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Submission on the *Draft New Zealand sea lion Threat Management Plan*

Please find my submission on the Threat Management Plan (TMP) for the New Zealand sea lion *Phocarctos hookeri*, as outlined in the Consultation Document, Background material and various supporting documents listed on the TMP consultation website.

In this submission, I highlight concerns with the TMP process and proposed outcomes, and also call for:

- an expert workshop exploring the existing uncertainty in sea lion exclusion device (SLED) efficacy, post-SLED survival and direct fishing impacts, the same as was done for pup mortality in June 2014, to thoroughly review fishing as a threat to sea lions at the Auckland Islands.
- direct action on existing direct and indirect fishing impacts and I propose using an area closure of one fishing use area in SQU6T around the Auckland Islands.
- a review of the "best estimate" of the disease *Klebsiella*, as there is good reason to believe that this estimate has been over-estimated in the TMP process leading to the risk of *Klebsiella* being overstated in the TMP
- a review of the "best estimate" of the direct effects of fishing on the Auckland Islands subpopulation, as there is good reason to believe that this estimate has been under-estimated in the TMP process leading to the risk of fishing being understated in the TMP
- a review of the current operational plan for SQU6T taking into account the criticism by the 2013 expert panel review of sea lion modelling and management of the use of an 82% discount rate.
- greater transparency in how science information is used in formulating sea lion management decisions, such that scientific uncertainty is acknowledged and appropriately accommodated in management, and involvement of other stakeholder, other than the fishing industry, in the making of management decisions.

While I support the objective of the draft sea lion TMP, which is to "*promote the recovery and ensure the long-term viability of New Zealand sea lions*", **I am very concerned** that commercial fishing impacts are side-lined in the draft TMP. This is at odds with direct effects of commercial fishing (set-net and trawl fishing) being identified in the quantitative risk assessment process (Table 1) as the number one and number two risk to sea lions in the Otago Coast subpopulation and Auckland Islands subpopulation, respectively.

In the draft TMP document, despite commercial fishing being ranked so highly as long-term viability risk factors, the direct effects of fishing do not appear in the National Programme (yet a discussion forum on sea lions and a national engagement campaign do) (Figure 1). At the regional level, the high risk ranking of commercial fishing results in a last place in a list of four key regional goals (pups drowning or starving in holes (wallows) takes 1^{st} place, but was ranked 6^{th} by the risk assessment; only an average of 8% of pups die in wallows per year according to "best estimates") (Figure 1; see Figure 4 below).

Table 1. Ranking of risks to sea lions based on the quantitative risk assessment process. [Table taken as is from TMP Background document]

Auckland Islands subpopulation	Otago coast breeding population
1. *Klebsiella pneumoniae* disease	1. Direct effects of commercial setnet fishing
2. Direct effects of commercial trawl fishing	2. Deliberate human mortality
3. Male sea lion aggression	3. Entanglement
4. Trophic effects/prey availability	4. Male sea lion aggression
5. Hookworm disease	
6. Sea lion pups drowning or starving in holes	

It may well be argued that the placement in the lists in Figure 1 is not indicative of priority. However, examination of the "regional programme Table 2" in the draft TMP document indicates that the only high priority "threat focused programs" for fishing involve better monitoring of trawl fishing at Campbell Island and the Auckland Islands. These "threat focused programs" add nothing new, as these programs are or should already have been done by MPI to monitor threats to sea lions. Monitoring the impacts of commercial fishing is a core responsibility of the Ministry for Primary Industries. Clearly, despite calls from experts over the years, this monitoring has not been done or done properly. So effectively the sea lion TMP is calling for nothing tangible to be done about the high ranked risk that is commercial fishing.

For the Auckland Island subpopulation (68% of the breeding population), where direct fishing impacts are ranked second to disease (Table 1), as noted above, the focus of the TMP is almost solely on disease as the major risk factor. A focus on disease at the expense of any meaningful risk assessment of direct fishing effect is an outcome of the selective use of the available information in the TMP process, which incidentally the consultation document favourably refers to as a "robust information gathering and risk assessment phase".

Figure 1 The New Zealand sea lion Threat Management Plan [taken from TMP Consultation document]

A prime example of the selective nature of the TMP and risk assessment processes is the lack of discussion of existing expert concerns with the effectiveness of sea lion exclusion devices (SLEDs) (i.e. SLED efficacy).

International scientific experts and NZ fishing industry-hired consultants agree that there is little information to reliably inform post-SLED exit survival of sea lions (i.e. cryptic mortality) that have interacted with a SLED in the nets of the SQU6T trawl fishery around the Auckland Island (see below). However, the expert advice is consistently ignored and government officials are content to repeat mantra-like in operational plans, publications, press releases, Official Information Act responses and Ministerial briefings that "MPI consider that SLEDs greatly increase the survival probability of sea lions that enter a trawl net" (OIA16-0313 response). Indeed, in the TMP background document it states "MPI considers that approximately 82% of sea lions probably survive their interactions with fishing gear.". See below for further discussion of concerns with SLED efficacy and cryptic mortality, and how ignoring these concerns can lead to uncertain management outcomes for sea lions.

It is worth noting that simply repeating something does not make it true, especially when there are ongoing uncertainties, evidence to the contrary or indeed a lack of evidence. Whether a position can be supported requires appropriate investigation of the issue (clearly this has not been done here; see below). Ignoring significant uncertainties to defend a particular position is also not becoming of an organisation, and its processes, that professes to be science-based and is apparently governed by a set of standards with which to verify science information (e.g. MPI Research and Science Information Standard for New Zealand Fisheries April 2011).

Conversely, with regards to the selective nature of the TMP, the TMP and risk assessment processes repeatedly highlight that little is known about the disease *Klebsiella*, which is deemed to be the highest risk to the Auckland Islands subpopulation (Table 1). Despite considerable knowledge gaps and uncertainties regarding *Klebsiella* (a fundamental understanding of *Klebsiella* aetiology is lacking), the government willingly accepts stakeholder opinion when setting "best estimates" used in the risk assessment for *Klebsiella*'s role in pup mortality.

Note in this regard, expert concern has been raised about the *Klebsiella* "best estimates" used in determining the importance of the disease threat:

> "There was a concern that the effect of removing Klebsiella may be over estimated. Might need to re-examine how Klebsiella is represented in the best estimates/upper bounds" [Notes of TMP Workshop 2].

The fact that experts' concerns with SLED efficacy are not addressed in the TMP process is also at odds with the SLED efficacy concerns raised in the joint parliamentary press release of then-Minister of Conservation Nick Smith and Minister of MPI Nathan Guy. In the press release, Minister Guy stated "SLEDs are a great innovation but we need to continue to monitor the use and effectiveness of these devices" [6 March 2014]. Minister Smith stated in correspondence to me [dated 30 June 2014; Appendix 5]:

> The further addressing of any uncertainties around SLEDs is a matter of risk management and prioritisation. Both the Ministry for Primary Industries and Department of Conservation are working to prioritise research needs as part of the Threat Management Plan for New Zealand sea lions.
>
> I recently inspected a SLED at Motueka nets in Nelson to get a better appreciation of the technology. I stressed to participants that I was keen for further work to more accurately determine survival rates.

In the joint Ministerial press release announcing the TMP [6 March 2014], Minister Smith said:

> "The purpose of developing a new Threat Management Plan for the New Zealand sea lion is to review all the risks and explore all possible measures to ensure their survival. Options include

active field management such as intervening to reduce the several hundred deaths from misadventure and disease, extending or creating new marine mammal sanctuaries under the Marine Mammals Protection Act, or additional measures to reduce impacts of fishing".

Despite this, and efforts to have SLED efficacy and it important implications for direct fishing impacts discussed in the TMP process, and repeated assurances from government officials that all threats would be examined seriously (Appendices 1-5), SLED efficacy and the risk direct fishing poses to the sea lions were side-lined in the TMP process before being dismissed in the first expert panel workshop (April 2015) by a Science Manager of MPI (see below).

How will the sea lion TMP reverse the population decline using no direct actions?

Another major concern with the draft TMP is that it does not propose any direct actions that can be implemented now to mitigate the major threats to sea lions over the next 5 years (i.e. out to 2021). How the TMP proposes to reverse the decline of the sea lion population without direct action is unclear. Indeed, two of the four National Programme goals (Figure 1) involve forming groups to talk further about sea lions, while another goal involves doing more research on disease, and the last goal involves continuing the existing monitoring of sea lion population.

With regards to the major threat of the disease *Klebsiella*, no direct actions are available or advised by experts. For example, a vaccine is apparently at least 5 years away and will cost many millions of dollars to develop for sea lions. More immediate attempts at treating the disease (i.e. with antibiotics) are deemed to be not advisable due to unintended consequences, or more importantly, pups that present with the disease symptoms have a near 100% chance of deaths meaning this action would likely be a waste of time. Consequently, with so little known about the disease, the focus on this major threat is research and doing more diagnostic testing of existing material (Table 1 & Table 3, TMP Consultation Document). Perhaps in 5 years' time, government might be in a position to undertake some direct actions on this threat, meanwhile the population may well continue to decline.

Given the lack of direct actions and the heavy research focus of the draft TMP to address the major threat *Klebsiella*, it is unclear how sea lion managers will meet the short-term and long-term population goals identified in the TMP:

> ***"Long term, by 2036, the overall population is above the 2015 estimate of 11,800 sea lions and is increasing.***
>
> ***Short term, by 2021 and every 5 years thereafter, the overall sea lion population is on track to achieving the 20-year goal."*** [Population goals, sea lion TMP consultation document, pg 12]

While these population goals are not particularly ambitious, and may be meant to be easy targets for managers to hit, it is unclear how taking no direct action and focusing only on research will lead to the mitigation of the major identified threat of *Klebsiella* and ensure the "overall sea lion population [will be] on track to achieving the 20 year goal".

The expectation of turning around the declining trend in sea lions without taking any form of direct action is absurd.

Sea lion management to date has not taken any direct actions against *Klebsiella* and the population is declining. Given this, it is unclear why government is expecting that continuing to take no direct action on disease will suddenly result in the mitigation of this major threat. Expecting this outcome suggests that disease is an overestimated threat to sea lion recovery, a point raised by experts in the TMP process.

Government also attempts to allay any concerns that the short-term goal will not be met by saying that the TMP will be "reviewed every 5 years to evaluate progress" and that "Trigger points will enable review of the TMP within the 5-year period if required". This all sounds very reasonable. Indeed, a "trigger point" is provided as "an Auckland Islands sea lion pup count that is below 1,501." Other than this pup count trigger point, there are no "trigger points" mentioned in the TMP document, hence it is unclear what other factors will trigger a review of the TMP. Furthermore, given the TMP is proposing no direct actions in sea lion management, it is unclear what format a TMP review would take, as according to the draft TMP document, no direct actions are practical, hence the only avenue open to managers would be to do more research while documenting the ongoing decline of sea lions.

No budget exists for "high-priority" research projects until <u>at least</u> 2018

Despite the sea lion TMP being filled with research proposals (Table 3 in the TMP Consultation document), it is very concerning there is no budget in place to undertake any of this work until perhaps 2018.

The TMP process has been running since March 2014, but there clearly has been no budgetary planning for any research outcomes (or any potential direct actions, should they have been proposed) from the TMP process. This is made patently clear in an Official Information Act response (OIA16-0353), in which a MPI official clearly reminds colleagues that there is no budget for the first year of the TMP when discussing the projects in "Table 3 Research Priorities" in the TMP Consultation Document. The MPI official stated: in an email dated the:

> "This is future work as no budget for the 1st year of TMP but these projects may be funded in subsequent years" [MPI Official's statement in an email 21st April 2016 contained in OIA16-0353]

The lack of budget is quite concerning, especially when we look at the research projects that are ranked as high priority in "Table 3 Research Priorities". Many of these projects will go a long way to addressing important, existing uncertainties in sea lion management. For example, a better understanding of *Klebsiella* and SLED efficacy would allow better management of the sea lion population and potentially avoid unintentional harm from overly optimistic sea lion management (see below).

Not only is there no direct actions in the sea lion TMP, there is also no budget to fund any of the myriad of research projects proposed in the process.

Surely, government must have expected some important outcomes of the sea lion TMP process and should have planned funds to be available to put any important actions immediately into place? Indeed, the Ministers highlighted some of the potential outcomes of the TMP process when announcing the TMP back in March 2014. A lack of budget for sea lion management is perhaps an oversight (i.e. poor management) or indicates that government is not placing priority on reversing the decline in the sea lion population and hence is not taking sea lion management seriously.

Concerns with the conduct of the TMP process

The sea lion draft TMP document states the TMP was a "robust information gathering and risk assessment phase". Here I raise a number of concerns with the processes of the TMP.

- **Differential treatment of uncertainty in the major threats to sea lions**.

Far from being a review of all major threats and the remaining uncertainty in these threats (as stated by the Ministers for DOC and MPI), the TMP clearly focused on disease and ignored other threats, such as the direct effects of fishing. Indeed, despite significant uncertainty in SLED efficacy (see below), there was no workshop of experts to discuss issues with SLED efficacy or cryptic mortality. However, there was an expert workshop convened to discuss pup mortality within c. 3 months of the announcement of the sea lion TMP by the Ministers.

The minutes of the pup mortality workshop record concerns as to why there was a pup mortality workshop ahead of the TMP process and it was stated:

> "A question was raised as to why the pup mortality issue was being progressed ahead of the NZ sea lion Threat Management Plan (TMP) generally. It was clarified that Massey University wrote to Minister of Conservation asking for some tangible research and adaptive management techniques to investigate and address the high pup mortality during the coming field season. Due to time constraints in the development of the TMP and the researchers wanting to take action during the upcoming field season, the organisers saw this workshop as a parallel process running alongside the TMP and a way to potentially improve the situation in the interim. [minutes of the pup mortality workshop, 10 June 2014]

This statement is all well and good, but it does raise the issue of why there was not a similar workshop to examine the concerns about SLED efficacy and cryptic mortality, especially as various people, myself included, have raised issues with SLED efficacy with both the Minister of Conservation and the Minister of Primary Industries (Appendices 2 & 3). Here I call for an expert workshop to examine issues of SLED efficacy and cryptic mortality, so that direct fishing impacts on the sea lion population can be appropriate addressed.

- **TMP model was simultaneously being developed, employed and peer-reviewed**

The demographic model of Roberts & Doonan (2016) that formed the basis of the TMP process was simultaneously being peer-reviewed and developed, while being employed to explore the importance of various threats to sea lions.

For example, the TMP expert panel, in the first TMP expert panel workshop, made a range of suggestions to improve the demographic model and were still making "some minor technical recommendations to fine-tune the NIWA demographic modelling" [Minutes of the second expert panel workshop] in the second expert panel workshop.

The demographic model was developed under a contract to NIWA and as such there is not unlimited potential to improve the model in the funding constraints of that contract. Consequently, the demographic model is still a work in progress. It has also not been through the traditional peer-review process of publication in a peer-reviewed science journal (a point recommended by the expert panel; see minutes of the second TMP expert panel workshop), hence the modelling outcomes should be viewed with caution.

The need for appropriate peer-review of models is essential and has been demonstrated previously in New Zealand sea lion management. For example, for over 10 years various versions of the present Breen-Fu-Gilbert model (Breen et al. 2010) were deemed to be working well, despite significant concerns raised by various scientists (see Robertson 2011, submission on the IPP for SQU6T; available on MPI website). It was not until the model was reviewed by international modelling experts that the model's parameterisation was found wanting (Bradshaw et al. 2013). Indeed, the expert panel in 2013 concluded:

> "that, until the model has been modified, tested and re-run, it will be impossible to determine whether the current limits upon the SQU6T fishery will succeed in meeting the agreed management requirements. Delaying re-assessment of the situation and management for five years appears inherently risky in the face of the unknown uncertainty around the model's predictions." [pg1, (Bradshaw et al. 2013)].

Note, as is typically reported about the BFG model, the panel did state that the:

> "the model was carefully and correctly implemented and appears to be an acceptable basis for continued development."

However, as noted above, the expert panel had concerns with the parameters use in the model and noted:

> "the report describing it was somewhat unclear and some of the assumptions of the model included unknown and unaccounted for uncertainty. During the review, some issues were clarified by rerunning the model and others resolved by modifications to it. Some means of managing limits in this fishery is obviously required and the integrated model is currently the best available. However, the model is not without potentially important uncertainties. To make its management advice more defensible it requires an explicit plan and time-table for continued testing and development, for new data collection, and for the frequency of risk assessment to the NZSL populations." [Bradshaw et al. 2013]

- **Conflicts of interests were not declared or inappropriately declared in the TMP process**

In the Terms of Reference of the TMP workshops, the following was noted regarding declaring and managing Conflicts of Interests:

> **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. [Sea lion TMP Terms of Reference]

Only one conflict of interest was declared during the TMP process and that was in the second expert panel TMP (Day 1) according to an OIA response (OIA16-E-205). This declaration of a conflict of interest was made by Dr Paul Breen right before a competing demographic model was examined by the expert panel. Dr Breen and another author had written a comment (Middleton and Breen 2016 *Marine Biology*) on the published journal paper presenting the competing demographic model (Meyer et al. 2015 *Marine Biology*). The criticism in this comment has since been dismissed (Meyer et al. 2016 *Marine Biology*).

For this conflict of interest, clearly the Terms of Reference were not followed, as Dr Breen should have declared this conflict well before the workshop, instead the conflict was declared immediately prior to the presentation of the competing demographic model, perhaps for dramatic effect.

Of significantly more concern is another conflict of interest that remained undeclared over the course of the two expert panel TMP workshops. This involved one of the expert panel members (Professor Mark Hindell) who as an expert panel member in both workshops was tasked with peer-reviewing the demographic model of Roberts & Doonan (2016). The perceived conflict of interest arises because Professor Hindell was involved in the initial successful tender for the development of the demographic model (DOC 4428: New Zealand sea lions – Demographic assessment of the cause of decline at the Auckland Islands).

As with any conflict of interest, they may be real or perceived, but the key is that they are declared and appropriately managed. In this instance, it is unfortunate that this conflict of interest was not declared, especially as Professor Hindell was involved in an expert capacity to review a model that he helped developed initially.

- **Outcomes of the TMP are being made up by government officials on the run**

Despite a large number of research ideas coming out of the TMP process (see Table 3 Research Priorities" in the TMP Consultation Document), there is a clear lack of understanding of this information shown by government officials involved in the TMP decision making processes.

This is clearly demonstrated by a statement released under the Official Information Act of one official who was asked to comment on the research priorities in the TMP. Note that the next day a manager was to sign off on the information, hence it was stated that time was short. The official states:

> "Some comments from me on the research table, noting I suffer from a lack of context as well. Is this supposed to be future research covering all topics or something else? Depending on the scope I might have some more to add." [21 April 2016 email in OIA16-0353].

It is also clear that not a lot of consideration was given to information in the TMP consultation document. For example, I asked for further information about why a high priority research project examining SLED efficacy was included in "Table 3 Research Priorities" in the TMP Consultation Document, given that SLED efficacy and direct effects of fishing were considered not to be of concern in the TMP.

My query was put through as an Official Information Act request. In the OIA response, it was clear that MPI officials had to strategize how best to answer my query:

> MPI official 1: "I'm thinking it would be helpful to note that this project could potentially include flume tank testing as he has previously suggested. Would demonstrate that we have heard his suggestion and are including it in deliberations going forward?
>
> MPI Official 2: "We could state the sea lion forum will consider options for this research from various options suggested (including flume tank, acoustic cameras, etc)
>
> MPI Official 3: "Very good I will add that in. Really appreciate your assistance" [email thread morning of 28 June 2016 in OIA16-0353]

Note that this strategizing occurred 8 days after the TMP consultation documents were released for public consultation on the 20 June 2016. Clearly, sea lion managers are wanting to tell stakeholders what they want to hear and are making decision about the TMP as they go (I have raised flume tank testing of SLEDs previously, as has Forest and Bird officials). This suggests a reactionary approach to sea lion management rather than a well-considered and measured response to management.

- **Concerns with SLED efficacy were repeatedly removed from drafts of the TMP consultation documentation or were not included in the first place**

Despite the existence of unresolved expert concerns with SLED efficacy, post-SLED survivability and discount rates, none of this controversy is captured in the TMP documentation. For example, a link is provided to the *Fisheries Science* paper of Hamilton and Baker (2014) in the background document, but not the valid criticism of this paper (Robertson 2015).

When this was raised with a DOC official, I was told that many references were cut from the TMP background document. However, given the remaining uncertainty in SLED efficacy, it is unfortunate that any references that question the assumption of high SLED efficacy (the conclusion made by Hamilton and Baker (2014)) did not make it into the draft TMP documentation. As such, the documentation provided by the government does not provide a balanced perspective on SLED efficacy to the general public.

> "The **Background document was quite heavily pared back from its original size and many references were cut**, after we received feedback that we had to make the document more accessible to the general public. This also resulted in the Further Reading section being cut back to the links that we had on hand." [DOC official's response to why key references highlighting uncertainty with SLED efficacy were not in the TMP documentation; email 21 June 2016; bolding added]

When I enquired what information was removed from the documentation and what the "feedback" was, my query was processed as an Official Information Act request. The response to this provided me with a small number of draft versions of the TMP documents (OIA16-E-205). Comparison of these drafts showed that on two occasions statements that captured the uncertainty with the use of SLEDs (presumably inserted by DOC staff) were removed by MPI staff.

> "Since the introduction of SLEDs, therefore, estimates of the number of NZ sea lions interacting with trawls is highly uncertain." [sentence removed from Version 6 Background 01/10/2015 by an MPI Official, as noted by track changes]

> "There is a degree of uncertainty over the accuracy of the estimate of incidental sea lion captures; the efficacy of SLEDs'; the extent, if any, of likely long term impacts associated with fishing activities; as well as the exact impact that fishing related mortality has on the population where other variables such as environmental change may not be modelled accurately." [sentence removed from Version 19 Background 20/10/2015]

Other information, such as evidence of concerns with SLED efficacy (e.g. Bradshaw et al. 2013; Robertson 2015), apparently was never included in the TMP documents, which is perhaps no surprise given SLED efficacy has not been adequately addressed throughout the TMP process.

However, this does raise the question of how the general public, or even those not familiar with sea lion management, would know that these important expert concerns exist. Being selective in which key references to include in the TMP documentation could be perceived as attempting to manufacture certainty or consensus when in fact there is ample uncertainty and no consensus.

- **The sea lion TMP takes an "all or nothing" approach to management of various threats**

The TMP identifies that no one threat to sea lions is responsible for the decline of sea lions at the Auckland Islands and calls for a "holistic" approach to sea lion threat management. Despite the call for an "integrated response", some threats, such as the direct impacts of fishing are dismissed, because they apparently cannot halt or reverse the decline when mitigated based on current estimation of the threat (see below).

A clear example of the selective approach to threat mitigation is found in the investigation of the number of females or pups that need to be "saved" to effect population stability and growth at the Auckland Islands subpopulation (see below; Figure 2 & 3). It is clear that saving a small number of females each year (n=34) will stop the population decline in the short term. However, this is not highlighted as a viable management option, presumably because it does not solve the problem of a declining population outright. Indeed, Roberts & Doonan (2016) only present the idea that female survival needs to improve from the current 0.88 to 0.98 for the population to stabilise (see Figure 2).

This apparent focus on "all or nothing" management contradicts the calls for a "holistic" or "integrated response" to sea lion management. It would make sense to put in place management options that allow for some improvement to female survival, while at the same time improving the survival of pups. A small improvement in the survival of each category will undoubtedly lead to a better outcome than just focusing on one group alone.

To rectify the anomaly that the TMP does not contain any immediate direct actions, **here I outline a management option for a fishery closure that will allow direct action on existing direct and indirect fishing impacts on the Auckland Island subpopulation of sea lions**.

How many sea lions (pups or females) need to be saved to stop the decline?

In the second TMP expert panel workshop, it was suggested:

> "that the demographic rate scenario graph rates should/could be converted back into numbers, and then they could be used to inform management options (i.e. to get from pup survival from 0.4 to 0.6, how many animals need to be saved). [Progress Report – NZSL Threat Workshop 2].

This is a good suggestion, because it is intuitive for the public to understand and clearly identifies how many animals need to be saved to meet targets of improved pup survival or female survival. As such, it allows proposed targets to be placed into the context of what is feasible when it comes to saving pups and breeding age females. Unfortunately, this analysis has not been presented in the draft TMP or the quantitative risk assessment (Roberts & Doonan 2016), but I have done this here for the Auckland Islands subpopulation.

Based on the demographic rate scenario projections (Figure 18 in Roberts & Doonan 2016), I have calculated separately the number of females and the number of pups that are required to increase breeding female survival (Surv6-14) (Figure 2) and pup survival in the first year (Sur0) (Figure 3) to a stable population (i.e. Surv6-14: from 0.88 to 0.90; Surv0: from 0.38 to 0.6; Roberts & Doonan 2016). Details of these analyses are in the captions of the two figures.

This analysis indicates that saving as few as 34 female sea lions will immediately lead to a halt of the population decline for the next 5 years (note the immediate plateau of decline or reversal of decline for Surv6-14 values greater and equal to 0.90 in Figure 2). A total of 347 pups need to be saved in 2014 to stabilise the population after 2020 (Surv0 equal to 0.6, Figure 3).

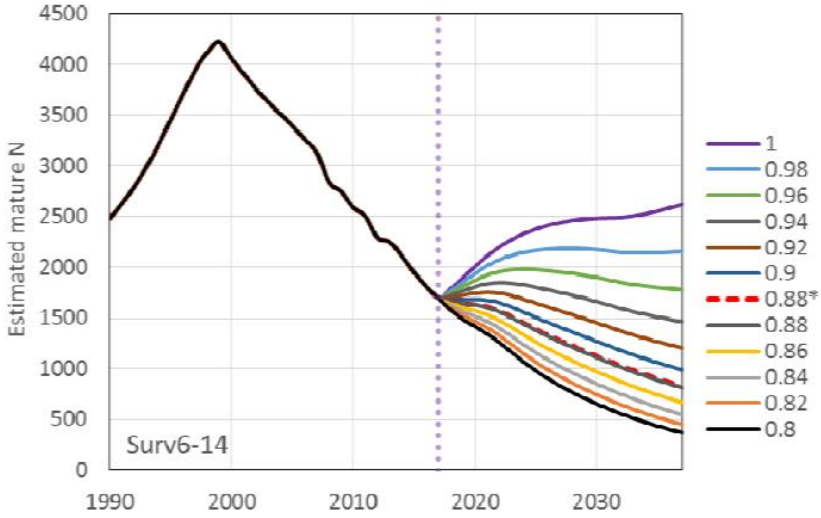

Figure 2 Demographic rate scenario projections of model estimated mature *N* at the Auckland Islands in the period 1990–2037 (Figure 18 taken from Roberts & Doonan 2016). If we assume that there are 1700 estimated mature N in 2017 (dashed vertical line), an increase of 0.02 for Surv6-14 (to 0.9) leads to an increase of 34 females. Note that for rates of 0.9 and above there is an immediate stabilisation or increase in the estimated mature N out to at least approximately year 2023. This indicates that the risk assessment (Roberts & Doonan 2016) shows that saving as few as 34 female sea lions will lead to a halt of the population decline for the next 5 years. Roberts & Doonan (2016) state that a Surv6-14 of 0.98 is required for a stable population out to 2037.

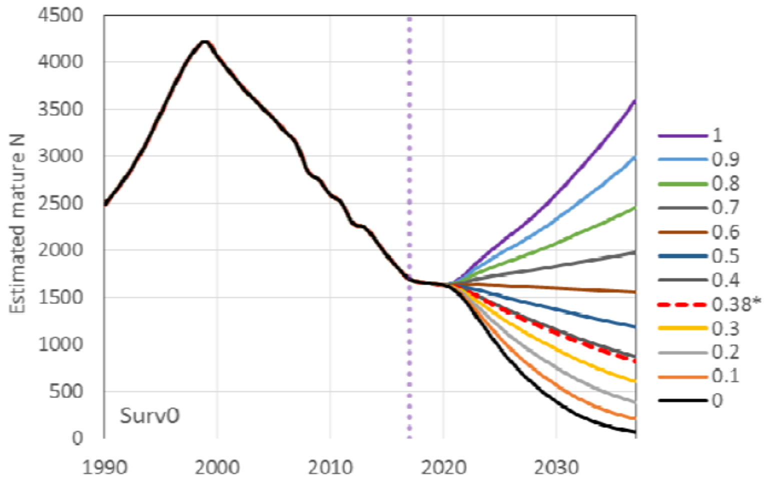

Figure 3 Demographic rate scenario projections of model estimated mature *N* at the Auckland Islands in the period 1990–2037 (Figure 18 taken from Roberts & Doonan 2016). If we assume that there were 1575 pups in 2014 (AEBAR 2015), to get to a stable population in c. 2023, a total of 347 pups needed to be saved (i.e. Surv0 of 0.6 is required).

We can put these numbers (i.e. saving 34 females or 347 pups) into some context by examining the "best estimates" for female fisheries bycatch and pup deaths that were provided by DOC and MPI for the risk triage process (Table 17 in Roberts & Doonan 2016).

Can we save enough pups to stop the population decline?

Looking at pup mortality first. It is clear from comparing the "best estimates" for 2014 and the 347 pups that must have been saved in 2014 to effect a stable population in 2023, that managers needed to avoid almost all pup deaths identified by the "best estimates" (359 pup deaths estimated in 2014, Table 2).

Table 2. Comparison of the number of pups and adult females that need to be saved to stop the population decline at the Auckland Islands subpopulation (i.e. 347 pups in 2014 & 34 females must be saved based on demographic rate scenario projections (Figure 18 in Roberts & Doonan 2016)) against "best estimates" of pup deaths in 2014 and average numbers of female deaths in commercial trawling, assuming varying degrees of discount rate (all from Table 17 in Roberts & Doonan 2016). "Trawl interaction" assumes that all sea lions interacting with a SLED die, while "Trawl captures" are female mortalities expected to be reported.

Pup deaths "best estimates" for 2014		Adult females	
Cause of death	**Number deaths**	**Fishing impact**	**Mean (2003-2016)**
Klebsiella disease	301	Trawl interactions	52.57
Wallows	35	Trawl – 20% discount	42.93
Starvation*	10	Trawl – 35% discount	35.71
Male aggression	13	Trawl – 82% discount	13.36
Total deaths in 2014	359	Trawl captures	11.39
% of dead pups to saved	96.7%		

* starvation refers to pups starving due to mother's death via trawl fishing or male aggression

Putting it simply, sea lion managers would need to make the Auckland Islands subpopulation of sea lions completely *Klebsiella*-free, as well as ensuring that no pups died of misadventure (dying in wallows), starvation or interactions with adult males. This all needed to be done in 2014 for the population to be stable (not increasing) in 4 to 6 years' time (see Figure 3).

Saving the required number of pups to stop the decline of sea lions, therefore, is obviously going to be a major task, perhaps even an unrealistic endeavour. It is important to remember that based on the TMP, *Klebsiella* is assumed to be the main source of pup mortality, significantly impacting the population every year (Figure 4). Clearly, there are no quick fix solutions to disease mitigation (see below), so we must conclude that saving pups alone will also not result in a quick fix to halting the decline of the New Zealand sea lion.

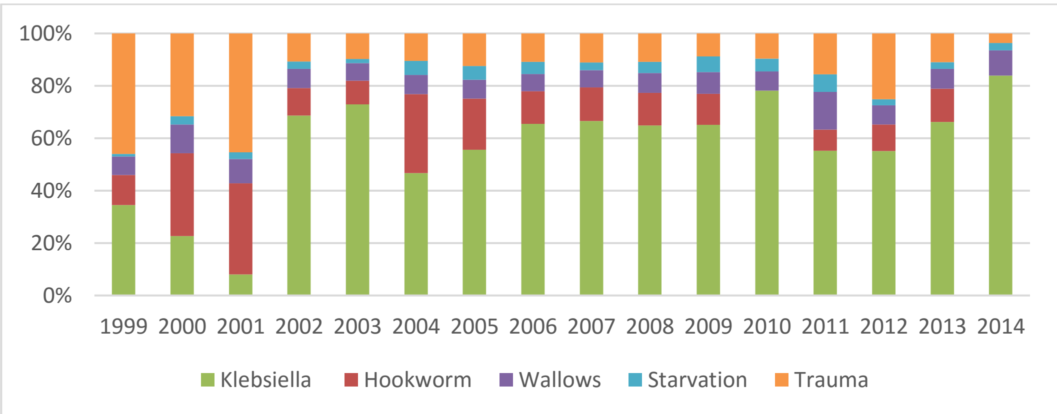

Figure 4 The role (percentage) each category of mortality plays in pup deaths. Total number in each year is the sum of the actual "best estimates" of pup deaths for that year used in the TMP triage process (Table 17 in Roberts & Doonan 2016).

Indeed, the experts at the workshop on pup mortality held in June 2014 clearly highlight that mitigating pup deaths from *Klebsiella* is going to be very difficult. The notes state (see below) that a vaccine for *Klebsiella*, an obvious step to a *Klebsiella*-free Auckland Islands subpopulation, is years away and that immediate treatment is "not recommended", which leaves **no current action options for *Klebsiella* other than more research**.

> "Can we develop a vaccine [for *Klebsiella*]?"
> "Yes, it is possible, but could take millions of dollars and at least 5 years of research".
>
> "What about treatment [of *Klebsiella*]?
> That's technically possible but not recommended. By the time you can see clinical signs, they're more than likely to die anyway. There are disadvantages to treating, such as antibiotic resistance, the fact that you would need a broad spectrum antibiotic to kill only *Klebsiella* but not the animal's natural bacteria. It would also need to reach the brain and the joints, which is difficult and not common in antibiotics." [from pg 9, *New Zealand sea lion pup mortality workshop: notes*, June 2014]

Consequently, expecting to reverse the decline of the Auckland Island subpopulation by solely targeting (saving) pups is demonstrably misguided. Indeed, the draft TMP document and other supporting documents call for a "holistic" approach to management to recover the sea lion population. Given these strong calls and that all threats should be controlled, it is surprising that action on the direct effects of fishing appear downplayed in the draft TMP.

> "Clearly multiple factors were acting on the population, and for management to recover the species a **holistic** view must be adopted." [Triage summary of Walker & Debski 2016; bolding added]
>
> "Sea lions are exposed to different natural and man-made threats. For this reason, the TMP takes a **holistic** approach to mitigate the key threats to ensure recovery across the whole sea lion population." [draft TMP document; bolding added]

Can we save enough females to stop the decline of sea lions?

Based on the demographic rate scenario projections (Roberts & Doonan 2016), it is clear that saving as few as 34 females would lead to an immediate stabilisation of the decline or even an increase of the Auckland Island subpopulation over the next 5 years (Figure 2).

It is interesting to note that 34 females saved is exactly half the current Fishing Related Mortality Limit (FRML) used in the operational plan of SQU6T (i.e. current FRML of 68; AEBAR 2105). The observation that saving 34 sea lions can effect a halt to the decline of the sea lion population, albeit in the short term, suggests that relatively minor reductions in sea lion bycatch can significantly alter population growth trajectories. This conclusion supports the findings of alternative demographic modelling of the New Zealand sea lion population (Meyer et al. 2015 *Marine Biology*). Furthermore, if minor changes in bycatch can lead to improvement of the population, then this draws into question the notion that the sea lion population can withstand even higher FMRLs in SQU6T (i.e. higher levels of allowed sea lion bycatch) as proposed by the dated Breen-Fu-Gilbert model (Breen et al. 2010). Given this, government needs to urgently review the setting of the FRML, which has ranged between 62 and 150 sea lions (2004-2016).

The main cause of female deaths at the Auckland Islands has been identified as commercial trawl fishing (Robertson & Chilvers 2011, *Mammal Review*), which is why so much time and effort has been involved in mitigating sea lion bycatch in the squid fishery around the Auckland Islands (SQU6T) (see AEBAR 2015 for further details).

Given the direct impacts of fishing on sea lions, any attempts to save females would require limitations on fishing effort or improvements in fishing gear to avoid female deaths. For any immediate action, limitations on fishing are required, as any improvements to fishing gear will require extensive research, development and verification, which, like a vaccine for *Klebsiella*, will take many years.

Whether saving 34 females is achievable via mitigating trawl fishing deaths depends heavily on the assumptions made about how effective SLEDs are in mitigating bycatch (i.e. assumptions of SLED efficacy) and the resulting discount rate for use of SLEDs in SQU6T (Table 2). SLED efficacy is still contentious as discussed below. However, based on the "best estimates" for direct fishing impacts used in the quantitative risk assessment (Roberts & Doonan 2016), it is apparent that limiting fishing effort or completely removing fishing effort allows 34 females to be saved when it is assumed that the discount rate for SLED use is 35% or less (Table 2).

From 2004-2007, the discount rate was set at 20%, before being increased to 35% (2008-2011). More recently the discount rate was increased to 82% (2012-present) on the assumption of high SLED efficacy (see below for further discussion of uncertainties with SLED efficacy and discount rate).

If we assume that the discount rate for SLED use is 82%, then removing fishing from SQU6T squid fishery area would only save 13 of the 34 required females. This will undoubtedly be seen by some, as reason for not limiting fishing. However, this "all or nothing" approach to sea lion management is counter to the stated "holistic" approach required for the species recovery (see quotes above) and overlooks the fact that any threats that can be even partially mitigated will have benefits for the sea lion population.

It is also important to remember that the expert panel convened in 2013 to review sea lion modelling and management, who "deliberate[d] extensively on the efficacy of SLEDs" [Bradshaw et al. 2013], questioned the use of the current 82% discount rate in sea lion management. The panel recommended a number of options for the discount rate, but tellingly the current 82% discount rate was not amongst them. As discussed below, the discount rate for SLED use is pivotal in the current management of sea lion bycatch in SQU6T.

The expert panel's report indicates that they thought the 82% discount rate was not precautionary, as they stated that the "most plausible value" for the discount rate would be one that is "deliberately low to provide a precautionary approach":

> "Our terms of reference specify that we are to evaluate the model as a management tool. We consider that until real data become available, MPI's options regarding discount rate use in the model are:
>
> 1. Abandoning discount rates altogether (possibly politically unacceptable and implausibly assuming no animals that leave via the SLED survive);
> 2. Setting a coin toss discount rate of 0.5 (which would be arbitrary);
> 3. Sampling the rate from an uninformative (wide-interval) prior distribution (the result of which will depend entirely on the arbitrary centring of that prior);
> 4. Estimating it directly in the model as a parameter (although it might not be estimable and might bias other parameter estimates);
> 5. Making a subjective choice as to the most 'plausible' value (but perhaps deliberately 'low' to provide a precautionary approach); or
> 6. Examining current tagging and other data to determine whether there is any information on survival of vulnerable age classes already available (also unlikely to provide much useful information)." [Pg 25, Expert panel review of sea lion management, Bradshaw et al. 2013]

Expert panel's recommendation ignored

At this point, it is worth noting that this significant expert panel recommendation has consistently been ignored by MPI when setting the new 5-year operational plan for SQU6T in 2012, and whenever this matter is raised, which I have done on a number of occasions (Appendices 1-5). I suspect that this matter will be ignored here also. It is unknown why MPI choses to ignore the expert's panel's concerns with the 82% discount rate (see below for further discussion on this matter). On one occasion when I raised the matter, I was told by an MPI official that:

> "In response to your questions, yes deepwater managers are aware of both the role of the SLED discount rate and the outcome of the panel review of the Breen-Fu-Gilbert model, **however we do not share your view of the report regarding the "seriousness" of the panels concern with the present discount rate.** MPI is continuing to work with DOC to prioritise and progress any work necessary to address the recommendations raised in the panel's report and how these priorities fit into the wider research priorities of both agencies." [Acting Manager Deepwater Fisheries, MPI, 25 March 2014; bolding added]

The Science Manager Aquatic Environment also offered his appraisal of the expert panel's intentions relative to their clear statements in the panel's report. This clearly shows that MPI are second guessing the expert panel. This goes a long way to explaining why the panel's recommendation of reviewing the current 82% discount rate has not be addressed three years on. The Science Manager stated:

> "I sat through the whole of the review and spent much time with the reviewers. I don't think we're viewing the panel's report optimistically. Nor do I think that experts' concerns and recommendations are being ignored. The key point is that we have many issues to deal with and the rapidity with which we move forward on each will be guided by our assessment of the risks, potential benefits, and other priorities." [MPI's Science Manager Aquatic Environment, 27 February 2014]

A "holistic" management approach requires saving both female sea lions and their pups.

The important point to consider when investigating how many pups or females need to be saved to meet improvements in survival rates is that the process of reversing the decline of the Auckland Island subpopulation is not just going to rely solely on saving pups <u>or</u> saving females. It will necessary require **both** females **and** pups to be saved.

Clearly, the impact of saving a smaller number of females is greater than the similar number of pups (compare Figure 2 and 3; also see Meyer et al. 2015 *Marine Biology*), but when combined, "saved" individuals (females and pups) will have a positive effect on population growth. Exactly what impact saving various combinations of *x* females and *x* pups will have on sea lion recovery could be modelled using the model of Roberts & Doonan (2016), but this obvious next step does not appear to have been done in the TMP process.

Given the call for a "holistic" approach to sea lion recovery, **restrictions on trawl fishing must be included as part of sea lion management that comes out of the draft TMP**. The analysis above indicates that restrictions on direct fishing impacts are an essential way forward. Fishing restrictions will result in immediate action to halt the population decline, as opposed to the research focus in the draft TMP that will not lead to halting the population decline any time soon.

I note that the Minister for Conservation and the Minister for Primary Industries indicated in their joint press release that area closures and measures to reduce fishing impacts are options on the table for sea lion management: "extending or creating new marine mammal sanctuaries under the Marine Mammals Protection Act, or additional measures to reduce impacts of fishing" [Ministerial press release].

The use of area closures to fishing do not mean commercial fishing must be completely stopped to save sea lions. The two are not mutually exclusive, especially as squid are found in other areas of the New Zealand Exclusive Economic Zone (EEZ). The key is to fish sustainably for target species, which is a legal requirement under New Zealand legislation as outlined in the environmental principles (Section 9) of the Fisheries Act 1996 (see page 13, TMP background document).

In the case of the Auckland Island squid fishery (SQU6T), any impacts of area closures that lead to reductions in fishing effort in SQU6T could be offset by moving fishing effort to other areas of the NZ EEZ (e.g. to SQU1T or SQU1J). For example, the predominant squid fishing area in SQU1T is a few hundred kilometres to the north of SQU6T on the Snares Shelf. Moving fishing effort allows industry to have certainty of tonnage, while allowing meaningful immediate actions to improve female survival and hence sea lion recovery.

However, moving fishing (foraging) effort is not a luxury available to the NZ sea lion population at the Auckland Islands. Foraging areas of breeding females are restricted to swimming distance from their dependent pups back on land. Although fishermen can fish for squid in other areas, it appears from discussion with government officials that fishers would rather fish with trawling at the Auckland Islands.

Does squid Total Allowable Commercial Catch (TACC) exist in other fishing management areas?

The current TACC for SQU6T is 32,369 tonnes (Figure 5). In the SQU1 area, there is 44,740 tonnes set aside for trawling (SQU1T) and 50,212 tonnes for jigging (SQU1J). "In 2008 only 3% of the SQU1J TACC (1371 tonnes) was harvested…[while]… in the same fishing year the total amount of squid harvested from the trawl fisheries was 56,000 tonnes, from a total allocation of 127,332 tonnes" (see quote below). This indicates that the 32,369 tonnes of TACC could be accommodated in SQU1 under the combined TACC for trawling and jigging.

> "There are three commercial squid fisheries in New Zealand; a trawl fishery which covers most of the EEZ, a second trawl fishery that is located specifically around the Auckland Islands in the sub-Antarctic, and a squid jigging fishery that covers most of the EEZ. In recent years there has been a decline in the number of vessels fishing in the jig fishery and in 2008 only 3% of the SQU1J TACC (1371 tonnes) was harvested. In the same fishing year the total amount of squid harvested from the trawl fisheries was 56,000 tonnes, from a total allocation of 127,332 tonnes. Because squid abundance varies naturally there are some years when squid is abundant and some years when abundance is scarce.
>
> Squid is a high volume fishery and frequently appears amongst the top five exports based simply of the volume of squid that is caught. Because of the natural variability, export revenues can be unpredictable and in some years are higher than in others.
>
> In the 2008 calendar year, 46,500 tonnes (processed weight) of squid was exported realising a value of $71m. Major markets include the China, Greece, Korea, the USA, Taiwan, Spain and Italy. In New Zealand squid can be purchased in supermarkets in the freezer section. Squid quota value across all fisheries was estimated to be worth $95m in 2008." [taken from MPI website http://fs.fish.govt.nz/Page.aspx?pk=5&tk=1&fpid=48 on 31/07/2016]

Fishery - Squid

Overview | **Catch** | Value | Sustainability

2011 2012 2013 2014 2015 2016 **2017**
for the 12 month period to 30/09/2017

9 items

Species code	Fishstock Code	Name	Reported comm. catch (kg)	TACC (kg)	Cust. allow. (kg)	Rec. allow. (kg)	Target	In QMS
BAR	BAR1	Barracouta Auckland (East)		11,000,456			Yes	Yes
BAR	BAR10	Barracouta Kermadec		10,000			Yes	Yes
BAR	BAR4	Barracouta Chatham Rise		3,019,152			Yes	Yes
BAR	BAR5	Barracouta Southland		7,470,000	2,000	3,000	Yes	Yes
BAR	BAR7	Barracouta Challenger		11,172,853			Yes	Yes
SQU	SQU10T	Arrow squid Kermadec, All meth...		10,000			Yes	Yes
SQU	SQU1J	Arrow squid All NZ waters exce...		50,212,100			Yes	Yes
SQU	SQU1T	Arrow squid All NZ waters exce...		44,740,881	0	0	Yes	Yes
SQU	SQU6T	Arrow squid Southern Islands, ...		32,369,400			Yes	Yes

Figure 5 Total allowable commercial catch (TACC) for SQU1J (jigging), SQU1T (trawling) and SQU6T (trawling). [Screen grab from MPI website: http://fs.fish.govt.nz/Page.aspx?pk=5&tk=96&fpid=48 on 31/07/2016]

Use of alternative fishing gear – jigging for squid

An alternative to area closures that will allow fishing effort with minimal direct fishing impacts on the sea lion population is to revert to squid jigging rather than trawling. As I noted in my 2011 submission on the SQU6T operational plan, jigging would allow fishing to continue without the risk of sea lion bycatch. A change to jigging would also benefit the seabird populations of the Auckland Islands, as SQU6T has one of the worst track records for seabird bycatch of the fisheries in the New Zealand EEZ.

> "Jigging for squid has very little bycatch (Sauer 1995), as demonstrated by interactions of fur seals and squid jigging in southern Australian waters where no fur seals are killed in jigging (Arnould et al. 2003). The change to jigging in SQU6T would see fishing related mortality, or any possibility of such mortality (i.e. unquantified "cryptic mortality"), disappear entirely.
>
> Squid jigging is used in other southern ocean squid fisheries off southern Australia, South Africa and as far south as around the Falkland Islands. The Falkland Island squid jigging fishery indicates that jigging is a viable fishing method for squid in the rough sub-Antarctic waters." [Robertson 2011 submission on 2011/2012 SQU6T IPP]

The idea of jigging has been repeatedly dismissed by New Zealand's fishing industry who cite jigging is a health and safety risk in the sub-Antarctic waters. Given jigging is conducted in some of the roughest oceans in the world (in the aub-Antarctic), this is clearly not the real concern. The resistance to reverting to jigging is most likely due to economic reasons and the need to hire or purchase specialist jigging boats that are unable to fish for other quota species.

Fishing area closures at the Auckland Islands will save females.

While the draft TMP lacks any actions on direct fishing impacts on the Auckland Island subpopulation, this is at odds with the "holistic" approach to sea lion recovery and the Ministers' statement that all options, including area closures, are to be considered.

Here I outline a proposal for direct action addressing fishing impacts at the Auckland Islands, remembering that saving any females is better for population recovery than saving none.

I acknowledge that this action is likely to be meet with stiff resistance from New Zealand's fishing industry, and perhaps iwi fishing interests, given the response of these groups to the government's recently proposed Kermadec Ocean Sanctuary. However, the closures I propose are not about stopping fishing (fishing effort could be moved to other areas, as noted above), but are instead about helping the sea lion population recover, which aligns well with the Kaitiakitanga role that iwi have over sea lions as a taonga, which is acknowledged in the TMP consultation documentation.

Squid fishing in SQU6T is concentrated into two areas; an area north-west and one south-east of the Auckland Islands (Figure 6). Female sea lion foraging overlaps with squid fishing in these areas and bycatch in the SQU6T trawl fishery has been observed for both fishing areas (Figure 7).

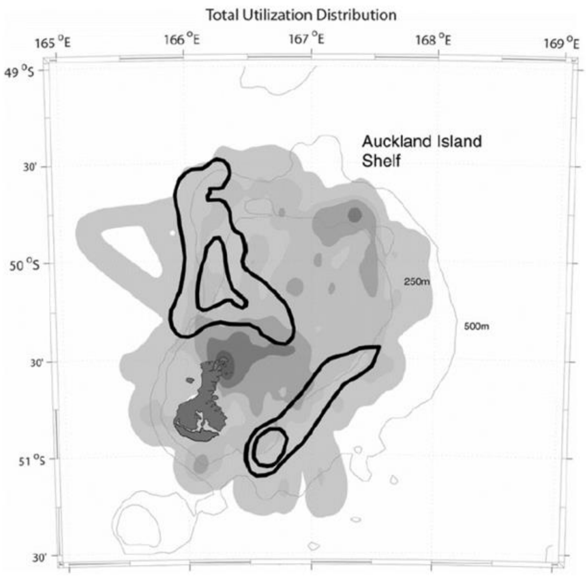

Figure 6 Map of the Auckland Islands showing fishing 50% and 95% use kernels and foraging locations of 55 female sea lions satellite tagged at Sandy Bay, Enderby Island. [taken from Chilvers et al. (2011) *Polar Biology*]

My proposal for an area closure is to close one of the two fishing areas in SQU6T, that being the north-west squid fishing area. As noted above, the lost fishing effort from the NW area could be moved to the Snares Shelf in SQU1, hence fishermen will not necessarily lose the opportunity to fish for squid.

Satellite tagging information indicates that female sea lions show strong fidelity in their foraging locations (as is also found in other otariid species; e.g. Lowther et al. 2012 *Animal Behaviour*), hence it is reasonable to assume that females foraging in the SQU6T NW area following the closure of this area to squid fishing will have minimal risk of becoming trawl bycatch in the remaining squid trawl effort.

Figure 7 Map of the Auckland Islands showing two areas of fishing (NW and SE areas) in the squid fishery SQU6T (dotted box) with sea lion bycatch (red dots) observed between 1995 and 2005 [taken from Thompson & Abraham 2010 AEBR66]

The proposed area closure may also go some way to addressing potential trophic impacts of the squid fishery on the sea lion population. However, it is important to note that what effect a reduction of squid fishing around the Auckland Islands would have on the "trophic effects on the sea lion population" is presently unknown. Indeed, the recent expert panel workshop noted regarding our understanding of trophic effects that:

> The 'best estimate' for trophic effects was considered to be trivial given large uncertainties around what these impacts are and the scale of those impacts. The Panel recommended that publication of this information should be accompanied by caveats noting the lack of data and that this component is little more than an educated "stab in the dark". [notes of TMP Expert Panel Workshop 2]

It would be safe to assume that a component of trophic effects encompasses the indirect effects of fishing (i.e. resource competition; Robertson & Chilvers 2011 *Mammal Review*). Consequently, removing squid fishing from the NW area of SQU6T, as proposed here, would leave the previously harvested squid in the environment, which may lead to a reduction in any trophic impacts on the sea lion population. This was a point noted by the second expert panel workshop:

> "it was highlighted that potential indirect effects of fishing are currently considered as part of trophic effects and thus the removal of fishing effort may result in additional benefits." [notes of TMP Expert Panel Workshop 2]

The TMP background document also notes that females foraging in the NW area display a distinct diving profile (mesopelagic divers) compared to females that forage to the NE on the Auckland Island shelf (benthic divers) (Figure 8). In the TMP background document it notes that "The meso-pelagic diving strategy requires less energy and these sea lions tend to be in better condition than those that are consistently diving deep". Given mesopelagic divers overlap with the NW fishing area, it is logical to assume that mesopelagic females are the majority of females drowned in the squid nets in the NW area (Figure 7). Consequently, it is likely that squid fishing has been killing females that are "in better condition" and that use the "diving strategy [that] requires less energy". This selection against mesopelagic divers will lead to the remaining females in the population displaying a more energy demanding diving strategy that apparently contributes to poorer condition.

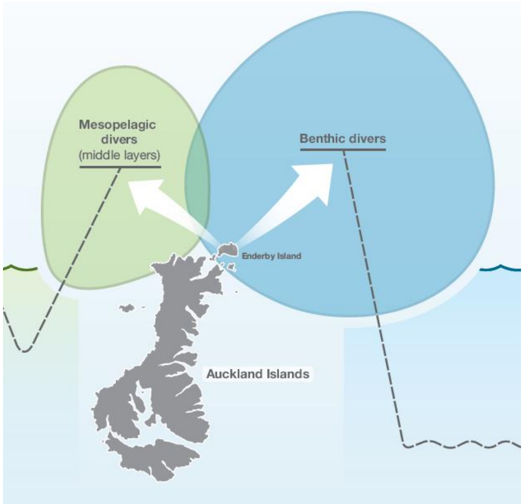

Figure 8 Map of the Auckland Islands showing the differences between the two distinct foraging strategies of female New Zealand sea lions observed from Enderby Island. Note the remainder of this diagram is incorrect (benthic divers do not dive to 3000m) and hence has not be included here. [taken from TMP background document]

Selection against mesopelagic divers by squid fishing bycatch and its selection for females in poorer body condition (i.e. benthic females) might also have implications for pup condition and survival. Indeed, AEBAR (2015) notes that there is “A weak, though significant positive correlation … identified between maternal body condition and pup mass in seasons prior to 2004-05. [AEBAR 2015]. Furthermore, AEBAR (2015) reports that in this time there was a positive relationship between female pup mass at week 3 and subsequent survival to age 2 (Figure 9). Given this, limiting bycatch of mesopelagic diving females in the NW squid fishing area of SQU6T might have positive effects on pup survival via improving pup condition, which should have further beneficial effects for sea lion recovery.

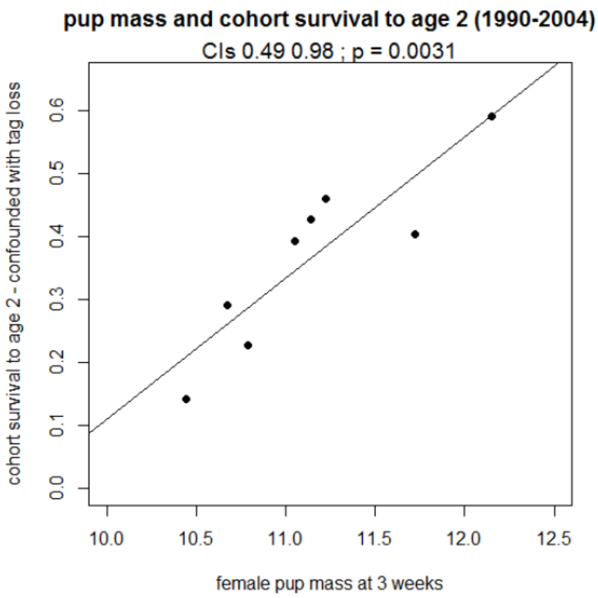

Figure 9 Relationship between female pup mass at week 3 and demographic modelling estimate of cohort survival to age 2. [taken from AEBAR 2015]

Quantitative risk assessment finds two main threats, and then there was one

The initial step in the quantitative risk assessment (Roberts & Doonan 2016's triage process; Figure 10) identified two main threats for the Auckland Islands subpopulation of sea lions when using upper values of threat mortality: *Klebsiella* disease and direct impacts of trawl fishing. All other threats were found to have no impact on population projection when mitigated (Figure 10). However, as noted above, there were concerns raised by the expert panel with how some of these threats were estimated (e.g. trophic effects).

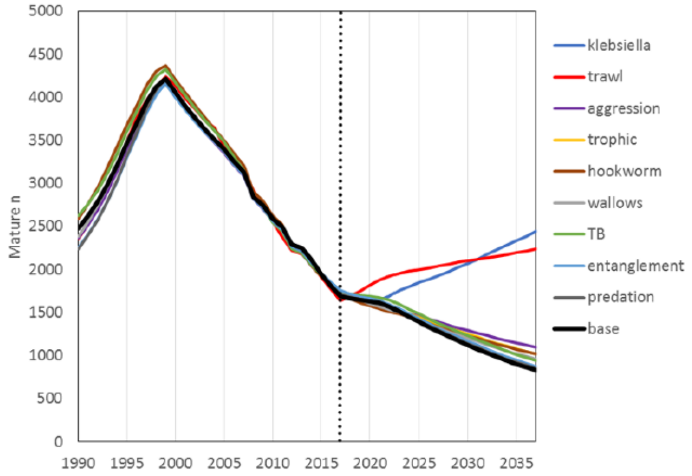

Figure 10 Triage projections of model estimated mature N at the Auckland Islands in the period 1990– 2037, using upper values of threat mortality. Black line = with all threats (base run). [Figure 15 taken from Roberts & Doonan (2016)]

As recorded in the second expert panel TMP workshop notes, the estimation of threats used in the triage process is not an exact science (i.e. some could be an educated "stab in the dark"). For example, the second workshop notes state when discussing upper bounds of threats:

> "There is need to be confiden[t] that sufficient upper bounds have been selected, and that other potentially high threats are not being neglected during the triage stage".

The workshop notes then go onto highlight concerns with a range of upper bounds and "best estimates" of various threats:

- "The upper bound and best estimate of female mortality from male aggression should be reviewed."
- "The upper bound and best estimate of pups in holes should be reviewed by the project team. The current upper bound value, which assumes that all drowned pups died, may be an overestimate."
- "Questions were raised around how "trophic effects" were estimated and incorporated into the triage projections"
- "The panel noted that the upper bound of trophic effects is probably set too low, given that it was set during a time of decline."
- "There was a concern that the effect of removing *Klebsiella* may be over estimated. Might need to re-examine how *Klebsiella* is represented in the best estimates/upper bounds."

In response to these concerns, Dr Jim Roberts in his presentation to the second expert panel workshop on his triage modelling (e.g. Roberts & Doonan 2016) reminded the TMP expert panel workshop that:

> "the triage is not a detailed analysis of impacts, but instead identifies what threats need to be carried forward to more detailed analysis". [Second expert panel TMP workshop notes]

While this might be the understanding of the modeller, this is unfortunately not how MPI and DOC appear to be viewing the triage process. Clearly, *Klebsiella* disease has "been carried forward to more detailed analysis" in the draft TMP document, while other highlighted threats have been dropped due to what appear to be contentious, arbitrary decisions about what constitutes "best estimates".

For example, the "best estimates" for direct impacts of trawl fishing on the Auckland Islands subpopulation clearly resulted in this impact going from being a significant threat (when upper bounds are used) to being one of no consequence when "best estimates" are used in the triage process.

Given the clear influence that "best estimates" have on the triage process, it is informative to examine how the "best estimates" were arrived at. Here I focus on the two main threats identified in the triage process (Figure 10) of *Klebsiella* disease and direct impacts of trawl fishing on the Auckland Islands sea lion subpopulation.

How reliable are the "best estimates"?

The second expert panel workshop noted that:

> "best estimate plots for disease will be subject to a high level of scrutiny and the parameters used must be defensible".

Given this advice, and the statement that the TMP process was a "robust information gathering and risk assessment phase", one might expect that information on how "best estimates" were derived would be readily available to anyone who requested the information. Unfortunately, this is not the case.

As an example, I asked the simple question about how the *Klebsiella* numbers ("best estimates") were decided on. In the report on the triage process, Roberts & Doonan (2016) state clearly in the caption of Table 17 that "Threat levels are "best estimate" values provided by MPI/DOC". There is no other indication how the "best estimates" were determined in that document. Nor is there any further information in Walker & Debski (2016), which summarises the triage work of Roberts & Doonan (2016).

When I contacted DOC, and then MPI, I was told that my question about how the *Klebsiella* "best estimates" were determined would need to be processed as an Official Information Act request. So in 20 working days, I might gain access to information that realistically should be available now. The question has to be asked, why does it take 20 working days and an OIA request to release information to defend "best estimates" for triage modelling done almost 12 months ago? Indeed, with the expert panel warning that parameters will come under "a high level of scrutiny" and "must be defensible", one would assume this information would be readily available.

As a postscript, I have now received a response to my OIA request from DOC. Unfortunately, this information (a number of spreadsheets) did not provide any clear rationale for how the "best estimates" were derived. I am left in the same position as the expert panel, which is questioning the "best estimates".

Are the *Klebsiella* "best estimates" overestimated?

As noted above, concerns were expressed that:

> "the effect of removing *Klebsiella* may be over estimated. Might need to re-examine how *Klebsiella* is represented in the best estimates/upper bounds."

Given this, it is important to review the estimation of the threat of *Klebsiella* in the triage process. Without undertaking this review, it cannot be ruled out that *Klebsiella* mitigation may have had a strong influence on the population projections because of the choice of "best estimates" by DOC and MPI, rather than any real impact of the disease.

Through-out the various stages of the TMP process, there have been repeated statements and comments on the lack of key information on the aetiology of *Klebsiella pneumoniae* in the New Zealand sea lion. Indeed in the TMP consultation document (pg 16) it says that monitoring is needed to:

> "gather information on a number of relevant factors including:
>
> - Prevalence of disease
> - Total mortality from disease
> - Identification of the strain of *Klebsiella*
> - Identification of the source and vectors of *Klebsiella*

The lack of key information is a reflection that the appropriate investigations, diagnostic tests and research have not yet been undertaken, despite *Klebsiella* being a concern in the sea lion population since 2001/02 (over 14 years).

Despite the clear lack of knowledge, the TMP makes very certain, strong statements about the risk of *Klebsiella* on the sea lion population. For example, in the TMP background document (pg.20), it states that:

- "Investigation of disease-related mortality of sea lion pups since 2010 **indicates that infection from *Klebsiella* has become an increasingly significant cause of pup mortality**."
- "…the **majority of deaths due to *Klebsiella* now occur… from a highly virulent strain of the bacteria**."
- "**Pup deaths are continuing to occur up until the end of the research observation period and perhaps beyond**, meaning that the full impact of this infection on the sea lion population may be larger than results from previous studies suggest. In addition, the highly virulent strain is present on the South Island and was responsible for the death of an Otago-born pup in early 2013". [bolding added]

When considering the "best estimates" of *Klebsiella*, an immediate red flag is the stated need to understand the "prevalence" and "total mortality from the disease", which forms part of the National Programme in the sea lion TMP. It would be fair to presume that these two parameters should have heavily informed the "best estimates" of *Klebsiella* used in the triage process. Indeed, the "best estimates" of *Klebsiella* in Table 17 of Roberts & Doonan (2016) show that the disease is assumed to occur every year and since 2010 it accounts for an average of 67% of pup deaths derived from "best estimates" in the Table 17 (see Figure 4 above).

With such high levels of disease as the "best estimates" for each year, it raises the question of how much worse is the upper bound for the *Klebsiella* threat and is that realistic? This is of course the concern raised by the expert panel.

With key information on prevalence and total mortality clearly still lacking, this calls into question the *Klebsiella* “best estimates” employed in the triage process. Indeed, in Roe et al. (2015, *Veterinary Microbiology*), it states that the prevalence of disease in necropsied pups between late 2006 and early 2010 was 57.5% based on a microbiological culture and PCR tests. In this same period, the percentage of pup deaths assigned to various threats using “best estimates” indicate that *Klebsiella* accounted for an average of 68.7% of pup deaths (Figure 4), which is an 11% difference when compared with best information on incidence of *Klebsiella* reported by Roe et al. (2015).

Review of the *Klebsiella* “best estimates” used in the triage process (Table 17 of Roberts & Doonan 2016) also highlights another issue with the strong statements in the TMP background document. For example, it is suggested that since 2010 “infection from *Klebsiella* has become an increasingly significant cause of pup mortality”. This statement is clearly at odds with the *Klebsiella* “best estimates” used in the triage process. The occurrence of *Klebsiella* is very similar to the period between 2006 and 2009 and below that seen in the two epidemic years of 2002 and 2003 (Table 3). Again this calls into question the “best estimates” of *Klebsiella* used in the triage process.

Table 3. The percentage of pup deaths that *Klebsiella* “best estimates” accounts for in various years. Total number in each year is the sum of the actual “best estimates” of all pup deaths for that year used in the TMP triage process (Table 17 in Roberts & Doonan 2016). .

Years	Pup deaths accounted for by *Klebsiella* (average)
1999 to 2001 (no *Klebsiella* reported)	21.7%
2002 to 2003 (the epizootic years)	70.8%
2004 to 2006*	55.9%
2006 to 2009	65.5%
2010 to 2014	67.8%

* Roe et al. (2015) states “The relative importance of [*Klebsiella*] as a cause of mortality appeared to decline after the 2002/03 epidemic.

Interestingly, the DOC and MPI supplied *Klebsiella* “best estimates” has the disease occurring in the population at the Auckland Islands before it was first reported in the 2001/02 epidemic ((21.7% of pup deaths, Table 3; see also Table 17 of Roberts & Doonan 2016). At present, there is no evidence to suggest that the disease was in the population prior to the first epidemic year – apparently the diagnostic test have not yet been done. This highlights an apparent willingness to incorporate *Klebsiella* in threat modelling for earlier years when there is no evidence of the disease. This appears to be further evidence that the risk of *Klebsiella* has been overestimated, as stated at the expert panel workshop.

As noted above, it is also claimed in the TMP consultation document that “…the majority of deaths due to *Klebsiella* now occur… from a highly virulent strain of the bacteria.” This statement is also at odds with the available evidence.

First, we do not know the strain of *Klebsiella* involved, which is why a National Programme goal of the TMP is identification of the strain of *Klebsiella*. Apparently, the genomes of the bacteria are being sequenced at present, but there is currently no information on strain for the *Klebsiella* in NZ sea lions (W. Roe pers comm). Apparently, researchers are no closer to knowing if the strain of *Klebsiella* responsible for the 2002 and 2003 epidemics is the same as the hypermucoid *Klebsiella* reported now (Wendi Roe pers comm; MPI/DOC TMP team members pers comm), which is because the relevant diagnostic tests have not been done on the earlier material. Indeed, there are two “high priority” research projects in the draft TMP (Table 3: Research Priorities) to undertake this essential work.

Second, it is important to note that virulence must be determined with careful study and should not be assumed. There are numerous genetic strains of *Klebsiella* in the KpI clade (Holt et al. 2015, *PNAS*). Virulence appears to be linked to hypermucoidy, but not all hypermucoid *Klebsiella* can infect healthy individuals (Holt et al. 2015). One strain that can cause severe disease in apparently healthy individuals (humans) has a potent combination of genes not seen in other *Klebsiella* strains (Holt et al. 2015). Clearly, a similar potent combination of genes needs to be demonstrated in New Zealand sea lions to make the claim of high virulence or the disease killing healthy individuals.

Klebsiella is typically a disease associated with immunosuppression (Holt et al. 2015), hence while it might be the proximate cause of pup mortality, it might not be the ultimate cause of pup death. Other factors might be resulting in pups becoming immunocompromised. Furthermore, it is not sufficient to assume "high" virulence, especially when it is not known if all pups die from exposure to the bacteria. In the pup morality workshop (June 2014), it was noted that experts are not sure if there is any natural resistance to *Klebsiella*. It was noted:

- "we don't know how pups mount an immune response to this pathogen"
- "the chances of a pup getting sick from this bacteria probably depend on the "dose" of the infection (whether they come in contact with large numbers of bacteria or only a few) as well as the route of infection (wound, inhalation, etc) and the response of the pup itself."

Indeed, case-control studies are mooted for this summer's field season, but as yet this important research has not been done, hence there is no good evidence to inform discussion on the virulence of the strain. What we do know is that the level of mortality from *Klebsiella* has not reached the levels seen in the two epidemic years (even when using the "best estimates"; Table 3). This indicates that *Klebsiella* of the early 2000s killed many more pups, hence without evidence to the contrary, it could be argued that it may have been more virulent than the current "highly virulent" strain.

Another strong statement in the TMP document is that "pup deaths [due to *Klebsiella*] are continuing to occur up until the end of the research observation period **and perhaps beyond**, meaning that the full impact of this infection on the sea lion population may be larger than results from previous studies suggest." That the disease might continue after the research team has left the Auckland Islands is very concerning, but again the best available information does not support this statement.

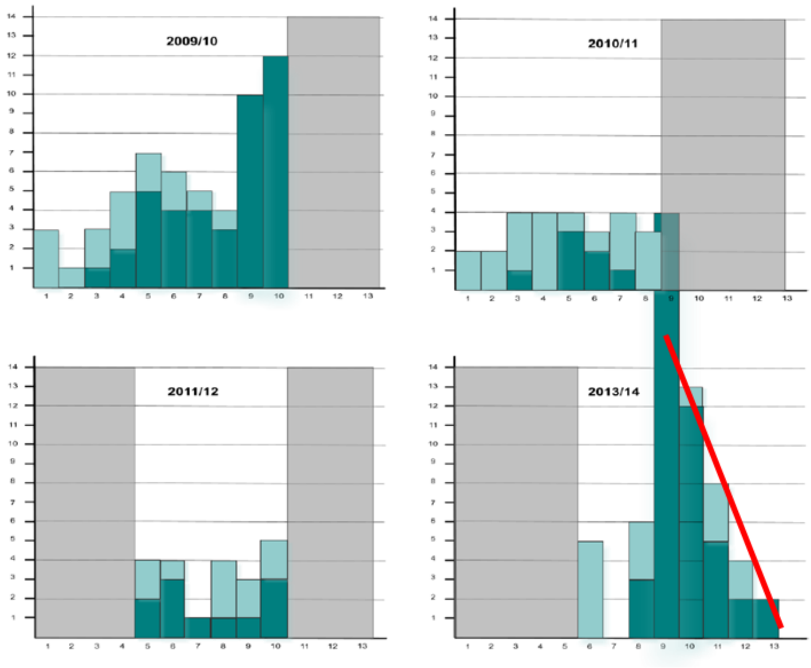

Figure 11 Pup deaths per week due to *K. pneumoniae* (dark green) and pup deaths due to causes other than *K. pneumoniae* (light green bars) for pups born at Sandy Bay, Enderby Island. The grey shading depicts when the research team was present on the island. Figures are taken from Roe et al. (2014). The added red trend-line in 2013/2014 depicts the decline in pup deaths detected.

Figure 11 shows the number of pup deaths attributed to *Klebsiella* and the time in the breeding season. It is true that *Klebsiella* cases appear to be "continuing to occur up until the end of the research observation period". However, there is poor evidence for large numbers of cases beyond the research observation period, as the TMP background document suggests. In fact, what data is available reported in Roe et al. (2014) suggests that the peak of *Klebsiella* infections occurs at c. week 10. The data for the extended research observation period in 2013/14 indicates that the number of cases is sharply dropping off by week 13 when the research team left Enderby Island. [With regards to occurrence of disease in the breeding season, I understand that in the coming season there are no plans to extend the disease monitoring work at the Auckland Islands. Given this, we may never know what is happening in the period when researchers are traditionally not present on the island (i.e. week 10 onwards).]

The TMP background document also leads the reader to believe that *Klebsiella* may have only recently made it to the NZ mainland, as it states "… the highly virulent strain is present on the South Island and was responsible for the death of an Otago-born pup in early 2013". It is of course well known that *Klebsiella* was reported as the cause of death in an adult male sea lion that died at Cannibal Bay, Catlins on the Otago Coastline (Wilkinson et al. 2006; see necropsy report in appendix 6). This has important implications for the origin and spread of the disease, as noted by Wilkinson et al. (2006). In particular, it highlights that males (at least) might act as vectors of *Klebsiella* between breeding colonies, potentially within a breeding season (Robertson et al. 2006 *Biological Conservation*).

It is unknown why this important event was not discussed in the pup mortality workshop in June 2014 or elsewhere in the TMP process or documentation. Indeed, it does not appear to have been raised at either of the expert panel TMP workshops based on the official meeting notes. Unfortunately, omissions such as this call into question the thoroughness of the assessment of threats in the TMP process.

Furthermore, the string of strong statements in the TMP documents, which are not supported by available evidence, suggests that in the face of considerable uncertainty in the knowledge of *Klebsiella*, government has decided that *Klebsiella* disease is the major threat and appear to have produced "best estimates" that support this position. **Consequently, I agree with the expert panel workshop's statement that, based on the available evidence, there is concern that the risk of *Klebsiella* has been overstated in the TMP.**

This of course has important implications for the outputs of the sea lion draft TMP, as it is heavily focused on *Klebsiella*. This disease focus means that disease research is likely to win out in any contests for MPI and DOC's limited research budget for sea lions at the expense of other threats (such as direct or indirect impacts of fishing).

As an aside, as noted above, there also are concerns with the determination of "best estimates" for other threats, like pups drowning in wallows. Based on the "best estimates", in each year there are an average of 48 pups drowned in wallows. This conflicts with the statement in the pup mortality workshop June 2014 notes that says "… **some years no pups fall into holes** because they move into different areas of the swards and forest where holes are not common". Despite this, the threat of deaths by falling in holes is modelled in every year in the TMP modelling (Figure 4).

Direct fishing impacts are dismissed by SLED efficacy assumptions

Contrary to the "best estimates" for *Klebsiella*, where uncertainty about disease has apparently led to a certainty that disease is a major threat, uncertainties with SLED efficacy and post-SLED exist survival of sea lions were ignored and government is certain fishing is not having a direct impact on the sea lion population. In the TMP process, DOC and MPI officials favour the pre-existing assumption that SLEDs function as designed and allow the majority of sea lions to survive a SLED interaction. Consequently, the "best estimate" of the direct impacts of fishing dismissed this threat to sea lions, principally by the use of a questionably-high discount rate for SLED use (see below).

It is worth reiterating two points with regards to the direct effect of fishing on sea lions. First, the triage process found that mitigation of the upper bound values for direct fishing impacts led to a dramatic recovery of the Auckland Islands subpopulation (Figure 10). Second, the *Review of the threats to the recovery of NZ sea lions and other otariid species* (Roberts 2015) concluded that for the threat of fishing mortality, low population size and low productivity play an important role in whether otariid populations can withstand even low frequencies of fishing mortality. Clearly, the New Zealand sea lion has low population size and also displays low productivity, hence it is logical to assume that they will also not be able to cope well with low levels of fishing bycatch (see Meyer et al. 2015 *Marine Biology*). Indeed, only 34 females need to be saved to effect a short-term stabilisation of the population.

> "incidental fishery mortality was identified as one of the main threats to Australian sea lion populations despite low numbers of mortalities, which were found to be sufficient to drive population decline due to low population size and productivity (Goldsworthy & Page 2007). As such, the population threat posed by direct fishery effects will depend on the extent of mortality relative to population size and on other factors that can affect survival and natality, including natural threats." [pg 6, *Review of the threats to the recovery of NZ sea lions and other otariid species* Roberts 2015]

Clearly, then the "removal" of direct fishing effects as a threat on the Auckland Islands subpopulation is a consequence of the "best estimate" values used in the triage process (see Figure 17 in Roberts & Doonan 2016). Like the *Klebsiella* "best estimates" discussed above, there is no supporting information on how the best estimates were derived. I have also asked how these "best estimates" were derived, but my question is also being treated as an Official Information Act request.

For example, comparing Tables 15 (upper bound values) and 17 ("best estimates") in Roberts & Doonan (2016), the upper bound values are referred to as "Commercial trawl – captures", while the "best estimates" have various columns of values for fishing that also includes one labelled "Commercial trawl – captures". The "upper bound" values are higher (and result in an effect of fishing) than the "best estimates", but it is not clear how the "best estimate" values were reduced.

Furthermore, among the "best estimate" values in Table 17, there is a column labelled "Commercial trawl – interactions". The traditional use of "interactions" in sea lion bycatch modelling refers "to the number of sea lion that would have been caught had no SLEDs been used" (Thompson et al. 2013 AEBR105). This value should be higher than the number of captures ("the sum of observed and estimated captures" Thompson et al. 2013 AEBAR 2105), but it is not. Indeed, we should reasonably expect the number of "interactions" to appear as an "upper bound" value in Table 15. The remaining fishing impacts are the interactions reduced by the discount rate of 20%, 35% or the current value of 82%.

The fishing threat values used in the triage process provide to Roberts & Doonan (2016) have clearly been altered, but unfortunately, there is no explanation how these have been produced. As noted above, the expert panel commented that the "best estimate plots for disease will be subject to a high level of scrutiny and the parameters used must be defensible". Given the controversial nature of SLED efficacy, and the government's assertions that fishing impacts have been resolved, it is surprising that a similar level of care was not taken in providing background to the fishing threat triage values.

Why were concerns with SLED efficacy not discussed in the TMP process?

When the Ministers announced the sea lion TMP in the March 2014 press release, Minister Nathan Guy cited the need to "monitor the use and effectiveness of [SLEDs]". Minister Smith also personally told me in correspondence that he "was keen for further work to more accurately determine survival rates" of sea lions interacting with SLEDs. Despite, these clear expectations for government officials and stakeholders to examine SLED efficacy further, it was not discussed in any meaningful way in the TMP process.

MPI's Science Manager Aquatic Environment gave a short presentation to the first expert panel TMP workshop in 2015 entitled "Direct Impacts of Fishing Threat Presentation #2 for the Sea Lion Threat Management Plan First Expert Panel Workshop, 28–31 April 2015." This presentation set out the government's perspective on SLED efficacy, the setting of the discount rate and the post-SLED exit survival of sea lions. According to those observing, this presentation dismissed any concerns raised with SLED efficacy and MPI's Science Manager Aquatic Environment when asked for his free and frank opinion about direct fishing impacts, concluded that these are not an issue. At that point any discussion of concerns with SLED efficacy ceased.

Throughout the TMP process, the government's conclusion that "SLEDs greatly increase the survival probability of sea lions that enter a trawl net" (OIA16-0313 response) and that "approximately 82% of sea lions probably survive their interactions with fishing gear." [TMP background document] has filtered through every step, including the triage process noted above. As such, the existing controversy with SLED function has not been reviewed, just placed to one side in favour of exploring other threats to the sea lion population.

Unfortunately, this treatment of existing concerns with SLED efficacy and post-SLED survival does not adequately reflect the expert concerns and the issues raised by the best available information on SLED function.

An excellent example of why serious scrutiny of SLED efficacy should have been included in the TMP process is the statement by the consultants who undertook the review of mitigation devices entitled *Technical Review: Development and Application of Bycatch Mitigation Devices for Marine Mammals in Mid-Water Trawl Gear* for the Australian Department of the Environment (Baker, B., Hamilton, S., McIntosh, R. and Finley, L. (2014). Technical Review: Development and Application of Bycatch Mitigation Devices for Marine Mammals in Mid-Water Trawl Gear. Report prepared for the Department of the Environment (on behalf of the expert panel) 12 May 2014.).

In this review, the consultants review seven case studies of bycatch mitigation devices, including the use of SLEDs in the squid fishery SQU6T. They make similar statements to MPI and DOC about SLED efficacy in the executive summary of the report, where they state that concerns with post-SLED escape survival, etc have been extensively investigated and are not supported by scientific evidence" when discussing the squid fishery.

> "For one fishery concern has been raised about the efficacy of excluder devices and post-escape survival of pinnipeds. It has been proposed the observed mortalities could be underestimated due to "cryptic" mortality, because some animals may suffer head trauma from impacting the excluder's hard grid that may compromise their post-escape survival, or may drown outside the net after escaping through the SLED, because they run out of breath before they reach the surface. **These assertions have been extensively investigated and are not supported by scientific evidence**." [Pg ix, Baker et al. 2014 DE report; bolding added]

Despite this very strong statement, in the case study discussion of SLED use in SQU6T, the authors make an equally strong, clear contradictory statement that captures exactly the issue with SLED efficacy and cryptic mortality. That is, they state it is clear that despite the research and assessments of SLEDs that the post-SLED survivability of a sea lion has not been demonstrated. Clearly, not enough discussion or research has focussed on the remaining concerns with SLED efficacy and post-SLED exit survival, to the point where a lack of evidence has become evidence for no effect at all:

> Although the **research and assessments of SLEDs have produced some inconclusive outcomes and have not been able to clearly demonstrate the post-SLED survivability of a sea lion**, there is also an absence of evidence to support the hypothesis that sea lions sustain life-threatening injuries when they pass through a SLED (Hamilton and Baker 2014 [*Fisheries Science*]). [pg51, Baker et al. 2014 DE report; bolding added].

The statement above is even more powerful when it is considered that one of the consultants making it was contracted by the New Zealand fishing industry to:

> "provide an independent overview of the available published scientific reports on SLED efficacy." [Open letter to Minister Nathan Guy MPI from George Clement CEO Deepwater Group (DWG)].

That contracted review resulted in a scientific publication in the science journal *Fisheries Research* in 2014 (Hamilton & Baker 2014) and also appears to form the basis of the sea lion SLED case study reported in the Baker et al. 2014 DE report. Note that the review presented in *Fisheries Science* was heavily criticised by Robertson (2015, *Fisheries Science*) in a comment (see also Hamilton & Baker 2015's reply). In the *Fisheries Research* paper, Hamilton & Baker (2014) make another clear statement that assumptions regarding SLED efficacy are based on a lack of evidence, this time to do with SLEDs retaining dead sea lions to be counted by government observers on vessels in SQU6T:

> "It is considered that the risk of sea lions dying in the net and falling out of the escape hole and, therefore, not being included in reported fisheries-related bycatch observations is unlikely (**although there has been no specific work to address this**) due to the SLED configuration…" [Hamilton & Baker 2014; bolding addded]

In an open letter to the Minister Nathan Guy (available as a link on Deepwater Group's website), the CEP of DWG Mr Clement stated that the Hamilton & Baker (2014) review constitutes "further information on the efficacy of SLEDs" and that the review concluded that SLEDs are working as planned. Mr Clement further states that this proves remaining concerns from scientists, such as myself, are incorrect (although he is rather more scathing in his description of scientists that raise concerns with SLED efficacy, suggesting that our actions in critiquing the science information is damaging to New Zealand):

> 27 March, 2014
>
> Dear Minister Guy,
>
> You have asked us for further information on the efficacy of SLEDs.
>
> Deepwater Group Ltd (DWG) represents the quota owners in New Zealand's deepwater fisheries who are committed to ensuring that New Zealand's EEZ fisheries are recognised as the best managed deepwater fisheries in the world. Within this objective, the aspirational goal is to reduce the number of incidental mortalities of New Zealand sea lions to as near to zero as is possible. We are actively engaged with scientists, engineers, fishermen, MPI and DOC to achieve this goal and we are making excellent progress in reducing the number of incidental mortalities.
>
> DWG has contracted Mr Barry Baker of Latitude 42 Environmental Consultants Pty Ltd to provide an independent overview of the available published scientific reports on SLED efficacy.
>
> Mr Baker is a globally recognised expert in bycatch mitigation and has undertaken contracts for DOC and MPI. He is an Appointed Scientific Councillor on bycatch to the Convention for the Conservation of Migratory Species of Wild Animals (CMS); was Chair of the Seabird Bycatch Working Group Agreement on the Conservation of Albatrosses and Petrels (ACAP) from 2005 to 2013; and is the Bycatch Mitigation Mentor for the Southern Seabirds Solutions Trust.
>
> Mr Baker recently reviewed all aspects of the development and implementation of SLEDs in the SQU6T fishery and concluded that:
>
> - SLEDs significantly reduce the risk of mortality of sea lions in trawl nets;

- The efficacy of SLEDs has contributed to reduced rates of observed mortality of sea lions in the fishery in recent years, and that
- **There remains no evidence to support the theory that sea lions sustain life-threatening injuries when interacting with SLEDS**.

DWG is aware there are a very small number of commentators, most of whom have not considered the available scientific information on this matter (or choose to ignore it), making unsubstantiated allegations to the effect that the fishing-induced mortalities and the 'ineffectiveness' of SLEDs are material in the decline of Auckland Islands sea lion population.

The long term economic benefits of our sustainable seafood industry and our excellent reputation as a country recognised worldwide as a producer of high quality sustainable seafood, should not be compromised by misdirected and scientifically unsupported arguments or emotional concerns that the decline of New Zealand sea lions is due to fishing when the scientific facts are clear that they don't.

The best scientific estimate is that the number of deaths of sea lions from the Auckland Island population is less that ~10 adults each year and is declining. Each year an estimated 625 adults over the age of 7 years from this population die of old age or natural mortality. It is clear that the very small number of mortalities seafood industry is not now causing harm to this population.

We urge the Government to urgently place the focus of any enquiry and remedial actions onto the other causes of mortality, particularly those killing large numbers of pups and yearlings, such as disease.

Regards,

George Clement

CEO

Deepwater Group [open letter to Minister Nathan Guy, DWG website: http://deepwatergroup.org/letter-evidence-that-sleds-save-sea-lions/, bolding added]

Clearly, the strong statements of the New Zealand fishing industry are self-interested bluster, but the single fact remains, their chosen expert clearly states that "**research and assessments of SLEDs have produced some inconclusive outcomes and have not been able to clearly demonstrate the post-SLED survivability of a sea lion**".

This lack of information on post-SLED survivability (i.e. cryptic mortality) also caused uncertainty with how best to derive "best estimates" for fishing threats in the second TMP expert panel workshop. Here it was noted:

"It was suggested that a new metric for estimating bycatch be used, potentially employing a cryptic mortality approach as a multiplier on the estimated observable captures. This approach has the advantage of transparency and simplicity. A running mean approach could be taken, using a multiplier on the observable capture rate over a 5-y period, for example. **However, the difficulty with this approach would be developing the methods to estimate the cryptic mortality multiplier**. [Notes of the second expert panel TMP workshop; bolding added]

Given the clear uncertainty with SLED function, an expert panel workshop on SLED efficacy and cryptic mortality should have been run at the start of the TMP process, along the lines of the pup mortality workshop held 3 months after the announcement of the TMP process. This would have allowed the valid existing concerns with SLED efficacy, post-SLED survivability and discount rates used in the SQU6T operational plan to be fully addressed. That SLED efficacy and post-SLED exit survival were not properly addressed in the TMP process raises significant concerns with the conclusion of the draft TMP, especially, the way in which the TMP effectively ignores the direct threats of fishing on the sea lion population.

Here I call for an expert workshop exploring the existing uncertainty in sea lion exclusion device (SLED) efficacy, post-SLED survival and direct fishing impacts, the same as was done for pup mortality in June 2014, to thoroughly review fishing as a threat to sea lions at the Auckland Islands.

Given the unresolved concerns with SLED efficacy, why is the discount rate still 82%?

In 2012, then-Minister of MPI David Carter increased the discount rate for SLED use in SQU6T from 35% to 82%. This was based on "new" evidence for high SLED efficacy that "suitably persuaded" the Minister. In 2013, the expert panel reviewing sea lion modelling and management questioned the use of the current 82% discount rate, suggesting the use of a rate "deliberately low to provide a precautionary approach" [Bradshaw et al. 2013, as noted above]. Despite this, and the ongoing concerns with SLED efficacy noted above and in Robertson (2015, *Fisheries Science*) and raised with government and Ministers (Appendices 1-5), MPI have resisted reviewing the 82% discount rate.

Apparently, the review of the SQU6T operational plan will take place in 2017, but this review will unlikely cover any issues with SLED efficacy given MPI's persistent stance on SLED efficacy.

As noted above, at the first expert panel TMP workshop, MPI's Science Manager Aquatic Environment gave a presentation that contained a slide that purports to show the "correct" discount rate for a trawl with a SLED (Figure 12). It is informative to examine this, because it highlights a number of issues with MPI's assumption of high survivability of sea lions that encounter a trawl net containing a SLED.

As noted above by the fishing industry's hired consultant, "**research and assessments of SLEDs have produced some inconclusive outcomes and have not been able to clearly demonstrate the post-SLED survivability of a sea lion**" [pg51, Baker et al. 2014 DE report], yet MPI persists with the assumption of very high (95%) "probability of surviving once free" (Figure 12). As indicated by the colours in Figure 12, this 95% probability of surviving once free of a SLED is based on the work on the probability of sea lions sustaining a Mild Traumatic Brain Injury (MTBI) from colliding with a SLED in a net (this is an added mortality risk of impacting the grid of a SLED).

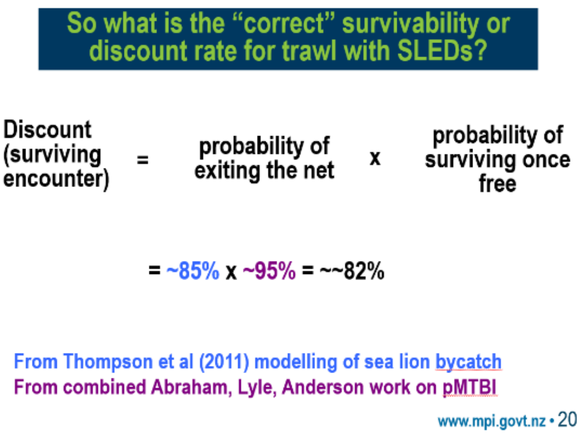

Figure 12 Powerpoint slide outlining the "correct" discount rate for SLEDs taken from MPI's Science Manager Aquatic Environment's presentation on "Direct Impacts of Fishing Threat Presentation #2 for the Sea Lion Threat Management Plan" First Expert Panel Workshop, 28–31 April 2015.

The 2013 expert panel noted that the MTBI work was only relevant to a part of the disagreement about post-SLED survival and that how many sea lions drown before reaching the surface is much harder to address. Further they noted that any views on how much cryptic mortality occurs is **unsubstantiated opinion**.

> "The substantial decline in the numbers of carcasses recovered from trawls (Thompson et al. 2013) suggests that many of the animals that enter trawls are now not brought on board. **There are ongoing disagreements about their fates, and these feed discussions about the real rate of bycatch affecting the NZSL population. The data on mild traumatic brain injury (MTBI, discussed in more detail below) is only relevant to part of this problem.** It is much harder to estimate how many other animals simply run out of air and drown outside the net as a result of the time they are detained within nets but were not recovered."…
>
> "…**in the absence of data, views on how much cryptic mortality actually occurs are simply unsubstantiated opinions**. An extra term or uncertainty could be added to the model to represent this, but it would be essentially arbitrary, and provide an additional opportunity for the subjective modification of results to fit preconceptions or political motives." [pg 17, Bradshaw et al. 2013; bolding added]

Given the clear expert opinion (remembering that independent expert panels are the pinnacle of MPI's science review process, see *Research and Science Information Standard for New Zealand Fisheries*, April 2011), it appears that the 95% "probability of surviving once free" used in determining the "correct" discount rate is "unsubstantiated opinion" of government officials. Clearly it is also at odds with Baker et al. (2014) statement that investigators "have not been able to clearly demonstrate the post-SLED survivability of a sea lion" and the statements of the 2013 expert panel (Bradshaw et al. 2013).

It is interesting to explore what happens when the full range of percentages (i.e. "unsubstantiated opinion") are entered into the MPI's Science Manager Aquatic Environment's equation for SLED discount rate (Figure 13). It is clear from this that post-SLED survival and assumptions of cryptic mortality play a significant role in setting the discount rate. For example, if post-SLED survival was assumed to be close to random (50%), then the discount rate should be set at 42.5%, which is only 7.5% above the previous 35% discount rate. If we take a pessimistic view of cryptic mortality and set post-SLED survival at 30%, which would be a precautionary approach to sea lion management, then the discount rate is 25.5%. A more optimistic view of post-SLED survival (i.e. 70%) results in a 59.5% discount rate.

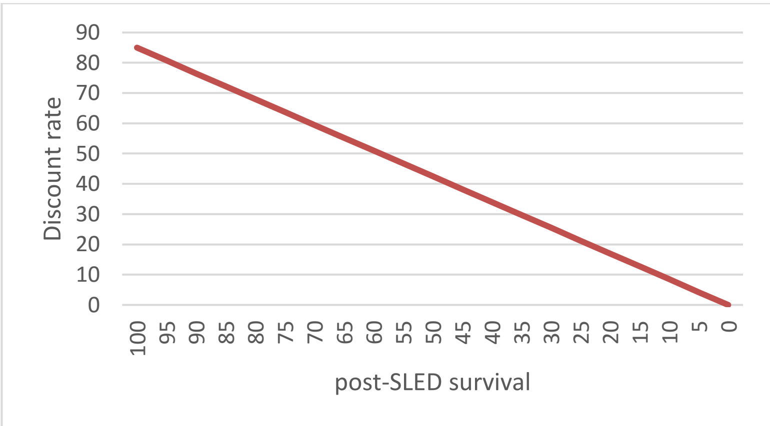

Figure 13 The discount rate calculated using the equation in Figure 12 and an 85% probability of exiting the net and varying the post-SLED survival probability between 100% and 0%. A 100% probability assumes all sea lions survives that gets out of a net, while 0% assumes all sea lions die after exiting the net.

Given the ongoing concerns with cryptic mortality estimation, there is clear need to rewind the apparently optimistic 82% discount rate used in SQU6T current operational plan. This should be done urgently as the effect of setting the discount rate incorrectly is that greater fishing effort is done than should be allowed against the fishing related mortality limit (FRML) (Figure 14).

Indeed, as shown in Figure 14, if the current discount rate is not 82% (i.e. 0.82), but instead 35% (i.e. 0.35), then with only 2000 tows of the allowed fishing effort (4700 tows) under the current operational plan leads to the FRML being exceeded in that fishing season. Normally at this point the Minister can close the fishery. However, sea lion manager would assume that only 21.2 estimated deaths had occurred, as they assume a discount rate of 0.82. If this was a year of high squid abundance fishing would continue potentially resulting in up to 180 estimated sea lion deaths or 2.6 times the allowed FRML of 68 sea lion deaths.

Fishery managers would not allow this level of estimated bycatch to happen if they were tracking the estimated sea lion deaths correctly against the FRML. However, this scenario could easily occur due to the setting of an incorrect discount rate. The end results would be unsustainable direct fishing impacts of SQU6T on the Auckland Islands sea lion subpopulation. Remember that as few as 34 females saved will influence the mature population size (Figure 2; see above).

strike rate (SR, deaths per 100 tows)	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89	5.89
discounted SR	1.06	1.18	1.47	1.77	2.06	2.36	2.65	2.95	3.24	3.53	3.83	4.12	4.42
SLED discount rate	0.82	0.8	0.75	0.7	0.65	0.6	0.55	0.5	0.45	0.4	0.35	0.3	0.25
tows													
Fishing effort in 2013 was 1015	10.8	12.0	14.9	17.9	20.9	23.9	26.9	29.9	32.9	35.9	38.9	41.8	44.8
1500	15.9	17.7	22.1	26.5	30.9	35.3	39.8	44.2	48.6	53.0	57.4	61.8	66.3
2000	21.2	23.6	29.5	35.3	41.2	47.1	53.0	58.9	64.8	70.7	76.6	82.5	88.4
2500	26.5	29.5	36.8	44.2	51.5	58.9	66.3	73.6	81.0	88.4	95.7	103.1	110.4
3000	31.8	35.3	44.2	53.0	61.8	70.7	79.5	88.4	97.2	106.0	114.9	123.7	132.5
3500	37.1	41.2	51.5	61.8	72.2	82.5	92.8	103.1	113.4	123.7	134.0	144.3	154.6
4000	42.4	47.1	58.9	70.7	82.5	94.2	106.0	117.8	129.6	141.4	153.1	164.9	176.7
4500	47.7	53.0	66.3	79.5	92.8	106.0	119.3	132.5	145.8	159.0	172.3	185.5	198.8
4700	49.8	55.4	69.2	83.0	96.9	110.7	124.6	138.4	152.3	166.1	179.9	193.8	207.6

Fishing related morality limit = 68 sea lions

Figure 14 Impact of varying discount rate on the strike rate and the estimated number of sea lion deaths (numbers in the box) for varying levels of fishing effort (up to 4700 tows in the current operation plan for SQU6T). Green denotes number of sea lion deaths that are below the current Fishing Related Mortality Limit (FRML of 68 sea lions), while red indicate the fishing effort (tows) that would exceed the FRML of 68. Discount rates highlighted in yellow are the present (0.82), past (0.35) and a 0.5 discount rate (i.e. 50%). This analysis highlights that optimistic discount rates can result in higher numbers of estimated deaths than expected.

Here I call for an urgent review of the current optimistic discount rate of 82%. Clearly, the best available information for SLED efficacy and post-SLED survival do not support this high discount rate.

Why are concerns with SLED efficacy not recorded in the TMP?

The short answer to this question is MPI runs a strict policy of separating the review of science from the implementation of management actions. This is clearly shown in MPI's Science Manager Aquatic Environment, who is responsible for the process to review science information, suggesting I find a fishery manager to speak to about my concerns that that scientific uncertainties in SLED efficacy raised by the 2013 expert panel looking at sea lion management (Bradshaw et al. 2013) were not being taken up in management.

> "MPI will consider the report and its recommendations case by case. This was a review of the model and associated science, not a review of management. Any changes to the science will be implemented through the normal AEWG and research planning processes which involve all stakeholders. …

> In due course, once we have all had time to digest the review's content, **I suggest you talk with the fishery managers about management.**" [email from MPI's Science Manager Aquatic Environment, 1 October 2013, over 2 months after MPI received the report Bradshaw et al. 2013; bolding added]

As a point of clarification, Bradshaw et al. (2013) did review aspects of the management of sea lions on which the "review of the model and associated science" impacted, as noted in their report's non-technical summary:

> "We also discuss wider issues around the suitability and practicality of meeting the currently agreed management targets for this sea lion population, and question the ministerial role in choosing some technical parameter values that affect the outcomes from the model." [Pg 1, Bradshaw et al. 2013, *Review of models and data underpinning the management of fishing-related mortality of New Zealand sea lions (*Phocarctos hookeri*), in the SQU6T trawl fishery* July 2013]

So apparently once the science information has been through MPI's "peer-review" process (see the *Research and Science Information Standard for New Zealand Fisheries*, April 2011), it is passed to the fishery managers and, of most concern, apparently is out of the hands of MPI's Science Manager Aquatic Environment, who is responsible for overseeing the use of science information in MPI's processes.

This perhaps goes some way to explaining how sea lion management actions, such as the optimistic 82% discount rate, can be put in place when they run counter to the level of uncertainty in the science information. Unfortunately for all involved, the disparity between the scientific uncertainty and the management certainty opens up government officials to the perception of bias, or as noted above by the expert panel (Bradshaw et al 2013) political influence.

MPI's defence of the separation of science and management (e.g. at the second expert panel TMP workshop the panel was reminded by an MPI official that they were reviewing the science and not the management, with another official (DOC) further saying that various government agencies need to have the ability to develop management options since it is their mandate) means that the scientific basis (or even basic logic) of management decisions are not open to scrutiny. This is not acceptable in a process that professes to be based in science.

This alone leads to concerns with management outcomes. However, in the case of management of New Zealand's Deepwater Fisheries, of which SQU6T is one, management decisions are made in consultation with the Deepwater Management Forum away from the involvement of expert scientists. This forum is a collaboration between MPI and the New Zealand fishing industry (developed under a Memorandum of Understanding), as represented by Deepwater Group (DWG) and apparently makes "decisions on non-statutory management measures" that in the past have included "the development and implementation of …sea lion exclusion devices" [pg 6, MOU document, http://www.fish.govt.nz/NR/rdonlyres/2E71D225-5866-4C47-8C72-96FBC7F4B66E/0/MOU2010_signed.pdf]. Note that the CEO of DWG is Mr Clement, who, in his open letter to Minister Nathan Guy, was so critical of scientists who highlighted concerns with existing uncertainties in SLED efficacy.

Clearly, what is required in sea lion management is greater transparency in the decision making process. To achieve this, the separation between science and management needs to be removed, such that scientific experts can reasonably guide management outcomes.

Thank you for the opportunity to submit on the draft sea lion TMP. I hope that my submission will result in a reappraisal of the document and it outcomes leading to some direct action aimed at halting the decline of the New Zealand sea lion.

Yours sincerely

Associate Professor Bruce Robertson

<u>Appendices:</u>

1. Email to Chief Scientist Fisheries MPI
2. Letter to Minister for MPI Nathan Guy outlining SLED efficacy concerns
3. Email to Minister for MPI Nathan Guy and then Minister of Conservation Nick Smith outlining SLED efficacy concerns
4. Letter from Minister Nathan Guy responding to my concerns about SLED efficacy
5. Letter from Minister Nick Smith responding to my concerns about SLED efficacy
6. Necropsy report from Massey University for the adult male found dead from *Klebsiella* at Cannibal Bay, Catlins 30/10/2003