adults	Otago - 2 in 15 yrs				1c		Yes	
Predation	Sharks	Pup mortality	All		0				1b		No	
Research	Injury/stress	Compromised health	All	Pupping rate	0				1b		No	
Research	Mortality	Adult/juvenile mortality	All	# of adults	3 (2 AI; 1 CI) in 25 years (2 F, 1 M)		0	rate per animal anesthetised	2a		No	
Research	Mortality	Pup mortality	All	# of pups	0		0	0	2a		No	
Research	Possible disease vectors & disturbance	Compromised health, adult/juvenile mortality, & displacement	All		0		0	-	1b		No	
Tourism & General recreation	Noise	Compromised health	All		0	-	0	0	2a		No	
Tourism & General recreation	Disturbance	Compromised health	All		0		0	0	2a		No	
Tourism & General recreation	Displacement	Displacement from suitable habitat	All		0		0	0	2a		No	
Vehicles	Vehicle strike	Physical injury	ML, SI		0		0	-	1b		No	
Vehicles	Vehicle strike	Adult mortality	ML	# of females	1 F per 7 yrs	skewed low	0	2 F per 7 years	2c	Annual	Yes	N/A
Vehicles	Vehicle strike	Indirect effect on pup	ML, SI	# of females	1 F per 7 yrs	skewed low	0	2 F per 7 years	2c	Annual	Yes	N/A
Vehicles	Boat strike	Injury/mortality & indirect effect on pup	All		0				1b		No	
Vehicles	Disturbance	Compromised health & displacement from suitable habitat	ML, SI		0				1b		No	