New Zealand sea lion: Review of options for future research and mitigation for New Zealand sea lion pup mortality

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Introduction

- Follow on discussion from the DOC/MPI pup mortality workshop held at Wellington Zoo on 10 June 2014
- Paper presented to that meeting:
  - Roe W, Roberts J, Childerhouse S (2014) Discussion paper on New Zealand sea lion pup mortality: causes and mitigation. Unpublished paper to Department of Conservation. 6 June 2014. 10 p.[1]
- Aim of this paper is to highlight and summarise issues with a view to generating discussion and positive action about pup mortality:
  - Childerhouse S, Roe W, Roberts J (2014) Discussion paper: Review of options for future research and mitigation for New Zealand sea lion pup mortality. Unpublished paper to Department of Conservation. 22 July 2014. 9 p.[2]

[1] Available at: http://www.doc.govt.nz/Documents/conservation/marine-and-coastal/marine-conservation-services/meetings/sea-lion-pup-mortality-discussion-paper.pdf
2 Available at: http://www.doc.govt.nz/conservation/marine-and-coastal/conservation-services-programme/meetings-and-project-updates/22-july-2014/

Knowledge gaps 1

- The following knowledge gaps were identified in Roe et al. (2014)
- Improving our understanding of Klebsiella – specifically determining if it is endemic to NZSLs and its mechanism for transmission and infection;
- Improved characterisation of pup mortality – this is important through the continuation of standardised autopsies including a review of over the length of the period that monitoring is important to correctly characterise the bulk of mortality;
- Formal investigation into the feasibility of developing treatment for Klebsiella – this would include determining if a vaccine is feasible in both development and practical implementation for wide spread field application;

Knowledge gaps 2

- Detailed modelling of the influence of pup mortality on long-term survival – to investigate the potential benefit of any mitigation options and whether they are likely to be effective with respect to influencing population growth;
- Carefully designed experimental approach to any adaptive management – any interventions that are undertaken need follow strict experimental designs (e.g. control vs. treatments) to ensure that any outcomes (either positive or negative) can be identified and quantified;
- Nutritional stress – understanding the indirect effects of this on pup mortality is critical and the relationship between maternal nutritional status and pup mortality in particular; and
- Reviewing impacts of research – it is important that informed decisions are made about research being undertaken on a nationally critical species and that any impacts are understood and weighed up against potential or expected benefits.

Mortality workshop outcomes 1

- Some of the general agreements included the following
- These outcomes are based on draft minutes of the Workshop and may not necessarily reflect the final agreements
- That during the 2014/15 field season, mitigation action should be taken to address the issue of pups dying in holes;
- Research on Klebsiella should be a priority including aspects such as genotyping, development of PCR test for it, and implementation of a concurrent case control study to better understand it. The case controls study should be run over 2 seasons and should include concurrent elements including worming trials (e.g. Ivomec) and the investigation of effects of tagging studies;
- There is a wealth of existing data and samples already collected and available that has not been fully analysed. It would be useful to undertake analysis of existing material including research prior to the 2014/15 season;

Mortality workshop outcomes 2

- An extended field season should be considered to allow for a complete characterisation of pup mortality later (and also potentially earlier) in the season;
- That there should be an review of potential marking techniques for NZSL pups including an assessment of potential impacts from each methods; and
- That nutritional stress has been identified as a contributing factor to pup mortality and this should be investigated further.

Issue	Item	Research/Mitigation options	Indicative additional resourcing	Indicative cost
Characterising pup mortality	1.1	Research – Enderby Island: There was good support for the continued characterisation of pup mortality during future field seasons. Additional personnel and/or skills would be required (e.g. vet) to undertake autopsies which would ideally be undertaken from the beginning of the breeding season into February or March requiring a longer field season (e.g. 8 weeks extra time)	Salaries	<$20k salaries <$5k field support TOTAL <$25k
	1.2	Research – Campbell Island: This was not specifically mentioned but relates closely to Item 1.1 (i.e. the characterisation of pup mortality during field seasons). The same process as for Enderby but would be quite a different and more expensive operation as teams would be have to in place early on in the breeding season and would require separate transport and salaries. Cost sharing options may be possible with other work programmes on Campbell and with Item 2.2. Likely to be 8 weeks field work for 3 people	Transport; salaries; field support (e.g. food, etc.)	<$50k return charter <$60k salary <$15k field support TOTAL <$125k
	1.3	Research – There was good support for the continued characterisation of pup mortality, specifically a reanalysis of previously collected data at the Workshop. This work would allow for the consistent characterisation of causes of pup mortality over time to investigate any changes and confirm the most significant causes. This could be undertaken at Massey on existing samples.	Lab costs, salaries	<$30k PhD stipend <$100k for lab testing of 10 years archived samples TOTAL <$130k
	1.4	Research - While not specifically mentioned as an outcome of the Wellington workshop, we believe that there is good support for detailed modelling of the influence of pup mortality on long-term survival – to investigate the potential benefit of any mitigation options and whether they are likely to be effective with respect to influencing population growth.	Salaries	<$20k salaries TOTAL <$20k

Issue	Item	Research/Mitigation options	Indicative additional resourcing	Indicative cost
Pups dying in holes	2.1	Mitigation – Enderby & Dundas Island: building ramps for pups to get out of pups. This has been trialled previously at Dundas and has been successful. Options are boardwalks (Dundas) or cutting steps or ramps (Sandy Bay). Would require team to put these in place prior to pups leaving the beach at Sandy Bay and Dundas but could be undertake alongside normal CSP work.	Materials for ramps (e.g. boardwalks, pegs); transport of materials to location	<$5k materials TOTAL <$5k
	2.2	Mitigation – Campbell Island: The same process as for Enderby and Dundas but would be quite a different and more expensive operation as teams would be have to in place prior to or early on in the breeding season (or it could be done during a winter trip) and would require separate transport and salaries. There is probably on a few days work on the Island if just building ramps is undertaken and nothing else. Cost sharing options may be possible with other work programmes on Campbell.	Materials for ramps (e.g. boardwalks, pegs); transport of materials & personnel to location; salaries; field support (e.g. food, etc.)	<$5k materials <$50k return charter <$5k salary <$5k field support TOTAL <$65k
	2.3	Research – Monitoring of the effectiveness of mitigation is important. There are many technical ways that it could be done (e.g. Chip readers or cameras) but probably the best approach is just to undertake regular counts of the number of pups in holes. This is probably the best way to under simply and cheaply monitor.	None	Nil – concurrent with CSP programme

Issue	Item	Research/Mitigation options	Indicative additional resourcing	Indicative cost
Klebsiella infection	3.1	Mitigation – Not really possible at this time given a lack of basic understanding of aetiology but standard practices should continue (e.g. quarantine between sites, equipment cleaned between individuals).	None	Nil – concurrent with CSP programme
	3.2	Research – Undertaking genotyping and development of PCR tests for presence. This will aid in further understanding the bacterium and hopefully lead to future mitigation	Lab costs, salaries	<$50k lab costs <$50k salaries TOTAL <$100k
	3.3	Research – Case Control Study: An experimental study undertaken on pups (and potentially their mothers) to investigate a range of issues including Klebsiella prevalence and aetiology and contributing factors. The study should be run over 2 seasons and could include concurrent elements including worming trials (e.g. Ivomec), the investigation of effects of tagging studies, and nutritional stress. Depending on the exact structure of such a programme, it would likely require additional personnel, skill sets and equipment (e.g. vet, vet sampling equipment, adult capture and handling experience & equipment for this). Extra person would be required for potentially a longer field season than the CSP programme and extra people to the standard CSP field team during that time. There would also be potentially significant cost and time involved in the analysis of samples that the field team bring back.	Will depend on the exact nature of the study but likely to include: extra transport (e.g. extra early and later trips), salaries, field support (e.g. food, etc.), lab and analysis costs, field equipment (e.g. adult capture equipment)	<$5k field equipment <$40k return charter <$20k salary (field) <$10k salary (lab) <$10k field support <$10k lab costs TOTAL <$105k

Issue	Item	Research/Mitigation options	Indicative additional resourcing	Indicative cost
Impacts of marking	4.1	Research – It would be useful to review potential marking methods (e.g. tagging, chipping, branding, photo-ID) including their advantages and disadvantages. This would need to be undertaken once clear aims for an ongoing marking programme were confirmed and stated so the different techniques could be evaluated against them. This should also include an evaluation of minimum sample sizes required to deliver robust outcomes against those (e.g. estimate age specific survival rates with a CV of 0.2)	Salaries	<$10k salaries TOTAL <$10k
	4.2	Research – it would be useful to undertake an evaluation of any impacts of the existing making programme (e.g. tagging, chipping). This could be done by the existing CSP team but would require supplemental skills (e.g. vet) to undertake autopsies. This would ideally form part of the case control study described in Item 3.3 rather than a stand alone project.	Salaries	<$5k salaries TOTAL <$5k
Nutritional stress	5.1	Research - This would ideally form part of the Case Control Study (e.g. Item 3.3) and would allow for the investigation of the effect of adult and pup nutrition on pup morality. Costs as per Item 3.3.	See 3.3	See 3.3
	5.2	Research - There is good support for detailed modelling of the influence of nutritional status on pup mortality. This project would include further modelling of existing data complemented by the addition of specific data collected on this issue from the 2014/15 season (e.g. collected as part of 3.3)	Salaries	<$50k salaries TOTAL <$50k

Issue	Item	Research/Mitigation options	Indicative additional resourcing	Indicative cost
Other issues	6.1	Research & Mitigation - Hookworm treatment: This could be undertaken to following on from the work of Chilvers et al. (2009). This is proposed as part of the Case Control Study outlined in Item 3.3	See 3.3	See 3.3
	6.2	Research – Pup production estimate for Campbell Island: This was not a specific recommendation of the Wellington workshop but would complement the other work possibly proposed at Campbell Island (e.g. building ramps for holes 2.2, investigating pup mortality 1.2). This work would require much the same resourcing as identified into Item 1.2 but two options are available: (a) a single long season with a marking (e.g. tagging) of pups at breeding colonies and resighting of marked and unmarked pups as they disperse from the colonies or (b) two separate trips with an early (January) marking trip and a later (March) resighting trip. It would be useful to explore which is likely to be the more cost effective choice balancing increased salaries for (a) against increased charter costs for (b).	See 2.2	See 2.2 but an additional 1-2 transport trip may be necessary if the trip is split into two parts
	6.3	Research – Age structure of breeding females at Auckland Islands: This was also no a specific recommendation of the Wellington workshop but would complement other work proposed at Enderby and Dundas and the existing CSP programme. Reproductive females could be caught and/or resighted at Sandy and Dundas Island to develop an age structure of females that would be directly comparable with that undertaken in 1999 to 2001. The costs would be similar to Item 3.3 but it would likely require 2 additional personnel to undertake adult female captures and (if Dundas was to be included) regular access to Dundas Island by helicopter or boat. Some additional field equipment would also be required (e.g. anaesthetic machine, anaesthetic) and a vet	See 3.3 plus two additional personnel, 3 additional trips to Dundas Is, field equipment & supplies	See 3.3 plus <$15k salaries <$5k field equipment <$5k field supplies

Recommendations – Auckland Is

- Implement a significantly expanded field season from the 'standard' CSP field programme by extending the field season to three months from mid-December to mid-March;
- Team size of 3 from mid-December to mid-January, 6 from mid-January to mid-February, and 3 from mid-February to mid-March;
- Undertake autopsies of pups through the whole season by an experienced vet;
- Undertake Case Control Study at for pups and mothers from as early in the season to departure. This study would focus on (a) identifying cause of pup mortality and contributing factors, (b) effectiveness of worming treatment (c) impacts of marking and (d) influence of nutrition state on pup morality and reproductive rate;
- Undertaken study if adult female age structure and Sandy Bay (and ideally Dundas as well) to complement the Case Control study; and
- Undertake mitigation of pup mortality in holes by building ramps in appropriate places

- An indicative cost for this full project would be in the order of **$160,000.**

Recommendations – Campbell Is

- Implement a field programme at Campbell Island;
- Two field seasons: one month in January and one month in March with a team size of three (subject to a review of the cost effectiveness of the two options);
- Undertake autopsies and sample collection of dead pups as per the Auckland Islands at the two main colonies and where ever else dead pups are found;
- Undertake a mark-recapture estimate of abundance by marking pups in January and recapturing them in March; and
- Undertake mitigation of pup mortality in holes by building ramps in appropriate places.

- An indicative costs for this full project would be in the order of **$125,000.**

Recommendations – Other

- Undertaking genotyping and development of PCR tests for the presence of Klebsiella;
- Analysis of all existing samples related to pup mortality to develop a definitive and comparable data set;
- Modelling of the influence of pup mortality on long-term population trends and any benefits that may be achieved;
- A review potential marking methods (e.g. tagging, chipping, branding, photo-ID) including their advantages and disadvantages; and
- Modelling of the potential influence of nutritional status on pup mortality, reproductive rate and population growth.

- An indicative cost for each of these projects is in the order of **$5,000 to $40,000 each.**