WWF-New Zealand submission:

Squid fishery around the Auckland Islands (SQU6T)
Initial Position Paper

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Purpose

The Ministry of Agriculture and Forestry (the Ministry) is consulting on the Operational Plan for the squid trawl fishery that operates around the Auckland Islands and has produced an initial position paper (IPP).

This document provides WWF-New Zealand’s submission on this IPP.

WWF-New Zealand

WWF-New Zealand (WWF) is part of a global network, using a science-based approach to encourage government, business and communities to conserve and manage our environment more sustainably. WWF’s mission is to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature, by:

- Conserving the world’s biological diversity;
- Ensuring that the use of renewable natural resources is sustainable;
- Promoting the reduction of pollution and wasteful consumption.

Summary of key points

- WWF is very concerned about the ongoing decline in pup production of New Zealand sea lions at the Auckland Islands and the risk of extinction (by 2035) of this species.
- Published papers have shown that the Auckland Islands squid fishery is the most likely cause of this decline – these papers were ignored by the Ministry.
- Through very narrow reductionist and theoretical analysis, the Ministry has concluded that the Auckland Islands squid fishery does not kill sufficient sea lions to affect the population.
- The Ministry proposes to remove the only Government limit on threats facing the sea lions.
- The Ministry’s analysis does not consider:
  - The recently increased threat status of the sea lion.
  - Non-fishing threats to the sea lions, singly or in combination with fishing-related threats.
  - Mortality in other fisheries\(^1\).
  - Indirect effects of fishing, such as competition for food.
  - Mortality of sea lions in the trawl that do not strike the sea lion exclusion device.
  - A reasonable estimate of the proportion of sea lions that drown after they leave the net.
  - A population model that reflects the reality of a declining population.
  - Other methods of catching squid that have low bycatch rates, such as jigging.

\(^1\) This is in the model, but not in the analysis.
Other policy options to effectively and efficiently manage threats to the sea lions.

- WWF calls for:
  - A comparative analysis of the threats facing the sea lions (by the Ministry and the Department of Conservation).
  - Development of a population model that addresses flaws in the current model and considers the effect of food competition and epidemics on pup production.
  - An explicit sea lion mortality limit in the Campbell southern blue whiting fishery.
  - An explicit sea lion mortality limit in the Auckland Islands squid trawl fishery that recognises all forms of cryptic mortality, based on mortality rate of about 6 sea lions per 100 tows.
  - The precautionary allocation of squid and other southern ocean fish stocks that explicitly consider direct and indirect effects of fishing on sea lions.

Background

Biology

The New Zealand sea lion is an important marine mammal. It²:

- Is NZ’s only endemic pinniped;
- Is listed as ‘nationally critical’ under the NZ threat classification system;
- Has the smallest population estimate of any otariid (eared or walking seals³);
- Once ranged along the entire length of the NZ coast, from the north of the North Island through to Stewart Island and the NZ sub-Antarctic Islands; and
- Has a population size that is thought to be reduced significantly from pre-sealing times.

The indicator that concerns WWF most is the decline in pup production since 1998 as indicated in the graph below.

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Clearly, the sea lion is a unique and important creature and is facing a significant decline in key population characteristics. The current rate of decline in the Auckland Island population would result in this population being functionally extinct by 2035\(^5\).

The significant feature of sea lion biology is the overlap between the areas where female sea lions forage and where the squid trawl fishery operates (see figure below):

Fig. 2: Distribution of foraging locations for 26 lactating female sea lions and overlap with squid trawl fisheries effort from the austral summers of 2001 to 2005.\(^6\)

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\(^4\) Taken from the IPP, after DoC.
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WWF is very concerned about the ongoing decline in pup production of New Zealand sea lions at the Auckland Islands and the risk of extinction of this species.

Threats

WWF is seriously concerned about this ongoing decline. What could be causing this? An objective assessment of the risks helps put the effects of fishing activities into context.

DoC produced a species management plan (SMP) for New Zealand sea lions in 2009. The SMP identifies the following threats to the sea lions:

**Human threats**

1. Direct effects of fishing (in particular, trawling)
2. Indirect effects of fishing
3. Human disturbance
4. Climate change
5. Pollution

**Non-human induced threats**

6. Disease
7. Predation
8. Tsunami

The SMP does not include any comparative analysis of the relative risk to sea lions. This analysis can be found in a recently published peer reviewed paper (Robertson and Chilvers, 2011). This paper identifies a similar list of threats:

**Non-anthropogenic factors**

(i) Disease epidemics;
(ii) Predation;
(iii) Permanent dispersal or migration;
(iv) Environmental change;

**Anthropogenic impacts**

(v) Population ‘overshoot’;
(vi) Genetic effects;
(vii) Effects of contaminants;
(viii) Indirect effects of fisheries (i.e. resource competition);
(ix) Direct effects of fisheries (i.e. by-catch deaths).

Robertson and Chilvers (2011) noted:

- While the Auckland Island population has declined, the Campbell Island population appears to be increasing slowly;

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7 Robertson and Chilvers (2011) used the term “epizootic”, which is an epidemic among animal populations.
8 This might occur where decrease in a predator (such as the sea lion) population allows its prey to increase to over-abundance. Once the pressure on the predator population ceases, the recovering predator increases to numbers sufficient to ‘overshoot’ prey availability, resulting in another decline in predator numbers to a smaller, sustainable population size.
9 Small populations and those that have been through severe bottlenecks tend to have reduced genetic diversity. This can lead to reduced fitness or inbreeding depression, which can impact on population growth and persistence over time.
A considerable body of research is available on NZ sea lions that can be used to investigate the cause or causes of their decline.

They analysed the nine possible reasons of the population decline and concluded that:

- Six [reasons] can be discounted (ii–vii).
- Bacterial [epidemics] (i) occur in the NZ sea lion population, but their impact has predominantly increased pup mortality, which is unlikely to cause the severe decline observed, as pup mortality throughout the species is naturally high and variable.
- The most plausible hypotheses, ... are that the observed decline, in particular, the decreasing number of breeding females in the Auckland Island population, is caused by:
  - (viii) fisheries-induced resource competition, and
  - (ix) fisheries-related by-catch.

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- Recent published studies conclude that direct and indirect impacts of fishing are the most likely cause of decline of the sea lion population.
- These papers are ignored by the Ministry.

**The IPP**

The IPP takes a very narrow perspective and as a result its conclusions are flawed. It notes:

> Although the long-term decline in pup counts remains a concern, the most recent research ... demonstrates that fishing is very unlikely to be having a direct effect on the sea lion population that could be considered adverse.

The paper also notes:

> Squid continues to be one of the main export earners for the seafood industry.

**No comparative risk assessment**

The IPP focuses solely on fishing related mortality, concluding that this is unlikely to have a direct effect on the sea lion population. While it expresses concern about the decline in pup counts, it does not suggest an alternative reason for this dramatic decline or indicate how fishing related mortality compares to other threats.

Robertson and Chilvers (2011) conclude that:

> The most plausible hypotheses, ... are that the observed decline... is caused by:
  - (viii) fisheries-induced resource competition, and
  - (ix) fisheries-related by-catch.

Surprisingly this paper is not even cited in the IPP and so its conclusions are not rebutted.

A very recent paper used an age-structured model of the NZ sea lion population at the Auckland Islands examine the predicted effects of fisheries mortality and catastrophes...
(bacterial epidemics), both separately and then combined, on population viability over a 100-year period. These models are then compared against empirical field data to determine the actual level of impacts being observed. Model results indicate:

- Although naturally occurring epidemics reduce the growth rate of the population, they do not cause a decline in the Auckland Island population.
- Sustained fisheries bycatch at current estimated levels, particularly considering its potential impact on adult female survival, could result in a population decline and possible functional extinction over the modelled time period.

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The Department of Conservation and the Ministry should cooperate to undertake a robust and comprehensive assessment of all key threats to population viability of the New Zealand sea lion.

**No consideration of interaction between threats**

Even if fishing related mortality is not the single more significant reason for the observed decline (and WWF does not accept this), the narrow analysis in the IPP does not allow an assessment of the interaction of threats. DoC’s NZ sea lion website\(^{10}\) notes:

> There is some suggestion that this level of [mortality] may limit the capacity for population recovery and may even cause population decline.

Robertson and Chilvers (2011) state:

> The NZ sea lion’s lowered reproductive ability will make the Auckland Island population even less resilient to any unusual or anthropogenic increase in mortality in the population.

A simple population viability analysis model\(^5\) found that:

> Bacterial epidemics don’t, in themselves, put the population into decline, but they all reduce the population’s growth rate, reducing the populations ability to sustain any other forms of mortality. If the worst bacterial epidemic (1998) were to occur once every 10 years, the population could not sustain any fishing mortality.

The need to address multiple threats is recognised in the SMP, which states:

> Reducing the vulnerability of the New Zealand sea lion will require an increase in the population size and the species’ breeding distribution. ... To achieve [this], \textit{a suite of management measures} would need to be applied.

The need for a comprehensive management of threats is particularly important given that non-human threats such as disease are not easily managed, and the feasibility of mitigating their impact is typically low to zero.\(^{11}\)

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The IPP considers direct fishing-related mortality of sea lions in isolation from other threats.

\(^{10}\) \url{http://www.doc.govt.nz/conservation/native-animals/marine-mammals/seals/nz-sea-lion/threats/}

\(^{11}\) Robertson and Chilvers (2011).
The comprehensive risk assessment should consider interactions between different threats.

**Focus on the squid fishery**

The IPP restricts its analysis to the mortality of sea lions in the Auckland Islands squid trawl fishery. It does not consider the not insignificant mortality (and possible indirect effects) in the scampi and southern blue whiting fisheries.\(^{12}\)

The number of sea lions estimated to have been captured in key fisheries are listed below\(^{13}\):

- Auckland Islands squid trawl: 13
- Campbell Island southern blue whiting trawl: 25
- Non-squid Auckland Islands trawl: 7
- Stewart Snares shelf trawl: 4
- All trawl: 48

The 13 estimated captures in the Auckland Islands squid trawl fishery compares with 85 estimated “interactions”, which is the number of sea lion that would have been caught if no SLEDs were used. Significantly the 95% confidence interval for the number of interactions is 28 to 191 (with upper confidence level for all interactions being 224), so if the assumption about the non-lethality of most of these interactions is flawed, there are potentially a very large number of sea lions being killed around the Auckland Islands.

In any case, the figures above show that a significant number of sea lions are being killed outside the Auckland Islands squid trawl fishery. The 2009–10 estimate of captures increased primarily because of an increase in estimated captures in the Campbell Island southern blue whiting (SBW) fishery. In the course of the development of the southern blue whiting fisheries chapter of the Deepwater Fisheries Plan, WWF suggested that the:

> SBW Plan is explicitly linked to the management of sea lion mortality in the Auckland Islands squid trawl (SQU6T) fishery, including the estimation and setting of a fishing related mortality limit (FRML).\(^{14}\)

Operational objective 2.2 in the SBW chapter states:

> Ensure that incidental New Zealand sea lion mortalities in the southern blue whiting fishery at the Campbell Islands (SBW6I) do not impact on the long term viability of the sea lion population and captures are minimised through good operational practices.

While WWF supports this objective, we note that the only actions proposed in the Plan relate to “better understanding ... of the nature and extent of sea lion interactions”.

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\(^{12}\) While the model relied on by the IPP includes an assessment of mortality in other fisheries, this analysis is not explicit in the IPP.


\(^{14}\) Email of 17 June 2011.
Recent data suggest that the Campbell Island SBW fishery is being an increasingly important source of sea lion mortality and hence the Fisheries Plan should include appropriate management measures.

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- The IPP focuses on sea lion mortality in the Auckland Island squid trawl fishery and does not explicitly consider mortality in other fisheries.
- As the Campbell Island sea lion population grows and the Auckland Island population declines, the former will become of greater significance.
- Explicit sea lion mortality limits must be included in the management of the Campbell Island southern blue whiting fishery.

Focus on direct effects of fishing

The IPP is clearly focused on the direct mortality associated with the squid fishery. The IPP justifies this through its reference to section 15 of the Fisheries Act, which sets out the Minister of Fisheries’ responsibilities for managing the fishing-related mortality of protected species. This leads to a focus on setting limits on fishing-related mortality as provided by section 15(2) of the Act.

However, the scope of the Fisheries Act is considerably broader than just setting limits on dead sea lions (and other protected species). Section 9 requires that:

All persons exercising or performing functions, duties, or powers under this Act, in relation to the utilisation of fisheries resources or ensuring sustainability, shall take into account the following environmental principles:

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

The Fisheries Act goes on to define “associated or dependent species” as:

Any non-harvested species taken or otherwise affected by the taking of any harvested species.

The IPP is therefore remiss in excluding any consideration of indirect effects of fishing on sea lions.

It is clear that the diet of sea lions includes squid and that the foraging range of female sea lions overlaps with the squid fishery:

- Sea lions at the Auckland and Campbell Islands have varied diets containing both fin fish (i.e. rattails, hoki and red cod) and cephalopods (squid and octopus).
- Female NZ sea lions forage over the entire Auckland Island shelf and are restricted in their area and duration of foraging by their need to return to dependent pups ashore.  

During years of low arrow squid recruitment, the amount of squid estimated to be required by the sea lion population as a component of their diet would have been similar to the amount harvested by the fishery. Robertson and Chilvers (2011) conclude that resource

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competition between the arrow squid fishery and sea lions is likely to occur, particularly when squid abundance is low.

How might this competition be manifested?

- The pup growth rate of NZ sea lions is lower than for other sea lions;
- The mean milk lipid (fat) content is the lowest reported for any otariid species;
- This may be due to competition for prey with fisheries and low energy content of available prey;
- Low reproductive rates and low pup growth, as seen in the Auckland Island sea lion population, have been shown to lead to lower survival and reproductive ability in individuals, and hence affect overall population size and growth.\(^5\)

Consequently, Robertson and Chilvers (2011) conclude:

- Indirect effects of fisheries through resource competition between fisheries and NZ sea lions are likely to occur;
- The extent to which they contribute to the severe decline in the population is undetermined.

Clearly, indirect effects of fishing should have been included in the IPP.

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- The IPP does not consider indirect effects of fishing, contrary to the provisions of the Fisheries Act.
- Studies have shown real and potential resource competition between sea lions and southern New Zealand fisheries.
- The maximum catch of squid should take resource competition into account.

**Focus on observed deaths**

The use of sea lion exclusion devices (SLEDs) potentially allows the direct mortality of sea lions in squid trawls to be reduced significantly. However, as there is the likelihood that at least some sea lions will die before and after exiting the net, the use of SLEDs prevents direct counts of the number of sea lions harmed or killed in the fishery.

Table 1 in the IPP continues the misleading practice in Ministry IPPs to focus on observed mortalities, in spite of the regular publication of reports that provide estimates of mortalities. These figures are highly dependent on observer coverage and understate the actual number of captures. WWF has repeatedly expressed concern about this practice.

The figures presented in this table show significant declines in the number and rate of observed mortalities. The IPP concludes that “improvements to SLED design and use are likely to have contributed to this trend”.

WWF agrees that “captures” have declined, but we suggest that does not necessarily equate with reduced direct mortality. Cryptic mortality, in which mortality does not result in a sea lion being retained by the net is not quantified in the IPP.
A paper by Lyle and Wilcox (2008) examined marine mammal interactions with trawls in the Small Pelagic Fishery (SPF) around Tasmania. This paper represents the most comprehensive assessment of the nature of operational interactions between marine mammals and mid-trawls available, including information on net entry and exit, and potential rates of survival. Its particular focus is on the effectiveness of sea exclusion devices (SEDs), which are broadly similar to the SLEDs deployed in the squid trawl fishery.

The paper notes:

An important observation from the study was that all seal mortalities eventually fell out of the escape exit prior to the net being brought onboard the vessel, suggesting that many would not have been observed without the camera system and hence the scope of the bycatch issue would have been understated, even with a high level of observer coverage.

There are important differences in the design of the escape opening of the SEDs that were subject to most of the analysis in the paper. The top opening configuration was trialled for about a month but owing to operational problems, was replaced with the bottom opening configuration. WWF understands that three passive seals were also lost out of the top escape opening, but it is unclear whether they were dead.

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- While sea lion exclusion devices are likely to reduce sea lion mortality, they also hide true mortality through the subsequent death of sea lions expelled from the trawls.
- Better estimates of true mortality are needed.

**Focus on within-trawl injuries to sea lions**

The IPP suggests that there are two factors that influence how effective SLEDs are at reducing sea lion mortalities:

1. The probability that animals escape from the net via the SLED’s escape hole, and
2. The probability that those animals that do successfully escape subsequently survive.

The IPP focuses on ascertaining the extent and frequency of injuries to sea lions sustained in collisions with the steel grid that excludes the sea lions from the cod end. This was due in part by the mistaken assumption that the lesions observed in frozen sea lions sent for necropsy were associated with damage through striking parts of the SLED. This assumption was shown to be in error.

The Ministry then commissioned some biomechanical modelling to come to the view that:

- Biomechanical modelling suggested that the probability of brain trauma sufficient in itself to cause death because of an impact with a SLED grid is zero;
- This means that animals are very unlikely to sustain any life-threatening injuries during the course of exiting the net via the SLED; and therefore

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The probability that animals have not had a life-threatening trauma after exiting a trawl net via a SLED is 97%.

A report commissioned for the Ministry\textsuperscript{17} examined footage of Australian fur seals interacting in the Australian jack mackerel mid-water trawl fishery. It noted that:

- Half of the mortalities were associated with interactions in which the first interaction did not result in any contact with the SED.

While it is true that a sea lion that suffers head injury is likely to be compromised in its return to the surface, it is also likely that animals that do not contact the SLED grid are impeded in their return to the surface. It is likely that the entry into the trawl net and the need to navigate out of the opening delays at least some animals such that they are unable to return to the surface in time. Such mortalities would be lost without trace.

In their study of seal interactions with SEDs, Lyle and Wilcox (2008)\textsuperscript{16} noted:

- Breath-hold duration is a critical determinant of survival potential. In about half of the recorded interactions, seals were observed within the net for less than 3 minutes, with about 70\% exiting after\textsuperscript{18} 6 minutes. Significantly, the maximum interaction duration for individuals that were judged to have actively exited the net by swimming back out the mouth was about 6 minutes.
- Responsiveness in individuals that were subsequently judged as mortalities ceased after an average of 8.3 minutes, with a maximum of 12.7 minutes.

The mean descent rate for New Zealand fur seals is just under $1.5 \text{ m s}^{-1}$\textsuperscript{19}, and this is likely to be similar for a New Zealand sea lion. Hence, it would take about two minutes to dive to a depth of around 200 m, with additional time required to locate and enter the net and return to the surface. Similar analysis for Australian fur seals diving to just 100 m concluded\textsuperscript{16}:

- For times exceeding about 10 minutes in the net, particularly at fishing depth, the probability of survival, even if the individual was ejected from the net, would decline progressively. This remains a significant uncertainty for any bycatch mitigation strategy, that is to say even if marine mammals can be directed out of the trawl gear, survival is not guaranteed.

All things being equal, a similar critical time for sea lions would be 8 minutes.

New Zealand sea lions dive almost continuously when at sea, and their diving behaviour is at or close to their physiological limits\textsuperscript{20}. This suggests that the sea lions have little room for delay in their feeding dives and the critical interaction time may be much less than 8 minutes, depending on the point during the dive that they enter the trawl net.

How does the IPP address this risk? It states:

\textsuperscript{17} Lyle, J. (2011). Fur seal interactions with SED excluder device. Project SRP2010-03 for the New Zealand Ministry of Fisheries.
\textsuperscript{18} We assume that “after” is in error and that “within” is the appropriate word.
\textsuperscript{19} Harcourt et al. (2002) – cited by Lyle and Wilcox (2008)
The Ministry is not aware of any information that would inform an estimate of the likelihood of post-exit drowning; as such the Ministry has assumed a reduction of the discount rate by 10% for the purpose of a sensitivity analysis.

The “discount rate” refers to the relative survival of sea lions encountering a net with a SLED that would have otherwise drowned in a net without a SLED. The IPP states that 85% of sea lions that enter a trawl net escape from the net. The 10% figure implies that 90% of the sea lions that escape from the net survive. There is no basis for this figure and WWF considers this to be excessively optimistic. Sensitivity analysis should have considered a more pessimistic scenario.

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- The IPP focuses on theoretical biomechanical modelling to “prove” that almost all sea lions that enter SLED equipped trawls are unharmed.
- The IPP should consider evidence that fur seals have drowned in trawls fitted with seal exclusion devices without striking the SED grid.
- The IPP should consider more realistic estimates of the proportion of sea lions that drown after leaving the trawl net.
- In the meantime, the Ministry should assume a mortality rate of about 6 sea lions per 100 tows.

**Reliance on an unsound model**

The IPP notes that a population model has been used since the 2003-04 fishing season to evaluate the performance of harvest control rules against the agreed management criteria to derive a fishing related mortality limit (FRML). The model was first developed in 2000 and is age-structured but not sex-specific, implemented as a Bayesian model in AD Model Builder. It was fitted using several data sets from sea lion population studies, bycatch estimates and fishing effort. The model was modified extensively in 2008 from the 2003 version, and in 2009 was modified again to increase the stochastic noise in survival and pupping rates in projections to address the low pup count seen in 2009.

A review of the model in terms of the population consequences of alternative bycatch control rules found:

- Sensitivity trials show that rule performance is sensitive to the assumed discount rate in projections, with higher discount rates giving more generous results.
  
  If the Ministry assumed discount rate were larger than the survival rate in reality, then a bycatch control rule would perform less well than the simulations indicated, and vice-versa.

- Results were not very sensitive to Ro the estimated rate of annual pup production per mature individual.

  Independent estimates of pupping rate suggest lower values than estimates from this model. The report notes “it remains a substantial concern that current pupping rates may be too low to replace the population”.

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A larger problem is the sensitivity of results to the model’s treatment of density-dependence.

Without density-dependence in the model or with a uniform prior, the population declined in the absence of fishing.

The performances of rules are better with the higher survival and pupping rates that give higher lambda; thus they are sensitive to the arbitrary values that must be used for z (density dependence shape parameter) and the lambda prior (maximum rate of population increase); this is both unavoidable and unfortunate.

WWF is particularly concerned that:

- The 2009 pup production was outside the 90% range of projections made with the 2008 model. This raises the question of whether the operating model had captured the full range of variability in sea lion population dynamics.

- Under rule 0, with no fishing, the population stabilised at a median of 94% of K (the carrying capacity). Where the population is less than K, it should have increased in the absence of fishing, which is clearly contrary to the observed ongoing decline. This suggests that:
  - The model is subject to fatal flaws; and/or
  - Fishing pressure inputs into the model are wrong.

- The model is not sex-specific, assuming a 50–50 sex ratio and that population parameters such as natural mortality are the same for both sexes. However:
  - Bycaught females may have dependent pups ashore and may also be pregnant, so one female death can kill up to three sea lions;
  - 71% of sea lions captured on observed vessels where SLEDs have been used are female;
  - Females 3 years old and over have lower survival estimates than their male counterparts, which is rare among otariids.

The results of a simple population viability analysis model found that:

- Current fishing mortality could result in population decline.

- None of the bacterial epidemics put the population into decline, but they all reduce the population’s growth rate, reducing the population’s ability to sustain any other forms of mortality.

- If the worst bacterial epidemic (1998) were to occur once every 10 years, the population could not sustain any fishing mortality

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The IPP concludes that fishing-related mortality is insignificant, yet the sea lion model used in the IPP predicts increasing population size under zero fishing mortality.

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22 The difference from 100% K is a modelling artefact and was not caused by the background catch.
23 The estimate of 89 is the average estimated number of deaths annually of NZ sea lions in SQU6T (both arrow squid and scampi fisheries) calculated by the Ministry between 1995–1996 and 2009–2010 taking into account the use of SLEDs since 2004.
The model used by the IPP has several other flaws and urgently needs review.

**No consideration of alternative fishing methods**

The IPP restricts its analysis to current squid fishing practices, i.e. trawling and does not consider alternative fishing methods with less impact on the sea lions. Jigging has been shown to have far lower bycatch rates in:

- **The Falkland Islands:**
  Squid jigging operations appear to cause very few incidental mortalities, which is fortunate in view of the large number of jigging vessels operating in the area.\(^{24}\)

- **Southern Australian waters:**
  There was no evidence of negative impacts on seals from vessel operations. The current level of interactions between Australian fur seals and vessels in the southern squid jig fishery appears minor.\(^{25}\)
  No threatened, endangered or protected species interactions have been reported to date. The occurrence of seals in the vicinity of working jig vessels has been raised as a concern in the past. However, observers on board jig vessels in 2002 found no evidence of negative effects on seals from jig fishing.\(^{26}\)

- **In New Zealand waters:**
  Squid jigging vessels off the Otago coast were observed for 100 days in 1998/1999 to determine the impact of the squid-jigging fishery on protected species. No seabirds or marine mammals were seen by observers to be injured or killed as a result of fishing operations even though fur seals fed on squid and fish species in the vicinity of the vessel. No jig-line entanglements were seen as a result of marine mammals feeding from the squid catch or other attendant species.\(^{27}\)

The success of squid jigging is greatly affected by weather; heavy winds and swells in Bass Strait in winter effectively halt the jig fishery.\(^{26}\) This may well be due to the smaller vessels used in the Australian fishery. Squid jigging did occur around the Auckland Islands previously, squid jigging has become less economically viable in New Zealand waters because of changes in the international marketplace since the mid 1990s.\(^{28}\)

WWF suggests that the international marketplace continues to change that there is likely to be a market for higher quality jigged squid than the bulk-caught trawled squid. An economic analysis of jigged squid harvest and sale is clearly needed.

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\(^{28}\) [http://www.seafoodindustry.co.nz/squidfacts](http://www.seafoodindustry.co.nz/squidfacts)
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- The IPP should consider other methods to catch squid, such as jigging, which have been demonstrated to have very low bycatch rates.
- An economic analysis of a squid jig fishery is needed.

**Narrow management response**

A range of policy instruments are available for the management of the impacts of the squid trawl fishery on sea lions:

1. Spatial controls through the extension of marine protected areas
2. Input controls mechanisms under the Fisheries Act including the prohibition of fishing within set areas and/or prohibition of specific fishing methods;
3a. Output controls where the Ministry sets a fishing related mortality limit (FRML) under the Fisheries Act;
3b. Output controls where the Department of Conservation sets maximum allowable levels of fishing related mortality (MALFIRM) through a population management plan (PMP) under the Marine Mammal Protection Act.
4. Spatial management of catch allocations.

Over the last decade the management of the squid fishery’s impacts on sea lions around the Auckland Islands has focused on (3a), closing the fishing season once an upper limit on sea lion deaths is reached (FRML). However, the calculated mortality limit is based on an estimated mortality rate per standard unit of effort (tow) and so is effectively a limit on fishing effort. While this has provided a partial incentive to reduce sea lion captures through the deployment of SLEDs:

- SLEDs hide the true mortality of sea lions in this fishery.
- The industry appears to be circumventing regulation, rather than focus on avoiding sea lion capture, by expanding the standard unit of effort through increasing trawl tow length.

The 2011 IPP goes further in suggesting that a FRML is no longer needed.

Extending spatial protection would not only increase protection for NZ sea lions, but would also enhance the protection of 52 breeding marine bird species (many of which are listed as vulnerable), as well as New Zealand fur seals, southern elephant seals and threatened southern right whales, all of which forage and breed around the Auckland Islands.

Recent bioeconomic analysis has shown that introducing a spatial dimension to the estimated sea lion mortality rate may lead to more efficient behaviour. Both squid and sea lion populations are heterogeneously distributed, and their catchability varies within SQU6T.

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29 Based on a concept in Chilvers (2008).
30 Between 2005 and 2008, the median tow length increased steadily from approximately 4 to 5.8 hours.
A system of zone-dependent strike rates to approximate variations in sea lion catchability may present a feasible policy option.

A simple quantitative model of squid and sea lion population dynamics explored harvesting strategies that minimise sea lion by catch while still maintaining a sustainable squid fishing industry\textsuperscript{32}. It found a temporal management may be a solution, where low fishing effort for the first half of the season followed by a high fishing effort is optimal.

Clearly it is beyond the scope of this submission to identify a specific policy instrument that is more effective and more efficient. However, but it is disappointing that the Ministry’s analysis of policy options has been so narrow over the last several years.

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- The IPP considers only a single policy instrument, i.e. setting a limit on sea lion mortality, then rejects this.
- Mortality limits based on fixed sea lion strike rates have encouraged the industry to increase trawl tow lengths.
- A comparative analysis of different policy options to manage the threat of fishing is urgently needed.

**Conclusions**

- The Auckland Islands population of New Zealand sea lions continues to decline and is threatened with extinction by 2035.
- Published papers have shown that the Auckland Islands squid fishery is the most likely cause of this decline. These papers were ignored in the IPP.
- Through very narrow reductionist and theoretical analysis, the Ministry has concluded that the Auckland Islands squid fishery does not kill sufficient sea lions to affect the population.
- The Ministry proposes to remove the only government limit on threats facing the sea lions.
- The Ministry’s analysis does not consider:
  - The recently increased threat status of the sea lion.
  - Non-fishing threats to the sea lions, singly or in combination with fishing-related threats.
  - Mortality in other fisheries\textsuperscript{33},
  - Indirect effects of fishing, such as competition for food.
  - Mortality of sea lions in the trawl that do not strike the SLED grid.


\textsuperscript{33} This is in the model, but not in the analysis.
- A reasonable estimate of the proportion of sea lions that drown after they leave the net.
- A population model that reflects the reality of a declining population.
- Other methods of catching squid that have low bycatch rates, such as jigging.
- Other policy options to effectively and efficiently manage threats to the sea lions.

**WWF calls for:**

- A comparative analysis of the threats facing the sea lions (by the Ministry and the Department of Conservation).
- Development of a population model that addresses flaws in the current model and considers the effect of food competition and epidemics on pup production.
- An explicit sea lion mortality limit in the Campbell southern blue whiting fishery.
- An explicit sea lion mortality limit in the Auckland Islands squid trawl fishery that recognises all forms of cryptic mortality, based on mortality rate of about 6 sea lions per 100 tows.
- The precautionary allocation of squid and other southern ocean fish stocks that explicitly consider direct and indirect effects of fishing on sea lions.

Thank you for considering the matters raised in this submission.

Sincerely,

Bob Zuur
Marine Advocate, WWF-New Zealand